SOUTHERN CALIFORNIA EDISON
TRANSMISSION AND DISTRIBUTION

Distribution Overhead Construction Standards (DOH)

2021 — FOURTH QUARTER ISSUE
October 29, 2021

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Distribution Overhead Construction Standards (DOH)

Revision Summary

2021 — Fourth Quarter Issue

Effective Date: October 29, 2021

Overview

The main purpose of this revision summary is to describe new revisions to this manual. (Some or all of the information may have been previously communicated to field personnel by other means.)

Table 1 lists the revisions. Clickable page/sheet numbers link directly to individual revisions or the first of a series of revisions.

Table 2 defines four types of revisions: (1) Admin (Administrative), (2) Technical, (3) New, and (4) Pilot.

Note: **Admin** *and* **Technical** *revisions to existing standards or existing* **Pilot** *projects are identified with change bars* **|** *in the left margin.* **New** *standards (as well as new pilot projects) do not receive change bars. Editorial revisions, such as corrections to spelling, do not receive change bars.*

A Getting Help section provides contact information.

Table 1: Revisions

Division Standard	Page/Sheet	Description	Type
AC 350	1	Updated Figure AC 350-1 to clarify dead-ending requirement.	Admin
CC 100	1	Specified definition of “coastal area” to provide clarity.	Admin
CC 190	All	Due to the adoption of an additional supplier, the Stockbridge damper section has been expanded to include installation instructions for spiral rod and shear bolt stockbridge damper installation. Additional diagrams and verbiage have been included to clarify proper installation of dampers. The span length requirements in Table CC 190-1 have been updated.	Technical
CO 460	1	An additional sentence was added to explain that vibration dampers will be installed in high loading areas if vibration on conductors is observed.	Admin
DC 320	1–2	Updated standard to include G.O. 95 secondary rack spreader design to maintain 8" minimum clearance requirement.	Technical
DC 410	3	Updated Table DC 410-1 pertaining to jumper wire and connectors requirements.	Admin
DC 536P	All	Initial Issue of DC 536P Pilot standards for nesting platform construction.	New
GR 120	1, 5	Added “Do Not Ground” Note to the 480 V 3-Phase, 3-Wire Y diagram. Updated scope of Figure GR 120-9.	Admin

Table 1: Revisions *(Continued)*

Division Standard	Page/Sheet	Description	Type
PO 112	All	Added Creative Pultrusion (CP) as an approved vendor for composite poles and marked Intelli-Pole standards as “For Reference Only” as they are no longer an approved vendor of composite poles.	Technical
PO 114P	1	Corrected definition of “coastal area” to align with other standard manuals.	Admin
PO 300	2 6–9	Specified definition of “coastal area” to provide clarity. Clarified Heavy-Duty Power-Installed Screw Anchor (PISA) is the preferred type of anchoring. Added comprehensive updates and details to clarify correct installation of anchor rods, anchor extensions, and cross plate anchor applications.	Technical
PO 310	2–4	Table PO 310-1: Key 10 5/8" × 6' Single Eye Cross-Plate anchor. Updated SAP info for Cross-Plate and Expanding Rock anchors.	Admin
PO 315	1 3	Table PO 315-1: Updated the description of Thimble and Triple Eye Rod anchor; updated description of Anchor Extension and added new options including Pisa Anchor extension. Specified definition of “coastal area” to provide clarity.	Technical Admin
PO 340	1 6–7	Updated Figures PO 340-1 and PO 340-2 for clarify guy length and insulator requirements. Updated Figure PO 340-5 and associated notes to provide clarity on installation requirements for rock anchor and rock anchor extension. Added new Figure PO 340-6: Roch Anchor Extension and ID Tagging.	Technical
PO 350	1	Figure PO 350-1 and note: clarified the bottom of the eye of the anchor rod shall be a minimum of 4" above finished grade.	Admin
PO 370	2	Updated Figure PO 370-2 to clarify guy attachment requirement.	Admin
PR 100	2	Specified definition of “coastal area” to provide clarity.	Admin
PR 129	1	Specified definition of “coastal area” to provide clarity.	Admin
SC 100P	1	Specified definition of “coastal area” to provide clarity.	Admin
SC 110P	1	Specified definition of “coastal area” to provide clarity.	Admin
T 127	2, 5	Added two notes referencing DOH T 725 which provides wiring diagrams for NET Generation Output Meters (NGOM).	Technical
T 326	2	Added two notes referencing DOH T 725 which provides wiring diagrams for NET Generation Output Meters (NGOM).	Technical

Table 1: Revisions *(Continued)*

Division Standard	Page/Sheet	Description	Type
T 356	2, 5	Added two notes referencing DOH T 725 which provides wiring diagrams for NET Generation Output Meters (NGOM).	Technical
T 376	2, 5	Added two notes referencing DOH T 725 which provides wiring diagrams for NET Generation Output Meters (NGOM).	Technical
T 399	2 4	Figure T 399-2: clarified installation requirements for 12/16 kV 3ph 3 W Pole Top Metering. Figure T 399-3: updated installation requirements pertaining to 33 kV, 3ph, 3 W Pole Top Metering.	Admin
T 431	2	Added two notes referencing DOH T 725 which provides wiring diagrams for NET Generation Output Meters (NGOM).	Admin
T 451	2, 5	Added two notes referencing DOH T 725 which provides wiring diagrams for NET Generation Output Meters (NGOM).	Technical
T 478	2, 5	Added two notes referencing DOH T 725 which provides wiring diagrams for NET Generation Output Meters (NGOM).	Technical
T 725	All	Initial Issue of T 725 standards for NGOM applications.	New

Table 2: Revision Types

Type	Definition
Admin	Administrative revisions do not significantly affect design, construction, maintenance or operation of the electrical distribution, substation, and transmission systems. They do not require Standards Review Team (SRT) or management approval; however, they have been approved by other organizations, as appropriate. They may include updates to material codes, updates to references, updates to standards for clarity, or deletions of outdated information.
Technical	Technical revisions are engineering changes to existing standards. They affect the design, construction, maintenance or operation of the electrical distribution, substation, and transmission systems. They require SRT and management approval.
New	Refers to a new standard. New technical standards require SRT and management approval.
Pilot	A *Pilot* is an in-field evaluation of a piece of equipment or work method, with the intention of approving for standardized use. Pilot standards will have a PILOT watermark so that they are easily identified throughout this manual.

Getting Help

Technical Revisions

If you have any comments, corrections, questions, or suggestions concerning manual revisions, please contact one of the following individuals at the numbers provided, or click on the name to send an email:

- [redacted]

Russ Ragsdale
Director, Asset & Engineering Strategy

DI — Division Index

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DOH–AC: Aerial Cable

TABLE OF CONTENTS

STANDARD **TITLE**

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AC 100 General

Scope AC 100.1 Aerial Cable General

1.0 General

1.1 Aerial cable installations are divided into four groups:

A. Aerial Bundled Cable (ABC) consists of one, two, or three individual cables, each having an aluminum conductor with cross-linked polyethylene with concentric neutral wires covered by a jacket. The factory-assembled cable comes with pre-spun and pre-wrapped messenger and lashing wires. This is the **preferred** aerial cable for three-phase application, since spinning is not required in the field. Use standard pothead termination or dead-break pre-molded rubber components and accessories, whenever possible, when splicing and terminating cable (Refer to Distribution Underground Construction Standards [DUG], Section JJ and DUG Section TP.) For Cable Data, see AC 110.

B. Cross-linked polyethylene, insulated with tinned copper shield wires

This cable should be installed with a copper-weld messenger in beach areas and high-contamination areas. A copper spinning wire should also be used. (Area A — See GR Section.) In other areas, a standard steel guy wire may be used with a stainless-steel spinning wire (SAP 10110481).

When splicing and terminating cable, standard underground devices should be used whenever possible. (Refer to DUG, Section JJ and DUG, Section TP.) For Cable Data see AC 110.

C. Rubber-like insulation, (old type — no longer purchased) copper or aluminum conductors with a copper tape insulation shielding. Cable data in AC 110 is shown as “For Reference Only.”

This cable was normally installed with a copper-weld messenger and fastened to the messenger with a copper spinning wire (SAP 10109328 — For Reference Only).

Splicing and terminating cable will be accomplished by the hand-taped method, which is illustrated later in this section.

= For Reference Only

1.2 The application of aerial cable is to be restricted to voltage levels between 2.4 kV to 16 kV. For special applications, refer to Field Engineering.

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AC 110 Cable Data

Scope AC 110.1 Aerial Bundled Cable (ABC)

Table AC 110–1: Cable Data — Aerial Bundled Cable (ABC)

SAP	Conductor Size (AWG/kcmil)	Number of Conductors	Insulation Thickness (mil)	Messenger Size (in)	Overall Assembly Diameter (in)	Total Assembly Weight (lb/ft)	MAX Span[a/] (ft)	Ampacity per Conductor[b/] (Amps)
10110298	1/0 AWG	3	220	3/8	3.05	2.46	220	152
10110299	350 kcmil	3	220	1/2	3.88	3.86	220	324
10213711	1/0AWG	2	220	3/8	2.87	1.80	220	152
10182608	1/0 AWG	1	220	3/8	1.90	1.07	300	152

[a/] The maximum span length is based on the following criteria:
A heavy loading district
A maximum sag at 15.5°C of 1.667% of the span length
A maximum tension at 15.5°C of not more than 30% of the messenger minimum breaking strength.
A maximum tension under loading of 0°F of not more than 50% of the messenger breaking strength.

[b/] Aerial Bundled Cable Normal Thermal Rating Criteria:
Ambient Temperature = 40°C
Conductor Temperature = 90°C
Load Factor = 100%
Surface absorption coefficient = 0.4
Latitude = 34°
Atmosphere = Clear
Local Sun Time = 1:00 pm

Table AC 110–2: Messenger Data — Aerial Bundled Cable (ABC)

Messenger Size (in)	Stranding (AWG)	Messenger Diameter (in)	Messenger Type	DC Resistance at 20ºC (Ohms/1000 ft)	Coefficient of Linear Expansion (X10^–6/ºF)	MAX Working Tension[a/] (lb)	Ampacity per Conductor[b/] (Amps)
3/8	7 - #8	0.385	EHS Copperweld - 30% Conductivity	0.308	7.2	6,945	154
1/2	7 - #6	0.486	EHS Copperweld - 30% Conductivity	0.194	7.2	10,230	203

[a/] The Maximum working tension has a safety factor of 2.

[b/] Copperweld Messenger Normal Thermal Rating Criteria:
Ambient Temperature = 40°C
Conductor Temperature = 85°C
Load Factor = 100%
Coefficient of Emissivity = 0.5
Coefficient of Solar Absorption = 0.5
Latitude = 34°
Elevation of Conductor above Sea Level = 6,000 ft
Atmosphere = Clear
Local Sun Time = 1:00 pm
Wind Speed = 2 ft/sec

Table AC 110–3: Cable Accessories — Aerial Bundled Cable (ABC)

Description	Reference Standard	Cable Size (AWG/kcmil)
Potheads	DUG TP 206	1/0, 350
Straight Splices	DUG JJ 611	1/0, 350
	DUG JJ 620	350
	DUG JJ 621	1/0
Locking Y-Splices	DUG JJ 650	1/0
200 A T-Splice/Accessories	DUG JJ 670	1/0
600 A T-Bodies/Accessories	DUG JJ 660	1/0, 350

Scope AC 110.2 Cross-Linked Polyethylene Insulated Aluminum

Table AC 110–4: Cable Data — Cross-Linked Polyethylene Insulated Aluminum

Number of Conductors	Size AWG or kcmil	Insulation Thickness 90 mil	Insulation Thickness 220 mil
		Amp per Conductor	
1	2		152
	1/0	202	202
3	2		135
	1/0	167	178
	350	364	372

Note(s):

1. Conductor temperature 90°C
2. Ambient temperature 40°C
3. Load factor 100%

Scope AC 110.3 Current Carrying Capacities Self-Supporting Shielded Aerial Cable

Table AC 110–5: Cable Data — Rubber-Like Insulation (Old Style)

Number of Conductors	Size AWG or kcmil	Insulation Thickness			
		90 mil		220 mil	
		Amp per Conductor			
		Copper	Aluminum	Copper	Aluminum
1	4	127		118	
	2	167	130	156	121
3	4	109		105	
	2	143	112	138	108
	1/0		149		142
	2/0	220		209	
	4/0	293	229	278	218
	350		315		296

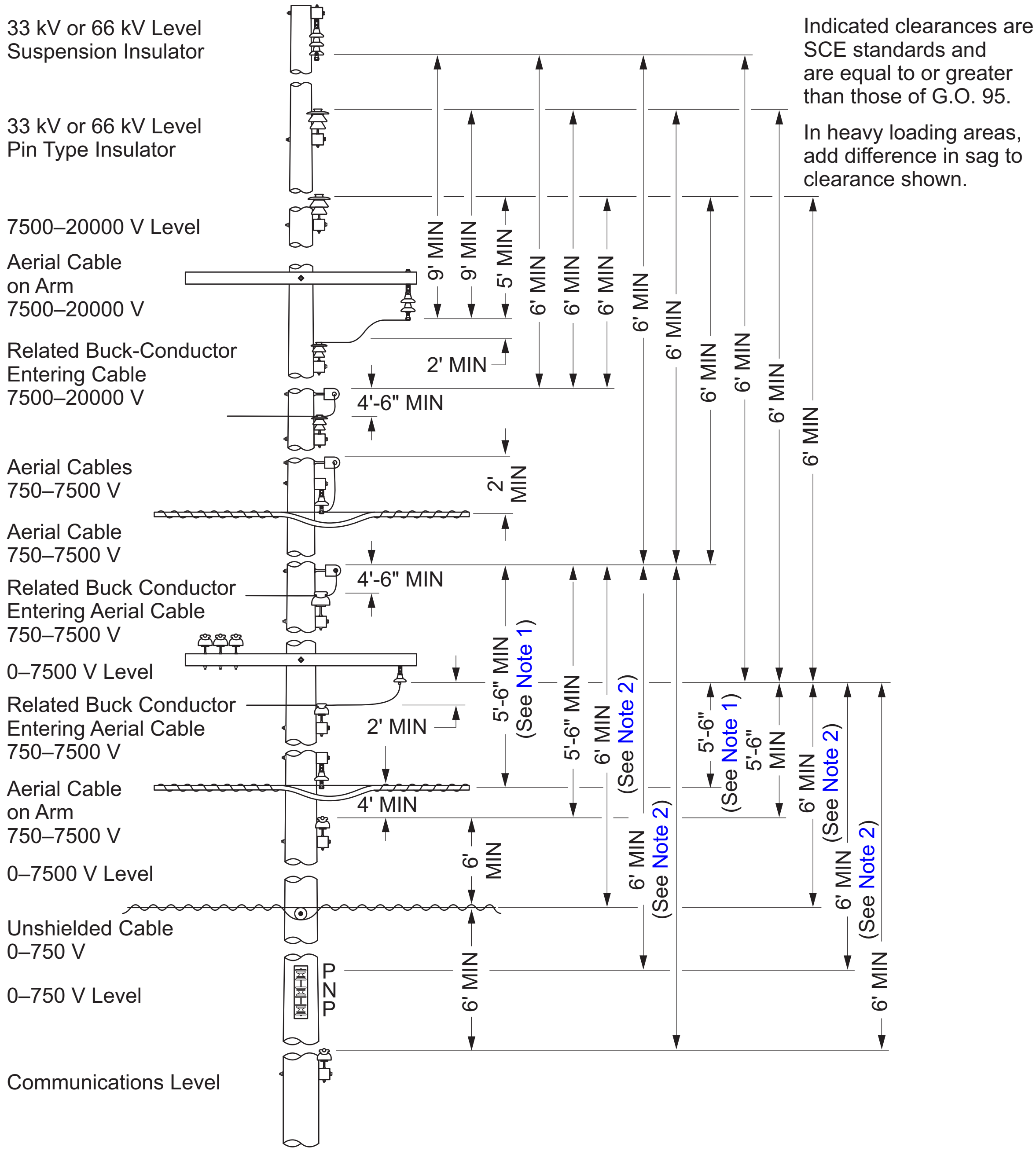
Note(s):

1. Conductor temperature
   a. 75°C for 90 mil
   b. 70°C for 220 mil
2. Ambient temperature 40°C
3. Load factor 100%

AC 120 Clearances

Scope AC 120.1 Above-Below-Right Angles (Line/Buck Arm)

Figure AC 120–1: Clearances Above-Below-Right Angles (Line/Buck Arm)

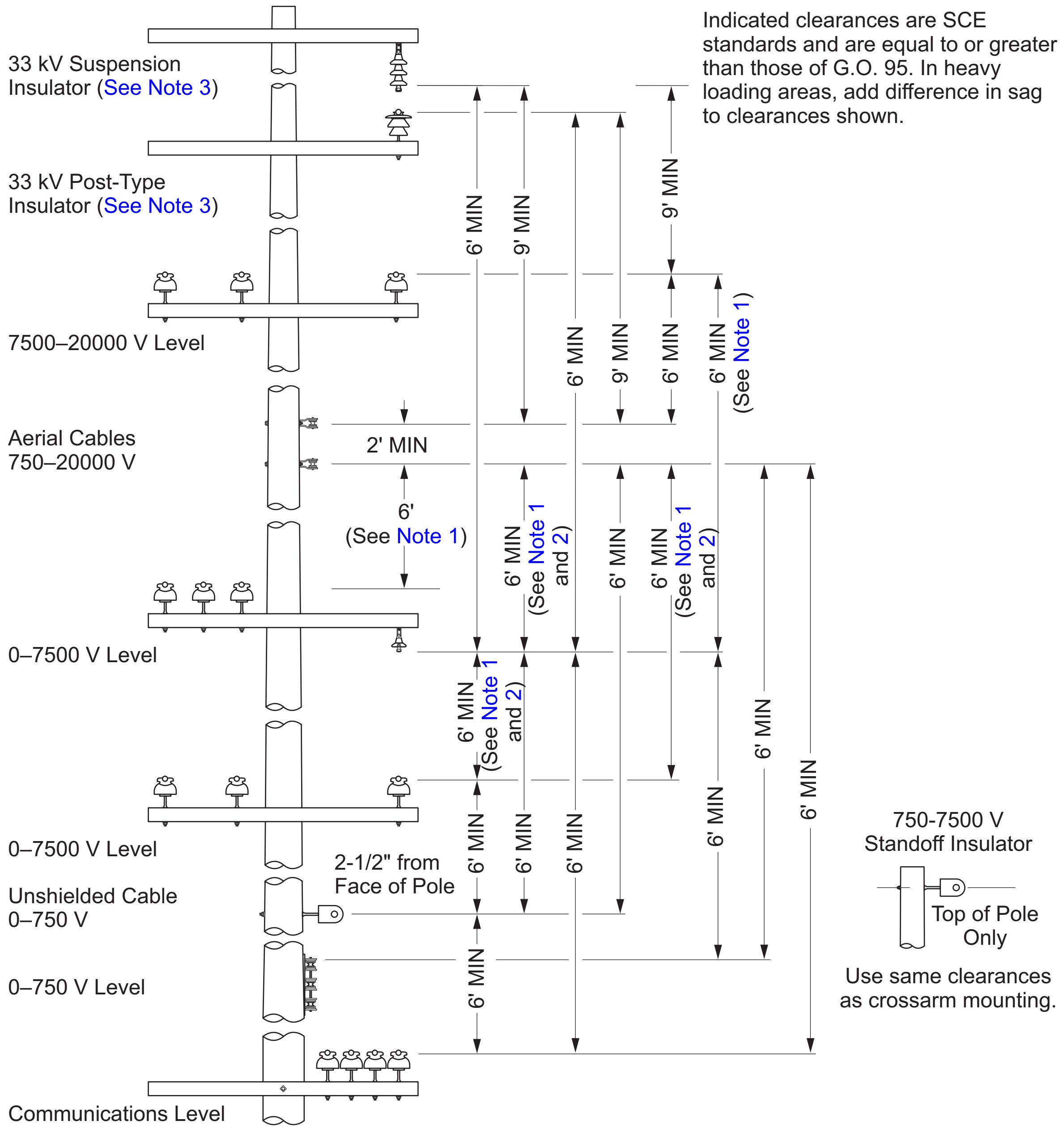


Note(s):

1. May be reduced to 4 feet for cable only on lower arm.
2. These clearances do not include the buck arm when buck arm is used. Clearances below must be calculated from that open wire level.

Scope AC 120.2 Above-Below-Parallel (Line Arms)

Figure AC 120–2: Clearances Above-Below-Parallel (Line Arms)



Note(s):

1. A 6-foot clearance between primary circuits will be used on new line construction and on pole replacements when minimum sag requirements per CO Section can be maintained.
2. Clearance may be reduced to 5-1/2 feet on existing arm construction.
3. For minimum clearance between 66 kV subtransmission conductors and distribution conductors (see Table DC 200–1).

What's Changed? Figure AC 120 was updated for clarity and Note 3 was added.

AC 130 Surge Arresters

Scope AC 130.1 Application of Surge Arresters

Surge arresters should be used at all points where open overhead wires are connected to aerial cables and at all transformer locations. Install arresters at both ends of all aerial cable sections on the system.

Surge arresters, when placed on a pole for the protection of apparatus or transformers, shall be located on the **same** pole. In this case, a secondary neutral ground should be placed on an adjacent pole whenever possible. If it is impossible to place the secondary neutral ground on an adjacent pole, and both grounds are installed on the same pole, see GR 105 for details on what to do.

Any transitions from Aerial Cable to an open circuit (or vice versa) by the use of potheads shall have surge arresters installed close to the potheads.

Selection of the proper surge arresters should be made as directed by Distribution Apparatus Construction Standards (DAP).

Arresters should be located as close as practical to the cable being protected.

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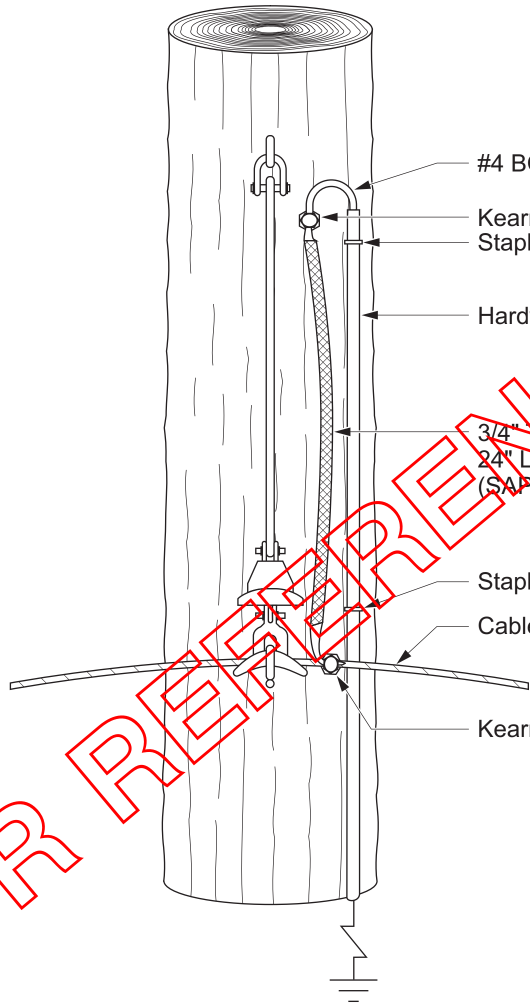
AC 140 Grounding

Scope AC 140.1 Flexible Ground Connections on Free-Swing Tree-Mounting

Figure AC 140–1: Flexible Ground Connections on Free-Swing Tree-Mounting

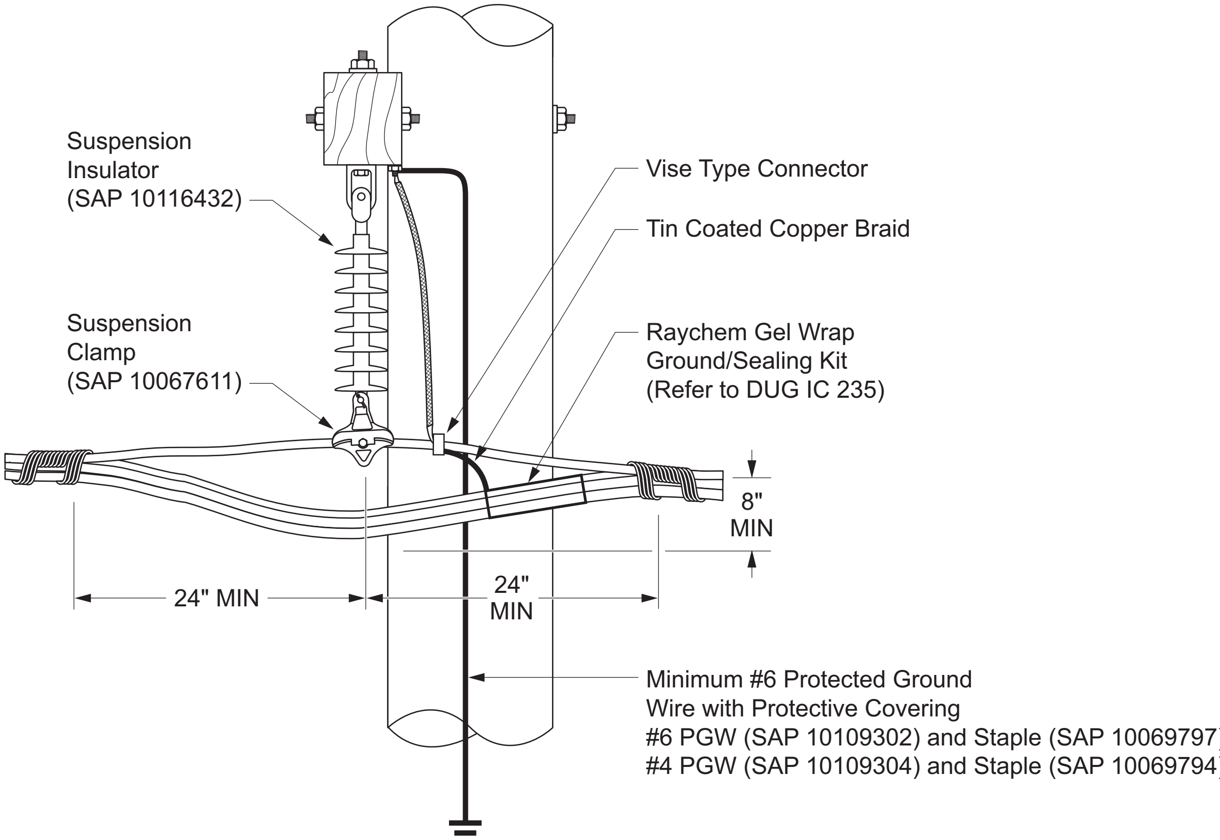


Note(s):

1. Messengers supporting aerial cable shall be effectively grounded at both ends of each run and at intermediate points not exceeding 800 feet apart per G.O. 95. It is recommended that messenger grounds be established at approximately 600 foot intervals.
2. Common grounds shall not be installed. Primary, secondary, and equipment grounds are to be separated. Where practical, primary grounds are to be installed on other than transformer poles. As a matter of preference, grounds should be installed on poles rather than trees.

Scope AC 140.2 Grounding Messenger for 4 kV, 12 kV, and 16 kV

Figure AC 140–2: Grounding Messenger for 4 kV, 12 kV, and 16 kV



Note(s):

1. Messengers supporting aerial cable shall be effectively grounded at both ends of each run and at intermediate points not exceeding 800 feet apart per G.O. 95. It is recommended that messenger grounds be established at approximately 600 foot intervals.
2. Do not install common grounds. Separate primary, secondary and equipment grounds. Where practical, install primary grounds on non-transformer poles.
3. The Cable Messenger, Concentric Neutral wires, and lashing wires will be electrically connected together. The messenger shall be electrically continuous throughout the circuit.
   A. At cable dead-ends, a jumper wire of equivalent size must be used to make the messenger wire electrically continuous.
   B. Incorporate the messenger into the personal grounding Equal Potential Zone (EPZ).
4. Use pothead construction when a location requires EPZ (Exception is 4 kV and below).

