JOINT BASE LEWIS-McCHORD DESIGN STANDARDS
DIVISION 33 - UTILITIES

SECTION 33 71 01.00 40

OVERHEAD TRANSMISSION AND DISTRIBUTION

08/18

PART 1 GENERAL

1.1 REFERENCES

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

ALLIANCE FOR TELECOMMUNICATIONS INDUSTRY SOLUTIONS (ATIS)

ATIS O5.1	(2008) Wood Poles -- Specifications & Dimensions

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2008) Electric Meters Code for Electricity Metering
ANSI C135.14	(1979) Staples with Rolled or Slash Points for Overhead Line Construction

AMERICAN WOOD PRESERVERS ASSOCIATION (AWPA)

AWPA A3	(2015) Standard Method for Determining Penetration of Preservatives and Fire Retardants
AWPA C1	(2003) All Timber Products - Preservative Treatment by Pressure Processes
AWPA C25	(2003) Sawn Crossarms - Preservative Treatment by Pressure Processes
AWPA C4	(2003) Poles - Preservative Treatment by Pressure Processes
AWPA T1	(2017) Use Category System: Processing and Treatment Standard

ASME INTERNATIONAL (ASME)

ASME B16.11	(2016) Forged Fittings, Socket-Welding and Threaded

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 36/A 36M	(2014) Standard Specification for Carbon Structural Steel
ASTM A 475	(2003; R 2014) Standard Specification for Zinc-Coated Steel Wire Strand
ASTM A 53/A 53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 575	(1996; E 2013; R 2013) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A 576	(2017) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM B 1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B 117	(2016) Standing Practice for Operating Salt Spray (Fog) Apparatus
ASTM B 2	(2013) Standard Specification for Medium-Hard-Drawn Copper Wire
ASTM B 230/B 230M	(2007; R 2016) Standard Specification for Aluminum 1350-H19 Wire for Electrical Purposes
ASTM B 231/B 231M	(2012) Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors
ASTM B 232/B 232M	(2017) Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR)
ASTM B 3	(2013) Standard Specification for Soft or Annealed Copper Wire
ASTM B 398/B 398M	(2015) Standard Specification for Aluminum-Alloy 6201-T81 Wire for Electrical Purposes
ASTM B 399/B 399M	(2004; R 2015) Standard Specification for Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors

ASTM B 8	(2011; R 2017) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D 117	(2010) Standard Guide for Sampling, Test Methods, Specifications and Guide for Electrical Insulating Oils of Petroleum Origin
ASTM D 1625	(1971; R 2000) Standard Specifications for Chromated Copper Arsenate
ASTM D 1654	(2008; E 2016; R 2017) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 3487	(2016; E 2017) Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus
ASTM D 709	(2017) Laminated Thermosetting Materials
ASTM D 877	(2002; R 2007) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
ASTM D 92	(2012a) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D 97	(2017b) Pour Point of Petroleum Products

FM GLOBAL (FM)

FM P7825	(2005) Approval Guide

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 18	(2012) Standard for Shunt Power Capacitors
IEEE 404	(2012) Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V
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) Zinc-Coated Ferrous Pole-Top Insulator Pins with Lead Threads for Overhead Line Construction
IEEE C2	(2017) National Electrical Safety Code

IEEE C37.32	(2002) High-Voltage Switches, Bus Supports, and Accessories - Schedules of Preferred Ratings, Construction Guidelines and Specifications
IEEE C37.41	(2016; Corr 2017) Standard 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	(2015) General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.20	(2017) Standard for Overhead Type Distribution Transformers, 500 KVA and Smaller: High Voltage 34 500 Volts and Below: Low Voltage, 7970/13,800 Y Volts and Below
IEEE C57.12.28	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.90	(2015; Corr 2017) Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.13	(2016) Requirements for Instrument Transformers
IEEE C57.15	(2009) Standard Requirements, Terminology, and Test Code for Step-Voltage Regulators
IEEE C62.11	(2012) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2017; Errata 2017) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 62271-111	(2012; ED 2.0) High Voltage Switchgear And Control gear Part 111: Overhead, Pad-Mounted, Dry Vault, And Submersible Automatic Circuit Reclosers And Fault Interrupters For Alternating Current Systems Up To 38 kV

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C12.7	(2014) Requirements for Watthour Meter Sockets
NEMA C29.2	(2012) American National Standard for Insulators - Wet-Process Porcelain and Toughened Glass - Suspension Type
NEMA C29.3	(1986; R 2012) American National Standard for Wet Process Porcelain Insulators - Spool Type
NEMA C29.4	(1989; R 2012) Standard for Wet-Process Porcelain Insulators - Strain Type
NEMA C29.5	(1984; R 2002) Wet-Process Porcelain Insulators (Low and Medium Voltage Pin Type)
ANSI/NEMA WC 71/ICEA S-96-659	(2014) Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy
NEMA C135.4	(1987) Zinc-Coated Ferrous Eyebolts and Nuts for Overhead Line Construction
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA WC 70	(2009) Power Cable Rated 2000 V or Less for the Distribution of Electrical Energy--S95-658
NEMA WC 74/ICEA S-93-639	(2012) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy
NEMA/ANSI C12.10	(2011) Physical Aspects of Watthour Meters - Safety Standards
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	(2017) 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
RUS Bull 345-67	(1998) REA Specification for Filled Telephone Cables, PE-39

