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USACE / NAVFAC / AFCESA **UFGS-16302N (February 2003)**

Preparing Activity: NAVFAC **Superseding UFGS-16302N (September 1999)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 23 June 2005

Latest change indicated by CHG tags.
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DIVISION 16 - ELECTRICAL

SECTION 16302N

UNDERGROUND TRANSMISSION AND DISTRIBUTION

02/03

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SECTION 16302N

UNDERGROUND TRANSMISSION AND DISTRIBUTION
02/03

****
NOTE: This guide specification covers the requirements for underground electrical work.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.
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NOTE: This guide specification does not cover all possible methods or requirements for providing underground facilities. To do so would be to produce an involved, confusing document. This guide specification presents the usual methods and the most used alternatives. Different materials and methods, properly specified, indicated, and economically used will be acceptable when approved by cognizant authority. For electrical manholes, handhole and accessories, refer to Section 02582 ELECTRICAL MANHOLE AND HANDHOLE.
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NOTE: TO DOWNLOAD UFGS GRAPHICS

Go to http://www.ccb.org/docs/ufgshome/graphtoc.pdf.
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NOTE: The following information shall be shown on the project drawings:

1. Where specification identifies type, size, color, finish, or other definitive information to be "as indicated," the engineer shall include the information on the drawings.

2. Location of ducts, and cables.

3. Types of wire and cable; number and sizes of conductors.

4. Special conditions.
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PART 1 GENERAL

1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.
****

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.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C119.1	(2002) Sealed Insulated Underground Connector Systems Rated 600 Volts
ANSI C2	(1997) National Electrical Safety Code

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS1	(1990) Impregnated-Paper-Insulated, Metallic Sheathed Cable, Solid Type
AEIC CS5	(1994; CS5a-1995) Cross-Linked Polyethylene Insulated Shielded Power Cables Rated 5 Through 46 kV
AEIC CS6	(1996) Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 69 kV

ASTM INTERNATIONAL (ASTM)

ASTM B 1	(2001) Hard-Drawn Copper Wire
ASTM B 8	(2004) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

ASTM C 260	(2001) Air-Entraining Admixtures for Concrete
ASTM F 512	(1995; R 2001e1) Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 404	(2000) Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V Through 500 000 V
IEEE Std 48	(1996; R 2003) Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2003) Acceptance Testing Specifications

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA RN 1	(1998) Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2003) Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
NEMA TC 3	(2004) Polyvinyl Chloride PVC Fittings for Use with Rigid PVC Conduit and Tubing
NEMA TC 6	(1990) PVC and ABS Plastic Utilities Duct for Underground Installation
NEMA TC 8	(1990) Extra-Strength PVC Plastic Utilities Duct for Underground Installation
NEMA TC 9	(2004) Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation
NEMA WC 7	(1988; Rev 3 1996) Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC 8	(1988; Rev 3 1996) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2005) National Electrical Code
NFPA 70B	(2002) Electrical Equipment Maintenance

UNDERWRITERS LABORATORIES (UL)

UL 1242	(2000; Rev thru May 2003) Electrical Intermediate Metal Conduit -- Steel
UL 467	(2004) Grounding and Bonding Equipment
UL 486A-486B	(2003; Rev thru Apr 2004) Wire Connectors
UL 510	(2005) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 514A	(2004) Metallic Outlet Boxes
UL 514B	(2004) Conduit, Tubing and Cable Fittings
UL 6	(2000; Rev thru May 2003) Rigid Metal Conduit
UL 651	(2000) Schedule 40 and 80 Rigid PVC Conduit
UL 83	(2003; Rev thru Mar 2004) Thermoplastic-Insulated Wires and Cables
UL 854	(2004) Service-Entrance Cables

1.2 RELATED REQUIREMENTS

Section 16050N BASIC ELECTRICAL MATERIALS AND METHODS and Section 02582 ELECTRICAL MANHOLE AND HANDHOLE, applies to this section with additions and modifications specified herein.

[1.2.1 Underground Service

Terminate underground service into building at a point 1525 mm 5 feet outside the building and projections thereof, except that service conductors shall be continuous to the interior terminating point indicated. Connections of the service to the service switch, panelboard, or load center is included in Section 16402 INTERIOR DISTRIBUTION SYSTEM. Protect ends of underground conduit with threaded metal caps or plastic plugs as applicable until connections are made.

]1.3 DEFINITIONS

a. In the text of this section, the words conduit and duct are used interchangeably and have the same meaning.

b. In the text of this section, "medium voltage cable splices," and "medium voltage cable joints" are used interchangeably and have the same meaning.

1.4 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item

should be required.

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 projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy 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.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

****

NOTE: Submittals are required for each kind, voltage, or type used on the project. Delete item (a), "Proposed precast sectional underground duct bank" for LANTNAVFACENGCOM projects.

****

Proposed precast sectional underground duct bank; G

SD-03 Product Data

****

NOTE: Submittals are required for each kind, voltage, or type used on the project.

****

Medium voltage cable; G

Medium voltage cable joints; G

Medium voltage cable terminations; G

[Live end caps; G]

600 volt wires and cables

Paper insulated lead covered (PILC) cables

SD-06 Test Reports

****
NOTE: Delete last sentence of paragraph, for SOUTHNAVFACENGCOM projects.
****

Acceptance checks and tests; G

Identify each cable for 600-volt, and medium voltage cable tests. When testing grounding electrodes and systems, identify each electrode and system for each test, as well as the resistance and soil conditions at the time the measurement were made.

SD-07 Certificates

Cable splicer/terminator; G

****
NOTE: For LANTNAVFACENGCOM projects, use the submittal item below in lieu of the above item.
****

Cable splicer qualifications; G

****
NOTE: Delete the paragraph below for LANTNAVFACENGCOM projects
****

[Thirty] [_____]calendar days before making splices or terminations, submit names of the cable splicers to be employed, together with proof that splicer has at least 3 years experience in splicing the type and rating of cables specified. Submit certification for each splicer by the cable joint kit manufacturer in the use of manufacturer's kits.

SD-08 Manufacturer's Instructions

****
NOTE: Delete this submttal list for LANTNAVFACENGCOM projects.
****

Ground megger

"UL listed" kit

Termination kit

Medium-voltage joints

SD-09 Manufacturer's Field Reports

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NOTE: Delete "Medium voltage cable tests" for SOUTHNAVFACENGCOM projects. For LANTNAVFACENGCOM projects, include this submittal items under SD-06 Test Reports
****

Arc-proofing test for cable fireproofing tape; G

Medium voltage cable tests; G

****
NOTE: Delete heat shrinkable joint test for LANTNAVFACENGCOM projects.
****

Factory engineered heat shrinkable joint kit

1.5 QUALITY ASSURANCE

****
NOTE: Delete the text of this paragraph for LANTNAVFACENGCOM projects.
****

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NOTE: In situations requiring work in confined spaces, provide names of "competent persons"; "competent person" means one who is capable of identifying and testing existing and potential hazards in confined spaces and who has authorization to take prompt action to eliminate hazards. Also, if work to be performed is covered by FAR clauses, the Contractor shall be required to prepare and submit a written confined space entry procedure per EM 385-1-1.
****

Each cable splicer may be required to make an approved dummy splice in the presence of the Contracting Officer in accordance with cable manufacturer's instructions. The Contractor shall furnish the material for dummy splices.

1.5.1 Cable Splicer Qualifications

a. In order to establish the cable workman's competency, the Contractor shall be required to submit the following within 30 calendar days prior to commencement of the splice/termination:

(1) Documentation to verify that the individual has completed a splice/termination of the type to be installed under this contract. The test splice-termination shall be performed at the job site for this contract under the supervision of the cable accessory manufacturer or his representative and witnessed by the Government.

(2) Documentation that said splice/termination has undergone and

passed the following tests by the splice-termination manufacturer or an independent testing laboratory.

TEST	Minimum Value 5 kV	15 kV	35 kV
Discharge Ext. Value with 3 pC or less	13 kV	20 kV	35 kV
AC withstand, 1 minute	35 kV	50 kV	75 kV
DC withstand, 15 minutes	65 kV	70 kV	100 kV

These results shall be attached for review

(3) A statement of the number of years in which the individual has been splicing/terminating medium voltage cable.

b. Criteria for waiver: Items a.1 and a.2 above may be waived on subsequent jobs provided the following criteria is satisfied:

(1) Documentation of prior completion of items a.1 and a.2 be submitted.

(2) A list of the last three jobs where the specific splices/terminations were installed within the past 12 consecutive months. The tabulation shall include splice/termination manufacturer, catalog number, and the number of splice/terminations installed.

c. Requalifications: Requalification to items a.1 and a.2 in above paragraph may be required if the splice installer can not demonstrate a prior history of splice/termination installation during the previous 12 consecutive months. The contractor shall furnish the material for splices and terminations.

1.5.2 Test Instrument and Procedure

****

NOTE: Delete this paragraph for LANTNAVFACENGCOM projects.

****

Submit for use of ground megger with proposed method indicated.

1.5.3 Manufacturer's Test

****

NOTE: Delete this paragraph for LANTNAVFACENGCOM projects.

****

Submit the manufacturer's test report indicating that performance of the heat shrinkable joint kit is equivalent to the cable rating, in accordance with the applicable sections of IEEE Std 48, IEEE Std 404, and AEIC CS1.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Conduit

2.1.1.1 Rigid Metal Conduit

UL 6, galvanized steel, threaded type.

