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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA-16124 (July 2003)
NASA - KSC
Superseding NASA-16124 (March 2003)

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DIVISION 16 - ELECTRICAL

SECTION 16124

MEDIUM VOLTAGE CABLE

07/03

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NASA-16124 (July 2003)
NATIONAL AERONAUTICS **NASA - KSC**
AND SPACE ADMINISTRATION **Superseding NASA-16124 (March 2003)**

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SECTION 16124

MEDIUM VOLTAGE CABLE
07/03

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NOTE: Delete, revise, or add to the text in this section to cover project requirements. Notes are for designer information and will not appear in the final project specification.

This section covers medium voltage cables, including 5 kV and 15 kV shielded single-conductor power cables, cable splices and terminations, potheads, and fireproofing cables in manholes.

Drawings should show plan layout of power cable and power-cable terminations. Electrical riser diagrams should show size, type, electrical characteristics, and raceway system of power cables and type of cable termination.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: The following references should not be manually edited except to add new references. References not used in the text will automatically be deleted from this section of the project specification.

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The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C119.1	(1986) Electric Connectors-Sealed Underground Connector Systems Rated 600

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS6	(October 1987, R 1989; 5th Ed) Specifications for Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 through 69 kV

ASTM INTERNATIONAL (ASTM)

ASTM B 8	(1999) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D 746	(1979; R 1987) Brittleness Temperature of Plastics and Elastomers by Impact

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 386	(1995) Separable Insulated Connector Systems for Power Distribution systems Above 600V
IEEE 48	(1996) Test Procedures and Requirements For Alternating Current Cable Terminations 2.5 kV Through 765 kV

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(1999) Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA WC 8	(1993) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-68-516)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

1.2 DEFINITIONS

Medium voltage power cables shall mean all cables rated above 601 to 35,000 volts.

1.3 GENERAL REQUIREMENTS

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NOTE: If Section 16003, "General Electrical Provisions," is not included in the project specification, applicable requirements therefrom should be inserted and the following paragraph deleted.
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Section 16003, "General Electrical Provisions," applies to work specified in this section.

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01330, "Submittals," and edit the

following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control. Include a columnar list of appropriate products and tests beneath each submittal description.

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The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

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

Single Conductor 5 kV Shielded Cable
Single Conductor 15 kV Shielded Cable
Cable Supports and Fittings
Cable Tags
Fireproof Tape
Splice Kits (including splice grounding)
Terminations

SD-06 Test Reports

Submit test Reports in accordance with the paragraph entitled, "Field Testing," of this section.

Insulation Resistance Test
Direct-current high-potential test

SD-07 Certificates

Listing of Products Installed shall be provided showing qualifications of cable splicers to the Contracting Officer prior to specified work.

The Contractor shall prepare and submit a Pulling Plan including calculations of pulling tension and sidewall pressure anticipated, and the maximum allowable pulling tension for each pull.

Certificates shall be provided for the following showing that the cable manufacturer has made factory-conducted tests on each shipping length of cable. Certified copies of test data shall show conformance with the referenced standards and shall be approved prior to delivery of cable.

Conductor Resistance
Accelerated Water Absorption Test
Water Immersion Test
Ionization
High-Voltage
Mechanical Integrity
Bending Test
High-Voltage Time Test
Dielectric Power Loss
Power-Factor Tests

Qualifications of Cable Splicers
Dielectric Termination Tests
Partial Discharge Test

SD-08 Manufacturer's Instructions

Manufacturer's instructions shall be provided showing the recommended sequence and method of installation for the following:

Single Conductor 5 kV Shielded Cable
Single Conductor 15 kV Shielded Cable
Terminations
Splice Kits (including splice grounding)

1.5 QUALIFICATIONS

Qualifications of cable splicers shall be provided.

Personnel performing splicing shall have [5] [_____] years experience in cable splicing and terminations of the type used in this project. Once a termination or splice has been started by a worker, the same person shall complete that particular splice. Each termination and splice shall be started and completed in one continuous work period.