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-90/027F	(1993) Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms
EPA 712-C-98-075	(1998) Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation"

UNDERWRITERS LABORATORIES (UL)

UL 467	(2013; Reprint Jun 2017) Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2013; Reprint Jan 2016) Wire Connectors
UL 510	(2017) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 6	(2007; Reprint Nov 2014) Electrical Rigid Metal Conduit-Steel

1.2 DEFINITIONS

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

1.3 SUBMITTALS

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NOTE: If 01 33 29 is incorporated in the specifications, select that option below. If not, select the option for 01 57 19. Include items noted at SD-01 and SD-11 as applicable, based on project scope.
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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the [Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING][Environmental Records Binder, in conformance to Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS]. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Insulating Liquid (Biobased Content); S

SD-02 Shop Drawings

Connection Diagram; G

Fabrication Drawings; G

Installation Drawings; G

SD-03 Product Data

Conductors; G

Insulators; G

Concrete poles; G

Steel poles; G

Wood Poles FIO

Nameplates; G

Pole top switch; G

Recloser; G

Sectionalizer; G

Cutouts; G

Transformer; G

Metering Equipment; G

Meters; G

Surge arresters; G

Guy strand FIO

Anchors FIO

SD-05 Design Data

Concrete poles Design; G

Steel poles Design; G

Power-Installed Screw Foundations; G

SD-06 Test Reports

Wood Crossarm Inspection Report; G

Field Test Plan; G

Field Quality Control; G

Ground resistance test reports; G

SD-07 Certificates

Concrete poles; G

Steel poles; G

Wood poles; G

Wood Crossarms; G

Transformer Losses; G

SD-09 Manufacturer's Field Reports

Overhead-type distribution transformer routine and other tests; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals, Data Package 5; G

SD-11 Closeout Submittals

Transformer test schedule; G

Insulating Liquid (Biobased Content); S

1.4 QUALITY ASSURANCE

1.4.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" 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.

1.4.2 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 shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall 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.

1.4.2.1 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.

1.4.2.2 Material and Equipment Manufacturing Date

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

1.4.3 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.

1.4.4 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.

1.4.4.1 Field Test Plan

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

1.5 MAINTENANCE

1.5.1 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

1.6 DELIVERY, STORAGE, AND HANDLING

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

transformers and switches shall be stored in accordance with the manufacturer's requirements. Wood poles held in storage for more than 2 weeks shall be stored in accordance with ATIS O5.1. Handling of wood poles shall be in accordance with ATIS O5.1, except that pointed tools capable of producing indentations more than inch in depth shall not be used. Nails and holes are not permitted in top of poles. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

1.7 WARRANTY

The equipment items shall 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

Consider materials specified herein or shown on contract drawings which are identical to materials listed in RUS 202-1 as conforming to requirements. Equipment and component items, not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 120 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch (1.6 mm)from the test mark. The described test mark and test evaluation shall be in accordance with ASTM D 1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

2.2 POLES

Poles shall be of lengths and classes or strengths indicated.

2.2.1 Wood Poles

Wood poles machine trimmed by turning, Douglas Fir, Western Larch or Western Red Cedar conforming to ATIS O5.1 and RUS Bull 1728F-700. Gain, bore and roof poles before treatment. Should additional gains be required subsequent to treatment, metal gain plates shall be provided. Pressure treat poles with chromated copper arsenate (CCA), except that Douglas Fir and Western Larch poles shall not be treated with CCA in accordance with AWPA C1, AWPA C4 and AWPA T1 as referenced in RUS Bull 1728F-700. The quality of each pole shall be ensured with "WQC" (wood quality control) brand on each piece, or by an approved inspection agency report.

Per Army Regulation 200-1, use chemical treatments that are non-toxic or as least toxic as feasible.

2.2.1.1 Preservative

For preservative used for humid, harsh environment, provide Chromated Copper Arsenate type (A)(B)(C) conforming to AWPA T1 and ASTM D1625.
Treat wood poles with waterborne preservatives conforming to AWPA T1

2.2.1.2 Preservative Application

Apply preservative treatment using a pressure process conforming to and AWPA T1 for Southern Pine. Determine penetration of preservatives as specified in AWPA A3 and obtain complete sapwood penetration. Before treatment, roof, gain and bore poles that are to be given a full-length preservative treatment. Plug unused holes in poles with treated wood-dowel pins. Treat field-cut gains or field-bored holes in poles with an approved preservative compound.

2.2.1.3 Storage

For poles stored for any reason more than 2 weeks, stack them on pressure treated or decay-resistant skids of such dimensions and so arranged as to support the poles without producing noticeable distortion. Stack poles in a manner that permits free circulation of air; with the bottom poles of the stacks at least 1-foot above ground level or any vegetation growing thereon. No decayed or decaying wood is permitted to remain underneath stored poles.

