

**AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT**

1. CONTRACT ID CODE \_\_\_\_\_ PAGE \_\_\_\_\_ OF \_\_\_\_\_ PAGES

2. AMENDMENT/MODIFICATION NO.		3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. <i>(If applicable)</i>
6. ISSUED BY	CODE	7. ADMINISTERED BY <i>(If other than Item 6)</i>		CODE

8. NAME AND ADDRESS OF CONTRACTOR <i>(No., street, county, State and ZIP Code)</i>	(X)	9A. AMENDMENT OF SOLICIATION NO.
		9B. DATED <i>(SEE ITEM 11)</i>
		10A. MODIFICATION OF CONTRACT/ORDER NO.
		10B. DATED <i>(SEE ITEM 11)</i>
CODE	FACILITY CODE	

**11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS**

The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers  is extended,  is not extended. Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:  
 (a) By completing items 8 and 15, and returning \_\_\_\_\_ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment your desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA *(If required)***13. THIS ITEM ONLY APPLIES TO MODIFICATION OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.**

CHECK ONE	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: <i>(Specify authority)</i> THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES <i>(such as changes in paying office, appropriation date, etc.)</i> SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
	D. OTHER <i>(Specify type of modification and authority)</i>

**E. IMPORTANT:** Contractor  is not,  is required to sign this document and return \_\_\_\_\_ copies to the issuing office.14. DESCRIPTION OF AMENDMENT/MODIFICATION *(Organized by UCF section headings, including solicitation/contract subject matter where feasible.)*

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER <i>(Type or print)</i>		16A. NAME AND TITLE OF CONTRACTING OFFICER <i>(Type or print)</i>	
15B. CONTRACTOR/OFFEROR	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA	16C. DATE SIGNED
<i>(Signature of person authorized to sign)</i>		<i>(Signature of Contracting Officer)</i>	

Item 14. Continued.

**CHANGES TO BIDDING SCHEDULE**

1. Replace the Bidding Schedule, with the accompanying new Bidding Schedule bearing the notation "ACCOMPANYING AMENDMENT NO. 0001 TO SOLICITATION NO. DACA63-01-B-0019."

**CHANGES TO THE SPECIFICATIONS**

2. Replacement Sections - Replace the following sections with the accompanying new sections of the same number and title, bearing the notation "ACCOMPANYING AMENDMENT NO. 0001 TO SOLICITATION NO. DACA63-01-B-0019:"

SECTION 16370A ELECTRICAL DISTRIBUTION SYSTEM, AERIAL  
SECTION 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

END OF AMENDMENT

ACCOMPANYING AMENDMENT NO. 0001 TO SOLICITATION NO. DACA63-01-B-0019  
Ammunition Infrastructure Improvements (Area F) (Title)  
Red River Army Depot, Texas (Location)

Solicitation No. DACA63-01-B-0019

BIDDING SCHEDULE  
 (To be attached to SF 1442)

Item No.	Description	Estimated Quantity	Unit	Unit Cost	Estimated Amount
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BASE BID:

All work required by the plans and specifications to construct the ammunition Infrastructure Improvements (Area F) Container Pad excluding the option.

0001	All work excluding Option No. 1	Job	Sum	***	\$_____
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TOTAL BASE BID \$\_\_\_\_\_

OPTION 1:

0002	All work required by the plans and specifications for the construction of the Gravel Pad in lieu of the turfing.	Job	Sum	***	\$_____
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TOTAL BASE BID PLUS OPTION NO. 1 \$\_\_\_\_\_

NOTES:

1. ARITHMETIC DISCREPANCIES: (1989 JUL)

(a) For the purpose of initial evaluation of bids, the following will be utilized in resolving arithmetic discrepancies found on the face of the bidding schedule as submitted by bidders:

(1) Obviously misplaced decimal points will be corrected;

(2) In case of discrepancy between unit price and extended price, the unit price will govern;

(3) Apparent errors in extension of unit prices will be corrected; and

(4) Apparent errors in addition of lump-sum and extended prices will be corrected.

(b) For the purposes of bid evaluation, the Government will proceed on the assumption that the bidder intends his bid to be evaluated on the basis of the unit prices, extensions, and totals arrived at by resolution of arithmetic discrepancies as provided above and the bid will be so reflected on the abstract of bids. (EFARS 14.406-2)

ACCOMPANYING AMENDMENT NO. 0001 TO SOLICITATION NO. DACA63-01-B-0019  
Ammunition Infrastructure Improvements (Area F) (Title)  
Red River Army Depot, Texas (Location)

Solicitation No. DACA63-01-B-0019

Notes: (cont)

2. If a modification to a bid based on unit prices is submitted, which provides for a lump sum adjustment to the total estimated cost, the application of the lump sum adjustment to each unit price in the bid schedule must be stated. If it is not stated, the bidder agrees that the lump sum adjustment shall be applied on a pro rata basis to every unit price in the bid schedule.

3. Bidders must bid on all items.

4. Costs attributable to Division 01 - General Requirements are assumed to be prorated among bid items listed.

5. Responders are advised that this requirement may be delayed, canceled or revised at any time during the solicitation, selection, evaluation, negotiation and/or final award process based on decisions related to DOD changes in force structure and disposition of the Armed Services.

6. For the purpose of this solicitation, the word "item" shall be considered to mean "schedule" as used in Provision 52,214-0019, CONTRACT AWARD--SEALED BIDDING--CONSTRUCTION, in Section 00100 INSTRUCTIONS, CONDITIONS, AND NOTICES TO BIDDERS, excluding additives, deductives or options

7. EXERCISE OF OPTIONS (SWDR 715-1-1)

The Government reserves the right to exercise the option(s) for up to 90 calendar days after award of the Base Bid without an increase in the Offeror's Bid Price. Completion of added options shall continue at the same schedule as the Base Bid unless otherwise noted in the CONSTRUCTION SCHEDULE, paragraph 1.1 entitled SCHEDULE.

END OF BIDDING SCHEDULE

SECTION 16370A

ELECTRICAL DISTRIBUTION SYSTEM, AERIAL

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 in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C29.1	(1988; R 1996) Electrical Power Insulators - Test Methods
ANSI C29.2	(1992) Insulators - Wet-Process Porcelain and Toughened Glass - Suspension Type
ANSI C29.3	(1986; R 1995) Wet Process Porcelain Insulators - Spool Type
ANSI C29.4	(1989; R 1995) Wet-Process Porcelain Insulators - Strain Type
ANSI C29.5	(1984; R 1995) Wet-Process Porcelain Insulators - Low- and Medium-Voltage Types
ANSI C29.6	(1996) Wet-Process Porcelain Insulators - High-Voltage Pin Type
ANSI C29.8	(1985; R 1995) Wet-Process Porcelain Insulators - Apparatus, Cap and Pin Type
ANSI C29.9	(1983; R 1996) Wet-Process Porcelain Insulators - Apparatus, Post-Type
ANSI C37.32	(1996) High-Voltage Air Switches, Bus Supports, and Switch Accessories - Schedules of Preferred Ratings, Manufacturing Specifications, and Application Guide
ANSI C57.12.20	(1997) Overhead Type Distribution Transformers, 500 KVA and Smaller: High Voltage 34 500 Volts and Below: Low Voltage, 7970/13 800 Y Volts and Below
ANSI C135.1	(1979) Galvanized Steel Bolts and Nuts for Overhead Line Construction
ANSI C135.2	(1987) Threaded Zinc-Coated Ferrous Strand-Eye Anchor Rods and Nuts for

