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USACE / NAVFAC / AFCESA / NASA **UFGS-33 71 01.00 20 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change UFGS-16301N (February 2003)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 1 April 2006

Latest change indicated by CHG tags.
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DIVISION 33 - UTILITIES

SECTION 33 71 01.00 20

OVERHEAD TRANSMISSION AND DISTRIBUTION

04/06

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SECTION 33 71 01.00 20

OVERHEAD TRANSMISSION AND DISTRIBUTION
04/06

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NOTE: This guide specification covers the requirements for overhead electrical work and utility poles.

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

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

Use of electronic communication is encouraged.

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

Go to http://www.wbdg.org/ccb/NAVGRAPH/graphtoc.pdf.
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NOTE: This section utilizes the following energy cost and loss value tables, found on CCB following the directions above.

Do not include list of tables, or tables themselves, in project specifications. Use tables to obtain values required in Part 2 of the specification.

TABLE NUMBER	TITLE
OH-1	Single-phase Pole-mounted Transformer Loss & Impedance Data Cost (EC) Less Than or Equal to $0.04 (2 pages)
OH-2	Single-phase Pole-mounted Transformer Loss & Impedance Data Cost (EC) Greater Than $.04 and Less Than or Equal to $0.08 (2 pages)
OH-3	Single-phase Pole-mounted Transformer Loss & Impedance Data Cost (EC) Greater Than $.08 and Less Than or Equal to $0.12 (2 pages)
EC-1	Energy costs at LANTNAVFACENGCOM Activities (2 pages)
EC-2	Energy costs at SOUTHNAVFACENGCOM Activities (2 pages)

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NOTE: The following information should be shown on the drawings:

1. Conductor sizes, types, and materials.

2. Guy strand type, size, and length.

3. Primary fused cutout; give voltage rating and state fusing (ampere rating) and "K" quick or "T" tardy required for coordination with existing upstream sectionalizing equipment.

4. Pole top switch. State voltage, current, and other operating characteristics. The applicable switch ratings are stated in IEEE C37.30.

5. Meter connections (can be determined from NEMA C12.10 or similar source).

6. Anchor type, description, and dimensions suitable for the ultimate load and the specific soil at location.

7. Indicate ruling span (average span length plus 2/3 of the difference between the longest and the average span).

8. Sag table(s) for the specific conductor, the ruling span(s) and the loading zone.

9. The mechanical strength of crossarms, insulators, pins, guys and anchors must be engineered for each job and the dimensions, materials, and other descriptions covered by drawings. Strength requirements of IEEE C2 are minimum.

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PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

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

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

ALLIANCE FOR TELECOMMUNICATIONS INDUSTRY SOLUTIONS (ATIS)

ATIS O5.1	(2002; 2004s) Specifications and Dimensions (for Wood Poles)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C135.14	(1979) Staples with Rolled or Slash Points for Overhead Line Construction

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C1	(2003) All Timber Products - Preservative Treatment by Pressure Processes
AWPA C25	(2003) Sawn Crossarms - Preservative Treatment by Pressure Processes
AWPA C4	(2003) Poles - Preservative Treatment by

Pressure Processes

ASME INTERNATIONAL (ASME)

ASME B16.11	(2005) Forged Fittings, Socket-Welding and Threaded

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2005) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 167	(2004) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 36/A 36M	(2005) Carbon Structural Steel
ASTM A 475	(2003) Zinc-Coated Steel Wire Strand
ASTM A 53/A 53M	(2004a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 575	(2002) Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A 576	(1990b; R 2000) Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM B 1	(2001) Hard-Drawn Copper Wire
ASTM B 2	(2000) Medium-Hard-Drawn Copper Wire
ASTM B 228	(2004) Concentric-Lay-Stranded Copper-Clad Steel Conductors
ASTM B 231/B 231M	(2004) Concentric-Lay-Stranded Aluminum 1350 Conductors
ASTM B 232/B 232M	(2001e1) Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR)
ASTM B 3	(2001) Soft or Annealed Copper Wire
ASTM B 397	(1985; R 1999) Concentric-Lay-Stranded Aluminum-Alloy 5005-H19 Conductors
ASTM B 399/B 399M	(2004) Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors
ASTM B 8	(2004) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D 117	(2002) Sampling, Test Methods, Specifications for Electrical Insulating Oils of Petroleum Origin

ASTM D 3487	(2000) Mineral Insulating Oil Used in Electrical Apparatus

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C12.7	(1993; R 1999) Requirements for Watthour Meter Sockets
IEEE C135.1	(1999) Zinc-Coated Steel Bolts and Nuts for Overhead Line Construction
IEEE C135.2	(1999) Threaded Zinc-Coated Ferrous Strand-Eye Anchor Rods and Nuts for Overhead Line Construction
IEEE C135.22	(1988) Insulator Pins with Lead Threads for Overhead Line Construction, Galvanized Ferrous Pole-Top
IEEE C2	(2005) National Electrical Safety Code
IEEE C37.30	(1997) Requirements for High-Voltage Switches
IEEE C37.41	(2000) Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories
IEEE C37.60	(2003) Requirements for Overhead, Pad Mounted, Dry Vault and Submersible Automatic Circuit Reclosers and Fault Interrupters for Alternating Current Systems Up to 38 kV
IEEE C37.63	(1997) Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizers for AC Systems
IEEE C57.12.00	(2000) General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.90	(1999) Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.13	(1993; R 2003) Standard Requirements for Instrument Transformers
IEEE C57.15	(1999) Requirements, Terminology, and Test Code for Step-Voltage Regulators
IEEE C62.11	(1999) Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1KV)
IEEE Std 18	(2002) Shunt Power Capacitors

IEEE Std 404	(2000) Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V Through 500 000 V

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2003) Acceptance Testing Specifications

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C12.1	(2001) Code for Electricity Metering
NEMA C12.10	(2004) Physical Aspects of Watthour Meters
NEMA C135.4	(1987) Zinc-Coated Ferrous Eyebolts and Nuts for Overhead Line Construction
NEMA C29.2	(1992; R 1999) Insulators Wet Process Porcelain and Toughened Glass - Suspension Type**
NEMA C29.3	(1986; R 2002) Wet Process Porcelain Insulators - Spool Type**
NEMA C29.4	(1989; R 2002) Wet-Process Porcelain Insulators - Strain Type**
NEMA C29.5	(1984; R 2002) Wet-Process Porcelain Insulators - Low- and Medium-Voltage Types**
NEMA C29.7	(1996; R 2002) Wet Process - Porcelain Insulators - High-Voltage Line-Post Type**
NEMA C37.32	(2002) High-Voltage Switches, Bus Supports, and Accessories - Schedules of Preferred Ratings, Construction Guidelines and Specifications**
NEMA C37.42	(1996) High Voltage Expulsion Type Distribution Class Fuses, Cutouts, Fuse Disconnecting Switches and Fuse Links**
NEMA C57.12.20	(1997; R 1998) Transformers -- Overhead Type Distribution Transformers, 500 kVA and Smaller: High-Voltage, 34500 Volts and Below; Low-Voltage, 7970/13800Y Volts and Below
NEMA C57.12.28	(1999) Pad-Mounted Equipment - Enclosure Integrity
NEMA ICS 6	(1993; R 2001) Industrial Control and Systems: Enclosures
NEMA WC 70	(1999; Errata 2001) Non-Shielded Power Cables Rated 2000 Volts or less for the Distribution of Electrical Energy

NEMA WC 71	(1999) Nonshielded Cables Rated 2001-5000 Volts for Use in the Distribution of Electric Energy
NEMA WC 74	(2000) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2005) National Electrical Code

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS 1728F-700	(1993) Wood Poles, Stubs, and Anchor Logs
RUS 1728H-701	(1993) Wood Crossarms Transmission Timbers and Pole Keys
RUS 202-1	(2004) List of Materials Acceptable for Use on Systems of RUS Electrification Borrowers

UNDERWRITERS LABORATORIES (UL)

UL 510	(2005) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 6	(2000; Rev thru May 2003) Rigid Metal Conduit

1.2 RELATED REQUIREMENTS

****
NOTE: This paragraph is to be included on Navy projects only.
****

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS and Section 26 08 00 APPARATUS INSPECTION AND TESTING apply to this section with additions and modifications specified herein.

[1.3 OVERHEAD SERVICE

Terminate overhead service conductors into buildings at service entrance fittings or weatherhead outside building. Installation and connection of service entrance equipment to overhead service conductor is included in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Nearby support bracket for overhead wires shall be not less than [_____] meters feet above finished grade at building.

]1.4 SUBMITTALS

****
NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept

to the minimum required for adequate quality control.