2.1.1.2 Rigid Metal Conduit, PVC Coated

UL 6, galvanized steel, threaded type, coated with a polyvinyl chloride (PVC) sheath bonded to the galvanized exterior surface, nominal one millimeter 40 mils thick, conforming to NEMA RN 1, Type A40, except that hardness shall be nominal 85 Shore A durometer, dielectric strength shall be minimum 15.75 kV per mm 400 volts per mil at 60 Hz, tensile strength shall be minimum 25 MPa 3500 psi, and aging shall be minimum 1000 hours in an Atlas Weatherometer.

2.1.1.3 Intermediate Metal Conduit

UL 1242, galvanized steel, threaded type.

2.1.1.4 Intermediate Metal conduit, PVC Coated

UL 1242, galvanized steel, threaded type, coated with a polyvinyl chloride (PVC) sheath bonded to the galvanized exterior surface, nominal one millimeter 40 mils thick, conforming to NEMA RN 1, Type A40, except that hardness shall be nominal 85 Shore A durometer, dielectric strength shall be minimum 15.75 kV per mm 400 volts per mil at 60 Hz, tensile strength shall be minimum 25 MPa 3500 psi, and aging shall be minimum 1000 hours in an Atlas Weatherometer.

2.1.1.5 Plastic Conduit for Direct Burial

****
NOTE: Close coordination with drawings is important. Make sure drawing terminology is correct ("conduit" where direct buried, and "duct" where concrete encased). If drawings require plastic conduit, refer to NEMA TC 2 for EPC-40-PVC for general underground direct burial use, and for EPC-80-PVC where additional crushing or impact strength would be appropriate. For plastic duct refer to NEMA TC 6 for type EB.
****

NEMA TC 2, [EPC-40-PVC] [or] [EPC-80-PVC] [as indicated].

2.1.1.6 Plastic Utilities Duct for Concrete Encasement

****
NOTE: For LANTNAVFACENGCOM projects, use the second bracketed paragraph.
****

[NEMA TC 8, ASTM F 512, [Type EB-35] [or] [as indicated].]

[NEMA TC 6, Type [EB] [or] [_____] [as indicated].]

2.1.2 Fittings

2.1.2.1 Metal Fittings

UL 514B, threaded type.

2.1.2.2 PVC Conduit Fittings

NEMA TC 3 [UL 514B] [UL 651].

2.1.2.3 PVC Duct Fittings

NEMA TC 9.

[2.1.2.4 Outlet Boxes for Steel Conduit

Outlet boxes for use with rigid or flexible steel conduit shall be cast-metal cadmium or zinc-coated if of ferrous metal with gasketed closures and shall conform to UL 514A.

]2.1.3 Conductors Rated 600 Volts and Less

****

NOTE: If aluminum conductor is permitted (not excluded), include requirement for adjusting the raceway sizes with additional reference to NEC. Also give detailed instructions as to materials and methods required for splicing and terminating 600-volt wires and cables with regard to the material used at bus or other connection point. Circuit identification shall be as indicated on the drawings. However, for projects within the Charleston Naval Base Complex, Pearl Harbor Naval Base Complex (including the Shipyard and SUBBASE) and other activities when customer requires it, conductors shall be copper. There are other instances when you may want to consider copper only (customer request, matching existing with small quantity, etc.). If copper only is specified, delete subparagraphs entitled "Wire and Cable Conductor Sizes" and "Aluminum Conductors" and other references to aluminum conductors.

If U.R.D. type cable is desired, specify that the construction shall include an extruded jacket to prevent corrosion or displacement of the concentric wire shield.

****

Conductor and conduit sizes indicated are for copper conductors unless otherwise noted. Insulated conductors shall have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout the cable length. Wires and cables manufactured more than [12] [24] months prior to date of delivery to the site shall not be used.

2.1.3.1 600 Volt Wires and Cables

****

NOTE: Type THW insulation can only be obtained in large quantity. Use of this type of insulation is not recommended for smaller projects. Types USE and THW are larger than THWN insulation. When they are allowed ensure that the conduit has been properly sized for the number of THW or USE wires indicated in each conduit run.

****

Service entrance and direct buried conductors shall conform to UL 854, Type USE. Conductors in conduit other than service entrance shall conform to UL 83, Type THWN [or THW]. Conductor size and number of conductors in each cable shall be as indicated. Conductors shall be color coded. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Conductor identification shall be by color-coded insulated conductors, plastic-coated self-sticking printed markers, colored nylon cable ties and plates, or heat shrink type sleeves. Control circuit terminations shall be properly identified. Conductors No. 10 AWG and smaller shall be solid copper. Conductors No. 8 AWG and larger shall be stranded copper. [All conductors shall be copper.] [Conductors No. 6 AWG and smaller shall be copper. Conductors No. 4 AWG and larger shall be either copper or aluminum, at the Contractor's option. Should the Contractor opt to use aluminum, he shall be responsible for meeting the requirements of the following paragraph, "Aluminum Conductors."] [As an exception to the preceding statement, do not substitute aluminum for copper if the equivalent aluminum size would exceed 500 KCMIL.]

a. Colors for coding conductors shall be:

208-VOLT SYSTEM	480-VOLT SYSTEM
Neutral - White	Neutral - White
Phase A - Black	Phase A - Brown
Phase B - Red	Phase B - Orange
Phase C - Blue	Phase C - Yellow
Grounding conductor - Green	Grounding conductor - Green

[b. Aluminum Conductors: Should the Contractor choose to use aluminum for conductors No. 4 AWG and larger, the Contractor shall be responsible for: Increasing the conductor size to have the same ampacity as the copper size indicated; increasing the conduit and pull box sizes to accommodate the larger size aluminum conductors in accordance with NFPA 70; ensuring that the pulling tension rating of the aluminum conductor is sufficient; relocating equipment, modifying equipment terminations, resizing equipment, and resolving to the satisfaction of the Contracting Officer problems that are direct results of the use of aluminum conductors in lieu of copper.]

(1) For 600-volt wiring, the aluminum conductors shall be of an aluminum alloy listed or labeled by UL as "component aluminum-wire stock (conductor material)." Type EC/1350 aluminum is not acceptable.

(2) Equipment manufacturer requirements: Where Contractor provides equipment whose manufacturer requires copper conductors

at the terminations, or requires that only copper conductors be provided between components of equipment, the Contractor shall provide copper conductors, or necessary splices, splice boxes, and other work required to satisfy manufacturer's requirements.

2.1.4 600 Volt Wire Connector and Terminals

Shall provide a uniform compression over the entire contact surface. Solderless terminal lugs shall be used on stranded conductors.

a. For use with copper conductors: UL 486A-486B.

[b. For use with aluminum conductors: UL 486A-486B. For connecting aluminum to copper, connectors shall be the circumferentially compressed, metallurgically bonded type.]

2.1.5 600 Volt Splices

Provide splices with a compression connector on the conductor and by insulating and waterproofing using one of the following methods which are suitable for continuous submersion in water and comply ANSI C119.1.

a. Provide cast-type splice insulation by means of molded casting process employing a thermosetting epoxy resin insulating material applied by a gravity poured method or by a pressure injected method. Provide component materials of the resin insulation in a packaged form ready for convenient mixing without removing from the package.

b. Gravity poured method shall employ materials and equipment contained in an approved commercial splicing kit which includes a mold suitable for the cables to be spliced. When the mold is in place around the joined conductors, prepare the resin mix and pour into the mold.

c. Provide [heavy wall] heat shrinkable splice insulation by means of a thermoplastic adhesive sealant material which shall be applied by a clean burning propane gas torch.

d. Provide a cold-shrink rubber splice which consists of EPDM rubber tube which has been factory stretched onto a spiraled core which is removed during splice installation. The installation shall not require heat or flame, or any additional materials such as covering or adhesive. It shall be designed for use with inline compression type connectors, or indoor, outdoor, direct-burial or submerged locations.

2.1.6 Medium Voltage Cable

Cable (conductor) sizes are designated by American Wire Gauge (AWG) and Thousand Circular Mils (Kcmil). Conductor and conduit sizes indicated are for copper conductors unless otherwise noted. Insulated conductors shall have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout cable length. Wires and cables manufactured more than [24] [12] months prior to date of delivery to the site shall not be accepted.

****

NOTE: For EPR: Cable ratings and insulation

thickness are shown in Table B1 of AEIC CS6. Jacket thickness is shown Table 4-3 of NEMA WC 8. For XLP: Cable ratings and insulation thickness are shown in Table B1 of AEIC CS5. Jacket thickness is shown in Table 4.5 of NEMA WC 7.

****

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NOTE: For projects within LANTNAVFACENGCOM: Use only EPR insulation with a tape shield unless specifically requested by the activity, or otherwise directed, to use or allow the use of XLP insulation, or wire shield. Values for 133 percent insulation shall be used on all systems other than four-wire, multi-grounded systems, unless specifically directed otherwise.

****

Cable for [34.5] [13.2] [12.47] [11.5] [4.16] [_____] kV underground distribution system shall be ozone resistant ethylene-propylene-rubber-insulated (EPR) cable conforming to NEMA WC 8, as applicable, and AEIC CS6 [or cross-linked-thermosetting-insulated (XLP) cable conforming to NEMA WC 7, as applicable, and AEIC CS5]. Cable shall be [single] [three] conductor, employing [concentric, Class B] [compact round] stranded copper conductors. Cable shall have conductor and insulation shielding. Insulation shielding shall be metal tape [or wire] type consisting of a concentric serving of tape [or wires] according to NEMA WC 8 [or NEMA WC 7]. Cable shall be rated [_____] kV with insulation and jacket thickness of [_____] and [_____] mm mils, respectively. Cable shall have a polyvinyl chloride jacket.\

2.1.6.1 Paper Insulated Lead Covered (PILC) Cables

****

NOTE: PILC cables for use on circuits 10KV or more shall be shielded. PILC cable is recommended only for projects where new cable system will be spliced to existing PILC cable distribution system.