Overhead Line Construction

ANSI C135.4	(1987) Zinc-Coated Ferrous Eyebolts and Nuts for Overhead Line Construction
ANSI C135.14	(1979) Staples with Rolled or Slash Points for Overhead Line Construction
ANSI C135.22	(1988) Zinc-Coated Ferrous Pole-Top Insulator Pins with Lead Threads for Overhead Line Construction
ANSI C135.30	(1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction
ANSI O5.1	(1992) Specifications and Dimensions for Wood Poles

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1997a) Carbon Structural Steel
ASTM A 123/A 123M	(1997ael) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(1998) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 475	(1998) Zinc-Coated Steel Wire Strand
ASTM A 575	(1996) Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A 576	(1990b; R 1995) Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM B 1	(1995) Hard-Drawn Copper Wire
ASTM B 8	(1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM B 228	(1998) Concentric-Lay-Stranded Copper-Clad Steel Conductors
ASTM B 230	(1998) Aluminum 1350-H19 Wire for Electrical Purposes
ASTM B 231	(1995) Concentric-Lay-Stranded Aluminum 1350 Conductors
ASTM B 232	(1997) Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR)

ASTM B 398	(1997) Aluminum-Alloy 6201-T81 Wire for Electrical Purposes
ASTM B 399	(1997) Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors
ASTM B 416	(1998) Concentric-Lay-Stranded Aluminum-Clad Steel Conductors
ASTM D 923	(1997) Sampling Electrical Insulating Liquids
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 4059	(1996) Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography.

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C4	(1995) Poles - Preservative Treatment by Pressure Processes
AWPA C25	(1995) Sawn Crossarms - Preservative Treatment by Pressure Processes
AWPA P1/P13	(1995) Standard for Coal Tar Creosote for Land and Fresh Water and Marine (Coastal Water Use)
AWPA P5	(1997) Standards for Waterborne Preservatives
AWPA P8	(1997) Standards for Oil-Borne Preservatives
AWPA P9	(1997) Standards for Solvents for Organic Preservative Systems

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code
IEEE C37.34	(1994) Test Code for High-Voltage Air Switches
IEEE C37.41	(1994; C37.41e) Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories

IEEE C37.60	(1981; R 1992) Requirements for Overhead, Pad Mounted, Dry Vault and Submersible Automatic Circuit Reclosers and Fault Interrupters for AC Systems
IEEE C37.63	(1997) Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizer for AC Systems
IEEE C57.12.00	(1993) Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.13.2	(1991) IEEE Standard Conformance Test Procedures for Instrument Transformers
IEEE C57.15	(1986; R 1992) Requirements, Terminology, and Test Code for Step-Voltage and Induction-Voltage Regulators
IEEE C57.19.00	(1991; R 1997) IEEE Standard General Requirements and Test Procedures for Outdoor Power Apparatus Bushings
IEEE C57.19.01	(1991; R 1997) IEEE Standard Performance Characteristics and Dimensions for Outdoor Apparatus Bushings
IEEE C57.98	(1993) Guide for Transformer Impulse Tests
IEEE C62.1	(1989; R 1994) Surge Arresters for AC Power Circuits
IEEE C62.2	(1987; R 1994) Guide for the Application of Gapped Silicon-Carbide Surge Arresters for Alternating Current Systems
IEEE C62.11	(1998) IEEE Standard Metal-Oxide Surge Arresters for AC Power Circuits
IEEE Std 18	(1992) Shunt Power Capacitors
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
IEEE Std 100	(1996) IEEE Standard Dictionary of Electrical and Electronics Terms
IEEE Std 242	(1986; R 1991) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

IEEE Std 399 (1997) Recommended Practice for Industrial and Commercial Power Systems Analysis

IEEE Std 404 (1993; errata) Cable Joints for Use with Extruded Dielectric Cable Rated 5000 V Through 138 000 V and Cable Joints for Use with Laminated Dielectric Cable Rated 2500 V Through 500 000 V

INSULATED CABLE ENGINEERING ASSOCIATION (ICEA)

ICEA S-70-547 (1992) Weather Resistant Polyolefin Covered Wire & Cable

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA HV 2 (1991) Application Guide for Ceramic Suspension Insulators

NEMA ICS 6 (1993) Industrial Control and Systems, Enclosures

NEMA LA 1 (1992) Surge Arresters

NEMA SG 2 (1993) High Voltage Fuses

NEMA WC 5 (1992; Rev 1) Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NEMA WC 7 (1991; Rev 1) Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NEMA WC 8 (1991; Rev 3 1996) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

RURAL UTILITIES SERVICES (RUS)

REA Bulletin 1728H-701 (1993) Crossarms (Solid and Laminated), Transmission Timbers and Pole Keys

UNDERWRITERS LABORATORIES (UL)

UL 467 (1993; Rev thru Aug 1996) Grounding and Bonding Equipment

UL 486A (1997; Rev thru Dec 1998) Wire Connectors  
and Soldering Lugs for Use with Copper  
Conductors

UL 486B (1997; Rev Jun 1997) Wire Connectors for  
Use with Aluminum Conductors

## 1.2 GENERAL REQUIREMENTS

### 1.2.1 Terminology

Terminology used in this specification is as defined in IEEE Std 100.

### 1.2.2 Service Conditions

Items provided under this section shall be specifically suitable for the following service conditions.

- a. Ambient Temperature 110<sup>o</sup> F
- b. Frequency 60 Hz

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

#### Electrical Distribution System; G

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings. Detail drawings shall as a minimum include:

- a. Poles.
- b. Crossarms.
- c. Transformers.
- d. Pole top switches.
- e. Conductors.
- f. Insulators.
- g. Surge arresters.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be submitted with the detail drawings. Approved departures shall be made at no additional cost to the Government.

Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:

a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded.

b. Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.

#### As-Built Drawings

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction.

The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

SD-03 Product Data

Protective Device; G

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

Nameplates; G

Catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material and Equipment; G

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include the item number, the quantity of items proposed, and the name of the manufacturer of the item.

General Installation Requirements; G

As a minimum, installation procedures for regulators and transformers. Procedures shall include diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment.

SD-06 Test Reports

Factory Tests; G

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests specified in applicable publications or in these specifications.

Field Testing; G

A proposed field test plan 30 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Operating Tests; G

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of 5 rings, and including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The condition specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.

#### SD-07 Certificates

##### Material and Equipment; G

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronic Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided under this section of the specifications conform to such requirements. The label of, or listing by, UL will be acceptable as evidence that the items conform thereto. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms thereto. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms thereto. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies.

