SECTION 33 71 02

UNDERGROUND ELECTRICAL DISTRIBUTION
02/15

PART 1 GENERAL

1.1 REFERENCES

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. Contractor may substitute compatible Japan Industrial Standard (JIS), Ministry of Land, Infrastructure and Transport (MLIT), Japan Electrical Safety Inspection Associations or Japan Power Cable Accessories Association (JCAA) standards for non-Japanese standards, as approved by the Contracting Officer's representative.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2023) National Electrical Safety Code

JAPANESE ELECTROTECHNICAL COMMITTEE (JEC)

JEC 3408	(2015) High voltage test of extra high voltage (11 kV to 500 kV) cross-linked polyethylene cable and connections

JAPANESE STANDARDS ASSOCIATION (JSA)

JIS A 5506	(2008) Manhole Covers for Sewerage Works
JIS A 5372	(2016) Precast Reinforced Concrete Products
JIS C 0365	(2007) Protection Against Electric Shock - Common Aspects for Installation and Equipment
JIS C 2336	(2012) Pressure-sensitive polyvinyl chloride tapes for electrical purposes
JIS C 2338	(2012) Polyester adhesive tape for electrical insulation
JIS C 2805	(2010) Crimp terminal for copper wire
JIS C 2806	(2003; R 2018) Bare crimping sleeve for copper wire
JIS C 2810	(1995; R 2021) General rules on non-separable type wire connectors for interior wiring
JIS C 3101	(1994; R 2021) Hard-drawn copper wires for electrical purposes
JIS C 3102	(1984) Annealed Copper Wires for Electrical Purposes

JIS C 3105	(1994; R 2021) Hard-drawn copper stranded conductors
JIS C 3108	(2016) Hard-drawn aluminium wires for electric purposes
JIS C 3109	(1994) Hard-drawn aluminium stranded conductors
JIS C 3341	(2000; R 2021) Polyvinyl chloride insulated drop service wires
JIS C 3362	(2009) 600 V Cross-linked polyethylene insulated cables
JIS C 3367	(2008) Power cables with extruded insulation and their accessories for rated voltages from 1 kV up to 30 kV -- Cables for rated voltages of 0.6/1 kV
JIS C 3605	(2022) 600 V Polyethylene Insulated Cables, Type CV
JIS C 3606	(2022) High-Voltage Cross-Linked Polyethylene Insulated Cables, Type CV or CE
JIS C 3653	(2004) Installation methods of power cables buried ground
JIS C 8305	(2019) Rigid Steel Conduits
JIS C 8330	(1999; R 2019) Fittings for rigid metal conduits
JIS C 8340	(1999; R 2019) Boxes And Box Covers For Rigid Metal Conduits
JIS C 8350	(1999; R 2014) Fittings for pliable metal conduits
JIS C 8380	(2009; R 2019) Plastic coated steel pipes for cable-ways
JIS C 8430	(2019) Unplasticized polyvinyl chloride (PVC-U) conduits
JIS C 8432	(2019) Fittings of unplasticized polyvinyl chloride (PVC-U) conduits
JIS C 60364-5-54	(2006; R 2015) Building Electrical Equipment-Part 5-54: Selection Of Electrical Equipment and Contruction-Grounding Equipment, Protective Conductor and Protective Bonding Conductor
JIS C 60364-6	(2010; R 2019) Low-voltage electrical

	installations -- Part 6: Verification
JIS C 60695-2-4-0	(1995) Fire hazard testing Part 2: Test methods -- Section 4/sheet 0: Diffusion type and premixed type flame test methods
JIS K 6741	(2016; R 2021) Unplasticized Poly (Vinyl Chloride) (PVC-U) Pipes
JIS K 6743	(2016) Unplasticized Poly (Vinyl Chloride) (PVC-U) Pipe Fittings for Water Supply

ELECTRICAL SAFETY INSPECTION ASSOCIATIONS

Denki Hoan Kyoukai	Japan Standard for Acceptance Testing and Inspections

JAPAN POWER CABLE ACCESSORIES ASSOCIATION (JCAA)

JCAA A 202	(1989) Indoor / outdoor termination connection for 3300V cross-linked polyethylene insulated power cable
JCAA A 203	(1992) Straight connection for 3300V cross-linked polyethylene insulated power cable
JCAA A 302	(1992) Indoor termination connection for 6600V cross-linked polyethylene insulated power cable
JCAA A 303	(1992) Outdoor termination connection for 6600V cross-linked polyethylene insulated power cable
JCAA A 305	(1992) Straight connection for 6600 V cross-linked polyethylene insulated power cable
JCAA A 501	(1988) Indoor termination connection for 22kV 33kV cross-linked polyethylene insulated power cable
JCAA A 502	(1988) Outdoor termination connection for 22kV 33kV cross-linked polyethylene insulated power cable
JCAA A 503	(1988) Straight connection for 22kV and 33kV cross-linked polyethylene insulated power cable

THE JAPANESE ELECTRIC WIRE & CABLE MAKERS' ASSOCIATION (JCMA)

JCS 0168-4	(2010) Calculation of allowable current for power cables under 33 kV- Part 4: Allowable current for 22 kV, 33 kV crosslinked polyethylene cables
JCS 0501	(2014) Allowable current calculation for

	power cables above 66kV
JCS 4516	(2010) 3300V Cross-Linked Polyethylene Cable
JCS 1226	(2003) Soft Stranded Wire

MINISTRY OF LAND, INFRASTRUCTURE, TRANSPORT AND TOURISM (MLIT)

MLIT DSKKS	Denki Setsubi Kouji Kanri Shishin (DSKKS) Electrical Construction Supervision Guidelines
MLIT ESS	(2019) MLIT Electrical Standard Specification (ESS)

THE SOCIETY OF HEATING, AIR-CONDITIONING AND SANITARY ENGINEERS OF JAPAN (SHASE)

SHASE-S 209	(2009) Manhole Cover

UNDERWRITERS LABORATORIES (UL)

UL 94	(2023; Seventh Edition) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

[1.2 SYSTEM DESCRIPTION

Items provided under this section must be specifically suitable for the following service conditions. Seismic details must [conform to UFC 3-310-04, "Seismic Design for Buildings" and Sections 13 48 00 [SEISMIC] BRACING FOR MISCELLANEOUS EQUIPMENT and 26 05 48.00 10 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT] [be as indicated].

a. Fungus Control [_____]

b. Altitude [_____] m.

c. Ambient Temperature [_____] degrees C.

d. Frequency [_____]

e. Ventilation [_____]

f. Seismic Parameters [_____]

g. Humidity Control [_____]

h. Corrosive Areas [_____]

i. [_____]

]1.3 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.4 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined.

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

c. Japan voltage range categories are defined as follows:
Low Voltage (Voltages less than 1kV)
High Voltage (Voltages 1kV thru 7kV)
Extra High Voltage (Voltages over 7kV)

d. In the text of this section, "[High][Extra-High] voltage cable splices," and "[High][Extra-High] voltage cable joints" are used interchangeably and have the same meaning.

[d. Underground structures subject to aircraft loading are indicated on the drawings.

]1.5 SUBMITTALS

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.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Precast underground structures; G[, [_____]]

SD-03 Product Data

[High][Extra-High] voltage cable; G[, [_____]]

[High][Extra-High] voltage cable joints; G[, [_____]]

[High][Extra-High] voltage cable terminations; G[, [_____]]

[Live end caps; G[, [_____]]

] Precast concrete structures; G[, [_____]]

Sealing Material

Pulling-In Irons

Manhole frames and covers; G[, [_____]]

Handhole frames and covers; G[, [_____]]

[Frames and Covers for Airfield Facilities; G[, [_____]]

][Ductile Iron Frames and Covers for Airfield Facilities; G[, [_____]]

] Composite/fiberglass handholes; G[, [_____]]

Cable supports (racks, arms and insulators); G[, [_____]]

[Protective Devices and Coordination Study; G[, [_____]]

][The study must be submitted with protective device equipment submittals. No time extension or similar contract modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed must be based on recommendations of this study. The Government must not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered or procured prior to approval of the study.