****

Cable for [34.5] [13.2] [12.47] [11.5] [4.16] kV distribution system shall be solid type impregnated-paper-insulated lead-covered cable conforming to AEIC CS1. Cable shall be [single] [three] conductor, employing [compact round] [concentric] stranded, copper conductor[s]. The cable shall have conductor shielding and insulation shielding over each individual conductor. The sheath shall be of the finest approved special fatigue resistant, age resistant arsenical lead alloy proved by experience and bending machine tests. The sheath shall be smooth and concentric, free of scars or indentations. The thickness of the sheath shall be in accordance with AEIC CS1. Any samples exceeding the specified thickness deviations at any point shall justify complete rejection of adjacent cable without further tests or qualifications. A protective covering of thermoplastic polyethylene shall be applied over the sheath. The rated voltage of the cable shall be [_____] kV [[_____] percent insulation level for [_____] kV system].

2.1.7 Medium Voltage Cable Terminations

IEEE Std 48 Class [1]. Provide terminations including stress control

terminator, ground clamp, connectors, and lugs. Terminator shall be the product of one manufacturer, suitable for the type and materials of the cable terminated. Furnish components in the form of a "UL listed" kit, including complete instructions which shall be followed for assembly and installation. Provide terminator as specified herein for terminating single conductor, [or the single conductor of multiconductor,] solid insulated, nonmetallic jacketed type cables for service voltage up to 35 KV indoor and outdoor. Do not use separate parts of copper or copper alloy in contact with aluminum alloy parts in the construction or installation of the terminator.

[2.1.7.1 Indoor Terminations/Terminations Within Equipment Enclosures

****
NOTE: Separable insulated connectors, such as load-break elbows, may be used with certain equipment. Where they are provided, they should be specified in the section that provides the equipment (i.e., Section 16272) and cross referenced herein for installation and testing.
****

****
NOTE: Provide with skirts. By including skirts for "indoor" and "within equipment" locations, tracking resistance is significantly improved.
****

Indoor terminator shall be cold-shrink type or heat shrinkable type.

a. Cold-Shrink Type:

****
NOTE: For Public Works Center, Pearl Harbor areas and systems, this type shall not be specified/ included in contract specifications.
****

Terminator shall be a one-piece design, where high-dielectric constant (capacitive) stress control is integrated within a skirted insulator made of silicone rubber, munsel gray in color. Termination shall not require heat or flame for installation. Termination kit shall contain all necessary materials (except for the lugs). Termination shall be designed for installation in low or highly contaminated indoor and outdoor locations and shall be rated for continuous operation at 90 degree C, with an emergency overload temperature rating of 130 degree C.

b. Heat Shrinkable Type

Terminator shall consist of a uniform cross section heat shrinkable polymeric construction stress relief tubing and environmentally sealed outer covering that is nontracking, resists heavy atmospheric contaminants, ultra violet rays and oxidative decomposition. Provide heat shrinkable sheds or skirts of the same material.

][2.1.7.2 Outdoor Terminations

Outdoor terminator shall be cold shrink type or porcelain insulator.

a. Cold-Shrink Type:

****
NOTE: For Public Works Center, Pearl Harbor areas and systems, this type shall not be specified/ included in contract specifications.
****

Terminator shall be a one-piece design, where high-dielectric constant (capacitive) stress control is integrated within a skirted insulator made of silicone rubber, munsel gray in color. Termination shall not require heat or flame for installation. Termination kit shall contain all necessary materials (except for the lugs). Termination shall be designed for installation in low or highly contaminated indoor and outdoor locations and shall be rated for continuous operation at 90 degree C, with an emergency overload temperature rating of 130 degree C.

b. Porcelain Insulator Type

Terminator shall comply with requirements of IEEE Std 48 Class 1, except that the requirements of design tightness test need not be met. However, the terminator shall not exude any insulating filler compound under either test or service. Terminator shall consist of a porcelain insulator, copper cable connector-hoodnut assembly and copper aerial lug as required, metal body and supporting bracket, sealed cable entrance, internal stress relief device for shielded cable, and insulating filler compound or material.

][2.1.7.3 Termination; Separable Insulated Connector Type

Provide as specified in Section [16272 PAD-MOUNTED TRANSFORMERS] [_____].

]2.1.7.4 Cast Epoxy Resin Type Termination

****
NOTE: Delete this paragragh for LANTNAVFACENGCOM projects.
****

IEEE Std 48, Class 1. Provide termination as specified herein for terminating single conductor, or the single conductors of multiconductor, solid insulated, nonmetallic jacketed type cables for service voltage up to 15 KV outdoor and 15 KV indoor. Terminations for shielded conductors shall include stress control, with a shield ground connection brought out through the insulation and covering, and grounded at installation. Terminations exposed to the weather shall include porcelain insulator and weather shield.

2.1.7.5 Terminator, Modular, Molded Rubber Type

****
NOTE: Delete this paragraph for LANTNAVFACENGCOM projects.
****

IEEE Std 48 Class 1. Provide terminator as specified herein for terminating single conductor, or the single conductor of multiconductor, solid insulated, nonmetallic jacketed type cables for service voltage up to 35 KV outdoor. Terminator shall consist of a stress control, ground clamp, nontracking rubber skirts, crimp-on connector, rubber cap, and aerial lug. Do not use separate parts of copper or copper alloy in contact with

aluminum or aluminum alloy parts in the construction and installation of the terminator.

2.1.7.6 Terminator, Cold-Shrink Rubber Type, Single Conductor PILC Cable

****
NOTE: Delete this paragraph for LANTNAVFACENGCOM, PWC Pearl Harbor areas and systems projects.
****

IEEE Std 48, Class 1. Provide terminations as specified herein for terminating single conductor PILC cable. Cable termination must be a one-piece cold shrink 15 kV or 25/28 kV Class device and meet all 15 kV, 25 kV (+ prorated 28 kV) requirements for Class 1 terminations as recorded in IEEE Std 48. Termination must be a molded rubber unit where the built-in stress relief mechanism uses the concept of high dielectric constant capacitive stress grading. Molded rubber insulator must be made from silicone rubber.

2.1.8 Medium Voltage Cable Joints

Provide joints (splices) in accordance with IEEE Std 404 suitable for the rated voltage, insulation level, and insulation type of the cable. Upon request, supply manufacturer's design qualification test report in accordance with IEEE Std 404. Connectors for joint shall be tin-plated electrolytic copper, having ends tapered and having center stops to equalize cable insertion. Connectors shall be rated for voltage of 35 kV minimum.

a. Heat-shrinkable joint: Consists of a uniform cross-section heat-shrinkable polymeric construction with a linear stress relief system, a high dielectric strength insulating material, and an integrally bonded outer conductor layer for shielding. Replace original cable jacket with a heavy-wall heat-shrinkable sleeve with [hot-melt adhesive coating.] [waterproof mastic seal on both ends.]

b. Watertight taped-type joint: Consists of an approved connector, self-fusing or self-bonding insulating tape, self-fusing semiconducting tape, tinned copper shielding tape or braid, and plastic tape.

[c. Vulcanized-type joint: Heat-pressure process of an approved type and employing materials and equipment suitable for the type and voltage of cables for which it is used. Materials used in the jointing process shall be fully and permanently compatible with materials in the cables. Vulcanized-type joints are limited to 5 kV systems.]

****
NOTE: Delete the following paragraph for PWC Pearl Harbor areas and systems.
****

[d. Cold-shrink rubber-type joint: Joint shall be of a cold shrink design that does not require any heat source for its installation. Splice insulation and jacket shall be of a one-piece factory formed cold shrink sleeve made of black EPDM rubber. Splice shall be packaged three splices per kit, including complete installation

instructions. Cold-shrink rubber-type joints are limited to 8.7 kV systems.]

[2.1.9 Live End Caps

Provide live end caps using a "kit" including a heat-shrinkable tube and a high dielectric strength, polymeric plug overlapping the conductor. End cap shall conform to applicable portions of IEEE Std 48.

]2.1.10 Tape

2.1.10.1 Insulating Tape

UL 510, plastic insulating tape, capable of performing in a continuous temperature environment of 80 degrees C.

2.1.10.2 Buried Warning and Identification Tape

Provide detectable aluminum foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried cable and conduit. Tape shall be detectable by an electronic detection instrument. Provide tape in rolls, 50 mm 2 inchesminimum width, color coded for the utility involved with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall be CAUTION BURIED [ELECTRIC] [,] [TELEPHONE] CABLE BELOW or similar. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.1.10.3 Fireproofing Tape

****
NOTE: For LANTNAVFACENGCOM, use the second bracketed paragraph.
****

[Fireproofing tape shall be approximately 0.762 mm thick by 75 mm 30 mils thick by 3 inches wide and shall consist of a flexible, unsupported elastomer that expands in fire to provide a thick char buildup between the flame and the cable. Tape shall be noncorrosive to cable sheath. Tape shall not give off a smoke when subjected to flame or support combustion. Tape shall not deteriorate when subjected to oil, water, gases, salt water, sewage, and fungus.]