#### SD-10 Operation and Maintenance Data

##### Electrical Distribution System; G

Six copies of Operation and Maintenance manuals electrical distribution system shall be provided, within 7 calendar days following the completion of tests and shall include assembly, installation, operation and maintenance instructions, spare parts

data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked. Manuals shall also include data outlining detailed procedures for system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment, basic operating features, and routine maintenance requirements shall also be included. Documents shall be bound in a binder marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare-parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers. Three additional copies of the instructions manual shall be provided within 30 calendar days following the manuals.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Oil filled transformers and switches shall be stored in accordance with the manufacturer's requirements. Wood poles held in storage for more than 2 weeks shall be stored in accordance with ANSI O5.1. Handling of wood poles shall be in accordance with ANSI O5.1, except that pointed tools capable of producing indentations more than 25 mm (1 inch) in depth shall not be used. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

#### 1.5 EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the Contracting Officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

### PART 2 PRODUCTS

#### 2.1 GENERAL REQUIREMENTS

Products shall conform to the following requirements. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

#### 2.2 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially

duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

## 2.3 NAMEPLATES

### 2.3.1 General

Each major component shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Equipment containing liquid-dielectrics shall have the type of dielectric on the nameplate. Nameplates shall be made of noncorrosive metal. As a minimum, nameplates shall be provided for transformers and switches.

### 2.3.2 Liquid-Filled Transformer Nameplates

Power transformers shall be provided in accordance with IEEE C57.12.00. Nameplates shall indicate the number of gallons and composition of liquid-dielectric, and shall be permanently marked with a statement that the transformer dielectric to be supplied is non-polychlorinated biphenyl. If transformer nameplate is not so marked, the Contractor shall furnish manufacturer's certification for each transformer that the dielectric is non-PCB classified, with less than 50 ppm PCB content in accordance with paragraph LIQUID DIELECTRICS. Certifications shall be related to serial numbers on transformer nameplates. Transformer dielectric exceeding the 50 ppm PCB content or transformers without certification will be considered as PCB insulated and will not be accepted.

## 2.4 CORROSION PROTECTION

### 2.4.1 Aluminum Materials

Aluminum shall not be used in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486B shall be used.

### 2.4.2 Ferrous Metal Materials

#### 2.4.2.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M and ASTM A 123/A 123M.

#### 2.4.2.2 Equipment

Equipment and component items, including but not limited to transformers and ferrous metal luminaires not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 120 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The described test mark and test evaluation shall be in accordance with ASTM D 1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip

galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

#### 2.4.3 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory shall be as specified in Section 09900 PAINTING, GENERAL.

### 2.5 CONDUCTORS, CONNECTORS, AND SPLICES

#### 2.5.1 Copper Conductors

Hard-drawn-copper conductors shall comply with ASTM B 1 and ASTM B 8 as appropriate for the conductor size.

#### 2.5.2 Connectors and Splices

Connectors and splices shall be of copper alloys for copper conductors, aluminum alloys for aluminum-composition conductors, and a type designed to minimize galvanic corrosion for copper to aluminum-composition conductors. Aluminum-composition and aluminum-composition to copper shall comply with UL 486B, and copper-to-copper shall comply with UL 486A.

### 2.6 MEDIUM-VOLTAGE LINES

#### 2.6.1 Bare Medium-Voltage Lines

Bare medium-voltage line conductors shall be selected to match the material type of the existing overhead primary conductor. Conductor types shall not be mixed on any project, unless specifically indicated. Conductors larger than No. 2 AWG shall be stranded.

### 2.7 POLES AND HARDWARE

Poles shall be of lengths and classes indicated.

#### 2.7.1 Wood Poles

Wood poles shall comply with ANSI O5.1, and shall be pressure treated in accordance with AWPA C4, with creosote conforming to AWPA P1/P13 or with oil-borne preservatives and petroleum conforming to AWPA P8 and AWPA P9, respectively, and waterborne preservatives conforming to AWPA P5. Waterborne preservatives shall be either chromated or ammoniacal copper arsenate. Any species listed in ANSI O5.1 for which a preservative treatment is not specified in AWPA C4, shall not be used; northern white cedar, if treated as specified for western red cedar, and western fir, if treated as specified for Douglas fir, may be used. Wood poles shall have pole markings located approximately 10 feet from pole butts for poles 50 feet or less in length, and 14 feet from the pole butts for poles longer than 55 feet in length. Poles shall be machine trimmed by turning smooth full length, and shall be roofed, gained, and bored prior to pressure treatment. Where poles are not provided with factory-cut gains, metal gain plates shall be provided.

### 2.7.2 Pole Line Hardware

Zinc-coated hardware shall comply with ANSI C135.1, ANSI C135.2, ANSI C135.4, ANSI C135.14 ANSI C135.22. Steel hardware shall comply with ASTM A 575 and ASTM A 576. Hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M. Pole-line hardware shall be hot-dip galvanized steel. Washers shall be installed under boltheads and nuts on wood surfaces and elsewhere as required. Washers used on through-bolts and double-arming bolts shall be approximately (2-1/4 inches square) and 3/16 inch thick. The diameter of holes in washers shall be the correct standard size for the bolt on which a washer is used. Washers for use under heads of carriage-bolts shall be of the proper size to fit over square shanks of bolts. Eye bolts, bolt eyes, eyenuts, strain-load plates, lag screws, guy clamps, fasteners, hooks, shims, and clevises shall be used wherever required to support and to protect poles, brackets, crossarms, guy wires, and insulators.

### 2.7.3 Armless Construction

Pole mounting brackets for line-post or pin insulators and eye bolts for suspension insulators shall be as shown. Brackets shall be attached to poles with a minimum of two bolts. Brackets may be either provided integrally as part of an insulator or attached to an insulator with a suitable stud. Bracket mounting surface shall be suitable for the shape of the pole. Brackets for wood poles shall have wood gripping members. Horizontal offset brackets shall have a 5-degree uplift angle. Pole top brackets shall conform to ANSI C135.22, except for modifications necessary to provide support for a line-post insulator. Brackets shall provide a strength exceeding that of the required insulator strength, but in no case less than a 2800 pound cantilever strength.

### 2.7.4 Guy Assemblies

Guy assemblies shall be as shown. Guy assemblies, including insulators and attachments, shall provide a strength exceeding the required guy strength. Anchors shall provide adequate strength to support all loads. Guy strand shall be as necessary. Guy material shall be as shown, except where two or more guys are used to provide the required strength. Guy rods shall be not less than in length by in diameter.

## 2.8 INSULATORS

Insulators shall comply with NEMA HV 2 for general requirements. Suspension insulators shall be used at corners, angles, dead-ends, other areas where line insulators do not provide adequate strength, and as indicated. Mechanical strength of suspension insulators and hardware shall exceed the rated breaking strength of the attached conductors.

### 2.8.1 Medium-Voltage Line Insulators

Medium-voltage line insulators shall comply with ANSI C29.2, ANSI C29.5, and ANSI C29.6, and as applicable. Ratings shall not be lower than the ANSI classes indicated in TABLE I. Horizontal line-post insulators shall be used for armless construction and shall have the same mechanical and

electrical ratings as vertical line-post insulators for the ANSI class indicated, but shall be modified to be suitable for horizontal installation. Where line-post insulators are used for angles greater than 15 degrees, clamp-top fittings shall be provided as well as for other locations shown. Conductor clamps for use with clamp-top, line-post insulators shall be hot-dip galvanized malleable iron for copper conductors and aluminum alloy for aluminum-composition conductors. Either line-post or pin insulators may be used for crossarm construction. Pin insulators for use on voltages in excess of 6 kV phase-to-phase shall be radio-interference-freed or else line-post insulators shall be used.