AC 200 Operating Instructions — Spinner

Scope AC 200.1 Operating Instructions for Model K Neale Spinner

1.0 Spinning Wire

The spinning wire for the Model K Spinner is wound on a metal spool. To load the spinning wire, first remove the empty spool from the spinner by loosening the knurled knob until the spool falls free and then insert the new spool, placing the notch in the spool holding the spinning wire end next to the tension pulley. Tighten knurled knob **finger tight** to force the retainer spring against the spool. Feed the spinning wire under the tension pulley, over the idler pulley, and around the drive pulley, **bringing the end of this wire between the spinner and the wire from the spool**. Repeat the same operations for the second spool on the opposite side of the spinner. **Be sure to install the second spool exactly the same as the first to ensure that they rotate in the same direction.**

2.0 Adjusting Tension of Spinning Wire

To adjust the tension of the spinning wire, loosen the screw holding the tension scale and rotate the scale to a higher or lower number in order to increase or decrease the tension. Be sure both tension scales are set exactly alike. Number 5 on the scale results in a tension of about 35 pounds using 0.090-inch copper wire. This is the tension that should be used for most sizes of cables.

3.0 Placing the Spinner on the Messenger

3.1 The drum of the spinner must be locked before the spinner is raised to the messenger. Open the front cable forming rollers, open the messenger guide jaws, and open the end-gate at the rear of the spinner; then place the spinner on the messenger. First close the messenger guide jaws, thus preventing the spinner from falling. Close the front cable forming rollers, placing the three cables in a V configuration as they enter the spinner.

3.2 Pull off sufficient spinning wire from both spools to properly terminate them.

3.3 Close the end-gate at the rear of the spinner and adjust the rollers to force the cables in close V configuration, centered in the spinner. Adjust the rear messenger pulley to pull the messenger down against the cable. Terminate the spinning wire on the messenger by means of temporary clamps. The spinner makes one revolution every 13 inches of forward travel. The left spinning wire facing the rear of the spinner is terminated 13 inches behind the spinner, and the right wire 6-1/2 inches behind the spinner. Proper spacing on terminations before starting will ensure correct spacing between wraps on the cable.

3.4 Attach the towing ropes and release the drum lock. Hang the cable placing dolly, and attach towing rope. Adjust main towing rope so the cable placing dolly will ride within 2 feet of the spinner.

4.0 Lubrication Instructions

4.1 The TENSION PULLEY and IDLER PULLEY should be oiled twice daily. Be sure to remove the excess oil so that none of the oil will be carried to the cables. Clean both the front and rear drum tracks twice daily.

4.2 The rest of the bearings are packed at the factory and should not require further lubrication.

Figure AC 200–1: Field-Assembled Aerial Cable Installation Tools and Equipment

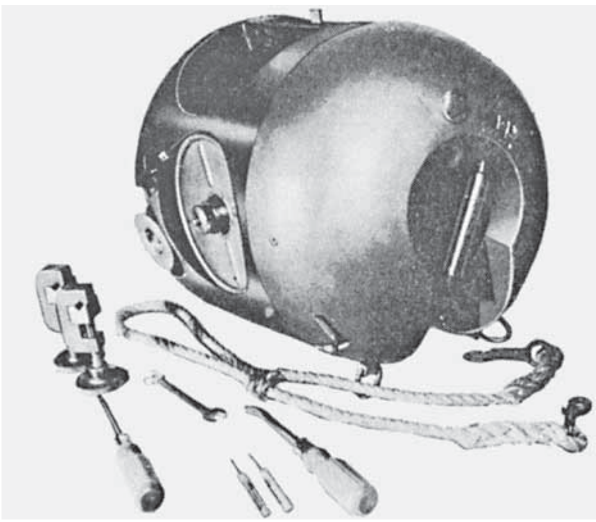


Figure AC 200–1.5: Neale Model K Pull Tyle Spinner
(SAP 843-25505)

Figure AC 200–1.6: Cable Pulling Dolly
(SAP PENDING)

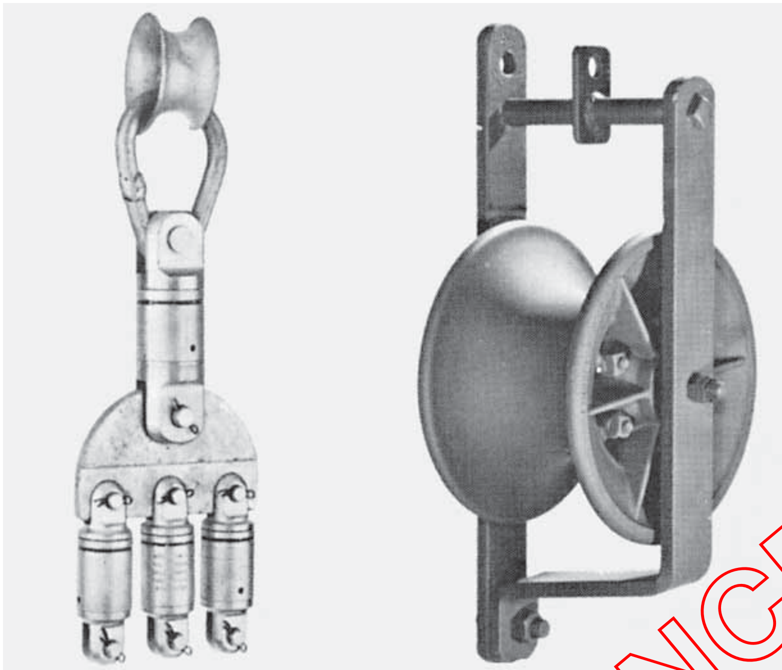


Figure AC 200–1.7: Cable Running Board
(SAP PENDING)

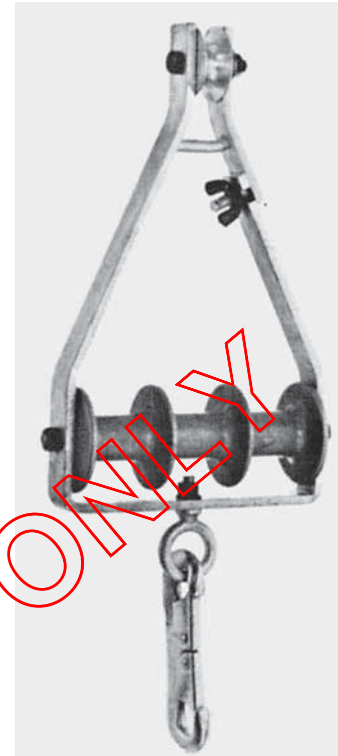


Figure AC 200–1.8: Cable Pulling Ring
(SAP PENDING)

Above illustrations are of tools and equipment normally used in the installation of field assembled aerial cable. These tools are available from Section 16, General Store. The number of cable placing rings normally used can be estimated on the basis of 20-foot spacing. Cable placing blocks may be used to greatest advantage when cable is to be directly polemounted.

Figure AC 200–2: Installation of Field-Assembled Aerial Cable

Figure AC 200–2.9

Messenger has been installed and tensioned. Cable placing rings are hung on messenger cotton line at approximately 20-foot intervals. The bull line is installed through the cable placing rings and cable blocks.

Figure AC 200–2.10

Cable and bull line are attached to running board. End of cotton line in front of first cable placing ring is tied to rear of running board. As cable is pulled in, cable placing rings follow running board in train, supporting cable on messenger.

Figure AC 200–2.11

Running Board in Midspan with cable placing rings following (Note sag clearance from other conductors). As running board completes each span of travel, ends of cotton line are tied off at poles to maintain position of cable placing rings.

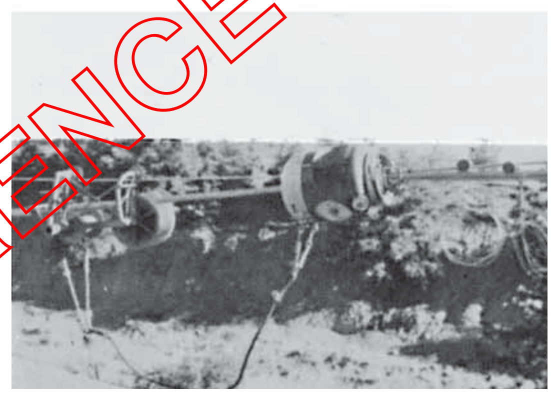


Figure AC 200–2.12

Cable-placing dolly and Model "K" spinner installed, preparatory to spinning. (Note sufficient spinning wire allowed for wrapped terminations, and secured to messenger with temporary clamps). See AC 210 for measurements on temporary spinning wire terminations.

Figure AC 200–2: Installation of Field-Assembled Aerial Cable *(Continued)*

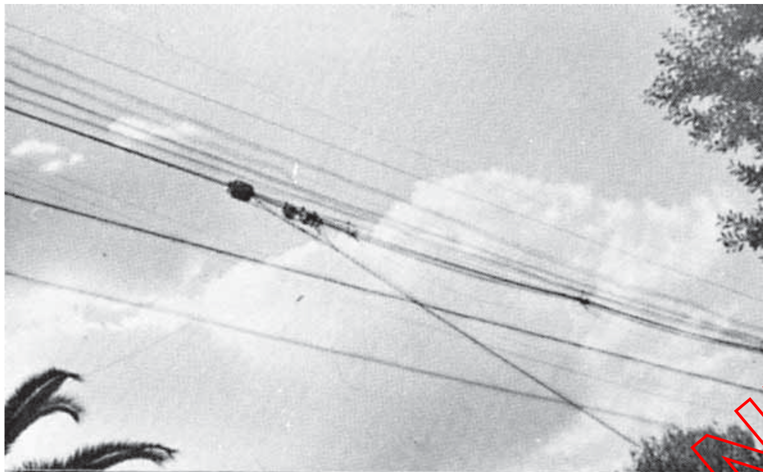
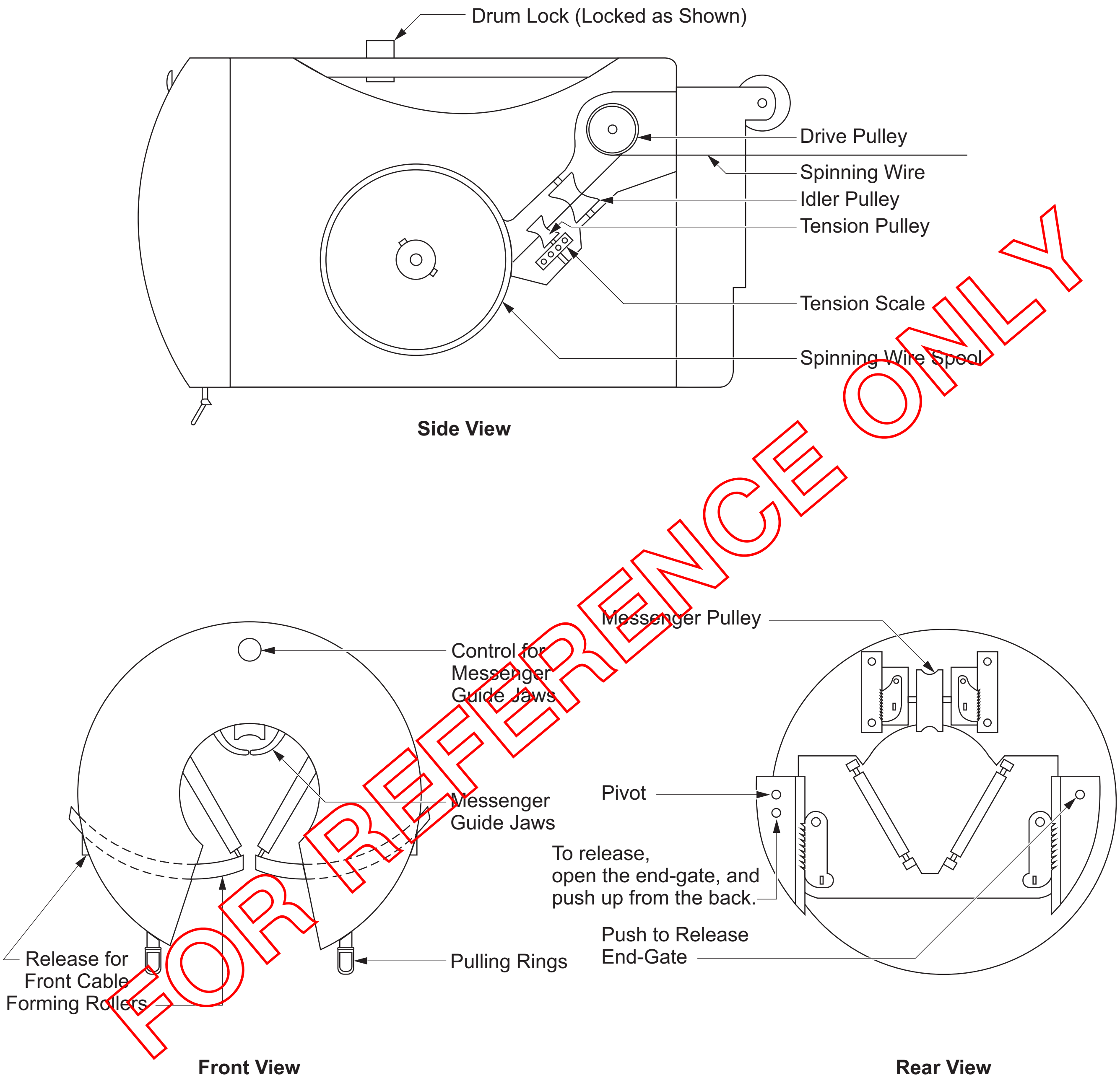


Figure AC 200–2.13

End of Cotton Line — Securing cable-placing rings are released, and the cable-placing dolly and spinner are towed by hand, lashing the cable to the messenger. (Note that cable-placing rings are pushed by the dolly and spinner to the next pole.)

Scope AC 200.2 Typical Operating Instructions — Spinner

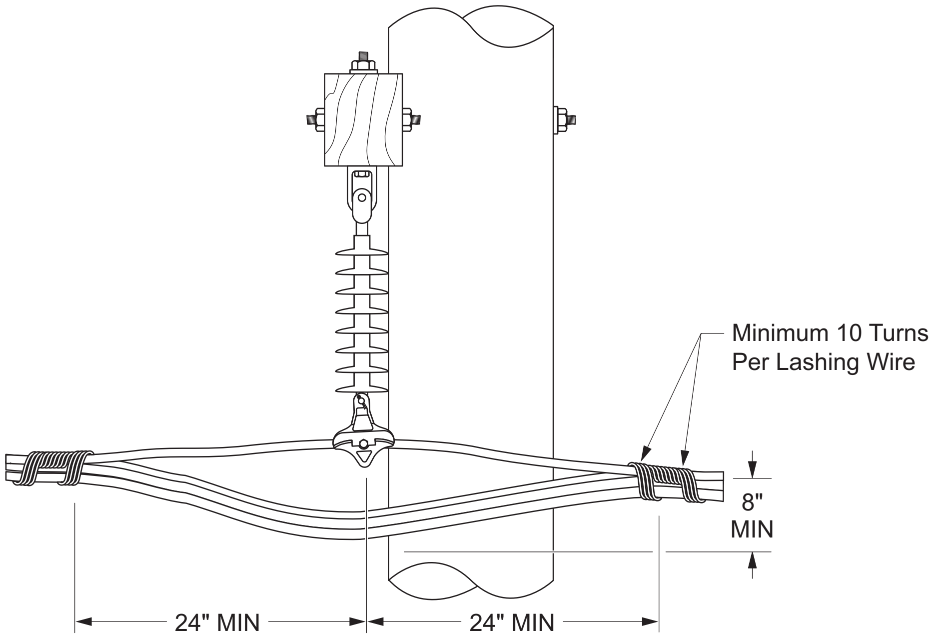
Figure AC 200–3: Spinner — Side, Front, and Rear Views

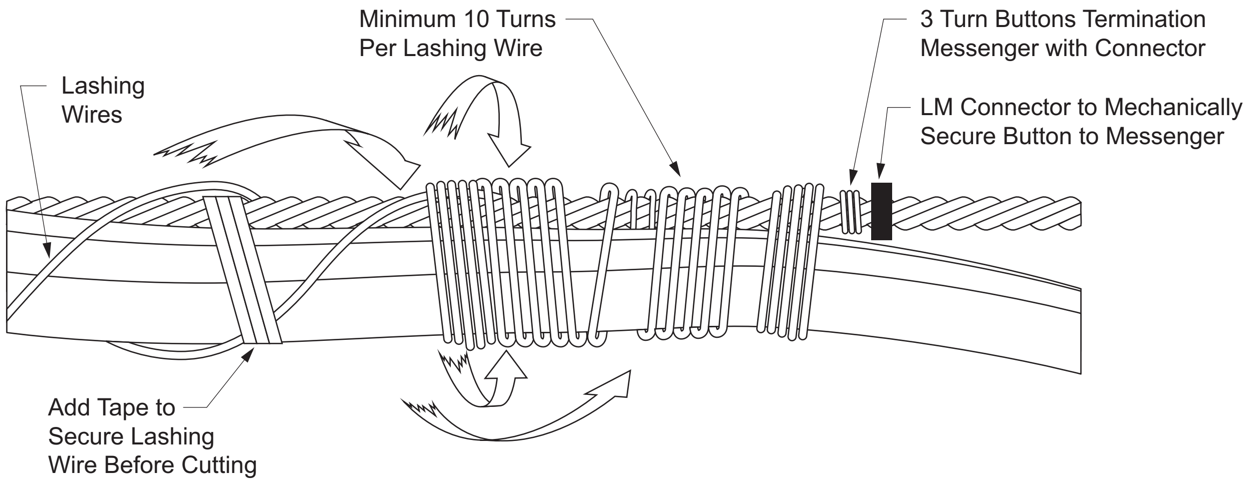


AC 210 Terminating Lashing Wires

Scope AC 210.1 Terminating Lashing Wires

Figure AC 210–1: Terminating Lashing Wires





Spinning Wire

SAP 10110481 Spool = 1,200 ft stainless steel
SAP 10109328 9 lb spool = 375 ft copper

Estimate: 2:1 for spinning on cable sizes smaller than 4/0
2:1 for spinning on cable sizes 4/0 and larger

= For Reference Only

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AC 215 Aerial Cable Installation Equipment

Scope AC 215.1 Aerial Cable Pulling Socks and Rollers

1.0 Aerial Cable Messenger Pulling Grip

1. Install pulling grip to the Copperweld messenger. See Table AC 215–1 below.

Table AC 215–1: Aerial Cable Messenger Pulling Grip

Voltage	Messenger Size	Messenger Diameter (in)	Grip Size	Kellems Grip Part Number	Rated Work Load (lb)	SAP
4/12/16 kV	3/8 (7-#8 AWG)	0.385	1/4" to 1/2"	033-27-1037	1,300	10144657
	1/2 (7-#6 AWG)	0.486				

2. Reinforce the tail end of the grip with a metal lock band or copper mousing wire.
3. Taper or stagger the phase conductors to allow an easy passage through the rollers.
4. Securely fasten the phase conductors and lashing wire to the messenger using metal lock bands.
5. Sufficiently cover metal lock bands and tapered/staggered conductors with 33 tape to prevent the cable assembly from snagging on rollers, branches or other obstacles.
6. Attach pulling line to pulling grip with a ball bearing or roller bearing swivel.

Figure AC 215–1: Aerial Cable Messenger Pulling Assembly

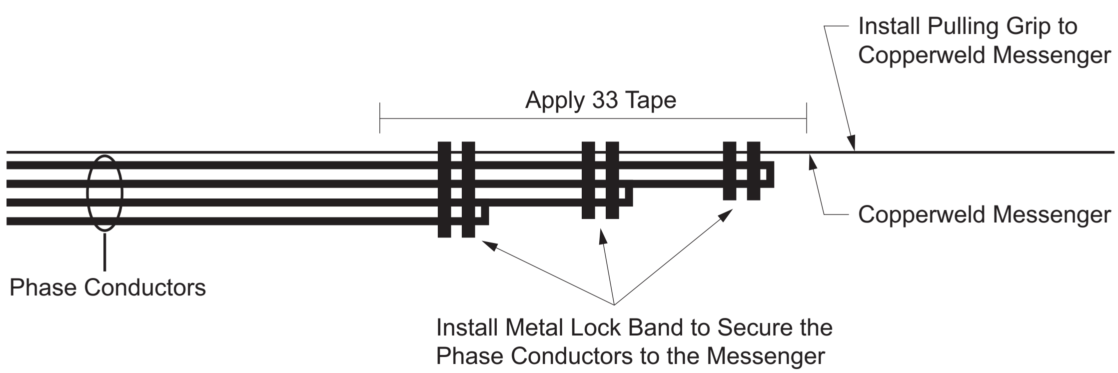


Table AC 215–2: Aerial Cable Rollers

Voltage	Aerial Cable Size	Overall Assembly Diameter (in)	Roller Width (in)	Green Lee Model Number[a/]	Rated Work Load (lb)	SAP
4/12/16 kV	3 - 1/0 AWG	2.37	5	650	4,000	10169509
	2 - 1/0 AWG	2.34	5	650	4,000	10169509
	3 - 350 kcmil	3.23	5	650	4,000	10169509

[a/] As an alternative, the Model HIS 10x5 roller may also be used and has a rated working load of 6,000 lb.

Note(s):

1. If grounding is required while stringing, see the overhead grounding manual for details.

Approved by:

What's Changed? New standard developed to provide installation equipment requirements for Aerial Cable.

Effective Date: 11-10-2011

AC 220 Messenger Tensions

Scope AC 220.1 Messenger Tensions

Table AC 220–1: Messenger

Cable Size 1, 2, or 3 Conductor	Messenger	SAP
To 1/0 Al	3/8" E.H.S. Copperweld — 30% Conductivity 3/8" E.H.S. Steel	10109359
To 350 kcmil Al	1/2" E.H.S. Copperweld — 30% Conductivity	10109360

Table AC 220–2: Messenger Tensions (without Cables) on Poles

Messenger Tensions (without Cable) on Poles (Span Lengths 125 through 175 Feet)				
Temp °F	Messenger Tension-Pounds			
	Final		[a]Pre-Stress (to be Left 12 hr)	
	3/8"	1/2"	3/8"	1/2"
40	3,600	5,000	4,500 lb minus 20 lb for each degree temperature drop expected during pre-stress period.	6,700 lb minus 25 lb for each degree temperature drop expected during pre-stress period.
50	3,500	4,850		
60	3,300	4,700		
70	3,200	4,550		
80	3,000	4,400		
90	2,900	4,250		
100	2,700	4,100		

[a] Use these tensions to determine guying requirements.

1.0 Pre-Stressing

1.1 Messengers are to be pulled to the tension shown under “Pre-Stress” in Table AC 220–2 (Sheet 1) and left at this tension for 12 hours to pre-stress the poles, messengers, guys and anchors. At the end of the 12-hour period, the tension should be checked with a dynamometer (see AC 220.2 (Sheet 3)). If the reading is 75 percent or more of the original tension (taking into account difference in temperature), slack off messenger to tension shown under “Final” in Table AC 220–2 and proceed with installation of cable. If the reading is less than 75 percent of the original tension at the end of the 12-hour period, inspect poles, guys, and anchors for settling, slippage, or failure. When the source of trouble has been located and eliminated, again pull messenger up to tension shown under “Pre-Stress.” If it does not then drop appreciably after a two-hour period, slack off messenger to tension shown under “Final” and proceed with installation of cable.

Note: For additional information, contact Field Engineering.

Table AC 220–3: Messenger Tensions (without Cables) on Trees]

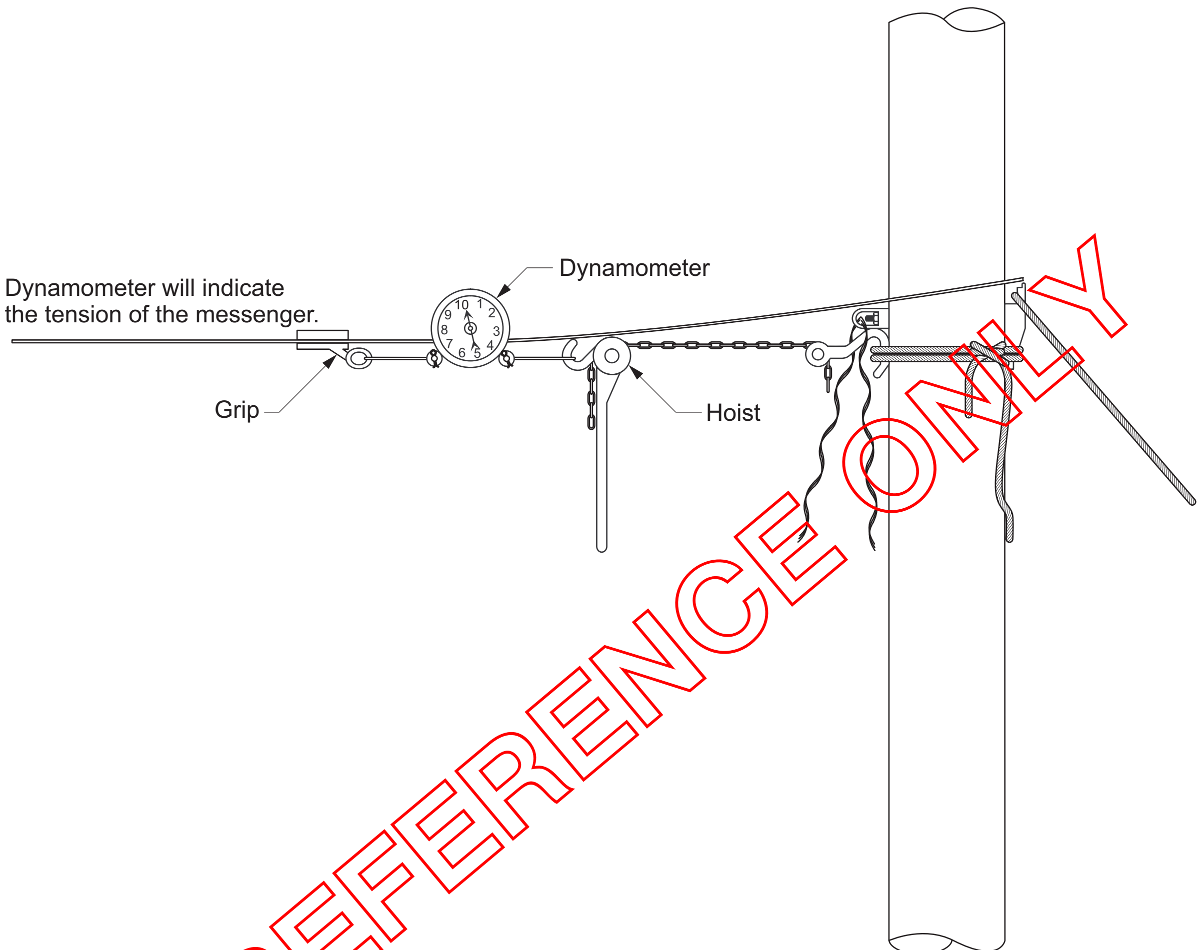
Temp °F	Messenger Size	Final Tension (lb)
60	3/8" Copperweld — 3/8" E.H.S. Steel	300
60	1/2" Copperweld	700

Note(s):

1. Pre-stress of messengers may be omitted on tree installations.

Scope AC 220.2 Messenger Tensions

Figure AC 220–1: Messenger Tensions



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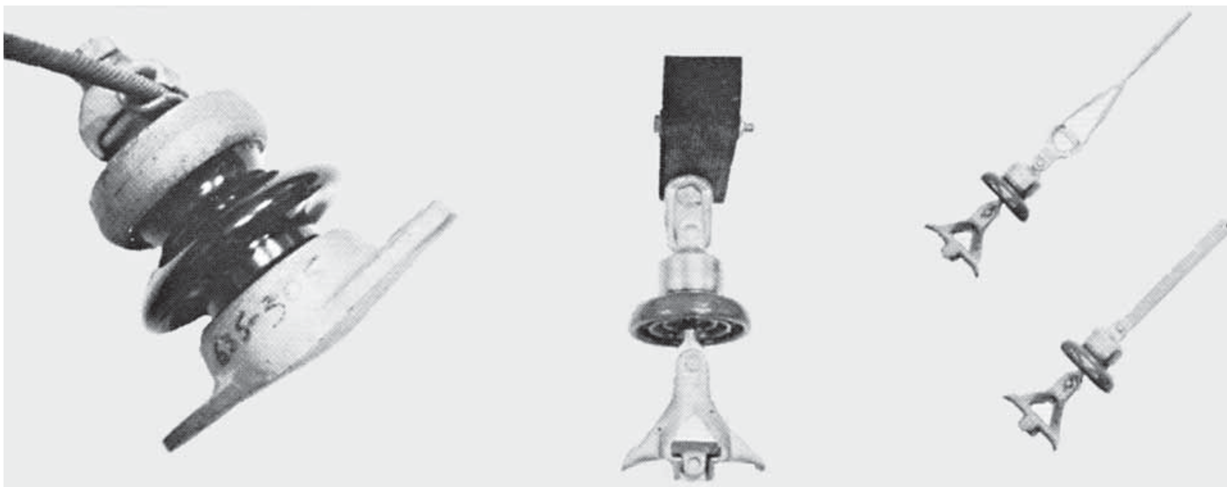
AC 230 Insulating the Aerial Cable Messenger

Scope AC 230.1 Insulating the Aerial Cable Messenger

General Order (G.O.) 95, Rule 33.1, provides that the neutral conductor shall be considered as carrying the same voltage as the other conductors of the circuit.

