SECTION 337149.13 - OVERHEAD MEDIUM-VOLTAGE WIRING

Revise this Section by deleting and inserting text to meet Project-specific requirements.

1. GENERAL
	* + 1. RELATED DOCUMENTS
				1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
			2. SUMMARY
				1. Section Includes:

Conductors, connectors, and splices.

Poles and crossarms.

Overhead-line grounding.

Hardware and accessories.

Surge arresters.

Cutouts, switches, and fuses.

Pole-mounted distribution transformers.

Primary metering equipment.

* + - 1. DEFINITIONS

Retain definition(s) remaining after this Section has been edited.

* + - * 1. BIL: Basic impulse level, stated in kilovolts.
				2. RUS: Department of Agriculture, Rural Utilities Service.
				3. Sag: The distance measured vertically from a conductor to the straight line joining its two points of support, measured at the midpoint of the span, unless otherwise indicated.

Final Sag: The sag of a conductor under specified conditions of loading and temperature applied after it has been subjected, for an appreciable period, to the loading prescribed for the loading district in which it is situated, or equivalent loading, and the loading removed. Final sag includes the effect of inelastic deformation (creep).

Initial Unloaded Sag: The sag of a conductor before the application of an external load.

* + - * 1. Secondary: Conductors and components for circuits operating at the utilization voltage of 600 V or less.
				2. Service: Set of insulated conductors extending from a pole to the metering point or service entrance connection at the location of utilization of electricity.
			1. SUBMITTALS
				1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
				4. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
				5. Qualification Data: For qualified [**manufacturer**] [**testing agency**].

Retain first paragraph below if not retaining "Source Quality Control" Article.

* + - * 1. Material Certificates: For the following items, from manufacturers:

Wood poles.

Concrete poles.

Wood crossarms.

* + - * 1. Listing Documentation: Indicate that products comply with RUS listing requirements specified in "Quality Assurance" Article.

Delete first paragraph below if fuses have been selected and coordinated as part of design and are adequately described in this Section or on Drawings or if protective device coordination is specified elsewhere. Retain paragraph if preparation of coordinated time-current curves is specified in "Cutouts, Switches, and Fuses" Article.

* + - * 1. Design Data:

Time-Current Coordination Curves: Illustrate optimum coordination of protective devices involved in the Work of this Section.

* + - * 1. Source-quality control reports.

Retain first paragraph below if Contractor is responsible for field quality-control testing and inspecting.

* + - * 1. Field quality-control reports.
				2. Survey records for locations of pole, anchors, and other features for inclusion in Project Record Documents.
			1. CLOSEOUT SUBMITTALS
				1. Operation and Maintenance Data: For [**switches**] [**transformers**] to include in emergency, operation, and maintenance manuals.
			2. MAINTENANCE MATERIAL SUBMITTALS
				1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Fuses: [**One**] <**Insert number**> additional spare fuse(s) or fuse element(s) for each furnished fuse or fuse element.

Special Tools: [**Two**] <**Insert number**> sets of special-purpose tools required for maintenance of cutouts, switches, and reclosers, complete with toolbox.

Padlocks: [**One**] <**Insert number**> for every [**three**] <**Insert number**> installed, but no fewer than [**three**] <**Insert number**>.

Insulators: [**One**] <**Insert number**> for every 10 of each type, but no fewer than [**three**] <**Insert number**> of each type.

* + - 1. QUALITY ASSURANCE

Retain first paragraph below if concrete poles are specified and Contractor or manufacturer selects testing and inspecting agencies.

* + - * 1. Concrete Pole Manufacturer Qualifications: Certified by PCI as a qualified manufacturer of concrete utility poles of type and size indicated for this Project.
				2. Inspection Agency Qualifications for Pole and Crossarm Inspection: An independent agency, acceptable to authorities having jurisdiction, qualified to conduct inspections indicated.

Retain first paragraph below if Contractor or manufacturer selects testing agency or if Contractor is required to provide services of a qualified testing agency in "Field Quality Control" Article.

* + - * 1. Testing Agency Qualifications: Accredited by NETA.

Testing Agency's Field Supervisor: Currently certified by NETA or an NRTL.

If wood poles or crossarms are specified, retain first paragraph below to require treatment situations after typical field-cutting and -drilling operations.

* + - * 1. Treatment Technician Qualifications for Field Treatment of Wood Poles and Crossarms: Certified by authorities having jurisdiction over environmental protection at the location of Project for field application of chemicals required.
				2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
				3. Overhead-Line Components, Devices, and Accessories: Currently listed in RUS Informational Publication 202-1 without restriction for the intended application.

If retaining second option in first paragraph below, change subsequent IEEE C2 references accordingly.

* + - * 1. Comply with [**IEEE C2**] [**CPUC General Order 95**], except where stricter requirements are indicated or where local requirements that are stricter apply.
				2. Strength of Line and Line Components Selected by Contractor: Provide grades of construction and strength required by IEEE C2 for conditions encountered at Project site for [**heavy**] [**medium**] [**light**] line loading unless otherwise indicated.
			1. DELIVERY, STORAGE, AND HANDLING
				1. Wood Pole Storage and Handling: Comply with ATIS O5.1. Do not use pointed handling tools capable of producing indentations greater than 1 inch .
			2. PROJECT CONDITIONS

Retain this article if interruption of existing service is required.

* + - * 1. Interruption of Existing Service: Do not interrupt service to facilities occupied by State or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

Notify Director’s Representative no fewer than [**two**] <**Insert number**> days in advance of proposed interruption of service.

Do not proceed with interruption of service without written permission by Director’s Representative.

* + - 1. COORDINATION
				1. Coordinate with utility supplying electricity to lines specified in this Section, and make [**final connections**] [**arrangements for final connections by utility**].

Coordinate paragraph below with service entrance provisions of facilities served by lines specified in this Section.

* + - * 1. Coordinate with those responsible for [**voice**] [**data**] [**video**] <**Insert services involved**> systems that will have cables supported by poles installed according to this Section.
1. PRODUCTS

Manufacturers and products listed in SpecAgent and MasterWorks Paragraph Builder are neither recommended nor endorsed by the AIA or AVITRU. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications.