] SD-06 Test Reports

Field Acceptance Checks and Tests;

1.6 QUALITY ASSURANCE

1.6.1 Precast Underground Structures

Submittal required for each type used. Provide calculations and drawings for precast manholes and handholes bearing the seal of a registered professional engineer including:

a. Material description (i.e., f'c and Fy)

b. Manufacturer's printed assembly and installation instructions

c. Design calculations

d. Reinforcing shop drawings in accordance with Manufacturer's recommendations.

e. Plans and elevations showing opening and pulling-in iron locations and details

1.6.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of IEEE C2 and JIS C 0365 unless more stringent requirements are specified or indicated.

1.6.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year

period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable, unless specified otherwise.

PART 2 PRODUCTS

2.1 CONDUIT, DUCTS, AND FITTINGS

2.1.1 Rigid Metal Conduit or Type G

JIS C 8305, Type G. Diameter of conduit shall be as indicated.

2.1.1.1 Rigid Metallic Conduit, PVC Coated or Type G; LL or LT

JIS C 8380, Type G; LL or LT.

2.1.2 Intermediate Metal Conduit or Type C

JIS C 8305, Type C.

2.1.2.1 Intermediate Metal Conduit, PVC Coated or Type C; LL or LT

JIS C 8380, Type C; LL or LT.

2.1.3 Plastic Conduit or Unplasticized Polyvinyl Chloride for Direct Burial and Riser Applications

[As indicated] [JIS C 3653, Type FEP] [or] JIS C 8430 for Type HIVE conduit of diameter of less than 100mm and JIS K 6741 for Type HIVP conduit diameter or 100mm and larger.

2.1.4 Plastic Duct or Unplasticized Polyvinyl Chloride for Concrete Encasement

Provide[as indicated][or JIS C 8430 for Type VE conduit of diameter of less than 100mm and JIS K 6741 for Type VP conduit diameter or 100mm and larger].

2.1.5 Innerduct

Provide corrugated [or solid wall] polyethylene (PE) or PVC innerducts, or fabric-mesh innerducts, with pullwire. Size as indicated.

2.1.6 Duct Sealant

UL 94 and JIS C 60695-2-4-0. Provide high-expansion urethane foam duct sealant that expands and hardens to form a closed, chemically and water resistant, rigid structure. Sealant must be compatible with common cable and wire jackets and capable of adhering to metals, plastics and concrete. Sealant must be capable of curing in temperature ranges of 2 degrees C to 35 degrees C. Cured sealant must withstand temperature ranges of -29 degrees C to 93 degrees C without loss of function.

2.1.7 Fittings

2.1.7.1 Metal Fittings

JIS C 8330 and JIS C 8350.

2.1.7.2 PVC or Unplasticized Polyvinyl Chloride Conduit Fittings

[JIS C 8432 for diameters less than 100mm][JIS K 6743 for diameters 100mm or larger].

[2.1.7.3 Outlet Boxes for Steel Conduit

Outlet boxes for use with rigid or flexible steel conduit must be cast-metal cadmium or zinc-coated if of ferrous metal with gasketed closures and must conform to JIS C 8340.

]2.2 LOW VOLTAGE INSULATED CONDUCTORS AND CABLES

Insulated conductors must be rated 600 volts and conform to the requirements of applicable codes and standards, including listing requirements[, or in accordance with JIS C 3362 or JIS C 3367]. Wires and cables manufactured more than [24][12] months prior to date of delivery to the site are not acceptable. Service entrance conductors must conform to JIS C 3341.

2.2.1 Conductor Types

Cable and duct sizes indicated are for copper conductors and [THHN/THWN] [EM-CE] unless otherwise noted. Conductors 5.5 sqmm and smaller must be solid. Conductors 8 sqmm and larger must be stranded.[Conductors 14 sqmm and smaller must be copper. Conductors 22 sqmm and larger may be either copper or aluminum, at the Contractor's option. Do not substitute aluminum for copper if the equivalent aluminum conductor size would exceed 250 sqmm. When the Contractor chooses to use aluminum for conductors 22 sqmm and larger, the Contractor must: increase the conductor size to have the same ampacity as the copper size indicated; increase the conduit and pull box sizes to accommodate the larger size aluminum conductors in accordance with applicable codes and standards; ensure that the pulling tension rating of the aluminum conductor is sufficient; relocate equipment, modify equipment terminations, resize equipment, and resolve to the satisfaction of the Contracting Officer problems that are direct results of the use of aluminum conductors in lieu of copper.][All conductors must be copper.]

2.2.2 Conductor Material

Unless specified or indicated otherwise or required, wires in conduit, other than service entrance, must be 600-volt,conforming to Type EM-CE,

EM-CET or EM-ECEQ conforming to JIS C 3605. Copper conductors must be annealed copper complying with JCS 1226 and JIS C 3102 and JIS C 3105.[Aluminum conductors must be Type AA-8000 aluminum conductors complying with JIS C 3108 and JIS C 3109, and must be of an aluminum alloy listed or labeled by UL as "component aluminum-wire stock (conductor material). Type 1350 is not acceptable. Intermixing of copper and aluminum conductors in the same raceway is not permitted.]

[2.2.3 Jackets

Multiconductor cables must have an overall PVC outer jacket.

][2.2.4 Direct Buried

Single-conductor [and multi-conductor]cables must be of a type identified for direct burial.

][2.2.5 In Duct

Cables must be single-conductor cable.[Cables in factory-installed, coilable-plastic-duct assemblies where extra physical protection is required.]

]2.2.6 Cable Marking

Insulated conductors must have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout the cable length.

Identify each cable by means of a fiber, laminated plastic, or non-ferrous metal tags, or approved equal, in each manhole, handhole, junction box, and each terminal. Each tag must contain the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

Conductors must be color coded. Provide conductor identification within each enclosure where a tap, splice, or termination is made. Conductor identification must be by color-coded insulated conductors, plastic-coated self-sticking printed markers, colored nylon cable ties and plates, heat shrink type sleeves,or colored electrical tape. Control circuit terminations must be properly identified. Color must be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutrals must be white with a different colored (not green) stripe for each. Color of ungrounded conductors in different voltage systems must be as follows:

a. Three-phase - Primary

(1) Phase A - red

(2) Phase B - white

(3) Phase C - blue

b. Three-phase - Secondary

(1) Phase A - red

(2) Phase B - black

(3) Phase C - blue

c. 480/277 volt, three phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

d. Single phase: Black and red

[d. On three-phase, four-wire delta system, high leg must be orange, as required.

]2.3 LOW VOLTAGE WIRE CONNECTORS AND TERMINALS

Must provide a uniform compression over the entire conductor contact surface. Use solderless terminal lugs on stranded conductors.

a. For use with copper conductors: JIS C 2805, JIS C 2806 and JIS C 2810.

[b. For use with aluminum conductors: JIS C 2805, JIS C 2806 and JIS C 2810. For connecting aluminum to copper, connectors must be the circumferentially compressed, metallurgically bonded type.

]2.4 LOW VOLTAGE SPLICES

Provide splices in conductors 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.

2.4.1 Heat Shrinkable Splice

Provide heat shrinkable splice insulation by means of a thermoplastic adhesive sealant material applied in accordance with the manufacturer's written instructions.