Therefore, on circuits where the messenger is also used as the neutral, the messenger **must** be insulated in one of the following suggested methods.

Figure AC 230–1: Insulating the Aerial Cable Messenger



Horizontal Line Post Insulator
For top of pole only.
Insulator (SAP 10116394)
Messenger Clamp for 3/8" or 1/2" (SAP 10067463)

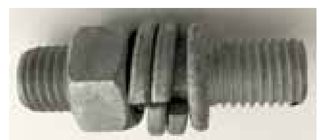
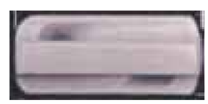
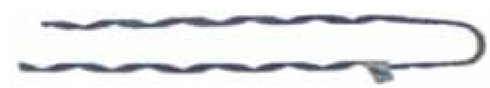
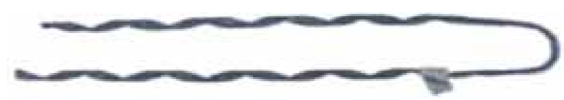
Suspension Method
Suspension Clamp for Crossarm or Trees.
3/8" through 9/16" (SAP 10067611)
Tree Attachment
5/16" through 1/2" (SAP 10067610)

Note(s):

1. For simplicity, all construction drawings in this section show the messenger insulated. Delete insulators for circuits where the messenger is not used as a neutral.

= For Reference Only

Table AC 230–1: Insulators, Dead Ends, and Miscellaneous for Aerial Bundled Cable

SAP	Description	Picture
	Insulators	
10116349	15 kV Silicone Post-Type (Clamp Top)	
10068619	Angle Base	
10116404	Short Stud	
10116432	Suspension/Dead-End Insulator	
10116492	Guy Strain Insulator	
	Dead Ends	
10067955	3/8-inch Copperweld Preform	
10067956	1/2 Copperweld Preform	
10067485	Full Tension Dead End Shoe Quadrant Clamp	
10067502	Bolted Dead End Shoe	

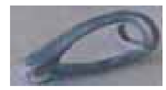
Insulating the Aerial Cable Messenger

What's Changed? Removed rows for Stand Off, Clamp Top, Horizontal-Post and Pin-Type insulators. Added Silicone Post-Type insulator. Added rows for Angle Base and Hog Eye.

Approved by: RR

Effective Date: 01-29-2021

Table AC 230–1: Insulators, Dead Ends, and Miscellaneous for Aerial Bundled Cable *(Continued)*

SAP	Description	Picture
	Miscellaneous	
10067611	Suspension Clamp	
10067656	Clevis (Heart)	
10068525	Span Guy Eye	
10067854	Dead-End Eye (Hog Eye)	

Effective Date: 01-29-2021

What's Changed? Removed rows for Stand Off, Clamp Top, Horizontal-Post and Pin-Type insulators. Added Silicone Post-Type insulator. Added rows for Angle Base and Hog Eye.

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AC 290 Aerial Cable Angle Construction Requirements

Scope AC 290.1 Angle Construction Requirements

See Table AC 290–1 for guidance on angle construction requirements on Aerial Cable systems. For each construction type listed below, the deviation must not exceed the applicable limiting angle provided below.

See DC 585 for determination of deviation angle.

Table AC 290–1: Angle Construction Requirements

Construction Type	Limiting Angle	Standard Reference
Free Swing	30°	AC 330
Pole-Mounted Double Dead-End	60°	AC 345
Pole Mounted Corner	90°	AC 360

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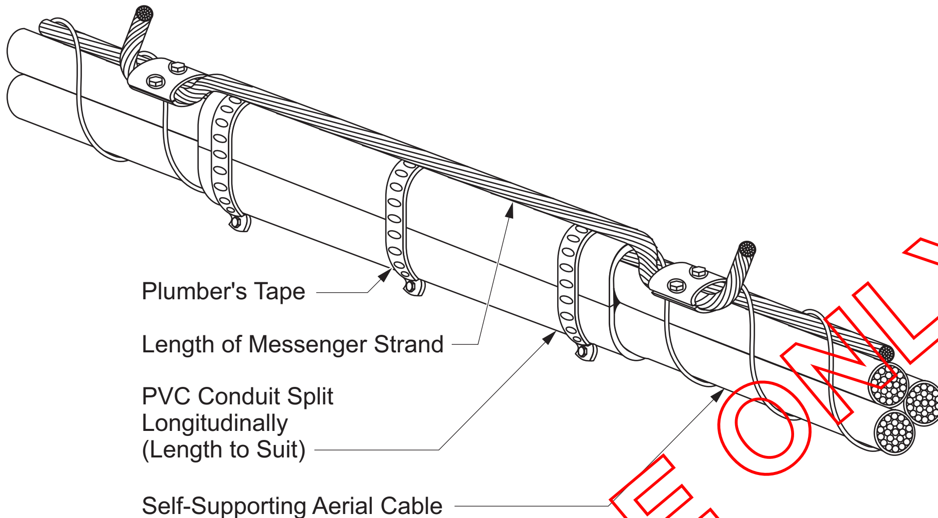
AC 300 Aerial Cable Tree Guard

Scope AC 300.1 Aerial Cable Tree Guard

Figure AC 300–1: Aerial Cable Tree Guard



Note(s):

1. Tree guard to be used over messenger and cable where the cable is in direct or very frequent contact with tree trunks or limbs one-inch in diameter or larger.

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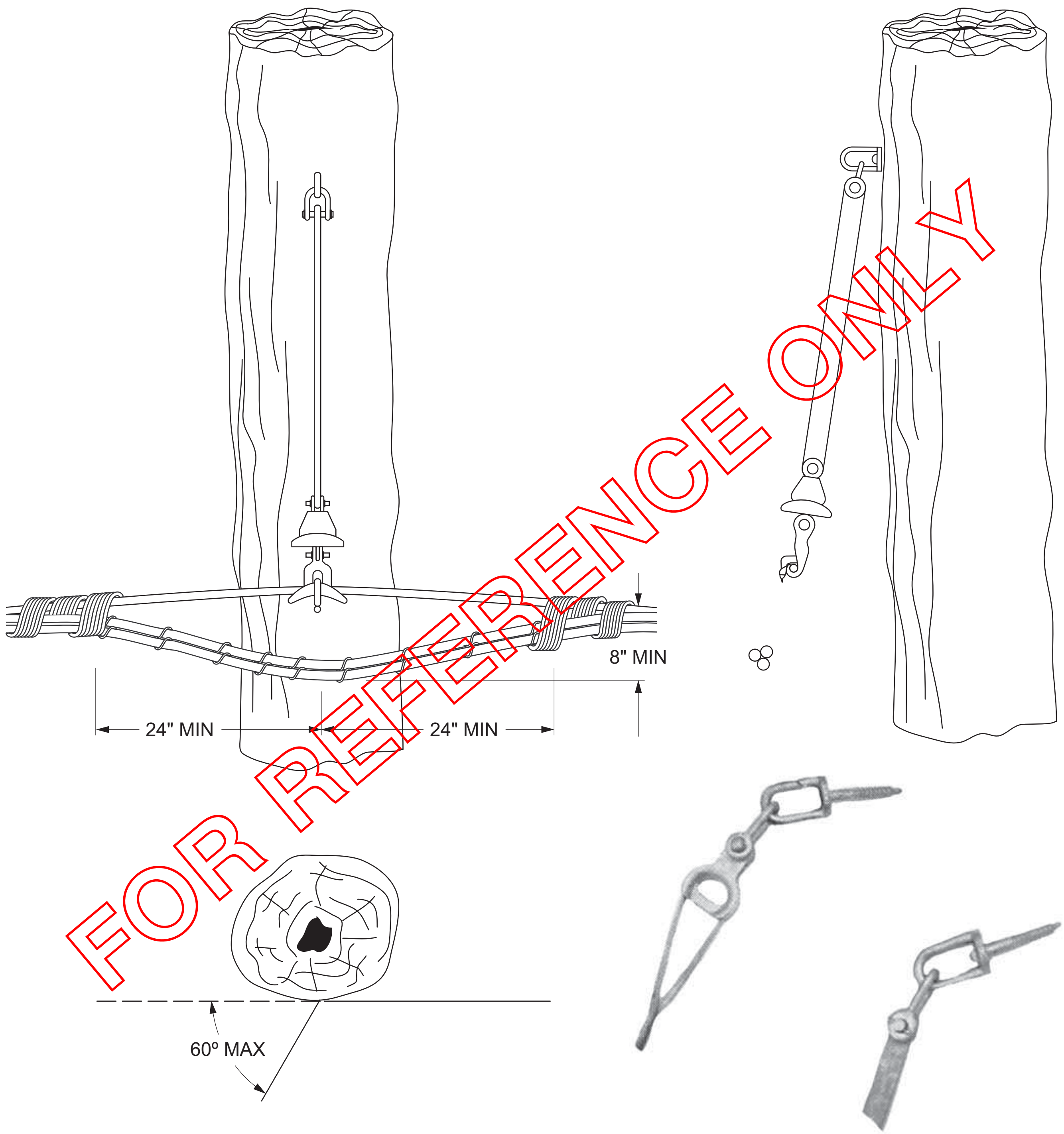
AC 310 Tree-Mounted Aerial Cable Free Swing

Scope AC 310.1 Tree-Mounted Aerial Cable Free Swing

Figure AC 310–1: Tree-Mounted Aerial Cable Free Swing



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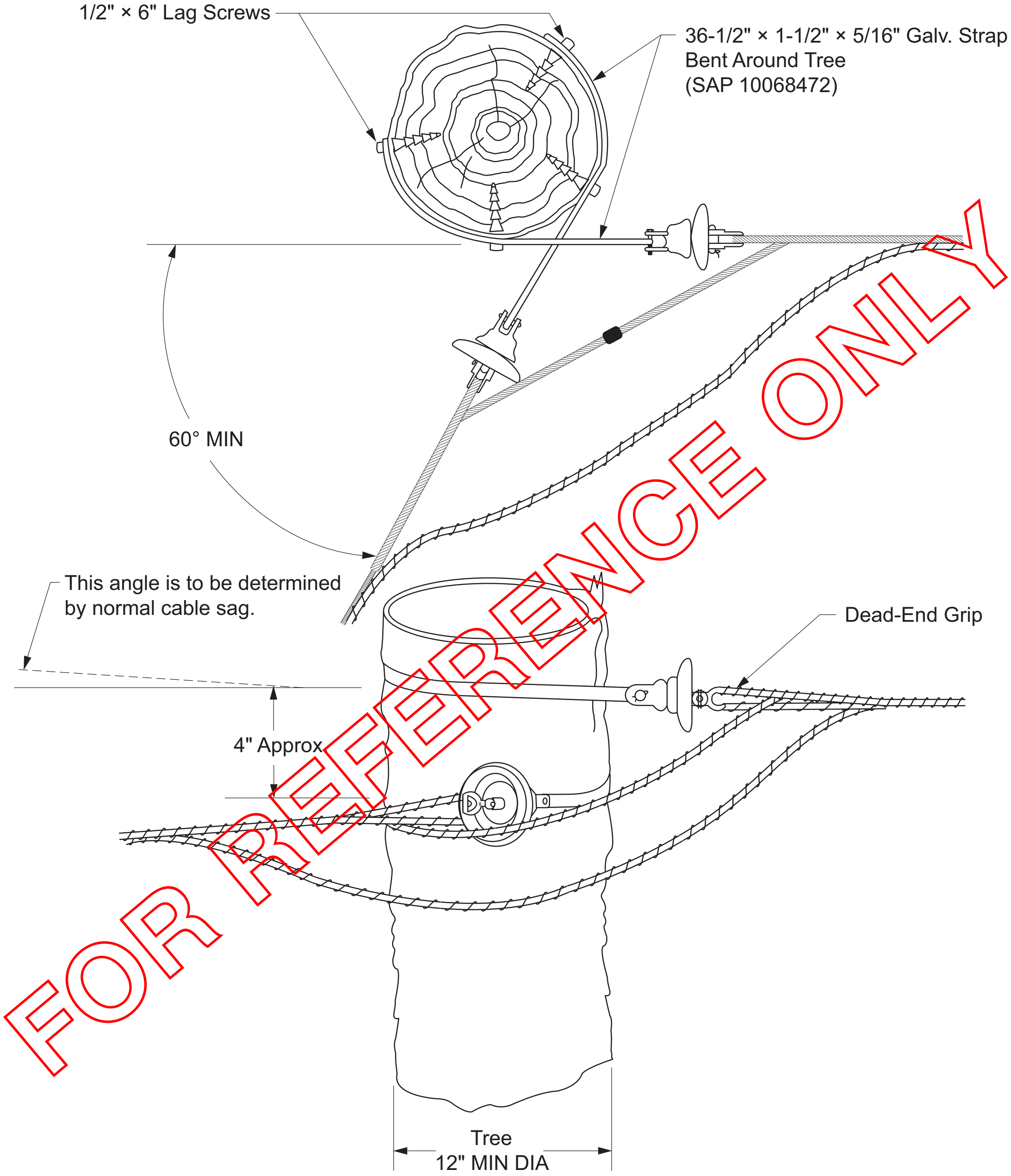
AC 320 Aerial Cable Tree-Mounted Corner

Scope AC 320.1 Aerial Cable Tree-Mounted Corner

Figure AC 320–1: Aerial Cable Tree-Mounted Corner



This construction is to be used for angles of deviation in excess of 60°.

Approved by:	Aerial Cable Tree-Mounted Corner	AC 320 Sheet 1 of 1
Effective Date: 11-10-2011	**What's Changed?** Complete standard was marked "For Reference Only."	DOH

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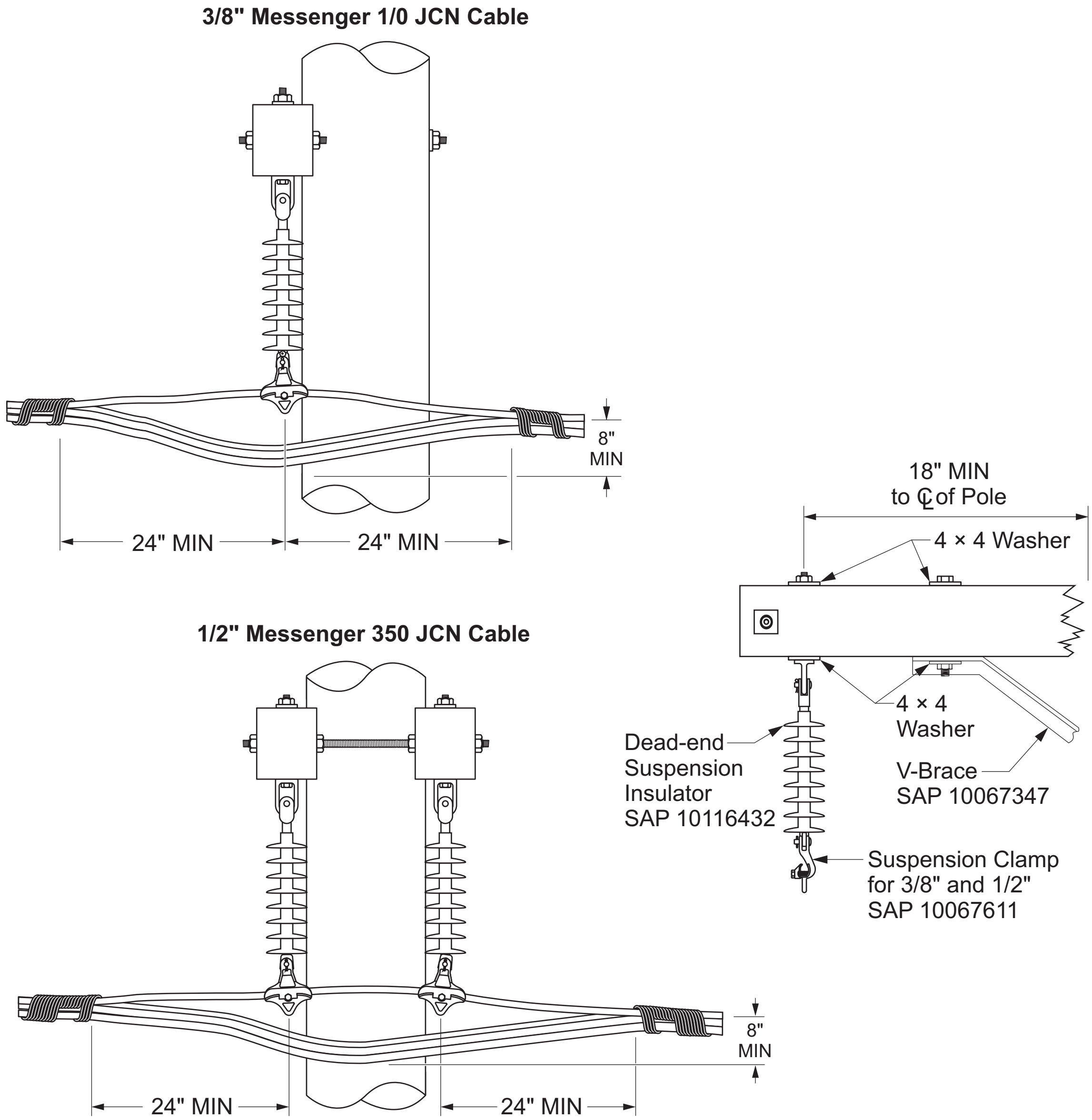
AC 330 Typical Aerial Cable Free Swing

Scope AC 330.1 Typical Aerial Cable Free Swing

Figure AC 330–1: Aerial Cable Free Swing



Note(s):

1. Install V-brace for all messenger sizes.
2. Maximum angle of deviation is 30°.
3. Install chain shackle (SAP 10068452) between hog eye and insulator, and also between shoe and insulator.
4. Install stand-off bracket (SAP 10214167) between pole and V-Brace.

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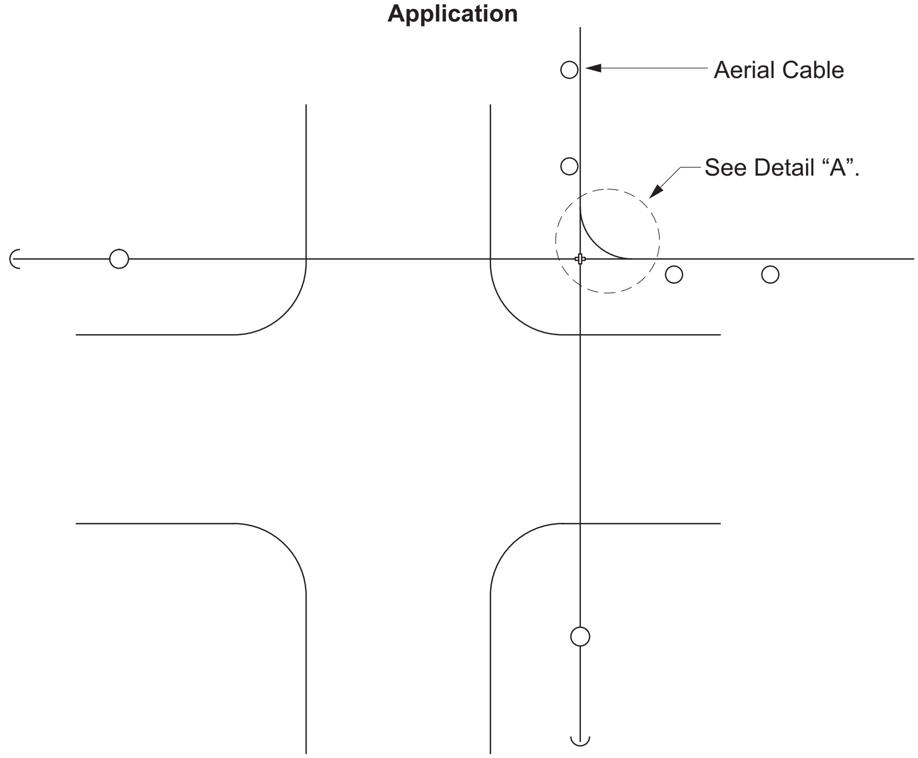
AC 340 Aerial Cable Flying Dead-End Corner

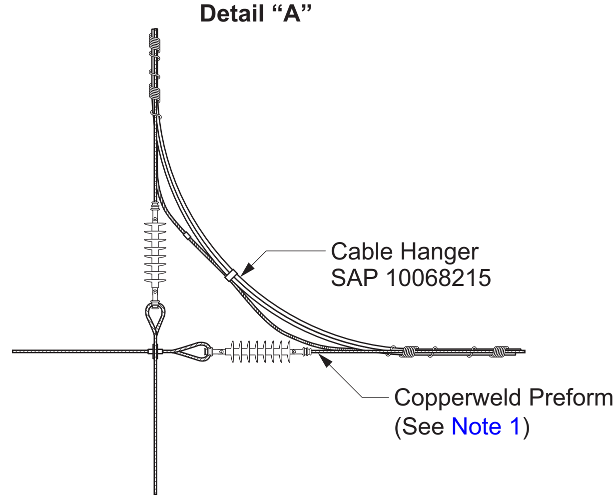
Scope AC 340.1 Typical Aerial Cable Flying Dead-End Corner

Figure AC 340–1: Aerial Cable Flying Dead-End Corner

Application



Detail “A”



Note(s):

1. Guy strain insulator is an alternative insulator for 2.4/4.16 kV systems.

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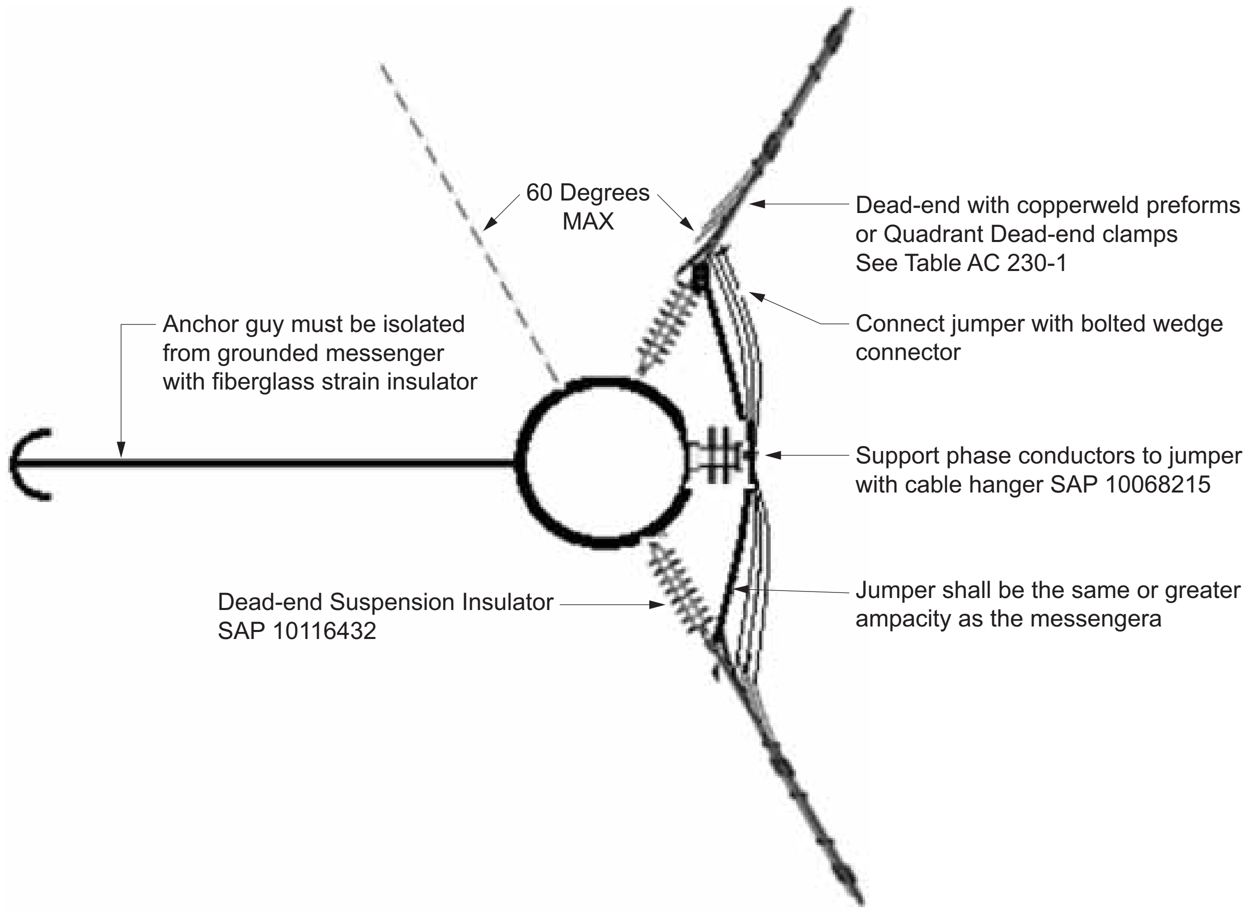
AC 345 Pole-Mounted Double Dead-End

Scope AC 345.1 Typical Pole-Mounted Double Dead-End

Figure AC 345–1: Typical Pole-Mounted Double Dead-End



Note(s):

1. Use separate through bolts and hog eyes if deviation angle exceeds 30 degrees.

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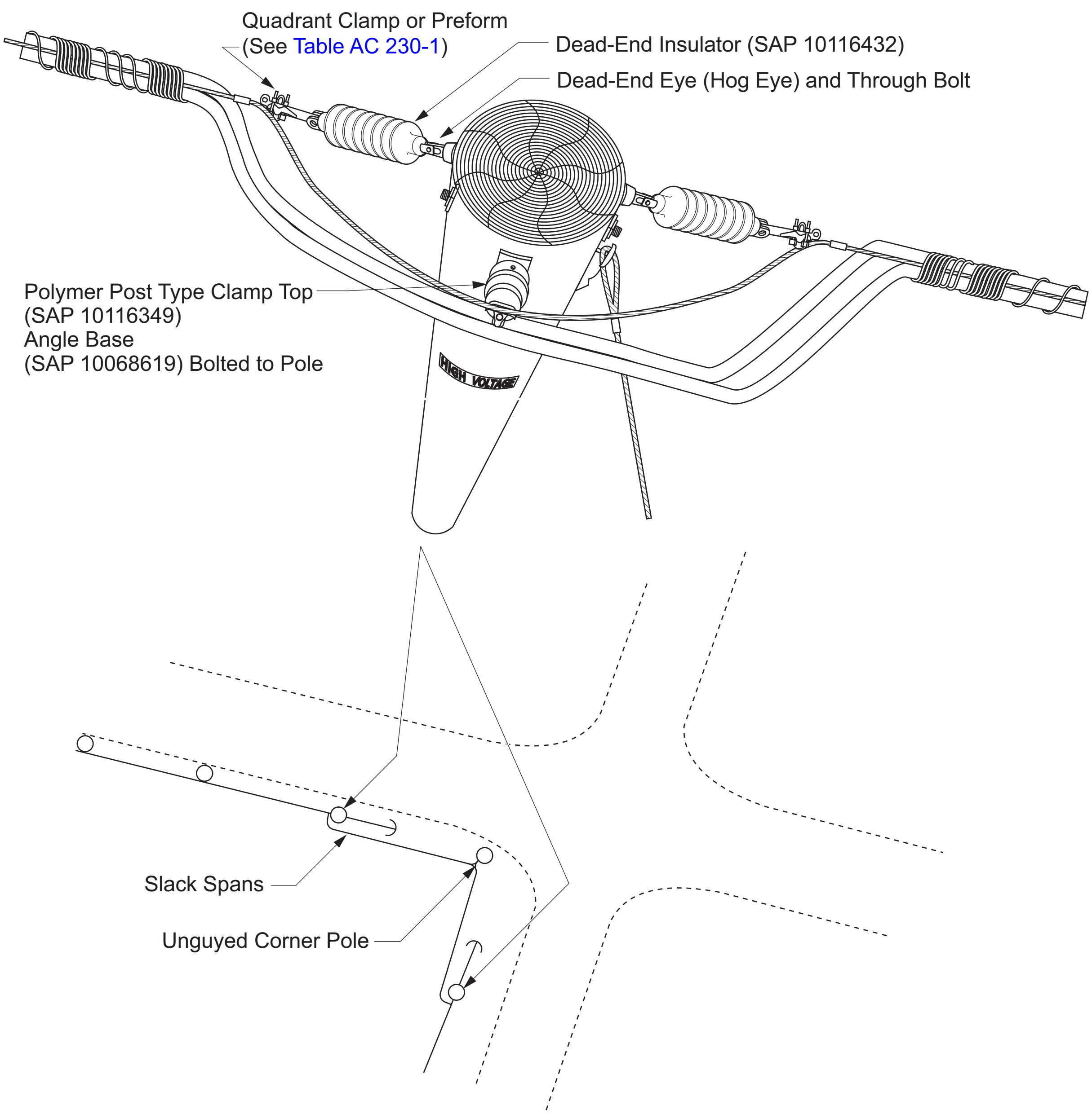
AC 350 Aerial Cable Dead-End with Anchor Guy

Scope AC 350.1 Aerial Cable Dead-End with Anchor Guy

See Table AC 230–1 for insulators, dead-ends, and miscellaneous hardware.

