UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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OVERHEAD TRANSMISSION AND DISTRIBUTION

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USACE / NAVFAC / AFCEC / NASA	**UFGS-33 71 01 (May 2019)**
	Change 1 - 11/19

Preparing Activity: NAVFAC	**Superseding**
	UFGS-33 71 01 (July 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION 33 71 01

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

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
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NOTE: This guide specification is for 0-35 kV Overhead Transmission and Distribution and 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 Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

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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/ANSI 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.

10. Avian protection on power lines as required by the Federal, State, and Local Land Management or Wildlife Conservation Agencies.

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PART 1 GENERAL

1.1 REFERENCES

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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 Reference Identifier (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 ANSI O5.1	(2017) Wood Poles -- Specifications & Dimensions

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

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

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A240/A240M	(2023) Standard Specification for Chromium

	and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A475	(2022) Standard Specification for Metallic-Coated Steel Wire Strand
ASTM A575	(2020) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A576	(2017) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B2	(2013) Standard Specification for Medium-Hard-Drawn Copper Wire
ASTM B3	(2013) Standard Specification for Soft or Annealed Copper Wire
ASTM B8	(2011; R 2017) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B230/B230M	(2022) Standard Specification for Aluminum 1350-H19 Wire for Electrical Purposes
ASTM B231/B231M	(2016; R 2021) Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors
ASTM B232/B232M	(2022) Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR)
ASTM B398/B398M	(2022) Standard Specification for Aluminum-Alloy 6201-T81 Wire for Electrical Purposes
ASTM B399/B399M	(2023) Standard Specification for Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors
ASTM B857	(2018) Standard Specification for Shaped Wire Compact Concentric-Lay-Stranded Alunimum Conductors, Coated-Steel Supported (ACSS/TW)
ASTM D92	(2012a) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D97	(2017b) Standard Test Method for Pour Point of Petroleum Products

ASTM D117	(2018) Standard Guide for Sampling, Test Methods, and Specifications for Electrical Insulating Liquids
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D877/D877M	(2019) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D3487	(2016; E2017) Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 18	(2012) Standard for Shunt Power Capacitors
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 404	(2012) Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.30.1	(2011)Standard Requirements for AC High-Voltage Air Switches Rated Above 1000 V
IEEE C37.41	(2016; Corr 2017) Design Tests for High-Voltage (>1000 V) Fuses and Accessories
IEEE C37.42	(2016) Specifications for High-Voltage (> 1000 V) Fuses and Accessories
IEEE C37.63	(2013) Standard Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizers for AC Systems
IEEE C57.12.00	(2021) General Requirements for Liquid-Immersed Distribution, Power, and

	Regulating Transformers
IEEE C57.12.20	(2017) Overhead-Type Distribution Transformers, 500 KVA and Smaller: High Voltage, 34 500 Volts and Below; Low Voltage, 7970/13,800 Y V and Below
IEEE C57.12.28	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.31	(2010; Corr 2014) Standard for Pole-Mounted Equipment - Enclosure Integrity
IEEE C57.12.90	(2021) Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers
IEEE C57.15	(2018) Standard Requirements, Terminology, and Test Code for Step-Voltage Regulators
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)
IEEE C135.1	(1999) Standard for 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) Standard for Zinc-Coated Ferrous Pole-Top Insulator Pins with Lead Threads for Overhead Line Construction
IEEE C135.30	(1988) Standard for Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 62271-111	(2019) High Voltage Switchgear And Controlgear - Part 111: Automatic Circuit Reclosers for Alternating Current Systems up to and including 38 kV

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.7	(2022) Requirements for Watthour Meter Sockets
ANSI C29.2	(2020) American National Standard for Insulators - Wet-Process Porcelain and Toughened Glass - Distribution Suspension Type
ANSI C29.3	(2015; R 2022) American National Standard for Wet Process Porcelain Insulators - Spool Type
ANSI C29.4	(2022) Standard for Wet-Process Porcelain Insulators - Strain Type
ANSI C29.5	(2022) Wet-Process Porcelain Insulators (Low and Medium Voltage Pin Type)
ANSI/NEMA WC 71/ICEA S-96-659	(2014; R 2022) Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA WC 70	(2021) Power Cable Rated 2000 Volts or Less for the Distribution of Electrical Energy
NEMA WC 74/ICEA S-93-639	(2022) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy
NEMA/ANSI C12.10	(2011; R 2021) Physical Aspects of Watthour Meters - Safety Standard
NEMA/ANSI C29.7	(1996; 2002) American National Standard for Wet Process Porcelain Insulators - High-Voltage Line Post Type

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

OECD Test 203	(1992) Fish Acute Toxicity Test

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS 202-1	(2004) List of Materials Acceptable for Use on Systems of RUS Electrification Borrowers
RUS Bull 1728H-701	(1993) Wood Crossarms (Solid and Laminated), Transmission Timbers and Pole Keys

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 712-C-98-075	(1998) Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation"
EPA 821-R-02-012	(2002) Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 431	Energy Efficiency Program for Certain Commercial and Industrial Equipment

UNDERWRITERS LABORATORIES (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2018; Reprint May 2021) UL Standard for Safety Wire Connectors
UL 510	(2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape

1.2 RELATED REQUIREMENTS

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

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, must be as defined in IEEE 100.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters 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.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Conductors; G[, [_____]]

Insulators; G[, [_____]]

Concrete Poles; G[, [_____]]

Steel Poles; G[, [_____]]

Wood Poles

Nameplates; G[, [_____]]

Pole Top Switch; G[, [_____]]

Recloser; G[, [_____]]

Sectionalizer; G[, [_____]]

Cutouts; G[, [_____]]

Transformer; G[, [_____]]

Metering Equipment; G[, [_____]]

Meters; G[, [_____]]

Surge Arresters; G[, [_____]]

Capacitors; G[, [_____]]

Voltage Regulator; G[, [_____]]

Guy Strand

Anchors

SD-05 Design Data

Concrete Poles; G[, [_____]]

Steel Poles; G[, [_____]]

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

SD-06 Test Reports

Wood Crossarm Inspection Report

Field Test Plan; G[, [_____]]

Field Quality Control; G[, [_____]]

Ground Resistance Test Reports; G[, [_____]]

Medium-Voltage Preassembled Cable Test; G[, [_____]]

Sag and Tension Test; G[, [_____]]

Low-Voltage Cable Test; G[, [_____]]

Acceptance Checks and Tests; G[, [_____]]

SD-07 Certificates

Concrete Poles; G[, [_____]]

Steel Poles; G[, [_____]]

Wood Poles; G[, [_____]]

Wood Crossarms; G[, [_____]]

Transformer Efficiencies; G[, [_____]]

SD-09 Manufacturer's Field Reports

Operation and Maintenance Manuals; G[, [_____]]

Transformer Test Schedule; G[, [_____]]

Overhead-type Distribution Transformer Routine and Other Tests; G [, [_____]]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals, Data Package 5; G[, [_____]]

[1.4.1 Government Submittal Review

****
NOTE: Use the following paragraph and subparagraphs regarding transformer submittals for NAVFAC projects. In the bracketed option, insert your appropriate NAVFAC Component organization and code. For other projects, submittal review must be performed by the designer of record. If submittal review by NAVFAC LANT is specifically desired, the responsible Government agency must coordinate with NAVFAC LANT, Code C144 during the design process. Add appropriate information in Section titled "Submittal Procedures" to coordinate with the special requirements.
****

[Code [C144][_____], NAVFAC [Atlantic] [_____] will review and approve transformer submittals.] As an exception to this paragraph, transformers manufactured by ABB in Athens, GA; by Cooper Power Systems in Lumberton, MS; by ERMCO in Dyersburg, TN; or by Howard Industries in Laurel, MS need not meet the submittal requirements of this contract. Instead, the following must be submitted.

a. A certification, from the manufacturer stating, that the manufacturer will meet the technical requirements of this specification.

b. Provide transformer test schedule and routine and other tests required by submittal item "SD-09 Manufacturer's Field Reports."

c. Provide Provide acceptance test reports received by submittal item "SD-06 Test Reports."

d. Provide operation and maintenance manuals required by submittal item "SD-10 Operation and Maintenance Data."

]1.5 QUALITY ASSURANCE

1.5.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory except of NFPA 70 when more stringent requirements are specified or indicated, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 and IEEE C2 unless more stringent requirements are specified or indicated.

1.5.2 Standard Products

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

the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.2.1 Alternative Qualifications

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

1.5.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site must not be used, unless specified otherwise.

1.5.3 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.

1.5.4 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.

1.5.4.1 Field Test Plan

Provide a proposed field test plan [20] [30] [_____] days prior to testing the installed system. No field test must be performed until the test plan is approved. The test plan must consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

1.6 OPERATIONS AND MAINTENANCE DATA

Provide operation and maintenance manuals for systems in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provides basic data relating to the design, operation, and maintenance of the electrical distribution system.

1.6.1 Additions to Operations and Maintenance Data

In addition to requirements of Data Package 5, include the following in the operation and maintenance manuals provided:

a. Assembly and installation drawings

b. Prices for spare parts and supply list

c. Date of purchase

1.7 DELIVERY, STORAGE, AND HANDLING

Devices and equipment must be visually inspected by the Contractor when received and prior to acceptance from conveyance. Protect stored items from the environment in accordance with the manufacturer's published instructions. Replace damaged items. Store oil filled transformers and switches in accordance with the manufacturer's requirements. Store wood poles held in storage for more than 2 weeks in accordance with ATIS ANSI O5.1. Handle wood poles in accordance with ATIS ANSI O5.1, except that pointed tools capable of producing indentations more than inch in depth must not be used. Nails and holes are not permitted in top of poles. Handle and store metal poles in accordance with the manufacturer's instructions.

1.8 WARRANTY

The equipment items must be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

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NOTE: A 120-hour test will be specified in a noncorrosive environment and a 480-hour test will be specified in a corrosive environment.

****

Consider materials specified herein or shown on contract drawings which are identical to materials listed in RUS 202-1 as conforming to requirements. Provide equipment and component items, not hot-dip galvanized or porcelain enamel finished, with corrosion-resistant finishes which must withstand [120] [480] hours of exposure to the salt spray test specified in ASTM B117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1.6 mm 1/16 inch from the test mark. Provide the described test mark and test evaluation in accordance with ASTM D1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Coat cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel with a zinc rich paint conforming to the manufacturer's standard.

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.

****

Provide poles of lengths and [classes] [strengths] indicated.

2.2.1 Wood Poles

****
NOTE: For NAVFAC LANT 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 ANSI O5.1. Gain, bore and roof poles before treatment. Should additional gains be required subsequent to treatment, metal gain plates must be provided. Pressure treat poles with [pentachlorophenol,] [ammoniacal copper arsenate (ACA),] [chromated copper arsenate (CCA)], except that Douglas Fir and Western Larch poles must not be treated with CCA in accordance with AWPA C1 and AWPA C4. Ensure the quality of each pole with "WQC" (wood quality control) brand on each piece, or by an approved inspection agency report.

2.2.2 Steel Poles

Design steel poles to withstand the loads specified in IEEE C2 multiplied by the appropriate overload capacity factors, hot-dip galvanized in accordance with ASTM A123/A123M and not painted. Poles must have tapered tubular members, either round in cross-section or polygonal, and comply with strength calculations performed by a registered professional engineer. Submit calculations in accordance with the design data portion of paragraph SUBMITTALS. Provide certification, from the manufacturer, that the technical requirements of this specification must be met. Pole shafts must be one piece. Poles must be welded construction with no bolts, rivets, or other means of fastening except as specifically approved. Pole markings must be approximately 900 to 1270 mm 3 to 4 feet above grade and must include manufacturer, year of manufacture, top and bottom diameters, length, and a loading tree. Provide attachment requirements as indicated, including grounding provisions. Climbing facilities are not required. Bases must 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.
****

Design concrete poles to withstand the loads specified in IEEE C2 multiplied by the appropriate overload capacity factors. Poles must be reinforced or prestressed, either cast or spun. Spun poles must be manufactured by a centrifugal spinning process with concrete pumped into a polished round tapered metal mold. Concrete for spun poles must have a compressive strength of at least 34.5 MPa 5000 psi at 28 days; steel wire must have an ultimate tensile strength of at least 827 MPa; 120,000 psi; and reinforcing bars must have an ultimate tensile strength of at least 276 MPa 40,000 psi. After the high speed spinning action is completed, a spun pole must be cured by a suitable wet steam process. Spun poles must have a water absorption of not greater than three percent to eliminate cracking and to prevent erosion. Concrete poles must have hollow shafts. Poles must have a hard, smooth, nonporous surface that is resistant to soil acids, road salts, and attacks of water and frost. Poles must not be

installed for at least 15 days after manufacture. Provide fittings and brackets that conform to the concrete pole design. Poles must conform to strength calculations performed by a registered professional engineer and submitted in accordance with design data portion of paragraph SUBMITTALS. Provide certification, from the manufacturer, that the technical requirements of this specification must be met.

2.3 CROSSARMS AND BRACKETS

2.3.1 Wood Crossarms

Conform to RUS Bull 1728H-701. Pressure treat crossarms with pentachlorophenol, chromated copper arsenate (CCA), or ammoniacal copper arsenate (ACA). Treatment must conform to AWPA C25. Crossarms must 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 must 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 must be 2.4 m 8 feet in length, except that 3.1 m 10 foot crossarms must be used for crossarm-mounted banked single-phase transformers or elsewhere as indicated. Crossarms must be machined, chamfered, trimmed, and bored for stud and bolt holes before pressure treatment. Factory drilling must 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 must provide required climbing space and wire clearances. Crossarms must 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 must 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 must be as indicated. Brackets must 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 must be suitable for the shape of the pole. Brackets for wood poles must have wood gripping members. Horizontal offset brackets must have a 5-degree uplift angle. Pole top brackets must conform to IEEE C135.22, except for modifications necessary to provide support for a line-post insulator. Brackets must 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 corrosive environments, galvanized steel pole-line hardware may not be acceptable and only hot-dip galvanized malleable or ductile iron should be permitted. Utilize the following sentence requiring hot-dip galvanized hardware in corrosive environments defined as those project locations in

Environmental Severity Classification (ESC) C3 thru C5. See UFC 1-200-01 for determination of ESC for project locations. For other locations, local usage should be checked. Navy projects require hot-dip galvanized hardware only.

****

Hardware must be hot-dip galvanized in accordance with ASTM A153/A153M and ASTM A123/A123M.

****

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 must comply with IEEE C135.1, IEEE C135.2, IEEE C135.22. Steel hardware must comply with ASTM A575 and ASTM A576. Pole-line hardware must be hot-dip galvanized[steel.][steel, except anchor rods of the copper-molten welded-to-steel type with nonferrous corrosion-resistant fittings must be used.] Intall washers under boltheads and nuts on wood surfaces and elsewhere as required. Washers used on through-bolts and double-arming bolts must 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 must be the correct standard size for the bolt on which a washer is used. Washers for use under heads of carriage-bolts must be of the proper size to fit over square shanks of bolts. Use eye bolts, bolt eyes, eyenuts, strain-load plates, lag screws, guy clamps, fasteners, hooks, shims, and clevises 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 ANSI C29.3 Class 53-2. Use the values in Table II for NAVFAC LANT projects.

TABLE I					
Voltage kV	NESC min. dry flashover kV	ANSI C29.5 Pin	NEMA/ANSI C29.7 Post ("L" or "S")	ANSI C29.2A and ANSI C29.2B 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
15	55	55-3	57-1	2/52-1 or 2/52-9	54-2
25	75	55-6 C29.6	57-2	2/52-4	54-3
35	100	56-3	57-2	3/52-4	54-3

TABLE II					
Voltage kV	NEMA C29.3 Spool	ANSI C29.5 Pin	NEMA/ANSI C29.7 Post ("L" or "S")	ANSI C29.2A and ANSI C29.2B Suspension	ANSI C29.4 Guy Strain
5. or less	53-2	55-3	57-1	52-1	54-4
15	53-2	55-3	57-1	2/52-1	54-4
35	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 must members. When the engineer determines that station policy differs from these requirements, insulators which match the policy in effect at the station must be specified by ANSI reference and class. Insulator flashover values must 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, use fiberglass guy strain insulators where other interference problems exist.

****

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

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

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

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

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

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

]2.6 OVERHEAD CONDUCTORS, CONNECTORS AND SPLICES

****
NOTE: For NAVFAC LANT projects, do not use "aluminum conductor steel reinforced (ACSR)."
****

Conductors of bare [copper] [aluminum (AAC)] [aluminum alloy (AAAC)] [aluminum conductor steel reinforced (ACSR)] [aluminum conductor steel supported (ACSS)] of sizes and types indicated.[Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486A-486B must be used.]

2.6.1 Solid Copper

ASTM B1, ASTM B2, and ASTM B3, hard-drawn, medium-hard-drawn, and soft-drawn, respectively. ASTM B8, stranded.

2.6.2 Aluminum (AAC)

ASTM B230/B230M and ASTM B231/B231M.

2.6.3 Aluminum Alloy (AAAC)

ASTM B398/B398M or ASTM B399/B399M.

2.6.4 Aluminum Conductor Steel Reinforced (ACSR)

ASTM B232/B232M, aluminum.

2.6.5 Aluminum Conductor Steel Supported (ACSS)

ASTM B857, aluminum.

2.6.6 Connectors and Splices

Connectors and splices must 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, aluminum-composition to copper, and copper-to-copper must comply with UL 486A-486B.

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, ACSR, or ACSS must be No. 4 AWG and for copper, No. 6 AWG. For NAVFAC LANT projects, do not use ACSR.

****

[Service][Secondary] cables must be [aluminum] [copper], [triplex] [quadruplex] with cross-linked polyethylene insulation on the phase conductors. Neutral must be bare [ACSR] [ACSS] [aluminum alloy] [hard drawn copper] and must be the same size as the phase conductors unless otherwise indicated. Cables shall conform to [NEMA WC 70][and][ANSI/NEMA WC 71/ICEA S-96-659] [ASTM B857] for cross-linked polyethylene insulation.

2.8 GUY STRAND

[ASTM A475, [high-strength] [extra high-strength], Class A or B, galvanized strand steel cable][Class 30 [high-strength] [extra high-strength] copper-clad steel]. Guy strand must 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 MARKERS

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 must provide strength conforming to IEEE C2 for the grade of construction of the line. Designated maximum holding power rating assumes proper installation in Class 5 soil (medium dense coarse sand and sandy gravels; stiff to very stiff and slays). When the anchor is installed in poorer soils, the holding power of the anchor must be derated by 25 percent in Class 6 soil, 50 percent in Class 7 soil. For Class 8 soil it is usually necessary to use power driven

screw anchors which can penetrate the poor soil into firmer soil. In areas of extremely high chemical activity of the soil, anchor rods and ground rods must be completely encased in concrete to point 100 mm 4 inches above finished grade. Anchors must be a special unit to be indicated.

****

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

2.10.1 Screw Anchors

****

NOTE: For NAVFAC LANT 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 A53/A53M, 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.

2.10.3 Rock Anchors

Rock anchors having a manufacturer's rating of [102,310][160,130] Newtons [23,000][36,000] pounds.

2.11 GROUNDING AND BONDING

2.11.1 Driven Ground Rods

****

NOTE: Use "copper-clad steel" ground rods for NAVFAC LANT projects.

****

Provide cone pointed [copper-clad steel ground rods conforming to UL 467][zinc-coated steel ground rods conforming to IEEE C135.30][solid stainless steel ground rods] not less than 19 mm 3/4 inch in diameter by 3.1 m 10 feet in length. Sectional type rods may be used for rods 6.1 m 20 feet or longer.

2.11.2 Grounding Conductors

ASTM B3. Provide soft drawn copper wire ground conductors a minimum No. 4 AWG. Ground wire protectors must be PVC. Keep ground conductors straight and short. Minimize bends in all ground connections.

2.11.3 Grounding Connections

UL 467. Exothermic weld or compression connector.

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, polymeric-housed, surge arresters arranged for [crossarm] [equipment] mounting. RMS voltage rating must be [3] [6] [9] [10] [12] [15] [27] [30] [36] kV. Arresters must be [Distribution] [Intermediate] [Station] class.

2.13 FUSED CUTOUTS

****

NOTE: For NAVFAC LANT projects, use "open type" cutouts with Type "K" fuses as indicated.

Provide IEEE C37.41 rated backup current limiting fuses in series with Type K (fast-acting) expulsion fuses on systems that are: greater than 15 kV; 15 kV and lower that have available fault currents equal to or greater than 7,000 asymmetrical amperes. Expulsion fuses and backup current limiting fuse must be properly coordinated with other protective devices on the system. Expulsion fuses will interrupt current in 0.01 second or greater. Backup current limiting fuse will interrupt current in less than 0.01 seconds. Existing systems must continue to use the expulsion fuse link type that represents the standard for that system.

****

[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 IEEE C37.42. [IEEE C37.41 rated backup current limiting fuses in series with Type K expulsion fuses.]Type [K] [T] fuses conforming to IEEE 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

The riser shield must 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 UNDERGROUND ELECTRICAL DISTRIBUTION.

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. Fully self-protected transformers must not be used.

****

a. IEEE C57.12.20.

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

c. Insulating liquid:

****

NOTE: Choose one of the following options. For the Navy, choose less-flammable transformer liquids for all projects unless there is a specific requirement to do otherwise.

****

[Mineral oil: ASTM D3487, Type II, tested in accordance with ASTM D117. Provide identification of transformer as "non-PCB" and "Type II mineral oil" on the nameplate.

][Less-flammable transformer liquids: NFPA 70 and FM APP GUIDE for less-flammable liquids having a fire point not less than 300 degrees C tested per ASTM D92 and a dielectric strength not less than 33 kV tested per ASTM D877/D877M. Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid on the nameplate.

The fluid must be a biodegradable electrical insulating and cooling liquid classified by UL and approved by FM as "less flammable fluids. The fluid must meet the following fluid properties:

(1) Pour point: ASTM D97, less than -15 degrees C

(2) Aquatic biodegradation: EPA 712-C-98-075, 100 percent.

(3) Trout toxicity: OECD Test 203, zero mortality of EPA 821-R-02-012, pass.

] 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 must 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 must be corrosion resistant and must be fabricated of stainless steel conforming to ASTM A240/A240M, Type 304 or 304L.]Paint coating system must comply with IEEE C57.12.28 regardless of tank and cover material. Finish coat must 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 Efficiencies

****

NOTE: Single phase transformer losses and efficiency requirements have been modified into the table included within the specification and the previous Navy loss tables have been deleted.

10 CFR 431, Subpart K is a result of the Energy Policy and Conservation Act (EPACT) of 2005 and is the "minimum" industry standard for distribution transformers manufactured on or after January 1, 2016.

****

Provide single phase transformer efficiency calculations utilizing the actual no-load and load loss values obtained during the routine tests performed on the actual transformer(s) prepared for this project. Reference no-load losses (NLL) at 20 degrees C. Reference load losses (LL) at 55 degrees C and at 50 percent of the nameplate load. The transformer is not acceptable if the calculated transformer efficiency is less than the efficiency indicated in the "KVA / Efficiency" table below. The table is based on requirements contained within 10 CFR 431, Subpart K, for a liquid-immersed distribution transformer. Submit certification, including supporting calculations, from the manufacturer indicating conformance.

kVA Single phase	EFFICIENCY (percent)
10	98.70
15	98.82
25	98.95
37.50	99.05
50	99.11
75	99.19

[2.16 GROUP-OPERATED LOAD INTERRUPTER SWITCHES

2.16.1 Manually Operated Type (Switch Handle Operated)

Manually operated (switch handle operated) load interrupter switches must comply with IEEE C37.30.1 and must be of the outdoor, manually-operated, three-pole, single-throw type with either tilting or rotating insulators. Switches must be equipped with interrupters capable of interrupting currents equal to the switch's continuous current rating. Each switch must be preassembled for the indicated configuration and mounting. Moving contacts must be of the high-pressure, limited-area type, designed to ensure continuous surface contact. Switches must be fused or non-fused as indicated. Switches must be complete with necessary operating mechanisms, handles, and other items required for manual operation from the ground. Switch operating handles must be located approximately 1.1 meters 3 feet 6 inches above final grade. Insulation of switch operating mechanisms must include both insulated interphase rod sections and insulated vertical shafts. Provide each handle must be provided with a padlock arranged to lock the switch in both the open and the closed position.

[2.16.2 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 must be rated in accordance with and comply with the requirements of IEEE C37.30.1 and must be of the outdoor, three-pole, [pole-mounted] [crossarm-mounted] type. Interrupter devices must be [air-insulated] [SF6-insulated, puffer-type] switches capable of interrupting currents equal to the switch continuous current ratings indicated. Switches must utilize an electric motor-charged, stored-energy (spring-driven) operator to simultaneously trip all phases. A switch-control unit must 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 must 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 must be provided by a battery mounted in the control unit enclosure. The switch control unit must 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 must be provided for a minimum of [_____] [four] sequential opening and closing operation without battery charging. The switch control unit must be configured for supervisory, control, and data acquisition (SCADA) function, including local and remote operation. Provide voltage and current sensors, one set for each phase, for monitoring of both normal and fault conditions. Provide switches with visual indication of open switch contact for clearance and isolation purposes. Provide switch mechanisms with provisions for grounding of nonenergized metal parts. Provide the switch control unit with a switch operations.

]][2.17 RECLOSER

****

NOTE: Manufacturers information or catalog information is required to edit this paragraph.

****

IEC 62271-111, IEEE C37.60. Operating temperature range of minus 40 degree C to 55 degree C. Paint the reclosure tank Munsell 5BG7.0/0.4 sky gray (ANSI 70), with paint coateing system compying with IEEE C57.12.31. The Munsell color notation is specified in ASTM D1535.

a. [Electronically] [Hydraulically] operated, in [air] [epoxy] [oil] insulating medium with [oil] [vacuum] interruption.

b. [Three-phase][Single-phase].

c. [15.5kV] [27kV] [38kV] maximum design voltage. [2.4kV] [4.8kV] [8.32kV] [14.4kV] [24.9kV] [34.5kV][_____] nominal operating voltage.

d. [100A] [200A] [400A] [600A] [800A] [1200A] [_____] continuous current.

e. [50] [60] hertz.

f. [8kA] [10kA] [12kA] [16kA] [20kA] [_____] interrupting rating, symmetrical.

g. [110] [125] [150] [170] kV BIL.

h. [Form 6][Form 4D] recloser control.

][2.18 SECTIONALIZER

****
NOTE: Manufacturers information or catalog information is required to edit this paragraph.
****

IEEE C37.63. Operating temperature range of minus 40 degree C to 55 degree C. Paint the reclosure tank Munsell 5BG7.0/0.4 sky gray (ANSI 70), with paint coateing system compying with IEEE C57.12.31. The Munsell color notation is specified in ASTM D1535.

a. [Electronically][Hydraulically] operated, oil-insulated.

b. Three-phase.

c. [15.5 kV] [27 kV] [38 kV] maximum design voltage. [2.4 kV] [4.8 kV] [8.32 kV] [14.4 kV] [24.9 kV][_____] nominal operating voltage.

d. 200 A continuous current. 440 A interrupting loadbreak current.

e. [50] [60] Hertz.

f. 9 kV maximum momentary and making current, asymmetrical.

g. [110] [125] [150] kV BIL.

][2.19 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 Activity.
****

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

2.19.1 Potential Transformers

Potential transformers must be rated for outdoor service fitted for crossarm mounting and secondary connection box for conduit connection. Voltage rating must be [2.4] [4.16] [7.2] [12.0] [12.47] [_____] kV to 120 volts ac, 60 Hz. Transformers must 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].

2.19.2 Current Transformers

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

2.19.3 Watthour Meter

Provide meter with provisions for future pulse initiation.

a. Meters: NEMA/ANSI C12.10 and ANSI 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: must 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 ANSI C12.7 with [manual] [automatic] current short-circulating device.]["A" base type mounting].

[2.19.4 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 must short circuit current supply before opening meter circuit. Switch handles of potential switches must be black. Switch handles of current switches must be red.

]2.19.5 Metering Enclosure

Metering enclosure must 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 must 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.

]2.20 CAPACITORS

IEEE 18. Operating temperature range of minus 40 degrees C to 46 degrees C. Provide capacitor tank fabricated of stainless steel conforming to ASTM A240/A240M, Type 409. Paint the capacitor tank Munsell 5BG7.0/0.4 sky gray (ANSI 70), with paint coating system complying with IEEE C57.12.31. The Munsell color notation is specified in ASTM D1535. Capacitor equipment must comply with IEEE 18 and must be of the three-phase, grounded-wye, outdoor type rated for continuous operation and automatically switched. Equipment must be suitable for mounting on a single pole. Polychlorinated biphenyl and tetrachloroethylene (perchloroethylene) must not be used as the dielectric. Equipment must be rated for the system voltage. The indicated kvars must 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]. Provide necessary transformers for sensing circuit variations and for low-voltage control. Provide oil-immersed switches for automatic switching of capacitors, and must be electrically separate from ungrounded capacitor enclosures and metal frames. Installations must include one primary fuse cutout and one surge arrester for each ungrounded phase conductor. Fuse link ratings must be in accordance with the manufacturer's recommendations. Capacitor equipment, except for low-voltage control and primary fuse cutouts, must be subassembled and coordinated by one manufacturer. Ship units, including metal pole-mounting supports and hardware, in complete sections ready for connection at the site. Low-voltage equipment must be socket or cabinet type, mounted on the pole approximately 1.2 m 4 feet above grade, must be connected with the necessary wiring in conduit to capacitor equipment, and must be provided with secondary arrester protection against switching surges when recommended by the manufacturer.

2.21 VOLTAGE REGULATOR

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

Voltage regulators must comply with IEEE C57.15 and must be of the outdoor, self-cooled, 55/65 degrees C temperature rise, single-phase type. Windings and the load-tap-changing mechanism must be mineral-oil-immersed. When operating under load, a regulator must 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 must provide Class 1 accuracy. Bypass surge arresters must be suitable for [a grounded] [an ungrounded] system and for the associated regulator voltage.[[Station][Intermediate] class surge arresters must 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].

2.21.1 Ratings

Ratings at 60 Hz must be

Maximum voltage.....[_____]

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

Current.....[_____]

2.21.2 Bypass and Isolation Switches

Switches must be of the outdoor, stickhook-operated, single-pole, single-throw, vertical-break type suitable for the indicated mounting. Switches must 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 must 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 must not be possible until after the bypass circuit is closed. Ratings at 60 Hz must 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.....[_____]

2.21.3 Miscellaneous

Standard accessories and components in accordance with IEEE C57.15 must be provided. Single-phase units must be provided with additional components and accessories required by IEEE C57.15 for three-phase units. Install regulator control approximately 1.5 m 5 feet from ground on field side of pole. Control cable must be properly shielded or installed in suitable conduit.

2.22 ELECTRICAL TAPES

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

2.23 CAULKING COMPOUND

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

2.24 NAMEPLATES

2.24.1 Manufacturer's Nameplate

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. Equipment containing liquid-dielectrics must have the type of dielectric on the nameplate.

2.24.2 Field Fabricated Nameplates

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription must identify the function and, when applicable, the position. Nameplates must be melamine plastic, 3 mm 0.125 inch thick, white with [black] [_____] center core. Surface must be matte finish. Corners must be square. Accurately align lettering and engrave into the core. Minimum size of nameplates must be 25 by 65 mm one by 2.5 inches. Lettering must be a minimum of 6.35 mm 0.25 inch high normal block style.

2.25 SOURCE QUALITY CONTROL

2.25.1 Transformer Test Schedule

The Government reserves the right to 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 must not exceed 12 months for both test floor instruments and leased specialty equipment.

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

(5) Calibrating standard must 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.

2.25.2 Routine and Other Tests

IEEE C57.12.00 and IEEE C57.12.90. Routine and other tests must 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 must 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 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 must be as indicated.

3.1.1 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 must be not less than [_____] meters feet above finished grade at building. Drip loops must be formed on conductors at entrances to buildings, cabinets, or conduits.

3.1.2 Tree Trimming

Where lines pass through trees, trees must be trimmed at least [4.5 meters 15 feet] [_____] clear on both sides horizontally and below for medium-voltage lines, and [1.5 meters5 feet] [_____] clear on both sides horizontally and below for other lines. No branch must overhang horizontal clearances. Where trees are indicated to be removed to provide a clear right-of-way, clearing is specified in Section 31 11 00 CLEARING AND GRUBBING.

3.1.3 Wood Pole Installation

****
NOTE: Include the bracketed sentence for projects where poles will be set in tropical areas including tropical areas of the Pacific Ocean, that are infested by the Formosan termite, coptotermes formosanus shirake. Delete it in other projects. Coordinate termiticide treatment, both chemical and application quantity selected, with the installation pest management coordinator.
****

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 [_____] liters gallons of a termiticide solution. Treatment requirements are specified in Section 31 31 16.13 Chemical Termite Control.]

3.1.3.1 Setting Depth of Pole

Pole setting depths must 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	1980	1370
15200	2130	1370
16720	2280	1520
18240	2440	1520

Length of Pole (mm)	Setting in Soil (mm)	Setting in Solid Rock (mm)
19810	2590	1675
21340	2740	1675
22860	2895	1825
24380	3050	1825
25910	3200	1980
27430	3350	1980
28950	3500	2130
30480	3810	2280

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
65	8.5	5.5
70	9.0	5.5
75	9.5	6.0
80	10.0	6.0
85	10.5	6.5
90	11.0	6.5

Length of Pole (feet)	Setting in Soil (feet)	Setting in Solid Rock (feet)
95	11.5	7.0
100	12.5	7.5

3.1.3.2 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 approximately 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 must be set 150 mm 6 inches deeper.]

3.1.3.3 Setting in Solid Rock

"Setting in Solid Rock," as specified in paragraph 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.

3.1.3.4 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 must be depth of soil in addition to depth specified under "Setting in Solid Rock" in paragraph SETTING DEPTH OF POLE, provided, however, that such depth must not exceed depth specified under "Setting in Soil."

3.1.3.5 Setting on Sloping Ground

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

3.1.3.6 Backfill

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

3.1.3.7 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 must 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 must be on opposite side of pole from gain, with flat side against pole.

3.1.3.8 Alignment of Poles

Set poles in alignment and plumb except at corners, terminals, angles, junctions, or other points of strain, where they must 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 must not vary more than 1525 mm 5 feet in height. When ground is uneven, poles differing in length must 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 must be sawed off the top. Holes must be dug large enough to permit the proper use of tampers to full depth of hole.

3.1.3.9 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.

3.1.4 Steel and Concrete Pole Setting

Poles must be mounted on cast-in-place or power-installed screw foundations. [Concrete poles must be embedded in accordance with the details indicated.] Provide conduit elbows for cable entrances into pole interiors.

3.1.4.1 Cast-In-Place Foundations

Concrete foundations, sized as indicated, must 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 CAST-IN-PLACE CONCRETE. After the concrete has cured, pole anchor bases must be set on foundations and leveled by shimming between anchor bases and foundations or by setting anchor bases on leveling nuts and grouting. Poles must be set plumb. Anchor bolts must be the manufacturer's standard, and not less than necessary to meet the pole wind loading specified herein and other design requirements.

3.1.4.2 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 must be of at least 6.4 mm 1/4 inch thick structural steel conforming to ASTM A36/A36M and hot-dip galvanized in accordance with ASTM A123/A123M. Mark conduit slots in screw foundation shafts and top plates to indicate orientation. Design calculations indicating adequate strength must be approved before installation of screw foundation is permitted.

3.1.5 Anchors and Guys

Place anchors in line with strain. Indicate the length of the guy lead

(distance from base of pole to the top of the anchor rod).

3.1.5.1 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.

3.1.5.2 Backfilling Near [Plate] Anchors

****

NOTE: If plate anchors are chosen, for NAVFAC LANT 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.

]3.1.5.3 Screw Anchors

Install screw anchors by torquing with boring machine.

3.1.5.4 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.

3.1.5.5 Rock Anchors

Install rock anchors minimum depth 305 mm 12 inches in solid rock.

3.1.5.6 Guy Installation

****

NOTE: Guy strand must be insulated or grounded in conformance with IEEE C2 or local practice.

A soil survey should be completed early in the design to properly select the type of anchor.

****

Provide guys where indicated, with loads and strengths as indicated, and wherever conductor tensions are not balanced, such as at angles, corners and dead-ends. Where single guy will not provide the required strength, provide two or more guys. Where guys are wrapped around poles, at least two guy hooks must be provided. Provide pole shims where guy tension exceeds 27,000 Newtons 6000 pounds. Provide guy clamps 152 mm 6 inches in length with three 16 mm 5/8 inch bolts, or offset-type guy clamps, or approved guy grips at each guy terminal. Securely clamp plastic guy marker to the guy or anchor at the bottom and top of marker.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.]

3.1.6 Hardware

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

3.1.7 Grounding

****
NOTE: For Army projects, the designer will specify the grounding configuration and the number and type of electrodes required. See TM 5-811-1 for guidance. Coordinate with NFPA 70 and IEEE C2.

Delete the bracketed sentence for Army projects.
****

Unless otherwise indicated, grounding must conform to IEEE C2 and NFPA 70.[Pole grounding electrodes must 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 must apply.]

3.1.7.1 Grounding Electrode Installation

****
NOTE: Modify and/or delete paragraphs in accordance with project requirements.

The designer should investigate the soil resistivity during the preliminary design phase to determine the design required to ensure that the grounding values are obtained. For areas where the water table is low and/or the soil resistivity is high (such as volcanic soils, sand, or rock), delete the additional electrode provisions and provide a design to meet the site requirements.
****

Install grounding electrodes as follows:

a. Driven rod electrodes - Unless otherwise indicated, locate ground rods approximately 900 mm 3 feet out from base of the pole and drive into the earth until the tops of the rods are approximately 300 mm one foot below finished grade. Evenly spaced multiple rods at least 3 m 10 feet apart and connected together 600 mm 2 feet below grade with a minimum No. 6 bare copper conductor.

b. Plate electrodes - Install plate electrodes in accordance with the manufacturer's instructions and IEEE C2 and NFPA 70.

****
NOTE: Use the following paragraph for Army projects only.
****

[c. Ground resistance - The maximum resistance of a [driven ground rod] [plate electrode] must not exceed 25 ohms under normally dry conditions. Whenever the required ground resistance is not met, provide additional electrodes [interconnected with grounding conductors] [as indicated], to achieve the specified ground resistance. The additional electrodes will be [up to three, [2.4] [3] m [8] [10] feet rods spaced a minimum of 3 m 10 feet apart] [a single extension-type rod, [15.9] [19.1] mm [5/8] [3/4] inch diameter, up to 9.1 m 30 feet long, [driven perpendicular to grade] [coupled and driven with the first rod]]. 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, notify the Contracting Officer immediately.

]3.1.7.2 Grounding Electrode Conductors

****
NOTE: If grounding details are provided on the drawings, delete the bracketed information.
****

[On multi-grounded circuits, as defined in IEEE C2, provide a single continuous vertical grounding electrode conductor. Bond neutrals, surge arresters, and equipment grounding conductors to this conductor. For single-grounded or ungrounded systems, provide a grounding electrode conductor for the surge arrester and equipment grounding conductors and a separate grounding electrode conductor for the secondary neutrals. Staple grounding electrode conductors to wood poles at intervals not exceeding 600 mm 2 feet. On metal poles, a preformed galvanized steel strap, 15.9 mm 5/8 inch wide by 0.853 22 gaugeminimum by length, secured by a preformed locking method standard with the manufacturer, must be used to support a grounding electrode conductor installation on the pole and spaced at intervals not exceeding 1.5 m 5 feet with one band not more than 75 mm 3 inches from each end of the vertical grounding electrode conductor.]Size grounding electrode conductors as indicated. Connect secondary system neutral conductors directly to the transformer neutral bushings, then connected with a neutral bonding jumper between the transformer neutral bushing and the vertical grounding electrode conductor as indicated. Bends greater than 45 degrees in grounding electrode conductor are not permitted.

3.1.7.3 Grounding Electrode Connections

Make above grade grounding connections on pole lines by exothermic weld or by using a compression connector. Make below grade grounding connections by exothermic weld. 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 must 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 must provide visible indication that a connector has been fully compressed on ground wire.

3.1.7.4 Grounding and Grounded Connections

a. Where no primary or common neutral exists, bond surge arresters and frames of equipment operating at over 750 volts together and connected

to a dedicated primary grounding electrode.

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

c. When a primary or common neutral exists, the neutral must be connected to a grounding electrode. Transformer secondary neutral bushing and frames of equipment operating at under 750 volts must be bonded together and connected to a common neutral and to a common grounding electrode.

3.1.7.5 Protective Molding

Protect grounding conductors which are run on surface of wood poles by PVC molding extending from ground line throughout communication and transformer spaces.

3.1.8 CONDUCTOR INSTALLATION

3.1.8.1 Line Conductors

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

[Unless otherwise indicated, install conductors in compliance with IEEE C2 Grade B requirements and in accordance with revised manufacturer's approved tables of sags and tensions.]Handle conductors 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 must 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 must not be less than the applicable NEMA specification recommendation. Conductors must not be drawn over rough or rocky ground, nor around sharp bends. When installed by machine power, conductors must be drawn from a mounted reel through stringing sheaves in straight lines clear of obstructions. Initial sag and tension must 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.

3.1.8.2 Connectors and Splices

Conductor splices, as installed, must exceed ultimate rated strength of conductor and must be of type recommended by conductor manufacturer. No splice must be permitted within 3050 mm 10 feet of a support. Connectors and splices must be mechanically and electrically secure under tension and must be of the nonbolted compression type. The tensile strength of any splice must be not less than the rated breaking strength of the conductor. Splice materials, sleeves, fittings, and connectors must be noncorrosive and must not adversely affect conductors. Aluminum-composition conductors must 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 must be of types recommended by the connector manufacturer. Primary line apparatus taps must be by means of hot line clamps attached to compression type bail clamps (stirrups). Low-voltage connectors for copper conductors must be of the solderless pressure type. Noninsulated connectors must 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 must be installed above the copper.

3.1.8.3 Conductor-To-Insulator Attachments

Conductors must 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 must be as specified in TABLE I.

TABLE I - 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

3.1.8.4 Armor Rods

Provide armor rods for AAC, AAAC, and ACSR conductors. Armor rods must 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 must 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 must 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 must 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 must be used.

3.1.8.5 Ties

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

3.1.8.6 Low-Voltage Insulated Cables

Support low-voltage cables on clevis fittings using spool insulators. Provide dead-end clevis fittings and suspensions insulators where required

for adequate strength. Dead-end construction must provide a strength exceeding the rated breaking strength of the neutral messenger. Provide clevis attachments with not less than 15.9 mm 5/8 inch through-bolts. Secondary racks may be used when installed on wood poles and where the span length does not exceed 61 m 200 feet. Secondary racks must be two-, three-, or four-wire, complete with spool insulators. Racks must meet strength and deflection requirements for heavy-duty steel racks, and must be rounded and smooth to avoid damage to conductor insulation. Each insulator must be held in place with a 15.9 mm 5/8 inch button-head bolt equipped with a nonferrous cotter pin, or equivalent, at the bottom. Attach racks for dead-ending four No. 4/0 AWG or four larger conductors to poles with three 15.9 mm 5/8 inch through-bolts. Attach other secondary racks to poles with at least two 15.9 mm 5/8 inch through-bolts. Minimum vertical spacing between conductors must not be less than 200 mm 8 inches.

3.1.8.7 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 must be indicated.
****

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

3.1.8.8 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 NAVFAC LANT 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.

3.1.8.9 Fittings

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

3.1.8.10 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.

[3.1.9 Pole Mounted Metering Equipment

3.1.9.1 Primary Meters

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

3.1.9.2 Installing Meter System

Metering enclosure must 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. Indicate phase sequence and color code of potential and current leads. 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. Train wire at sides and bottom of enclosure back board and secured by plastic wraps.

]3.1.10 Pole Top Switch Installation

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

3.1.10.1 Operating Handle

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

[3.1.11 Recloser

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

][3.1.12 Sectionalizer

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

]3.1.13 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.][Secure PVC riser shields on poles as indicated.]

3.2 TRANSFORMER INSTALLATION

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

Transformers must be carefully installed so as not to scratch finishes or damage bushings. Transformers must be installed in accordance with the manufacturer's instructions. After installation, surfaces must be inspected and scratches must 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. Refer to "Instructions to view/print graphics" for access to Navy plates.
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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); Migratory Bird Treaty of 1918 (16 U.S.C 703 et. seq.); IEEE 1651 IEEE Guide for Reducing Bird-Related Outages; and IEEE 1656 IEEE Guide for Testing the Electrical, Mechanical, and Durability Performance of Wildlife Protective Devices on Overhead Power Distribution Systems Rated up to 38 kV 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.
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Bolt crossarms to poles with 15.9 mm 5/8 inch through-bolts with square washers at each end. Extend bolts not less than 3 mm 1/8 inch nor more than 50 mm 2 inches beyond nuts. On single crossarm construction, install the bolt head on the crossarm side of the pole. [Fiberglass][Metal][Wood] crossarm braces must be provided on crossarms. Flat braces may be provided for 2.4 m 8 foot crossarms and must be 6.4 by 31.8 mm 1/4 by 1-1/4 inches, not less than 700 mm 28 inches in length. Bolt flat braces 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 must 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. Bolt angle braces 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 must 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

Set line arms and buck arms at right angles to lines for straight runs and for angles 45 degrees and greater; and line arms must bisect angles of turns of less than 45 degrees. Use dead-end assemblies for turns where shown. Install buck arms , as shown on the pole plate(s), at corners and junction poles. Provide double crossarms at ends of joint use or conflict sections, at dead-ends, and at angles and corners to provide adequate vertical and longitudinal strength. Provide double crossarms at each line-crossing structure and where lines not attached to the same pole cross each other.

3.3.2 Equipment Arms

Set equipment arms parallel or at right angles to lines as required to provide climbing space. Locate equipment arms below line construction to provide necessary wire and equipment clearances.

]3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting must be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.5 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.6 FIELD QUALITY CONTROL

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

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3.6.1 General

[Perform field testing in the presence of the Contracting Officer.]The Contractor must notify the Contracting Officer [_____] days prior to conducting tests. The Contractor must furnish materials, labor, and equipment necessary to conduct field tests. The Contractor must perform tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor must 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.

3.6.2 Safety

The Contractor must 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 must replace any devices or equipment which are damaged due to improper test procedures or handling.

3.6.3 Medium-Voltage Preassembled Cable Test

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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.

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After installation, prior to connection to an existing system, and before the operating test, the medium-voltage preassembled cable system must be given a high potential test. Apply direct-current voltage 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 must 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 must be in accordance with NEMA WC 74/ICEA S-93-639 for the particular type of cable installed, and must not exceed the recommendations of IEEE 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 must make necessary repairs or replace cables as directed. Repaired or replaced cables shall be retested.

3.6.4 Sag and Tension Test

The Contracting Officer must 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.

3.6.5 Low-Voltage Cable Test

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NOTE: The insulation resistance test (dielectric test) value is based on the recommendation contained in IEEE 525. Delete the cable test if no low voltage cables are in the project.

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For underground secondary or service laterals from overhead lines, the low-voltage cable, complete with splices, must 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 must 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 must 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)

Repair each cable failing this test or replace. The repaired cable must then be retested until failures have been eliminated.

3.6.6 Pre-Energization Services

Perform the following services on the equipment listed below. Perform these services subsequent to testing but prior to the initial energization. Inspect the equipment to insure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Inspect terminations of conductors at major equipment to ensure the adequacy of connections. Inspect bare and insulated conductors between such terminations to detect possible damage during installation. If factory tests were not performed on completed assemblies, perform tests after the installation of completed assemblies. Inspect components 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 must be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested must be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer. Items for which such services must be provided, but are not limited to, are the following:

Capacitors.

Switches.

3.6.7 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.

3.6.7.1 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

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

3.6.7.2 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.

[3.6.7.3 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. Test sample 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.

][3.6.7.4 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. Test sample 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.

][3.6.7.5 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.

][3.6.7.6 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.

][3.6.7.7 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.

]3.6.7.8 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 resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument

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.

(2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. 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.

3.6.8 Devices Subject to Manual Operation

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

3.6.9 Follow-Up Verification

Upon completion of acceptance checks and tests, the Contractor must show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function.

-- End of Section --