2.4.2 Cold Shrink Rubber Splice

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 must not require heat or flame, or any additional materials such as covering or adhesive. It must be designed for use with inline compression type connectors, or indoor, outdoor, direct-burial or submerged locations.

2.5 [HIGH][EXTRA-HIGH] VOLTAGE CABLE

Cable (conductor) sizes are designated bymillimeters (mm) and square milimeters (sqmm). Conductor and conduit sizes indicated are for copper conductors unless otherwise noted. Insulated conductors must 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 are not acceptable. Provide single conductor type cables unless otherwise indicated.

2.5.1 Cable Configuration

Provide [Type CVT, conforming to JCS 4516 for 3.3kV][Type EM-CET, conforming to JIS C 3606 for 6.6kV][or][Type EM-CET, conforming to JCS 0168-4 for 22kV and 33kV][Type CV-CVT, conforming to JCS 0501 for 66kV and 77kV].[concentric neutral underground distribution cable][metallic armored cables, consisting of three-conductor, multi-conductor cables, with insulation and shielding, as specified, using [a galvanized steel][an aluminum] interlocked tape armor and thermoplastic jacket]. Provide cables manufactured for use in[duct][or][direct burial] applications[as indicated]. Cable must be rated [3.3kV][5 kV][6.6kV][15 kV][22kV][25 kV][28 kV][33kV][35 kV][66kV][77kV][as indicated] with [[100][133] percent insulation level][[ ] insulation resistance].

2.5.2 Conductor Material

Provide concentric-lay-stranded, Class B[compact round] conductors. Provide[aluminum alloy conductors complying with JIS C 3108 and JIS C 3109][aluminum alloy cables, 3/4 hard minimum for regular concentric and compressed stranding or for compacted stranding][soft drawn copper cables complying with JCS 1226 and JIS C 3102 and JIS C 3105 for regular concentric and compressed stranding or JIS C 3606 for compact stranding].

2.5.3 Insulation

Provide [ethylene-propylene-rubber (EPR) insulation][tree-retardant cross-linked thermosetting polyethylene (XLP) insulation].

2.5.4 Shielding

Cables rated for 2 kV and above must have a semiconducting conductor shield, a semiconducting insulation shield, and an overall copper[tape][or][wire] shield for each phase.

2.5.5 Neutrals

[Neutral conductors must be [copper][aluminum], employing the same insulation and jacket materials as phase conductors, except that a 600-volt insulation rating is acceptable.][Concentric neutrals conductors must be copper, having a combined ampacity [equal to][1/3 of] the phase conductor ampacity rating.][For high impedance grounded neutral systems, the neutral conductors from the neutral point of the transformer or generator to the connection point at the impedance must utilize [copper][aluminum] conductors, employing the same insulation level and construction as the phase conductors.

]2.5.6 Jackets

Provide cables with a [PVC][_____] jacket.[Direct buried cables must be rated for direct burial.][Provide type UD cables with an overall jacket.] [Provide PVC jackets with a separator that prevents contact with underlying semiconducting insulating shield.]

2.6 [HIGH][EXTRA-HIGH] VOLTAGE CABLE TERMINATIONS

Provide indoor terminator/outdoor terminations with skirts. [JCAA A 202 for 3.3kV][JCAA A 302 and JCAA A 303 for 6.6kV][JCAA A 501 and JCAA A 502 for 22kV and 33kV][JEC 3408 for 66kV and 77kV]; of the molded elastomer, prestretched elastomer, or heat-shrinkable elastomer. Acceptable

elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Terminations, where required, must be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, or armor. Terminations must be provided in a kit, including: skirts, stress control terminator, ground clamp, connectors, lugs, and complete instructions for assembly and installation. Terminations must be the product of one manufacturer, suitable for the type, diameter, insulation class and level, and materials of the cable terminated. Do not use separate parts of copper or copper alloy in contact with aluminum alloy parts in the construction or installation of the terminator.

2.6.1 Cold-Shrink Type

Terminator must be a one-piece design, utilizing the manufacturer's latest technology, where high-dielectric constant (capacitive) stress control is integrated within a skirted insulator made of silicone rubber. Termination must not require heat or flame for installation. Termination kit must contain all necessary materials (except for the lugs). Termination must be designed for installation in low or highly contaminated indoor and outdoor locations and must resist ultraviolet rays and oxidative decomposition.

2.6.2 Heat Shrinkable Type

Terminator must 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. Termination must be designed for installation in low or highly contaminated indoor or outdoor locations.

[2.6.3 Separable Insulated Connector Type

Provide connector with steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material. Provide connectors of the loadbreak or deadbreak type as indicated, of suitable construction for the application and the type of cable connected, and that include cable shield adaptors. Provide external clamping points and test points. Separable connectors must not be used in manholes/handholes.

[a. 200 Ampere loadbreak connector ratings: Voltage: [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL]. Short time rating: 10,000 rms symmetrical amperes.
]
[b. 600 Ampere deadbreak connector ratings: Voltage: [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL]. Short time rating: 25,000 rms symmetrical amperes.[Connectors must have 200 ampere bushing interface[for surge arresters][as indicated].]
]
[c. Provide[[one][_____] set[s] of three grounding elbows][and][[one][_____] set[s] of three feed-thru inserts]. Deliver [grounding elbows][and][feed-thru inserts] to the Contracting Officer.
]
[d. Install one set of faulted circuit indicators on the test points of

each set of separable insulated connectors. Indicators must be self powered; with automatic trip with mechanical flag indication upon overcurrent followed by loss of system voltage, and automatic reset upon restoration of system voltage. Indicators must be compact, sealed corrosion resistant construction with provision for hotstick installation and operation.

]]2.7 [HIGH][EXTRA-HIGH] VOLTAGE CABLE JOINTS

Provide joints (splices) in accordance with [JCAA A 203 for 3.3kV][JCAA A 305 for 6.6kV][JCAA A 503 for 22kV and 33 kV][JEC 3408 for 66kV and 77kV] suitable for the rated voltage, insulation level, insulation type, and construction of the cable. Joints must be certified by the manufacturer for waterproof, submersible applications. Upon request, supply manufacturer's design qualification test report in accordance with [JCAA A 203 for 3.3kV][JCAA A 305 for 6.6kV][JCAA A 503 for 22kV and 33 kV][JEC 3408 for 66kV and 77kV]. Connectors for joint must be tin-plated electrolytic copper, having ends tapered and having center stops to equalize cable insertion.

2.7.1 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.

2.7.2 Cold-Shrink Rubber-Type Joint

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

2.8 TELECOMMUNICATIONS CABLING

Provide telecommunications cabling in accordance with Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP).

[2.9 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 must conform to applicable portions of [JCAA A 202 for 3.3kV][JCAA A 302 and JCAA A 303 for 6.6kV][JCAA A 501 and JCAA A 502 for 22kV and 33kV][JEC 3408 for 66kV and 77kV].

]2.10 TAPE

2.10.1 Insulating Tape

JIS C 2336 and JIS C 2338, plastic insulating tape, capable of performing in a continuous temperature environment of 80 degrees C.

2.10.2 Buried Warning and Identification Tape

Provide detectable tape in accordance with Section [31 23 00.00 20

EXCAVATION AND FILL][31 00 00 EARTHWORK].

2.10.3 Fireproofing Tape

Provide tape composed of a flexible, conformable, unsupported intumescent elastomer. Tape must be not less than 0.762 mm thick, noncorrosive to cable sheath, self-extinguishing, noncombustible, adhesive-free, and must not deteriorate when subjected to oil, water, gases, salt water, sewage, and fungus.

2.11 PULL ROPE

Plastic or flat pull line (bull line) having a minimum tensile strength of 890 N.