TABLE I

MINIMUM ANSI RATING OF MEDIUM-VOLTAGE INSULATORS BY CLASS

Voltage Level	Line-Post	Pin	Suspension
6 kV to 15 kV	57-1 or 11	55-5	Two 52-2
	57-2 or 12	56-3	Two 52-3 or 4

#### 2.8.2 Strain Insulators for Guy Wires

Strain insulators for use in insulated guy assemblies shall comply with ANSI C29.4 for porcelain or equivalent fiberglass, and shall have a mechanical strength exceeding the rated breaking strength of the attached guy wire. Insulators shall be not smaller than Class 54-2 for lines of 6 kV to 15 kV.

#### 2.8.3 Apparatus Insulators

Apparatus insulators shall comply with IEEE C57.19.00, IEEE C57.19.01, ANSI C29.8, and ANSI C29.9 as applicable.

### 2.9 CROSSARM ASSEMBLIES

#### 2.9.1 Crossarms

Crossarms shall comply with REA Bulletin 1728H-701 and shall be solid wood, distribution type, except cross-sectional area with pressure treatment conforming to AWPA C25, and a 1/4 inch, 45 degree chamfer on all top edges. Cross-sectional area minimum dimensions shall be 4-1/4 inches in height by 3-1/4 inches in depth in accordance with IEEE C2 for Grade B construction. Crossarms shall be 8 feet in length, except that 10 foot crossarms shall be used for crossarm-mounted banked single-phase transformers or elsewhere as indicated. Crossarms shall be machined, chamfered, trimmed, and bored for stud and bolt holes before pressure treatment. Factory drilling shall be provided for pole and brace mounting, for four pin or four vertical line-post insulators, and for four suspension insulators, except where otherwise indicated or required. Drilling shall provide required climbing space and wire clearances. Crossarms shall be straight and free of twists to within 1/10 inch per foot of length. Bend or twist shall be in one direction only.

## 2.10 FUSES MEDIUM-VOLTAGE

### 2.10.1 Fuse Cutouts

Medium-voltage fuses and cutouts shall comply with NEMA SG 2 and shall be of the open type construction ratings and types indicated. Open-link cut-outs are not acceptable. Fuses shall be either indicating or dropout type. Fuse ratings shall be as indicated. Fuse cutouts shall be equipped with mounting brackets suitable for the indicated installations.

## 2.11 TRANSFORMERS

Transformers shall comply with IEEE C57.12.00 for general requirements and ANSI C57.12.20 for specific requirements for overhead transformers. Overhead distribution transformers shall be of the outdoor type, mineral-oil-insulated single-phase as indicated and have two separate windings per phase. Transformers shall be provided with necessary auxiliary mounting devices suitable for the indicated installation. Transformers shall have four 2-1/2 percent rated kVA high-voltage taps above and below rated primary voltage. Transformer installations shall include one primary fuse cutout and one surge arrester for each ungrounded phase conductor. Self-protected transformers are not acceptable. Transformer tanks shall have a standard gray finish.

## 2.12 SURGE ARRESTERS

Surge arresters shall comply with NEMA LA 1 and IEEE C62.1, IEEE C62.2, and IEEE C62.11, and shall be provided for protection of aerial-to-underground transitions, transformers and other indicated equipment. Arresters shall be rated as shown. Arresters shall be equipped with mounting brackets suitable for the indicated installations. Arresters shall be suitable for outdoor installations.

## 2.13 GROUNDING AND BONDING

### 2.13.1 Driven Ground Rods

Ground rods shall be of copper-clad steel conforming to UL 467 not less than in diameter by in length of the sectional type driven full length into the earth.

### 2.13.2 Grounding Conductors

Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same material as the phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Bare conductors shall be ASTM B 8 soft-drawn unless otherwise indicated. Aluminum is not acceptable.

## 2.14 PADLOCKS

Padlocks shall comply with Section 08700 'Builders' Hardware.

## 2.15 WARNING SIGNS

Warning signs shall be porcelain enameled steel or approved equal. Voltage warning signs shall comply with IEEE C2.

#### 2.16 LIQUID DIELECTRICS

Liquid dielectrics for transformers shall be non-polychlorinated biphenyl (PCB) mineral-oil or less-flammable liquid as specified. Nonflammable fluids shall not be used. Tetrachloroethylene (perchloroethylene) and 1, 2, 4 tetrachlorobenzene fluids shall not be used. Liquid dielectrics in retrofitted equipment shall be certified by the manufacturer as having less than 50 parts-per-million (ppm) PCB content. In lieu of the manufacturer's certification, the Contractor may submit a test sample of the dielectric in accordance with ASTM D 923 and have tests performed per ASTM D 4059 at a testing facility approved by the Contracting Officer. Equipment with test results indicating PCB level exceeding 50 ppm shall be replaced.

#### 2.17 FACTORY TESTS

Factory tests shall be performed, as follows, in accordance with the applicable publications and with other requirements of these specifications. The Contracting Officer shall be notified at least 10 days before the equipment is ready for testing.

- a. Transformers: Manufacturer's standard routine design and other tests in accordance with IEEE C57.12.00.
- b. Electric Power Insulators: Manufacturer's standard tests in accordance with ANSI C29.1.

### PART 3 EXECUTION

#### 3.1 GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Circuits installed in conduits or underground and splices and terminations for medium-voltage cable shall conform to the requirements of Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

##### 3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of IEEE C2, Grade B construction. No reduction in clearance shall be made. The installation shall also comply with the applicable parts of NFPA 70.

##### 3.1.2 Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall notify the Contracting Officer of any discrepancy before performing any work.

##### 3.1.3 Tree Trimming

Where lines pass through trees, trees shall be trimmed at least 15 feet clear on both sides horizontally and below for medium-voltage lines, and 5 feet clear on both sides horizontally and below for other lines, and no branch shall overhang horizontal clearances. Where trees are indicated to be removed to provide a clear right-of-way, clearing is specified in Section 02230 CLEARING AND GRUBBING.

#### 3.1.4 Disposal of Liquid Dielectrics

PCB-contaminated dielectric shall be marked as PCB and transported to and incinerated by an approved EPA waste disposal facility. The Contractor shall furnish certification of proper disposal. Contaminated dielectric shall not be diluted to lower the level of contamination.

### 3.2 POLE INSTALLATION

Joint-use electric/roadway-lighting poles for overhead electric and communication lines shall be wood poles utilizing armless construction. Cluster-mounted banked single-phase transformer installations shall be provided. Crossarm construction shall be provided for support of other equipment, except where direct-pole mounting is indicated. Provision for communication services is required on pole-line construction, except where specifically noted otherwise. A vertical pole space of not less than shall be reserved at indicated locations.