* + - 1. CONDUCTORS, CONNECTORS, AND SPLICES

Retain one of first four paragraphs below. Indicate conductor size and type on Drawings. See Evaluations for conductor alternatives.

* + - * 1. Conductor Type AAC: [**Bare**] [**and covered**], all-aluminum, Alloy 1350-H19, complying with ASTM B230 and ASTM B231.
				2. Conductor Type AAAC: [**Bare**] [**and covered**], all-aluminum-alloy, Alloy 6201-T81, complying with ASTM B398 and ASTM B399.
				3. Conductor Type ACSR: [**Bare**] [**and covered**], aluminum conductor, steel reinforced, complying with ASTM B232.
				4. Conductor Type CU: [**Bare**] [**and covered**], hard-drawn copper, complying with ASTM B1 and ASTM B8.

Retain first paragraph below to prescribe covering for line conductors. Thickness indicated below is generally used for 15-kV installations. Use manufacturer's data for other voltages.

* + - * 1. Conductor Covering: UV resistant, complying with ICEA-S-70-547. [**HDPE**] [**or**] [**XLP**], [**150 mils** ] <**Insert value**> thick.

Retain first paragraph below for messenger-supported multiconductor cables. Indicate conductor size and number of conductors on Drawings.

* + - * 1. Self-Supported, Multiconductor, Insulated Medium-Voltage Wiring: Factory-assembled, messenger-supported type, listed under UL 1072 as sunlight-resistant Type MV cable for cable tray use.

Conductors: [**Aluminum, Alloy 1350, complying with ASTM B230 and ASTM B231**] [**Hard-drawn copper, complying with ASTM B1 and ASTM B8**]; stranded for No. 2 AWG and larger.

Conductor Insulation: [**XLP, complying with NEMA WC 70/ICEA S-95-658**] [**EPR, complying with NEMA WC 70/ICEA S-95-658**] <**Insert insulation**>.

Insulation Level: [**100**] [**133**] <**Insert number**> percent of rated circuit line-to-line voltage.

Conductor Shield: Extruded, nonconducting, thermoset material, complying with NEMA WC 70/ICEA S-95-658; 18-mil minimum thickness.

Insulation Shield: Include the following two components:

Nonmetallic conducting, material complying with NEMA WC 70/ICEA S-95-658 and UL 1072, extruded over, and free stripping from the insulation.

Metallic Tape Shield: Bare copper, 5-mil minimum thickness, helically applied with a 15 percent minimum overlap.

Retain first subparagraph below if jacket is required.

Conductor Jacket: Extruded, chlorosulfonated-polyethylene-based material, complying with NEMA WC 70/ICEA S-95-658.

Messenger: [**Copper**] [**Composite copper and copper**]-clad steel.

Conductor Support Strap: Copper strap, wound around conductors and messenger the full length of the cable.

Retain one of first three paragraphs below. Indicate conductor size, number of conductors, and type on Drawings. Types AAC and AAAC aluminum conductors are also available. Covering thickness indicated below is typical for wires No. 1/0 AWG and larger. Use 30-mil cover for No. 6 AWG and No. 4 AWG; 45-mil cover for No. 2 AWG and No. 1 AWG.

* + - * 1. Secondary-Voltage Line Conductors: [**Aluminum conductor, steel reinforced, complying with ASTM B232/B232M**] [**Covered aluminum conductor, steel reinforced, complying with ICEA S-70-547, with HDPE or XLP covering**], [**60 mils** ] <**Insert value**> thick.
				2. Secondary-Voltage Line Conductors: [**Bare hard-drawn copper, complying with ASTM B1 and ASTM B8**] [**Covered hard-drawn copper, complying with ICEA S-70-547, with HDPE or XLP covering**], [**60 mils** ] <**Insert value**> thick.[**Neutral-supported, secondary service-drop cable.**]
				3. Racked Secondary Conductors, 600 V and Less: [**Copper, insulated with XLP, complying with NEMA WC 70/ICEA S-95-658**] <**Insert conductor and insulation combination**>.
				4. Neutral-Supported, Secondary Service-Drop Cable, 600 V and Less: Insulated conductors with bare neutral, complying with ICEA S-76-474, and using the following combination of materials:

Conductors and Neutral: [**Copper with copper-clad-steel neutral**] [**Aluminum with bare Alloy 1350 aluminum neutral**] [**Aluminum with ACSR neutral**].

Insulation: [**XLP, complying with NEMA WC 70/ICEA S-95-658**] [**High-modular-weight, low-density polyethylene**] [**Weather-resistant polyolefin, complying with ICEA S-70-547**].

* + - * 1. Connectors, Splices, and Conductor Securing and Protecting Components: Items include wire clamps, ties, conductor armor, fittings, connectors, and terminals. Listed for the specific applications and conductor types and combinations of materials used. Descriptions as follows for various applications:

Copper to Copper: Copper alloy, complying with UL 486A-486B.

Aluminum Composition to Aluminum Composition: Aluminum alloy, complying with UL 486A-486B.

Copper to Aluminum Composition: Type suitable for this purpose, complying with UL 486A-486B.

Connectors and Splices for Secondary Conductors: Listed and labeled for the conditions and materials involved in each application.

Taps for Medium-Voltage Line Conductors: Hot-line clamps, screw type, with concealed threads and bare, hard-drawn copper stirrups. Listed for the combination of materials being connected.

Splices under Tension: Compression type with strength exceeding the conductors spliced.

Splices and Terminations for Covered Conductors: As recommended by conductor manufacturer for conductor and covering combination and for specific materials and physical arrangement of each splice.

Splices and Terminations for Insulated Medium-Voltage Conductors: Comply with requirements in Section 260513 "Medium-Voltage Cables."

* + - 1. WOOD POLES

See Evaluations for discussion of wood preservatives. Douglas fir and western larch poles may not be treated with chromated copper arsenate preservatives.