2.12 GROUNDING AND BONDING

2.12.1 Driven Ground Rods

Provide [copper-clad steel ground rods conforming to JIS C 60364-5-54][solid copper ground rods conforming to JIS C 60364-5-54][solid stainless steel ground rods] not less than [19 mm] in diameter by [3.1 m] in length. Sectional type rods may be used for rods 6 meters or longer.

2.12.2 Grounding Conductors

Stranded-bare copper conductors must conform to JIS C 3105 soft-drawn unless otherwise indicated. Solid-bare copper conductors must conform to JIS C 3101 for sizes 8 sqmm and smaller. Insulated conductors must be of the same material as phase conductors and green color-coded, except that conductors must be rated no more than 600 volts. Aluminum is not acceptable.

2.13 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. In addition, provide concrete for encasement of underground ducts with 20 MPa minimum 28-day compressive strength. Concrete associated with electrical work for other than encasement of underground ducts must be 30 MPa minimum 28-day compressive strength unless specified otherwise.

2.14 UNDERGROUND STRUCTURES

Provide precast concrete underground structures or standard type cast-in-place manhole types as indicated, conforming to JIS A 5372. Top, walls, and bottom must consist of reinforced concrete. Walls and bottom must be of monolithic concrete construction. Locate duct entrances and windows near the corners of structures to facilitate cable racking. Covers must fit the frames without undue play. Form steel and iron to shape and size with sharp lines and angles. Castings must be free from warp and blow holes that may impair strength or appearance. Exposed metal must have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Install a pulling-in iron in the wall opposite each duct line entrance. Cable racks, including rack arms and insulators, must be adequate to accommodate the cable.

2.14.1 Cast-In-Place Concrete Structures

Concrete must conform to Section 03 30 00 CAST-IN-PLACE CONCRETE.[Construct walls on a footing of cast-in-place concrete except that precast concrete base sections may be used for precast concrete manhole risers.][Concrete block must conform to Section 04 20 00, MASONRY.][Concrete block is not allowed in areas subject to aircraft loading.]

2.14.2 Precast Concrete Structures, Risers and Tops

Precast concrete underground structures may be provided in lieu of cast-in-place subject to the requirements specified below. Precast units must be the product of a manufacturer regularly engaged in the manufacture of precast concrete products, including precast manholes.

2.14.2.1 General

Precast concrete structures must have the same accessories and facilities as required for cast-in-place structures. Likewise, precast structures must have plan area and clear heights not less than those of cast-in-place structures. Concrete materials and methods of construction must be the same as for cast-in-place concrete construction, as modified herein. Slope in floor may be omitted provided precast sections are poured in reinforced steel forms. Concrete for precast work must have a 28-day compressive strength of not less than 30 MPa. Structures may be precast to the design and details indicated for cast-in-place construction, precast monolithically and placed as a unit, or structures may be assembled sections, designed and produced by the manufacturer in accordance with the requirements specified. Structures must be identified with the manufacturer's name embedded in or otherwise permanently attached to an interior wall face.

2.14.2.2 Design for Precast Structures

In the absence of detailed on-site soil information, design for the following soil parameters/site conditions:

a. Angle of Internal Friction (phi) = 0.523 rad

b. Unit Weight of Soil (Dry) = 1760 kg/m^3, (Saturated) = 2080 kg/m^3

c. Coefficient of Lateral Earth Pressure (Ka) = 0.33

d. Ground Water Level = 915 mm below ground elevation

e. Vertical design loads must include full dead, superimposed dead, and live loads including a 30 percent magnification factor for impact. Live loads must consider all types and magnitudes of vehicular (automotive, industrial, or aircraft) traffic to be encountered. The minimum design vertical load must be for H20 highway loading.

f. Horizontal design loads must include full geostatic and hydrostatic pressures for the soil parameters, water table, and depth of installation to be encountered. Also, horizontal loads imposed by adjacent structure foundations, and horizontal load components of vertical design loads, including impact, must be considered, along with a pulling-in iron design load of 26,700 N.

g. Each structural component must be designed for the load combination and positioning resulting in the maximum shear and moment for thatparticular component.

h. Design must also consider the live loads induced in the handling, installation, and backfilling of the manholes. Provide lifting devices to ensure structural integrity during handling and installation.

2.14.2.3 Construction

Structure top, bottom, and wall must be of a uniform thickness of not less than 150 mm. Thin-walled knock-out panels for designed or future duct bank entrances are not permitted. Provide quantity, size, and location of duct bank entrance windows as directed, and cast completely open by the precaster. Size of windows must exceed the nominal duct bank envelope dimensions by at least 305 mm vertically and horizontally to preclude in-field window modifications made necessary by duct bank misalignment. However, the sides of precast windows must be a minimum of 150 mm from the inside surface of adjacent walls, floors, or ceilings. Form the perimeter of precast window openings to have a keyed or inward flared surface to provide a positive interlock with the mating duct bank envelope. Provide welded wire fabric reinforcing through window openings for in-field cutting and flaring into duct bank envelopes. Provide additional reinforcing steel comprised of at least two No. 13 bars around window openings. Provide drain sumps a minimum of 305 mm in diameter and 100 mm deep for precast structures.

2.14.2.4 Joints

Provide tongue-and-groove joints on mating edges of precast components. Shiplap joints are not allowed. Design joints to firmly interlock adjoining components and to provide waterproof junctions and adequate shear transfer. Seal joints watertight using preformed plastic strip. Install sealing material in strict accordance with the sealant manufacturer's printed instructions. Provide waterproofing at conduit/duct entrances into structures, and where access frame meets the top slab, provide continuous grout seal.

2.14.3 Manhole Frames and Covers

Provide cast iron frames and covers for manholes conforming to SHASE-S 209 and JIS A 5506. Cast the words "ELECTRIC" or "TELECOMMUNICATIONS" in the top face of power and telecommunications manhole covers, respectively.

2.14.4 Handhole Frames and Covers

Frames and covers of steel must be welded by qualified welders in accordance with standard commercial practice. Steel covers must be rolled-steel floor plate having an approved antislip surface. Hinges must be of [stainless steel with bronze hinge pin] [wrought steel], 125 by 125 mm by approximately 4.75 mm thick, without screw holes, and must be for full surface application by fillet welding. Hinges must have nonremovable pins and five knuckles. The surfaces of plates under hinges must be true after the removal of raised antislip surface, by grinding or other approved method.

[2.14.5 Frames and Covers for Airfield Facilities

Fabricate frames and covers for airfield use of standard commercial grade steel welded by qualified welders. Covers must be of rolled steel floor plate having an approved anti-slip surface. Steel frames and covers must be hot dipped galvanized after fabrication.

][2.14.6 Ductile Iron Frames and Covers for Airfield Facilities

At the contractor's option, ductile iron covers and frames designed for a minimum proof load of 45,000 kg may be provided in lieu of the steel frames and covers indicated. Covers must be of the same material as the frames (i.e. ductile iron frame with ductile iron cover, galvanized steel frame with galvanized steel cover). Perform proof loading in accordance with applicable codes and standards. Proof loads must be physically stamped into the cover. Provide the Contracting Officer copies of previous proof load test results performed on the same frames and covers as proposed for this contract. Modify the top of the structure to accept the ductile iron structure in lieu of the steel structure indicated. The finished structure must be level and non-rocking, with the top flush with the surrounding pavement.

]2.14.7 Brick for Manhole Collar

Provide sewer and manhole brick as required per applicable codes and standards.

2.14.8 Composite/Fiberglass Handholes and Covers

Provide handholes and covers of polymer concrete, reinforced with heavy weave fiberglass with a design load (Tier rating) appropriate for or greater than the intended use. All covers are required to have the Tier level rating embossed on the surface and this rating must not exceed the design load of the box.