#### 3.2.1 Wood Pole Setting

Wood Pole Setting: Wood poles shall be set straight and firm. In normal firm ground, minimum pole-setting depths shall be as listed in Table II. Poles in straight runs shall be in a straight line. Curved poles shall be placed with curvatures in the direction of the pole line. Poles shall be set to maintain as even a grade as practicable. When the average ground run is level, consecutive poles shall not vary more than 5 feet in height.

When the ground is uneven, poles differing in length shall be kept to a minimum by locating poles to avoid the highest and lowest ground points. If it becomes necessary to shorten a pole, a piece shall be sawed off the top end and roofed. If any pole is shortened after treatment, the shortened end of the pole shall be given an application of hot preservative. Holes shall be dug large enough to permit proper use of tampers to the full depth of a hole. Earth shall be placed into the hole in (6 inch) 6 inch maximum layers, then thoroughly tamped before the next layer is placed. Surplus earth shall be placed around each pole in a conical shape and packed tightly to drain water away from poles.

TABLE II

MINIMUM POLE-SETTING DEPTH (FEET)

Length Overall Feet	Straight Lines	Curves, Corners, and Points of Extra Strain
20	5.0	5.0

TABLE II  
 MINIMUM POLE-SETTING DEPTH (FEET)

Length Overall Feet	Straight Lines	Curves, Corners, and Points of Extra Strain
25	5.5	5.5
30	5.5	5.5
35	6.0	6.0
40	6.5	6.5
45	6.5	7.0
50	7.0	7.5
55	7.5	8.0
60	8.0	8.5
65	8.5	9.0
70	9.0	9.5
75	9.5	10.0
80	10.0	10.5
85	10.5	11.0
90	11.0	11.5
95	11.5	12.0
100	12.5	12.5

### 3.3 CROSSARM MOUNTING

Crossarms shall be bolted to poles with 5/8 inch through-bolts with square washers at each end. Bolts shall extend not less than 1/8 inch nor more than 2 inches beyond nuts. On single crossarm construction, the bolt head shall be installed on the crossarm side of the pole. Metal crossarm braces shall be provided on crossarms. Flat braces may be provided for 8 foot crossarms and shall be 1/4 by 1-1/4 inches, not less than 28 inches in length. Flat braces shall be bolted to arms with 3/8 inch carriage bolts with round or square washers between boltheads and crossarms, and secured to poles with 1/2 by 4 inch lag screws after crossarms are leveled and aligned. Angle braces are required for 10 foot crossarms and shall be 60 inch span by 18 inch drop formed in one piece from 1-1/2 by 1-1/2 by 3/16 inch angle. Angle braces shall be bolted to crossarms with 1/2 inch bolts with round or square washers between boltheads and crossarms, and secured to poles with 5/8 inch through-bolts. Double crossarms shall be securely held in position by means of 5/8 inch double-arming bolts. Each double-arming bolt shall be equipped with four nuts and four square washers.

### 3.4 GUY INSTALLATION

Guys shall be provided where shown, with loads and strengths as indicated, and wherever conductor tensions are not balanced, such as at angles, corners, and dead-ends. Where a single guy will not provide the required strength, two or more guys shall be provided. Where guys are wrapped around poles, at least two guy hooks shall be provided and pole shims shall be provided where guy tension exceeds 6000 pounds. Guy clamps 6 inches in length with three 5/8 inch bolts, or offset-type guy clamps, or

approved guy grips shall be provided at each guy terminal. Guy-strain insulators shall be provided in each guy for wood poles. A half-round yellow polyvinyl, fiberglass, or other suitable plastic guy marker, not less than 8 feet in length, shall be provided at the anchor end of each guy shown, securely clamped to the guy or anchor at the bottom and top of the marker.

### 3.5 CONDUCTOR INSTALLATION

#### 3.5.1 Line Conductors

Unless otherwise indicated, conductors shall be installed in accordance with manufacturer's approved tables of sags and tensions. Proper care shall be taken in handling and stringing conductors to avoid abrasions, sharp bends, cuts, kinks, or any possibility of damage to insulation or conductors. Conductors shall be paid out with the free end of conductors fixed and cable reels portable, except where terrain or obstructions make this method unfeasible. Bend radius for any insulated conductor shall not be less than the applicable NEMA specification recommendation. Conductors shall not be drawn over rough or rocky ground, nor around sharp bends. When installed by machine power, conductors shall be drawn from a mounted reel through stringing sheaves in straight lines clear of obstructions. Initial sag and tension shall be checked by the Contractor, in accordance with the manufacturer's approved sag and tension charts, within an elapsed time after installation as recommended by the manufacturer.

#### 3.5.2 Connectors and Splices

Connectors and splices shall be mechanically and electrically secure under tension and shall be of the nonbolted compression type. The tensile strength of any splice shall be not less than the rated breaking strength of the conductor. Splice materials, sleeves, fittings, and connectors shall be noncorrosive and shall not adversely affect conductors. Low-voltage connectors for copper conductors shall be of the solderless pressure type.

#### 3.5.3 Conductor-To-Insulator Attachments

Conductors shall be attached to insulators by means of clamps, shoes or tie wires, in accordance with the type of insulator. For insulators requiring conductor tie-wire attachments, tie-wire sizes shall be as indicated in TABLE II.

TABLE II

TIE-WIRE REQUIREMENTS

CONDUCTOR Copper (AWG)	TIE WIRE Soft-Drawn Copper (AWG)
6	8
4 and 2	6
1 through 3/0	4

TABLE II

TIE-WIRE REQUIREMENTS

CONDUCTOR	TIE WIRE
Copper (AWG)	Soft-Drawn Copper (AWG)
4/0 and larger	2

### 3.6 TRANSFORMER INSTALLATION

Transformers shall be carefully installed so as not to scratch finishes or damage bushings. Transformers shall be installed in accordance with the manufacturer's instructions. After installation, surfaces shall be inspected and scratches shall be touched up with a finish provided by the transformer manufacturer for this purpose.

### 3.7 CONNECTIONS TO UTILITY LINES

The Contractor shall coordinate the work with the Contracting Officer and shall provide for final connections to the utility electric lines.

### 3.8 CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS

Connections between aerial and underground systems shall be made as shown. Underground cables shall be extended up poles in conduit to cable terminations. Conduits shall be secured to poles by two-hole galvanized steel pipe straps spaced not more than 10 feet apart and with one support not more than 12 inches from any bend or termination. Cables shall be supported by devices separate from the conduit or guard, near their point of exit from the riser conduit or guard. Cables guards shall be secured in accordance with the manufacturers published procedure. Risers shall be equipped with bushings to protect cables.

### 3.9 GROUNDING

Noncurrent-carrying metal parts of equipment and conductor assemblies, such as luminaires, medium-voltage cable terminations, panel enclosures, transformers, and other noncurrent-carrying metal items shall be grounded. Additional grounding of equipment, neutral, and surge arrester grounding systems shall be installed at poles where indicated.