2.2.1.4 Handling

Do not drag treated poles along the ground. Do not use pole tongs, cant hooks, and other pointed tools capable of producing indentations more than 1 inch in depth, in handling the poles. Do not apply tools to the groundline section of any pole. Groundline section is that portion between 1 foot above and 2 feet below the ground line.

2.2.2 Steel Poles

Steel poles shall be designed to withstand the loads specified in IEEE C2 multiplied by the appropriate overload capacity factors, shall be hot-dip galvanized in accordance with ASTM A 123/A 123M and shall not be painted. Poles shall have tapered tubular members, either round in cross-section or polygonal, and comply with strength calculations performed by a registered professional engineer. Calculations shall be submitted in accordance with the design data portion of paragraph entitled "SUBMITTALS." Provide certification, from the manufacturer, that the technical requirements of this specification shall be met. Pole shafts shall be one piece. Poles shall be welded construction with no bolts, rivets, or other means of fastening except as specifically approved. Pole markings shall be approximately 3 to 4 feet above grade and shall include manufacturer, year of manufacture, top and bottom diameters, length, and a loading tree. Attachment requirements shall be provided as indicated, including grounding provisions. Climbing facilities are not required. Bases shall be of the anchor-bolt-mounted type.

2.2.3 Concrete Poles

Concrete poles shall be designed to withstand the loads specified in IEEE C2 multiplied by the appropriate overload capacity factors. Poles shall be reinforced or prestressed, either cast or spun. Spun poles shall be manufactured by a centrifugal spinning process with concrete pumped into a polished round tapered metal mold. Concrete for spun poles shall have a compressive strength of at least 5000 psi at 28 days; steel wire shall have an ultimate tensile strength of at least 120,000 psi; and reinforcing bars shall have an ultimate tensile strength of at least 40,000 psi. After the high speed spinning action is completed, a spun pole shall be cured by a suitable wet steam process. Spun poles shall have a water absorption of not

greater than three percent to eliminate cracking and to prevent erosion. Concrete poles shall have hollow shafts. Poles shall have a hard, smooth, nonporous surface that is resistant to soil acids, road salts, and attacks of water and frost. Poles shall not be installed for at least 15 days after manufacture. Fittings and brackets that conform to the concrete pole design shall be provided. Poles shall conform to strength calculations performed by a registered professional engineer and submitted in accordance with design data portion of paragraph entitled "SUBMITTALS." Provide certification, from the manufacturer, that the technical requirements of this specification shall be met.

2.3 CROSSARMS AND BRACKETS

2.3.1 Wood Crossarms

Conform to RUS Bull 1728H-701. Pressure treat crossarms with chromated copper arsenate. Treatment shall conform to AWPA C25. Crossarms shall be solid wood, distribution type, and a 1/4 inch 45 degree chamfer on all top edges. Cross-sectional area minimum dimensions shall be 4-1/4 inches in height by 3-1/4 inches in depth in accordance with IEEE C2 for Grade B construction. Crossarms (Single feeder) shall be 9 feet in length for 4/0 ACSR or Smaller and 10’-8” for 336.4 ACSR. Crossarms (Double feeders) shall be minimum 14 feet for 336.4 ACSR. Crossarms shall be machined, chamfered, trimmed, and bored for stud and bolt holes before pressure treatment. Factory drilling shall be provided for pole and brace mounting, for four pin or four vertical line-post insulators, and for four suspension insulators, except where otherwise indicated or required. Drilling shall provide required climbing space and wire clearances. Crossarms shall be straight and free of twists to within 1/10 inch per foot of length. Bend or twist shall be in one direction only.

Per Army Regulation 200-1, use chemical treatments that are non-toxic or as least toxic as feasible.

2.3.2 Crossarm Braces

Provide flat steel or steel angle as indicated. Provide 28” flat braces (with 38” span) for arms 9 feet or shorter. Provide angle braces with 60 inch span for 10’-8” foot crossarms.

2.3.3 Armless Construction

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

2.4 HARDWARE

Hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M and ASTM A 123/A 123M.
Zinc-coated hardware shall comply with IEEE C135.1, IEEE C135.2, NEMA C135.4, ANSI C135.14 IEEE C135.22. Steel hardware shall comply with ASTM A 575 and ASTM A 576. Pole-line hardware shall be hot-dip galvanized steel. Washers shall be installed under bolt heads and nuts on wood surfaces and elsewhere as required. Washers used on through-bolts and double-arming bolts shall be approximately 2-1/4 inches square and 3/16 inch thick, except 3" square washers shall be used on crossarn center bolt where attached to pole. The diameter of holes in washers shall be the correct standard size for the bolt on which a washer is used. Washers for use under heads of carriage-bolts shall be of the proper size to fit over square shanks of bolts. Eye bolts, bolt eyes, eyenuts, strain-load plates, lag screws, guy clamps, fasteners, hooks, shims, and clevises shall be used wherever required to support and to protect poles, brackets, crossarms, guy wires, and insulators.