This configuration can also be used for Grade “A” crossings

Figure AC 350–1: Aerial Cable Dead-End with Anchor Guy



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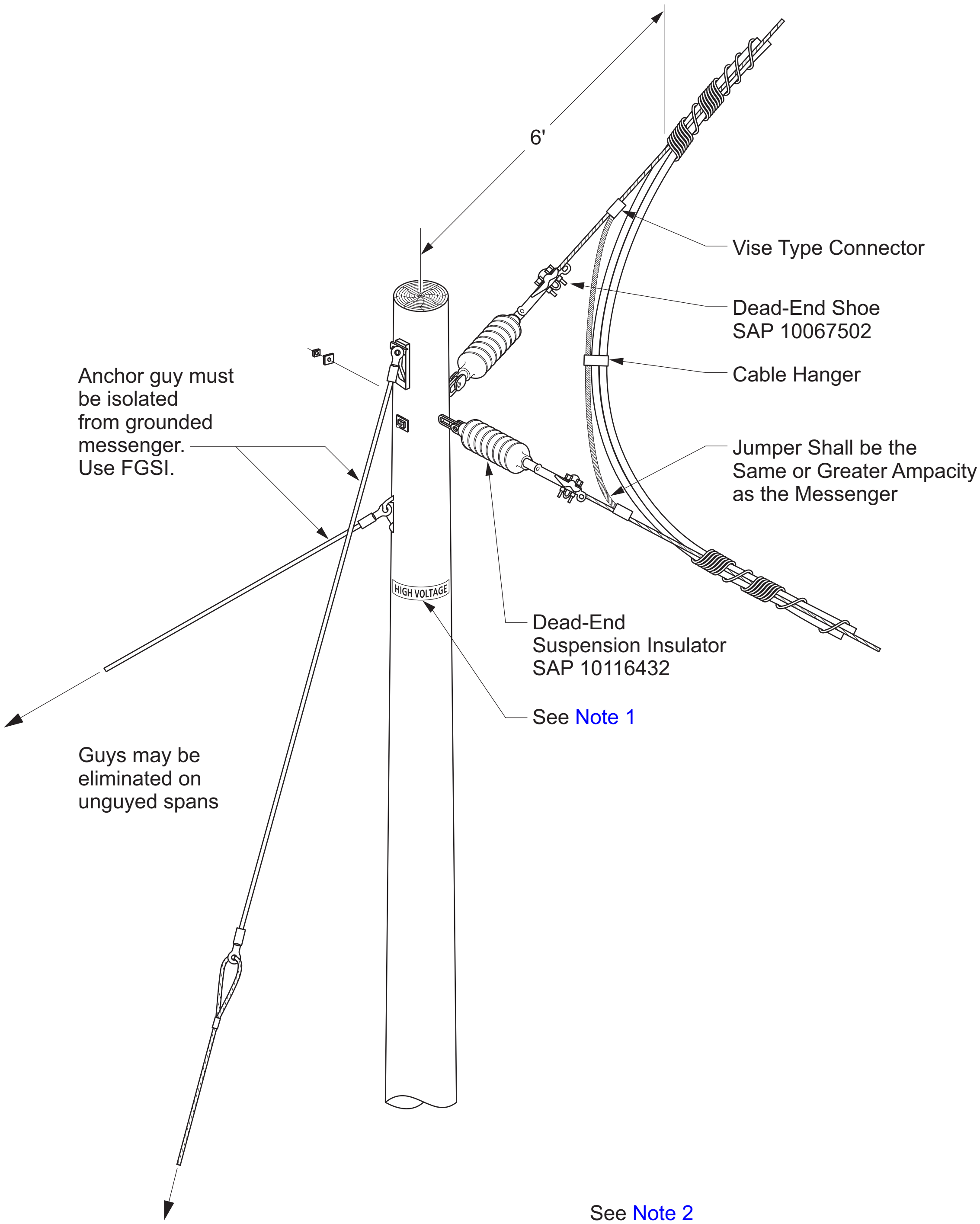
AC 360 Pole-Mounted Corner

Scope AC 360.1 Typical Pole-Mounted Corner

Figure AC 360–1: Typical Pole-Mounted Corner



See Note 2

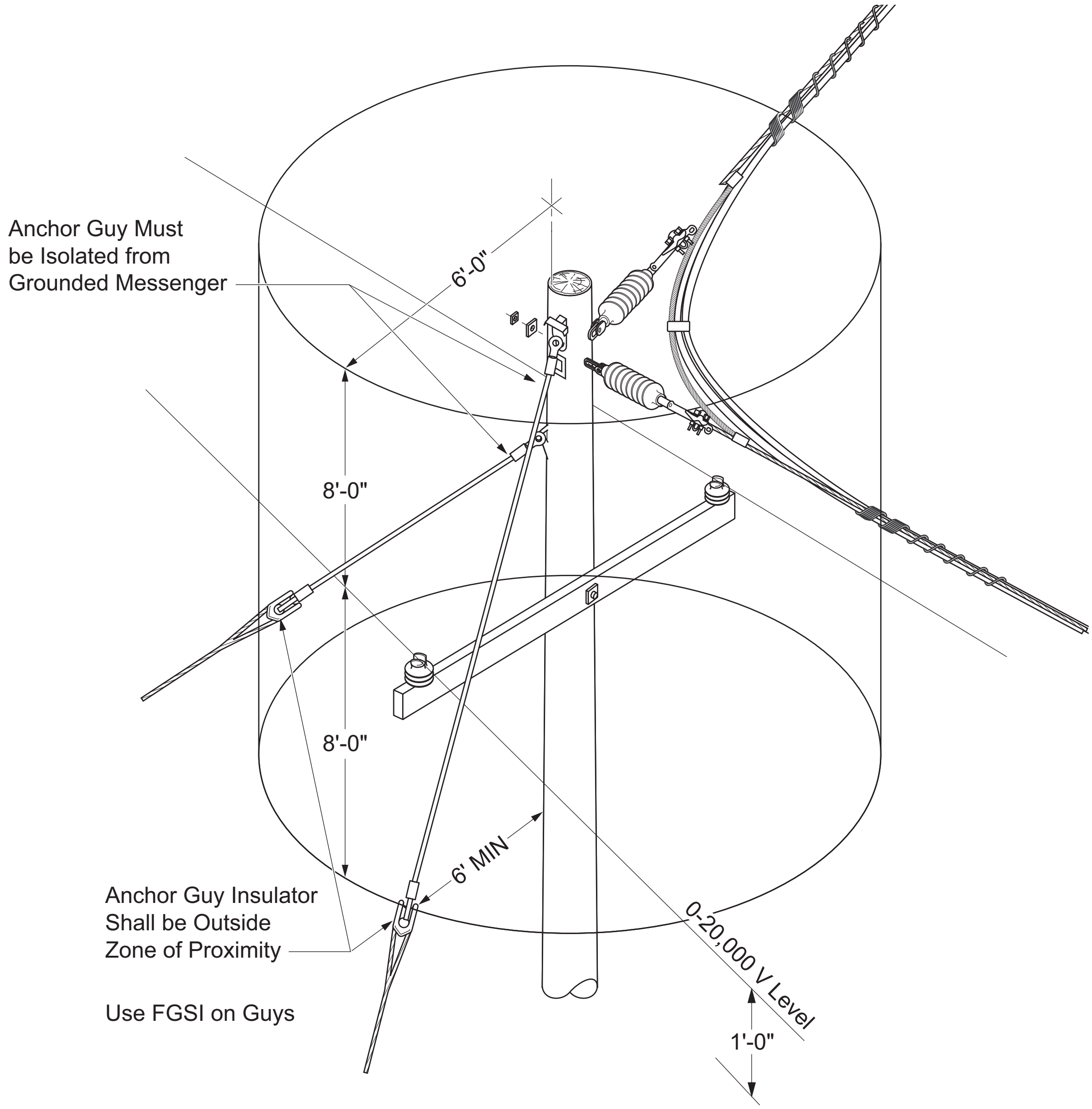
Note(s):

1. See PO 120 for High Voltage sign installation requirements.
2. See AC 370 for zone of proximity.

AC 370 Anchor Guy — Zone of Proximity

Scope AC 370.1 Anchor Guy — Zone of Proximity

Figure AC 370–1: Anchor Guy — Zone of Proximity



Note(s):

1. See AC 340 for guying details.

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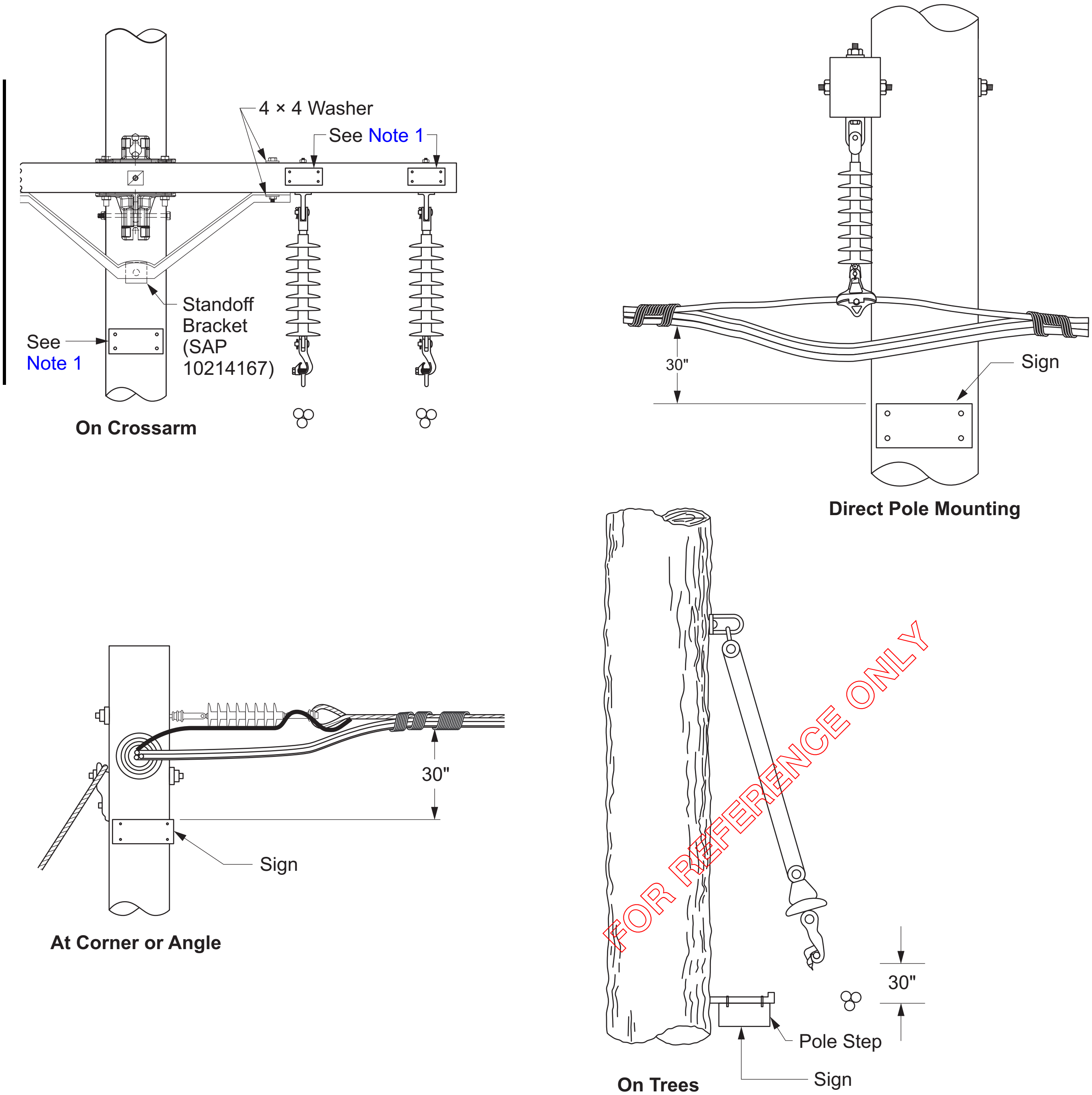
AC 380 Voltage Designation Sign

Scope AC 380.1 Voltage Designation Sign

Figure AC 380–1: Voltage Designation Sign



Note(s):

1. See PO 120 for High Voltage sign installation requirements.

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AC 400 2.4/4/12/16 kV Aerial Cable Connection to Transformer

Scope AC 400.1 2.4/4/12/16 kV Aerial Jacketed Cable Connection to Transformer

Figure AC 400–1: 2.4/4/12/16 kV Aerial Jacketed Cable Connection to Transformer (Top View)

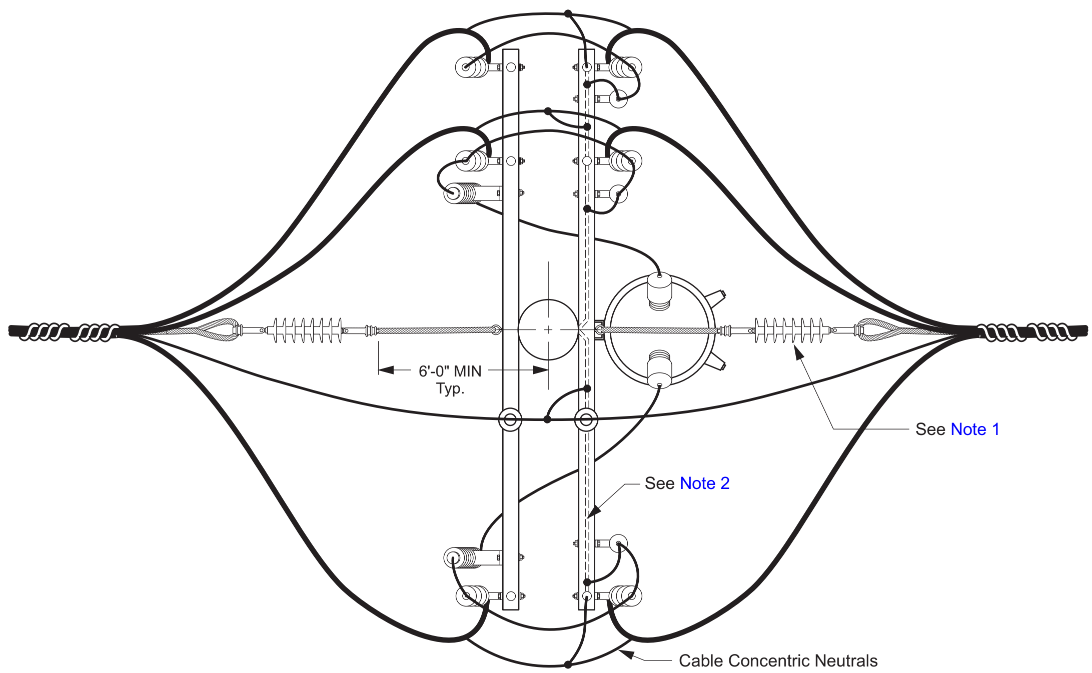
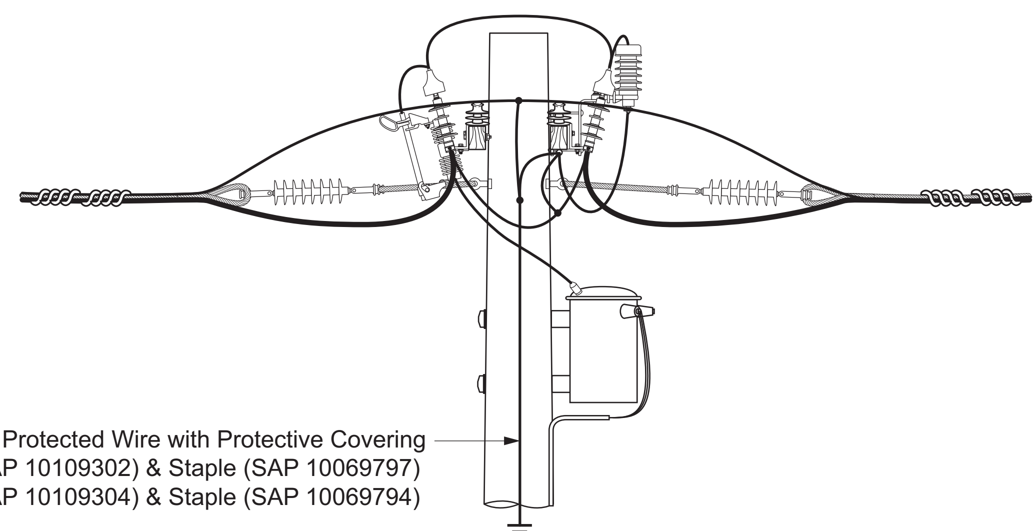


Figure AC 400–2: 4/12/16 kV Aerial Cable Connection to Transformer (Side View)

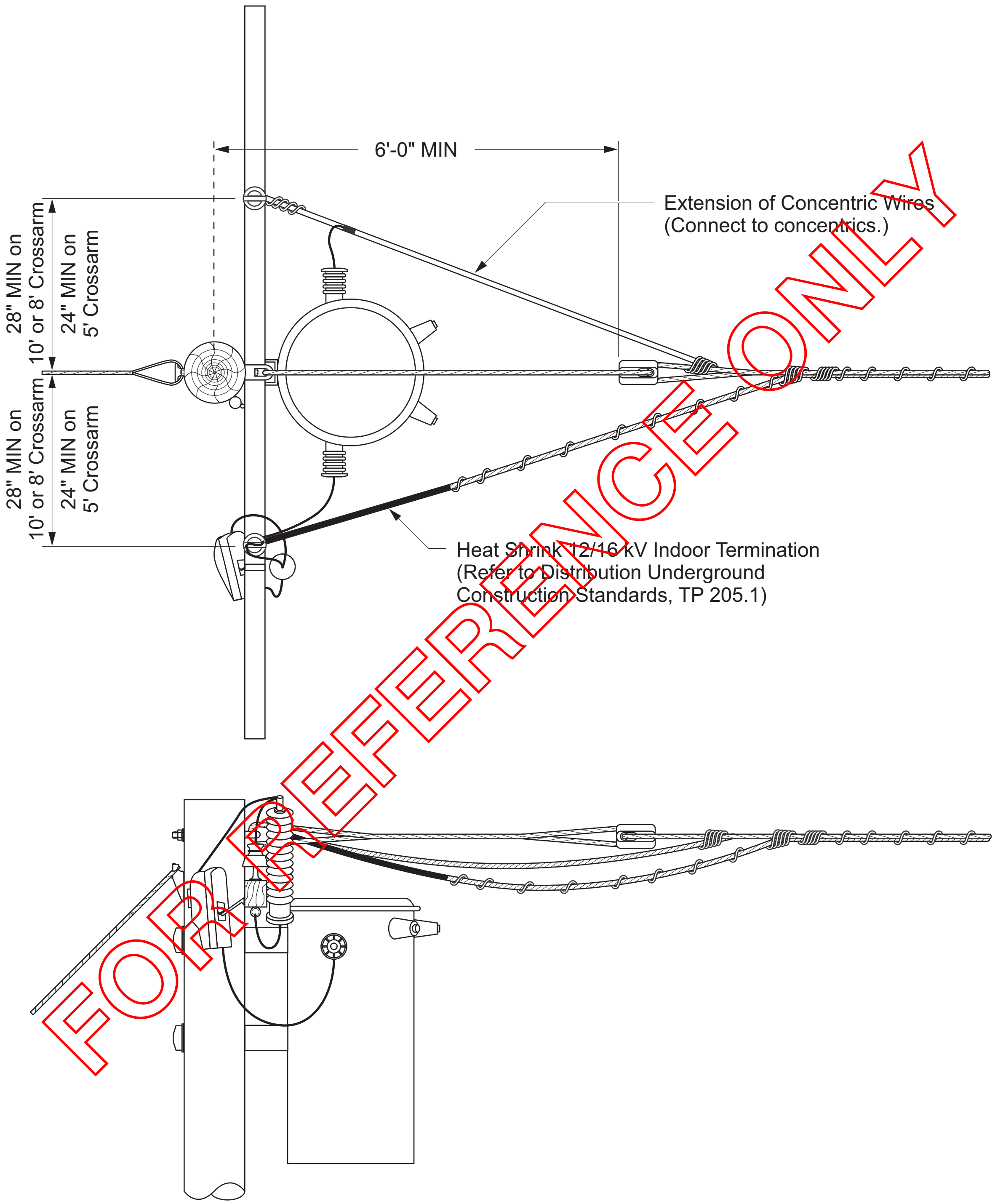


Note(s):

1. Guy strain insulator is an alternative insulator for 2.4/4.16 kV systems.
2. Connect surge arresters, concentric neutrals and messenger to #2 B.C. in PVC under arm. Connect #6 MIN ground wire to #2 B.C. in PVC under arm.

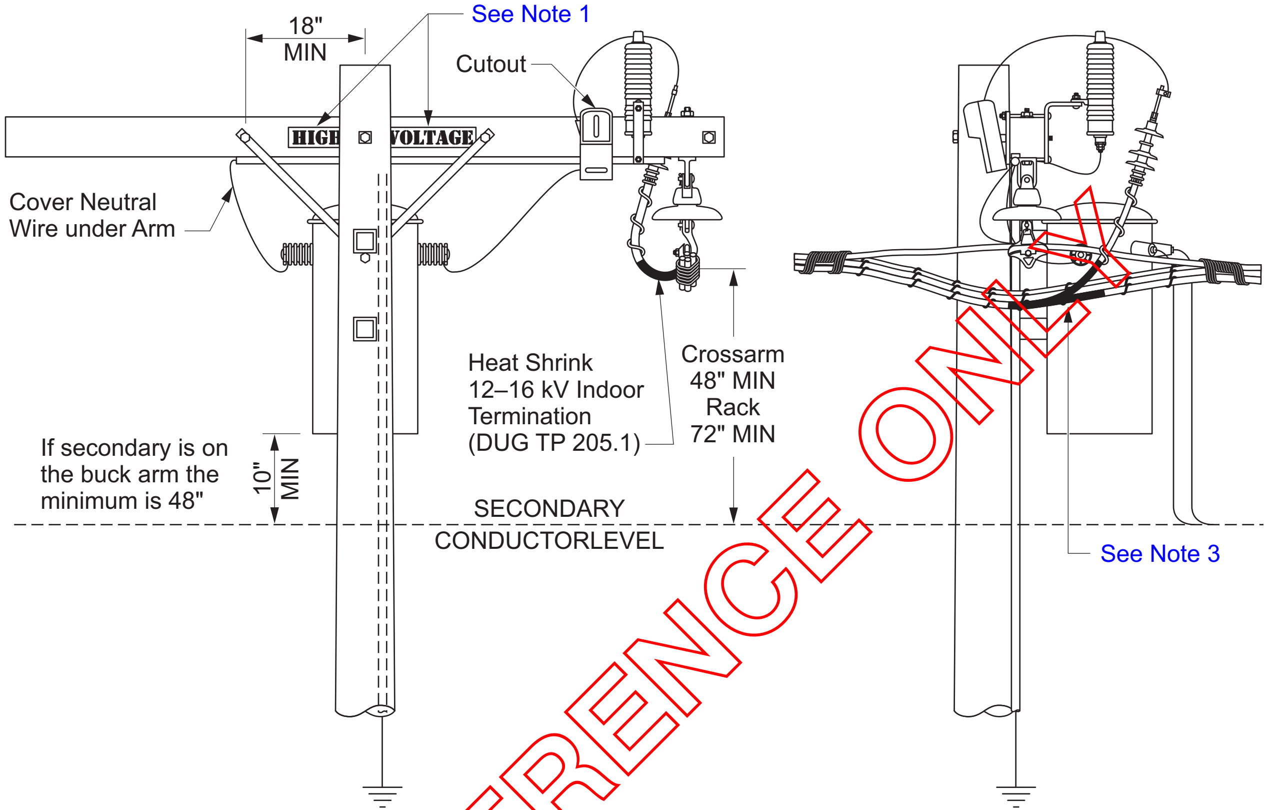
Scope AC 400.2 2.4 kV 1/C Aerial Cable Connection to Transformer Dead-End Construction

Figure AC 400–3: 2.4 kV 1/C Aerial Cable Connection to Transformer Dead-End Construction



Scope AC 400.3 2.4 kV 1/C Aerial Cable Connection to Transformer

Figure AC 400–4: 2.4 kV 1/C Aerial Cable Connection to Transformer

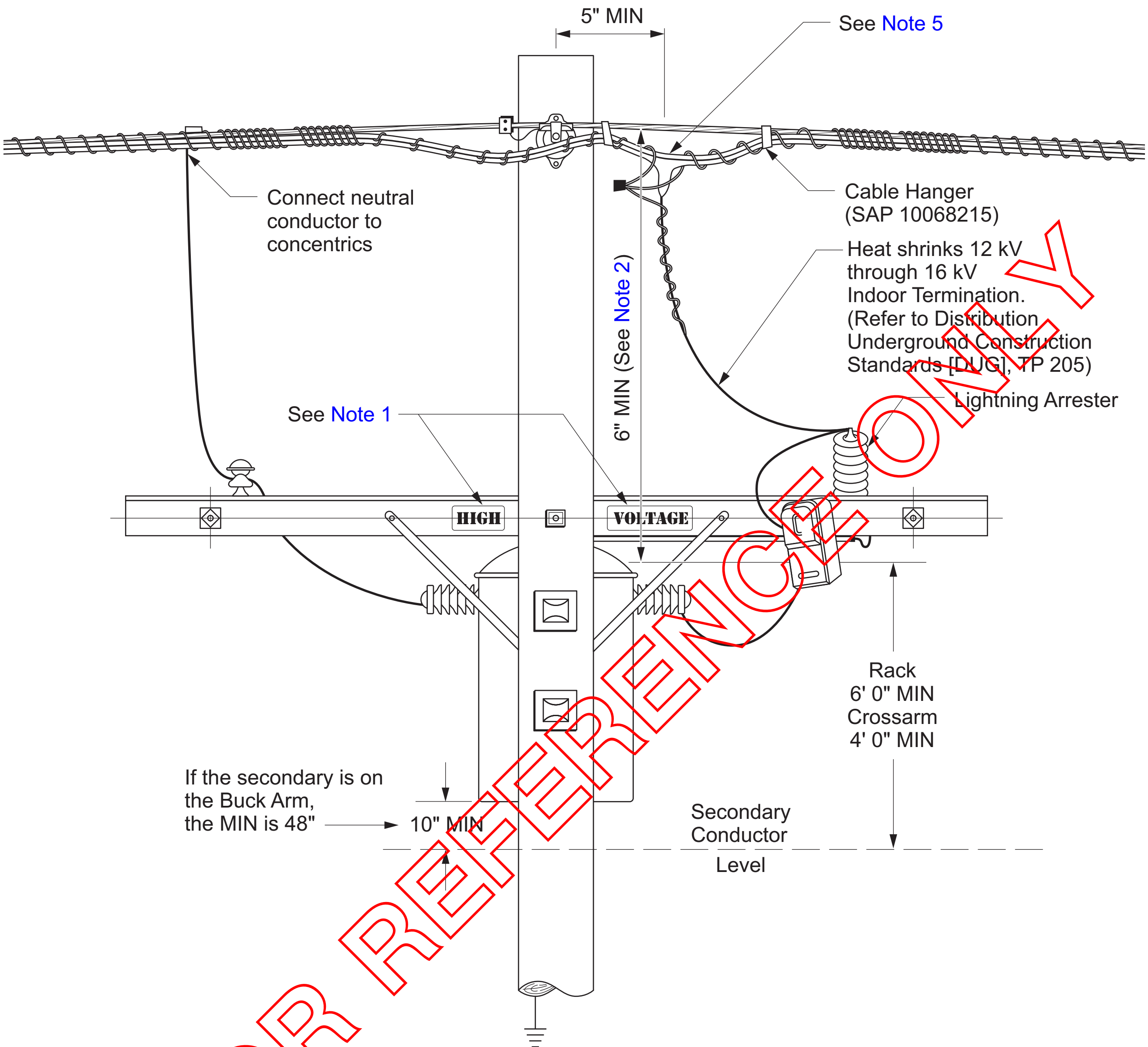


For 3/8" and 1/2" messenger located more than 28" from C/L of pole, use V-shaped brace

Note(s):

1. See PO 120 for High Voltage sign installation requirements.
2. Concentric wires should be interconnected at Y-Splice.
3. Y Splice #2 and 1/0 JJ 650.1 350 - Taped AC 465.