* + - * 1. Comply with ATIS O5.1 and RUS Bulletin 1728F-700, for wood poles pressure treated with [**creosote**] [**pentachlorophenol,**] [**ammoniacal copper arsenate,**] [**ammoniacal copper zinc arsenate**] [**chromated copper arsenate**].
				2. Wood Species: [**Douglas fir**] [**Lodgepole pine**] [**Western larch**] [**Southern yellow pine**] <**Insert wood species selected from ATIS O5.1**>.
				3. Pole Marking:

Manufacturer's Mark: Comply with ATIS O5.1; locate 10 feet from the pole butt for poles 50 feet long or less.

Pole Number: Machine-embossed aluminum, alphanumeric characters not less than 2-1/2 inches high, with aluminum nails.

* + - * 1. Factory Operations: Machine trim poles by turning smooth, full length. Roof, gain, and bore poles before pressure treatment.
			1. CONCRETE POLES

See Evaluations for concrete pole applications.

* + - * 1. Description: Spuncast prestressed concrete, complying with requirements of ASTM C1089.

Retain subparagraph below when pole details and loading shown on Drawings are coordinated with requirements of this Bulletin.

Comply with requirements of RUS Bulletin 1724E-216.

Coordinate first paragraph below with submittal and certification requirements in Part 1 and with Drawings.

* + - * 1. Design: Base design on calculation of strength required by IEEE C2 or indicated on Drawings, whichever is greater. Design shall be suitable for installation at a location where annual temperature range is between [**minus 4 deg F and plus 100 deg F** ] <**Insert design temperature range at site location**>. Include pole design for embedded attachments matching fittings, brackets, and other items installed in the field.

To avoid unnecessary design and manufacturing time, effort, and cost, revise first three paragraphs below to require only those features required for this specific Project.

* + - * 1. Shaft: Hollow, for poles at overhead-to-underground connections. Provide 3-1/2-inch- minimum cable raceway capacity, with [**conduit elbow**] [**cable entry port**] at base.
				2. Water Absorption: Not more than 3 percent.
				3. Surface: Smooth, hard, nonporous, and resistant to [**soil acids**] [**road salts**] [**frost and freezing damage**].
				4. Pole Marking:

Manufacturer's Mark: Comply with ATIS O5.1; locate 10 feet from the pole butt for poles 50 feet long or less.

Pole Number: Machine-embossed aluminum, alphanumeric characters not less than 2-1/2 inches high.

* + - 1. CROSSARMS

Wood units in first paragraph below are adequate for most crossarm loading situations. Indicate steel-angle crossarms if extra strength is required. Coordinate with Drawings.

* + - * 1. Description: [**Solid-wood distribution type, complying with RUS Bulletin 1728H-701 for specified construction grade**] [**Galvanized, steel angles**], and complying with IEEE C2 for required climbing space and wire clearances.

Use flat braces in paragraph below for most applications. Ribbed, flat steel braces and steel-angle braces are available for unusually heavy loading.

* + - * 1. Braces: Galvanized, flat, ferrous-metal units; 1/4 inch thick by 1-1/4 inches wide, minimum, with length to suit crossarm dimensions.
			1. GUYS AND ANCHORS
				1. Guy Strand Assemblies: Cable and attachment assemblies shall have uniform minimum breaking strength of the cable.

Cable: Seven strands. [**Zinc-coated steel, complying with ASTM A475**] [**Aluminum-clad steel, complying with ASTM B416**] [**Copper-clad steel, complying with ASTM B228**]. Breaking strength shall be not less than [**10,000 lb** ] <**Insert value**>.

Cable Termination:

Retain one of first two subparagraphs below. If retaining both, show pole attachment method on Drawings.

Thimble eye.

Hooks and guy strain plates, complying with IEEE C135.1.

Preformed galvanized-steel guy grips, matching material, galvanizing, and strength of the guy strand assembly.

* + - * 1. Anchor and Anchor-Rod Assemblies: Hot-dip galvanized steel.

Power-installed screw-type anchors.

15-inch screw; with rod 96 inches long by 1-1/2 inches in diameter. Rated at 10,000 lb when installed.

Guy anchors shall have strength and holding area as required for anchor load and soil conditions at location of that anchor.

<**Insert anchor size or type**>.

* + - * 1. Strain Insulators: Epoxy-bonded fiberglass of length to meet clearance requirements specified in "Guy Installation" Article.
				2. Guy Markers: Round, of vinyl or PVC material, [**white**] [**yellow**] color, 96 inches long. Shatter resistant at temperatures below 0 deg F.
			1. HARDWARE AND ACCESSORIES
				1. Description: Ferrous-metal items include, but are not limited to, bolts, nuts, washers, crossarm gains and braces, insulator pins, anchor rods, anchors, eyebolts, staples, and transformer brackets.

For humid tropical or semitropical marine climates, revise option in subparagraph below. Determine local experience and practice.

Comply with IEEE C135.1, IEEE C135.2, ANSI C135.4, ANSI C135.22, and RUS Informational Publication 202-1 listings[**with the exception that base material shall be malleable iron or ductile iron, and finish shall be hot-dip galvanized**].

Coordinate first two paragraphs below with Drawings for style, arrangement, and pole connection detail.

* + - * 1. Insulator Brackets: Hot-dip galvanized steel, style as indicated, designed to hold vertical-post-type or pin-type insulators, with [**one**] [**two**]-bolt attachment to pole.
				2. Secondary Insulator Racks: Hot-dip galvanized steel, style as indicated, with smooth, rounded 12-gage struts designed to support [**two**] [**three**] [**four**] spool insulators for attachment of secondary drop conductors. Spool spacing of [**4 inches** ] [**8 inches** ] [**12 inches** ].

Coordinate first paragraph below with Drawings for sizing of conductor capacity.

* + - * 1. Pole Riser Shields: Galvanized steel with [**boot**] [**backplate**] [**vent**].