2.5 INSULATORS

Provide polymer insulators.

a. Line post type insulators: NEMA C29.7, Class as stated in the Delivery or Task Order.

b. Suspension insulators: NEMA C29.2, Quantity per Phase and Class as stated in the Delivery or Task Order.

c. Spool insulators: ANSI/NEMA C29.3, Class 53-2 or as stated in the Delivery or Task Order.

d. Guy strain insulators: NEMA C29.4, ANSI Class 54-2 or as stated in the Delivery or Task Order, except provide fiberglass type when used with underground terminal or when other interference problems exist.

e. Pin insulators: NEMA C29.5, ANSI Class 55-3 or as stated in the Delivery or Task Order.

f. Dead-End insulators: NEMA C29.2, ANSI Class DS-15 or as stated in the delivery task order.

2.6 OVERHEAD CONDUCTORS, CONNECTORS AND SPLICES

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

2.6.1 Solid Copper

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

2.6.2 Aluminum (AAC)

ASTM B 230/B 230M and ASTM B 231/B 231M.

2.6.3 Aluminum Alloy (AAAC)

ASTM B 398/B 398M or ASTM B 399/B 399M.

2.6.4 Aluminum Conductor Steel Reinforced (ACSR)

ASTM B 232/B 232M, aluminum.

2.6.5 Connectors and Splices

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

2.7 NEUTRAL-SUPPORTED SECONDARY AND SERVICE DROP CABLES (TRIPLEX, QUADPLEX)

Service and secondary cables shall be aluminum with cross-linked polyethylene insulation on the phase conductors. Neutral shall be bare hard drawn copper and shall be the same size as the phase conductors unless otherwise indicated. Cables shall conform to NEMA WC 70 and ANSI/MEMA WC 71/ICEA S-96-659 for cross-linked polyethylene insulation.

2.8 GUY STRAND

Galvanized steel wire strand per ASTM A475 class A or B, Grade EHS with a minimum breaking strength of 15,400 lbs for 3/8" Strand and 20,800 lbs for 7/16" Strand. 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, yellow colored, 8 feet long and shatter resistant at sub-zero temperatures.

2.9.1 Guy Attachment

Tripleye guy attachment at anchor and Guy Hooks or "Rams Head" with ¾"Ø bolt with 3" Square Curved Washer to attach to pole. Only "Span Guys" may use thimble eyes to attach to pole.

2.10 ANCHORS AND ANCHOR RODS

Anchors shall present holding area indicated on drawings as a minimum. Anchor rods shall be triple thimble-eye, 3/4 inch diameter by 7 feet long for screw in helical anchors and 8 feet for forged eye rods used with plate anchors. Anchors and anchor rods shall be hot dip galvanized.

2.10.1 Screw Anchors

Heleical screw in anchors shall be a minimum of 10" diameter and have a minimum torque rating of 10,000 FT-LB with 2-1/4" (small) or 2-1/2" (large) square hub.

2.10.2 Plate Anchors

Minimum area and manufacturer's rating as stated in the Delivery or Task Order, 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 23,000 pounds (102,310 Newtons).

2.11 GROUNDING AND BONDING

2.11.1 Driven Ground Rods

Provide copper-clad steel ground rods conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length. Sectional type rods may be used for rods 20 feet or longer.

2.11.2 Grounding Conductors

ASTM B 8. Provide soft drawn copper wire ground conductors a minimum No. 4 AWG. Ground wire protectors shall be PVC.

2.11.3 Grounding Connections

UL 467. Exothermic weld or compression connector (ONLY at Test Well, installed with 12 ton press, minimum).

2.12 SURGE ARRESTERS

IEEE C62.11, metal oxide, polymeric-housed, surge arresters arranged for crossarm or equipment mounting as stated in the Delivery or Task Order. 15 kV RMS voltage rating shall be suitable for the installation. Arresters shall be Distribution class.

2.13 FUSED CUTOUTS

Enclosed type fused cutouts in ratings and types as stated in the Delivery or Task Order, conforming to IEEE C37.42. Open link type fuse cutouts are not acceptable.

2.14 CONDUIT RISERS AND CONDUCTORS

The riser shield shall be PVC containing a PVC back plate and PVC extension shield or a rigid galvanized steel conduit, as indicated, and conforming to UL 6. Provide conductors and terminations as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION SYSTEM.

2.15 TRANSFORMER (OVERHEAD-TYPE DISTRIBUTION)

a. IEEE C57.12.20.

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

c. Insulating liquid:

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NOTE: If 01 33 29 is incorporated in the specifications, select that

option below. If not, select the option for 01 57 19.
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Provide products and documentation in accordance with Section [01 33 29 SUSTAINABILITY REPORTING][01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS] paragraph BIO-BASED PRODUCTS. For more information see https://sftool.gov/greenprocurement/green-products/8/miscellaneous/100/fluid-filled-transformers/0 and https://www.biopreferred.gov/BioPreferred/.

Mineral oil: ASTM D 3487, Type II, tested in accordance with ASTM D 117. Provide identification of transformer as "non-PCB" and "Type II mineral oil" on the nameplate.

Less-flammable transformer liquids: NFPA 70 and FM P7825 for less-flammable liquids having a fire point not less than 300 degrees C tested per ASTM D 92 and a dielectric strength not less than 33 kV tested per ASTM D 877 and ASTM D1816. Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid on the nameplate.