[Furnish tape composed of a flexible conformable unsupported intumescent elastomer. Tape shall be not less than 0.762 mm .030 inch thick, noncorrosive to cable sheath, self-extinguishing, noncombustible, and shall not deteriorate when subjected to oil, water, gases, salt water, sewage, and fungus.]

2.1.11 Pull Rope

Shall be plastic having a minimum tensile strength of 890 N 200 pounds. [Leave a minimum of 610 mm 24 inches of slack at each end of the pull wires.]

2.1.12 Grounding and Bonding Equipment

UL 467. Ground rods shall be copper clad steel with diameter adequate to

permit driving to full length of the rod, but not less than 19 mm 3/4 inch in diameter and 3050 mm 10 feet long unless otherwise indicated.

2.1.13 Cable Tags

Provide as specified in Section 16050N BASIC ELECTRICAL MATERIALS AND METHODS.

2.2 SOURCE QUALITY CONTROL

2.2.1 Arc-Proofing Test for Cable Fireproofing Tape

Manufacturer shall test [one] [three] sample [assembly] [assemblies, each] consisting of a straight lead tube 305 mm 12 inches long with a 65.5 mm 2 1/2 inch outside diameter, and a 3.175-mm 1/8 inch thick wall, and covered with one-half lap layer of arc and fireproofing material per manufacturer's instructions. The arc and fireproofing tape shall withstand extreme temperature of a high-current fault arc 13,000 degrees K for 70 cycles as determined by using an argon directed plasma jet capable of constantly producing and maintaining an arc temperature of 13,000 degrees K. Temperature (13,000 degrees K) of the ignited arc between the cathode and anode shall be obtained from a dc power source of 305 (plus or minus 5) amperes and 20 (plus or minus 1) volts. The arc shall be directed toward the sample assembly accurately positioned 5 (plus or minus 1) millimeters downstream in the plasma from the anode orifice by fixed flow rate of argon gas (0.18 g per second). Each sample assembly shall be tested at three unrelated points. Start time for tests shall be taken from recorded peak current when the specimen is exposed to the full test temperature. Surface heat on the specimen prior to that time shall be minimal. The end point is established when the plasma or conductive arc penetrates the protective tape and strikes the lead tube. Submittals for arc-proofing tape shall indicate that the test has been performed and passed by the manufacturer.

2.2.2 Medium Voltage Cable Tests

Results of [AEIC C5] [and] [AEIC CS6] qualification and production tests as applicable for each type of medium voltage cable.

PART 3 EXECUTION

3.1 INSTALLATION

****
NOTE: Soil treatment for termite control shall conform to Section 02361, "Soil Treatment for Termite Control," except that application to direct burial cable installation shall be as specified. In lieu of soil poisoning, cable in direct-buried EPC-40-PVC conduit can be a more economical and practical way of protecting cable from termites.
****

****
NOTE: CALPUC publication applies only to State of California Public Utilities Commission CALPUC G.O.128, "Construction of Underground Electric Supply and Communication System" for underground electrical work. For other states, delete this publication and insert other publications which

govern underground electrical work for that state. Revise reference paragraph to include deletion or addition of state publication.

[NFPA 70] and [ANSI C2] [and CALPUC G.O.128].

3.1.1 Contractor Damage

NOTE: Use this paragraph for LANTNAVFACENGCOM projects only.

The Contractor shall promptly repair any indicated utility lines or systems damaged by Contractor operations. Damage to lines or systems not indicated, which are caused by Contractor operations, shall be treated as "Changes" under the terms of the General Provisions of the contract. If the Contractor is advised in writing of the location of a nonindicated line or system, such notice shall provide that portion of the line or system with "indicated" status in determining liability for damages. In any event, the Contractor shall immediately notify the Contracting Officer of any such damage.

3.1.2 Concrete

NOTE: Use first bracketed paragraph when project includes a concrete section in Division 03; otherwise, second bracketed paragraph may be used.

[Concrete work for electrical requirements shall be 20 MPa 3000 psiminimum ultimate 28-day compressive strength with 25 mm one inchminimum aggregate conforming to the requirements of Section [03300N CAST-IN-PLACE CONCRETE].]

NOTE: If concrete requirements are detailed and no cast-in-place concrete section is to be included in the project specification, refer to Section 03300, "Cast-In-Place Concrete" and select such portions needed to provide complete requirements.

[Shall be composed of fine aggregate, coarse aggregate, portland cement, and water so proportioned and mixed as to produce a plastic, workable mixture. Fine aggregate shall be of hard, dense, durable, clean, and uncoated sand. The coarse aggregate shall be reasonably well graded from 4.75 to 25 mm 3/16 to one inch. The fine and coarse aggregates shall be free from injurious amounts of dirt, vegetable matter, soft fragments or other deleterious substances. Water shall be fresh, clean, and free from salts, alkali, organic matter, and other impurities. Concrete shall have a compressive strength of [20] [30] MPa [3000] [4000] psi at the age of 28 days. Slump shall not exceed [75] [100] mm [3] [4] inches. Retempering of concrete will not be permitted. Exposed, unformed concrete surfaces shall be given a smooth, wood float finish. Concrete shall be cured for a period of not less than 7 days, and concrete made with high early strength portland cement shall be repaired by patching honeycombed or otherwise defective areas with cement mortar as directed by the Contracting Officer.

Air entrain concrete exposed to weather using and air-entraining admixture conforming to ASTM C 260. Air content shall be between 4 and 6 percent.]

3.1.3 Direct Burial System

****
NOTE: Direct earth burial cables generally require direct burial splices. Observe marker slab requirements previously covered in this specification.
****

Bury cables directly in earth, except under [railroad tracks,] [paved areas,] and [roadways], and install cables in conduit encased in concrete. Install cables buried directly in earth in the following manner:

a. Slope ducts to drain.

b. Excavate trenches in which the cables are placed by hand or with mechanical trenching equipment, and provide a minimum cable cover of 610 mm 24 inches below finished grade for power conductors operated at 600 volts and less, and 765 mm 30 inches to the top of the cables for over 600 volts. Trenches shall be not less than [150] [200] mm [6] [8] inches wide, and shall be in straight lines between cable markers. [Cable plows shall not be used.] Bends in trenches shall have a radius of not less than 915 mm 36 inches. Where two or more cables are laid parallel in the same trench, space cables laterally at not less than 75 mm 3 inches apart, except that communication cable shall be separated from power cable by a minimum distance of 305 mm 12 inches.

c. When rock is encountered, remove to a depth of at least 75 mm 3 inches below the cable and fill the space with sand or clean earth free from particles larger than 6 mm 1/4 inch.

d. Do not unreel and pull cables into the trench from one end. However, the cable [may] [shall] be unreeled on grade and lifted into position [[on a 75 mm 3 inch sand bedding] with 75 mm 3 inches more sand placed on top of cable and a redwood plank placed on top of the sand the entire length of the cable run. Plank shall be 50 by 200 mm 2 by 8 inch [redwood], [_____] brush treated three coats with a pentachlorophenol light oil solution]. [Cable bedding and cover shall consist of material which would pass a 6 mm 1/4 inch screen with no sharp material.]

e. Provide color, type and depth of warning tape as specified in Section 02300 EARTHWORK.

3.1.3.1 Cutting Cable

****
NOTE: Delete this paragraph for LANTNAVFACENGCOM projects.
****

Use heat shrink adhesive coated caps on cable ends or tape cable ends immediately after cutting to prevent moisture from entering the cable. Varnish the tape when cable is not expected to be connected for at least 72 hours.

3.1.3.2 Restoration

Replace sod which has been removed, as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, pad construction, and other work to original condition and maintain until final acceptance. Provide necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging or mulching. [Perform work in accordance with [Section 02921 SEEDING][Section 02922 SODDING][Section 02923 SPRIGGING] and Section 02930 EXTERIOR PLANTS.]

3.1.3.3 Crossing Cables

Separate cables crossing other cables or metal piping from each other by not less than [75] [305] mm [3] [12] inches of well tamped earth.

3.1.3.4 Splicing

Provide cables in one piece without splices between connections except where the distance exceeds the lengths in which cables are manufactured.

3.1.3.5 Bends

Bends in cables shall have an inner radius not less than [those specified in NFPA 70 for the type of cable specified.] [12 times the cable diameter.]

3.1.3.6 Horizontal Slack

Leave approximately 915 mm 3 feet of horizontal slack in the ground on each end of cable runs, on each side of connection boxes, and at points where connections are brought above ground. Where cable is brought above ground, leave additional slack to make necessary connections. [Enclose splices in lead-sheathed or armored cables in split-type cast-iron splice boxes; after completion of the connection, fill with insulating filler compound and tightly clamp the box.]

3.1.3.7 Identification Slabs [Markers]

Provide a slab at each change of direction of cable, over the ends of ducts or conduits which are installed under paved areas and roadways, and over each splice. Identification slabs shall be of concrete, approximately 500 mm square by 150 mm 20 inches square by 6 inches thick and shall be set flat in the ground so that top surface projects not less than 20 mm 3/4 inch, nor more than 30 mm 1 1/4 inchesabove ground. Concrete shall have a compressive strength of not less than 20 MPa 3000 psi and have a smooth troweled finish on exposed surface. Inscribe an identifying legend such as "electric cable," "telephone cable," "splice," or other applicable designation on the top surface of the slab before concrete hardens. Inscribe circuit identification symbols on slabs as directed. Letters or figures shall be approximately 50 mm 2 inches high and grooves shall be approximately 6 mm 1/4 inch in width and depth. Install slabs so that the side nearest the inscription on top shall include an arrow indicating the side nearest the cable.