Padlocks in first paragraph below complying with ASTM F883 are classified as "PO1" (key operated) and "PO2" (combination operated), with Grades 1 through 6 and Grade 6 being the highest quality, and with Option A: Key is captive in cylinder when padlock is unlocked; Option B: Removable cylinder; Option C: Changeable combination; Option D: Combination operated with key control; Option E: Corrosion resistant; Option F: Provided with nonferrous shackles; and Option G: Environmental resistant.

* + - * 1. Padlocks: ASTM F883.

Class: [**PO1**] [**PO2**].

Grade: [**1**] [**2**] [**3**] [**3**] [**5**] [**6**].

Option: [**A**] [**B**] [**C**] [**D**] [**E**] [**F**] [**G**].

For medium-voltage work, first paragraph below and requirement to comply with IEEE C2 in "Quality Assurance" Article will specify insulators with adequate flashover ratings for normal environmental conditions. For contaminated atmospheres, including marine environments, add the specific insulator-class designations or other identification from the relevant ANSI or CEA standards. Retain insulator types and classes that will provide adequate flashover resistance under local conditions. Alternatively, schedule insulator application by ANSI designations on Drawings. Check local practice. See Evaluations. Coordinate with Drawings.

* + - * 1. Insulators: Units rated 6 kV and above shall be free from radio interference.

Porcelain insulators shall be wet-process type, complying with the following:

Pin: ANSI C29.5.

Line Post: ANSI C29.7. Include mounting stud of length suitable for each mounting arrangement used.

Suspension: ANSI C29.2.

Guy Strain: ANSI C29.4.

Secondary Spool: ANSI C29.3, Class 53-2.

Polymer-composite, fiberglass-reinforced insulators shall comply with the following:

Line Post: CEA LWIWG-02.

Dead End/Suspension: CEA LWIWG-01.

Guy Strain: Fiberglass reinforced, epoxy finished. Designed specifically for use in guy assemblies.

Ground rods and connectors are specified in Section 260526 "Grounding and Bonding for Electrical Systems."

* + - * 1. Grounding Materials: Comply with Section 260526 "Grounding and Bonding for Electrical Systems," using materials listed by RUS for the intended purpose without restriction.

Conductors: No. 4 AWG, minimum; bare, solid, annealed copper, complying with ASTM B8 unless otherwise indicated.

Ground Conductor Protectors: PVC or half-round wood molding, [**fir, pressure treated according to AWPA C25**] [**cypress**] [**cedar**].

* + - 1. SURGE ARRESTERS

See Evaluations for various surge arrester types and construction.

* + - * 1. Distribution-Class Surge Arresters: [**Porcelain**] [**Polymer**]-enclosed, gapless, metal-oxide type[**with automatic-indicating type, ground-lead disconnection feature**], complying with IEEE C62.11 and NEMA LA 1.
				2. Intermediate-Class Surge Arresters: [**Porcelain**] [**Polymer**]-enclosed, gapless, metal-oxide type, complying with IEEE C62.11 and NEMA LA 1.

Coordinate subparagraph below with Drawings. Delete if ratings are indicated in schedule. See sample schedule in the Evaluations.

Voltage Rating: [**3**] [**6**] [**9**] [**10**] [**12**] [**15**] [**27**] [**30**] [**36**] kV[**, at the altitude of Project,**] unless otherwise indicated.

* + - 1. CUTOUTS, SWITCHES, AND FUSES

Delete current ratings in remaining paragraphs if indicated on Drawings.

* + - * 1. Description: Medium-voltage disconnect, protective[**, and bypass**] units shall be rated for the line-to-line voltage of the systems in which installed, unless higher ratings are indicated. BIL ratings are [**45**] [**60**] [**75**] [**95**] [**150**] [**200**] kV.

Momentary Current Rating of Switching Devices: [**20**] [**40**] <**Insert value**> kA, asymmetrical at nominal system operating voltage.

Coordinate both subparagraphs below with Drawings. First subparagraph may place vital design decisions with Contractor without appropriate control and safeguards; delete if fuses have been selected and coordinated as part of the design and are adequately described in this Section or on Drawings or if protective device coordination is specified in Section 260573.19 "Arc-Flash Hazard Analysis."

Fuse Characteristics: Time-current characteristics for each set of fuses selected according to written recommendations of manufacturer of component protected by the fuses and coordinated with upstream and downstream protective devices. Prepare time-current coordination curves according to IEEE 242 that illustrate optimum coordination of devices in this Project.

Interrupting Rating of Fuses: <**Insert value**> symmetrical A at nominal system operating voltage.

* + - * 1. Fuse Cutouts: [**Open**] [**enclosed**] type, rated [**100**] [**200**] A, continuous, complying with ANSI C37.42.

Fuses: Enclosed link, [**Type K**] [**Type T**], complying with ANSI C37.42.

Retain first subparagraph below if fuse ratings are not shown on Drawings; revise to suit Project.

Fuse Current Rating: 150 percent of the transformer full-load current unless otherwise indicated.

Retain both subparagraphs below if some cutouts are applied as switches. Verify application and ratings with manufacturers.

Switching Application: Include switch link instead of fuse.

Switch Current Interrupting Rating: [**Transformer magnetizing current**] <**Insert value**>.

* + - * 1. Fused Switches: Single-pole, manual units.

Delete ratings in first subparagraph below if shown on Drawings.

Switch Rating: [**400**] [**600**]-A rms continuous and load-current interrupting.

Fuses: Dropout-type power fuses.

Delete ratings in first paragraph below if shown on Drawings.

* + - * 1. Nonfused Switches: Single-pole, manual units, rated [**100**] [**200**] [**400**] [**600**]-A rms continuous.
				2. Group-Operated, Load-Interrupter Switches: [**Fused**] [**Nonfused**], three-pole, single-throw units, manually operated by handle through insulated mechanical linkage.

High-pressure contact type, complying with ANSI C37.32.

Coordinate first two subparagraphs below with Drawings.

Factory assembled to suit specific configuration and mounting conditions for this Project.

Operating Handle: Padlock equipped.

Current Interrupting Rating: Equal to continuous current rating of switch.

Coordinate subparagraph below with Drawings.

Fuses: Nondropout power type.