1.6 CABLE VOLTAGE RATINGS AND USE

Medium-voltage power cables shall include multiple- and single-conductor cables rated as follows, phase-to-phase, for grounded neutral systems:

Cables rated [5,000] [15,000] volts, grounded neutral, shall be used on [2,400/4,160] [13,200] [13,800]-volt, three-phase, 60-hertz distribution systems.

Cables shall be installed in a duct and manhole system which may be subject to continuous immersion in a coastal environment containing brackish water at depths of up to 15 feet 4.5 meters.

1.7 FACTORY TESTING

Certified evidence shall be submitted that the cable manufacturer has made factory-conducted tests on each shipping length (reel) of cable; certified copies of test data shall be submitted in accordance with applicable provisions of the referenced standard. Tests on each length of cable shall include conductor resistance; ionization; high voltage; partial discharge test. Contracting Officer or designee shall have the option of witnessing required factory testing at no additional cost. A schedule of manufacturing and testing shall be provided in advance to permit such witnessing, if desired.

Certified evidence shall be submitted that the cable manufacturer has made factory-conducted sample tests in accordance with the applicable referenced standards. Tests on each sample of cable shall include mechanical integrity, bending test, high-voltage time test, dielectric power loss, dielectric termination tests and power-factor tests. Certified copies of test data shall show conformance to the requirements of referenced standards and shall be submitted for approval prior to shipment of the cable.

Prior to manufacturing, data regarding degradation of proposed insulating material and cable performance due to water immersion test as specified in

this specification shall be provided to Contracting Officer or designee. Information shall indicate A.C. breakdown stress in kV/mm or V/mil versus immersion time. A complete cable description and condition under which cable was tested shall accompany the test information. Accelerated water absorption test shall also be submitted.

1.8 SHIPMENT

Listing of products installed shall be submitted.

The shipment of cable shall be made on reels in such a manner that the cable will be protected from mechanical injury. Each end of each length of cable shall be hermetically sealed using heat-shrinkable molded cable end caps to exclude moisture and securely attached to the reel.

The minimum diameter of the reel drum shall be 14 times the overall diameter of the cable. Those reels less than 60 inches 1524 millimeter in diameter shall have arbor holes sized for 2-1/2 inches 65 millimeter spindles; those greater than 60 inches 1524 millimeter in diameter shall have arbor holes sized for 3 inch 76 millimeter spindles. Reel sizes shall accommodate reel lengths specified in purchase order. Each reel shall contain only one length of cable cut to order.

Each reel shall have an arrow and appropriate wording stenciled in plain view on each side to indicate proper rotation of reels. Each reel shall be plainly marked on each side, and on a tag attached to the cable end inside the lagging, with the following information:

a. Purchaser's order number:

b. Complete description of cable including manufacturer, cable size, voltage rating, percent insulation rating, insulating material, conductor size(s), year of manufacture;

c. Actual shipping cable (reel) length;

d. Reel number (e.g. 2 of 10);

e. Gross weight (i.e. with reel) and net weight (i.e. cable only).

Reels shall be shipped in a vertical position, sufficiently blocked in the bed of shipping vehicle to preclude movement.

PART 2 PRODUCTS

2.1 CONDUCTORS

2.1.1 Material

Core (phase) conductor material shall be annealed copper in accordance with ASTM B 8 with a filled strand construction. Conductor shall be filled with semiconducting material to prevent moisture migration. Filler material shall have proven long term chemical compatibility with both the conductor and overlying insulation screen materials.

2.1.2 Stranding

Conductors shall be Class B stranded.

2.2 CABLE IDENTIFICATION

Cables shall have printing on the outer jacket showing the cable type, name of the manufacturer, the year in which the cable was manufactured, sequential cable reel length markings and a unique number for identification purposes. Information shall be closely grouped on the tape at 6 foot 1.8 meters maximum intervals to permit complete identification.