3.1.3.8 Cable End Seal

****

NOTE: Delete this paragraph for LANTNAVFACENGCOM projects.

****

Ends of cable shall be taped immediately after cutting to prevent moisture from entering the cable. Where the cable is not expected to be connected for at least 72 hours, the tape shall also be varnished.

3.1.4 Underground Conduit/Duct Without Concrete Encasement

Type of conduit shall be [EPC-40-PVC,] [EPC-80-PVC,] [PVC-coated rigid galvanized steel,] [PVC-coated intermediate galvanized steel,] [rigid galvanized steel,] [intermediate galvanized,] [or] [rigid galvanized steel field wrapped with 0.254 mm 0.010 inch thick pressure-sensitive plastic tape applied with a 50 percent overlap].

3.1.4.1 Conduit Installation

Top of the conduit shall be not less than 610 mm 24 inches below grade, and shall have a minimum slope of 75 mm 3 inches in each 30 meters 100 feet away from buildings and toward manholes and other necessary drainage points. Run conduit in straight lines except where a change of direction is necessary. As each conduit run is completed, for conduit sizes 75 mm 3 inches and larger, draw a flexible testing mandrel approximately 305 mm 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs. For conduit sizes less than 75 mm 3 inches, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs. Provide not less than 75 mm 3 inches clearance from the conduit to each side of the trench. A minimum clearance of 65 mm 2 1/2 inches shall be provided between adjacent conduits. Grade bottom of trench smooth; where rock, soft spots, or sharp-edged materials are encountered, excavate the bottom for an additional 75 mm 3 inches, fill and tamp level with original bottom with sand or earth free from particles, that would be retained on a 6.25 mm 1/4 inch sieve. Provide color, type and depth of warning tape as specified in Section 02300 EARTHWORK.

3.1.4.2 Encasement Under Roads and Structures

Under roads, paved areas, and railroad tracks, install conduits in concrete encasement of rectangular cross-section providing a minimum of 75 mm 3 inch concrete cover around ducts. Concrete encasement shall extend at least 1525 mm 5 feet beyond the edges of paved areas and roads, and 3660 mm 12 feet beyond the rails on each side of railroad tracks. Conduits to be installed under existing paved areas which are not to be disturbed, and under roads and railroad tracks, shall be zinc-coated, rigid steel, jacked into place. [Hydraulic jet method shall not be used.]

3.1.4.3 Multiple Conduits

Separate multiple conduits by a minimum distance of 65 mm 2 1/2 inches, except that light and power conduits shall be separated from control, signal, and telephone conduits by a minimum distance of 75 mm 3 inches. Stagger the joints of the conduits by rows and layers to strengthen the conduit assembly. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly shall consist of base spacers, intermediate spacers, and top spacers to provide a completely enclosed and locked-in conduit assembly. Install spacers per manufacturer's instructions, but provide a minimum of two spacer assemblies per 3050 mm 10

feet of conduit assembly.

3.1.5 Underground Duct with Concrete Encasement

****
NOTE: Edit this paragraph to comply with project requirements concerning type of structure or duct, strength of concrete, concrete mix, metal accessories, and excavating and grading. Indicate special reinforcing where required, particularly with duct banks of non-rectangular cross-section. Designer shall contact local telephone company, where applicable, concerning size of signal manholes and number and type of signal duct required.
****

****
NOTE: See standard plates 1 through 4 attached hereto, covering manholes and handholes. For projects other than LANTNAVFACENGCOM: Plates needed may be modified and used on drawings or attached to contract specification. For LANTNAVFACENGCOM projects: DO NOT attached plates to contract specifications. Plates should be put on drawings without modifications. Provide notes below the plates to indicate changes or clarifications to the plates.
****

Construct underground duct lines of individual conduits encased in concrete. Except where rigid galvanized steel conduit is indicated or specified, the conduit shall be PVC Type EB-35. Do not mix different kinds of conduit in any one duct bank. Ducts shall not be smaller than [100] [125] mm [4] [5] inches in diameter unless otherwise indicated. Concrete encasement surrounding the bank shall be rectangular in cross-section and shall provide at least 75 mm 3 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of [50] [65] mm [2] [2 1/2] inches, except separate light and power conduits from control, signal, and telephone conduits by a minimum concrete thickness of 75 mm 3 inches. [Provide color, type and depth of warning tape as specified in Section 02300 EARTHWORK.]

3.1.5.1 Depth of Encasement

Top of the concrete encasement shall not be less than 450 mm 18 inches below grade [except that under roads and pavement concrete be a minimum of 610 mm 24 inches below grade] [and under railroad tracks a minimum of 1270 mm 50 inches below top of rails].

3.1.5.2 Slope of Encasement

Duct banks shall have a continuous slope downward toward underground structures and away from buildings with a minimum pitch of 75 mm in 30 meters 3 inches in 100 feet. Except at conduit risers, accomplish changes in direction of runs exceeding a total of 0.175 rad 10 degrees, either vertical or horizontal, by long sweep bends having a minimum radius of curvature of7.62 meters 25 feet; 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 455 mm 18 inches for use with conduits of

less than 75 mm 3 inches in diameter and a minimum radius of 915 mm 36 inches for ducts of 75 mm 3 inches in diameter and larger. Excavate trenches along straight lines from structure to structure before ducts are laid or structure constructed so the elevation can be adjusted, if necessary, to avoid unseen obstruction.

3.1.5.3 Conduits

Terminate conduits in end-bells where duct lines enter underground structures. Stagger conduit joints by rows and layers to strengthen the duct bank. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly shall consist of base spacers, intermediate spacers, and top spacers to provide a completely enclosed and locked-in duct bank. Install spacers per manufacture's instructions, but provide a minimum of two spacer assemblies per 3050 mm 10 feet of duct bank. Before pouring concrete, anchor duct bank assemblies to prevent the assemblies from floating during concrete pouring. Anchoring shall be done by driving reinforcing rods adjacent to every other duct spacer assembly and attaching the rod to the spacer assembly.

3.1.5.4 Test Mandrel

As each section of a duct line is completed from structure to structure, draw a flexible testing mandrel approximately 305 mm 12 inches long with a diameter less than the diameter of the conduit through each conduit. After which, draw a stiff bristle brush through the conduit, until conduit is clear of particles of earth, sand, and gravel; then immediately install end plugs.

3.1.5.5 Conduit Plugs and Pull Rope

New conduit indicated as being unused or empty shall be provided with plugs on each end. Plugs shall contain a weephole or screen to allow water drainage. Provide a plastic pull rope having 915 mm 3 feet of slack at each end of unused or empty conduits.

3.1.5.6 Connections to Manholes

Duct bank envelopes connecting to underground structures shall be flared to have enlarged cross-section at the manhole entrance to provide additional shear strength. Dimensions of the flared cross-section shall be larger than the corresponding manhole opening dimensions by no less than 300 mm 12 inches in each direction. Perimeter of the duct bank opening in the underground structure shall be flared toward the inside or keyed to provide a positive interlock between the duct bank and the wall of the structure. Use vibrators when this portion of the encasement is poured to assure a seal between the envelope and the wall of the structure.

3.1.5.7 Connections to Existing [Manholes] [Handholes]

For duct bank connections to existing structures, break the structure wall out to the dimensions required and preserve steel in the structure wall. Cut steel and [extend into] [bend out to tie into the reinforcing of] the duct bank envelope. Chip the perimeter surface of the duct bank opening to form a key or flared surface, providing a positive connection with the duct bank envelope.

3.1.5.8 Connections to Existing Concrete Pads

For duct bank connections to concrete pads, break an opening in the pad out to the dimensions required and preserve steel in pad. Cut the steel and [extend into] [bend out to tie into the reinforcing of] the duct bank envelope. Chip out the opening in the pad to form a key for the duct bank envelope.

3.1.5.9 Connections to Existing Ducts

Where connections to existing duct banks are indicated, excavate the banks to the maximum depth necessary. Cut off the banks and remove loose concrete from the conduits before new concrete-encased ducts are installed. Provide a reinforced concrete collar, poured monolithically with the new duct bank, to take the shear at the joint of the duct banks. [Remove existing cables which constitute interference with the work.] [Abandon in place those no longer used ducts and cables which do not interfere with the work.]

3.1.5.10 Partially Completed Duct Banks

During construction wherever a construction joint is necessary in a duct bank, prevent debris such as mud, and, and dirt from entering ducts by providing suitable conduit plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of 610 mm 2 feet back into the envelope and a minimum of 610 mm 2 feet beyond the end of the envelope. Provide one No. 4 bar in each corner, 75 mm 3 inches from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately 305 mm one footapart. Restrain reinforcing assembly from moving during concrete pouring.

[3.1.5.11 Removal of Ducts

Where duct lines are removed from existing underground structures, close the openings to waterproof the structure. Chip out the wall opening to provide a key for the new section of wall.

][3.1.5.12 Optional Precast Sectional Underground Duct Bank

****
NOTE: Delete this paragraph for LANTNAVFACENGCOM projects.
****

The Contractor may choose to substitute concrete, precast, sectional, underground duct bank, with PVC conduits, for the cast-in-place underground conduit with concrete encasement. Key and tie together precast sections in a manner to provide the strength and integrity of a cast-in-place structure. Keep conduits in alignment from section to section to provide a smooth surface for pulling cables. Lock precast sections together so that the maximum gap after settlement does not exceed 6 mm 1/4 inch. Fill gaps between concrete sections with flexible plastic grouting material to prevent entry of water and foreign material. Install rebar in precast sections in accordance with the requirements of cast-in-place duct banks. Key the precast duct bank into manholes, with a cast-in-place section, of 915 mm 3 feet minimum, joining the last section to each manhole. The alignment vertically and horizontally of any two adjacent sections shall not vary more than 6 mm 1/4 inch when measured from end of conduit to end of conduit. Concrete strength shall be the same as for cast-in-place

units. Precast duct banks without the PVC conduits will not be permitted.