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

(1) Pour point: ASTM D 97, less than - 10 degrees C

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

(3) Trout toxicity: OECD Test 203, zero mortality of EPA 600/4-90/027F, pass.

d. Ratings: As stated in the RFP, SOW, Delivery or Task Order.

e. Single-phase connections: As stated in the RFP, SOW, Delivery or Task Order.

f. Three-phase connections: As stated in the RFP, SOW, Delivery or Task Order.

g. Taps:

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

i. Corrosion Protection:

Provide transformer tanks and covers that are corrosion resistant and are fabricated of stainless steel conforming to ASTM A167, Type 304 or 304L.] Provide paint coating system that complies with IEEE C57.12.28 regardless of tank and cover material. Provide light gray, ANSI color No. 70 finish coat.

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

2.16 GROUP-OPERATED LOAD INTERRUPTER SWITCHES

2.16.1 Manually Operated Type (Switch Handle Operated)

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

2.16.2 REMOTELY OPERATED TYPE (STORED-ENERGY ACTUATOR)

Provide remotely-operated, [air-insulated] [SF6 insulated] load interrupter switches that are rated in accordance with and comply with the requirements of IEEE C37.32 and are of the outdoor, three-pole, pole-mounted type. Provide interrupter devices that are SF6-insulated, puffer-type switches capable of interrupting currents equal to the switch continuous current ratings indicated. Provide switches that utilize an electric motor-charged, stored-energy (spring-driven) operator to simultaneously trip all phases. Provide a switch-control unit for push-button operation from the ground and remote switch actuation via telemetry. Provide a switch-control unit that is pad-lockable, tamper-resistant, in a NEMA ICS 6, Type 3R enclosure, which is connected to the switch actuator by a shielded control cable. Provide control power for closing and tripping by a battery mounted in the control unit enclosure. Provide the switch control unit with a separate 120 volt ac circuit for the battery powered. Power for charging the operator mechanism is 120 volt ac or battery powered. If operator mechanism charging power is from a battery, provide capacity for a minimum of four sequential opening and closing operation without battery charging. Configure the switch control unit 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 non-energized metal parts. Provide the switch control unit with switch operations.

2.17 RECLOSER

IEC 62271-111. Recloser controller shall be hydraulically operated and utilize oil operating medium.

2.18 SECTIONALIZER

Install sectionalizer(s) strictly in accordance with manufacturer's instructions.
IEEE C37.63.

2.19 CAPACITORS

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

2.20 VOLTAGE REGULATOR

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

2.20.1 Ratings

Ratings at 60 Hz shall be

Maximum voltage.....As stated in the Delivery or Task Order

Basic Insulation Level (BIL).....95

Current.....As stated in the Delivery or Task Order

2.20.2 Bypass and Isolation Switches

Switches shall be of the outdoor, stickhook-operated, single-pole, single-throw, vertical-break type suitable for the indicated mounting. Switches shall be of a type designed to provide bypass of a single-phase regulator circuit by an integral sequence which always occurs when each switch is opened or closed. Each opening sequence shall initially bypass the single-phase regulator circuit, then open the input and output circuits, and finally interrupt the exciting current. Opening any single-phase regulator

circuit shall not be possible until after the bypass circuit is closed. Ratings at 60 Hz shall be in accordance with IEEE C37.41 and as stated.

2.20.3 Miscellaneous

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

2.21 ELECTRICAL TAPES

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

2.22 CALKING COMPOUND

Provide compound for sealing of conduit risers that is of a puttylike consistency workable with hands at temperatures as low as 35 degrees F, that does not slump at a temperature of 300 degrees F, and that does not harden materially when exposed to air. Provide compound that readily caulks or adheres to clean surfaces of the materials with which it is designed to be used. Provide compound that has no injurious effects upon the workmen or upon the materials.

2.23 NAMEPLATES

2.23.1 Manufacturer's Nameplate

Each item of equipment shall 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 shall have the type of dielectric on the nameplate.

2.23.2 Field Fabricated Nameplates

ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, .0625 (1/16")inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

2.24 SOURCE QUALITY CONTROL

2.24.1 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 shall not exceed 12 months for both test floor instruments and leased specialty equipment.

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

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

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

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

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

2.24.2 Medium-Voltage Preassembled Cable Test

After installation, prior to connection to an existing system, and before the operating test, give the medium-voltage preassembled cable system 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, isolate the cables by opening applicable protective devices and disconnecting equipment. Provide the method, voltage, length of time, and other characteristics of the test for initial installation in accordance with NEMA WC 74/ICEA S-93-639 for the particular type of cable installed, and do not exceed the recommendations of IEEE 404 for cable joints unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. For any cable that fails 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, make necessary repairs or replace cables as directed. Retest repaired or replaced cables.

2.24.3 Sag and Tension Test

Give the Contracting Officer prior notice of the time schedule for stringing conductors or cables serving overhead medium-voltage circuits. The Contracting Officer 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.

2.24.4 Low-Voltage Cable Test

For underground secondary or service laterals from overhead lines, provide the low-voltage cable, complete with splices, that is tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The 500 volts dc test voltage, 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. Provide insulation with a minimum value of:

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 or replace each cable failing this test. Retest the repaired cable then until failures have been eliminated.