* + - * 1. Group-Operated, Air-Break (Nonloadbreak) Switches: Three-pole, single-throw units, manually operated by handle through insulated mechanical linkage.

Comply with ANSI C37.32.

Coordinate first two subparagraphs below with Drawings.

Factory assembled to suit specific configuration and mounting conditions for this Project.

Operating Handle: Padlock equipped.

Suitable for field conversion to load-interrupter switch by adding interrupter modules.

* + - 1. DISTRIBUTION TRANSFORMERS
				1. Description: Single-phase, two-winding, [**single**] [**two**]-bushing, liquid-filled, self-cooled, pole-mounting distribution type, suitable for external fuse and surge suppressor protection; complying with IEEE C 57.12.00, and tested according to IEEE C 57.12.90[**.**][**and with the following additional requirements:**]

Cooling Class: OA.

Temperature Rise: 65 deg C.

Retain one of first three subparagraphs below. Retain second subparagraph for less-flammable insulating liquid for locations close to buildings, pedestrian areas, and high-fire-risk forests and grasslands. Retain third subparagraph for less-flammable and biodegradable properties.

Insulating Liquid: Mineral oil, ASTM D3487, Type II.

Insulating Liquid: High molecular weight, mineral oil based, and UL listed as less-flammable type.

Insulating Liquid: Biodegradable insulating and cooling liquid, UL listed as less flammable type.

Identification: Label the transformer as "non-PCB" and place manufacturer's name and type of fluid on the nameplate.

* + - * 1. BIL: [**95**] [**75**] [**60**] kV.

Retain first paragraph below if only one voltage is used and it is not indicated on Drawings. Insert a secondary-voltage paragraph if only one voltage is used and it is not indicated on Drawings.

* + - * 1. Primary Voltage: <**Insert voltage**>.
				2. Taps: [**Two, 2.5 percent above and below**] [**Four, 2.5 percent below**], high-voltage and full-load rated.[**Tap changer shall have an external operating handle.**]
				3. Mounting Brackets: [**Single**] [**Double**], integral; suitable for pole mounting, individually or in cluster, or on crossarm.

NEMA TP 1 includes standards to calculate avoided cost of electricity due to reduction of transformer losses when Contractor offers transformers with better than the minimum efficiencies. Revise first paragraph below to comply with requirements of NEMA TP 1 if bidding documents include bid modifications due to avoided costs of electricity.

* + - * 1. Minimum Efficiency: Class 1, as defined by NEMA TP 1, based on test results that comply with requirements of NEMA TP 2.

Retain first paragraph below for locations with contaminated atmosphere. Consult manufacturers and revise to suit local conditions.

* + - * 1. Bushings: Creepage distance shall exceed nominal value standard for unit rating by at least 75 percent.

Retain first two paragraphs below for installations in corrosive environments.

* + - * 1. Hardware: Stainless steel.
				2. Tank and Cover: Stainless steel, complying with ASTM A167, Type 304 or 304L, with paint coating exterior finish system complying with IEEE C57.12.28, including manufacturer's standard color finish coat.
				3. Show transformer kiloampere capacity using 2-1/2-inch numerals placed near the low-voltage bushings.
			1. GROUNDING
				1. Bare Grounding Conductor and Conductor Protector for Wood Poles:

No. 4 AWG minimum, soft-drawn copper.

Conductor Protector: Half-round PVC or wood molding; if wood, use pressure-treated fir, cypress, or cedar.

* + - * 1. Ground Rods: [**Copper-clad**] [**Zinc-coated**] [**Stainless**] steel[**, sectional type**]; [**3/4 inch by 10 feet** ] [**5/8 by 96 inches** ] in diameter.
			1. PRIMARY METERING EQUIPMENT
				1. Manufacturers: Subject to compliance with requirements, [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
				2. Metering Transformers:
				3. Description: Outdoor current and potential transformers, designed for crossarm mounting, complying with IEEE C57.13, and having the following features:

BIL: [**45**] [**60**] [**75**] [**95**] [**150**] [**200**] kV.

Secondary connection box arranged for conduit connection.

Potential-Transformer Voltage Rating: [**2.4**] [**4.16**] [**7.2**] [**12.0**] [**12.47**] <**Insert value**> kV to 120-V ac, 60 Hz.

Potential-Transformer Accuracy Class: Minimum 0.3 at [**75**] <**Insert value**>-VA burden.

Voltage Rating: [**2.4**] [**4.16**] [**7.2**] [**12.0**] [**12.47**] <**Insert value**> kV.

Current Rating: <**Insert value**> to 5 A.

Accuracy Class: Minimum 0.2 at [**50**] <**Insert value**>-VA burden.

* + - * 1. Watt-Hour Meter: Outdoor solid-state unit, [**with demand register,**] [**arranged for pulse initiation,**] complying with ANSI C12.10, and including the following ratings and features:

Retain first option in first subparagraph below for metering delta configuration; retain second option for metering wye configuration.

Form: [**8S**] [**9S**].

Element: [**2**] [**2-1/2**] [**3**].

Voltage: 120 V.

Current: 2-1/2 A.

Frequency: 60 Hz.

Kilowatt-Hour Register: Five-digit type.

Demand-Register Multiplier: A quantity in even hundreds, indicated on meter face.

Demand-Register Interval: [**15**] [**30**] minutes.

Mounting: On matching socket, complying with ANSI C12.7, and complete with automatic current short-circuiting device.

Meter Test Block: Matched to meter, and furnished and equipped with open knife switches designed to isolate each metering component for test.

Meter Cabinet: Galvanized steel; weatherproof enclosure with pole-mounting bracket and the following features:

Hinged Door: Arranged for padlocking in closed position.

Size: Adequate to house meter and other equipment indicated, but not less than 20 by 30 by 11 inches deep.

* + - 1. SOURCE QUALITY CONTROL
				1. Factory Tests: Conduct routine tests of [**transformers**] [**medium-voltage switches**] [**and**] [**metering equipment**] according to referenced standards.

Retain first paragraph below if required. Independent certification may be acceptable to authorities having jurisdiction without further monitoring of plant's quality-control and testing program by Owner.

