





References not used in the text will automatically  
be deleted from this section of the project  
specification when you choose to reconcile  
references in the publish print process.

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The publications listed below form a part of this specification to the  
extent referenced. The publications are referred to within the text by the  
basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A 1011/A 1011M (2004a) Standard Specification for Steel,  
Sheet, and Strip, Hot-Rolled, Carbon,  
Structural, High-Strength Low-Alloy and  
High-Strength Low-Alloy with Improved  
Formability

ASTM A 123/A 123M (2002) Standard Specification for Zinc  
(Hot-Dip Galvanized) Coatings on Iron and  
Steel Products

ASTM A 153/A 153M (2005) Standard Specification for Zinc  
Coating (Hot-Dip) on Iron and Steel  
Hardware

ASTM A 48/A 48M (2003) Standard Specification for Gray  
Iron Castings

ASTM F 512 (1995; R 2001e1) Standard Specification  
for Smooth-Wall Poly (Vinyl Chloride)  
(PVC) Conduit and Fittings for Underground  
Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2005) National Electrical Code 2005  
Edition

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-V-51 (Rev F) Varnish: Asphalt

UNDERWRITERS LABORATORIES (UL)

UL 6 (2003) UL Standard for Safety for  
Electrical Rigid Metal Conduit-Steel

1.2 GENERAL REQUIREMENTS

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NOTE: If Section 16003S GENERAL ELECTRICAL  
PROVISIONS is not included in the project  
specification, applicable requirements therefrom  
should be inserted and the following paragraph  
deleted.

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Section 16003S GENERAL ELECTRICAL PROVISIONS applies to work specified in

this section.

### 1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

Fabrication Drawings shall be submitted for the following by the Contractor in accordance with paragraph entitled, "Drawings," of this section.

Conduit and Fittings  
Separators  
Markers  
Grounding Conductor  
Manholes

Installation drawings shall be submitted for Underground Duct Systems and Manholes in accordance with the paragraph entitled,

"Installation," of this section.

#### SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Conduit and Fittings  
Separators  
Markers  
Grounding Conductor  
Manholes

Additional data for the following accessories shall be submitted for the following items:

Manhole Frames and Covers  
Sump Cover  
Pulling Irons  
Cable Supports

Material, Equipment, and Fixture Lists shall be submitted in accordance with paragraph entitled, "Underground Duct Systems and Manholes," of this section.

#### SD-06 Test Reports

Test Reports shall be submitted in accordance with paragraph entitled, "Reports," of this section.

#### SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted in accordance with paragraph entitled, "Underground Duct Systems and Manholes," of this section.

### 1.4 DRAWINGS

Fabrication Drawings shall be submitted for Conduit and Fittings, Separators, Markers, Grounding Conductor and Manholes consisting of fabrication and assembly details to be performed in the factory.

### 1.5 UNDERGROUND DUCT SYSTEMS AND MANHOLES

Material, Equipment, and Fixture Lists shall be submitted including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

Manufacturer's Instructions shall be submitted for the Underground Duct Systems and Manholes including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

## PART 2 PRODUCTS

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NOTE: Revise as necessary to meet project  
requirements.  
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## 2.1 CONDUIT AND FITTINGS

[Conduit and fittings in duct banks shall be rigid unplasticized polyvinylchloride and shall conform to ASTM F 512, (heavy-wall, Schedule 40, polyvinylchloride designed for underground and in walls when encased in concrete).]

[Conduit and fittings in duct banks shall be rigid galvanized steel and shall conform to UL 6.]

Aluminum conduit shall not be permitted.

## 2.2 SEPARATORS

Separators or spacing blocks shall be made of concrete, plastic, or other suitable nonmetallic nondecaying material.

## 2.3 MARKERS

Markers shall be made of 17,000 kilopascal 2,500-pound per square inch (psi) concrete 150 millimeter 6 inches square or round section by 1220 millimeter 4 feet, minimum (minimum 920 millimeter 3-feet above grade and a minimum 3010 millimeter 1-foot below grade). Top edges of the marker shall have a 153 millimeter 1/2-inch chamfer all around.

## 2.4 GROUNDING CONDUCTOR

A grounding conductor shall be installed above the concrete encasement of the duct banks and shall be no smaller than a 8.25 millimeter diameter (AWG No. 1/0) AWG No. 1/0 stranded bare copper conductor.

## 2.5 MANHOLES

Manholes shall be of the types indicated and shall be constructed in accordance with applicable details as indicated. Concrete shall be 17,000 kilopascal 2,500 psi at 28 calendar days.