2.15 CABLE SUPPORTS (RACKS, ARMS, AND INSULATORS)

The metal portion of racks and arms must be zinc-coated after fabrication.

2.15.1 Cable Rack Stanchions

The wall bracket or stanchion must be 100 mm by approximately 38 mm by 4.76 mm channel steel, or 100 mm by approximately 25 mm glass-reinforced nylon with recessed bolt mounting holes, 1220 mm long (minimum) in manholes. Slots for mounting cable rack arms must be spaced at 200 mm intervals.

2.15.2 Rack Arms

Cable rack arms must be steel or malleable iron or glass reinforced nylon and must be of the removable type. Rack arm length must be a minimum of 200 mm and a maximum of 305 mm.

2.15.3 Insulators

Insulators for metal rack arms must be dry-process glazed porcelain. Insulators are not required for nylon arms.

2.16 CABLE TAGS IN MANHOLES

Provide tags for each power cable located in manholes. The tags must be polyethylene. Do not provide handwritten letters. The first position on the power cable tag must denote the voltage. The second through sixth positions on the tag must identify the circuit. The next to last position must denote the phase of the circuit and include the Greek "phi" symbol. The last position must denote the cable size. As an example, a tag could have the following designation: "11.5 NAS 1-8(Phase A)500," denoting that the tagged cable is on the 11.5kV system circuit number NAS 1-8, underground, Phase A, sized at 500 kcmil.

2.16.1 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 22.4 MPa; and that are 2 millimeter thick (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 77 degrees C. Provide 1.3 mm (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ties must have a minimum loop tensile strength of 778.75 N. The cable tags must have black block letters, numbers, and symbols 25 mm high on a yellow background. Letters, numbers, and symbols must not fall off or change positions regardless of the cable tags' orientation.

2.17 [HIGH][EXTRA-HIGH] VOLTAGE ABOVE GROUND CABLE TERMINATING CABINETS

Cable terminating cabinets must be hook-stick operable, deadfront construction. Provide cabinets with [200 A. loadbreak junctions and elbow-type separable loadbreak connectors, cable parking stands, and grounding lugs][600 A. dead-break junctions and elbow-type separable dead-break connectors, cable parking stands, and grounding lugs]. Provide cable terminating equipment [as indicated].

Ratings at [50][60] Hz must be:

Nominal voltage (kV)	[_____]
Rated maximum voltage (kV)	[[3.3][6.6][15][22][25
Rated continuous current (A)	[[200][600]]
One-second short-time current-carrying capacity (kA)	[_____]
BIL (kV)	[_____]

2.18 LOW VOLTAGE ABOVE GROUND TERMINATION PEDESTAL

Provide copolymer polypropylene, low voltage above ground termination pedestal manufactured through an injection molding process. Pedestals must resist fertilizers, salt air environments and ultra-violet radiation. Pedestal top must be imprinted with a "WARNING" and "ELECTRIC" identification. Pedestal must contain [three][four] lay-in six port connectors. Connectors must be dual rated for aluminum or copper, and

capable of terminating conductors ranging from [5.5 sqmm to 250 sqmm]. Protect each connector with a clear, hard lexan (plastic) cover. Pedestal must be provided with rust-free material and stainless steel hardware. Pedestal must be lockable.

2.19 PROTECTIVE DEVICES AND COORDINATION

Provide protective devices and coordination as specified in Section 26 28 01.00 10 COORDINATED POWER SYSTEM PROTECTION.

2.20 SOURCE QUALITY CONTROL

2.20.1 Arc-Proofing Test for Cable Fireproofing Tape

Manufacturer must test one sample assembly consisting of a straight lead tube 305 mm long with a 65.5 mm outside diameter, and a 3.175 mm thick wall, and covered with one-half lap layer of arc and fireproofing tape per manufacturer's instructions. The arc and fireproofing tape must 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 must be obtained from a dc power source of 305 (plus or minus 5) amperes and 20 (plus or minus 1) volts. The arc must 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 must be tested at three unrelated points. Start time for tests must 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 must 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 must indicate that the test has been performed and passed by the manufacturer.

2.20.2 [HIGH][EXTRA-HIGH] Voltage Cable Qualification and Production Tests

Results of qualification and production tests as applicable for each type of [high][extra-high] voltage cable.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment and devices in accordance with the manufacturer's published instructions and with the requirements and recommendations of applicable codes and standards and IEEE C2. In addition to these requirements, install telecommunications in accordance with MLIT ESS.

3.2 CABLE INSPECTION

Inspect each cable reel for correct storage positions, signs of physical damage, and broken end seals prior to installation. If end seal is broken, remove moisture from cable prior to installation in accordance with the cable manufacturer's recommendations.

[3.3 CABLE INSTALLATION PLAN AND PROCEDURE

Obtain from the manufacturer an installation manual or set of instructions

which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature limits for installation, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, maximum allowable pulling tension, and maximum allowable sidewall bearing pressure. [Prepare a checklist of significant requirements][Perform pulling calculations and prepare a pulling plan] and submit along with the manufacturer's instructions in accordance with SUBMITTALS. Install cable strictly in accordance with the cable manufacturer's recommendations and the approved installation plan.

[Calculations and pulling plan must include:

a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.

b. List of cable installation equipment.

c. Lubricant manufacturer's application instructions.

d. Procedure for resealing cable ends to prevent moisture from entering cable.

e. Cable pulling tension calculations of all cable pulls.

f. Cable percentage conduit fill.

g. Cable sidewall bearing pressure.

h. Cable minimum bend radius and minimum diameter of pulling wheels used.

i. Cable jam ratio.

j. Maximum allowable pulling tension on each different type and size of conductor.

k. Maximum allowable pulling tension on pulling device.

]]3.4 UNDERGROUND FEEDERS SUPPLYING BUILDINGS

Terminate underground feeders supplying building at a point 1525 mm outside the building and projections thereof, except that conductors must be continuous to the terminating point indicated. Coordinate connections of the feeders to the service entrance equipment with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide [PVC, Type EPC-40][IMC][RGS][Type G][Type FEP][Type VP][Type VE][Type HIVP][Type HIVE] conduit from the supply equipment to a point 1525 mm outside the building and projections thereof. Protect ends of underground conduit with plastic plugs until connections are made.

[Encase the underground portion of the conduit in a concrete envelope and bury as specified for underground duct with concrete encasement.

]3.5 UNDERGROUND STRUCTURE CONSTRUCTION

Provide standard type cast-in-place construction as specified herein and as indicated, or precast construction as specified herein. Horizontal concrete surfaces of floors must have a smooth trowel finish. Cure concrete by applying two coats of white pigmented membrane forming-curing

compound in strict accordance with the manufacturer's printed instructions, except that precast concrete may be steam cured. Curing compound must conform to manufacturer's recommendations. Locate duct entrances and windows in the center of end walls (shorter) and near the corners of sidewalls (longer) to facilitate cable racking and splicing. Covers for underground structures must fit the frames without undue play. Steel and iron must be formed to shape and size with sharp lines and angles. Castings must be free from warp and blow holes that may impair strength or appearance. Exposed metal must have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Manhole locations, as indicated, are approximate. Coordinate exact manhole locations with other utilities and finished grading and paving.

3.5.1 Cast-In-Place Concrete Structures

[Construct walls on a footing of cast-in-place concrete except that precast concrete base sections may be used for precast concrete manhole risers.][Provide concrete block conforming to Section 04 20 00 MASONRY.][Concrete block is not allowed in areas subject to aircraft loading.]