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

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

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

****

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: Include the bracketed option on "CI44" and 074 review" for LANTNAVFACENGCOM and SOUTHNAVFACENGCOM projects respectively. For other projects, submittal review shall be performed by the designer of record; If submittal review by LANTNAVFACENGCOM or SOUTHNAVFACENGCOM is specifically desired, the responsible Government agency must coordinate with the respective Code CI44 or 074 during the design process. Add appropriate information in Section titled "Submittal Procedures" to coordinate with the special requirements.

****

[[Code CI44, Atlantic] [Code 074, Southern] Division, Naval Facilities Engineering Command will review and approve transformer submittals.] As an exception to this paragraph, transformers manufactured by ABB in Athens, GA; by Cooper Power Systems in Waukesha, WI or Nacogdoches, TX; or by Howard Industries in Laurel, MS need not meet the submittal requirements of this contract. Instead, the following shall be submitted.

a. A certification, from the manufacturer, that the technical requirements of this specification shall be met.

b. Routine and other tests (paragraph entitled "Routine and Other Tests, shall be conducted by the manufacturer and [may] [will] be witnessed by the Government (paragraph entitled "Source Quality Control"). Provide certified copies of the tests.

c. Provide field test reports (paragraph entitled "Field Quality Control").

SD-03 Product Data

Conductors[; G][; G, [_____]]

Insulators[; G][; G, [_____]]

Concrete poles[; G][; G, [_____]]

Steel poles[; G][; G, [_____]]

Wood Poles

Nameplates[; G][; G, [_____]]

Pole top switch[; G][; G, [_____]]

Recloser[; G][; G, [_____]]

Sectionalizer[; G][; G, [_____]]

Cutouts[; G][; G, [_____]]

Transformer[; G][; G, [_____]]

Metering equipment[; G][; G, [_____]]

Meters[; G][; G, [_____]]

Surge arresters[; G][; G, [_____]]

Guy strand

Anchors

SD-05 Design Data

Concrete poles[; G][; G, [_____]]

Steel poles[; G][; G, [_____]]

Power-Installed Screw Foundations[; G][; G, [_____]]

SD-06 Test Reports

Wood Crossarm Inspection Report

Field Test Plan[; G][; G, [_____]]

Field Quality Control[; G][; G, [_____]]

****
NOTE: For SOUTHNAVFACENGCOM, delete "Ground resistance test reports" and the associated subparagraph.
****

Ground resistance test reports[; G][; G, [_____]]

Submit report of the acceptance test results as specified by paragraph entitled "Field Quality Control"

SD-07 Certificates

Concrete poles[; G][; G, [_____]]

Steel poles[; G][; G, [_____]]

Wood poles[; G][; G, [_____]]

Wood crossarms[; G][; G, [_____]]

Transformer Losses[; G][; G, [_____]]

Submit certification from the manufacturer indicating conformance with the paragraph entitled "Specified Transformer Losses."

SD-09 Manufacturer's Field Reports

Overhead-type distribution transformer routine and other tests[; G][; G, [_____]]

SD-11 Closeout Submittals

Transformer test schedule[; G][; G, [_____]]

1.5 QUALITY ASSURANCE

1.5.1 Ground Resistance Test Reports

Submit the measured ground resistance of grounding system. When testing grounding electrodes and grounding systems, identify each grounding electrode and each grounding system for testing. Include the test method and test setup (i.e. pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

1.5.2 Wood Crossarm Inspection Report

Furnish an inspection report from an independent inspection agency, approved by the Contracting Officer, stating that offered products comply with applicable AWPA and RUS standards. The RUS approved Quality Mark "WQC" on each crossarm will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

1.5.2.1 Field Test Plan

Provide a proposed field test plan [20] [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.

1.6 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 ATIS O5.1. Handling of wood poles shall be in accordance with ATIS O5.1, except that pointed tools capable of producing indentations more than inch in depth shall not be used. Nails and holes are not permitted in top of poles. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Consider materials specified herein or shown on contract drawings which are identical to materials listed in RUS 202-1 as conforming to requirements.

2.2 POLES

****
NOTE: Use "class" for wood poles and "strength" for concrete and steel poles. Follow local utility practice regarding grounding metallic items on poles, after coordination with local DPW/BCE. Specify clearances and climbing space in accordance with IEEE C2 or applicable state code.
****

Poles shall be of lengths and [classes] [strengths] indicated.

2.2.1 Wood Poles

****
NOTE: For LANTNAVFACENGCOM projects, do not use lodgepole pine or Western Larch poles.
****

Wood poles machine trimmed by turning, [Douglas Fir] [Lodgepole Pine] [Western Larch] [Southern Yellow Pine] [_____] conforming to ATIS O5.1 and RUS 1728F-700. Gain, bore and roof poles before treatment. Should additional gains be required subsequent to treatment, metal gain plates shall be provided. Pressure treat poles with [pentachlorophenol,] [ammoniacal copper arsenate (ACA),] [chromated copper arsenate (CCA)], except that Douglas Fir and Western Larch poles shall not be treated with CCA in accordance with AWPA C1 and AWPA C4 as referenced in RUS 1728F-700. The quality of each pole shall be ensured with "WQC" (wood quality control) brand on each piece, or by an approved inspection agency report.

2.2.2 Steel Poles

Steel poles shall be designed to withstand the loads specified in IEEE C2 multiplied by the appropriate overload capacity factors, shall be hot-dip

galvanized in accordance with ASTM A 123/A 123M and shall not be painted. Poles shall have tapered tubular members, either round in cross-section or polygonal, and comply with strength calculations performed by a registered professional engineer. Calculations shall be submitted in accordance with the design data portion of paragraph entitled "SUBMITTALS." Provide certification, from the manufacturer, that the technical requirements of this specification shall be met. Pole shafts shall be one piece. Poles shall be welded construction with no bolts, rivets, or other means of fastening except as specifically approved. Pole markings shall be approximately 900 to 1270 mm 3 to 4 feet above grade and shall include manufacturer, year of manufacture, top and bottom diameters, length, and a loading tree. Attachment requirements shall be provided as indicated, including grounding provisions. Climbing facilities are not required. Bases shall be of the anchor-bolt-mounted type.

2.2.3 Concrete Poles

****
NOTE: In areas where freezing temperatures occur, the minimum compressive strength given for concrete in spun poles should be increased in line with concrete design for such temperatures.
****

Concrete poles shall be designed to withstand the loads specified in IEEE C2 multiplied by the appropriate overload capacity factors. Poles shall be reinforced or prestressed, either cast or spun. Spun poles shall be manufactured by a centrifugal spinning process with concrete pumped into a polished round tapered metal mold. Concrete for spun poles shall have a compressive strength of at least 34.5 MPa 5000 psi at 28 days; steel wire shall have an ultimate tensile strength of at least 827 MPa; 120,000 psi; and reinforcing bars shall have an ultimate tensile strength of at least 276 MPa 40,000 psi. After the high speed spinning action is completed, a spun pole shall be cured by a suitable wet steam process. Spun poles shall have a water absorption of not greater than three percent to eliminate cracking and to prevent erosion. Concrete poles shall have hollow shafts. Poles shall have a hard, smooth, nonporous surface that is resistant to soil acids, road salts, and attacks of water and frost. Poles shall not be installed for at least 15 days after manufacture. Fittings and brackets that conform to the concrete pole design shall be provided. Poles shall conform to strength calculations performed by a registered professional engineer and submitted in accordance with design data portion of paragraph entitled "SUBMITTALS." Provide certification, from the manufacturer, that the technical requirements of this specification shall be met.

2.3 CROSSARMS

2.3.1 Wood Crossarms

Conform to RUS 1728H-701. Pressure treat crossarms with pentachlorophenol, chromated copper arsenate (CCA), or ammoniacal copper arsenate (ACA). Treatment shall conform to AWPA C25. Crossarms shall be solid wood, distribution type, and a 6.4 mm 1/4 inch 45 degree chamfer on all top edges. Cross-sectional area minimum dimensions shall be 108.0 mm 4-1/4 inches in height by 82.6 mm 3-1/4 inches in depth in accordance with IEEE C2 for Grade B construction. Crossarms shall be 2.4 m 8 feet in length, except that 3.1 m 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 2.5 mm per 304.8 mm 1/10 inch per foot of length. Bend or twist shall be in one direction only.

2.3.2 Crossarm Braces

Provide [flat steel] [or] [steel angle] as indicated. Provide braces with [965 mm span with 2440 mm crossarms] [and] [1520 mm span with 3050 mm crossarms] [38 inch span for 8 foot crossarms] [and] [60 inch span for 10 foot crossarms].

2.3.3 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 IEEE 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 12.5 kN 2800 pound cantilever strength.