Precast concrete manholes having the required strength and inside dimensions may be utilized upon approval by the Contracting Officer.

### 2.5.1 Manhole Frames and Covers

Manhole frames and covers shall be as indicated and shall be gray cast iron with machine finished or nonrocking bearing surfaces in accordance with ASTM A 48/A 48M, Class 30B Gray Iron Castings.

### 2.5.2 Sump Cover

Sump covers shall be as indicated. Covers shall be gray cast iron conforming to ASTM A 48/A 48M, Class 30B Gray Iron Castings.

### 2.5.3 Pulling Irons

Pulling irons shall be 22 millimeter 7/8-inch diameter galvanized-steel bar with an exposed triangular-shaped opening, when set, 230 millimeter 9 inches on each side. Steel bars shall be merchant quality. Galvanizing shall conform to ASTM A 153/A 153M.

#### 2.5.4 Cable Supports

Cable racks shall be heavy duty, hot-dip galvanized T-section steel, 65 by 57 millimeter by 64 millimeter 2-1/2 by 2-1/4 inches by 1/4 inch in size and punched with 14 holes, 40 millimeter 1-1/2-inches on center for attaching cable hooks. Racks shall be hot-rolled merchant-quality steel-bar-size tees. Galvanizing shall conform to ASTM A 123/A 123M.

Cable hooks shall be 5 millimeter 3/16-inch hot-galvanized sheet steel pressed to channel shape. Hooks shall be 65 millimeter 2-1/2-inches wide and 360 millimeter 14-inches long and shall be vertically pinned to the cable racks. Hooks shall be hot-rolled commercial-quality sheet steel conforming to ASTM A 1011/A 1011M. Galvanizing shall conform to ASTM A 123/A 123M.

Insulators for cable support shall be high-glazed wet-process porcelain.

#### 2.6 REPORTS

Test Reports for 17,000 kilopascal 2500-psi concrete shall be submitted to the Contracting Officer.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

##### 3.1.1 Duct Banks

Duct banks shall consist of single or multiple conduit assemblies encased in concrete and installed with top of duct or duct bank not less than 800 millimeter 30 inches below established grade. Duct bank assemblies shall conform to the requirements indicated.

Conduit shall be thoroughly cleaned before using or installing. During construction and after the duct line is completed, the ends of the conduit shall be plugged to prevent water from washing mud into the conduit or manholes. Conduit shall be kept clean and free of concrete, dirt, and any other foreign substance during construction. All conduit runs should be installed so they will drain throughout the run (cable are safe in dry conduits).

Duct lines shall be laid to a minimum grade of 100 millimeter per 30 meter 4 inches per 100 feet. Grade may be from one manhole to the next or both ways from a high point between manholes, depending on the contour of the finished grade.

Duct banks installed under or adjacent to roads or shoulders of roads shall be encased in reinforced concrete. Duct lines shall be installed so that the top of the concrete in encased ductlines is not less than 460 millimeter 18 inches, or so that the duct in nonencased ductlines is not less than 600 millimeter 24-inches below finished grade or finished paving at any point, except at railroad crossings. At railroad crossings, ductlines shall be encased with reinforced concrete. Top of the concrete shall be not less than 1220 millimeter 4 feet below the base of the rail.

All polyvinylchloride conduits in ductbanks between the last manhole and the tunnel shall be pneumatically pressure tested at 34 kilopascal 5 psi for five minutes with a maximum 3.0 kilopascal 0.5 psi pressure drop. Test to be accomplished prior to concrete encasement. Test results to be

submitted and approved by the Contracting Officer's Technical Representative prior to concrete encasement.

Changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long-sweep bends having a minimum radius of 7500 meter 25 feet, except that manufactured bends may be used at ends of short runs of 30 meter 100 feet or less and then only at or close to the end of the run. Long-sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 450 millimeter 18 inches for use with ducts of less than 75 millimeter 3 inches in diameter and a minimum radius of 920 millimeter 36 inches for ducts of 75 millimeter 3 inches in diameter and larger.

Conduit shall terminate in end bells where duct lines enter manholes.

After the duct line has been completed, a standard flexible mandrel not less than 300 millimeter 12-inches long, with a diameter approximately 6 millimeter 1/4 inch less than the inside diameter of the conduit, shall be pulled through each conduit, after which a brush with stiff bristles shall be pulled through each conduit to make certain that no particles of earth, sand, or gravel have been left in the line.