]3.1.6 Underground Conduit for Service Feeders Into Buildings

Shall be [PVC, Type EPC-40] [galvanized rigid steel or steel IMC] from the service equipment to a point 1525 mm 5 feet beyond the building and projections thereof. Protect the ends of the conduit [by threaded metal caps or bushings; coat the threads with graphite grease or other coating]. Clean and plug conduit until conductors are installed. [Encase the underground portion of the conduit in a concrete envelope and bury as specified for underground duct with concrete encasement.]

[3.1.7 Conduit Protection at Concrete Penetrations

Galvanized conduits which penetrate concrete (slabs, pavement, and walls) in wet locations shall be PVC coated and shall extend from at least 50 mm 2 inches within the concrete to the first coupling or fitting outside the concrete (minimum of 150 mm 6 inches from penetration).

]3.1.8 Buried Warning and Identification Tape

Bury tape with the printed side up at a depth of 305 mm 12 inches below the top surface of earth or the top surface of the subgrade under pavements.

3.1.9 Cable Pulling

[Test existing duct lines with a mandrel and thoroughly swab out to remove foreign material before pulling cables.] Pull cables down grade with the feed-in point at the manhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through manhole opening and into duct runs. Do not exceed the specified cable bending radii when installing cable under any conditions, including turnups into switches, transformers, switchgear, switchboards, and other enclosures. Cable with tape [or wire] shield shall have a bending radius not less than 12 times the overall diameter of the completed cable. If basket-grip type cable-pulling devices are used to pull cable in place, cut off the section of cable under the grip before splicing and terminating.

3.1.9.1 Cable Lubricants

****
NOTE: Use the first bracketed sentence for LANTNAVFACENGCOM projects.
****

[Use lubricants that are specifically recommended by the cable manufacturer for assisting in pulling jacketed cables]. [Cable lubricants shall be [petroleum grease for lead covered cables] [soapstone, graphite, or talc for rubber or plastic jacketed cables.] Lubricant shall not be deleterious to the cable sheath, jacket, or outer coverings.]

3.1.9.2 Cable Pulling Tensions

****
NOTE: Delete the bracketed sentence for LANTNAVFACENGCOM projects.
****

Tensions shall not exceed the maximum pulling tension recommended by the

cable manufacturer. [Monitor pulling tension during cable installation to ensure maximum pulling tension is not exceeded.]

3.1.9.3 Secondary Cable Runs, 600 Volts and Less

****
NOTE: Delete this paragraph for LANTNAVFACENGCOM projects.
****

Provide insulated copper equipment grounding conductor, sized as required by the rating of the overcurrent device supplying the phase conductors.

3.1.9.4 Cables in [Manholes,] [and] [Handholes,] [and] [Vaults]

****
NOTE: On contracts where existing cables are recircuited special attention should be given to changing existing cable identification tags in each manhole to reflect new circuit numbers.
****

Do not install cables utilizing the shortest route, but route along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support on brackets and cable insulators at a maximum of [1220 mm] [450 mm] [4 feet] [18 inches]. Support cable splices in underground structures by racks on each side of the splice. Locate splices to prevent cyclic bending in the spliced sheath. Install cables at middle and bottom of cable racks, leaving top space open for future cables, except as otherwise indicated for existing installations. Provide one spare three-insulator rack arm for each cable rack in each underground structure. In existing manholes, handholes and vaults where new ducts are to be terminated or where new cables are to be installed, modify the existing installation of cables, cable supports and grounding as required for a uniform installation with cables carefully arranged and supported in the same manner as specified for new cable. [Provide [_____] cable racks in each underground structure through which cable is run.]

3.1.9.5 Cable Tags in [Manholes] [and] [Handholes] [and] [Vaults]

Provide cable markers (or tags) as specified in Section 16050N BASIC ELECTRICAL MATERIALS AND METHODS.

[3.1.9.6 Conductors Installed in Parallel

Conductors shall be grouped such that each conduit of a parallel run contains 1 Phase A conductor, 1 Phase B conductor, 1 Phase C conductor, and 1 neutral conductor.

]3.1.10 600 Volt Cable Splicing and Terminating

****
NOTE: For LANTNAVFACENGCOM projects, use the second bracketed paragraph.
****

[Protect terminations of insulated power and lighting cables from accidental contact, deterioration of coverings and moisture by providing

terminating devices and materials. Install terminations of insulated power and lighting cables [and] [cable joints] in accordance with the manufacturer's requirements. Make terminations with materials and methods as indicated or specified herein or as designated by the written instructions of the cable manufacturer and termination kitmanufacturer.]

[Provide splices and terminations to protect 600 volts insulated power and lighting cables from accidental contact, deterioration of coverings and moisture. Make terminations and splices with materials and methods as indicated or specified herein and as designated by the written instructions of the manufacturer. Do not allow the cables to be moved until after the splicing material has completely set. [Make splices in underground distribution systems only in accessible locations such as manholes and handholes.]]

3.1.10.1 Splices for 600 Volt Class Cables

****

NOTE: Delete this subparagraph for LANTNAVFACENGCOM projects. Direct earth burial cables generally require direct burial splices. Incorporate marker slab requirements previously covered in this specification.

****

****

NOTE: Delete subparagraph on cold shrink joints for PWC Pearl Harbor areas and systems.

****

Splices in underground distribution systems shall made [only in accessible locations such as manholes and handholes,] with a compression connector on the conductor and by insulating and waterproofing by one of the following methods suitable for continuous submersion in water and [comply with] [pass] ANSI C119.1.

a. Provide cast-type splice insulation by means of molded casting process employing a thermosetting epoxy resin insulating material applied by a gravity poured method or by a pressure injected method. Provide component materials of the resin insulation in a packaged form ready for convenient mixing without removing from the package. Do not allow the cables to be moved until after the splicing material has completely set.

b. Gravity poured method shall employ materials and equipment contained in an approved commercial splicing kit which includes a mold suitable for the cables to be spliced. When the mold is in place around the joined conductors, prepare the resin mix and pour into the mold. Do not allow cables to be moved until after the splicing materials have completely set.

c. Provide [heavy wall] heat shrinkable splice insulation by means of a thermoplastic adhesive sealant material which should be applied by a clean burning propane gas torch. Cables may be moved when joint is cool to the touch.

d. Provide a cold-shrink rubber splice which consists of EPDM rubber tube which has been factory stretched onto a spiraled core which is removed during splice installation. The installation shall not

require heat or flame, or any additional materials such as coverings or adhesive. It shall be designed for use with inline compression type connectors, or indoor, outdoor, direct-burial or submerged locations.

e. Where aluminum conductors are provided, use particular care in making up joints and terminations. Remove surface oxides by cleaning with a wire brush or emery cloth. Provide joint compound on conductors, and UL listed solid aluminum connectors for connecting aluminum to aluminum. When connecting aluminum to copper, provide connectors specifically designed for connecting aluminum to copper.

[3.1.10.2 Terminating Aluminum Conductors

****
NOTE: Use this paragraph for LANTNAVFACENGCOM projects only.
****

a. Use particular care in making up joints and terminations. Remove surface oxides by cleaning with a wire brush or emery cloth. Apply joint compound to conductors, and use UL-listed solid aluminum connectors for connecting aluminum conductors. When connecting aluminum to copper conductors, use connectors specifically designed for this purpose.

b. Terminate aluminum conductors to copper bus either by: (1) in line splicing a copper pigtail to the aluminum conductor (copper pigtail shall have a ampacity at least that of the aluminum conductor); or (2) using a circumferential compression type, aluminum bodied terminal lug UL listed for AL/CU and steel Belleville spring washers, flat washers, bolts, and nuts. Belleville spring washers shall be cadmium-plated hardened steel. Install the Belleville spring washers with the crown up toward the nut or bolt head, with the concave side of the Belleville bearing on a heavy-duty, wide series flat washer of larger diameter than the Belleville. Tighten nuts sufficient to flatten Belleville and leave in that position. Lubricate hardware with joint compound prior to making connection. Wire brush and apply joint compound to conductor prior to inserting in lug.

c. Terminate aluminum conductors to aluminum bus by using all-aluminum nuts, bolts, washers, and lugs. Wire brush and apply joint compound to conductor prior to inserting in lug. Lubricate hardware with joint compound prior to making connection; if bus contact surface is unplated, scratch-brush and coat with joint compound (without grit).

]3.1.11 Medium Voltage Cable Terminations

****
NOTE: Use this paragraph for LANTNAVFACENGCOM projects only.
****

Provide terminating devices and materials to protect medium voltage cable terminations from accidental contact, deterioration of coverings, and moisture. Make terminations by using materials and methods specified

herein and as designated by the written instruction of the cable manufacturer and termination kit manufacturer. Termination for high-voltage cables shall be rated, and be capable of withstanding test voltages, in accordance with IEEE Std 48. Terminations of single- and multiconductor cables shall include the securing and sealing of the sheath and insulation of the cable conductors, stress relief and grounding of cable shields of shielded cable, and grounding of neutral conductors, metallic sheaths, and armor. Adequately support cables and cable terminations to avoid any excessive strain on the termination and the conductor connection.