* + - * 1. Testing Agency: [**Director’s Representative will engage**] [**Engage**] a qualified testing agency to inspect poles and crossarms before and after preservative treatment for compliance of wood poles and crossarms with requirements indicated. RUS quality mark "WQC" on each item is acceptable in place of inspection as evidence of compliance.
				2. Poles and crossarms will be considered defective if they do not pass tests and inspections.
				3. Prepare test and inspection reports.
1. EXECUTION
	* + 1. RIGHT-OF-WAY CLEARANCE AND TREE TRIMMING

Coordinate this article with Sections referenced in first paragraph below.

* + - * 1. Clear right of way according to Section 310000 "Earthwork."
				2. Clear right of way to maintain minimum clearances required by IEEE C2, unless Drawings indicate greater clearances or greater clearances are required by state or local codes or regulations. If no minimum requirements are mandated, maintain a minimum of 15 feet on both sides horizontally and below medium-voltage conductors and 60 inches on both sides horizontally and below secondary-voltage conductors. Remove overhanging branches.
			1. GENERAL INSTALLATION REQUIREMENTS
				1. Install underground power and metering circuits and those circuits indicated to be in raceways according to Section 260543 "Underground Ducts and Raceways for Electrical Systems" and Section 260513 "Medium-Voltage Cables," and make splices and terminations for those circuits according to the applicable Sections.
				2. Engage the services of a licensed surveyor to verify dimensions by field measurement, to identify locations of poles, anchors, and other features, and to verify all clearances. The survey document shall also identify locations of connections to new and existing supply lines and to primary and secondary services. Notify Architect of discrepancies and field conditions that are not indicated and that will affect installation.
				3. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
				4. Apply warning signs and equipment labels according to Section 260553 "Identification for Electrical Systems."
			2. CONDUCTOR INSTALLATION, GENERAL
				1. Handle and string conductors to prevent cuts, gouges, scratches, kinks, flattening, or deformation. Remove damaged sections and splice conductors.

Coordinate both subparagraphs below with Drawings.

String new conductors to "initial" sag values recommended by manufacturer for type and size of conductor except as otherwise indicated.

Retain subparagraph below for existing lines.

Conductors Reinstalled or Resagged: String to "final" sag values recommended by manufacturer for type and size of conductor except as otherwise indicated.

* + - * 1. Connections, Splices, and Terminations: Use kits listed for the specific type of connection and combination of materials in the connection or recommended for the specific use by manufacturer of material on which applied.

Splice Location: Do not install within 10 feet of a support.

Line Conductors and Service Drops: Install so strength exceeds ultimate rated strength of conductor.

Splices and Terminations of Covered Conductors: Comply with manufacturer's written instructions.

Splices and Terminations of Insulated Conductors of Self-Supported, Medium-Voltage Cable: Comply with manufacturer's written instructions.

* + - 1. MEDIUM-VOLTAGE LINE CONDUCTOR INSTALLATION

Coordinate first paragraph below with Drawings.

* + - * 1. Application: Install bare conductors unless otherwise indicated.

Retain first paragraph below if using aluminum or aluminum-composition conductors.

* + - * 1. Armor Rod: Install to protect conductors if line conductors are supported by insulators.
				2. Flat Aluminum Armor Wire: Install to protect conductors if they are supported by, or attached to, galvanized or coated iron or steel clamps or fittings.
				3. Support line conductors and taps as follows:

Use wire ties for conductor attachment to pin and vertical post insulators unless otherwise indicated.

Install wire ties tight against conductor and insulator, and turn ends back and flat against conductor, to eliminate exposed wire ends.

Use wire clamps on horizontal post, dead end, and suspension insulators unless otherwise indicated.

* + - 1. POLE AND CROSSARM INSTALLATION

Coordinate first paragraph below with Drawings.

* + - * 1. Pole Orientation: Align curve of curved wood poles with straight-line runs of three or more poles. Align gained surfaces perpendicular to runs.
				2. Elevation of Line above Grade: Install poles with top at same elevation, unless grade changes dictate elevation change in poles, and according to the following:

On level ground, set poles so tops of consecutive poles vary not more than 60 inches in elevation.

Shorten wood poles by cutting off the top and make cuts to shed water. Apply preservative to cuts.

* + - * 1. Set poles according to the following:

Make pole holes vertical, uniform in diameter, and large enough to permit effective use of tamping bars all around. Bore or excavate holes with an average diameter at grade less than twice the diameter of the pole at the same grade.

Indicate pole setting depth here or on Drawings. See Evaluations for guidance on determining suitable setting depth. Verify that the setting depths are appropriate for concrete poles, if used.

Use minimum depths indicated, except at locations where hole is partly or entirely in rock and if hole is not vertical or has a diameter at grade more than two times the pole diameter at the same level; in these conditions, increase the depth of the hole by the following increments before setting the pole:

Poles up to 35 Feet Long: 24 inches.

Poles 36 to 60 Feet Long: 30 inches.

Poles 61 to 75 Feet Long: 36 inches.

For poles on slopes, indicated hole depth is from finished grade at lowest side of hole.

Set poles in alignment and plumb except at dead ends, angles, and points of extra strain; rake poles against conductor strain 1 inch minimum, 2 inches maximum, (after conductors are installed at required tension) for each 10 feet of pole length. Rake poles so they will not lean or bend in direction of strain when loaded.

Backfill holes in 6-inch maximum lifts, and thoroughly tamp each layer before starting the next.

Place surplus earth around pole in a conical shape, and tamp thoroughly to provide drainage away from pole.

Set poles so alternate crossarm gains face in alternate directions, except at terminals and dead ends; place gains on last two poles on side facing terminal or dead end.

Retain subparagraph below where applicable for projects in seismic areas.

Poles Set in Concrete Paved Areas: Install poles with minimum of 6-inch- wide, unpaved gap between the pole and the edge of adjacent concrete slab. Fill unpaved ring with [**pea gravel**] <**Insert appropriate material**> to a level 1 inch below top of concrete slab.