2.4 HARDWARE

****
NOTE: In hot humid marine atmospheres, galvanized steel pole-line hardware may not be acceptable and only hot-dip galvanized malleable or ductile iron should be permitted. Local usage should be checked. NAVFACENGCOM requires hot-dip galvanized hardware only.
****

Hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M.

****
NOTE: Do not use this paragraph for Navy projects. The pole line construction criteria for the Navy, including the listing of materials, is covered in the pole plates.
****

[Zinc-coated hardware shall comply with IEEE C135.1, IEEE C135.2, NEMA C135.4, ANSI C135.14 IEEE C135.22. Steel hardware shall comply with ASTM A 575 and ASTM A 576. Pole-line hardware shall be hot-dip galvanized [steel.] [steel, except anchor rods of the copper-molten welded-to-steel type with nonferrous corrosion-resistant fittings shall be used]. 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 57.2 mm square 2-1/4 inches square and 4.8 mm 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.]

2.5 INSULATORS

****

NOTE: Stipulate insulator class required for each application. The following table suggests insulator types from specific ANSI Standards for application under normal conditions. Number followed by diagonal slash indicates quantity of insulators when other than one. Environments with unusual contaminant conditions would require special treatment. Spool insulators for use with brackets, or devices to support the neutral-messenger of triplex or quadruplex, secondary or service cables should conform to NEMA C29.3 Class 53-2. Use the values in Table II for LANTNAVFACENGCOM projects.

TABLE I

Voltage kV	NESC min. dry flashover kV	ANSI C29.5 Pin	C29.7 Post ("L" or "S")	NEMA C29.2 Suspension	ANSI C29.4 Guy Strain
5. or less	20	55-1	57-1	52-1	54-1
7.2	39	55-3	57-1	2/52-1 or 2-52-9	54-1
13.2	55	55-3	57-1	2/52-1 or 2/52-9	54-2
23	75	55-6 C29.6	57-2	2/52-4	54-3
34.5	100	56-3	57-2	3/52-4	54-3

TABLE II

Voltage kV	ANSI C29.3 Spool	ANSI C29.5 Pin	C29.7 Post ("L" or "S")	NEMA C29.2 Suspension	ANSI C29.4 Guy Strain
5. or less	53-2	55-3	57-1	52-1	54-4
15.	53-2	55-5	57-1	2/52-1	54-4
34.5	53-2	---	57-4	3/52-4	54-4

When specifying or indicating post insulators, add the appropriate "L" or "S" designation indicating "L" long studs or "S" short. Example: "57-1L" would indicate an insulator for wood crossarms and "57-1S" would indicate an insulator for use on steel members. When the engineer determines that station policy differs from these requirements, insulators which match the policy in effect at the station shall be specified by ANSI reference and class. Insulator flashover values shall be determined from Table 273-1, IEEE C2. In areas with severe lightning problems, transmission line corners and dead ends should be provided with special pressure-treated wood-guy insulators having arcing horns for lighting discharge. In addition to being

used with underground terminals, fiberglass guy strain insulators shall be used where other interference problems exist.

****

Provide wet-process porcelain insulators which are radio interference free.

[a. Line post type insulators: NEMA C29.7, Class [_____].]

[b. Suspension insulators: NEMA C29.2 [4/52-4 for 34.5 kV on NAVSTA NORVA], Quantity per Phase, [_____], Class [_____].]

[c. Spool insulators: NEMA C29.3, Class [_____].]

[d. Guy strain insulators: NEMA C29.4, Class [_____], [except provide fiberglass type when used with underground terminal or when other interference problems exist].]

[e. Pin insulators: NEMA C29.5, Class [_____].]

2.6 OVERHEAD CONDUCTORS

****

NOTE: For LANTNAVFACENGCOM projects, do not use "copper clad steel" or "aluminum conductor steel reinforced (ACSR)."

****

Conductors of bare [copper] [aluminum (AAC)] [aluminum alloy (AAAC)] [copper clad steel] [aluminum conductor steel reinforced (ACSR)] of sizes and types indicated.

2.6.1 Solid Copper

ASTM B 1, ASTM B 2, and ASTM B 3, hard-drawn, medium-hard-drawn, and soft-drawn, respectively. ASTM B 8, stranded.

2.6.2 Aluminum

ASTM B 231/B 231M.

2.6.2.1 Aluminum Alloy

ASTM B 397 or ASTM B 399/B 399M.

2.6.2.2 Steel Reinforced

ASTM B 232/B 232M, aluminum.

2.6.3 Copper-Clad Steel

ASTM B 228.

2.7 NEUTRAL-SUPPORTED SECONDARY AND SERVICE DROP CABLES

****

NOTE: The term "secondary," for our general purpose, means either bare or insulated conductors installed between poles and operated at the

utilization voltage. Bare conductors should be utilized on long span, open wire design when a neutral-supported secondary cable is not appropriate due to weight. When using bare conductors for secondary applications use the above paragraph entitled "Overhead Conductors". "Services" are insulated conductors extending from a pole to the metering point or service entrance connection at the utilization point. Minimum conductor size for aluminum, aluminum alloy, or ACSR shall be No. 4 AWG and for copper, No. 6 AWG. For LANTNAVFACENGCOM projects, do not use ACSR.

****

[Service] [Secondary] cables shall be [aluminum] [copper], [triplex] [quadruplex] with cross-linked polyethylene insulation on the phase conductors. Neutral shall be bare [ACSR] [aluminum alloy] [hard drawn copper] and shall be the same size as the phase conductors unless otherwise indicated. Cables shall conform to [NEMA WC 70][and][NEMA WC 71] for cross-linked polyethylene insulation.

2.8 GUY STRAND

ASTM A 475, [high-strength] [extra-high strength], Class A or B, galvanized strand steel cable. Guy strand shall be [_____] mm inch in diameter with a minimum breaking strength of [_____] Newton pounds. Provide guy terminations designed for use with the particular strand and developing at least the ultimate breaking strength of the strand.

2.9 ROUND GUY GUARDS

Vinyl or PVC material, [white] [yellow] colored, 2440 mm 8 feet long and shatter resistant at sub-zero temperatures.

2.9.1 Guy Attachment

Thimble eye guy attachment.

2.10 ANCHORS AND ANCHOR RODS

****

NOTE: Complete guy-anchor assembly shall provide strength conforming to IEEE C2 for the grade of construction of the line. In areas of extremely high chemical activity of the soil, anchor rods and ground rods shall be completely encased in concrete to point 100 mm 4 inches above finished grade. Anchors shall be a special unit to be indicated.

****

Anchors shall be [plate] [screw] anchors [presenting holding area indicated on drawings as a minimum]. Anchor rods shall be [twin] thimble-eye, [19] [25] mm diameter by 2440 mm [3/4] [one] inch diameter by 8 feet long. Anchors and anchor rods shall be hot dip galvanized.

2.10.1 Screw Anchors

****

NOTE: For LANTNAVFACENGCOM projects normally use

screw type anchors. Provide Newton pound rating and leave out "[fitting Class 6000]."

****

Screw type [swamp] anchors having a manufacturer's rating [of not less than [_____] Newton pounds in loose to medium sand/clay soil, Class 6] [at least equal to rating indicated] and extra heavy pipe rods conforming to ASTM A 53/A 53M, Schedule 80, and couplings conforming to ASME B16.11, [fitting Class 6000.]

2.10.2 Plate Anchors

Minimum area of [_____] square mm inches and rated by manufacturer for [_____] Newton pounds or more in soils classified as medium dense coarse sand and sandy gravels; firm to stiff clays and silts.

2.11 GROUND RODS

****

NOTE: Use "copper clad steel" ground rods for LANTNAVFACENGCOM projects.

****

[Copper-weld type] [Copper clad steel] [Sectional type] ground rods at least 19 mm 3/4 inch in diameter and 3050 mm 10 feet long. Die-stamp each near top with name or trademark of manufacturer and length of rod in millimeter feet. Rods shall have a hard, clean, smooth, continuous, surface throughout length of rod.

2.11.1 Ground Wire

Provide soft drawn copper wire ground conductors a minimum No. 4 AWG. Ground wire protectors may be either PVC or half round wood molding. [Wood molding shall be fir, pressure treated in accordance with AWPA C25, or shall be cypress or cedar.]

2.12 SURGE ARRESTERS

****

NOTE: Rating of lightning (surge) arresters should be 125 percent of the nominal line-to-ground voltage of four-wire, multi-grounded neutral systems; 80 percent of the nominal line-to-line voltage for three-wire, solidly grounded neutral systems; or nominal line-to-line voltage for delta and ungrounded-wye systems. Distribution class arresters should normally be used. However, use intermediate class on the 34.5 kV system at Naval Base, Norfolk, VA.