2.24.5 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. Provide components capable of being both manually and electrically operated that are operated manually prior to the first electrical operation. Provide components capable of being calibrated, adjusted, and tested and calibrate, adjust and test in accordance with the instructions of the equipment manufacturer. Items for which such services are provided, but are not limited to, are the following:

a. Capacitors

b. Switches

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.

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
(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] [_____].

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.

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.

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.

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.

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.

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.

Grounding System

a. Visual and mechanical inspection
(1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests
(1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. Provide an instrument that is 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.

Devices Subject to Manual Operation

Operate each device subject to manual operation at least three times, demonstrating satisfactory operation each time.

Follow-Up Verification

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

2.24.6 Routine and Other Tests

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

a. Polarity

b. Ratio

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

d. Load losses (LL) and impedance voltage

e. Dielectric

(1) Impulse
(2) Applied voltage
(3) Induced voltage

f. Leak

PART 3 EXECUTION

3.1 INSTALLATION

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

3.1.1 Overhead Service

Terminate overhead service conductors into buildings at service entrance fittings or weatherhead outside building. Installation and connection of service entrance equipment to overhead service conductor is included in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Nearby support bracket for overhead wires shall comply with NFPA 70 at building. Drip loops shall be formed on conductors at entrances to buildings, cabinets, or conduits.

3.1.2 Tree Trimming

Where lines pass through trees, trees shall be trimmed at least 15 feet clear on both sides horizontally and below for medium-voltage lines, and 5 feet clear on both sides horizontally and below for other lines. No branch shall overhang horizontal clearances. Where trees are indicated to be removed to provide a clear right-of-way, clearing is specified in Section 31 11 00 CLEARING AND GRUBBING.

3.1.3 Wood Pole Installation

Provide pole holes at least as large at the top as at the bottom and large enough to provide 4 inch clearance between the pole and side of the hole.

3.1.3.1 Setting Depth of Pole

Pole setting depths shall be as follows:

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
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 2 feet deep;

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

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

3.1.3.3 Setting in Solid Rock

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

3.1.3.4 Setting With Soil Over Solid Rock

Where a layer of soil 2 feet or less in depth over solid rock exists, depth of hole shall be depth of soil in addition to depth specified under "Setting in Solid Rock" in paragraph entitled "Setting Depth of Pole," provided, however, that such depth shall not exceed depth specified under "Setting in Soil."

3.1.3.5 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 shall be on side facing terminal or dead end. On unusually long spans, set poles so that crossarm comes on side of pole away from long span. Where pole top pins are used, they shall be on opposite side of pole from gain, with flat side against pole.

3.1.3.8 Alignment of Poles

Set poles in alignment and plumb except at corners, terminals, angles, junctions, or other points of strain, where they shall be set and raked against the strain. Set not less than 2 inches for each 10 feet of pole length above grade, nor more than 4 inches for each 10 feet of pole length

after conductors are installed at required tension. When average ground run is level, consecutive poles shall not vary more than 5 feet in height. When ground is uneven, poles differing in length shall be kept to a minimum by locating poles to avoid the highest and lowest ground points. If it becomes necessary to shorten a pole, a piece shall be sawed off the top. Holes shall be dug large enough to permit the proper use of tampers to full depth of hole.

3.1.3.9 Pole Caps

Provide plastic pole caps with 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 1 1/4 inch nail.

3.1.4 Steel and Concrete Pole Setting

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

3.1.4.1 Cast-In-Place Foundations

Concrete foundations, sized as indicated, shall have anchor bolts accurately set in foundations using templates supplied by the pole manufacturer. Concrete work and grouting is specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. After the concrete has cured, pole anchor bases shall be set on foundations and leveled by shimming between anchor bases and foundations or by setting anchor bases on leveling nuts and grouting. Poles shall be set plumb. Anchor bolts shall be the manufacturer's standard, and not less than necessary to meet the pole wind loading specified herein and other design requirements.

3.1.4.2 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 shall be of at least 1/4 inch thick structural steel conforming to ASTM A 36/A 36M and hot-dip galvanized in accordance with ASTM A 123/A 123M. Conduit slots in screw foundation shafts and top plates shall be marked to indicate orientation. Design calculations indicating adequate strength shall be approved before installation of screw foundation is permitted. Calculations shall be submitted in accordance with the design data portion of paragraph entitled "SUBMITTALS."

3.1.5 Anchors and Guys

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

3.1.5.1 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 6 to 9 inches out of ground to prevent burial of rod eye.

3.1.5.2 Backfilling Near Anchors

Backfill plate, expanding, concrete, or cone type anchors with tightly tamped coarse rock 2 feet immediately above anchor and then with tightly tamped earth filling remainder 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 12 inches in solid rock.

3.1.5.6 Guy Installation

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, two or more guys shall be provided. Terminate top of gut on guy hook with ¾" bolt and 3" Square curved washer on back. Preforme Guy-Grip Dead-Ends or "Universal" Grade Automatic Strandvise or other approved guy grips shall be provided 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. Re-tighten guy after initial wire stringing if necessary.