#### 3.9.1 Grounding Electrodes

Grounding electrodes shall be installed as follows:

- a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be located approximately 3 feet out from base of the pole and shall be driven into the earth until the tops of the rods are approximately 1 foot below finished grade. Multiple rods shall be evenly spaced at least 10 feet apart and connected together 2 feet below grade with a minimum No. 6 bare copper conductor.
- b. Pole butt electrodes - Pole butt electrodes shall be installed where indicated, except that this method shall not be the sole grounding electrode at transformer locations. The pole butt electrode shall consist of a coil of at least 12 feet of minimum No. 6 bare copper conductor stapled to the butt of the pole.
- c. Ground Resistance - The maximum resistance of a driven ground rod shall not exceed 25 ohms under normally dry conditions. Whenever the required ground resistance is not met, provide additional

electrodes interconnected with grounding conductors to achieve the specified ground resistance. The additional electrodes will be up to three, 10 feet rods spaced a minimum of apart. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

### 3.9.2 Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors in compliance with UL 467, and those below grade shall be made by a fusion-welding process.

### 3.9.3 Grounding Electrode Conductors

On multi-grounded circuits, as defined in IEEE C2, provide a single continuous vertical grounding electrode conductor. Neutrals, surge arresters, and equipment grounding conductors shall be bonded to this conductor. Grounding electrode conductors shall be sized as shown. Grounding electrode conductors shall be stapled to wood poles at intervals not exceeding 2 feet. Bends greater than 45 degrees in grounding electrode conductor are not permitted.

## 3.10 FIELD TESTING

### 3.10.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 10 days prior to conducting tests. The Contractor shall furnish materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results.

Field reports will be signed and dated by the Contractor.

### 3.10.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

### 3.10.3 Ground-Resistance Tests

The resistance of each pole ground shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate

grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes shall be provided.

#### 3.10.4 Medium-Voltage Cable Test

After installation, prior to connection to an existing system, and before the operating test, the medium-voltage cable system shall be given a high potential test. Direct-current voltage shall be applied on the phase conductor of the system by connecting the conductor to one terminal and connecting the ground of the cable to the other terminal for the test. Prior to the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment. The method, voltage, length of time, and other characteristics of the test for initial installation shall be in accordance with NEMA WC 7 or NEMA WC 8 for the particular type of cable installed, and shall not exceed the recommendations of IEEE Std 404 for cable joints unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed. Repaired or replaced cables shall be retested.

#### 3.10.5 Sag and Tension Test

The Contracting Officer shall be given prior notice of the time schedule for stringing conductors or cables serving overhead medium-voltage circuits and reserves the right to witness the procedures used for ascertaining that initial stringing sags and tensions are in compliance with requirements for the applicable loading district and cable weight.

#### 3.10.6 Low-Voltage Cable Test

For underground secondary or service laterals from overhead lines, the low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations of conductors in the same trench, duct, or cable, with other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

$R \text{ in megohms} = (\text{rated voltage in kV} + 1) \times 1000 / (\text{length of cable in feet})$

Each cable failing this test shall be repaired or replaced. The repaired cable shall then be retested until failures have been eliminated.

#### 3.10.7 Liquid-Filled Transformer Tests

The following field tests shall be performed on liquid-filled transformers.

Pass-fail criteria shall be in accordance with the transformer manufacturer's specifications.

- a. Insulation resistance test phase-to-ground.
- b. Turns ratio test.

#### 3.10.8 Pre-Energization Services

The following services shall be performed on the equipment listed below. These services shall be performed subsequent to testing but prior to the initial energization. The equipment shall be inspected to insure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at major equipment shall be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations shall be inspected to detect possible damage during installation. If factory tests were not performed on completed assemblies, tests shall be performed after the installation of completed assemblies. Components shall be inspected for damage caused during installation or shipment and to ensure that packaging materials have been removed. Components capable of being both manually and electrically operated shall be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested shall be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer. Items for which such services shall be provided, but are not limited to, are the following:

Switches.

Transformers.

#### 3.10.9 Operating Tests

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

#### 3.11 MANUFACTURER'S FIELD SERVICE

##### 3.11.1 Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 4 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations. A VHS format video tape of the entire training session shall be submitted.

##### 3.11.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of the equipment, assist in the performance of the onsite tests, initial operation, and instruct personnel as to the operational and maintenance features of the equipment.

3.12 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --

SECTION 16375A

ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

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 in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C29.1	(1988; R 1996) Electrical Power Insulators - Test Methods
ANSI C37.46	(1981; R 1992) Power Fuses and Fuse Disconnecting Switches
ANSI C80.1	(1995) Rigid Steel Conduit - Zinc Coated
ANSI C119.1	(1986) Sealed Insulated Underground Connector Systems Rated 600 Volts
ANSI O5.1	(1992) Specifications and Dimensions for Wood Poles

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(1995) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B 3	(1995) Soft or Annealed Copper Wire
ASTM B 8	(1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM B 496	(1992) Compact Round Concentric-Lay-Stranded Copper Conductors
ASTM D 923	(1991) Sampling Electrical Insulating Liquids
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 4059	(1996) Analysis of Polychlorinated

Biphenyls in Insulating Liquids by Gas  
Chromatography

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

- AEIC CS5 (1994) Cross-linked Polyethylene Insulated  
Shielded Power Cables Rated 5 Through 46 kV
- AEIC CS6 (1996) Ethylene Propylene Rubber Insulated  
Shielded Power Cables Rated 5 Through 69 kV

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

- IEEE C2 (1997) National Electrical Safety Code
- IEEE ANSI/IEEE C57.12.00 (1993) IEEE Standard General Requirements  
for Liquid-Immersed Distribution, Power,  
and Regulating Transformers
- IEEE C62.1 (1989; R 1994) Surge Arresters for AC  
Power Circuits
- IEEE C62.2 (1987; R 1994) Guide for the Application  
of Gapped Silicon-Carbide Surge Arresters  
for Alternating Current Systems
- IEEE C62.11 (1993) IEEE Standard Metal-Oxide Surge  
Arresters for AC Power Circuits
- IEEE Std 48 (1996) Standard Test Procedures and  
Requirements for Alternating-Current Cable  
Terminations 2.5 kV through 765 kV
- IEEE Std 81 (1983) Guide for Measuring Earth  
Resistivity, Ground Impedance, and Earth  
Surface Potentials of a Ground System  
(Part 1)
- IEEE Std 100 (1996) IEEE Standard Dictionary of  
Electrical and Electronics Terms
- IEEE Std 242 (1986; R 1991) Recommended Practice for  
Protection and Coordination of Industrial  
and Commercial Power Systems
- IEEE Std 399 (1997) Recommended Practice for Industrial  
and Commercial Power Systems Analysis
- IEEE Std 404 (1993; errata) Cable Joints for Use with  
Extruded Dielectric Cable Rated 5000 V  
through 138 000 V and Cable Joints for Use  
with Laminated Dielectric Cable Rated 2500  
V Through 500 000 V

IEEE Std 592 (1990; R 1996) Exposed Semiconducting Shields on Premolded High Voltage Cable Joints and Separable Insulated Connectors

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1 (1993) Molded Case Circuit Breakers and Molded Case Switches

NEMA FB 1 (1993) Fittings, Cast Metal Boxes and Conduit Bodies for Conduit and Cable Assemblies