2.3 15 KV CABLES

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NOTE: Due to the high available fault currents on Kennedy Space Center's 5 kV and 15 kV systems, minimum conductor and concentric neutral sizes are required. for most areas of KSC, use at least #4/0 AWG with full neutral or 350 kcmil with 1/3-neutral. Areas far from supply substations may be able to use smaller cable sizes. Conduit size should be 5-inch minimum.

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2.3.1 General; 15 kV Cable

Single conductor 15 kV shielded cable assemblies shall consist of: Conductor core described above, an extruded semiconducting shield over the conductors, 220 mils 5.59 millimeter of ethylene-propylene-rubber (EPR) insulation, an extruded semiconducting insulation shield, a concentric neutral, and a polyethylene (PE) jacket. The cable shall be rated for minimum 90 degrees C continuous conductor temperature and 130 degrees emergency overload.

Single-conductor, ethylene-propylene-insulated, polyethylene-jacketed, shielded cable shall conform to NEMA WC 8 and AEIC CS6.

2.3.2 15 kV Cable Conductor Shielding

Conductors shall have a stress control layer consisting of extruded material applied between the conductor and the insulation to form a conductor shield (strand screen). This material shall have proven long-term chemical compatibility with both the conductor and overlying insulation materials. This stress control layer shall meet the electrical and physical requirements of NEMA WC 8.

2.3.3 Insulation; 15 kV Cable

Insulation material shall be an ozone resistant, extruded thermosetting ethylene-propylene based polymer. Insulation shall be capable of withstanding the continuous and emergency overload temperature ratings of the conductor.

2.3.4 Non-metallic Insulation Shield; 15 kV Cable

Extruded insulation shield shall be an extruded thermoset material compatible with the insulation and jacket. Insulation shield shall be applied directly over and bonded to the insulation, and shall comply with AEIC CS6.

2.3.5 Concentric Neutral Shield; 15 kV Cable

Copper wires helically applied over the insulation shield. Minimum total cross sectional area of the shield wires is 1/3 the core conductor and no less than 20 #14 AWG, 13 #12 AWG or 9 #10 AWG. Minimum size of an individual shield wire is #14 AWG. Where "full neutral" is specified, minimum total cross sectional area of the shield wires is equal to the core conductor.

2.3.6 Jacket; 15 kV Cable

Polyethylene (PE) shall be extruded over the concentric neutral to a minimum thickness of 80 mils 2 millimeter.

2.4 5 KV CABLES

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NOTE: Due to the high available fault currents on Kennedy Space Center's 5 kV and 15 kV systems, minimum conductor and concentric neutral sizes are required. for most areas of KSC, use at least #4/0 AWG with full neutral or 350 kcmil with 1/3-neutral. Areas far from supply substations may be able to use smaller cable sizes. Conduit size should be 5-inch minimum.

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2.4.1 General; 5 kV Cables

Single conductor 5 kV shielded cable assemblies shall consist of: Conductor core described above, an extruded semiconducting shield over the conductors, 115 mils 2.92 millimeter of ethylene-propylene-rubber (EPR) insulation, an extruded semiconducting insulation shield, a concentric neutral, and a polyethylene (PE) jacket. The cable shall be rated for minimum 90 degrees C continuous conductor temperature and 130 degrees emergency overload.

Single-conductor, ethylene-propylene-insulated, polyethylene-jacketed, shielded cable shall conform to NEMA WC 8 and AEIC CS6.

2.4.2 5 kV Cable Conductor Shielding

Conductors shall have a stress control layer consisting of extruded material applied between the conductor and the insulation to form a conductor shield (strand screen). This material shall have proven long-term chemical compatibility with both the conductor and overlying insulation materials. This stress control layer shall meet the electrical and physical requirements of NEMA WC 8.

2.4.3 Insulation; 5 kV Cable

Insulation material shall be an ozone resistant, extruded thermosetting ethylene-propylene based polymer. Insulation shall be capable of withstanding the continuous and emergency overload temperature ratings of the conductor.