****

IEEE C62.11, metal oxide, porcelain housed, surge arresters arranged for [crossarm] [equipment] mounting. RMS voltage rating shall be [3] [6] [9] [10] [12] [15] [27] [30] [36] kV. Arresters shall be [Distribution] [Intermediate] [Station] class.

2.13 FUSED CUTOUTS

****

NOTE: Include last bracketed sentence for NAS Pensacola projects. Delete it in all other projects. For SOUTHNAVFACENGCOM projects, use fused cutouts with wet process porcelain insulators. For LANTNAVFACENGCOM projects, use "open type" cutouts with Type "K" fuses as indicated.

****

[Open] [Enclosed] type fused cutouts rated [100] [200] amperes and [_____] amperes symmetrical interrupting current at [[7.8] [15] kV ungrounded] [8.3/15 kV gnd Y] [15/26 kV gnd Y] [27/34.5 kV gnd Y], conforming to NEMA C37.42. Type [K] [T] fuses conforming to NEMA C37.42 with ampere ratings [as indicated] [equal to 150 percent of the transformer full load rating]. Open link type fuse cutouts are not acceptable. [Provide heavy duty open drop-out type, rated 15 kV, 200 Amp, 7,100 Amp I.C. (Sym.).]

2.14 CONDUIT RISERS AND CONDUCTORS

****

NOTE: Choose Section 33 71 02.00 20 for Navy projects and Section 33 70 02.00 10 for other projects. For LANTNAVFACENGCOM, use Section L-16303N UNDERGROUND ELECTRICAL WORK in lieu of Section 33 71 02.00 20.

****

The riser shield shall be PVC containing a PVC back plate and PVC extension shield or a rigid galvanized steel conduit, as indicated, and conforming to UL 6. Provide conductors and terminations as specified in[Section 33 71 02.00 20 UNDERGROUND TRANSMISSION AND DISTRIBUTION][Section 33 70 02.00 10 ELECTRICAL DISTRIBUTION SYSTEM UNDERGROUND.]

2.15 TRANSFORMER (OVERHEAD-TYPE DISTRIBUTION)

****

NOTE: Use the following guidelines for specifying transformers.

1. Use IEEE C57.12.00, Figure 3 (a), voltage designations, such as 4160 V - 120/240 V.

2. Select impedance value in accordance with technical note under paragraph entitled "Specified Transformer Losses."

3. Fully self-protected transformers shall not be used.

****

a. NEMA C57.12.20.

b. Single phase, self-cooled, 65 degrees C. continuous temperature rise, two winding, 60 Hertz.

c. Insulating liquid:

(1) Mineral oil per ASTM D 3487, Type II, tested in accordance with ASTM D 117.

(2) Provide identification of transformer as "non-PCB" on the nameplate.

(3) Do not provide insulating liquids containing polychlorinated biphenyls (PCB) or tetrachloroethylene (TCE) or perchloroethylene.

d. Ratings:

(1) kVA: [_____].

(2) BIL: [95] [75] [60] kV.

(3) Primary voltage: [_____] kV.

(4) Secondary voltage: [_____] volts.

(5) Minimum Tested Impedance at 85 degrees C: [____] percent.

[e. Single-phase connections:

(1) Connect primary: [Phase-to-phase] [Phase-to-ground].

(2) Provide transformer with [_____] high voltage bushing(s).]

[f. Three-phase connections:

(1) Connect primary: [Grounded wye] [Ungrounded wye] [Delta].

(2) Connect secondary: [Grounded wye] [Delta], for [_____] volt, three phase, [_____] wire service.

(3) Provide transformer with [_____] high voltage bushings.]

g. Taps:

(1) Provide four 2 1/2 percent full capacity taps, 2 above and 2 below rated primary voltage. Tap changer shall have external handle.

****

NOTE: The "series-multiple voltage-changing switch" would be in the primary winding of the transformer and is for dual-voltage systems. It is normally used when a base is planning a voltage upgrade of its primary distribution system or when there are multiple systems on base and they would like the transformer to be interchangeable. Caution: If this option is indicated, the BIL level must be specified for the higher voltage and actual transformer losses would have to be coordinated with multiple manufacturers and be specified to obtain an energy efficient transformer.

****

[h. Externally operated Series-Multiple Voltage-Changing Switch.]

i. Corrosion Protection:

****

NOTE: In hostile environments, the additional cost of stainless steel tanks and covers may be justified.
****

[Transformer tanks and covers shall be corrosion resistant and shall be fabricated of stainless steel conforming to ASTM A 167, Type 304 or 304L.] Paint coating system shall comply with NEMA C57.12.28 regardless of tank and cover material. Finish coat shall be light gray, ANSI color No. 70.

j. Show transformer kVA capacity using 65 mm 2 1/2 inch Arabic numerals placed near the low-voltage bushings.

2.15.1 Specified Transformer Losses

****
NOTE: Steps to specifying transformer losses.

1. Print Tables OH-1, OH-2, OH-3, and EC-1 or EC-2 as applicable (directions included at the front of this specification).

2. Obtain energy cost for the specific activity from the cognizant EFD or PWC. Energy costs should be based on the cost of energy without the demand charge factors scaled in. Use Table EC-1 for energy costs at the LANTNAVFACENGCOM activities indicated. Use Table EC-2 for energy costs at the SOUTHNAVFACENGCOM activities indicated. (Additional tables will be added for other EFD's as the information becomes available.

3. Use Tables OH-1, OH-2, and OH-3 to specify losses and impedances for transformers based on energy cost range, and transformer primary and secondary voltages.

4. Perform fault current calculations to verify that distribution equipment is coordinated with impedance specified.
****

No-load losses (NLL) in watts at 20 degrees C, and load losses (LL) in watts at 85 degrees C, shall be as follows:

NAME	KVA	"NLL"	"LL"
[T1]	[_____]	[_____]	[_____]
[T2]	[_____]	[_____]	[_____]

The values for the specified losses shall be used for comparison with the losses determined during the routine tests. If the routine test values exceed the specified values by more than the tolerances allowed by Table 19 in IEEE C57.12.00, the transformer is unacceptable.

2.16 POLE TOP SWITCH

****
NOTE: In areas where coating of ice on the switch

exceeds 9.525 mm 3/8 inch, other type of switch should be considered. Consult appropriate EFD/EFA Code CI44 for the type of switch required.
****

Pole top switch shall comply with IEEE C37.30, shall be [vertical] [horizontal] type switches, three-pole gang operated, with a padlock arrangement for locking in both open and closed positions. Steel parts shall be hot-dip galvanized. Operating rods shall be isolated from the switch by an insulating link or section located as close to the switch as possible. [Switch shall be designed [for double crossarm mounting] [and] [for breaking a 9.525 mm 3/8 inch coating of ice before contacts are opened or closed].] Each switch shall be rated for [14.4] [25] [34.5] kV, [110] [150] [200] kV BIL, with a continuous current rating and load-break rating of 600 amperes, and a momentary rating of 40,000 rms amperes asymmetrical.

[2.17 RECLOSER

IEEE C37.60. [Recloser controller shall be [electronically] [hydraulically] operated and utilize [oil] [vacuum] operating medium.]

][2.18 SECTIONALIZER

IEEE C37.63.

]2.19 GROUP-OPERATED LOAD INTERRUPTER SWITCHES

2.19.1 Manually Operated Type (Switch Handle Operated)

Manually operated (switch handle operated) load interrupter switches shall comply with NEMA C37.32 and shall be of the outdoor, manually-operated, three-pole, single-throw type with either tilting or rotating insulators. Switches shall be equipped with interrupters capable of interrupting currents equal to the switch's continuous current rating. Each switch shall be preassembled for the indicated configuration and mounting. Moving contacts shall be of the high-pressure, limited-area type, designed to ensure continuous surface contact. Switches shall be fused or non-fused as indicated. Switches shall be complete with necessary operating mechanisms, handles, and other items required for manual operation from the ground. Switch operating handles shall be located approximately 1.1 meters 3 feet 6 inches above final grade. Insulation of switch operating mechanisms shall include both insulated interphase rod sections and insulated vertical shafts. Each handle shall be provided with a padlock arranged to lock the switch in both the open and the closed position.