Pneumatic rodding may be used to draw in the lead wire.

Where connection is made to an existing duct that is of a different material and shape from the duct line being installed, a suitable coupling of a type recommended by the duct manufacturer shall be used.

Conduit joints in concrete encasement may be placed side by side horizontally but shall be staggered at least 150 millimeter 6 inches vertically.

Separators shall be placed not greater than 1200 millimeter 4 feet on center. Ducts shall be securely anchored to prevent movement during the placement of concrete. At least 75 millimeter 3 inches of concrete shall be provided at bottom, top, and sides, except that concrete shall be at least 150 millimeter 6 inches at railroad crossings.

Both concrete bed and cover under railroad tracks, across ditches, or under paving shall be reinforced with two 15 millimeter diameter (No. 4) No. 4 reinforcing bars. Each single conduit of the duct bank shall be completely encased in concrete. Specified thickness of concrete encasement is minimum and may be increased to fit the actual shape of the trench.

Conduit joints shall be made up in accordance with the manufacturer's recommendations for the particular conduit and coupling selected.

A grounding conductor shall be installed above the concrete encasement. Grounding conductor shall extend along all electrical duct banks including stubs through each electrical distribution system manhole and to each transformer and switching-station installation.

### 3.1.2 Markers

Duct bank markers, where required, shall be located at the ends of duct banks except at manholes or handholes at approximately every 60 meter 200 feet along the duct run and at each change in direction of the duct run. Markers shall be placed 600 millimeter 2 feet to the right of the duct



bank, facing the longitudinal axis of the run in the direction of the electrical load.

The letter "D" with two arrows shall be impressed or cast on top of the marker. One arrow shall be located below the letter and shall point toward the ducts. Second arrow shall be located adjacent to the letter and shall point in a direction parallel to the ducts. The letter and the arrow adjacent to it shall each be approximately 75 millimeter 3-inches long. The arrow under the letter shall be 50 millimeter 2-inches long. The letter and arrows shall be V-shaped, and shall have a width of stroke at least 6 millimeter 1/4 inch at the top and a depth of 6 millimeter. 1/4 inch.

In paved areas, the top of the duct markers shall be flush with the finished surface of the paving.

Where the duct bank changes direction, the arrow located adjacent to the letter shall be cast or impressed with an angle in the arrow the same as the angular change of the duct bank.

### 3.1.3 Manholes

Exact location of each manhole shall be determined after careful consideration has been given to the location of other utilities, grading, and paving. Location of each manhole shall be approved by the Contracting Officer before construction of the manhole is started.

Frame and cover shall be delivered on the job unpainted and, after inspection and approval, shall be given 2 coats of asphalt varnish conforming to FS TT-V-51. Frames shall be securely fastened to manholes with 20 millimeter 3/4-inch anchor bolts.

When a manhole sump is required, as indicated, a cast-metal grille sump frame and cover shall be installed over the sump.

In paved areas, the top of manhole covers shall be flush with the finished surface of the paving. In unpaved areas, the top of manhole covers shall be approximately 15 millimeter 1/2-inch above the finished grade and 150 millimeter 6 inches above unfinished grade.

Where existing grades are encountered that are higher than indicated finished grades, a sufficient number of courses of brick shall be temporarily installed between the top of the manhole and the manhole frame to elevate the manhole cover to the existing grade level.

Where duct lines enter manholes, the sections of duct either may be cast in the concrete or may enter the manhole through a square or rectangular opening of suitable dimensions provided in the manhole walls. Where openings are provided for the entrance of duct lines, the space between ducts and between ducts and manhole walls shall be calked tight with lead wool or an approved equivalent.

Cables shall be supported on walls by hot-dip galvanized steel cable racks equipped with adjustable hooks and insulators. Cable racks shall be installed in each manhole with not less than two spare hooks shall be installed on each cable rack. Insulators shall not be required on spare hooks.

A pulling iron shall be installed in the wall opposite each duct line

entrance into the manhole.

In each electrical manhole, at a convenient point close to the wall, a ground rod minimum 3 meter 10 feet long, shall be driven into the earth before the floor is poured so that approximately 200 millimeter 8 inches of the ground rod will extend above the manhole floor.

When precast concrete manholes are used, the top of the ground rod may be below the floor and the ground conductor brought into the manhole by means of a 11.7 millimeter diameter (No. 4/0 AWG) No. 4/0 AWG cable through a watertight sleeve in the manhole wall or floor.

Grounding and bonding shall meet the requirements of NFPA 70.

-- End of Section --