3.1.12 Medium Voltage Cable Joints

****

NOTE: Use the first bracketed paragraph for LANTNAVFACENGCOM projects.

****

****

NOTE: Delete subparagraph on cold shrink joints for PWC Pearl Harbor areas and systems.

****

[Provide power cable joints (splices) suitable for continuous immersion in water [and direct burial]. Make joints only in accessible locations in manholes or handholes by using materials and methods specified herein and as designated by the written instructions of the cable manufacturer and the joint kit manufacturer. [Clearly mark joints buried directly in earth by an identification slab.] Size connectors properly for the cable being connected and crimp using a full circle compression tool.]

[Provide power cable joints suitable for direct burial or continuous immersion in water [and made only in accessible locations in manholes or handholes]. [Clearly mark joints buried directly in earth by an identification slab.]

a. Make medium-voltage joints by using a kit of one manufacturer and with written approval of the manufacturer of the cable which is to be spliced. Provide the [Contracting Officer] [Contractor's Quality Control Representative] with a copy of the manufacturer's instructions before jointing is started. Upon request, supply manufacturer's design qualification test report in accordance with IEEE Std 404. Joint design shall have been proof tested in accordance with IEEE Std 404. Connectors for joint shall be tin-plated electrolytic copper, having ends tapered and having center stops to equalize cable insertion.

(1) Epoxy cast-type joint methods: Provide cast-type joint insulation by means of a molded casting process employing a thermosetting epoxy resin insulating material which shall be applied by a gravity poured method or by a pressure injected method. Provide component materials of the resin insulation in a packaged form ready for convenient mixing without removing from the package. Do not allow cables to be moved until after the jointing material has completely set.

(2) EPR cast-type joint: Provide insulation by means of a molded casting process employing an ethylene propylene-rubber (EPR) jointing compound which results in an inseparable bond between the

jointing material and cable insulation. The molding process shall include injection of molding material into the mold to ensure void-free joints.

(3) Watertight taped-type joint: Consists of an approved connector, self-fusing tape (splicing compound), self-bonding semiconducting tape, tinned copper shielding tape or braid, and plastic tape.

(4) Tape overcast-type joint: Watertight taped-type, overcast with an epoxy resin construction for the cast-type, pressure method. Provide joint suitable for the rated voltage of the cable, to a limit of 15 KV.

(5) Vulcanized-type joint: Heat-pressure process of an approved type and employing materials and equipment suitable for the type and voltage of cables for which it is used. Materials used in the jointing process shall be fully and permanently compatible with materials in the cables. Provide joint suitable for the rated voltage of the cable, to a limit of 5 KV.

(6) Heat-shrinkable joint: A uniform cross-section heat-shrinkable polymeric construction consisting of a linear stress relief system, a high dielectric strength insulating material, and an integrally bonded outer conductor layer for shielding. Replace original cable jacket with a heavy-wall heat-shrinkable sleeve with hot-melt adhesive coating. Provide joint suitable for the rated voltage of the cable.

(7) Cold-shrink rubber-type joint: Joint shall be of a cold shrink design that does not require any heat source for its installation. Splice insulation and jacket shall be of a one-piece factory formed cold shrink sleeve made of black EPDM rubber. Splice shall be packaged three splices per kit, including complete installation instructions. Provide joint suitable for the rated voltage of the cable, to a limit of 8.7 kV.

(8) Inline molded rubber-type joint: The concentric neutral (CN) or jacketed concentric neutral (JCN) cable joint must meet the requirements of IEEE Std 404 for the voltage rating of the cable it is to be used on 15, 25 or 35 kV. It must be rated for continuous operation at 90 degrees C, with an emergency overload temperature rating of 130 degrees C. The joint shall be a slip-on design made of molded peroxide cured EPDM rubber, with a separate jacket over the splice and neutral wires consisting of an EPDM rubber tube which has been factory stretched onto a spiraled core, which is removed during installation. The splice shall be rated for indoor, outdoor or direct burial applications.]

3.1.12.1 Joints in Shielded Cables

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NOTE: For LANTNAVFACENGCOM, the bracketed sentences apply to Naval Base, Norfolk, VA. 34.5 kV distribution systems.
****

Cover the joined area with metallic tape, or material like the original cable shield and connect it to the cable shield on each side of the splice.

[Insulate cable shield for 34.5 kV system splices into sections at each splice to prevent circulating currents in the shield. Ground each insulated section at one point only] [Ground ends of insulated sections terminating in potheads at the pothead terminal only]. Provide a bare copper ground connection brought out in a watertight manner and grounded to a ground rod as part of the splice installation. Ground conductors, connections, and rods shall be as specified elsewhere in this section. Wire shall be trained to the sides of the enclosure to prevent interference with the working area.

[3.1.12.2 Lead-Sheathed Cable Joints

Prepare for jointing by cutting the lead sheath back the required distance and belling the remaining cable sheath to prevent damage to the conductor insulation. Clean insulated conductors and tape and cut insulation to expose bare wires for the required distance. Clean conductor thoroughly, then join by a split or slotted tinned copper connector or other approved connector. Solder conductors and connector and wrap joint with compatible semiconducting tape and insulating tape as recommended by the manufacturer so that insulation will be at least equal to the rated insulation of the cable. [For cable over 7500 volts operating voltage, provide cable shield splice.] Center the lead sleeve over the prepared joint, and [boil out the area with hot insulating oil,] [fill with an insulating oil] [fill with an insulating compound] and solder seal. [Alternately use a factory-engineered heat shrinkable joint kit to complete the splice. Heat shrinkable joint kit shall contain necessary materials except connector to provide oil stop and oil seal, electrical stress, control, insulation, shielding and environmental sealing. Kit shall allow for external grounding.]

]3.1.13 Cable End Caps

Cable ends shall be sealed at all times with coated heat shrinkable end caps. Cables ends shall be sealed when the cable is delivered to the job site, while the cable is stored and during installation of the cable. The caps shall remain in place until the cable is spliced or terminated. Sealing compounds and tape are not acceptable substitutes for heat shrinkable end caps. Cable which is not sealed in the specified manner at all times will be rejected.

[3.1.14 Live End Caps

Provide live end caps for single conductor medium voltage cables where indicated.

]3.1.15 Fireproofing of Cables in Manholes, Handholes and Vaults

Fireproof (arc proof) wire and cables which will carry current at 2200 volts or more in manholes, handholes, and vaults.

3.1.15.1 Fireproofing Tape

Tightly wrap strips of fireproofing tape around each cable spirally in half-laped wrapping. Install tape in accordance with manufacturer's instructions.

[3.1.15.2 Tape-Wrap

Tape-wrap lead-sheathed or other metallic-sheathed or metallic armored

cables without a nonmetallic protective covering over the sheath or armor prior to application of fireproofing. Wrap shall be in the form of two tightly applied half-lapped layers of a pressure-sensitive 0.254 mm 10 mil thick plastic tape, and shall extend not less than 25 mm one inch into the duct. Even out irregularities of the cable, such as at splices, with insulation putty before applying tape.

]3.1.16 Grounding Systems

****
NOTE: For LANTNAVFACENGCOM projects, use the first bracketed paragraph. Designer must determine the grounding requirements for each project. Show all necessary ground rods, ground girdles, etc., on the drawings. For Communications - Electronic facilities, specify a maximum resistance to ground of 10 ohms (required by MIL-STD-188-124A).
****

[Noncurrent-carrying metallic parts associated with electrical equipment shall have a maximum resistance to solid earth ground not exceeding the following values:

[Generating and control equipment 1000 volts and over: 1 ohm]

[Main substations] [, distribution substations] [, switching stations] [, primary distribution stations enclosed by fences]:

[500 kVA or less: 5 ohms]
[500 kVA to 1000 kVA: 5 ohms]
[1000 kVA or over: 3 ohms]

[Pad-mounted transformers without protective fences: 5 ohms]

[Ground in manholes, handholes, and vaults: 5 ohms]

[Grounding other metal enclosures of primary voltage electrical and electrically-operated equipment: 5 ohms]

[Grounded secondary distribution system neutral and noncurrent-carrying metal parts associated with distribution systems and grounds not otherwise covered: 5 ohms]

When work in addition to that indicated or specified is directed in order to obtain the specified ground resistance, the provisions of the contract covering "Changes" shall apply.]

[Shall be as indicated, and as required by NFPA 70 and ANSI C2.]

3.1.16.1 Grounding Electrodes

****
NOTE: In areas of extremely high chemical activity of soil, ground rods and other metals must not be placed in direct contact with soil. Ground rods shall be completely encased in concrete and connections made to them by thermit welds. Chemical isolation from soil shall be maintained to a point at least 100 mm 4 inches above finished grade. When

necessary to use metal conduit, it shall be encased in concrete, tape wrapped, PVC coated or otherwise fully protected against chemical activity.

****

Provide cone pointed driven ground rods driven full depth plus 150 mm 6 inches, installed to provide an earth ground of the appropriate value for the particular equipment being grounded.

3.1.16.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, [excepting specifically those connections for which access for periodic testing is required,] by exothermic weld or compression connector.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.

3.1.16.3 Grounding Conductors

Grounding conductors shall be stranded-bare copper conforming to ASTM B 8, Class B, for sizes No. 6 AWG and larger, and shall be solid-bare copper conforming to ASTM B 1 for sizes No. 8 and smaller. Cable sheaths, cable shields, conduit, and equipment shall be grounded with No. 6 AWG [, except 34.5 kV cable sheaths and cable shields shall be grounded with No. 4/0 AWG].