Figure AC 400–5: 2.4 kV 1/C Aerial Cable Connection to Transformer



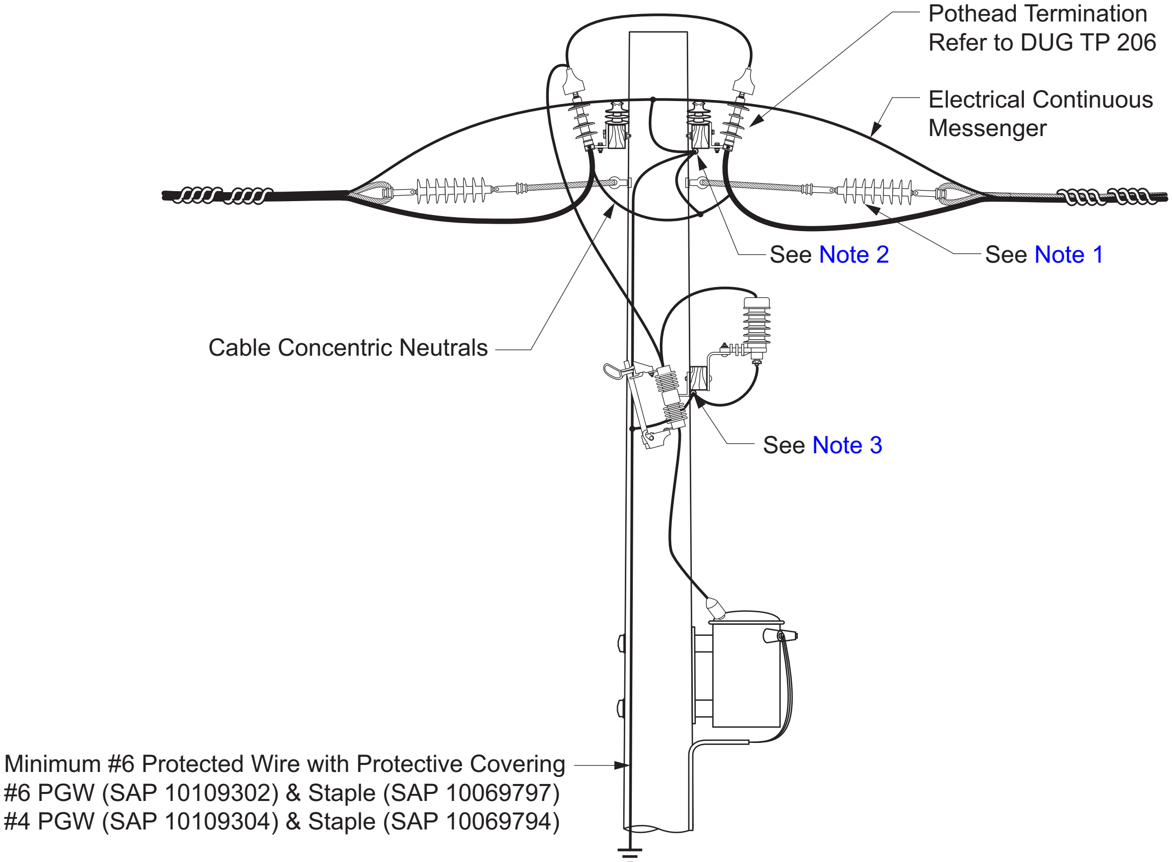
Note(s):

1. See PO 120 for High Voltage sign installation requirements.
2. Aerial cable mounted on crossarm — 54-inch vertical clearance.
3. Concentric wires should be interconnected at Y-splice.
4. For arm-mounted feed-through construction, see AC 400.3 (Sheet 3).
5. Y-Splice #2 and 1/0 JJ 650.1 350 — Taped T-Splice AC 465.

AC 410 4/12/16 kV Aerial Cable Connected to 3-1Ø Transformer Bank

Scope AC 410.1 4/12/16 kV Aerial Cable Connected to 3-1Ø Transformer Bank

Figure AC 410–1: 4/12/16 kV Aerial Cable Connected to 3-1Ø Transformer Bank (Side View)

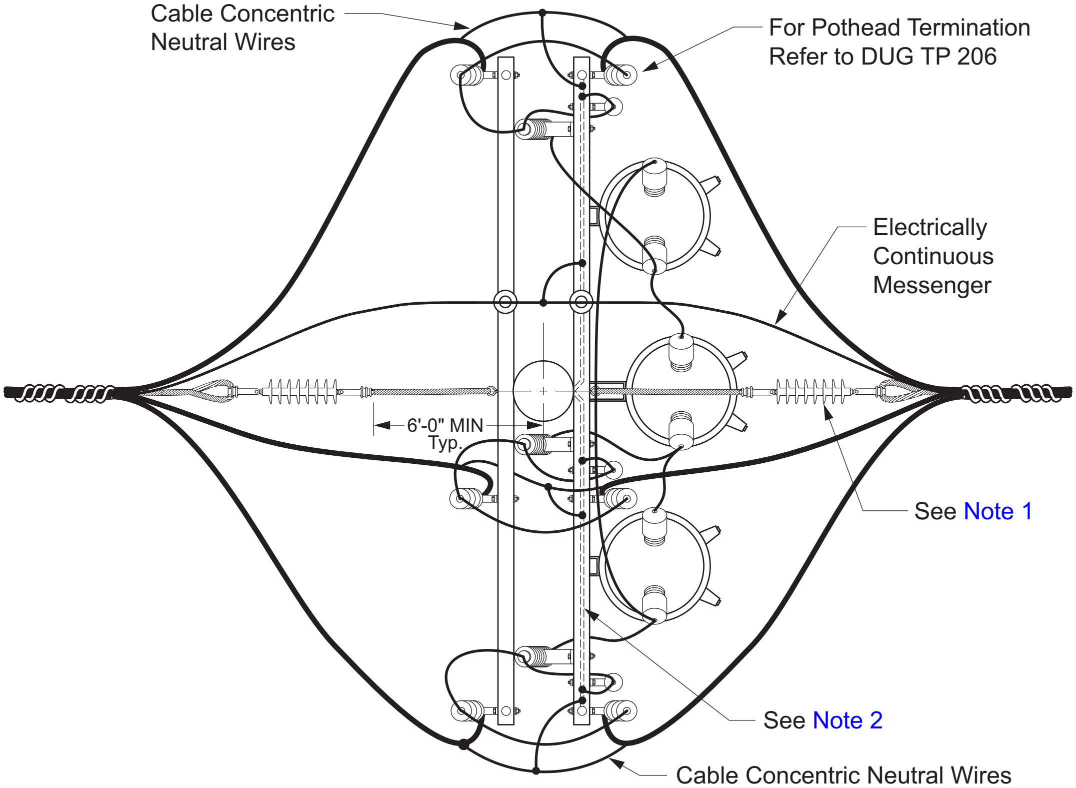


Side View

Note(s):

1. Guy strain insulator is an alternate insulator for 2.4/4.16 kV systems.
2. Connect concentric neutrals and messenger to #2 B.C. in PVC under arm. Connect #6 Min ground wire to #2 B.C. in PVC under arm.
3. Connect surge arrester ground to #6 B.C. in PVC under arm. Connect #6 Min ground wire to #6 B.C. in PVC under arm.

Figure AC 410–2: 4/12/16 kV Aerial Cable Connected to 3-1Ø Transformer Bank (Top View)



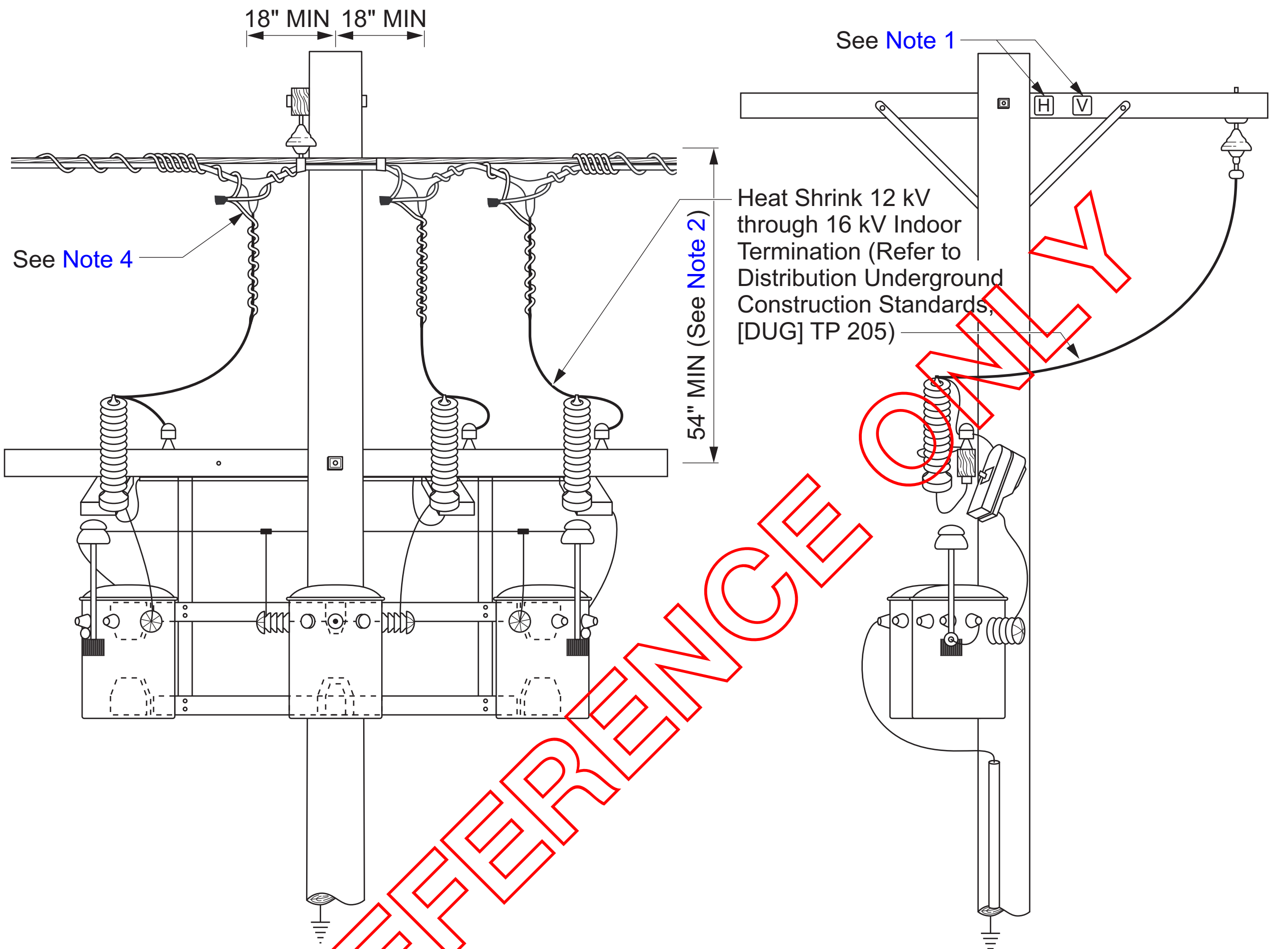
Top View

Note(s):

1. Guy strain insulator is an alternate insulator for 2.4/4.16 kV systems.
2. Connect concentric neutrals and messenger to #2 B.C. in PVC under arm. Connect #6 Min ground wire to #2 B.C. in PVC under arm.

Scope AC 410.2 4 kV Aerial Cable Connected to 3Ø Transformer Bank

Figure AC 410–3: 4 kV Aerial Cable Connected to 3Ø Transformer Bank



Note(s):

1. See PO 120 for High Voltage sign installation requirements.
2. If cable is at top of pole, cable may be mounted directly to pole with horizontal post insulator with 6-foot vertical clearance to transformer.
3. Concentric wires should be interconnected at Y-splices.
4. Y-Splice #2 and 1/0 JJ 650.1 350 — Taped T-Splice AC 465.

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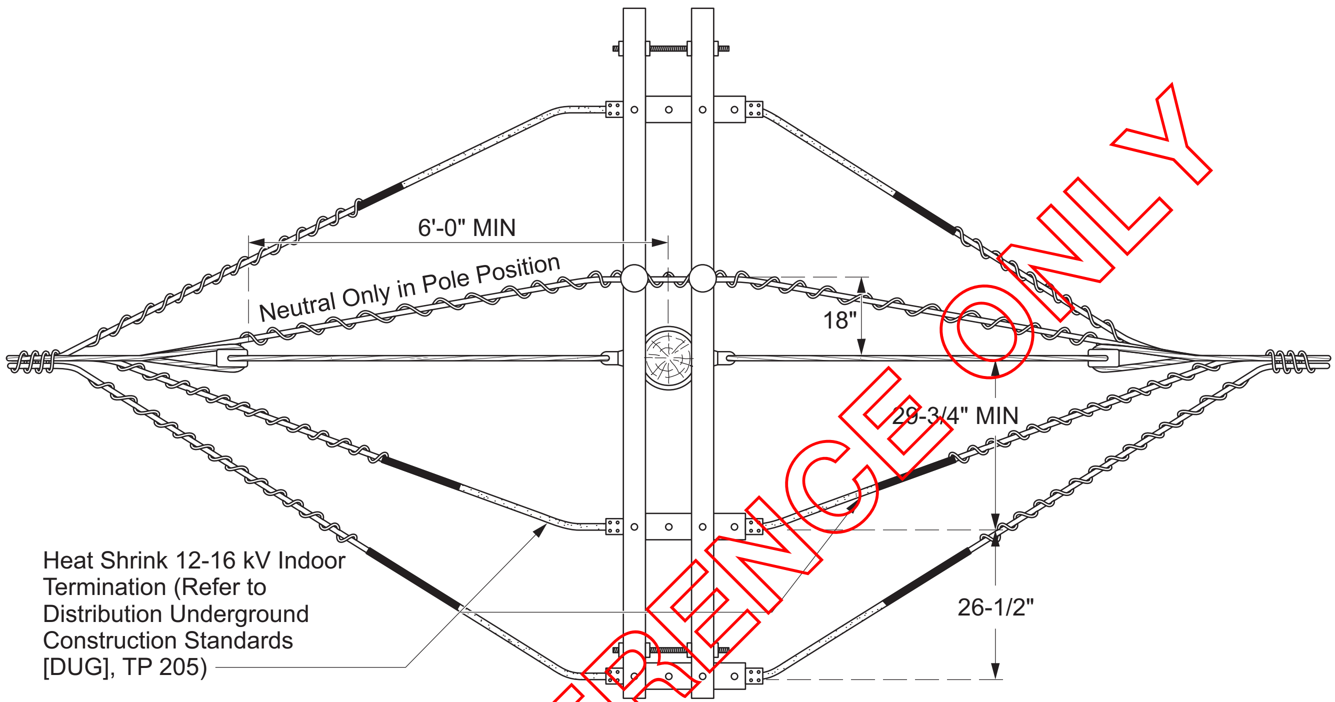
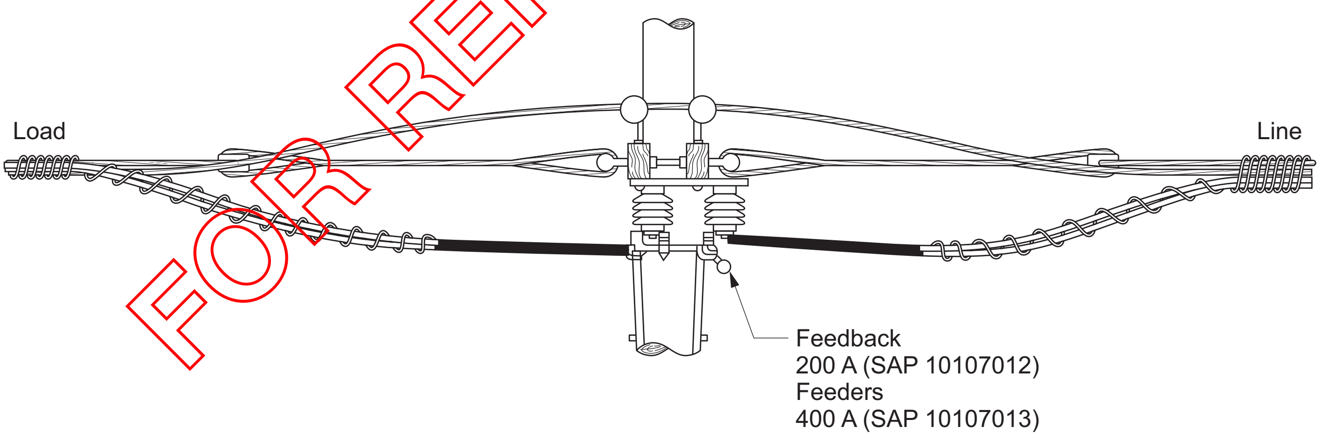
AC 420 2.4/4/12/16 kV Aerial Cable Disconnect Switches

Scope AC 420.1 2.4/4/12/16 kV Aerial Cable Disconnect Switches

Figure AC 420–1: 2.4/4 kV Aerial Cable Disconnect Switches





Note(s):

1. Neutral conductor is extension of concentric wire.

Figure AC 420–2: 2.4/4/12/16 kV Aerial Cable Disconnect Switches (Top View)

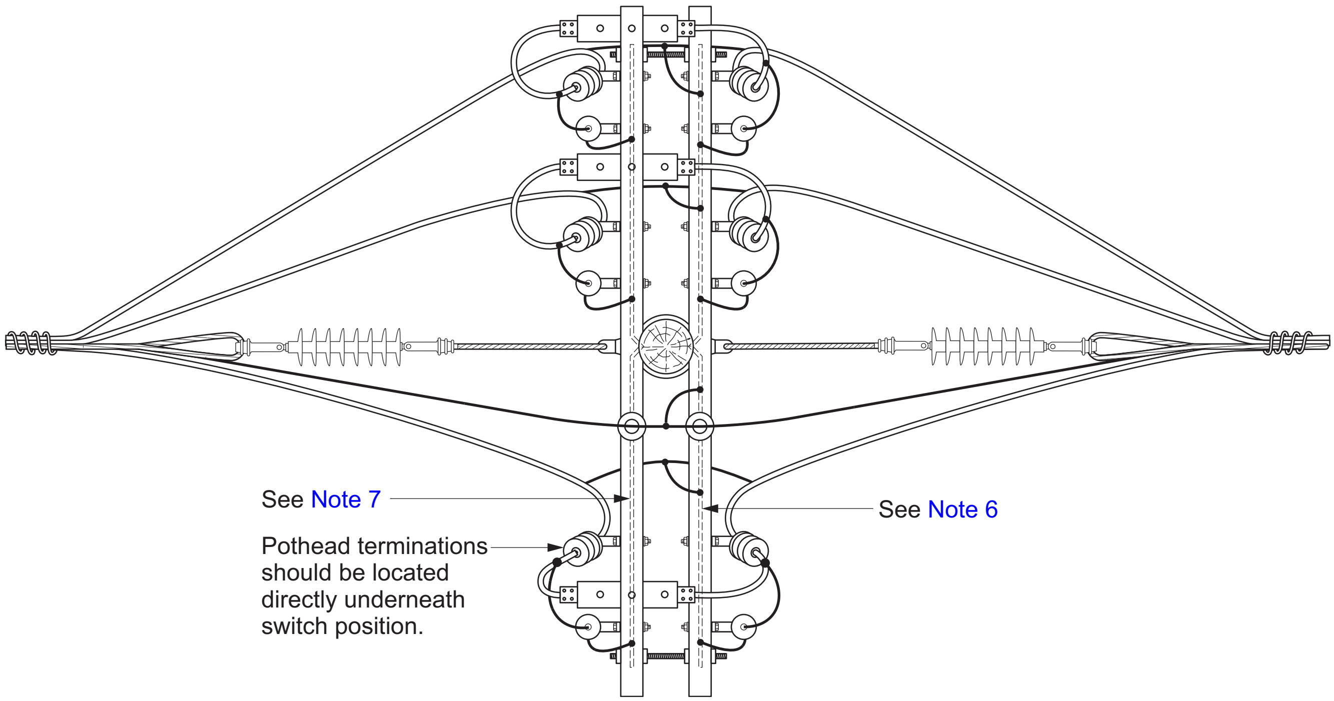
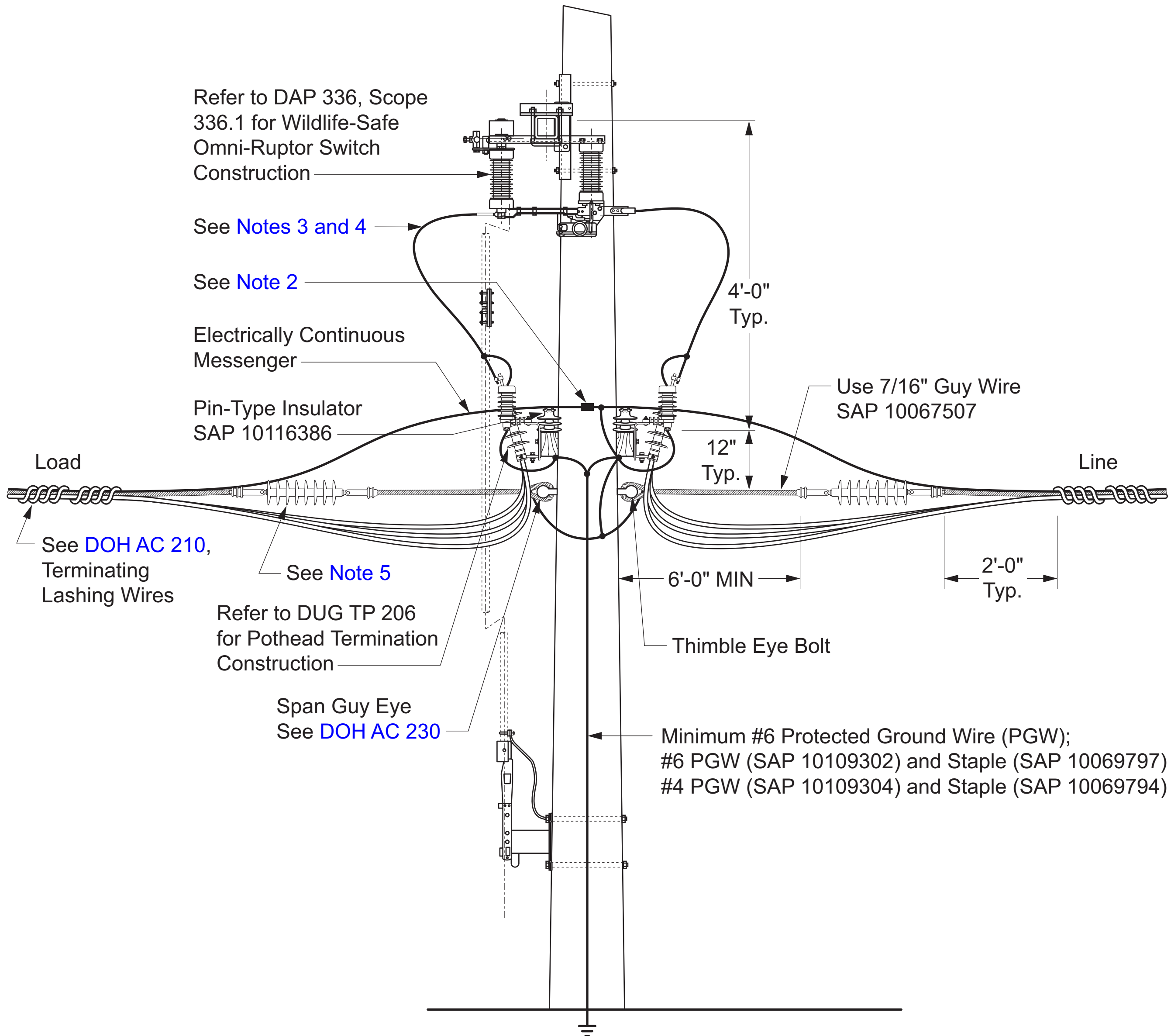


Figure AC 420–3: 2.4/4/12/16 kV Aerial Cable Disconnect Switches (Side View)



Note(s):

1. Install V-brace for all messenger sizes, SAP 10067347.
2. Connect Copperweld messenger using a 2 Bolt Parallel Groove Copper Clamp, SAP 10111580.
3. Jumper shall have an equivalent or greater ampacity than Aerial Cable.
4. Cover the wire per DC 535 Wildlife Protection.
5. Guy strain insulator is an alternate insulator for 2.4/4.16 kV systems.
6. Connect concentric neutrals, surge arresters and messengers to #2 B.C. in PVC under arm. Connect #6 MIN ground wire to #2 B.C. in PVC under arm.
7. Connect surge arrester ground to #6 B.C. in PVC under arm. Connect #6 MIN ground wire to #6 B.C. in PVC under arm.