[2.19.2 Remotely Operated Type (Stored-Energy Actuator)

****
NOTE: SF6 switches are available for nominal voltages of 15 kV through 34.5 kV in 600 ampere continuous and load-break ratings. Delete SCADA equipment and remote telemetry when not required.
****

Remotely-operated, [air-insulated] [SF6 insulated] load interrupter switches shall be rated in accordance with and comply with the requirements of NEMA C37.32 and shall be of the outdoor, three-pole, [pole-mounted] [crossarm-mounted] type. Interrupter devices shall be [air-insulated] [SF6-insulated, puffer-type] switches capable of interrupting currents

equal to the switch continuous current ratings indicated. Switches shall utilize an electric motor-charged, stored-energy (spring-driven) operator to simultaneously trip all phases. A switch-control unit shall be provided [for push-button operation from the ground] [for push-button operation from the ground and remote switch actuation via telemetry]. The switch-control unit shall be pad-lockable, tamper-resistant, in a NEMA ICS 6, Type [3R] [4] [4X] [4X-SS] enclosure, which is connected to the switch actuator by a shielded control cable. Control power for closing and tripping shall be provided by a battery mounted in the control unit enclosure. The switch control unit shall be provided with a separate 120 volt ac circuit for the battery powered. Power for charging the operator mechanism may be 120 volt ac or battery powered. If operator mechanism charging power is from a battery, capacity shall be provided for a minimum of [_____] [four] sequential opening and closing operation without battery charging. The switch control unit shall be configured for supervisory, control, and data acquisition (SCADA) function, including local and remote operation. Voltage and current sensors shall be provided, one set for each phase, for monitoring of both normal and fault conditions. Switches shall be provided with visual indication of open switch contact for clearance and isolation purposes. Switch mechanisms shall be provided with provisions for grounding of nonenergized metal parts. The switch control unit shall be provided with a switch operations.

][2.20 METERING EQUIPMENT

****
NOTE: "Metering Equipment" paragraph and its subparagraphs are for primary metering and should only be used when primary metering is required by the local utility company and specific metering requirements have been properly coordinated with the cognizant EFD/EFA. Secondary metering shall normally be covered in Sections 26 12 19.10 THREE-PHASE PAD-MOUNTED TRANSFORMERS, 26 12 19.20 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS, or 26 20 00 INTERIOR DISTRIBUTION SYSTEM as applicable.
****

Pole mounted metering equipment shall include current transformers, potential transformers, watthour meter, [meter test switch block,] metering enclosure, wire, conduit and fittings.

]2.20.1 Potential Transformers

Potential transformers shall be rated for outdoor service fitted for crossarm mounting and secondary connection box for conduit connection. Voltage rating shall be [2.4] [4.16] [7.2] [12.0] [12.47] [_____] kV to 120 volts ac, 60 Hz. Transformers shall conform to the requirements of IEEE C57.13 BIL [45] [60] [75] [95] kV and accuracy Class 0.3 (min.) of [75 VA] [burden Y].

2.20.2 Current Transformers

Current transformers shall be rated for outdoor service with crossarm mounting and secondary connection box for conduit connection. Voltage rating shall be [2.4] [4.16] [7.2] [12.47] [12.0] [_____] kV. Current rating shall be [_____] to 5 amperes. Transformers shall conform to requirements of IEEE C57.13, BIL [45] [60] [75] [95] kV and accuracy Class 0.3 at [B2.0] [50 VA].

2.20.3 Watthour Meter

Provide meter with provisions for future pulse initiation.

a. Meters: NEMA C12.10 and NEMA C12.1; when providing meter with electronic time-of-use register.

(1) Form: [5A] [5S] [6A] [6S].

(2) Element: [2] [2 1/2] [3].

(3) Voltage: 120 volts.

(4) Current: 2 1/2 amperes.

(5) Frequency: 60 hertz.

(6) Kilowatt hour register: 5 dial or 5 digit type.

b. Demand register:

(1) Solid state type.

(2) Meter reading multiplier:

(a) Indicate multiplier on the meter face.

(b) Provide multiplier in even hundreds.

(3) Demand interval length: shall be programmed for [15] [30] [60] minutes with rolling demand up to six subintervals per interval.

c. Mounting:

(1) Provide meter with [matching socket per IEEE C12.7 with [manual] [automatic] current short-circulating device.] ["A" base type mounting].

[2.20.4 Meter Test Block

Provide meter test block with [T] [10] pole group of open knife type switches designed for the isolation of metering devices at meter location by opening each circuit individually. Current switches shall short circuit current supply before opening meter circuit. Switch handles of potential switches shall be black. Switch handles of current switches shall be red.

]2.20.5 Metering Enclosure

Metering enclosure shall be of galvanized steel, weatherproof construction with pole mounting bracket, and 19 mm 3/4 inch exterior plywood, full size backboard and hinged door arranged for padlocking in closed position. Internal space shall be adequate to house equipment and wiring but not smaller than 510 by 760 by 280 mm 20 by 30 by 11 inches deep. Paint metal manufacturer's standard finish.

2.21 CAPACITORS

Capacitor equipment shall comply with IEEE Std 18 and shall be of the three-phase, grounded-wye, outdoor type rated for continuous operation and automatically switched. Equipment shall be suitable for mounting on a single pole. Polychlorinated biphenyl and tetrachloroethylene (perchloroethylene) shall not be used as the dielectric. Equipment shall be rated for the system voltage. The indicated kvars shall be automatically switched by [single-step] [time switch] [voltage] [current] [kilovar] [control] [multiple-step] [voltage] [kilovar] [control providing the indicated number of steps and switching the indicated kvar]. Necessary transformers shall be provided for sensing circuit variations and for low-voltage control. Oil-immersed switches shall be provided for automatic switching of capacitors, and shall be electrically separate from ungrounded capacitor enclosures and metal frames. Installations shall include one primary fuse cutout and one surge arrester for each ungrounded phase conductor. Fuse link ratings shall be in accordance with the manufacturer's recommendations. Capacitor equipment, except for low-voltage control and primary fuse cutouts, shall be subassembled and coordinated by one manufacturer. Units, including metal pole-mounting supports and hardware, shall be shipped in complete sections ready for connection at the site. Low-voltage equipment shall be socket or cabinet type, mounted on the pole approximately 1.2 m 4 feet above grade, shall be connected with the necessary wiring in conduit to capacitor equipment, and shall be provided with secondary arrester protection against switching surges when recommended by the manufacturer.

2.22 VOLTAGE REGULATOR

****

NOTE: Bypass arresters are normally standard equipment. Incoming line arresters may not be needed. Coordinate with the manufacturer.

****

Voltage regulators shall comply with IEEE C57.15 and shall be of the outdoor, self-cooled, 55/65 degrees C temperature rise, single-phase type. Windings and the load-tap-changing mechanism shall be mineral-oil-immersed. When operating under load, a regulator shall provide plus and minus 10 percent automatic voltage regulation in approximately 5/8 percent steps, with 16 steps above and 16 steps below rated voltage. Automatic control equipment shall provide Class 1 accuracy. Bypass surge arresters shall be suitable for [a grounded] [an ungrounded] system and for the associated regulator voltage. [[Station] [Intermediate] class surge arresters shall be mounted next to each incoming line bushing on a regulator tank-mounted bracket and connected to a surge arrester ground pad-mounted on the regulator tank].

2.22.1 Ratings

Ratings at 60 Hz shall be

Maximum voltage.....[_____]

Basic Insulation Level (BIL).....[_____]

Current.....[_____]

2.22.2 Bypass and Isolation Switches

Switches shall be of the outdoor, stickhook-operated, single-pole, single-throw, vertical-break type suitable for the indicated mounting. Switches shall be of a type designed to provide bypass of a single-phase regulator circuit by an integral sequence which always occurs when each switch is opened or closed. Each opening sequence shall initially bypass the single-phase regulator circuit, then open the input and output circuits, and finally interrupt the exciting current. Opening any single-phase regulator circuit shall not be possible until after the bypass circuit is closed. Ratings at 60 Hz shall be in accordance with IEEE C37.41 and as follows:

Maximum voltage.....[_____]

Nominal voltage class.....[_____]

BIL.....[_____]

Momentary asymmetrical current in the closed position.....[_____]

Momentary asymmetrical current in the bypass position.....[_____]

Continuous and interrupting current.....[_____]

2.22.3 Miscellaneous

Standard accessories and components in accordance with IEEE C57.15shall be provided. Single-phase units shall be provided with additional components and accessories required by IEEE C57.15 for three-phase units.

2.23 ELECTRICAL TAPES

Tapes shall be UL listed for electrical insulation and other purposes in wire and cable splices. Terminations, repairs and miscellaneous purposes, electrical tapes shall comply with UL 510.

2.24 CALKING COMPOUND

Compound for sealing of conduit risers shall be of a puttylike consistency workable with hands at temperatures as low as 2 degrees C 35 degrees F, shall not slump at a temperature of 150 degrees C 300 degrees F, and shall not harden materially when exposed to air. Compound shall readily calk or adhere to clean surfaces of the materials with which it is designed to be used. Compound shall have no injurious effects upon the workmen or upon the materials.

2.25 NAMEPLATES

****
NOTE: Do not use this paragraph for Navy projects. The Navy uses Section 16050, "Basic Electrical Materials and Methods" which contains these requirements.
****

2.25.1 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, regulators, circuit breakers, capacitors, meters and switches.

2.26 SOURCE QUALITY CONTROL

****
NOTE: Use "reserves the right to" on all projects, except those for SOUTHNAVFACENGCOM.
****

2.26.1 Transformer Test Schedule

The Government [reserves the right to] [will] witness tests. Provide transformer test schedule for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Test Instrument Calibration

(1) The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

(2) The accuracy shall be directly traceable to the National Institute of Standards and Technology.

(3) Instrument calibration frequency schedule shall not exceed 12 months for both test floor instruments and leased specialty equipment.

(4) Dated calibration labels shall be visible on all test equipment.

(5) Calibrating standard shall be of higher accuracy than that of the instrument tested.

(6) Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

(a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

(b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.26.2 Routine and Other Tests

IEEE C57.12.00 and IEEE C57.12.90. Routine and other tests shall be performed by the manufacturer on [each of] the actual transformer(s) prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site.

Required tests shall be as follows:

a. Polarity

b. Ratio

c. No-load losses (NLL) and excitation current

d. Load losses (LL) and impedance voltage

e. Dielectric

(1) Impulse

(2) Applied voltage

(3) Induced voltage

f. Leak

PART 3 EXECUTION

3.1 INSTALLATION

****
NOTE: In areas where the applicable State code is more stringent, substitute it for IEEE C2 and make the required changes under paragraph entitled "References." In California, use CALPUC G.O.95, State of California Public Utilities Commission.
****

Provide overhead pole line installation conforming to requirements of [_____] [IEEE C2] [CALPUC G.O. 95] for Grade [B] [C] construction of overhead lines in [light] [medium] [heavy] loading districts and NFPA 70 for overhead services. Provide material required to make connections into existing system and perform excavating, backfilling, and other incidental labor. Consider street, alleys, roads and drives "public." Pole configuration shall be as indicated.

3.1.1 Wood Pole Installation

****
NOTE: Include the bracketed sentence for projects where poles will be set in tropical areas of the Pacific Ocean, that are infested by the Formosan termite, coptotermes formosanus shirake. Delete it in other projects. For PACNAVFACENGCOM projects, contact Code 18, Environmental Division, for latest guidance on termite treatment methods.
****

Provide pole holes at least as large at the top as at the bottom and large enough to provide 100 mm 4 inch clearance between the pole and side of the hole. [Provide a 150 mm 6 inch band of soil around and down to the base of the pole treated with 7.5 to 11.4 liters 2 to 3 gallons of a one percent dursban TC termiticide solution.]

3.1.1.1 Setting Depth of Pole

Pole setting depths shall be as follows:

Length of Pole (mm)	Setting in Soil (mm)	Setting in Solid Rock (mm)
6095	1520	910
7600	1675	1065
9120	1675	1065
10640	1825	1215
12160	1825	1215
13680	1975	1370
15200	2130	1370
16720	2280	1520
18240	2440	1520

Length of Pole (feet)	Setting in Soil (feet)	Setting in Solid Rock (feet)
20	5.0	3.0
25	5.5	3.5
30	5.5	3.5
35	6.0	4.0
40	6.0	4.0
45	6.5	4.5
50	7.0	4.5
55	7.5	5.0
60	8.0	5.0

3.1.1.2 Setting in Soil, Sand, and Gravel

"Setting in Soil" depths, as specified in paragraph entitled "Setting Depth of Pole," apply where the following occurs:

a. Where pole holes are in soil, sand, or gravel or any combination of these;

b. Where soil layer over solid rock is more than 610 mm 2 feet deep;

c. Where hole in solid rock is not substantially vertical; or

d. Where diameter of hole at surface of rock exceeds twice the diameter of pole at same level. [At corners, dead ends and other points of extra strain, poles 12160 mm 40 feet or more long shall be set 150 mm 6 inches deeper.]

3.1.1.3 Setting in Solid Rock

"Setting in Solid Rock," as specified in paragraph entitled "Setting Depth of Pole," applies where poles are to be set in solid rock and where hole is substantially vertical, approximately uniform in diameter and large enough to permit use of tamping bars the full depth of hole.

3.1.1.4 Setting With Soil Over Solid Rock

Where a layer of soil 610 mm 2 feet or less in depth over solid rock exists, depth of hole shall be depth of soil in addition to depth specified under "Setting in Solid Rock" in paragraph entitled "Setting Depth of

Pole," provided, however, that such depth shall not exceed depth specified under "Setting in Soil."

3.1.1.5 Setting on Sloping Ground

On sloping ground, always measure hole depth from low side of hole.

3.1.1.6 Backfill

Thoroughly tamp pole backfill for full depth of the hole and mound excess fill around the pole.

3.1.1.7 Setting Poles

Set poles so that alternate crossarm gains face in opposite directions, except at terminals and dead ends where gains of last two poles shall be on side facing terminal or dead end. On unusually long spans, set poles so that crossarm comes on side of pole away from long span. Where pole top pins are used, they shall be on opposite side of pole from gain, with flat side against pole.

3.1.1.8 Alignment of Poles

Set poles in alignment and plumb except at corners, terminals, angles, junctions, or other points of strain, where they shall be set and raked against the strain. Set not less than 50 mm 2 inches for each 3050 mm 10 feet of pole length above grade, nor more than 100 mm 4 inches for each 3050 mm 10 feet of pole length after conductors are installed at required tension. When average ground run is level, consecutive poles shall not vary more than 1525 mm 5 feet in height. When 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. Holes shall be dug large enough to permit the proper use of tampers to full depth of hole.

3.1.1.9 Pole Caps

****
NOTE: Pole caps are not necessary for ACA/CCA treated poles.
****

Provide plastic pole caps with 6.35 mm 1/4 inch sealing rings and four nailing tabs. Fill sealing area with either a bituminous, elastigum roof cement or an acceptable preservative paste to level of sealing ring to eliminate possibility of condensation. Place on pole top and nail each tab down with a 31.75 mm 1 1/4 inch nail.

3.1.2 Steel and Concrete Pole Setting

Poles shall be mounted on cast-in-place or power-installed screw foundations. [Concrete poles shall be embedded in accordance with the details shown.] Conduit elbows shall be provided for cable entrances into pole interiors.

3.1.2.1 Cast-In-Place Foundations

****
NOTE: Use Section 03 31 00.00 10, CAST-IN-PLACE

STRUCTURAL CONCRETE for Army projects, Section 03 30 00.00 20 CAST-IN-PLACE CONCRETE for Navy projects and Section 03 40 00.00 40 CAST-IN-PLACE CONCRETE for NASA projects.

****

Concrete foundations, sized as indicated, shall have anchor bolts accurately set in foundations using templates supplied by the pole manufacturer. Concrete work and grouting is specified in[Section 03 30 00.00 20 CAST-IN-PLACE CONCRETE][Section 03 31 00.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE][Section 03 40 00.00 40 CAST-IN-PLACE CONCRETE]. After the concrete has cured, pole anchor bases shall be set on foundations and leveled by shimming between anchor bases and foundations or by setting anchor bases on leveling nuts and grouting. Poles shall be set plumb. Anchor bolts shall be the manufacturer's standard, and not less than necessary to meet the pole wind loading specified herein and other design requirements.

3.1.2.2 Power-Installed Screw Foundations

Power-installed screw foundations may be used if they have the required strength, mounting-bolt, and top plate dimensions. Screw foundations shall be of at least 6.4 mm 1/4 inch thick structural steel conforming to ASTM A 36/A 36M and hot-dip galvanized in accordance with ASTM A 123/A 123M. Conduit slots in screw foundation shafts and top plates shall be marked to indicate orientation. Design calculations indicating adequate strength shall be approved before installation of screw foundation is permitted. Calculations shall be submitted in accordance with the design data portion of paragraph entitled "SUBMITTALS."

3.1.3 Anchors and Guys

Place anchors in line with strain. The length of the guy lead (distance from base of pole to the top of the anchor rod) shall be as indicated.

3.1.3.1 Setting Anchors

Set anchors in place with anchor rod aligned with, and pointing directly at, guy attachment on the pole with the anchor rod projecting 150 to 230 mm 6 to 9 inches out of ground to prevent burial of rod eye.

3.1.3.2 Backfilling Near [Plate] Anchors

****

NOTE: If plate anchors are chosen, for LANTNAVFACENGCOM projects, include the bracketed option in the title of the paragraph and use the second bracketed sentence.

****

[Backfill plate, expanding, concrete, or cone type anchors [with tightly tamped coarse rock 610 mm 2 feet immediately above anchor and then] with tightly tamped earth filling [remainder of] hole.]

[Backfill plate anchors with tightly tamped earth for full depth of hole.]

3.1.3.3 Screw Anchors

Install screw anchors by torquing with boring machine.

3.1.3.4 Swamp Anchors

Install swamp anchors by torquing with boring machine or wrenches, adding sections of pipe as required until anchor helix is fully engaged in firm soil.

3.1.3.5 Setting Guy Strands

****
NOTE: Guy strand shall be insulated or grounded in conformance with IEEE C2 or practice in the particular station.
****

Complete anchor and guy installation, dead end to dead end, and tighten guy before wire stringing and sagging is begun on that line section. [Provide strain insulators at a point on guy strand 2435 mm 8 feet minimum from the ground and 1825 mm 6 feet minimum from the surface of pole.] [Effectively ground and bond guys to the system neutral.]

3.1.4 Hardware

Provide hardware with washer against wood and with nuts and lock nuts applied wrench tight. Provide locknuts on threaded hardware connections. Locknuts shall be M-F style and not palnut style.

3.1.5 Grounding

Unless otherwise indicated, grounding shall conform to IEEE C2. Pole grounding electrodes shall have a resistance to ground not exceeding 25 ohms. When work in addition to that indicated or specified is directed in order to obtain specified ground resistance, provisions of the contract covering changes shall apply.

3.1.5.1 Ground Rod Connections

Make ground rod connections on pole lines by exothermic weld or by using a compression connector for ground wire or wire to rod connections. Make exothermic welds strictly in accordance with manufacturer's written recommendations. Welds which have puffed up or which show convex surfaces indicating improper cleaning, are not acceptable. No mechanical connectors are required at exothermic weldments. Compression connectors shall be type that uses a hydraulic compression tool to provide correct pressure. Provide tools and dies recommended by compression connector manufacturer. An embossing die code or similar method shall provide visible indication that a connector has been fully compressed on ground wire.

3.1.5.2 Grounding and Grounded Connections

a. Where no primary or common neutral exists, surge arresters and frames of equipment operating at over 750 volts shall be bonded together and connected to a dedicated primary grounding electrode.

b. Where no primary or common neutral exists, transformer secondary neutral bushing, secondary neutral conductor, and frames of equipment operating at under 750 volts shall be bonded together and connected to a dedicated secondary grounding electrode.

c. When a primary or common neutral exists, connect all grounding and grounded conductors to a common grounding electrode.

3.1.5.3 Protective Molding

Protect grounding conductors which are run on surface of wood poles by wood molding [or plastic molding of equal mechanical strength] extending from ground line throughout communication and transformer spaces.

3.1.6 CONDUCTOR INSTALLATION

3.1.6.1 Line Conductors

****
NOTE: Do not use bracketed sentence for Navy projects only. Instead, sag and tension tables should be provided and values indicated on the drawings.
****

[Unless otherwise indicated, conductors shall be installed in accordance with manufacturer's approved tables of sags and tensions.]Conductors shall be handled with care necessary to prevent nicking, kinking, gouging, abrasions, sharp bends, cuts, flattening, or otherwise deforming or weakening conductor or any damage to insulation or impairing its conductivity. Remove damaged sections of conductor and splice conductor. 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.

3.1.6.2 Connectors and Splices

Conductor splices, as installed, shall exceed ultimate rated strength of conductor and shall be of type recommended by conductor manufacturer. No splice shall be permitted within 3050 mm 10 feet of a support. 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. Aluminum-composition conductors shall be wire brushed and an oxide inhibitor applied before making a compression connection. Connectors which are factory-filled with an inhibitor are acceptable. Inhibitors and compression tools shall be of types recommended by the connector manufacturer. Primary line apparatus taps shall be by means of hot line clamps attached to compression type bail clamps (stirrups). Low-voltage connectors for copper conductors shall be of the solderless pressure type. Noninsulated connectors shall be smoothly taped to provide a waterproof insulation equivalent to the original insulation, when installed on insulated conductors. On overhead connections of aluminum and copper, the aluminum shall be installed above the copper.

3.1.6.3 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
4/0 and larger	2
AAC, AAAC, or ACSR (AWG)	AAAC OR AAC (AWG)
Any size	6 or 4

3.1.6.4 Armor Rods

Armor rods shall be provided for AAC, AAAC, and ACSR conductors. Armor rods shall be installed at supports, except armor rods will not be required at primary dead-end assemblies if aluminum or aluminum-lined zinc-coated steel clamps are used. Lengths and methods of fastening armor rods shall be in accordance with the manufacturer's recommendations. For span lengths of less than 61 m, 200 feet, flat aluminum armor rods may be used. Flat armor rods, not less than 762.0 micrometers by 6.4 mm 0.03 by 0.25 inch shall be used on No. 1 AWG AAC and AAAC and smaller conductors and on No. 5 AWG ACSR and smaller conductors. On larger sizes, flat armor rods shall be not less than 1.3 by 7.6 mm. 0.05 by 0.30 inches. For span lengths of 61 m 200 feet or more, preformed round armor rods shall be used.

3.1.6.5 Ties

Provide ties on pin insulators tight against conductor and insulator and ends turned down flat against conductor so that no wire ends project.

3.1.6.6 Reinstalling Conductors

****

NOTE: Sag tables are usually available from conductor manufacturers. For projects which entail considerable length of overhead line, sag tables for the particular line as designed shall be indicated.

****

Existing conductors to be reinstalled or resagged shall be strung to "final" sag table values indicated for the particular conductor type and size involved.

3.1.6.7 New Conductor Installation

****

NOTE: Sag tables are usually available from conductor manufacturers. For projects which entail considerable length of overhead line, sag tables for the particular line as designed should be indicated. Use "indicated" on LANTNAVFACENGCOM projects.

****

String new conductors to "initial" sag table values [indicated] [recommended by the manufacturer] for conductor type and size of conductor and ruling span indicated.

3.1.6.8 Fittings

Dead end fittings[, clamp or compression type,] shall conform to written recommendations of conductor manufacturer and shall develop full ultimate strength of conductor.

3.1.6.9 Aluminum Connections

Make aluminum connections to copper or other material using only splices, connectors, lugs, or fittings designed for that specific purpose. Keep a copy of manufacturer's instructions for applying these fittings at job site for use of the inspector.

[3.1.7 Pole Mounted Metering Equipment

3.1.7.1 Primary Meters

Install primary metering transformers [as indicated] [according to manufacturer's drawings]. Make connections to metering circuits within each transformer conduit connection box.

3.1.7.2 Installing Meter System

Metering enclosure shall house kWh meter [and meter test block]. Secure the enclosure to pole at a height of 1825 mm 6 feet above grade to center of the enclosure. Ground enclosure.

a. Connect meter as indicated.

[b. Connect meter test block between meter and metering transformers to isolate meter for removal, test or adjustment.]

c. Phase sequence and color code of potential and current leads shall be identical. Mark wires which are connected to transformer terminals identified with polarity marks (dots) by a colored plastic tape around the wire at each end.

d. No splices are permissible in metering circuits. Wire shall be trained at sides and bottom of enclosure back board and secured by plastic wraps.

]3.1.8 Pole Top Switch Installation

Install pole top switch strictly according to manufacturer's installation drawings and information.

3.1.8.1 Operating Handle

Locate approximately 1520 mm 5 feet above ground on field side of pole.

[3.1.9 Recloser

Install recloser(s) strictly in accordance with manufacturer's instructions.

][3.1.10 Sectionalizer

Install sectionalizer(s) strictly in accordance with manufacturer's instructions.

]3.1.11 Risers

Secure galvanized steel conduits on poles by two hole galvanized steel pipe straps spaced as indicated and within 910 mm 3 feet of any outlet or termination. Ground metallic conduits.

3.2 TRANSFORMER INSTALLATION

****
NOTE: Specify phase sequence in accordance with the local practice.
****

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.

[3.3 CROSSARM MOUNTING

****
NOTE: Do not use this paragraph and subparagraphs for Navy projects. The Navy provides this information on the drawings. Utilize Navy plates during design of Navy projects.
****

****
NOTE: Normally flat braces will be specified for 2.4 m (8 foot) crossarms and angle braces for 3.1 m (10 foot) crossarms to agree with REA construction. An angle brace is also required on 2.4 m (8 foot) arms where conductors have a breaking strength of more than 20.0 kN (4500 pounds). Extreme loading conditions may also warrant the extra cost of the stronger angle brace under other circumstances.

Metal crossarm braces will reduce the effective BIL rating of the pole. In high lightning areas specify fiberglass braces.

Consult REA Bulletin 61-10, "Protection of Bald and Golden Eagles from Power lines." The requirement for wooden crossarm braces should be verified for each state and land area in accordance with the Bald

Eagle Protection Act of 1940, (16 U.S.C. 703 et seq.) as amended; Endangered Species Act of 1973 (87 Stat. 1064); and Migratory Bird Treaty of 1918 (16 U.S.C 703 et. seq.) as amended. Potential requirement sources are the Bureau of Land Management, U.S. Department of the Interior, and Federal, State, and Local Land Management or Wildlife Conservation Agencies.

****

Crossarms shall be bolted to poles with 15.9 mm 5/8 inchthrough-bolts with square washers at each end. Bolts shall extend not less than 3 mm 1/8 inch nor more than 50 mm 2 inches beyond nuts. On single crossarm construction, the bolt head shall be installed on the crossarm side of the pole. [Fiberglass] [Metal] [Wood] crossarm braces shall be provided on crossarms. Flat braces may be provided for 2.4 m 8 foot crossarms and shall be 6.4 by 31.8 mm, 1/4 by 1-1/4 inches, not less than 700 mm 28 inches in length. Flat braces shall be bolted to arms with 9.5 mm 3/8 inch carriage bolts with round or square washers between boltheads and crossarms, and secured to poles with 50.8 by 101.6 mm 1/2 by 4 inch lag screws after crossarms are leveled and aligned. Angle braces are required for 3.1 m 10 foot crossarms and shall be 1.5 m 60 inch span by 457.2 mm 18 inch drop formed in one piece from 38.1 by 38.1 by 4.8 mm 1-1/2 by 1-1/2 by 3/16 inch angle. Angle braces shall be bolted to crossarms with 50.8 mm 1/2 inch bolts with round or square washers between boltheads and crossarms, and secured to poles with 15.9 mm 5/8 inch through-bolts. Double crossarms shall be securely held in position by means of 15.9 mm 5/8 inch double-arming bolts. Each double-arming bolt shall be equipped with four nuts and four square washers.

3.3.1 Line Arms and Buck Arms

Line arms and buck arms shall be set at right angles to lines for straight runs and for angles 45 degrees and greater; and line arms shall bisect angles of turns of less than 45 degrees. Dead-end assemblies shall be used for turns where shown. Buck arms shall be installed, as shown, at corners and junction poles. Double crossarms shall be provided at ends of joint use or conflict sections, at dead-ends, and at angles and corners to provide adequate vertical and longitudinal strength. Double crossarms shall be provided at each line-crossing structure and where lines not attached to the same pole cross each other.

3.3.2 Equipment Arms

Equipment arms shall be set parallel or at right angles to lines as required to provide climbing space. Equipment arms shall be located below line construction to provide necessary wire and equipment clearances.

]3.4 FIELD QUALITY CONTROL

****

NOTE: Select types to suit project conditions and delete all others. Delete all paragraphs not applicable. Tests must be justified.

****

3.4.1 General

[Field testing shall be performed in the presence of the Contracting

Officer.]The Contractor shall notify the Contracting Officer [_____] 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.

3.4.2 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.

3.4.3 Medium-Voltage Preassembled Cable Test

****

NOTE: If the installation is tapping a new feeder to an existing feeder using a "T" splice, modify the paragraph to indicate that when existing cable cannot be readily disconnected, the system should only be tested to the lower (after installation) voltage. Delete the test if no cable is installed in the project.

****

After installation, prior to connection to an existing system, and before the operating test, the medium-voltage preassembled cable system shall be given a high potential test. Direct-current voltage shall be applied on each phase conductor of the system by connecting conductors at one terminal and connecting grounds or metallic shieldings or sheaths of the cable at the other terminal for each 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 74 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.

3.4.4 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.

3.4.5 Low-Voltage Cable Test

****

NOTE: The insulation resistance test (dielectric

test) value is based on the recommendation contained in IEEE Std 525. Delete the cable test if no low voltage cables are in the project.

****

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 in megohms = (rated voltage in kV + 1) x 304,800/(length of cable in meters)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 then be retested until failures have been eliminated.

3.4.6 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:

Capacitors.

Switches.

3.4.7 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.4.7.1 Overhead-Type Distribution Transformers

a. Visual and mechanical inspection

(1) Compare equipment nameplate information with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey is not required.

(4) Perform specific inspections and mechanical tests as recommended by manufacturer.

(5) Verify correct equipment grounding.

b. Electrical tests

****
NOTE: Coordinate the option on series-multiple voltage-changing switch with the option in paragraph entitled "Transformers (Overhead-Type Distribution)" herein.
****

[(1) Insure that the series-multiple voltage-changing switch is in the correct position. Transformers are normally shipped in the series position.]

(2) Perform insulation-resistance tests.

(3) Perform continuity test.

(4) Set tap changer to provide a secondary voltage of [120/240] [120/208] [_____].

3.4.7.2 Pole Top Interrupter Switch

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate information with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify appropriate equipment grounding.

(4) Perform mechanical operator tests in accordance with manufacturer's instructions.

(5) Verify correct blade alignment, blade penetration, travel stops, arc interrupter operation, and mechanical operation.

b. Electrical Tests

(1) Perform insulation-resistance tests.

(2) Perform dc over-potential tests.

(3) Perform contact-resistance tests across each switch blade.

[3.4.7.3 Reclosers

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Inspect alignment and grounding.

(4) Perform mechanical operation and contact alignment tests on both the recloser and its operating mechanism in accordance with manufacturer's instructions.

(5) Verify tightness of accessible bolted electrical connections.

(6) Inspect for correct insulating liquid level.

b. Electrical Tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter.

(2) Perform a contact resistance test

(3) Sample insulating liquid. Sample shall be tested for:

(a) Dielectric breakdown voltage

(b) Color

(c) Visual condition

(4) Test protective functions.

[(5) Perform vacuum bottle integrity test (overpotential) across each vacuum bottle with the recloser in the open position in strict accordance with manufacturer's instructions.]

(6) Perform overpotential tests.

(7) Determine time delay for each programmed reclosing interval.

(8) Verify lockout for unsuccessful reclosing.

(9) Determine reset time.

(10) Verify instantaneous overcurrent lockout.

][3.4.7.4 Sectionalizers

a. Visual and Mechanical inspection

(1) Compare equipment nameplate data with approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Inspect alignment and grounding.

(4) Perform mechanical operation and contact alignment tests on both the sectionalizer and its operating mechanism in accordance with manufacturer's instructions.

(5) Verify tightness of accessible bolted electrical connections.

(6) Inspect for correct insulating liquid level.

b. Electrical Tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter.

(2) Perform a contact resistance test.

(3) Sample insulating liquid. Sample shall be tested for:

(a) Dielectric breakdown voltage

(b) Color

(c) Visual condition

(4) Perform overpotential tests.

(5) Test sectionalizer counting function.

(6) Test sectionalizer lockout function.

(7) Test for reset timing on trip actuator.

][3.4.7.5 Potential Transformers

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Verify correct connection.

(3) Verify that adequate clearances exist between primary and secondary circuit wiring.

(4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.

(5) Verify that all required grounding and shorting connections provide good contact.

(6) Verify correct fuse sizes.

b. Electrical Tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter

(2) Perform insulation-resistance tests.

(3) Perform polarity tests.

(4) Perform turns-ratio tests.

][3.4.7.6 Current Transformers

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify correct connection.

(4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.

(5) Verify that all required grounding and shorting connections provide good contact.

b. Electrical Tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter

(2) Perform insulation-resistance tests.

(3) Perform polarity tests.

(4) Perform ratio-verification tests.

][3.4.7.7 Metering

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of electrical connections.

b. Electrical Tests

(1) Verify accuracy of meters at 25 percent, 50 percent, 75 percent, and 100 percent of full scale.

(2) Calibrate watthour meters according to manufacturer's published data.

(3) Verify all instrument multipliers.

]3.4.7.8 Grounding System

a. Visual and mechanical inspection

(1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

(1) Perform ground-impedance measurements utilizing the

fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

3.4.8 Devices Subject to Manual Operation

Each device subject to manual operation shall be operated at least three times, demonstrating satisfactory operation each time.

3.4.9 Follow-Up Verification

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

3.5 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of English unit measurement, and not on metric measurement commonly agreed to by the manufacturers or other parties. The English and metric units for the measurements shown are as follows:

Products	English Units	Metric Units
a. Crossarm Braces		
- Span	38 inches	965 mm
	60 inches	1520 mm
b. Anchor Rod		
- Diameter	3/4 inch	19 mm
	one inch	25 mm
c. Ground Rod		
- Diameter	3/4 inch	19 mm
- Length	10 feet	3050 mm

-- End of Section --