NEMA FU 1 (1986) Low Voltage Cartridge Fuses

NEMA LA 1 (1992) Surge Arresters

NEMA TC 6 (1990) PVC and ABS Plastic Utilities Duct for Underground Installation

NEMA WC 7 (1991; Rev 1) Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NEMA WC 8 (1991; Rev 1; Rev 2) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 6 (1997) Rigid Metal Conduit

UL 467 (1993; Rev thru Aug 1996) Grounding and Bonding Equipment

UL 486A (1997) Wire Connectors and Soldering Lugs for Use with Copper Conductors

UL 486B (1997; Rev Jun 1997) Wire Connectors for Use with Aluminum Conductors

UL 489 (1996; Rev thru Nov 1997) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures

UL 514A (1996; Rev Jul 1998) Metallic Outlet Boxes

UL 651	(1995; Rev thru Oct 1998) Schedule 40 and 80 Rigid PVC Conduit
UL 1072	(1995; Rev Mar 1998) Medium-Voltage Power Cable
UL 1242	(1996; Rev Apr 1997) Intermediate Metal Conduit

## 1.2 GENERAL REQUIREMENTS

### 1.2.1 Terminology

Terminology used in this specification is as defined in IEEE Std 100.

### 1.2.2 Service Conditions

Items provided under this section shall be specifically suitable for the following service conditions.

- a. Ambient Temperature 110 degrees F
- b. Frequency 60 Hz

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

#### Electrical Distribution System; G

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams manufacturers standard installation drawings and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be included with the detail drawings. Approved departures shall be made at no additional cost to the Government.

Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting

Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:

a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit entrance, access requirements for installation and maintenance, physical size, electrical characteristics, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. All optional items shall be clearly identified as included or excluded.

b. Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.

#### As-Built Drawings

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall provide three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction.

The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within 10 calendar days from the time the drawings are returned to the Contractor.

#### SD-03 Product Data

##### Protective Device; G

The study shall 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 shall be based on recommendations of this study. The Government shall not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

##### Nameplates; G

Catalog cuts, brochures, circulars, specifications, product

data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material and Equipment; G

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each such item.

General Installation Requirements; G

Procedures shall include cable pulling plans, diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment.

SD-06 Test Reports

Factory Tests; G

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests. The manufacturer's pass-fail criteria for tests specified in paragraph FIELD TESTING shall be included.

Field Testing; G

A proposed field test plan, 30 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Operating Tests; G

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of three rings, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The condition specified for the test.

- f. The test results, signed and dated.
- g. A description of adjustments made.

Cable Installation; G

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each cable pull. Sections shall be separated by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

- a. Site layout drawing with cable pulls numerically identified.
- b. A list of equipment used, with calibration certifications. The manufacturer and quantity of lubricant used on pull.
- c. The cable manufacturer and type of cable.
- d. The dates of cable pulls, time of day, and ambient temperature.
- e. The length of cable pull and calculated cable pulling tensions.
- f. The actual cable pulling tensions encountered during pull.

SD-07 Certificates

Material and Equipment; G

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided conform to such requirements.

The label of, or listing by, UL will be acceptable as evidence that the items conform. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies. Compliance with above-named requirements does not relieve the

Contractor from compliance with any other requirements of the specifications.

Cable Joints; G

A certification that contains the names and the qualifications of people recommended to perform the splicing and termination of medium-voltage cables approved for installation under this contract. The certification shall indicate that any person recommended to perform actual splicing and terminations has been adequately trained in the proper techniques and have had at least three recent years of experience in splicing and terminating the same or similar types of cables approved for installation. In addition, any person recommended by the Contractor may be required to perform a practice splice and termination, in the presence of the Contracting Officer, before being approved as a qualified installer. If that additional requirement is imposed, the Contractor shall provide short sections of the approved types of cables along with the approved type of splice and termination kits, and detailed manufacturer's instruction for the proper splicing and termination of the approved cable types.

Cable Installer Qualifications; G

The Contractor shall provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations. A resume shall be provided showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers.

SD-10 Operation and Maintenance Data

Electrical Distribution System; G

Six copies of operation and maintenance manuals, within 7 calendar days following the completion of tests and including assembly, installation, operation and maintenance instructions, spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked. Manuals shall also include data outlining detailed procedures for system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment, basic operating features, and routine maintenance requirements shall also be included. Documents shall be bound in a binder marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

Three additional copies of the instructions manual shall be provided within 30 calendar days following the manuals.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced.

#### 1.5 EXTRA MATERIALS

Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

### PART 2 PRODUCTS

#### 2.1 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

#### 2.2 NAMEPLATES

##### 2.2.1 General

Each major component of this specification shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Nameplates shall be made of noncorrosive metal.

#### 2.3 CORROSION PROTECTION

##### 2.3.1 Ferrous Metal Materials

###### 2.3.1.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M and ASTM A 123/A 123M.

###### 2.3.1.2 Equipment

Equipment and component items, including but not limited to transformer stations and ferrous metal luminaries not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 120 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The

scribed test mark and test evaluation shall be in accordance with ASTM D 1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

## 2.4 CABLES

Cables shall be single conductor type unless otherwise indicated.

### 2.4.1 Low-Voltage Cables

Cables shall be rated 600 volts and shall conform to the requirements of NFPA 70, and must be UL listed for the application or meet the applicable section of either ICEA or NEMA standards.

#### 2.4.1.1 Conductor Material

Underground cables shall be annealed copper complying with ASTM B 3 and ASTM B 8. Intermixing of copper and aluminum conductors is not permitted.

#### 2.4.1.2 Insulation

Insulation must be in accordance with NFPA 70, and must be UL listed for the application or meet the applicable sections of either ICEA, or NEMA standards.

#### 2.4.1.3 Jackets

Multiconductor cables shall have an overall PVC outer jacket.

#### 2.4.1.4 In Duct

Cables shall be single-conductor cable, in accordance with NFPA 70.

## 2.5 CABLE JOINTS, TERMINATIONS, AND CONNECTORS

### 2.5.1 Low-Voltage Cable Splices

Low-voltage cable splices and terminations shall be rated at not less than 600 Volts. Splices in conductors No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A. Splices in conductors No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A and UL 486B.

Splices shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket. Splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

### 2.5.2 Terminations

Terminations shall be in accordance with IEEE Std 48, Class 1 or Class 2; of the molded elastomer, wet-process porcelain, prestretched elastomer, heat-shrinkable elastomer, or taped type. 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 shall be of the outdoor type, except that where installed inside outdoor equipment housings which are sealed against normal infiltration of moisture and outside air, indoor, Class 2 terminations are acceptable. Class 3 terminations are not acceptable. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, and armor.

## 2.6 CONDUIT AND DUCTS

Ducts shall be single, round-bore type, with wall thickness and fittings suitable for the application.

### 2.6.1 Metallic Conduit

Intermediate metal conduit shall comply with UL 1242. Rigid galvanized steel conduit shall comply with UL 6 and ANSI C80.1. Metallic conduit fittings and outlets shall comply with UL 514A and NEMA FB 1.

### 2.6.2 Nonmetallic Ducts

UL 651 or Schedule 80 as indicated, or NEMA TC 6 type DB.