3.5.2 Precast Concrete Construction

Set commercial precast structures on 150 mm of level, 90 percent compacted granular fill, 19 mm to 25 mm size, extending 305 mm beyond the structure on each side. Compact granular fill by a minimum of four passes with a plate type vibrator. Installation must additionally conform to the manufacturer's instructions.

3.5.3 Pulling-In Irons

Provide steel bars bent as indicated, and cast in the walls and floors. Alternatively, pipe sleeves may be precast into the walls and floors where required to accept U-bolts or other types of pulling-in devices possessing the strengths and clearances stated herein. The final installation of pulling-in devices must be made permanent. Cover and seal exterior projections of thru-wall type pulling-in devices with an appropriate protective coating. In the floor the irons must be a minimum of 150 mm from the edge of the sump, and in the walls the irons must be located within 150 mm of the projected center of the duct bank pattern or precast window in the opposite wall. However, the pulling-in iron must not be located within 150 mm of an adjacent interior surface, or duct or precast window located within the same wall as the iron. If a pulling-in iron cannot be located directly opposite the corresponding duct bank or precast window due to this clearance limitation, locate the iron directly above or below the projected center of the duct bank pattern or precast window the minimum distance required to preserve the 150 mm clearance previously stated. In the case of directly opposing precast windows, pulling-in irons consisting of a 915 mm length of No. 5 reinforcing bar, formed into a hairpin, may be cast-in-place within the precast windows simultaneously with the end of the corresponding duct bank envelope. Irons installed in this manner must be positioned directly in line with, or when not possible, directly above or below the projected center of the duct bank pattern entering the opposite wall, while maintaining a minimum clear distance of 75 mm from any edge of the cast-in-place duct bank envelope or any individual duct. Pulling-in irons must have a clear projection into the structure of approximately 100 mm and must be designed to withstand a

minimum pulling-in load of 26,700 N. Irons must be hot-dipped galvanized after fabrication.

3.5.4 Cable Racks, Arms and Insulators

Cable racks, arms and insulators must be sufficient to accommodate the cables. Space racks in power manholes not more than 915 mm apart, and provide each manhole wall with a minimum of two racks. Space racks in signal manholes not more than 420 mm apart with the end rack being no further than 305 mm from the adjacent wall. Methods of anchoring cable racks must be as follows:

a. Provide a 15 mm diameter by 125 mm long anchor bolt with 75 mm foot cast in structure wall with 50 mm protrusion of threaded portion of bolt into structure. Provide 15 mm steel square head nut on each anchor bolt. Coat threads of anchor bolts with suitable coating immediately prior to installing nuts.

b. Provide concrete channel insert with a minimum load rating of 1192 kg per meter. Insert channel must be steel of the same length as "vertical rack channel;" channel insert must be cast flush in structure wall. Provide 15 mm steel nuts in channel insert to receive 15 mm diameter by 75 mm long steel, square head anchor bolts.

c. Provide concrete "spot insert" at each anchor bolt location, cast flush in structure wall. Each insert must have minimum 365 kg load rating. Provide 15 mm diameter by 75 mm long steel, square head anchor bolt at each anchor point. Coat threads of anchor bolts with suitable coating immediately prior to installing bolts.

3.5.5 Field Painting

Cast-iron frames and covers not buried in concrete or masonry must be cleaned of mortar, rust, grease, dirt and other deleterious materials, and given a coat of bituminous paint.

[3.6 DIRECT BURIAL CABLE SYSTEM

Cables must be buried directly in the earth below the frostline [as indicated][to the requirements of IEEE C2 and JIS C 0365, whichever is more stringent].

3.6.1 Trenching

Excavate trenches for direct-burial cables to provide a minimum cable cover of 610 mm below finished grade for power conductors operated at 600 volts or less, and 765 mm below finished grade for over 600 volts in accordance with IEEE C2 and JIS C 0365. When rock is encountered, remove to a depth of at least 75 mm below the cable and fill the space with sand or clean earth free from particles larger than 6 mm. Bottoms of trenches must be smooth and free of stones and sharp objects. Where materials in bottoms of trenches are other than sand, a 75 mm 3 inch layer of sand must be laid first and compacted to approximate densities of surrounding firm soil. Trenches must be not less than [150][200] mm wide, and must be in straight lines between cable markers.[Cable plows must not be used.] Bends in trenches must have a radius [of not less than 915 mm][consistent with the cable manufacturer's published minimum cable bending radius for the cable installed].

3.6.2 Cable Installation

Unreel cables along the sides of or in trenches and carefully place on sand or earth bottoms. Pulling cables into direct-burial trenches from a fixed reel position is not permitted, except as required to pull cables through conduits under paving or railroad tracks.

Where two or more cables are laid parallel in the same trench, space cables laterally at not less than 75 mm apart, except that communication cable must be separated from power cable by a minimum distance of 305 mm.

Where direct-burial cables cross under roads or other paving exceeding 1.5 m in width, such cables must be installed in[concrete-encased] ducts. Where direct-burial cables cross under railroad tracks, such cables must be installed in [reinforced concrete-encased ducts][ducts installed through rigid galvanized steel sleeves]. Ducts must extend at least 1.5 m beyond each edge of any paving and at least 1.5 m beyond each side of any railroad tracks. Cables may be pulled into duct from a fixed reel where suitable rollers are provided in the trench. Where direct burial cable transitions to duct-enclosed cable, direct-burial cables must be centered in duct entrances, and a waterproof nonhardening mastic compound must be used to facilitate such centering. If paving or railroad tracks are in place where cables are to be installed, coated rigid steel conduits driven under the paving or railroad tracks may be used in lieu of concrete-encased ducts. Prevent damage to conduit coatings by providing ferrous pipe jackets or by predrilling. Where cuts are made in any paving, the paving and subbase must be restored to their original condition. Where cable is placed in duct(e.g. under paved areas, roads, or railroads), slope ducts to drain.

3.6.3 Splicing

Provide cables in one piece without splices between connections except where the distance exceeds the lengths in which cables are manufactured.[Where splices are required, provide splices designed and rated for direct burial.][Where splices are required, install splices only in maintenance manholes/handholes or cabinets/pedestals.]

3.6.4 Bends

Bends in cables must have an inner radius not less than those specified for the type of cable, per manufacturer's recommendation.

3.6.5 Horizontal Slack

Leave approximately 915 mm 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.]

3.6.6 Identification Slabs[or 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[, over the ends of ducts or conduits stubbed out for future use][, and over each splice]. Identification slabs must be of concrete, approximately 500

mm square by 150 mm thick and must be set flat in the ground so that top surface projects not less than 20 mm, nor more than 30 mm above ground. Concrete must have a compressive strength of not less than 20 MPa 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 indicated. Letters or figures must be approximately 50 mm high and grooves must be approximately 6 mm in width and depth. Install slabs so that the side nearest the inscription on top must include an arrow indicating the side nearest the cable. Provide color, type and depth of warning tape as specified in Section [31 23 00.00 20 EXCAVATION AND FILL][31 00 00 EARTHWORK].

]3.7 UNDERGROUND CONDUIT AND DUCT SYSTEMS

3.7.1 Requirements

Run conduit in straight lines except where a change of direction is necessary. Provide numbers and sizes of ducts as indicated. Provide a 100 sqmm bare copper grounding conductor for [high][extra-high]-voltage distribution duct banks as indicated in drawings. Bond grounding conductor to ground rings (loops) in all manholes and to ground rings (loops) at all equipment slabs (pads). Route grounding conductor into manholes with the duct bank (sleeving is not required). Ducts must have a continuous slope downward toward underground structures and away from buildings, laid with a minimum slope of [75 mm][100 mm] per 30 m. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Provide ducts with end bells whenever duct lines terminate in structures.

Perform changes in ductbank direction as follows:

a. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable.

b. The minimum manufactured bend radius must be 450 mm for ducts of less than 80 mm diameter, and 900 mm for ducts 80 mm or greater in diameter.

c. As an exception to the bend radius required above, provide field manufactured longsweep bends having a minimum radius of 7.6 m for a change of direction of more than 5 degrees, either horizontally or vertically, using a combination of curved and straight sections. Maximum manufactured curved sections: 30 degrees.

3.7.2 Treatment

Ducts must be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers must be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer must be used whenever an existing duct is connected to a duct of different material or shape. Ducts must be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts must be thoroughly cleaned before being laid. Plastic ducts must be stored on a flat surface and protected from the direct rays of the sun.

3.7.3 Conduit Cleaning

As each conduit run is completed, for conduit sizes 75 mm and larger, draw a flexible testing mandrel approximately 305 mm 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, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs.

3.7.4 Jacking and Drilling Under Roads and Structures

Conduits to be installed under existing paved areas which are not to be disturbed, and under roads and railroad tracks, must be zinc-coated, rigid steel, jacked into place. Where ducts are jacked under existing pavement, rigid steel conduit must be installed because of its strength. To protect the corrosion-resistant conduit coating, predrilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. For crossings of existing railroads and airfield pavements greater than 15 m in length, the predrilling method or the jack-and-sleeve method will be used. Separators or spacing blocks must be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 1.2 m on centers. [Hydraulic jet method must not be used.]

[3.7.5 Galvanized Conduit Concrete Penetrations

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

]3.7.6 Multiple Conduits

Separate multiple conduits by a minimum distance of 75 mm[, except that light and power conduits must be separated from control, signal, and telephone conduits by a minimum distance of [300] mm]. Stagger the joints of the conduits by rows (horizontally) and layers (vertically) to strengthen the conduit assembly. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly must consist of base spacers, intermediate spacers, ties, and locking device on top 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 of conduit assembly.

3.7.7 Conduit Plugs and Pull Rope

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

3.7.8 Conduit and Duct Without Concrete Encasement

Depths to top of the conduit must be not less than 610 mm below finished grade. Provide not less than 75 mm clearance from the conduit to each side of the trench. Grade bottom of trench smooth; where rock, soft spots, or sharp-edged materials are encountered, excavate the bottom for an additional 75 mm, fill and tamp level with original bottom with sand or

earth free from particles, that would be retained on a 6.25 mm sieve. The first 150 mm layer of backfill cover must be sand compacted as previously specified. The rest of the excavation must be backfilled and compacted in 75 to 150 mm layers. Provide color, type and depth of warning tape as specified in Section [31 23 00.00 20 EXCAVATION AND FILL][31 00 00 EARTHWORK].

3.7.8.1 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 concrete cover around ducts. Concrete encasement must extend at least 1525 mm beyond the edges of paved areas and roads, and 3660 mm beyond the rails on each side of railroad tracks. Depths to top of the concrete envelope must be not less than 610 mm below finished grade[, and under railroad tracks not less than 1270 mm below the top of the rails].

[3.7.8.2 Directional Boring

HDPE conduits must be installed below the frostline and as specified herein.

[For distribution voltages greater than 1000 volts and less than 34,500 volts, depths to the top of the conduit must not be less than 1220 mm in pavement-covered areas and not less than 3050 mm in non-pavement-covered areas.][For distribution voltages less than 1000 volts, depths to the top of the conduit must not be less than 1220 mm in pavement- or non-pavement-covered areas.][For branch circuit wiring less than 600 volts, depths to the top of the conduit must not be less than 610 mm in pavement- or non-pavement-covered areas.]

]3.7.9 Duct Encased in Concrete

Construct underground duct lines of individual conduits encased in concrete. Depths to top of the concrete envelope must be not less than 450 mm below finished grade[, except under roads and pavement, concrete envelope must be not less than 610 mm below finished grade][, and under railroad tracks not less than 1270 mm below the top of the rails]. Do not mix different kinds of conduit in any one duct bank. Concrete encasement surrounding the bank must be rectangular in cross-section and must provide at least 75 mm of concrete cover for ducts. Separate conduits by a minimum concrete thickness of 75 mm. Before pouring concrete, anchor duct bank assemblies to prevent the assemblies from floating during concrete pouring. Anchoring must be done by driving reinforcing rods adjacent to duct spacer assemblies and attaching the rods to the spacer assembly.[Provide steel reinforcing in the concrete envelope as indicated.][Provide color, type and depth of warning tape as specified in Section [31 00 00 EARTHWORK][31 23 00.00 20 EXCAVATION AND FILL.]]

3.7.9.1 Connections to Manholes

Duct bank envelopes connecting to underground structures must be flared to have enlarged cross-section at the manhole entrance to provide additional shear strength. Dimensions of the flared cross-section must be larger than the corresponding manhole opening dimensions by no less than 300 mm in each direction. Perimeter of the duct bank opening in the underground structure must 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.

3.7.9.2 Connections to Existing Underground Structures

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.

3.7.9.3 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.

3.7.9.4 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.]

3.7.9.5 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 back into the envelope and a minimum of 610 mm beyond the end of the envelope. Provide one No. 13 bar in each corner, 75 mm from the edge of the envelope. Secure corner bars with two No. 10 ties, spaced approximately 305 mm apart. Restrain reinforcing assembly from moving during concrete pouring.

[3.7.9.6 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.

]3.7.10 Duct Sealing

Seal all electrical penetrations for radon mitigation, maintaining integrity of the vapor barrier, and to prevent infiltration of air, insects, and vermin.

3.8 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 must 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.

3.8.1 Cable Lubricants

Use lubricants that are specifically recommended by the cable manufacturer for assisting in pulling jacketed cables.

3.9 CABLES IN UNDERGROUND STRUCTURES

Do not install cables utilizing the shortest path between penetrations, 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. 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.

3.9.1 Cable Tag Installation

Install cable tags in each manhole as specified, including each splice. Tag wire and cable provided by this contract. Install cable tags over the fireproofing, if any, and locate the tags so that they are clearly visible without disturbing any cabling or wiring in the manholes.

3.10 CONDUCTORS INSTALLED IN PARALLEL

Conductors must 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.

3.11 LOW VOLTAGE CABLE SPLICING AND TERMINATING

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, handholes, or aboveground termination pedestals.]

[3.11.1 Terminating Aluminum Conductors

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

must 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 must 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 inhibiting 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).

]3.12 [HIGH][EXTRA-HIGH] VOLTAGE CABLE TERMINATIONS

Make terminations in accordance with the written instruction of the termination kit manufacturer.

3.13 [HIGH][EXTRA-HIGH] VOLTAGE CABLE JOINTS

Provide power cable joints (splices) suitable for continuous immersion in water. Make joints only in accessible locations in manholes or handholes by using materials and methods in accordance with the written instructions of the joint kit manufacturer.

3.13.1 Joints in Shielded Cables

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. Provide a bare copper ground connection brought out in a watertight manner and grounded to the manhole grounding loop as part of the splice installation. Ground conductors, connections, and rods must be as specified elsewhere in this section. Wire must be trained to the sides of the enclosure to prevent interference with the working area.

[3.13.2 Joints in Armored Cables

Armored cable joints must be enclosed in compound-filled, cast-iron or alloy splice boxes equipped with stuffing boxes and armor clamps of a suitable type and size for the cable being installed.

]3.14 CABLE END CAPS

Cable ends must be sealed at all times with coated heat shrinkable end caps. Cables ends must be sealed when the cable is delivered to the job site, while the cable is stored and during installation of the cable. The caps must 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.

[3.15 LIVE END CAPS

Provide live end caps for single conductor [high][extra-high] voltage

cables where indicated.