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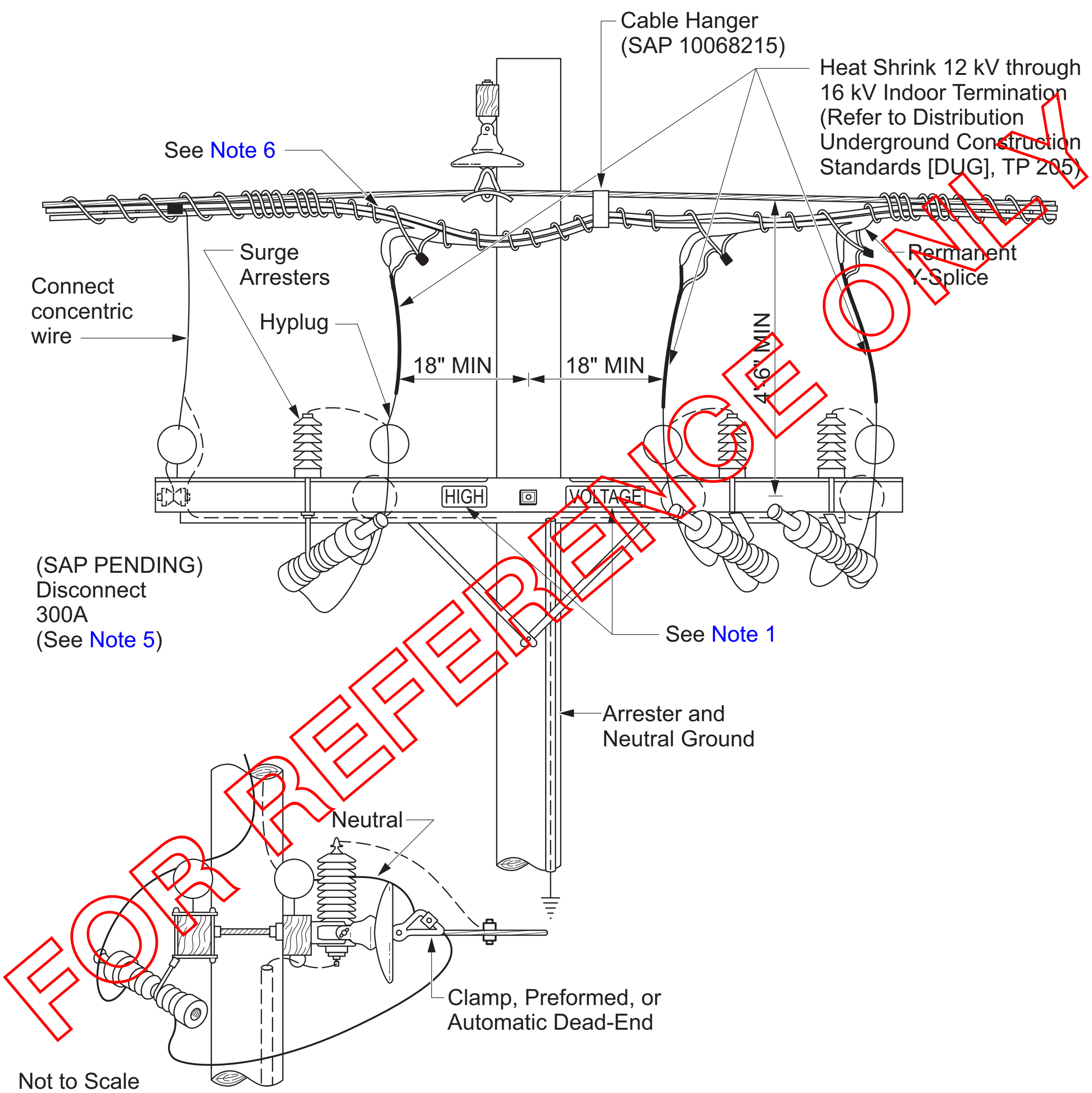
AC 425 2.4/4 kV Aerial Cable Tap Connected to Open Wire

Scope AC 425.1 2.4/4 kV Aerial Cable Tap Connected to Open Wire

Figure AC 425–1: 2.4/4 kV Aerial Cable Tap Connected to Open Wire



Note(s):

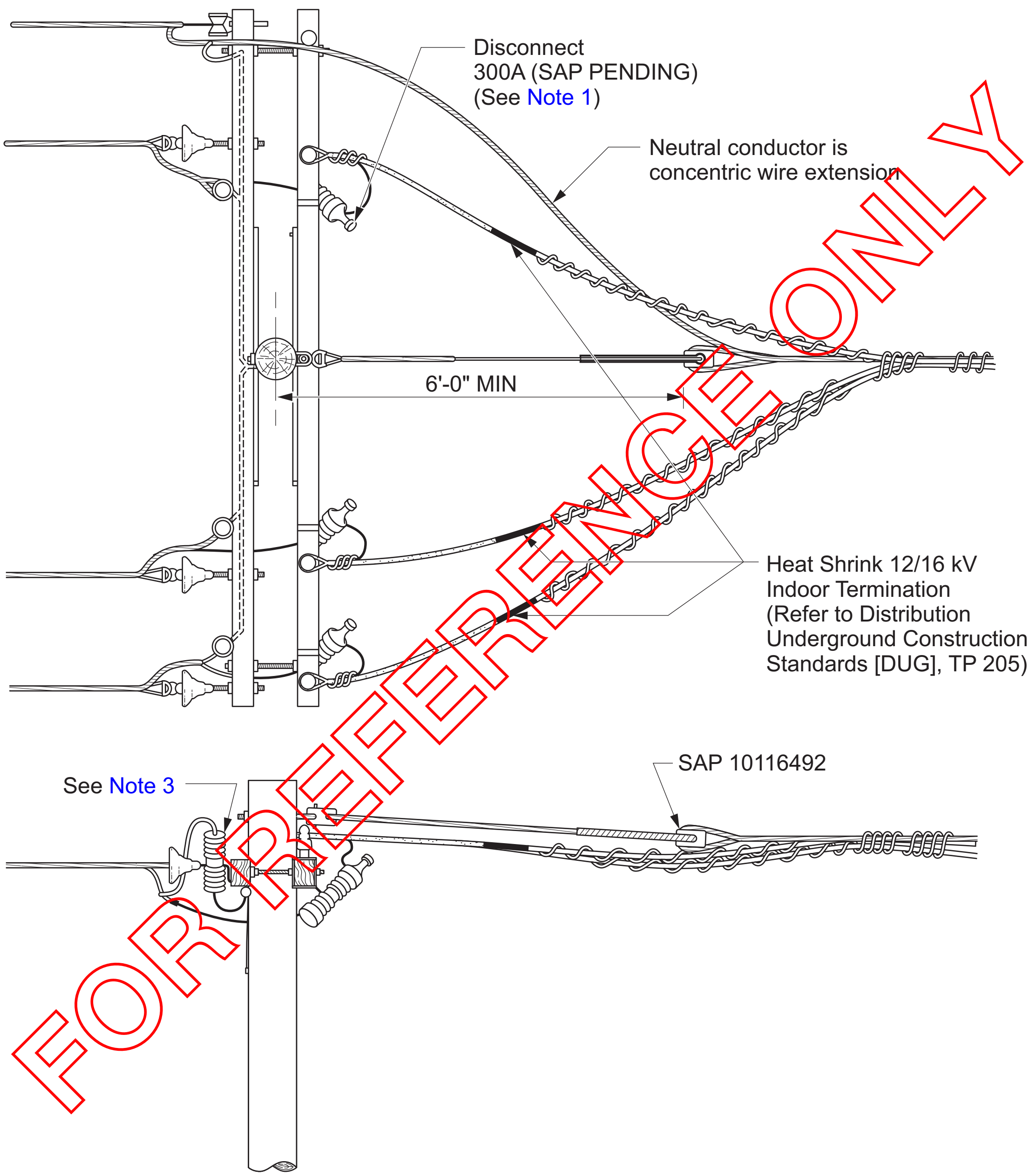
1. See PO 120 for High Voltage sign installation requirements.
2. Omit disconnects if less than 100-kVA transformer capacity is connected to open wire, and open wire cannot be transferred to another circuit.
3. Use cutout, Positect disconnect type (SAP PENDING) for open wire cable installation.
4. Disconnects ordered under the above codes will be furnished with solid blades for disconnect purpose only.
5. Concentric wire should be interconnected at Y-splices.
6. Y-Splice #2 and 1/0 JJ 650.1 350 — Taped T-Splice AC 465.

What's Changed? Revised Notes and Figure to reflect HIGH VOLTAGE sign installation requirements.

AC 430 4/12/16 kV Aerial Cable Connected to Open Wire

Scope AC 430.1 4 kV Aerial Cable Connected to Open Wire

Figure AC 430–1: 4 kV Aerial Cable Connected to Open Wire

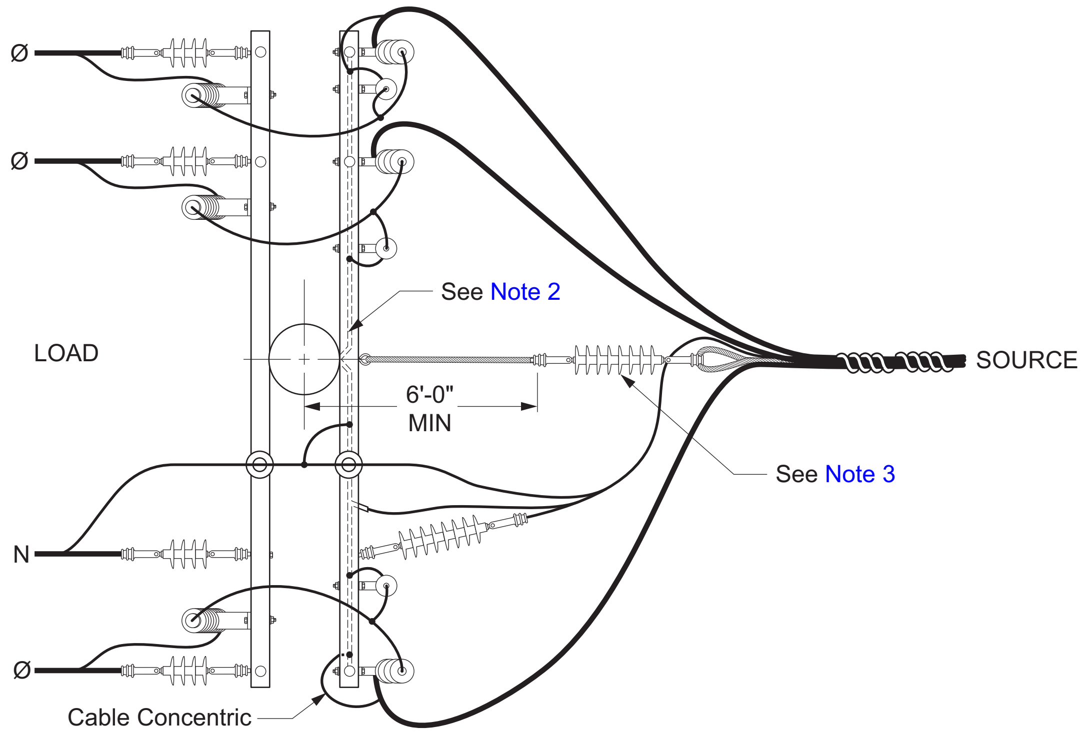


Note(s):

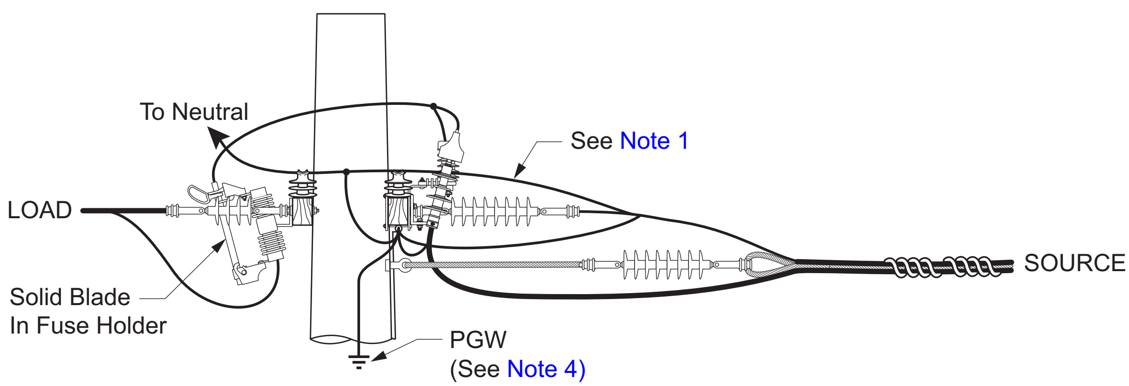
1. Omit disconnects if less than 100 kVA transformer capacity is connected to open wire and open wire cannot be transferred to another circuit.
2. Connect neutral ground to surge arrester ground.
3. Surge Arrester — For applications, see AC 400.

Scope AC 430.2 4/12/16 kV Aerial Jacketed Cable Connected to Open Wire

Figure AC 430–2: 4/12/16 kV Aerial Jacketed Cable Connected to Open Wire — In-Line



TOP VIEW

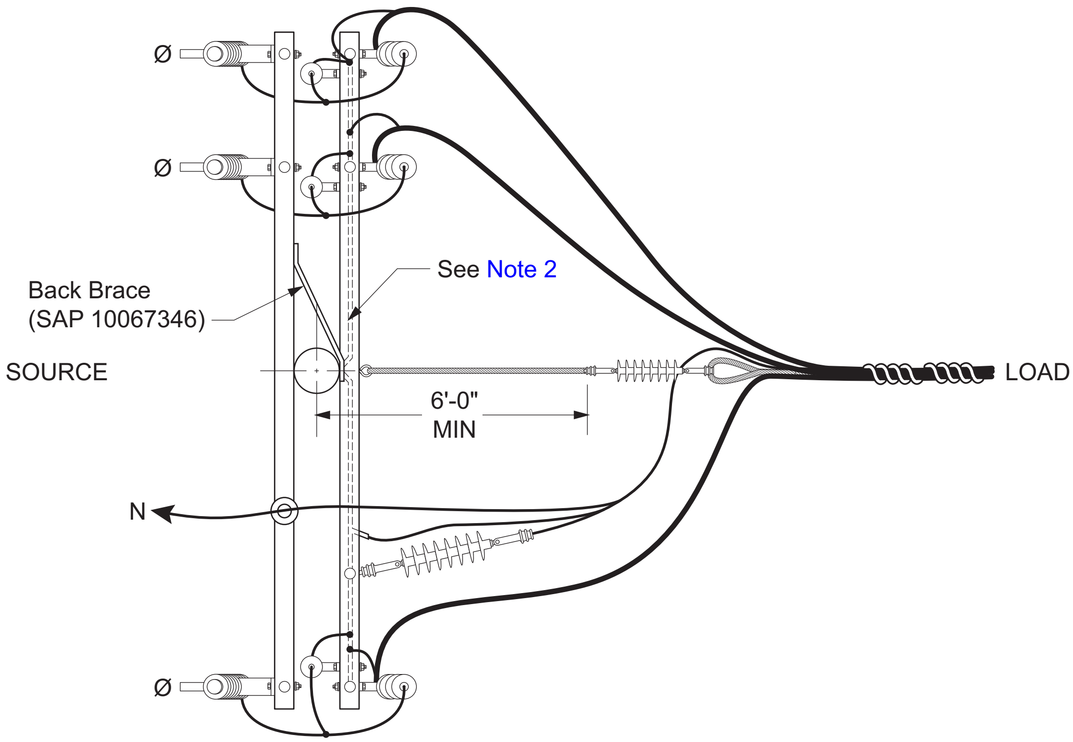


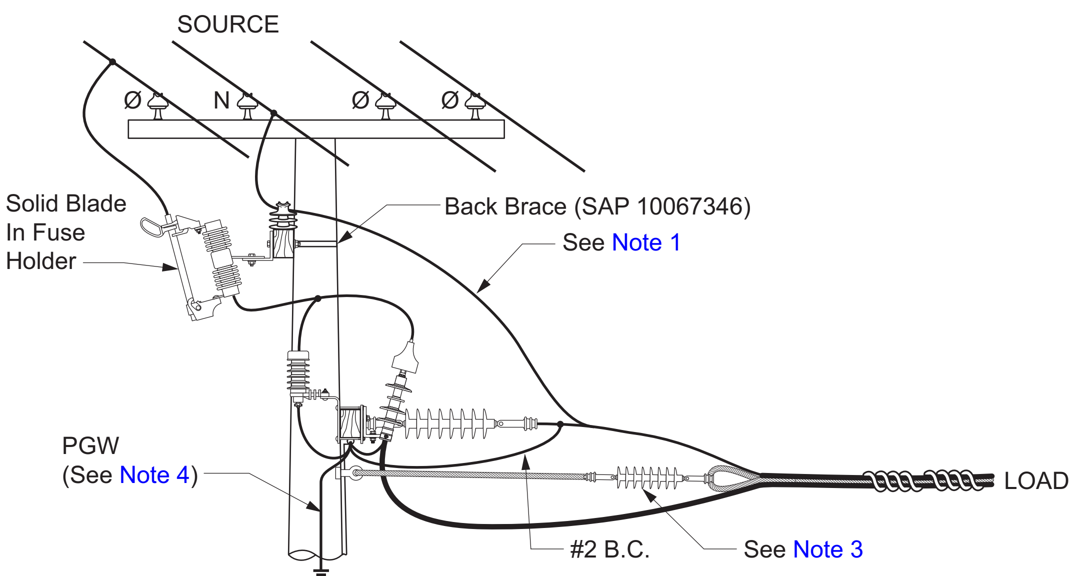
SIDE VIEW

Note(s):

1. Use #2 B.C. neutral for 1/0 3-Phase Aerial Cable and 4/0 B.C. for 350 3-Phase Aerial Cable.
2. Connect surge arrester, concentric neutrals and messenger to #2 B.C. in PVC under arm. Connect #6 MIN ground wire to #2 B.C. in PVC under arm.
3. Guy strain insulator is an alternate insulator for 2.4/4.16 kV systems.
4. Minimum #6 protected ground wire (PGW). #6 PGW (SAP 10109302) and Staple (SAP 10069797); #4 PGW (SAP 10109304) and Staple (SAP 10069794).

Figure AC 430–3: 4/12/16 kV Aerial Jacketed Cable Connected to Open Wire — Tap Line (Bucked Arm)





Note(s):

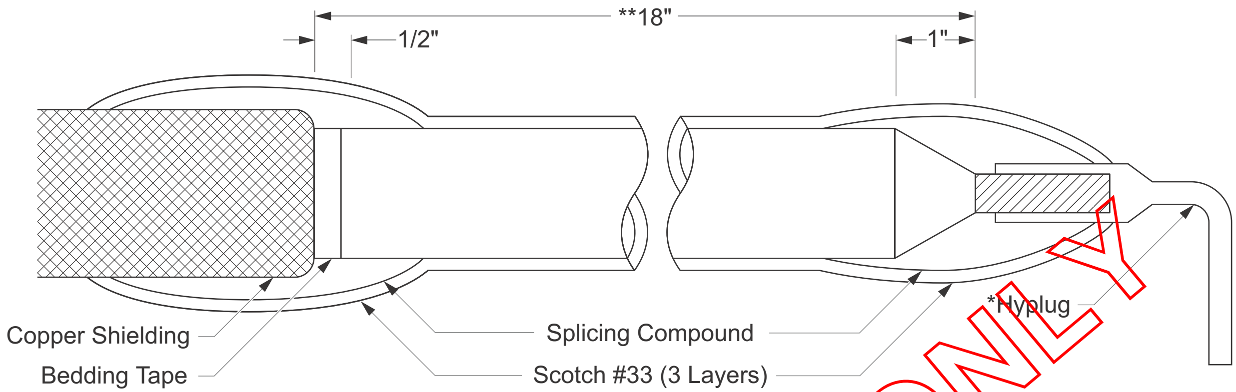
1. Use #2 B.C. neutral for 1/0 3-Phase Aerial Cable and 4/0 B.C. for 350 3-Phase Aerial Cable.
2. Connect surge arrester, concentric neutrals and messenger to #2 B.C. in PVC under arm. Connect #6 MIN ground wire to #2 B.C. in PVC under arm.

3. Guy strain insulator is an alternate insulator for 2.4/4.16 kV systems.
4. Minimum #6 protected ground wire (PGW). #6 PGW (SAP 10109302) and Staple (SAP 10069797); #4 PGW (SAP 10109304) and Staple (SAP 10069794).

AC 450 Termination of Old-Style Cable Rubber Insulated with Copper Tape Shielding

Scope AC 450.1 Typical Single Conductor — 5 kV — Shielded Rubber-Like Cable

Figure AC 450–1: Typical Single Conductor — 5 kV — Shielded Rubber-Like Cable



* Hylug may be used in place of hyplug.
** May be longer than 18".

Note(s):

1. To select proper hyplug and for proper compression tool, refer to Distribution Underground Construction Standards (DUG), TP 100 and TP 101.

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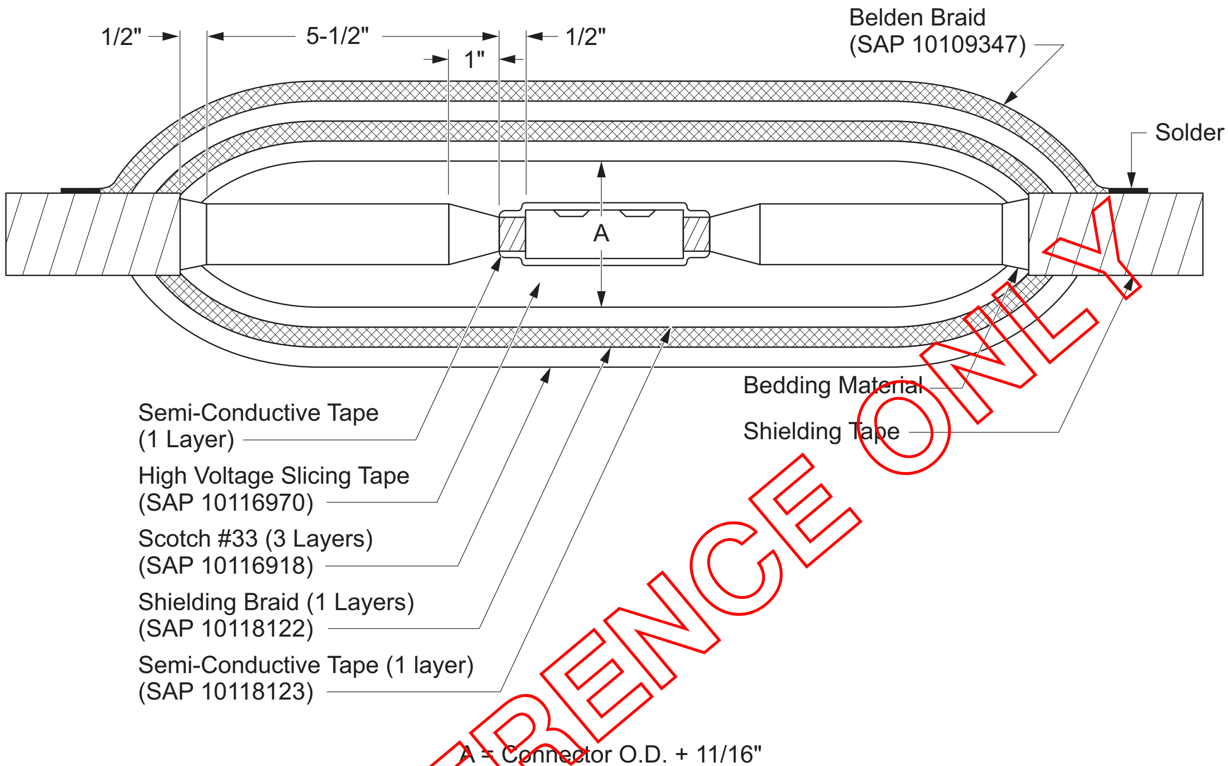
AC 455 Splicing Old-Style Cable Rubber Insulated with Copper Tape Shielding

Scope AC 455.1 Single Conductor — 5 kV — Shielded Rubber-Like Aerial Cable

Figure AC 455–1: Single Conductor — 5 kV — Shielded Rubber-Like Aerial Cable



Note(s):

1. To select proper connector and for proper compression tool, refer to Distribution Underground Construction Standards (DUG), JJ 110 and JJ 116.

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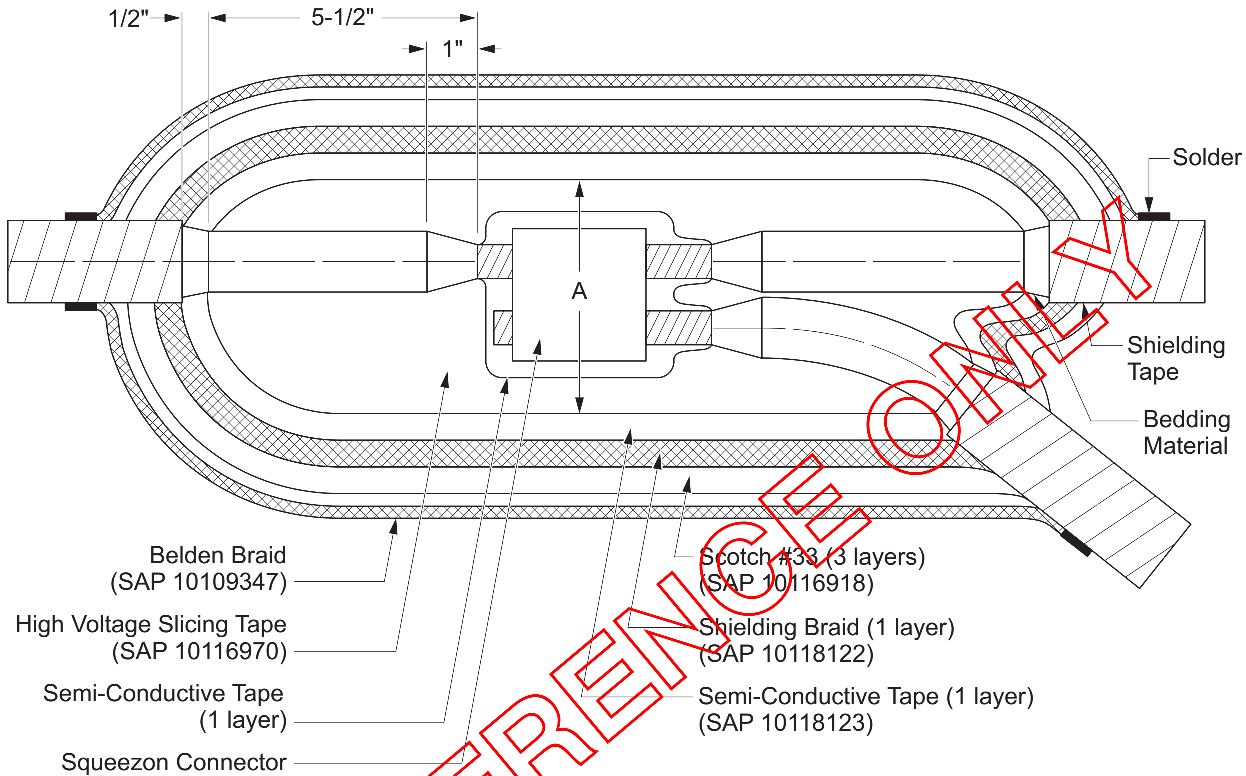
AC 460 Y-Splice for Old Style Cable Rubber Insulated with Copper Tape Shielding

Scope AC 460.1 Typical Single Conductor — 5 kV — Shielded Rubber-Like Aerial Cable

Figure AC 460–1: Typical Single Conductor — 5 kV — Shielded Rubber-Like Aerial Cable



A = Connector O.D. + 11/16"

Note(s):

1. To select proper connector and for proper compression tool, refer to the Distribution Underground Construction Standards (DUG), JJ 120

AC 465 350 kcmil T-Tap Using Polyethylene Insulated Primary Cable

Scope AC 465.1 Tee Splice — 1/C 5–16 kV Polyethylene — Insulated Cables 350 kcmil to #2-220 mil

1.0 Instructions

1.1 Measure and cut cables, leaving sufficient concentric wires for final attachment.

1.2 Remove the insulation and semi-conducting insulation shielding for a distance of "B" inches. **Care should be taken to avoid nicking the conductor strands**.