### 2.6.3 Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees F, shall neither slump at a temperature of 300 degrees F, nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

## 2.7 POLES AND HARDWARE

Poles and hardware shall be in accordance with Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.

## 2.8 GROUNDING AND BONDING

### 2.8.1 Driven Ground Rods

Ground rods shall be copper-clad steel conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length. Sectional type rods may be used.

## 2.8.2 Grounding Conductors

Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same material as phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Bare conductors shall be ASTM B 8 soft-drawn unless otherwise indicated. Aluminum is not acceptable.

## PART 3 EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Circuits installed aerially shall conform to the requirements of Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL. Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

#### 3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable.

#### 3.1.2 Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

### 3.2 CABLE AND CONDUIT INSTALLATION

The Contractor shall 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, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, etc. The Contractor shall then prepare a checklist of significant requirements and perform pulling calculations and prepare a pulling plan which shall be submitted along with the manufacturers instructions in accordance with SUBMITTALS.

#### 3.2.1 Cable Installation Plan and Procedure

Cable shall be installed strictly in accordance with the cable manufacturer's recommendations. Each circuit shall be identified by means of a fiber, laminated plastic, or non-ferrous metal tags, or approved equal. Each tag shall contain the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

##### 3.2.1.1 Cable Inspection

The cable reel shall be inspected for correct storage positions, signs of

physical damage, and broken end seals. If end seal is broken, moisture shall be removed from cable in accordance with the cable manufacturer's recommendations.

#### 3.2.1.2 Duct Cleaning

Duct shall be cleaned with an assembly that consists of a flexible mandrel (manufacturers standard product in lengths recommended for the specific size and type of duct) that is 1/4 inch less than inside diameter of duct, 2 wire brushes, and a rag. The cleaning assembly shall be pulled through conduit a minimum of 2 times or until less than a volume of 8 cubic inches of debris is expelled from the duct.

#### 3.2.1.3 Duct Lubrication

The cable lubricant shall be compatible with the cable jacket for cable that is being installed. Application of lubricant shall be in accordance with lubricant manufacturer's recommendations.

#### 3.2.1.4 Cable Installation

The Contractor shall provide a cable feeding truck and a cable pulling winch as required. The Contractor shall provide a pulling grip or pulling eye in accordance with cable manufacturer's recommendations. The pulling grip or pulling eye apparatus shall be attached to polypropylene or manilla rope followed by lubricant front end packs and then by power cables. A dynamometer shall be used to monitor pulling tension. Pulling tension shall not exceed cable manufacturer's recommendations. The Contractor shall not allow cables to cross over while cables are being fed into duct. For cable installation in cold weather, cables shall be kept at 50 degrees F temperature for at least 24 hours before installation.

#### 3.2.1.5 Cable Installation Plan

The Contractor shall submit a cable installation plan for all cable pulls in accordance with the detail drawings portion of paragraph SUBMITTALS. Cable installation plan shall 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 thrust 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.

### 3.2.2 Duct Line

Cables shall be installed in duct lines where indicated. Neutral and grounding conductors shall be installed in the same duct with their associated phase conductors.

## 3.3 DUCT LINES

### 3.3.1 Requirements

Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 4 inches per 100 feet. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3 inch diameter, and 36 inches for ducts 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of (25 feet) 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used.

### 3.3.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

### 3.3.3 Nonencased Direct-Burial

Top of duct lines shall be below the frost line depth of 36 inches, but not less than (21.5 inches) below finished grade and shall be installed with a minimum of 3 inches of earth around each duct. Bottoms of trenches shall be smooth and free of stones, soft spots, and sharp objects. Where bottoms of trenches comprise materials other than sand, a 3 inch layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts. Joints in adjacent tiers of duct shall be vertically staggered at least 6 inches. The first 6 inch layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be backfilled and compacted in (3 to 6 inches)3 to 6 inch layers. Duct banks may be held in alignment with earth. However,

high-tiered banks shall use a wooden frame or equivalent form to hold ducts in alignment prior to backfilling.

### 3.3.4 Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved.

#### 3.3.4.1 Plastic Duct

Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4-turn twist to set the joint tightly.

#### 3.3.5 Duct Line Markers

Duct line marker shall be a 5 mil brightly colored plastic tape, not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers with a continuous metallic backing and a corrosion-resistant 1 mil metallic foil core to permit easy location of the duct line, and shall be placed approximately 12 inches below finished grade.

### 3.4 CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS

Connections between aerial and underground systems shall be made as shown. Underground cables shall be extended up poles in conduit to cable terminations. Conduits shall be secured to the poles by 2-hole galvanized steel pipe straps spaced not more than (10 feet)10 feet apart and with 1 strap not more than (12 inches) 12 inches from any bend or termination. Conduits shall be equipped with bushings to protect cables and minimize water entry. Cables shall be supported by devices separate from the conduit near their point of exit from the conduit.

#### 3.4.1 Pole Installation

Pole installation shall be in accordance with Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.

### 3.5 GROUNDING

#### 3.5.1 Grounding Electrodes

Grounding electrodes shall be installed as shown on the drawings and as follows:

- a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be driven into the earth until the tops of the rods are approximately 1 foot below finished grade.
- b. Additional electrodes - When the required ground resistance is not met, additional electrodes shall be provided interconnected with grounding conductors to achieve the specified ground resistance.

The additional electrodes will be up to three rods spaced a minimum of (10 feet) apart. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately.

### 3.5.2 Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors, in compliance with UL 467, and those below grade shall be made by a fusion-welding process.

### 3.5.3 Grounding and Bonding Conductors

Grounding and bonding conductors include conductors used to bond equipment frames to the grounding electrode system. Grounding and bonding conductors shall be sized as shown, and located to provide maximum physical protection. Bends greater than 45 degrees in ground conductors are not permitted.

### 3.5.4 Riser Pole Grounding

A single continuous vertical grounding electrode conductor shall be installed on each riser pole and connected directly to the grounding electrodes indicated on the drawings or required by these specifications. All equipment, neutrals, surge arresters, and items required to be grounded shall be connected directly to this vertical conductor. The grounding electrode conductor shall be sized as shown. Grounding electrode conductors shall be stapled to wood poles at intervals not exceeding 2 feet.

## 3.6 FIELD TESTING

### 3.6.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 10 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Field test reports shall be signed and dated by the Contractor.

### 3.6.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

### 3.6.3 Ground-Resistance Tests

The resistance of each grounding electrode shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

- a. Single rod electrode - 25 ohms.
- b. Multiple rod electrodes - 25 ohms.

#### 3.6.4 Low-Voltage Cable Test

Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

$R$  in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet)

Each cable failing this test shall be repaired or replaced. The repaired cable shall be retested until failures have been eliminated.

#### 3.6.5 Operating Tests

After the installation is completed, and at such times as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the requirements herein. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

### 3.7 MANUFACTURER'S FIELD SERVICE

#### 3.7.1 Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 4 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, and servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations. A VHS format video tape of the entire training session shall be submitted.

#### 3.7.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of the equipment, assist in the performance of the onsite tests, initial operation, and instruct personnel as to the operational and maintenance features of the equipment.

### 3.8 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --