

Specification Section 02584 Underground Ducts and Utility Structures

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**Sandia
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Laboratories**



U.S. DEPARTMENT OF
ENERGY



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UNDERGROUND DUCTS AND UTILITY STRUCTURES

Change Log

Rev.	By	Date	Type	Change Description	ID
0	EB/VL	4/16/12	Subst	In Section 3.01(B) Execution, specified that burial depth of 36" is for over 600V, and changed SDR to SCO; in Section 3.01(Q) Execution, removed wording to clarify that tracer wire is not needed on the primary side of a transformer.	

CONSTRUCTION STANDARD SPECIFICATION

SECTION 02584

UNDERGROUND DUCTS AND UTILITY STRUCTURES

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PART 1 - GENERAL

1.01 SUMMARY

- A. This Section covers the construction and emplacement of buried duct banks and manholes as site infrastructure. It does not cover the pulling of wire or cables into the finished ductbank or manhole. The following items and accessory materials are addressed:
 - 1. Ducts in direct-buried duct banks.
 - 2. Ducts in concrete-encased duct banks.
 - 3. Manholes and manhole accessories.
- B. Related Sections include the following:
 - 1. Section 01330, *Submittal Procedures*
 - 2. Section 02200, *Earthwork*
 - 3. Section 03300, *Cast-In-Place Concrete*

1.02 REFERENCES

The current editions of the referenced standards are a part of this section.

- A. General
 - 1. ASTM C33 - *Standard Specification for Concrete Aggregates*
- B. Conduit
 - 1. NEMA[®] C80.1 - *Specification for Rigid Steel Conduit, Zinc Coated*
 - 2. UL[®] 1242 and NEMA C80.6 - *Intermediate Metal Conduit*
 - 3. NEMA RN 1 - *Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit*
 - 4. NEMA TC 2 - *Electrical Polyvinyl Chloride (PVC) Tubing and Conduit*
 - 5. ANSI/NEMA FB 1 - *Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable*
 - 6. NEMA TC 3 - *PVC Fittings for Use With Rigid PVC Conduit and Tubing*
- C. Manholes
 - 1. AASHTO - *Standard Specification for Highway Bridges*
 - 2. ANSI/ASTM A153 - *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*

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3. ANSI/ASTM A659 - *Standard Specification for Commercial Steel (CS), Sheet and Strip, Carbon (0.16 Maximum to 0.25 Maximum Percent), Hot-Rolled*
4. ASTM A48 - *Standard Specification for Gray Iron Castings*
5. ASTM A123 - *Standard Specification for Zinc (Hot-Galvanized) Coatings on Iron and Steel Products*

1.03 SUBMITTALS

The Contractor shall submit catalog data as required per SNL Standard Specification Section 01330, *Submittal Procedures*.

PART 2 - PRODUCTS

2.01 GENERAL

All materials shall be new and applicable as listed, labeled, or approved by the Underwriters' Laboratories, Inc. Defective equipment or equipment damaged in the course of installation or test shall be replaced or repaired in an approved manner.

2.02 CONDUIT AND DUCT SYSTEMS - GENERAL

Conduit and duct systems shall be of the type specified in the drawings and shall meet the requirements herein.

- A. Conduits shall be joined in such a way as to prevent solid matter from entering the joints. Joints shall form a continuous smooth interior surface between joining conduit sections so that cable will not be damaged when pulled past the joint.
- B. Conduit installed on bridges, building roofs, or high-temperature areas shall incorporate expansion joints. Metallic conduit on a bridge shall be grounded.
- C. Pull boxes shall be "FL" style box assemblies of Fibrelyte[®] composite materials as manufactured by Christy Concrete products or approved equal, unless otherwise noted on drawings. Material compressive strength shall not be less than 11,000 psi. Covers shall be bolted-down using penta-head bolts, heavy duty to meet AASHTO H20 traffic load and logo as indicated. Boxes shall be stackable for extra depth. Dimensions of pull boxes shall be as specified on drawings.
- D. Communication conduit for fiber optic cable shall have high capacity flexible multiple channel inner duct manufactured by FO-DUCT or as specified on contract drawings. The number of channels shall be specified on the contract drawings.

2.03 METALLIC CONDUIT - GENERAL

All steel conduits, RGS or IMC, in direct contact with the earth shall receive a corrosion protective covering that is mechanically applied in a factory or field plant especially equipped for this purpose, or as herein specified.

2.04 RIGID METAL CONDUIT AND FITTINGS

- A. Rigid steel conduit: ANSI C80.1.

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- B. PVC externally coated conduit: NEMA RN 1; rigid steel conduit with external 20-mil PVC coating and internal galvanized surface.
- C. Fittings and conduit bodies: ANSI/NEMA FB 1; threaded type, material to match conduit.

2.05 INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS

- A. Galvanized steel conduit: UL 1242 and ANSI C80.6.
- B. PVC externally coated conduit: NEMA RN 1; intermediate metal conduit with external 20-mil PVC coating and internal galvanized surface.
- C. Fittings and conduit bodies: ANSI/NEMA FB 1; use fittings and conduit bodies specified above for rigid steel conduit.

2.06 NON-METALLIC CONDUIT - CONCRETE ENCASED

- A. Conduit: NEMA TC 2; Schedule 40 PVC or Schedule 80 PVC as indicated on the drawings.
- B. Fittings and conduit bodies: NEMA TC 3.
- C. The concrete for the duct bank envelope shall conform in quality to all requirements for placing and curing as described in Section 03300. Concrete shall not be emplaced until inspection of the completed ducts is obtained from the SCO.
- D. Soil backfilling of the excavation shall not occur until the concrete has set for 5 hours. Conduit shall be not covered with backfill until the installation approval is obtained from the SCO.
- E. For vertical stub-ups, horizontal bends, and any off-sets greater than 22° in primary electrical and communication underground conduit runs, use PVC-coated rigid steel or IMC factory bends. For electrical conduits, the minimum radius shall be 24 inches for 3 inches and smaller conduit and 36 inches radius for conduit larger than 3 inches, unless noted otherwise on the drawings. For communication conduits, the minimum radius shall be 48 inches for 4-inch conduit and a 60-inch radius for 5-inch conduit, unless noted otherwise on the drawings. Standard radius conduit can be used for secondary electrical conduit if so specified on drawings.

2.07 CORROSION PROTECTION

Non-PVC-coated underground metallic conduit and fittings that are in direct contact with the earth or concrete shall be protected from corrosion. One of the following methods shall be used:

- A. One application, half-lapped, of Minnesota Mining and Manufacturing Company "Scotchwrap" No. 51, Plymouth Rubber Co. "Plywrap 20" or Westape, Inc. 20 mil Pipe Wrap, or equivalent, shall be applied. A "Scotch Coat" No. 101 pipe coating resin treatment, or equivalent, will also be accepted.
 - 1. All elbows or bends shall have the wrap applied after the conduit is bent.
 - 2. Fittings shall have two separate applications of the above, half lapped and extending one tape width onto the adjoining ducts.

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- B. Factory coated PVC on rigid conduit.

2.08 MANHOLES - GENERAL

- A. Manholes can be either precast concrete or cast-in-place as designated on the drawings.
- B. Drainage shall be provided to keep the manholes free of water during construction.

2.09 MANHOLES - PRECAST CONCRETE

- A. Manufacturer shall have documented experience in the manufacture of manholes for a minimum of three years.
- B. Base course material shall be sand, 3 inches minimum compacted 95%.
- C. Precast concrete: Air-entrained, 4,000 psi minimum compressive strength at 28 days.
- D. Reinforcing: AASHTO HS-20; bridge loading.
- E. Manhole Shape: As indicated on drawings.
- F. Inside Dimensions: As indicated on drawings.
- G. Wall Thickness: AASHTO HS-20; bridge loading.
- H. Include 40-inch diameter grooved opening in top section for frame and cover for power manholes and 36-inch diameter grooved opening for communication manholes.
- I. Frame and Cover Sections: 36-inch diameter clear opening for power manholes and 30-inch diameter for communication manholes.
- J. Include one 12-inch drain opening and two 1-inch ground rod openings in base, one each diagonally opposite corners, not less than 6 inches or greater than 12 inches from the wall.
- K. Window for Duct Entry: Unless otherwise specified on drawings, nine 6-inch knockouts in three rows of three on 8.56-inch centers shall be provided on each wall with top row of knockouts not less than two feet below top of manhole. Refer to contract drawings for specific construction details.
- L. Include cable-pulling irons opposite each duct entry.
- M. Include inserts for cable racks on three-foot centers.
- N. Include metal ladder in manhole, steps at 16 inches on center, ladder bolted to manhole neck.
- O. Ram-Nek[®], Kent Seal[™], or approved equal sealants shall be used to seal the joints in the manhole.

2.10 MANHOLES - CONCRETE CAST-IN-PLACE

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- A. All provisions of Parts 2.9 and 2.11 unless specified in this part.
- B. Concrete: 3,000 psi minimum compressive strength at 28 days in conformance with requirements of Section 03300, *Cast-In-Place Concrete*.
- C. Provide reinforcing under the provisions of Section 03300, *Cast-In-Place Concrete*.

2.11 MANHOLE ACCESSORIES

- A. Manhole Frames and Covers: ASTM A48; Class 30B gray cast iron, machine finished with flat bearing surfaces. Covers shall be round and have "Electric" or "Signal" as designated on plans and "SNLA" in permanent lettering.
- B. Sump Covers: ASTM A48; Class 30B gray cast iron.
- C. Pulling Irons: 7/8-inch-diameter steel bar forming a triangle of 9 inches per side when set. Galvanize to ANSI/ASTM A153 for irregular shaped articles. Locate opposite each duct entry.
- D. Cable Rack Inserts: Steel channel insert with minimum load rating of 800 pounds, length to match cable rack channel. Locate 3 feet on center.
- E. Cable Rack Channel: 1-1/2 x 3/4 inch steel channel wall bracket, 48 inch length, with cable rack arm mounting slots on 1-1/2 inch centers.
- F. Cable Racks: ANSI/ASTM A659; steel channel, 1-1/2 x 3/4 x 14 inches with fiberglass reinforced polyester or porcelain cable supports and fastener to match mounting channel.
- G. Manhole Ladder: Cast iron, suitable for manhole shape and construction, and hot-dip galvanized.
- I. Ground Rods: 3/4-inch x 10-foot Copperweld.
- J. Grade Rings: Pre-cast concrete (4000 psi minimum compressive strength at 28 days) with inside diameter equivalent to manhole opening specified in Part 2.9H. The ring shall have circumferential rebar #3 minimum with a trowel finish to provide a true plane within 1/8 inch, as determined with a 5-foot straight edge.

PART 3 - EXECUTION

3.01 CONDUITS - GENERAL

- A. Where underground crossings are known, field verify horizontal and vertical locations prior to excavation and placement of conduit. Notify the Sandia Construction Observer (SCO) of any deviations to the drawings. Any profile changes and existing utility line crossings are to be as built on drawings showing: type of line, size, and depth below the surface.
- B. For systems over 600V, install at 36-inch minimum depth of burial to top of electrical duct bank (top of concrete to finished grade). If site conditions do not permit this depth of burial, contact the SCO for instructions.

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- C. Spacers shall be used where more than one duct is installed and shall be the standard product of the duct manufacturer for the type and size duct. They shall be located at 5-foot intervals, secured to the ducts with #16 gage iron wire. The spacers shall be securely anchored every ten (10) feet to the bottom of the trench to prevent ducts from floating during concrete pouring. Unless otherwise noted on drawings, 40-inch conduit shall have an approximately 7.5-inch spacing center-to-center, both horizontally and vertically; 5-inch conduit shall have an approximate 8.56-inch spacing center-to-center.
- D. Preparation and placing of concrete shall be in accordance with provisions of Section 03300, *Cast-In-Place Concrete*. Concrete mix design shall be a minimum of 2500 psi with ¾-inch aggregate and 6-inch slump. Care shall be taken in the placement to prevent voids around the ducts. The top of the concrete encasement shall be a smooth finish accomplished by mechanical vibrator or spading the surface.
- E. Terminate conduits in an end bell at manhole and building foundation penetrations. Stub-ups of rigid or IMC duct in equipment pads shall have insulated grounding bushings.
- F. Conduit and duct runs shall be short, straight runs between points of the system.
- G. Duct runs shall be graded to drain toward one or both terminal points of the duct run. The slope shall not be less than 2 inches for every 100 feet of length, unless otherwise shown on contract drawings.
- H. Conduits and duct runs shall be installed on compacted soil when entering a manhole, building foundation, crossing a road, railroad track, or bridge abutment to prevent shear stress on the conduit.
- I. All paving and concrete cuts shall be made with a concrete saw. All surfaces and structures to be replaced shall match existing.
- J. Conduit penetrations into buildings, or through above-ground foundations, shall be sealed with duct seal or conduit sealer to prevent gas or water entry.
- K. Trenching and backfilling shall be in accordance with Section 02200, *Earthwork*.
- L. Empty ducts running between manholes shall have a ¼-inch polypropylene pull rope provided in each duct, with 2 feet of slack at each end, and with the ends secured to a suitable structure (not a conductor) inside each manhole.
- M. Conduit stub-outs other than in manholes shall be RGS or IMC and not encased in concrete for future accessibility. A threaded PVC cap shall be installed on each stub-out to prevent moisture or debris from entering the duct system, except for stub-outs inside panels or switchgear. A ¼-inch polypropylene pull rope shall be provided in each duct, with at least 2 feet of slack at each end. The ends of the rope shall be secured to a ¼-20 eye-bolt securely attached through the PVC cap.
- M. Empty ducts not running between two manholes (i.e., between switchgear and a manhole, or switchgear and a transformer, etc.) shall be labeled at both ends with a Panduit® Marker Plate (Model # MP350-C). The label shall be marked with a Sharpie® permanent ink pen and secured to the pull rope on the inside of the duct so as to indicate destination of the duct.

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- N. When multiple channel inner ducts (FO-DUCT) are pulled through conduit, secure every 10-foot section so as to prevent rolling of channels within conduit. Leave one-foot ends protruding from face of manhole.
- O. Conduit or duct banks shall maintain 1 foot vertical and 1 foot horizontal separation from other utility lines where possible.
- P. A warning tape shall be installed one foot above duct. The warning tape shall be of inert plastic film 4 mils thick specifically formulated for prolonged use underground, resistant to alkalis and acids found in soil. It shall have a tensile strength of 30 pounds per 3-inch-wide strip. The tape shall bear a continuous printed message repeated every 36 inches. The tape shall be Terra Tape Standard 250 manufactured by Reef Industries, Inc., or approved equal. The tape shall be colored in accordance with American Public Works Association[®] (APWA) recommended color code for marking buried lines of all types. Current recommended colors are Red for power lines and Orange for telephone/signal.
- Q. Install by direct burial a tracer wire one foot above and centered across the conduit or duct. This may be coincident with the warning tape specified herein. Use #10AWG stranded copper wire with red RHW insulation, with no breaks along its length. Bring the tracer wire 12 inches above grade adjacent to the point of stub-out through a ½-inch PVC sleeve, and secure to the stub-out at an accessible location. If the stub-out is to rise inside switchgear or other enclosure which cannot be opened safely while energized, bring the tracer wire outside the equipment footprint and secure it there. For pad-mount transformers, bring the secondary conduit tracer wires up into the secondary compartment. Label the tracer wire as to its function, the ductbank or conduit run it follows, and the location of the far terminus. Cap the ends with a Wirenut[®] or similar protective cover. Insure the tracer wire is not grounded at any point.
- R. Where above-grade marking of underground utilities is indicated on drawings, the marking shall be in accordance with Standard Drawing WU5006STD, *Utility Markers for Buried Pipe and Cable*.
- S. Duct bank crossing streets with less than 2'-6" of earth cover shall be reinforced with four #4 rebar equally spaced at the bottom of the duct bank.
- T. A 4/0 stranded bare copper ground wire shall be installed in the bottom of the duct bank and between manholes. The 4/0 ground is to be connected to the 4/0 ground bus in the manhole with an exothermic connection or approved UL mechanical connector.
- V. For concrete encased conduits, provide minimum 3-inch concrete cover at bottom, 4-inch at top, and minimum of 4 to a maximum of 6-inch cover at sides of conduit or ductbank.
- W. Swab the duct at completion of construction. A mandrel ¼-inch - 3/8-inch smaller than the conduit shall be pulled through each conduit. A circular wire brush the same diameter of the conduit shall be pulled through the conduit. After cleaning, install caps as herein specified, to protect against the entry of dirt or moisture.

3.02 MANHOLES - PRECAST CONCRETE

- A. Excavate, install base material, and compact base material. Compact to 95% density or as required by manufacturer.

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- B. Install, seal, and waterproof precast sections in accordance with manufacturer's instructions.
- C. Use precast grade ring sections to bring manhole entrance to proper elevation.
- D. Install manholes plumb.
- E. Set the top of each manhole to finished elevation.

3.03 MANHOLES - CAST-IN-PLACE CONCRETE

- A. Form cast-in-place manholes, inside and outside surfaces, in accordance with provisions of Section 03300, *Cast-In-Place Concrete*.
- B. Manhole Shape: As indicated on drawings.
- C. Inside Dimensions: As indicated on drawings.
- D. Wall Thickness: As indicated on drawings.
- E. Form window for duct entry as indicated on drawings.
- F. Include 12-inch drain opening and two 1-inch ground rod openings in base section.
- G. Cast cable-pulling irons in place opposite each duct entry window.
- H. Cast inserts for cable racks in place at 3-foot centers.

3.04 MANHOLE ACCESSORIES

- A. Where manhole drainage is into sewers, suitable traps shall be provided to prevent entrance of sewer gas into manholes and duct systems.
- B. Install 2 ground rods with top protruding 4 inches above manhole floor. Connect ground rods with 4/0 bare copper run around perimeter of inside manhole at floor. Copper conductor connection to ground rod to be exothermic, or UL-listed mechanical connection.
- C. Attach cable racks to inserts after manhole construction is complete.

3.05 MANHOLE AND PULL BOX CONCRETE COLLARS

- A. Install a 1-foot-wide concrete (3,000 psi, 3/4-inch aggregate) collar around the manhole or pull box cover, unless noted otherwise on drawings.
- B. As a minimum the height of the concrete collar should go from the top of the manhole or pull box cover to eight inches below grade.
- C. The top of the concrete collar shall slope down away from the cover so that no water will accumulate around the cover.

- END OF SECTION -

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