1.3 Remove the semi-conducting insulation shielding for a distance of "A" inches. **Take care when removing the shielding so that the insulation is not nicked or damaged**.

1.4 Pencil the insulation with appropriate penciling tools (#2 = SAP 10145334, 350 CLP = SAP 10145338).

1.5 Clean the conductor strands and immediately compress the connector onto the bared conductors. Remove any burrs remaining on the connector. **Clean the exposed insulation with M-50**. (#2 MD6, Die BG, 350 CLP UT15 Die 15C A 96R.)

1.6 Compact wads of semi-conducting tape into the connector indents (only when indenting).

1.7 Apply one (1) half-lapped layer of semi-conducting tape over the connector and stranded conductors, extending one-quarter inch onto penciled insulation.

1.8 Apply half-lapped layers of high-voltage insulating tape to Diameters "C" and "D," forming gradual slopes at each end, extending tape to edge of semi-conducting insulation shielding. Two diameters are given, since the connector barrels may be of different diameters. **Do not overlap the semi-conducting shielding with insulating tape**.

1.9 Apply one (1) half-lapped layer of semi-conducting tape; one (1) half-lapped layer of copper shielding braid, and six half-lapped layers of splice jacketing tape to the required dimensions, overlapping the semi-conducting shielding as shown on the drawing.

1.10 Twist the concentric neutral wires together and, as shown, apply a connector of semi-conducting shielding with insulating tape.

Figure AC 465–1: T-Splice — 1/C, 5–16 kV Polyethylene Insulated Cable 350 kcmil to #2 220 mil

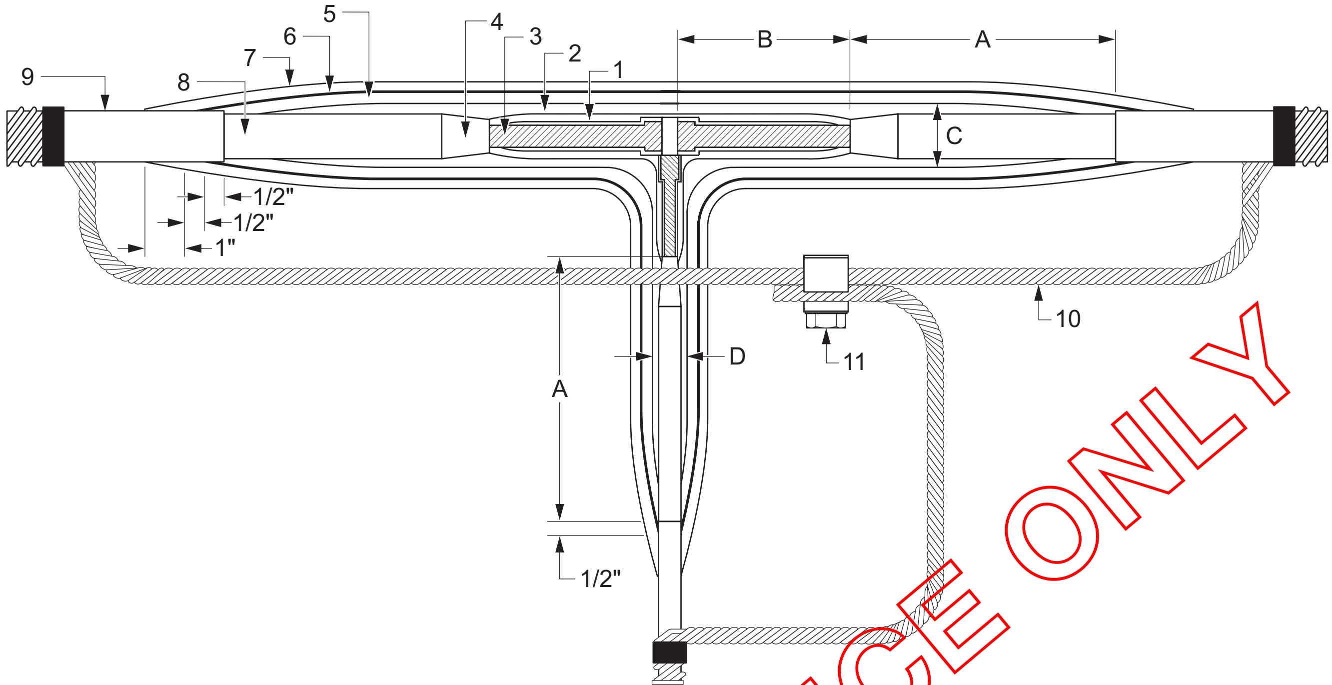


Table AC 465–1: 350 kcmil T-Tap Using Polyethylene Insulated Primary Cable

Legend		
Number	**Item**	**SAP**
1	Compression Tee Connector	PENDING
2	Semi-Conducting Tape	10118123
3	Stranded Conductor	—
4	High Voltage Insulating Tape	—
5	Semi-Conducting Tape	10118123
6	Tinned Copper Shielding Braid	10118122
7	Jacketing Tape	10116918
8	Polyethylene Insulation	—
9	Cable Shielding—Semi-Conducting	—
10	Twisted Concentric Wires	—
11	Connector	—
12	Ground Wire	—

Voltage	Dimensions			
	A	**B**	**C**	**D**
5 kV	3"	Connector Depth Plus 1/2"	Diameter over Connector Plus 1/2"	
12 kV 16 kV	6-1/4"		Diameter over Connector Plus 3/4"	

Note(s):

1. To select proper hyplug and for proper compression tool, refer to the Distribution Underground Construction Standards [DUG], TP 100 and TP 101.

AC 470 Sag Charts and Tension Stringing Tables for Aerial Bundled Cable

Scope AC 470.1 Directions for Use

The following tables provide sag and temperature stringing tension information for aerial bundled cable. Each aerial bundled cable configuration has its own respective chart. Separate charts are provided for light loading and heavy loading areas.

Note that ABC with more conductors may have less sag due to higher design tensions being used.

For directions on use of sag charts, see CO 120 Sag Charts — Directions for Use

Scope AC 470.2 **Sag Charts and Tension Stringing Tables for 3 Conductor 1/0 Aerial Bundled Cable for Light Loading Areas**

Table AC 470–1: Sag — Temperature Stringing Table 3 Conductor 1/0 Aerial Bundled Cable for Light Loading Areas

	Sag					
	Initial Stringing Sag				Final Sag	
Span (ft)	50°F	70°F	90°F	110°F	70°F	130°F
40	0'-1"	0'-1"	0'-2"	0'-2"	0'-1"	0'-2"
60	0'-3"	0'-3"	0'-3"	0'-4"	0'-3"	0'-4"
80	0'-6"	0'-6"	0'-6"	0'-7"	0'-6"	0'-8"
100	0'-9"	0'-9"	0'-10"	0'-11"	0'-10"	1'-0"
120	1'-1"	1'-2"	1'-3"	1'-4"	1'-2"	1'-6"
140	1'-6"	1'-7"	1'-8"	1'-9"	1'-8"	2'-0"
160	2'-0"	2'-2"	2'-3"	2'-4"	2'-2"	2'-7"
180	2'-7"	2'-9"	2'-11"	3'-0"	2'-10"	3'-3"
200	3'-4"	3'-5"	3'-7"	3'-9"	3'-7"	4'-1"
220	4'-1"	4'-3"	4'-5"	4'-7"	4'-4"	4'-11"

Table AC 470–2: Tension — Temperature Stringing Table 3 Conductor 1/0 Aerial Bundled Cable for Light Loading Areas

	Tension (lb)					
	Initial Stringing Tension				Final Tension	
Span (ft)	50°F	70°F	90°F	110°F	70°F	130°F
40	3827	3587	3345	3103	3473	2634
60	3782	3547	3313	3079	3430	2636
80	3721	3495	3270	3050	3375	2638
100	3648	3433	3222	3016	3312	2640
120	3568	3366	3170	2982	3246	2641
140	3484	3298	3119	2948	3181	2643
160	3401	3231	3069	2916	3120	2645
180	3321	3168	3023	2886	3064	2646
200	3247	3110	2981	2860	3014	2647
220	3180	3059	2944	2837	2971	2648

Scope AC 470.3 Sag Charts and Tension Stringing Tables for 3 Conductor 1/0 Aerial Bundled Cable for Heavy Loading Areas

Table AC 470–3: Sag — Temperature Stringing Table 3 Conductor 1/0 Aerial Bundled Cable for Heavy Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
40	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-3"
60	0'-4"	0'-4"	0'-5"	0'-5"	0'-5"	0'-6"
80	0'-8"	0'-9"	0'-9"	0'-10"	0'-10"	1'-0"
100	1'-3"	1'-4"	1'-5"	1'-6"	1'-5"	1'-9"
120	2'-0"	2'-2"	2'-3"	2'-4"	2'-4"	2'-8"
140	3'-1"	3'-2"	3'-4"	3'-5"	3'-5"	3'-9"
160	4'-4"	4'-5"	4'-7"	4'-8"	4'-8"	5'-0"
180	5'-9"	5'-10"	6'-0"	6'-1"	6'-1"	6'-5"
200	7'-4"	7'-6"	7'-7"	7'-9"	7'-8"	8'-1"
220	9'-2"	9'-3"	9'-5"	9'-6"	9'-6"	9'-10"

Table AC 470–4: Tension — Temperature Stringing Table 3 Conductor 1/0 Aerial Bundled Cable for Heavy Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
40	3283	3040	2798	2558	2838	2035
60	2958	2729	2506	2290	2504	1825
80	2564	2367	2182	2009	2147	1648
100	2188	2040	1905	1784	1863	1529
120	1904	1804	1713	1631	1676	1455
140	1718	1651	1589	1533	1561	1408
160	1599	1553	1510	1469	1487	1376
180	1521	1488	1456	1426	1439	1354
200	1468	1443	1418	1395	1405	1339
220	1431	1411	1391	1373	1380	1327

Scope AC 470.4 Sag Charts and Tension Stringing Tables for 3 Conductor 350 kcmil Aerial Bundled Cable for Light Loading Areas

Table AC 470–5: Sag — Temperature Stringing Table 3 Conductor 350 kcmil Aerial Bundled Cable for Light Loading Areas

	Sag					
	Initial Stringing Sag				Final Sag	
Span (ft)	50°F	70°F	90°F	110°F	70°F	130°F
40	0'-2"	0'-2"	0'-2"	0'-3"	0'-2"	0'-3"
60	0'-5"	0'-5"	0'-6"	0'-6"	0'-5"	0'-7"
80	0'-8"	0'-9"	0'-10"	0'-11"	0'-9"	1'-7"
100	1'-1"	1'-2"	1'-3"	1'-4"	1'-3"	1'-6"
120	1'-8"	1'-9"	1'-10"	1'-11"	1'-9"	2'-1"
140	2'-3"	2'-4"	2'-6"	2'-7"	2'-5"	2'-10"
160	3'-0"	3'-1"	3'-3"	3'-5"	3'-2"	3'-7"
180	3'-10"	4'-0"	4'-1"	4'-3"	4'-0"	4'-6"
200	4'-9"	4'-11"	5'-1"	5'-3"	5'-0"	5'-6"
220	5'-10"	6'-0"	6'-2"	6'-4"	6'-0"	6'-6"

Table AC 470–6: Tension — Temperature Stringing Table 3 Conductor 350 kcmil Aerial Bundled Cable for Light Loading Areas

	Tension (lb)					
	Initial Stringing Tension				Final Sag	
Span (ft)	50°F	70°F	90°F	110°F	70°F	130°F
40	4446	4069	3700	3340	3936	2751
60	4387	4040	3706	3388	3916	2898
80	4317	4006	3713	3438	3895	3032
100	4245	3973	3719	3485	3875	3147
120	4176	3942	3725	3525	3857	3242
140	4115	3916	3731	3560	3842	3320
160	4063	3893	3735	3588	3829	3384
180	4019	3874	3738	3612	3819	3437
200	3982	3858	3741	3632	3811	3481
220	3952	3845	3744	3649	3804	3517

Scope AC 470.5 **Sag Charts and Tension Stringing Tables for 3 Conductor 350 kcmil Aerial Bundled Cable for Heavy Loading Areas**

Table AC 470–7: Sag — Temperature Stringing Table 3 Conductor 350 kcmil Aerial Bundled Cable for Heavy Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
40	0'-3"	0'-3"	0'-3"	0'-4"	0'-3"	0'-5"
60	0'-6"	0'-7"	0'-8"	0'-9"	0'-8"	0'-10"
80	1'-1"	1'-2"	1'-3"	1'-4"	1'-3"	2'-1"
100	1'-10"	2'-0"	2'-1"	2'-2"	2'-1"	2'-4"
120	2'-10"	3'-0"	3'-1"	3'-2"	3'-1"	3'-4"
140	4'-1"	4'-2"	4'-3"	4'-4"	4'-3"	4'-7"
160	5'-5"	5'-7"	5'-8"	5'-9"	5'-8"	6'-0"
180	7'-0"	7'-2"	7'-3"	7'-4"	7'-3"	7'-7"
200	8'-10"	8'-11"	9'-1"	9'-2"	9'-1"	9'-5"
220	10'-10"	10'-11"	11'-0"	11'-2"	11'-0"	11'-4"

Table AC 470–8: Tension — Temperature Stringing Table 3 Conductor 350 kcmil Aerial Bundled Cable for Heavy Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
40	3562	3208	2870	2554	2980	2006
60	3152	2872	2619	2392	2675	2018
80	2791	2600	2429	2278	2454	2025
100	2547	2421	2308	2205	2319	2029
120	2395	2310	2232	2160	2237	2032
140	2299	2239	2183	2130	2186	2034
160	2237	2192	2150	2110	2152	2035
180	2194	2160	2127	2095	2128	2036
200	2164	2136	2110	2085	2111	2037
220	2141	2119	2098	2077	2098	2037

Scope AC 470.6 Sag Charts and Tension Stringing Tables for 2 Conductor 1/0 Aerial Bundled Cable for Light Loading Areas

Table AC 470–9: Sag — Temperature Stringing Table 2 Conductor 1/0 Aerial Bundled Cable for Light Loading Areas

	Sag					
	Initial Stringing Sag				Final Sag	
Span (ft)	50°F	70°F	90°F	110°F	70°F	130°F
40	0'-1"	0'-1"	0'-2"	0'-2"	0'-2"	0'-2"
60	0'-3"	0'-3"	0'-4"	0'-4"	0'-3"	0'-5"
80	0'-6"	0'-6"	0'-7"	0'-7"	0'-6"	0'-9"
100	0'-9"	0'-10"	0'-11"	1'-0"	0'-10"	1'-2"
120	1'-1"	1'-2"	1'-3"	1'-5"	1'-3"	1'-7"
140	1'-6"	1'-8"	1'-9"	1'-11"	1'-9"	2'-2"
160	2'-1"	2'-2"	2'-4"	2'-6"	2'-3"	2'-9"
180	2'-8"	2'-10"	3'-0"	3'-2"	2'-11"	3'-5"
200	3'-4"	3'-6"	3'-9"	3'-11"	3'-7"	4'-2"
220	4'-2"	4'-4"	4'-6"	4'-9"	4'-5"	5'-0"

Table AC 470–10: Tension — Temperature Stringing Table 2 Conductor 1/0 Aerial Bundled Cable for Light Loading Areas

	Tension (lb)					
	Initial Stringing Tension				Final Sag	
Span (ft)	50°F	70°F	90°F	110°F	70°F	130°F
40	2709	2464	2220	1980	2375	1571
60	2670	2434	2203	1980	2347	1615
80	2620	2398	2183	1980	2312	1661
100	2563	2357	2162	1980	2275	1702
120	2502	2315	2141	1979	2238	1739
140	2442	2275	2121	1979	2204	1771
160	2386	2238	2103	1979	2174	1798
180	2335	2205	2087	1979	2148	1821
200	2289	2177	2073	1979	2125	1841
220	2250	2152	2062	1979	2106	1857

Scope AC 470.7 **Sag Charts and Tension Stringing Tables for 2 Conductor 1/0 Aerial Bundled Cable for Heavy Loading Areas**

Table AC 470–11: Sag — Temperature Stringing Table 2 Conductor 1/0 Aerial Bundled Cable for Heavy Loading Areas

	Sag					
	Initial Stringing Sag				Final Sag	
Span (ft)	**50°F**	**70°F**	**90°F**	**110°F**	**70°F**	**130°F**
40	0'-2"	0'-2"	0'-2"	0'-3"	0'-2"	0'-3"
60	0'-4"	0'-5"	0'-6"	0'-6"	0'-6"	0'-8"
80	0'-9"	0'-10"	0'-11"	1'-0"	0'-11"	1'-3"
100	1'-5"	1'-6"	1'-8"	1'-9"	1'-8"	2'-0"
120	2'-3"	2'-5"	2'-6"	2'-8"	2'-6"	2'-11"
140	3'-4"	3'-5"	3'-7"	3'-9"	3'-7"	4'-0"
160	4'-7"	4'-8"	4'-10"	4'-11"	4'-10"	5'-3"
180	6'-0"	6'-1"	6'-3"	6'-4"	6'-3"	6'-8"
200	7'-7"	7'-8"	7'-10"	7'-11"	7'-10"	8'-3"
220	9'-4"	9'-5"	9'-7"	9'-8"	9'-7"	10'-0"

Table AC 470–12: Tension — Temperature Stringing Table 2 Conductor 1/0 Aerial Bundled Cable for Heavy Loading Areas

	Tension (lb)					
	Initial Stringing Tension				Final Sag	
Span (ft)	**50°F**	**70°F**	**90°F**	**110°F**	**70°F**	**130°F**
40	2164	1925	1694	1473	1768	1069
60	1880	1673	1482	1311	1517	1020
80	1585	1432	1298	1183	1307	989
100	1360	1262	1176	1101	1175	971
120	1220	1157	1101	1051	1098	960
140	1136	1093	1055	1019	1051	953
160	1083	1053	1025	999	1022	948
180	1048	1026	1004	984	1002	945
200	1024	1007	990	974	988	942
220	1007	993	979	966	977	940

Scope AC 470.8 **Sag Charts and Tension Stringing Tables for 1 Conductor 1/0 Aerial Bundled Cable for Light Loading Areas**

Table AC 470–13: Sag — Temperature Stringing Table 1 Conductor 1/0 Aerial Bundled Cable for Light Loading Areas

	Sag					
	Initial Stringing Sag				Final Sag	
Span (ft)	50°F	70°F	90°F	110°F	70°F	130°F
40	0'-1"	0'-2"	0'-2"	0'-3"	0'-2"	0'-4"
60	0'-3"	0'-4"	0'-4"	0'-5"	0'-4"	0'-7"
80	0'-6"	0'-7"	0'-8"	0'-9"	0'-7"	1'-8"
100	0'-9"	0'-11"	1'-0"	1'-1"	0'-11"	1'-4"
120	1'-2"	1'-3"	1'-5"	1'-7"	1'-4"	1'-10"
140	1'-7"	1'-9"	1'-11"	2'-1"	1'-10"	2'-4"
160	2'-1"	2'-4"	2'-6"	2'-8"	2'-4"	2'-11"
180	2'-9"	2'-11"	3'-1"	3'-4"	3'-0"	3'-7"
200	3'-5"	3'-7"	3'-10"	4'-0"	3'-8"	4'-4"
220	4'-2"	4'-5"	4'-7"	4'-10"	4'-6"	5'-1"
240	5'-0"	5'-3"	5'-5"	5'-8"	5'-4"	6'-0"
260	5'-11"	6'-2"	6'-5"	6'-7"	6'-3"	6'-11"
280	6'-11"	7'-2"	7'-4"	7'-7"	7'-3"	7'-11"
300	7'-11"	8'-2"	8'-5"	8'-8"	8'-3"	9'-0"

Table AC 470–14: Tension — Temperature Stringing Table 1 Conductor 1/0 Aerial Bundled Cable for Light Loading Areas

	Tension (lb)					
	Initial Stringing Tension				Final Sag	
Span (ft)	50°F	70°F	90°F	110°F	70°F	130°F
40	1565	1330	1107	902	1247	610
60	1541	1325	1125	950	1250	717
80	1513	1318	1145	996	1253	804
100	1483	1312	1163	1035	1256	874
120	1454	1306	1178	1069	1258	932
140	1428	1301	1192	1098	1260	979
160	1405	1297	1203	1121	1262	1019
180	1386	1294	1212	1141	1264	1051
200	1370	1291	1220	1158	1265	1079
220	1357	1288	1227	1172	1266	1102
240	1346	1286	1232	1184	1266	1121
260	1336	1284	1237	1194	1267	1138
280	1329	1283	1241	1202	1268	1152
300	1322	1282	1244	1209	1268	1164

Scope AC 470.9 **Sag Charts and Tension Stringing Tables for 1 Conductor 1/0 Aerial Bundled Cable for Heavy Loading Areas**

Table AC 470–15: Sag — Temperature Stringing Table 1 Conductor 1/0 Aerial Bundled Cable for Heavy Loading Areas

	Sag					
	Initial Stringing Sag				Final Sag	
Span (ft)	50°F	70°F	90°F	110°F	70°F	130°F
40	0'-2"	0'-3"	0'-3"	0'-4"	0'-3"	0'-6"
60	0'-6"	0'-7"	0'-8"	0'-9"	0'-8"	0'-11"
80	1'-0"	1'-1"	1'-2"	1'-4"	1'-2"	2'-1"
100	1'-8"	1'-10"	1'-11"	2'-0"	1'-11"	2'-3"
120	2'-7"	2'-8"	2'-10"	2'-11"	2'-9"	3'-2"
140	3'-7"	3'-9"	3'-10"	4'-0"	3'-10"	4'-3"
160	4'-10"	5'-0"	5'-1"	5'-3"	5'-1"	5'-5"
180	6'-3"	6'-4"	6'-6"	6'-7"	6'-6"	6'-10"
200	7'-9"	7'-11"	8'-0"	8'-2"	8'-0"	8'-5"
220	9'-6"	9'-8"	9'-9"	9'-11"	9'-9"	10'-2"
240	11'-5"	11'-6"	11'-8"	11'-10"	11'-8"	12'-0"
260	13'-6"	13'-7"	13'-9"	13'-10"	13'-9"	14'-1"
280	15'-9"	15'-10"	16'-0"	16'-1"	15'-11"	16'-4"
300	18'-2"	18'-3"	18'-5"	18'-6"	18'-4"	18'-9"

Table AC 470–16: Tension — Temperature Stringing Table 1 Conductor 1/0 Aerial Bundled Cable for Heavy Loading Areas

	Tension (lb)					
	Initial Stringing Tension				Final Tension	
Span (ft)	50°F	70°F	90°F	110°F	70°F	130°F
40	1060	861	691	559	739	396
60	884	750	645	565	669	459
80	760	682	619	568	632	495
100	692	645	605	570	612	518
120	655	623	596	571	601	532
140	632	610	590	572	594	542
160	618	602	587	573	590	549
180	609	596	584	573	586	554
200	602	592	582	573	584	558
220	597	589	581	574	582	561
240	593	587	580	574	581	563
260	590	585	579	574	580	564
280	588	583	579	574	579	566
300	586	582	578	574	579	567

1.0 Guying

Conductor tensions for guying 3 Conductor 1/0 Aerial Bundled Cable is 4,167 pounds in Light Loading Areas.

Conductor tensions for guying 3 Conductor 1/0 Aerial Bundled Cable is 4,168 pounds in Heavy Loading Areas.

Conductor tensions for guying 2 Conductor 1/0 Aerial Bundled Cable is 3,058 pounds in Light Loading and Heavy Loading Areas.

Conductor tensions for guying 1 Conductor 1/0 Aerial Bundled Cable is 1,902 pounds in Light Loading and Heavy Loading Areas.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearance.

AC 472 Reduced Tension Sag Charts and Tension Stringing for Aerial Bundled Cable

Scope AC 472.1 Directions for Use

The following tables provide reduced tension sag and temperature stringing tension information for aerial bundled cable.

See CO 168 for directions for use of reduced tension span sag charts.