2.4.4 Non-metallic Insulation Shield; 5 kV Cable

Extruded insulation shield shall be an extruded thermoset material

compatible with the insulation and jacket. Insulation shield shall be applied directly over and bonded to the insulation, and shall comply with AEIC CS6.

2.4.5 Concentric Neutral Shield; 5 kV Cable

Copper wires helically applied over the insulation shield. Minimum total cross sectional area of the shield wires is 1/3 the core conductor and no less than 20 #14 AWG, 13 #12 AWG or 9 #10 AWG. Minimum size of an individual shield wire is #14 AWG. Where "full neutral" is specified, minimum total cross sectional area of the shield wires is equal to the core conductor.

2.4.6 Jacket; 5 kV Cable

Polyethylene (PE) shall be extruded over the concentric neutral to a minimum thickness of 80 mils 2 millimeter.

2.5 INSULATED MEDIUM VOLTAGE CONNECTORS

IEEE 386. Connector shall have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material Provide connectors as indicated.

a. 200 Ampere loadbreak connector ratings: Voltage: 15kV, 95kV BIL. Short time rating: 10,000 amperes rms, symmetrical for a time duration of 0.17 seconds.

b. 600 Ampere deadbreak connector ratings: Voltage: 15kV, 95kV BIL. Short time rating: 27,000 ampere rms, symmetrical for a time duration of 4.0 seconds.

Connections shall be compatible with equipment bushings.

2.6 SPLICES

Splice kits shall be the product of a single manufacturer, either heat shrink or cold shrink, meeting the requirements of the paragraph entitled "Splices and Terminations" under Part 3 of this specification.

2.5 TERMINATIONS

Terminations shall be Class 1 per IEEE 48.

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NOTE: Coordinate the following paragraph with Section 02585, "Medium Voltage Underground Power Distribution" if Section 02585 is used in this project.
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2.6 CABLE SUPPORTS AND FITTINGS

[Cable supports, related fittings, and accessories for use in corrosive underground locations, such as manholes, shall be provided with a factory applied coating of polyvinylchloride of at least [20] [_____] mils [0.51] [_____] millimeter thick. Polyvinylchloride (PVC) coated items shall have a uniform thickness and be free of blisters, breaks, and holidays. PVC

compound shall conform to ASTM D 746.]

[Cable racks, rack arms, cable tray supports and related fittings shall be UL listed [standard] [heavy]-duty nonmetallic [glass-reinforced nylon] [polycarbonate].]

2.7 CABLE TAGS IN MANHOLES AND AT TERMINATIONS

Provide tags for each cable or wire located in manholes and at each termination. Tag all cables indicated to have tags.

2.7.1 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 4500 pounds per square inch 31 MPa; and that are 0.035-inch 0.9 millimeter thick, non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 300 degrees F 150 degrees C. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ties shall have a minimum loop tensile strength of 175 pound 780 newtons. The cable tags shall have block letters, numbers, and symbols 1 inch 25 millimeter high on a yellow background. Letters, numbers, and symbols shall not fall off or change positions regardless of the cable tags orientation.

2.8 FIREPROOF TAPE

Fireproof tape shall be approximately 30 mils 0.8 millimeter thick by 3 inches 76 millimeters wide. The tape shall consist of a flexible, unsupported elastomer that expands in fire to provide a thick char buildup between the flame and the cable. The tape shall not give off a smoke when subjected to flames or support combustion. The tape shall not deteriorate when subjected to oil, water, gases, salt water, sewage and fungus.

PART 3 EXECUTION

3.1 INSTALLATION

Medium-voltage cables shall be installed in accordance with NFPA 70.

Verify existing phasing and phase rotation at each interface with existing cables or equipment. Provide qualified personnel and the appropriate medium and low voltage test equipment as required to safely perform this phasing. Match and maintain existing system phasing and phase rotation at each splice and termination.