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 shall be M-F style and not palnut style.

3.1.7 Grounding

Unless otherwise indicated, grounding shall conform to IEEE C2 and NFPA 70.

3.1.7.1 Grounding Electrode Installation

Grounding electrodes shall be installed as follows:

a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be located approximately 3 feet out from base of the pole and shall be driven into the earth until the tops of the rods are approximately 1 foot below finished grade. Multiple rods shall be evenly spaced at least 10 feet apart and connected together 2 feet below grade with a minimum No. 4 bare copper conductor.

b. Plate electrodes - Plate electrodes shall be installed in accordance with the manufacturer's instructions and IEEE C2 and NFPA 70.

c. Ground resistance - The maximum resistance of a driven ground rod or plate electrode shall not exceed 25 ohms under normally dry conditions. Whenever the required ground resistance is not met, provide additional electrodes interconnected with grounding conductors or as indicated to achieve the specified ground resistance. The additional electrodes will be up to three, 10 foot rods spaced a minimum of 10 feet apart. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer immediately.

3.1.7.2 Grounding Electrode Conductors

On multi-grounded circuits, as defined in IEEE C2, provide a single continuous vertical grounding electrode conductor. Neutrals, surge arresters, and equipment grounding conductors shall be bonded to this conductor. 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. Grounding electrode conductors shall be stapled to wood poles at intervals not exceeding 2 feet. On metal poles, a preformed galvanized steel strap, 5/8 inch wide by 22 gauge minimum by length, secured by a preformed locking method standard with the manufacturer, shall be used to support a grounding electrode conductor installation on the pole and spaced at intervals not exceeding 5 feet with one band not more than 3 inches from each end of the vertical grounding electrode conductor. Grounding electrode conductors shall be sized as indicated. Secondary system neutral conductors shall be connected 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 or compression connector. Make exothermic welds strictly in accordance with manufacturer's written recommendations. Welds which have puffed up or which show convex surfaces indicating improper cleaning, are not acceptable. No mechanical connectors are required at exothermic weldments. Compression connectors shall be type that uses a 12 ton hydraulic compression tool to provide correct pressure. Provide tools and dies recommended by compression connector manufacturer. An embossing die code or similar method shall provide visible indication that a connector has been fully compressed on ground wire.

3.1.7.4 Grounding and Grounded Connections

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

b. Where no primary or common neutral exists, transformer secondary neutral bushing, secondary neutral conductor, shall be bonded together and connected to a dedicated secondary grounding electrode.

3.1.7.5 Protective Molding

Protect grounding conductors which are run on surface of wood poles by PVC molding extending to 8 feet above ground line.

3.1.8 CONDUCTOR INSTALLATION

3.1.8.1 Line Conductors

Unless otherwise indicated, conductors shall be installed in accordance with manufacturer's approved tables of sags and tensions or Tacoma Power (TPU) Sag & Tension Tables A-OH-0001 through A-OH-0014. Conductors shall be handled with care necessary to prevent nicking, kinking, gouging, abrasions, sharp bends, cuts, flattening, or otherwise deforming or weakening conductor or any damage to insulation or impairing its conductivity. Remove damaged sections of conductor and splice conductor. Bend radius for any insulated conductor shall not be less than the applicable NEMA specification recommendation. Conductors shall not be drawn over rough or rocky ground, nor around sharp bends. When installed by machine power, conductors shall be drawn from a mounted reel through stringing sheaves in straight lines clear of obstructions. Initial sag and tension shall be checked by the Contractor, in accordance with the manufacturer's approved sag and tension charts, within an elapsed time after installation as recommended by the manufacturer.

3.1.8.2 Connectors and Splices

Conductor splices, as installed, shall exceed ultimate rated strength of conductor and shall be of type recommended by conductor manufacturer. No splice shall be permitted within 10 feet of a support. Splices shall be mechanically and electrically secure under tension and shall be of the nonbolted compression type. The tensile strength of any splice shall be not less than the rated breaking strength of the conductor. Splice materials, sleeves, fittings, and connectors shall be noncorrosive and shall not adversely affect conductors. Aluminum-composition conductors shall be wire brushed and an oxide inhibitor applied before making a compression connection. Connectors which are factory-filled with an inhibitor are acceptable. Inhibitors and compression tools shall be of types recommended by the connector manufacturer. Primary line apparatus taps shall be by means of hot line clamps attached to mechanical type bail clamps (stirrups). Low-voltage connectors for copper conductors shall be of the solderless pressure type. Noninsulated connectors shall be smoothly taped to provide a waterproof insulation equivalent to the original insulation, when installed on insulated conductors. On overhead connections of aluminum and copper, the aluminum shall be installed above the copper.

3.1.8.3 Conductor-To-Insulator Attachments

Conductors shall be attached to insulators by means of clamps, shoes or tie wires, in accordance with the type of insulator. For insulators requiring conductor tie-wire attachments, tie-wire sizes shall be as 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)**
#4 through 1/0	6
2/0 and Larger	4

3.1.8.4 Armor Rods

Armor rods shall be provided for AAC, AAAC, and ACSR conductors for angles over 10 degrees, long spans where the weight of wire will cause crushing at insulator or areas where vibration is historically a problem. Armor rods shall be installed at supports, except armor rods will not be required at primary dead-end assemblies if aluminum or aluminum-lined zinc-coated steel clamps are used. Lengths and methods of fastening armor rods shall be in accordance with the manufacturer's recommendations. For span lengths of less than 200 feet, flat aluminum armor rods may be used. Flat armor rods, not less than 0.03 by 0.25 inch shall be used on No. 1 AWG AAC and AAAC and smaller conductors and on No. 5 AWG ACSR and smaller conductors. On larger sizes, flat armor rods shall be not less than 0.05 by 0.30 inches. For span lengths of 200 feet or more, preformed round armor rods shall 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

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

3.1.8.7 Reinstalling Conductors

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

3.1.8.8 New Conductor Installation

String new conductors to "initial" sag table values recommended by the manufacturer or Tacoma Power (TPU) Sag & Tension Tables A-OH-0001 through A-OH-0014 for conductor type and size of conductor and ruling span indicated.

3.1.8.9 Fittings

Dead end fittings shall conform to written recommendations of conductor manufacturer and shall 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 Top Switch Installation

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

3.1.9.1 Operating Handle

Locate approximately 3’-6” above ground on field side of pole.

3.1.10 Recloser

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

3.1.11 Sectionalizer

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

3.1.12 Risers

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

3.2 TRANSFORMER INSTALLATION

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

3.3 CROSSARM MOUNTING

Crossarms shall be bolted to poles with 5/8 inch through-bolts (for single arms) or DA bolts (for Double Arms) with square washers at each end for 9 foot long, or less crossarms. 3/4 inch through bolts (for single arms) or DA Bolts for Double Arms) with 3” square washers shall be used for heavy 10’-8” arms used with 336.4 ACSR conductor and larger. Bolts shall extend not less than 1/8 inch nor more than 2 inches beyond nuts. On single

crossarm construction, the bolt head shall be installed on the crossarm side of the pole. Fiberglass, Metal or Wood crossarm braces shall be provided on crossarms. Flat braces may be provided for 9 foot crossarms and shall be 1/4 by 1-1/4 inches, not less than 28 inches in length. Flat braces shall be bolted to arms with 3/8 inch carriage bolts with round or square washers between bolt heads and crossarms, and secured to poles with 1/2 by 4 inch lag screws after crossarms are leveled and aligned. Angle braces are required for 10 foot crossarms and shall be 60 inch span by 18 inch drop formed in one piece from 1-1/2 by 1-1/2 by 3/16 inch angle. Angle braces shall be bolted to crossarms with 1/2 inch bolts with round or square washers between bolt heads and crossarms, and secured to poles with 5/8 inch through-bolts. Double crossarms shall be securely held in position by means of 5/8 or 3/4 inch double-arming bolts. Each double-arming bolt shall be equipped with four nuts and four square washers.

3.3.1 Line Arms and Buck Arms

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

3.3.2 Equipment Arms

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

3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall 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

3.6.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 7 days prior to conducting tests. The Contractor shall furnish materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of tests which includes date, test performed, personnel involved,

devices tested, serial number and name of test equipment, and test results. Field reports will be signed and dated by the Contractor.

3.6.2 Safety

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

3.6.3 Medium-Voltage Preassembled Cable Test (This is not applicable to bare overhead wires). [Note: Generally this is covered in the Underground Distribution Specification Section 33 71 02]

After installation, prior to connection to an existing system, and before the operating test, the medium-voltage preassembled cable system shall be given a high potential test. VLF AC Hipot test shall be applied to each phase conductor of the system by connecting conductors at one terminal and connecting grounds or metallic shieldings or sheaths of the cable at the other terminal for each test. Prior to the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment. The method, voltage, length of time, and other characteristics of the test for initial installation shall be in accordance with NEMA WC 74 for the particular type of cable installed, and shall not exceed the recommendations of IEEE Std 404 for cable joints unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Do not Hipot test through Switches or Transformers. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed. Repaired or replaced cables shall be retested.

3.6.4 Sag and Tension Test

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

3.6.5 Low-Voltage Cable Test

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

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

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

3.6.6 Pre-Energization Services

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

Capacitors.

Switches.

3.6.7 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

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

(2) {Note: Unless there is an issue detected in other tests, use the factory CTR, do not perform this test as it may void the manufacturer’s warranty.}

(3) Perform continuity test.

(4) Set tap changer to provide a secondary voltage as stated in the Delivery or Task Order.

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.

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. Sample shall be tested for:

(a) Dielectric breakdown voltage

(b) Color

(c) Visual condition

(4) Test protective functions.

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

(6) Perform overpotential tests.

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

(8) Verify lockout for unsuccessful reclosing.

(9) Determine reset time.

(10) Verify instantaneous overcurrent lockout.

3.6.7.4 Grounding System

a. Visual and mechanical inspection

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

b. Electrical tests

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

3.6.8 Devices Subject to Manual Operation

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

3.6.9 Follow-Up Verification

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

-- End of Section --