* + - * 1. Field treat factory-treated poles and crossarms as follows:

Poles Treated More Than One Year before Installation: Treat portion from 24 inches above ground line to butt.

Field-Bored Holes and Field-Cut Gains and Pole Tops: Treat cut portions.

Unused Holes: Treat and plug with treated-wood-dowel drive pins.

Engage the services of a technician certified according to "Quality Assurance" Article to apply treatment. Comply with requirements in AWPA standards that govern original factory treatment for field-applied treatment and application of chemicals.

* + - * 1. Crossarm Installation: Set line crossarms at right angle to line for straight runs and for angles 45 degrees and more. Bisect angles less than 45 degrees.

Buck Arms: Install at corners and junction poles unless otherwise indicated.

Double Crossarms: Install at dead ends, corners, angles, and line crossings.

Equipment Arms: Locate below lines and set parallel or at right angles to them, whichever provides best climbing space.

Gains: Install factory-cut or metal-pole gains only. Do not cut gains in field without specific written approval.

* + - * 1. Locate pole numbers to provide maximum visibility from the road or patrol route.
			1. GUY INSTALLATION
				1. Install guys to resist unbalanced loads, including those developed at angles, corners, and dead ends. Install two or more guys if a single guy will not provide adequate strength. Install separate guys if unbalanced loads are separated by 36 inches or more. Comply with IEEE C2.

Coordinate first subparagraph below with "Guys and Anchors" Article.

Unless a thimble eye is used, at the pole end, install a minimum of two guy hooks and two guy strain plates.

At the anchor end, attach guy strand assembly with preformed grips.

Coordinate first paragraph below with Drawings.

* + - * 1. Protect guy strands from damage. Replace damaged guy strands. Install guy insulators where required to comply with IEEE C2 clearance requirements.

Retain first paragraph below unless anchor selection is based on specific survey at each guy location or where selected strength of guy assembly indicated is adequate for conditions encountered in Project.

* + - * 1. Install guys with a lead-to-height ratio of 1 to 1 unless otherwise indicated. The minimum lead-to-height ratio shall be 1/2 to 1. When less than 1 to 1, increase guy strength by the ratio of the sine of the lead angle indicated to the sine of the lead angle provided.
				2. Install screw-type guy anchors aligned in soil with guy. Set with anchor rod pointing at guy attachment on pole and rod projecting 6 to 9 inches from ground.
				3. Install strain insulators to provide a minimum of 12 inches of clearance between the nearest energized surface and the strain insulator fitting farthest from the pole. When loaded to the tension indicated, fiberglass strain insulators shall be loaded to not more than two-thirds of manufacturer's published rating.
				4. Guy Markers: Install at anchor end of guys to visually mark the guy wire at all accessible locations. Clamp to guy strand or anchor at top and bottom of marker.
			1. HARDWARE AND ACCESSORIES INSTALLATION
				1. Install washers against wood and under nuts, including eyenuts and locknuts.
				2. Install nuts and locknuts wrench-tight on threaded connections.
			2. INSULATOR INSTALLATION

Coordinate first paragraph below with Drawings.

* + - * 1. Medium-Voltage Line Application: Install [**pin**] [**or**] [**post**] type, except install suspension type at corners, angles, dead ends, and other locations where horizontal forces exceed rated values for pin or line-post-type units.

Install suspension insulators and hardware that have mechanical strength exceeding rated breaking strength of attached conductors.

Retain subparagraph below for projects using armless construction.

Install horizontal line-post insulators for armless construction.

* + - * 1. Post-Insulator Conductor Support: Where installed horizontally and for line angles more than 15 degrees, install clamp-top conductor clamps.
				2. Install spool-type insulators for secondary lines mounted on clevis attachments or secondary racks.
				3. Guy Strain Type: Install [**porcelain**] [**fiberglass-reinforced**] units.
			1. SURGE ARRESTERS
				1. Install surge arresters to protect [**distribution**] [**metering equipment**] [**reclosers**], [**group-operated, load-interrupter switches**], [**aerial-to-underground transitions**], and other items indicated.

Units Installed 6000 Feet or More above Sea Level: Use arresters specifically rated for this service.

* + - 1. CUTOUT, SWITCH, AND FUSE INSTALLATION
				1. Hook-Stick-Operated Switches: Install to maximize safe operating access.
				2. Group-Operated, Load-Interrupter Switches and Air-Break Switches: Install operating handle 42 inches above finished grade.

Locking Provisions: Install padlock at hasp.

* + - 1. GROUNDING OVERHEAD LINES
				1. Comply with IEEE C2 grounding requirements.

Grounding practices of the local utility company may differ from requirements in six paragraphs below. Although overhead-line grounding specified in this article is not for the utility company's use and does not have to comply with its standards, it is possible the utility company may be requested to repair or maintain the line in the future. For this reason, it may be desirable to design some grounding features according to the utility company's standards. Utility companies, for economic reasons, often design to a standard lower than what is appropriate for Project requirements. Alternatively, because of their experience with wind, ice, and lightning conditions in their service area, utility companies may design to a higher standard than is required by authorities having jurisdiction. In addition to Project requirements, evaluate the local utility company's practice and revise paragraphs accordingly. This evaluation is particularly important if Project's overhead lines connect with utility lines.

* + - * 1. Install [**two**] <**Insert number**> parallel ground rods if resistance to ground by a single, ground-rod electrode exceeds 25 ohms.
				2. Drive ground rods until tops are 12 inches below finished grade in undisturbed earth.
				3. Ground-Rod Connections: Install bolted connectors for underground connections and connections to rods.
				4. Lightning Arrester Grounding Conductors: Separate from other grounding conductors.
				5. Secondary Neutral and Transformer Enclosure: Interconnect and connect to grounding conductor.
				6. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communications service and transformer spaces.
			1. METERING COMPONENT INSTALLATION

Coordinate this article with Drawings.

* + - * 1. Current and Voltage Transformers: Install secondary conductors between transformers and cabinet in sleeves made of [**galvanized rigid steel**] [**intermediate metal**] [**PVC**] conduit. Install to prevent collection of moisture in raceway and cabinet system.
				2. Meter Cabinet: Mount on pole, 72 inches above finished grade to center of cabinet.