Cable shall be installed in underground duct banks; in conduit above and below grade; inside buildings; by open wire method; on insulator hooks; on racks; in wall and ceiling mounted cable trays; in manholes; and by direct burial.

Cable or conductors of a primary distribution system shall be rejected when installed openly in cable trays or openly racked along interior walls; in the same raceway or conduit with ac/dc control circuits or ac power circuits operating at less than 600 volts; or in a manner allowing cable to support its own weight.

3.1.1 Protection During Splicing Operations

Blowers shall be provided to force fresh air into manholes or confined

areas where free movement or circulation of air is obstructed. Waterproof protective coverings shall be available on the work site to provide protection against moisture while a splice is being made. Pumps shall be used to keep manholes dry during splicing operations. Under no conditions shall a splice or termination be made with the interior of a cable exposed to moisture. Conductor insulation paper shall be moisture-tested before the splice is made. A manhole ring at least [6] [_____]-inches [150] [_____] millimeter above ground shall be used around the manhole entrance to keep surface water from entering the manhole. Unused ducts shall be plugged and water seepage through ducts in use shall be stopped before the splice is started.

3.1.2 Duct Cleaning

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NOTE: Delete the heading and the following paragraph if the installation of power cables is in ducts and manholes provided under this project. Provisions for cleaning new duct are adequately covered in Section 02585, "Medium Voltage Underground Power Distribution."

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Ducts shall be thoroughly cleaned before installation of power cables. A standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material in the line.

3.1.2.1 PVC Duct

Mandrel length shall be not less than 12 inches long and shall have a diameter 1/2 inch less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. Brush diameter shall be the same or slightly larger than the diameter of the duct.

3.1.2.2 Existing Fiber (Orangeburg) Duct

Push rod through duct. Pull a series of four-2 inch wire brushes back and forth through the duct. Progressively increase the size of the four wire brushes until four-4 inch wire brushes can be pulled back and forth, and all of the debris has been removed. Next pull a flexible mandrel with two-4 inch heavy duty wire brushes on each side through the duct. The mandrel shall not be less than 12 inches long, and shall have a diameter that is inch to 1 inch less than the inside diameter of the duct. Next, pull a 5 foot section of sample cable, equivalent to what is being used. Finally, make the final cable pull on the same day the sample cable was pulled.

3.1.3 Pulling Cables in Ducts and Manholes

A pulling plan shall be submitted.

Medium-voltage cables shall be pulled into ducts with equipment designed for this purpose, including power-driven winch, cable-feeding flexible tube guide, long radius quadrant block cable pulling sheaves, cable grips, and lubricants. A sufficient number of trained personnel and equipment with two-way radio communication capability shall be employed to ensure the careful and proper installation of the cable.

Cable reel shall be set up at the side of the manhole or tunnel hatch opening and above the duct or hatch level, allowing the cable to enter through the opening without reverse bending. Flexible tube guide shall be installed through the opening in a manner that will prevent the cable from rubbing on the edges of any structural member (manhole frame, chimney, duct, etc.).

Two long-radius (30 inches 760 millimeter minimum) quadrant block cable pulling sheaves and necessary jamb skid support shall be used at the pulling end to ensure that sidewall pressures during pulling will not be excessive. A dynamometer shall be used in the pulling line to ensure that the pulling force is not exceeded. The pulling force shall not exceed the smaller of: allowable tension on pulling device, allowable tension on cable, or the tension which produces the allowable sidewall pressure. The allowable tension on the pulling device is 6500 pounds 28,900 newtons for pulling eyes [and 1000 pounds 4400 newtons for pulling grip (where allowed)]. The allowable tension on cable shall not exceed the value computed from the following equation:

TM = 0.008 0.036 X N X CM

Where: TM = maximum allowable pulling tension in pounds newtons

N = number of conductors in the cable

CM = cross-sectional area of each conductor in circular mils square millimeter

The allowable sidewall pressure is the smaller of 500 pounds per foot 7300 newtons per meter of bend radius or the cable manufacturer's recommended maximum value. The pulling plan submittal shall show the calculations for allowable tension and sidewall pressure as well as the anticipated tension and sidewall pressure for each pull in the project.

Cable shall be unreeled from the top of the reel. Payout shall be carefully controlled. Cable to be pulled shall be attached through a swivel to the main pulling wire by means of a [pulling eye installed by the factory or approved cable splicer] [suitable cable grip permitted only on cables less than 200 feet 60 meter long and less than 2 inches 50 millimeter in diameter].

Pulling eyes shall be attached to the cable conductors of the 3-1/C circuit to prevent damage to the cable structure. The entire 3-1/C circuit must be pulled simultaneously.

Minimum bending radius during cable pulling operations shall be 30 inches 760 millimeter. For permanent cable bending/racking the minimum bending radius shall be 12 times cable diameter.

Cables shall be liberally coated with a suitable cable-pulling lubricant as it enters the tube guide or duct. Grease and oil lubricants shall not be used. Nonmetallic sheathed cables shall be covered with wire-pulling compounds when required which have no deleterious effects on the cable. Rollers, sheaves, or tube guides around which the cable is pulled shall conform to the 30 inches 760 millimeter minimum bending radius of the cable during the pulling operations.

Cables shall be pulled into ducts at a speed not to exceed [50] [_____] feet per minute [15] [_____] meters per minute and not in excess of maximum

permissible pulling tension specified by the cable manufacturer. Cable pulling using a vehicle shall not be permitted. Pulling operations shall be stopped immediately with any indication of binding or obstruction and shall not be resumed until such difficulty is corrected. Sufficient slack shall be provided for free movement of cable due to expansion or contraction.

Cable splices made up in manholes shall be firmly supported on cable racks as indicated. No cable splices shall be pulled in ducts. Cable ends shall overlap at the ends of a section to provide sufficient undamaged cable for splicing. Cables to be spliced in manholes shall overlap the centerline of the proposed joint by not less than [2] [_____] feet [600] [_____] millimeter.

Cables cut in the field shall have the cut ends immediately sealed to prevent entrance of moisture with heat-shrinkable molded cable end caps.

3.1.4 Splices and Terminations

Splices shall be made in manholes except where cable terminations are specifically indicated. Splicing and terminating of cables shall be expedited to minimize exposure and cable deterioration.

The cable concentric neutral/shield wires shall be connected across each side of the splice and shall also be connected to one or two bare copper wires which are connected to the manhole grounding system. The total cross sectional area of the bare copper wires shall be at least equal to the shield size. All connections within the splice shall be made utilizing barrel-type compression connectors and appropriate compression tools with proper size dies to ensure a satisfactory mechanical and electrical joint. Bare connections of concentric neutral/shield wires shall be either contained within the splice kit or shall be sealed via an additional outer covering. This outer covering shall consist of a heavy wall, heat-shrinkable tubing containing adhesive material (mastic) that melts as heat is applied and the outer tubing shrinks to form a moisture proof environmental seal. The outer tubing shall conform to ANSI C119.1. Extra precautions shall be taken to seal around the exit area of the bare copper jumpers with additional mastic, per the splice manufacturer's recommendations.

Cables shall be terminated in approved cable terminations, rated Class 1 per IEEE 48. Dry terminations with medium voltage pennants, preformed, and hand wrapped stress cones may be used for terminating cables. Terminations shall be provided with adequate means for making external connections to the cable conductors of single-conductor cables (phase and concentric neutral); protecting the cable insulation against moisture, oil, or other contaminant; physically protecting and supporting cables, and maintaining the insulation level of the cable.

Terminations shall be field fabricated from termination kits supplied by and in accordance with the termination manufacturer's recommendations for the type, size, and electrical characteristics of the cable.

Installation shall include built-up or prefabricated heat or cold shrink stress-relief cones at the terminals of all shielded cables and at the terminals of single-conductor lead-covered cables rated 15 kV and above.

Cable splices shall be field fabricated from pre-molded or heat-shrinkable splicing kits supplied by and in accordance with the cable manufacturer's

recommendations for the type, size, and electrical characteristics of the cable specified. Cable splices in manholes shall be located midway between cable racks on walls of manholes and supported with cable arms at approximately the same elevation as the enclosing duct.

Cable splices shall be installed on cable racks or by other approved methods which will minimize physical stress on the splice connections. Splices shall be supported at approximately the same elevation as the installed cable except where space limitations or existing cable length limitations make this method impractical or impossible.

All universal demountable splices shall be supported in such manner so as to minimize physical stress on the splice connections. Each cable end termination shall be supported using a pair of saddle type supports under the cable end termination and/or cable with a minimum [12] [_____] inches [300] [_____] millimeter and a maximum [30] [_____] inches [750] [_____] millimeter separation between the supports. Cable end termination and cable shall be secured to the supports in such a manner as to prevent movement of termination or cable at the support. Saddle type supports shall be installed on galvanized steel framing channel anchored to the wall or securely fastened to the cable tray or installed by other approved methods.

3.1.5 Fireproofing

Provide fireproofing (Arc Proofing) for individual cable conductor in manholes, handholes and vaults which will carry current at 2200 volts or more.

Tightly wrap strips of fireproofing tape around each cable spirally in half-lapped wrapping. The tape shall extend 1 inch 25 millimeter into the ducts. To prevent unraveling, random wrap the fireproofing tape the entire length of the fireproofing with pressure-sensitive glass cloth tape.

3.1.6 Cable Tag Installation

Install cable tags in each manhole and at each termination as specified. Install cable tags over the fireproofing and position the tags so that they are clearly visible without disturbing any cabling or wiring in the manholes and equipment.

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NOTE: Although NETA ATS and referenced standards indicate higher DC High Potential test voltages, KSC has elected to use the values shown below.
****

3.2 FIELD TESTING

After the installation of power cables has been completed, including splices, joints, and terminations, and before the cable is energized, each medium voltage cable shall be subjected to field testing in accordance with NETA ATS and the following requirements.

Test equipment, labor, and trained technical personnel shall be Contractor provided as necessary to perform the electrical acceptance tests.

The Contractor shall obtain KSC Cable Test Report forms from the Contracting Officer prior to commencing Field Testing. All tests shall be

recorded on forms provided.

Arrangements shall be made to have tests witnessed and approved by the Contracting Officer.

Each power-cable installation shall be completely isolated from extraneous electrical connections at cable terminations and joints. Safety precautions shall be observed.

Each power cable shall first be given an insulation resistance test using a megohmmeter with a voltage output of at least 2,500-volts. Test shall be applied for a long enough time to fully charge the cable (no less than one minute). Readings shall be recorded as indicated on forms provided. Minimum reading shall be 5000 megohms at an ambient temperature of 68 degrees F 20 degrees C. Readings taken at other than 68 degrees F 20 degrees C ambient temperatures shall be corrected accordingly.

Upon successful completion of the insulation resistance test, the cable shall be subjected to a direct-current high-potential test. Maximum DC test voltage for new 15 kV cable shall be 40 kilovolts, and for new 5 kV cable shall be 15 kilovolts. Where new and existing cables are spliced together, maximum DC test voltage for 15 kV cable shall be 12 kilovolts and for 5 kv cable shall be 3600 volts.

Leakage current readings and voltage decay readings shall be recorded as indicated in NETA ATS and the KSC supplied test report form.
Final acceptance shall depend upon the satisfactory performance of the cable under test. No cable shall be energized until recorded test data have been approved by the Contracting Officer.

Terminations shall be clean and dry and shall be tested per IEEE 48. Radiographic tests shall be performed on all terminations at the discretion of the Contracting Officer to determine if voids exist in the termination. Unacceptable cable, splices or terminations shall be reworked at no additional expense to the Government.

-- End of Section --