]3.16 FIREPROOFING OF CABLES IN UNDERGROUND STRUCTURES

Fireproof (arc proof) wire and cables which will carry current at 2200 volts or more in underground structures.

3.16.1 Fireproofing Tape

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

[3.16.2 Tape-Wrap

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

]3.17 GROUNDING SYSTEMS

IEEE C2 and JIS C 0365, except provide grounding systems with a resistance to solid earth ground not exceeding [25][_____] ohms.

3.17.1 Grounding Electrodes

Provide cone pointed driven ground rods driven full depth plus[150 mm][300 mm], installed to provide an earth ground of the appropriate value for the particular equipment being grounded.
If the specified ground resistance is not met, an additional ground rod must be provided (placed not less than 1830 mm from the first rod). Should the resultant (combined) resistance exceed the specified resistance, measured not less than 48 hours after rainfall, notify the Contracting Officer immediately.

3.17.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, 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 must be as recommended by the manufacturer. An embossing die code or other standard method must provide visible indication that a connector has been adequately compressed on the ground wire.

3.17.3 Grounding Conductors

Provide bare grounding conductors, except where installed in conduit with

associated phase conductors. Ground cable sheaths, cable shields, conduit, and equipment with 14 sqmm. Ground other noncurrent-carrying metal parts and equipment frames of metal-enclosed equipment. Ground metallic frames and covers of handholes and pull boxes with a braided, copper ground strap with equivalent ampacity of 14 sqmm.[Provide direct connections to the grounding conductor with 600 v insulated, full-size conductor for each grounded neutral of each feeder circuit, which is spliced within the manhole.]

3.17.4 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.

3.17.5 Manhole Grounding

Loop a 100 sqmm grounding conductor around the interior perimeter, approximately 305 mm above finished floor. Secure the conductor to the manhole walls at intervals not exceeding 914 mm. Connect the conductor to the manhole grounding electrode with 100 sqmm conductor. Connect all incoming 100 sqmm grounding conductors to the ground loop adjacent to the point of entry into the manhole. Bond the ground loop to all cable shields, metal cable racks, and other metal equipment with a minimum 14 sqmm conductor.

[3.17.6 Fence Grounding

[Provide grounding for fences as indicated.][Provide grounding for fences with a ground rod at each fixed gate post and at each corner post.] Drive ground rods until the top is 305 mm below grade. Attach a 22 sqmm 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 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 must be bonded to its gatepost by a 3 by 25 mm flexible braided copper strap and ground post clamps. Clamps must be of the anti-electrolysis type.

][3.17.7 Metal Splice Case Grounding

Metal splice cases for [high][extra-high]-voltage direct-burial cable must be grounded by connection to a driven ground rod located within 600 mm of each splice box using a grounding electrode conductor having a current-carrying capacity of at least 20 percent of the individual phase conductors in the associated splice box, but not less than 14 sqmm.

]3.18 EXCAVATING, BACKFILLING, AND COMPACTING

Provide in accordance with Section [31 23 00.00 20 EXCAVATION AND FILL][31 00 00 EARTHWORK].

3.18.1 Reconditioning of Surfaces

3.18.1.1 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, and provide topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.[Provide work in accordance with Section 32 92 19 SEEDING and Section 32 93 00 EXTERIOR PLANTS.]

3.18.1.2 Paving Repairs

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 [32 13 13.06 PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES][_____].]

3.19 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.19.1 Concrete Slabs (Pads) for Equipment

Unless otherwise indicated, the slab must be at least 200 mm thick, reinforced with a 150 mm by 150 mm - MW19 by MW19 (6 by 6 - W2.9 by W2.9) mesh, placed uniformly 100 mm from the top of the slab. Slab must be placed on a 150 mm thick, well-compacted gravel base. Top of concrete slab must be approximately 100 mm above finished grade with gradual slope for drainage. Edges above grade must have 15 mm chamfer. Slab must be of adequate size to project at least 200 mm beyond the equipment.

Stub up conduits, with bushings, 50 mm into cable wells in the concrete pad. Coordinate dimensions of cable wells with transformer cable training areas.

[3.19.2 Sealing

When the installation is complete, seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals must be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

]3.20 FIELD QUALITY CONTROL

3.20.1 Performance of Field Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, and include the following visual and mechanical inspections and electrical tests, performed in accordance with Denki Hoan Kyoukai and MLIT DSKKS.

3.20.1.1 [High][Extra-High] Voltage Cables

Perform tests after installation of cable, splices, and terminators and before terminating to equipment or splicing to existing circuits.

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) Visually inspect jacket and insulation condition.

(7) 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 acceptance test on new cables before the new cables are connected to existing cables and placed into service, including terminations and joints. Perform maintenance test on complete cable system after the new cables are connected to existing cables and placed into service, including existing cable, terminations, and joints. Tests must be very low frequency (VLF) alternating voltage withstand tests. VLF test frequency must be 0.05 Hz minimum for a duration of 60 minutes using a sinusoidal waveform. Test voltages must be as follows:

CABLE RATING AC TEST VOLTAGE for ACCEPTANCE TESTING	
3.3kV	9kV (peak)
5 kV	10kV rms(peak)
6.6 kV	17kV rms(peak)
8 kV	13kV rms(peak)
15 kV	20kV rms(peak)
22 kV	44kV rms(peak)
25 kV	31kV rms(peak)
33 kV	63kV (peak)
35 kV	44kV rms(peak)

CABLE RATING AC TEST VOLTAGE for ACCEPTANCE TESTING	
66 kV	85kV (peak)
77 kV	95kV (peak)

CABLE RATING AC TEST VOLTAGE for MAINTENANCE TESTING	
3.3kV	Per manufacturer requirements.
5 kV	7kV rms(peak)
6.6 kV	Per manufacturer requirements.
8 kV	10kV rms(peak)
15 kV	16kV rms(peak)
22 kV	Per manufacturer requirements.
25 kV	23kV rms(peak)
33 kV	Per manufacturer requirements.
35 kV	33kV rms(peak)
66 kV	Per manufacturer requirements.
77 kV	Per manufacturer requirements.

(3) In lieu of the acceptance testing required in item (2), High Voltage Direct Current (HVDC) test is an alternative acceptance test on newly installed cables. Maximum applied DC test voltage shall be determined in consultation with the manufacturer of the cable and cable accessories for the type of cable being tested. The maximum test voltage to be maintained for 10 minutes. After reaching the maximum test voltage, the current magnitude should be recorded at least twice: once at approximately 2 min and again at the end of the test period (10 min) Contractor shall submit test procedure and standard use as reference for testing to the government for review and approval.

3.20.1.2 Low Voltage Cables, 600-Volt

Perform tests after installation of cable, splices and terminations and before terminating to equipment or splicing to existing circuits.

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) Verify tightness of accessible bolted electrical connections.

(4) Inspect compression-applied connectors for correct cable match and indentation.

(5) Visually inspect jacket and insulation condition.

(6) Inspect for proper phase identification and arrangement.

b. Electrical Tests

(1) Perform insulation resistance tests on wiring 14 sqmm and larger diameter using instrument which applies voltage of approximately 1000 volts dc for one minute.

(2) Perform continuity tests to insure correct cable connection.

3.20.1.3 Grounding System

a. Visual and mechanical inspection

Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

Perform ground-impedance measurements utilizing the fall-of-potential method in accordance with JIS C 60364-6. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument must be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test. Provide site diagram indicating location of test probes with associated distances, and provide a plot of resistance vs. distance.

3.20.2 Follow-Up Verification

Upon completion of acceptance checks and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Contracting Officer must be given 5 working days advance notice of the dates and times of checking and testing.

.... -- End of Section --