Make conduit connections with raintight hubs.

Install metering transformer secondary leads without splices. Train leads at sides and bottom of enclosure, and secure with wire ties.

Install meter and meter test block within cabinet.

Install identical phase sequence, and color-code for both potential and current leads.

Identify leads using designations consistent with marking on transformer terminals.

* + - 1. FIELD QUALITY CONTROL

Retain first paragraph below to identify who shall perform tests and inspections. If retaining second option, retain "Field quality-control reports" paragraph in "Informational Submittals" Article.

* + - * 1. Testing Agency: [**Director’s Representative will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

Retain first paragraph below to require a factory-authorized service representative to perform inspections, tests, and adjustments.

* + - * 1. Manufacturer's Field Service: Engage a Company Service Advisor to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

Retain first paragraph below to require Contractor to perform tests and inspections.

* + - * 1. Perform tests and inspections.

Retain first paragraph below to describe tests and inspections to be performed.

* + - * 1. Tests and Inspections:

Furnish instruments and equipment required for tests that comply with NETA Acceptance Testing Specification.

Retain first subparagraph below unless local experience, quality of oversight during construction, and nature of Project indicate anchor testing is unnecessary or if testing will be performed by Owner-engaged testing and inspecting agency.

Guy Anchors: Test one of each type and capacity installed[**, plus additional units specifically indicated for testing**]. Apply rated pull-out force in the same pull direction applied by the guy at the test location.

Acceptable Test Results: Denoted by movement of less than 3/8 inch by the holding component of the anchor in the earth or other medium in which it is installed.

Replace or reinstall, at Architect's option, all anchors of same type and capacity as anchor type that fails this test.

Ground Resistance: Comply with Section 260526 "Grounding and Bonding for Electrical Systems." Measure resistance of each separate grounding electrode, including pole grounds. Also measure resistance of separate grounding electrode systems before bonding together.

Perform tests and obtain acceptable results before energizing any portion of overhead electrical distribution system.

Results and Follow-up: If ground resistance for a single ground electrode or pole ground, tested individually, exceeds 25 ohms, add a ground electrode not less than 10 feet away and interconnect with No. 2 AWG, minimum, bare conductor buried at least 12 inches below furnished grade.

Aerial Conductor Sag and Tension: Observe procedures used by Contractor to verify that initial stringing sags and tensions comply with IEEE C2 and conductor manufacturer's product data and written recommendations.

Self-Supported, Medium-Voltage Cable: After installation, while cable is isolated, and after terminations are installed and before connecting or energizing, apply dc voltage between each phase conductor and grounding connections of sheath or metallic shield. Comply with NEMA WC 70/ICEA S-95-658 for method, voltage, duration, pass-fail performance, and other test criteria. Perform other field inspections and tests recommended by manufacturer.

Neutral-Supported, Secondary Service-Drop Cable: Test for insulation resistance while cable is isolated, before connecting or energizing. Minimum acceptable resistance is 100 megohms.

Retain first subparagraph below if existing surge arresters are reused. Do not reuse porcelain-enclosed, silicon carbide arresters 13 years old or older.

Existing Surge Arresters: Disconnect and measure resistance between line and ground terminals with a megger test rated 600 V or more. Acceptable resistance values are 300 megohms and more.

New Surge Arresters, Cutouts, and Switches: Inspect after installation and connection to wiring. Verify that ratings and characteristics match approved submittals and comply with system requirements. Verify that installation complies with requirements and that clearances of units and connecting wiring comply with IEEE C2 requirements.

Verify proper grounding of metallic equipment parts.

Fuses and Disconnect Links: Verify that ratings and characteristics match submittals and comply with system requirements.

Switches:

Manually operate each cutout and switch at least three times, to verify proper operation.

Verify correct contact alignment, blade penetration, travel stops, and arc interrupter operation.

Group-Operated, Load-Interrupter Switches and Air-Break Switches:

Perform mechanical operator tests according to manufacturer's written instructions.

Test resistance to ground of parts to be energized. Acceptable value is 200,000 megohms.

Perform contact-resistance test across all switch blade contacts. Refer to manufacturer's data for acceptable contact resistance.

Verify that clearances of energized parts and connecting wires comply with IEEE C2 requirements.

Distribution Transformers: Inspect after installation and connection to wiring and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.

Inspect for physical damage, cracked insulators, leaks, tightness of connections, and overall mechanical and electrical integrity.

Perform preenergizing inspections and tests recommended by manufacturer.

Verify proper equipment grounding.

Verify that clearances of terminals and connecting wires comply with IEEE C2.

Metering Transformers: Inspect after installation and connection to wires, and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.

Verify proper connections, tightness of bolted connections, and integrity of mounting provisions.

Verify that required grounding and shorting connections provide good contact.

Verify that clearances of terminals and connecting wires comply with IEEE C2.

Perform electrical tests according to manufacturer's written instructions, including insulation-resistance tests, polarity tests, and turns-ratio and ratio-verification tests.

Meters: Inspect after installation and connection to wiring and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.

Verify tightness of electrical connections.

Verify accuracy at 25, 50, 75, and 100 percent of full-rated load and verify all instrument multipliers according to manufacturer's written instructions.

* + - * 1. Prepare test and inspection reports.
			1. ADJUSTING

Retain this article if transformer tap settings are not indicated elsewhere.

* + - * 1. Distribution Transformers: Set voltage taps as directed by Architect.
			1. CLEANING
				1. After completing equipment installation, inspect equipment. Remove spots, dirt, and debris. Repair damaged finish to match original finish. For distribution transformer, use tank touchup paint provided by manufacturer.

Clean enclosures internally, on completion of installation, according to manufacturer's written instructions.

* + - 1. DEMONSTRATION
				1. [**Engage a Company Service Advisor to train**] [**Train**] Facility's maintenance personnel to adjust, operate, and maintain overhead electrical distribution.

END OF SECTION 337149.13