3.1.16.4 Ground Cable Crossing Expansion Joints

Protect ground cables crossing expansion joints or similar separations in structures and pavements by use of approved devices or methods of installation which provide the necessary slack in the cable across the joint to permit movement. Use stranded or other approved flexible copper cable across such separations.

[3.1.16.5 Ground Rod Connections

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NOTE: Do not use this paragraph except under special conditions where insulation is required.

****

Connect ground rods only to insulated copper ground conductor and weld the connection. Insulate entire area of the rod in the vicinity of the weld in accordance with UL 467and the connecting wire and seal against moisture penetration.

][3.1.16.6 Fence Grounding

[Fences shall be grounded as indicated.] [Fences shall be grounded with a

ground rod at each fixed gate post and at each corner post.] Drive ground rods until the top is 305 mm 12 inches below grade. Attach a No. 4 AWG copper conductor, by exothermic weld to the ground rods and extend underground to the immediate vicinity of fence post. Lace the conductor vertically into 305 mm 12 inches of fence mesh and fasten by two approved bronze compression fittings, one to bond wire to post and the other to bond wire to fence. Each gate section shall be bonded to its gatepost by a 3 by 25 mm 1/8 by one inch flexible braided copper strap and ground post clamps. Clamps shall be of the anti-electrolysis type.

][3.1.17 Special Conditions

During the construction of duct banks and underground structures located in streets, the streets shall remain open to traffic. Plan and execute the work to meet this condition. At locations where duct banks cross railroad tracks and the work requires closing of the tracks, secure permission from the Contracting Officer for each track closure.

]3.1.18 Earthwork for Utilities

Section 02300 EARTHWORK.

3.1.19 Reconditioning of Surfaces

3.1.19.1 Unpaved Surfaces

Restore to their original elevation and condition unpaved surfaces disturbed during installation of duct [or direct burial cable]. Preserve sod and topsoil removed during excavation and reinstall after backfilling is completed. Replace sod that is damaged by sod of quality equal to that removed. When the surface is disturbed in a newly seeded area, re-seed the restored surface with the same quantity and formula of seed as that used in the original seeding.

3.1.19.2 Paving Repairs

****

NOTE: Where paving repairs are a very minor part of project, the first bracketed paragraph may be used; otherwise, use the second bracketed paragraph and include other sections as needed (also include necessary cutting and patching details on the drawings.)

****

****

NOTE: Insert appropriate Section number and title in the blank below using format per UFC 1-300-02.

****

Where trenches, pits, or other excavations are made in existing roadways and other areas of pavement where surface treatment of any kind exists [, restore such surface treatment or pavement the same thickness and in the same kind as previously existed, except as otherwise specified, and to match and tie into the adjacent and surrounding existing surfaces.] [Make repairs as specified in Section [02752 PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES] [_____].]

3.1.20 Certificate of Competency for Cable Splicer/Terminator

****
NOTE: Delete this paragraph for LANTNAVFACENGCOM projects.
****

Certification of the qualification of the cable splicer/terminator shall be submitted, for approval, 30 days before splices or terminations are to be made in medium voltage (5 kV to 35 kV) cables. The certification shall include the training, and experience of the individual on the specific type and classification of cable to be provided under this contract. The certification shall indicate that the individual has had three or more years recent experience splicing and terminating medium voltage cables. The certification shall also list a minimum of three splices/terminations that have been in operation for more than one year. In addition, the individual may be required to perform a dummy or practice splice/termination in the presence of the Contracting Officer, before being approved as a qualified cable splicer. If that additional requirement is imposed, the Contractor shall provide short sections of the approved types of cables along with the approved type of splice/termination kit, and detailed manufacturer's instructions for the cable to be spliced. The Contracting Officer reserves the right to require additional proof of competency or to reject the individual and call for certification of an alternate cable splicer.

3.2 FIELD QUALITY CONTROL

As an exception to requirements that may be stated elsewhere in the contract, notify the Contracting Officer [5] [_____] working days prior to each test[s]. Furnish labor, equipment. and incidentals required for testing, except that the Government will provide electric power required for the tests. Correct defects in the work provided by the Contractor and repeat tests until the work is in compliance with contract requirements.

3.2.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, NFPA 70B, NETA ATS, and referenced ANSI standards. Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.2.1.1 600 Volt Cable Tests

Perform tests after wiring is completed, connected, and ready for operation, but prior to placing system in service and before any branch circuit breaker is closed.

a. Visual and Mechanical Inspection

(1) Inspect cables for physical damage and proper connection in accordance with contract plans and specifications.

(2) Test cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench. In the absence of manufacturer's data use NETA recommended values.

(3) Check cable color coding for compliance with contract specifications.

b. Electrical Tests

(1) Perform insulation-resistance test on each conductor with respect to ground and adjacent conductor; applied potential shall be 1000 volts DC for 1 minute; minimum insulation-resistance values shall not be less than 2 megohms.

(2) Perform continuity test to insure proper cable connection.

3.2.1.2 Medium Voltage Cables

Perform tests after installation of cable, splices, and terminators and before terminating to equipment.

a. Visual and Mechanical Inspection

(1) Inspect exposed cable sections for physical damage.

(2) Verify that cable is supplied and connected in accordance with contract plans and specifications.

(3) Inspect for proper shield grounding, cable support, and cable termination.

(4) Verify that cable bends are not less than ICEA or manufacturer's minimum allowable bending radius.

(5) Inspect for proper fireproofing.

[(6) If cables are terminated through window-type CT's, make an inspection to verify that neutrals and grounds are properly terminated for proper operation of protective devices.]

(7) Visually inspect jacket and insulation condition.

(8) Inspect for proper phase identification and arrangement.

b. Electrical Tests

(1) Perform a shield continuity test on each power cable by ohmmeter method. Record ohmic value, resistance values in excess of 10 ohms per 1000 feet of cable must be investigated and justified.

(2) Perform a DC high-potential test on all cables. Adhere to precautions and limits as specified in the applicable NEMA/ICEA Standard for the specific cable. Test procedure shall be as follows, and the results for each cable test shall be recorded as specified herein. Field acceptance test voltage [for 5 kV cable shall be 25 kV DC] [and] [for 15 kV cable shall be [[55] [65] kV DC] [53 kV DC with insulated connectors]] [and] [for 25 kV cable shall be [[80] [100] kV DC] [78 kV DC with insulated connectors]] [and] [for 35 kV cable shall be 100 kV DC].

****

NOTE: Use the following DC test voltages:

	EPR & XLP	PILC**
5kV Cable,	25kV	30kV
15kV Cable, 100 Percent Insulation	*53kV/55kV	65kV
15kV Cable, 133 Percent Insulation	*53kV/65kV	85kV
25kV Cable, 100 Percent Insulation	*78kV/80kV	105kV
25kV Cable, 133 Percent Insulation	*78kV/100kV	135kV
28kV Cable, 100 Percent Insulation	*78kV/85kV	115kV
35kV Cable, 100 Percent Insulation	100kV	145kV

***Use lower value when insulated connectors are connected to the cable being tested.**
****When PILC cable has nonmetallic outer jacket, reduce these values by 10 percent.**
****

(a) Current-sensing circuits in test equipment shall measure only the leakage current associated with the cable under test and shall not include internal leakage of the test equipment.

(b) Record wet- and dry-bulb temperatures or relative humidity and temperature.

(c) Test each section of cable individually.

(d) Individually test each conductor with all other conductors grounded; Ground all shields.

(e) Terminations shall be properly corona-suppressed by guard ring, field reduction sphere, or other suitable methods as necessary.

(f) Ensure that the maximum test voltage does not exceed the limits for terminators specified in IEEE standard 48 or manufacturer's specifications.

(g) Apply the DC high-potential test in at least five equal increments until maximum test voltage is reached. No increment shall exceed the voltage rating of the cable. Record DC leakage current at each step after a constant stabilization time consistent with system charging current.

(h) Raise the conductor to the specified maximum test voltage and hold for fifteen (15) minutes. Record readings of leakage current at 30 seconds and one minute and at one-minute intervals thereafter. Provide a graphic plot of readings with leakage current (X axis) versus voltage (Y axis) at each increment.

(i) Reduce the conductor test potential to zero and measure residual voltage at discrete intervals.

(j) Apply grounds for a time period adequate to drain all insulation stored charge.

(k) When new cables are spliced into existing cables, the DC high-potential test shall be performed on the new cable prior to splicing. After test results are approved for new cable and the splice is completed, an insulation-resistance test and a

shield-continuity test shall be performed on the length of new and existing cable including the splice. After a satisfactory insulation-resistance test, a DC high-potential test shall be performed on the completed cable system utilizing a test voltage 75 percent of new cable tested value.

3.2.1.3 Ground Rods

Perform ground resistance tests for ground rods before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Ground resistance shall also be measured for each piece of equipment and medium voltage cable splice to the ground electrode. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground electrode under test.

3.2.2 Approval of Test Results

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NOTE: Use this paragraph of specifications covering work under SOUTHNAVFACENGCOM cognizance.

****

Medium voltage cable test results shall be approved by SOUTHNAVFACENGCOM (Code 074).

3.3 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements are as follows:

PRODUCTS	INCH-POUND	METRIC
a. Fireproofing Tape		
- Thickness	30 mils	0.762 mm
- Width	3 inches	75 mm
b. Pull Wire		
- Tensile strength	200 pounds	890 Newton
c. Ground Rod		
- Diameter	3/4 inch	19 mm
- Length	10 feet	3050 mm

-- End of Section --