Scope AC 472.2 Sag Chart for New and Existing Reduced Tension Guyed Primary 1/0 — 350 Aerial Bundled Cable for Light-Loading Areas

Table AC 472–1: Sag Chart for New and Existing Reduced Tension Guyed Primary 1/0 — 350 Aerial Bundled Cable for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
3 Conductor, 350 ABC	50	3'-6"	3'-7"
	75	5'-0"	5'-1"
	100	5'-0"	5'-2"
	125	6'-3"	6'-6"
	150	7'-5"	7'-9"
	175	8'-8"	9'-1"
	200	9'-11"	10'-4"
3 Conductor, 1/0 ABC	50	3'-6"	3'-7"
	75	5'-0"	5'-1"
	100	5'-0"	5'-2"
	125	6'-2"	6'-6"
	150	7'-5"	7'-9"
	175	8'-8"	9'-1"
	200	9'-10"	10'-4"
2 Conductor, 1/0 ABC	50	3'-6"	3'-7"
	75	5'-0"	5'-1"
	100	5'-0"	5'-2"
	125	6'-2"	6'-6"
	150	7'-5"	7'-9"
	175	8'-8"	9'-1"
	200	9'-11"	10'-4"
1 Conductor, 1/0 ABC	50	3'-6"	3'-7"
	75	5'-0"	5'-1"
	100	5'-0"	5'-2"
	125	6'-3"	6'-6"
	150	7'-5"	7'-9"
	175	8'-8"	9'-1"
	200	9'-11"	10'-4"

Table AC 472–2: Stringing Tension Table for New and Existing Reduced Tension Guyed Primary 1/0 — 350 Aerial Bundled Cable for Light-Loading Areas

Conductor Type	Span (ft)	Initial Tension (lb)	Final Tension (lb)
		50–110°F	**130°F**
3 Conductor, 350 ABC	50	345	339
	75	543	531
	100	962	923
	125	1204	1154
	150	1446	1385
	175	1688	1617
	200	1931	1848
3 Conductor, 1/0 ABC	50	196	192
	75	308	301
	100	546	523
	125	683	654
	150	821	784
	175	959	915
	200	1097	1046
2 Conductor, 1/0 ABC	50	140	137
	75	221	216
	100	391	375
	125	489	469
	150	587	562
	175	686	656
	200	785	750
1 Conductor, 1/0 ABC	50	85	83
	75	133	131
	100	236	227
	125	295	284
	150	355	340
	175	414	397
	200	472	454

1.0 Guyed Span Tensions

Table AC 472–3: Guy Span Reduced Tensions: 1/0 — 350 Aerial Bundled Cable for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
	50	**462**
3 Conductor, 350 ABC	75	727
	100	1286
	125	1605
	150	1922
	175	2239
	200	2554
3 Conductor, 1/0 ABC	50	309
	75	485
	100	856
	125	1067
	150	1277
	175	1485
	200	1693
2 Conductor, 1/0 ABC	50	218
	75	343
	100	607
	125	757
	150	907
	175	1056
	200	1205
1 Conductor, 1/0 ABC	50	128
	75	201
	100	357
	125	445
	150	534
	175	622
	200	710

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope AC 472.3 Sag Chart for New Reduced Tension Unguyed 1/0 — 350 Aerial Bundled Cable for Light-Loading Areas

Table AC 472–4: Sag Chart for New Reduced Tension Unguyed 1/0 — 350 Aerial Bundled Cable for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
3 Conductor, 350 ABC	50	5'-0"	5'-1"
	75	7'-6"	7'-7"
	100	7'-6"	7'-8"
	125	9'-4"	9'-6"
3 Conductor, 1/0 ABC	50	5'-0"	5'-1"
	75	7'-6"	7'-7"
	100	7'-6"	7'-8"
	125	9'-4"	9'-6"
2 Conductor, 1/0 ABC	50	5'-0"	5'-1"
	75	7'-6"	7'-7"
	100	7'-6"	7'-8"
	125	9'-4"	9'-6"
1 Conductor, 1/0 ABC	50	5'-0"	5'-1"
	75	7'-6"	7'-7"
	100	7'-6"	7'-8"
	125	9'-4"	9'-6"

Table AC 472–5: Stringing Tension Table for New Reduced Tension Unguyed 1/0 — 350 Aerial Bundled Cable for Light-Loading Areas

Conductor Type	Span (ft)	Initial Tension 50–110°F	Final Tension 130°F
3 Conductor, 350 ABC	50	246	244
	75	370	366
	100	647	635
	125	809	794
3 Conductor, 1/0 ABC	50	140	138
	75	209	207
	100	367	360
	125	458	450
2 Conductor, 1/0 ABC	50	100	99
	75	150	149
	100	263	258
	125	328	322
1 Conductor, 1/0 ABC	50	61	60
	75	91	90
	100	159	156
	125	199	195

1.0 New Unguyed Span Tensions

Table AC 472–6: New Unguyed Span Reduced Tensions: 1/0 — 350 Aerial Bundled Cable for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
3 Conductor, 350 ABC	50	329
	75	493
	100	864
	125	1079
3 Conductor, 1/0 ABC	50	220
	75	329
	100	576
	125	720
2 Conductor, 1/0 ABC	50	155
	75	233
	100	408
	125	509
1 Conductor, 1/0 ABC	50	91
	75	136
	100	239
	125	299

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope AC 472.4 Sag Chart for Existing and Rebuild Reduced Tension Unguyed 1/0 — 350 Aerial Bundled Cable for Light-Loading Areas

Table AC 472–7: Sag Chart for Existing and Rebuild Reduced Tension Unguyed 1/0 — 350 Aerial Bundled Cable for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
3 Conductor, 350 ABC	50	5'-0"	5'-1"
	75	7'-6"	7'-7"
	100	7'-6"	7'-8"
	125	9'-4"	9'-6"
	150	11'-3"	11'-5"
	175	13'-1"	13'-4"
3 Conductor, 1/0 ABC	50	5'-0"	5'-1"
	75	7'-6"	7'-7"
	100	7'-6"	7'-8"
	125	9'-4"	9'-6"
	150	11'-3"	11'-5"
	175	13'-1"	13'-4"
2 Conductor, 1/0 ABC	50	5'-0"	5'-1"
	75	7'-6"	7'-7"
	100	7'-6"	7'-8"
	125	9'-4"	9'-6"
	150	11'-3"	11'-5"
	175	13'-1"	13'-4"
1 Conductor, 1/0 ABC	50	5'-0"	5'-1"
	75	7'-6"	7'-7"
	100	7'-6"	7'-8"
	125	9'-4"	9'-6"
	150	11'-3"	11'-5"
	175	13'-1"	13'-4"

Table AC 472–8: Stringing Tension Table for Existing and Rebuild Reduced Tension Unguyed 1/0 — 350 Aerial Bundled Cable for Light-Loading Areas

Conductor Type	Conductor Type	Initial Tension (lb)	Final Tension (lb)
		50–110°F	130°F
3 Conductor, 350 ABC	50	246	244
	75	370	366
	100	647	635
	125	809	794
	150	971	953
	175	1133	1112
3 Conductor, 1/0 ABC	50	140	138
	75	209	207
	100	367	360
	125	458	450
	150	550	540
	175	642	630
2 Conductor, 1/0 ABC	50	100	99
	75	150	149
	100	263	258
	125	328	322
	150	394	387
	175	460	451
1 Conductor, 1/0 ABC	50	61	60
	75	91	90
	100	159	156
	125	199	195
	150	238	234
	175	278	273

1.0 Existing and Rebuild Unguyed Span Tension

Table AC 472–9: Existing and Rebuild Unguyed Span Reduced Tensions: 1/0 — 350 Aerial Bundled Cable for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
3 Conductor, 350 ABC	50	329
	75	493
	100	864
	125	1079
	150	1294
	175	1509
3 Conductor, 1/0 ABC	50	220
	75	329
	100	576
	125	720
	150	863
	175	1006
2 Conductor, 1/0 ABC	50	155
	75	233
	100	408
	125	509
	150	611
	175	712
1 Conductor, 1/0 ABC	50	91
	75	136
	100	239
	125	299
	150	358
	175	418

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope AC 472.5 Sag Chart for New and Existing Reduced Tension Guyed 1/0 — 350 Aerial Bundled Cable for Heavy-Loading Areas

Table AC 472–10: Sag Chart for New and Existing Reduced Tension Guyed 1/0 — 350 Aerial Bundled Cable for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
3 Conductor, 350 ABC	50	3'-6"	3'-7"
	75	5'-0"	5'-1"
	100	5'-0"	5'-2"
	125	6'-3"	6'-6"
	150	7'-5"	7'-9"
	175	8'-8"	9'-1"
3 Conductor, 1/0 ABC	50	3'-6"	3'-7"
	75	5'-0"	5'-1"
	100	5'-0"	5'-2"
	125	6'-2"	6'-6"
	150	7'-5"	7'-9"
	175	8'-8"	9'-1"
2 Conductor, 1/0 ABC	50	3'-6"	3'-7"
	75	5'-0"	5'-1"
	100	5'-0"	5'-2"
	125	6'-2"	6'-6"
	150	7'-5"	7'-9"
	175	8'-8"	9'-1"
1 Conductor, 1/0 ABC	50	3'-6"	3'-7"
	75	5'-0"	5'-1"
	100	5'-0"	5'-2"
	125	6'-3"	6'-6"
	150	7'-5"	7'-9"
	175	8'-8"	9'-1"

Table AC 472–11: Stringing Tension Table for New and Existing Reduced Tension Guyed 1/0 — 350 Aerial Bundled Cable for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
3 Conductor, 350 ABC	50	345	339
	75	543	531
	100	962	923
	125	1204	1154
	150	1446	1385
	175	1688	1617
3 Conductor, 1/0 ABC	50	196	192
	75	308	301
	100	546	523
	125	683	654
	150	821	784
	175	959	915
2 Conductor, 1/0 ABC	50	140	137
	75	221	216
	100	391	375
	125	489	469
	150	587	562
	175	686	656
1 Conductor, 1/0 ABC	50	345	339
	75	543	531
	100	962	923
	125	1204	1154
	150	1446	1385
	175	1688	1617

1.0 Guyed Span Tensions

Table AC 472–12: Guyed Span Reduced Tensions: 1/0 — 350 Aerial Bundled Cable for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
3 Conductor, 350 ABC	50	854
	75	1339
	100	2345
	125	2909
	150	3466
	175	4016
3 Conductor, 1/0 ABC	50	644
	75	1008
	100	1751
	125	2168
	150	2577
	175	2979
2 Conductor, 1/0 ABC	50	465
	75	728
	100	1275
	125	1582
	150	1884
	175	2182
1 Conductor, 1/0 ABC	50	284
	75	446
	100	788
	125	980
	150	1170
	175	1358

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope AC 472.6 Sag Chart for New Reduced Tension Unguyed 1/0 — 350 Aerial Bundled Cable for Heavy-Loading Areas

Table AC 472–13: Sag Chart for New Reduced Tension Unguyed 1/0 — 350 Aerial Bundled Cable for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
3 Conductor, 350 ABC	50	5'-0"	5'-1"
	75	7'-6"	7'-7"
	100	7'-6"	7'-8"
	125	9'-4"	9'-6"
3 Conductor, 1/0 ABC	50	5'-0"	5'-1"
	75	7'-6"	7'-7"
	100	7'-6"	7'-8"
	125	9'-4"	9'-6"
2 Conductor, 1/0 ABC	50	5'-0"	5'-1"
	75	7'-6"	7'-7"
	100	7'-6"	7'-8"
	125	9'-4"	9'-6"
1 Conductor, 1/0 ABC	50	5'-0"	5'-1"
	75	7'-6"	7'-7"
	100	7'-6"	7'-8"
	125	9'-4"	9'-6"

Table AC 472–14: Stringing Tension Table for New Reduced Tension Unguyed 1/0 — 350 Aerial Bundled Cable for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Tension	Final Tension
		50–110°F	130°F
3 Conductor, 350 ABC	50	246	244
	75	370	366
	100	647	635
	125	809	794
3 Conductor, 1/0 ABC	50	140	138
	75	209	207
	100	367	360
	125	458	450
2 Conductor, 1/0 ABC	50	100	99
	75	150	149
	100	263	258
	125	328	322
1 Conductor, 1/0 ABC	50	61	60
	75	91	90
	100	159	156
	125	199	195

1.0 New Unguyed Span Tensions

Table AC 472–15: New Unguyed Span Reduced Tensions: 1/0 — 350 Aerial Bundled Cable for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
3 Conductor, 350 ABC	50	607
	75	910
	100	1590
	125	1982
3 Conductor, 1/0 ABC	50	459
	75	687
	100	1197
	125	1492
2 Conductor, 1/0 ABC	50	330
	75	495
	100	865
	125	1078
1 Conductor, 1/0 ABC	50	202
	75	302
	100	530
	125	661

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope Sag Chart for Existing and Rebuild Reduced Tension Unguyed 1/0 — 350 Aerial Bundled Cable for Heavy-Loading AreasAC 472.7

Table AC 472–16: Sag Chart for Existing and Rebuild Reduced Tension Unguyed 1/0 — 350 Aerial Bundled Cable for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	**130°F**
3 Conductor, 350 ABC	50	5'-0"	5'-1"
	75	7'-6"	7'-7"
	100	7'-6"	7'-8"
	125	9'-4"	9'-6"
	150	11'-3"	11'-5"
	175	13'-1"	13'-4"
3 Conductor, 1/0 ABC	50	5'-0"	5'-1"
	75	7'-6"	7'-7"
	100	7'-6"	7'-8"
	125	9'-4"	9'-6"
	150	11'-3"	11'-5"
	175	13'-1"	13'-4"
2 Conductor, 1/0 ABC	50	5'-0"	5'-1"
	75	7'-6"	7'-7"
	100	7'-6"	7'-8"
	125	9'-4"	9'-6"
	150	11'-3"	11'-5"
	175	13'-1"	13'-4"
1 Conductor, 1/0 ABC	50	5'-0"	5'-1"
	75	7'-6"	7'-7"
	100	7'-6"	7'-8"
	125	9'-4"	9'-6"
	150	11'-3"	11'-5"
	175	13'-1"	13'-4"

Table AC 472–17: Stringing Tension Table for Existing and Rebuild Reduced Tension Unguyed 1/0 — 350 Aerial Bundled Cable for Heavy-Loading Areas

Conductor Type	Conductor Type	Initial Tension (lb)	Final Tension (lb)
		50–110°F	130°F
3 Conductor, 350 ABC	50	246	244
	75	370	366
	100	647	635
	125	809	794
	150	971	953
	175	1133	1112
3 Conductor, 1/0 ABC	50	140	138
	75	209	207
	100	367	360
	125	458	450
	150	550	540
	175	642	630
2 Conductor, 1/0 ABC	50	100	99
	75	150	149
	100	263	258
	125	328	322
	150	394	387
	175	460	451
1 Conductor, 1/0 ABC	50	61	60
	75	91	90
	100	159	156
	125	199	195
	150	238	234
	175	278	273

1.0 Existing and Rebuild Unguyed Span Tension

Table AC 472–18: Existing and Rebuild Unguyed Span Reduced Tensions: 1/0 — 350 Aerial Bundled Cable for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
3 Conductor, 350 ABC	50	607
	75	910
	100	1590
	125	1982
	150	2373
	175	2763
3 Conductor, 1/0 ABC	50	459
	75	687
	100	1197
	125	1492
	150	1784
	175	2075
2 Conductor, 1/0 ABC	50	330
	75	495
	100	865
	125	1078
	150	1291
	175	1502
1 Conductor, 1/0 ABC	50	202
	75	302
	100	530
	125	661
	150	792
	175	923

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

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The AP Section of the DOH manual had been removed and a new manual, the Distribution Apparatus Construction Standards (DAP) was created. Please refer to the new manual for the AP standards.

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DOH–CC: Covered Conductor

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CC 100 Covered Conductor

Scope CC 100.1 Covered Conductor General

1.0 General

Covered Conductor (CC), also known as tree wire, is a conductor that is protected by layers of insulating material. There are four components in the covered conductor: the conductor, a conductor shield, an inner layer, and an outer layer.

The conductor can be Aluminum Conductor Steel-Reinforced (ACSR) or Hard Drawn Copper (HDCU). Copper covered conductor is for coastal (within 1 mile of the ocean) applications due to copper being more resistant to corrosion than ACSR.

The conductor shield is made of a semi-conducting thermoset polymer. Its purpose is to reduce stress concentrations caused by flux lines from the individual conductor strands. By encircling the strands, it effectively transforms the strands into a single uniform conducting cylinder. The conductor shield can increase the life of the covered conductor by reducing the electrical stress on the contact area, therefore increasing the time to failure when an object makes contact with the covered conductor.

The inner layer is Crosslinked Low Density Polyethylene (XL-LDPE), which is an insulating material. The insulation contributes to the high impulse strength of the cover and protects the conductor from phase to phase and phase to ground contact.

The outer layer is Crosslinked High Density Polyethylene (XL-HDPE), which is an insulating material as well. It has the same insulating function as the inner layer. However, due to being high density, it is also a tougher layer, making it abrasion and impact resistant. The outer layer is also track resistant, which limits the charging current flowing on its surface. This track resistant property will help maintain the integrity of the insulation surface over time by significantly reducing electrical tracking that could lead to erosion of the insulation. Additionally, the XL-HDPE layer is specified for UV stability, making it less susceptible to UV degradation.

Covered conductor shall be treated and worked on as bare conductor and does not exempt tree trimming requirements.

NOTE

New installations of CC will have the XLPE layer as the outer layer. There will be some in-service 1/0 CC with the HDPE layer as the outer layer. The in-service 1/0 HDPE CC with a black covering is the 75°C rated covered conductor and will have a lower ampacity rating compared to new installations. The in-service 1/0 HDPE CC with a black stipe and gray covering is 90°C rated covered conductor and will have lower emergency and short circuit temperature ratings compared to the XLPE CC (see Table CC 110–1 and Table CC 110–2).

Figure CC 100–1: Covered Conductor

Two covered conductor designs are available: A 17 kV designed covered conductor and a 35 kV designed covered conductor.

- 17 kV Covered Conductors may be used for a maximum of 17 kV, single- or three-phase circuits, laterals, or feeders. Neutral conductors are covered.
- 35 kV Covered Conductor may be used for a maximum of 35 kV, single- or three-phase circuits, laterals, or feeders. Neutral conductors are covered.

Installing Covered Conductor is the same as installing bare conductor except:

☐ Polymer Pin-Type Insulators with Vice-Top Nylon Inserts must be used
☐ Splices, dead-ends, equipment bushing, fuses, and lightning arresters must be covered
☐ Outer covering must be stripped before making any connections
☐ Surge Arresters (see CC 130)

CC 110 Cable Data

Scope CC 110.1 15 kV Covered Conductors — 75°C Rated

Table CC 110–1: Cable Data — 75°C Rated ACSR Covered Conductor (Tree Wire)

SAP	Conductor Size (AWG)	Conductor Type (Stranding)	Cover Type	Weight (lb/ft)	Diameter (in)	Ampacity per Conductor[a/] (amps)
10110355	1/0	ACSR (6/1)	HDPE (150 mills)	0.262	0.698	202

[a/] Covered Conductor Cable Normal Operating Rating Criteria:
Ambient Temperature = 40°C
Conductor Temperature = 75°C
Load Factor = 100%
Wind Speed = 4 ft/sec
Coefficient of Emissivity = 0.91
Coefficient of Absorption = 0.95
Latitude = 34°
Elevation of Conductor above Sea Level = 6,000 ft
Atmosphere = Clear
Local Sun Time = 1:00 pm

= For Reference Only

Scope CC 110.2 17 kV Covered Conductors — 90°C Rated

Table CC 110–2: 17 kV Cable Data — 90°C Rated ACSR Covered Conductor (Tree Wire)

SAP	Conductor Size (AWG)	Conductor Type (Stranding)	Cover Type	Weight (lb/ft)	Conductor Diameter (in)	Overall Diameter (in)	Ampacity per Conductor[a/] (amps)
10211064	1/0	ACSR (6/1)	HDPE (165 mils)	0.284	0.398	0.728	271
10210583	1/0	ACSR (6/1)	XLPE (165 mills)	0.277	0.398	0.728	271
10210584	336.4	ACSR (18/1)	XLPE (165 mils)	0.564	0.684	1.014	550
10212540	336.4[b/]	ACSR (30/7)	XLPE (165 mils)	0.744	0.741	1.091	561
10210585	653.9	ACSR (18/3)	XLPE (180 mils)	0.973	0.953	1.313	835

a/ Covered Conductor Cable Normal Operating Rating Criteria:
Ambient Temperature = 40°C
Conductor Temperature = 90°C
Load Factor = 100%
Wind Speed = 4 ft/sec
Coefficient of Emissivity = 0.5
Coefficient of Absorption = 0.5
Latitude = 34°
Elevation of Conductor above Sea Level = 0 ft
Atmosphere = Clear
Local Sun Time = 1:00 pm

b/ See CC 122 for 336 (30/7) Covered Conductor Application and Construction Requirements.

= For Reference Only

Table CC 110–3: 17 kV Cable Data — 90°C Rated HDCU Covered Conductor (Tree Wire)

SAP	Conductor Size (AWG)	Conductor Type (Stranding)	Cover Type	Weight (lb/ft)	Conductor Diameter (in)	Overall Diameter (in)	Ampacity per Conductor[a/] (amps)
10211032	#2	HDCU (7)	XLPE (165 mils)	0.316	0.292	0.64	240
10211030	2/0	HDCU (7)	XLPE (165 mils)	0.569	0.414	0.783	367
10211031	4/0	HDCU (7)	XLPE (165 mils)	0.845	0.522	0.891	488

a/ Covered Conductor Cable Normal Operating Rating Criteria:
Ambient Temperature = 40°C
Conductor Temperature = 90°C
Load Factor = 100%
Wind Speed = 4 ft/sec
Coefficient of Emissivity = 0.5
Coefficient of Absorption = 0.5
Latitude = 34°
Elevation of Conductor above Sea Level = 0 ft
Atmosphere = Clear
Local Sun Time = 1:00 pm

What's Changed? Updated Table CC 110-2: 1/0 ACSR (6/1) shown for reference only. Added reference to CC 122 for 336 ACSR (30/7) covered conductor.

Scope CC 110.3 35 kV Covered Conductors — 90°C Rated

Table CC 110–4: 35 kV Cable Data — 90°C Rated ACSR Covered Conductor (Tree Wire)

SAP	Conductor Size (AWG)	Conductor Type (Stranding)	Cover Type	Weight (lb/ft)	Conductor Diameter (in)	Overall Diameter (in)	Ampacity per Conductor[a/] (amps)
10211784	1/0	ACSR (6/1)	XLPE (315 mils)	0.460	0.398	1.048	255
10211785	336.4	ACSR (18/1)	XLPE (315 mils)	0.850	0.684	1.333	518
10212033	336.4[b/]	ACSR (30/7)	XLPE (315 mils)	0.981	0.741	1.391	529
10211786	653.09	ACSR (18/3)	XLPE (320 mils)	1.242	0.952	1.603	784

[a/] Covered Conductor Cable Normal Operating Rating Criteria:
Ambient Temperature = 40°C
Conductor Temperature = 90°C
Load Factor = 100%
Wind Speed = 4 ft/sec
Coefficient of Emissivity = 0.5
Coefficient of Absorption = 0.5
Latitude = 34°
Elevation of Conductor above Sea Level = 0 ft
Atmosphere = Clear
Local Sun Time = 1:00 pm

[b/] See CC 122 for 336 (30/7) Covered Conductor Application and Construction Requirements.

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CC 120 Sagging and Clearances

Scope CC 120.1 Sagging Covered Conductors

Sag boards shall be used when sagging covered conductors. The use of sag boards will ensure that the covered conductor will be installed with the proper sag. It is important to ensure that proper sag is used in order to avoid vibration fatigue due to Aeolian vibration. Because the covering limits the movement of the conductor, covered conductors may be more susceptible to vibration fatigue if they are not sagged properly.

See Scope CO 100.1, Section 1.0 for information on sagging.

Scope CC 120.2 Directions for Use of Sag Charts

See CO 120 for directions for use of sag charts.

CAUTION

Do not use bare conductor sag values on covered conductor. It is important to follow the covered conductor sag charts. Lack of compliance may lead to failure.

Scope CC 120.3 Sag Chart and Clearances for 1/0 ACSR Covered Conductor

See Scope CO 140.2 for Sag and Clearances for 17 kV and 35 kV 1/0 ACSR Covered Conductor for Light-Loading Areas

See Scope CO 162.2 for Sag and Clearances for 17 kV and 35 kV 1/0 ACSR Covered Conductor for Heavy-Loading Areas

Scope CC 120.4 Sag Charts and Clearances 336.4 ACSR Covered Conductor

See Scope CO 140.3 for Sag and Clearances for 17 kV and 35 kV 336.4 ACSR Covered Conductor for Light-Loading Areas

See Scope CO 164.2 for Sag and Clearances for 17 kV and 35 kV 336.4 ACSR Covered Conductor for Heavy-Loading Areas

Scope CC 120.5 Sag Charts and Clearances 653.9 ACSR Covered Conductor

See Scope CO 142.2 for Sag and Clearances for 17 kV and 35 kV 653.9 ACSR Covered Conductor for Light-Loading Areas

See Scope CO 166.2 for Sag and Clearances for 17 kV and 35 kV 653.9 ACSR Covered Conductor for Heavy-Loading Areas

Scope CC 120.6 Sag Charts and Clearances #2 Copper Covered Conductor

See Scope CO 148.2 for Sag and Clearances for #2 Copper Covered Conductor for Light-Loading Areas.

See Scope CO 152.2 for Sag and Clearances for #2 Copper Covered Conductor for Heavy-Loading Areas.

Scope CC 120.7 Sag Charts and Clearances 2/0 Copper Covered Conductor

See Scope CO 148.3 for Sag and Clearances for 2/0 Copper Covered Conductor for Light-Loading Areas

See Scope CO 160.2 for Sag and Clearances for 2/0 Copper Covered Conductor for Heavy-Loading Areas

Scope CC 120.8 Sag Charts and Clearances 4/0 Copper Covered Conductor

See Scope CO 148.4 for Sag and Clearances for 4/0 Copper Covered Conductor for Light-Loading Areas

See Scope CO 160.3 for Sag and Clearances for 4/0 Copper Covered Conductor for Heavy-Loading Areas

CC 121 Reduce Tension Span Sag Charts for Covered Conductors

Scope CC 121.1 Directions for Use of Sag Charts

See Scope CO 168.1 for directions for use of sag charts.

CAUTION

Do not use bare conductor sag values on covered conductor. It is important to follow the covered conductor sag charts. Lack of compliance may lead to failure

Scope CC 121.2 Reduced Tension Sag Charts for Light-Loading Areas

See Scope CO 168.3 for Sag Chart for New and Existing Reduced Tension Guyed Primary 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas.

See Scope CO 168.5 for Sag Chart for New and Existing Reduced Tension Guyed Primary #2 — 4/0 Copper Covered Conductor for Light Loading Areas.

See Scope CO 168.9 for Sag Chart for New Reduced Tension Unguyed 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas.

See Scope CO 168.11 for New Reduced Tension Unguyed #2 — 4/0 Copper Covered Conductor for Light Loading Areas.

See Scope CO 168.15 for Sag Chart for Existing and Rebuild Reduced Tension Unguyed 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas.

See Scope CO 168.17 for Sag Chart for Existing and Rebuild Reduced Tension Unguyed #2 — 4/0 Copper Covered Conductor.

Scope CC 121.3 Reduced Tension Sag Charts for Heavy-Loading Areas

See Scope CO 168.20 for Sag Chart for New and Existing Reduced Tension Guyed 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas.

See Scope CO 168.22 for Sag Chart for New and Existing Reduced Tension Guyed #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas.

See Scope CO 168.26 for Sag Chart for New Reduced Tension Unguyed 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas.

See Scope CO 168.28 for Sag Chart for New Reduced Tension Unguyed #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas.

See Scope CO 168.32 for Sag Chart for Existing and Rebuild Reduced Tension Unguyed 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas.

See Scope CO 168.34 for Sag Chart for Existing and Rebuild Reduced Tension Unguyed #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas.

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CC 122 336 (30/7) ACSR Covered Conductor Application and Construction Requirements

Scope CC 122.1 336 (30/7) ACSR Covered Conductor Application and Construction Requirements

The following information provides general construction requirements when using 17 kV or 35 kV 336 (30/7) ACSR Covered Conductor.

The 336 (30/7) ACSR Covered Conductor is a high strength conductor and shall only be used for heavy loading areas. This conductor shall be considered when resolving ground clearance issues caused by other conductors. The G.O. 95 required consideration of ice in heavy loading areas in wire tension design limits results in greater conductor sags, which reduces the ground clearance distance. Because this conductor is high strength, it can be sagged at higher tensions which will increase ground clearance. The maximum design tension for the 336 (30/7) ACSR covered conductor will be 5,000 lb. Limiting the tension to 5,000 lb ensures that hardware such as the dead-end grips and crossarms will not be mechanically overloaded. To account for the high tensions used by the 336 (30/7) ACSR Covered Conductor, the following construction requirements are necessary:

☐ H-Frames or 3-pole structures will be required for dead-ends. 3-pole structures shall be considered if tensions will need to exceed 5,000 lb to meet ground clearance requirements.

See DC 630 for H-Frame Construction.

☐ H-Frames are required for tangent structures

See DC 630 for H-Frame Construction.

☐ Double 20 foot crossarms will be required for dead-ends.

See CO 700 for crossarm information.

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CC 130 Surge Arresters

Scope CC 130.1 Application of Surge Arresters for Covered Conductors

For covered conductors, overvoltage events can lead to conductor or insulation damage if the overvoltage initiates an arc. In order to mitigate potential damage to the covered conductor surge arresters are to be applied to equipment and risers in accordance with existing standard requirements for High Lightning Density areas per Distribution Apparatus Construction Standards (DAP), Subsection AP 400 5.2 and DDS-10 5.6.L.2, regardless of the lightning density at the installation location.

The specific equipment that must have arresters when installed in a covered conductor system are:

- Remote Automatic Reclosers (RARs)
- Remote Sectionalizing Reclosers (RSRs)
- Capacitors
- Line Voltage Regulators
- Potential Transformers (PTs) associated with Remote Control Switches (RCSs)
- PTs associated with Overhead Preferred Emergency (PE) Equipment
- Overhead Transformers (All installations)
- Branch Line Fusing Installations

All underground dips from overhead lines must have arresters installed.

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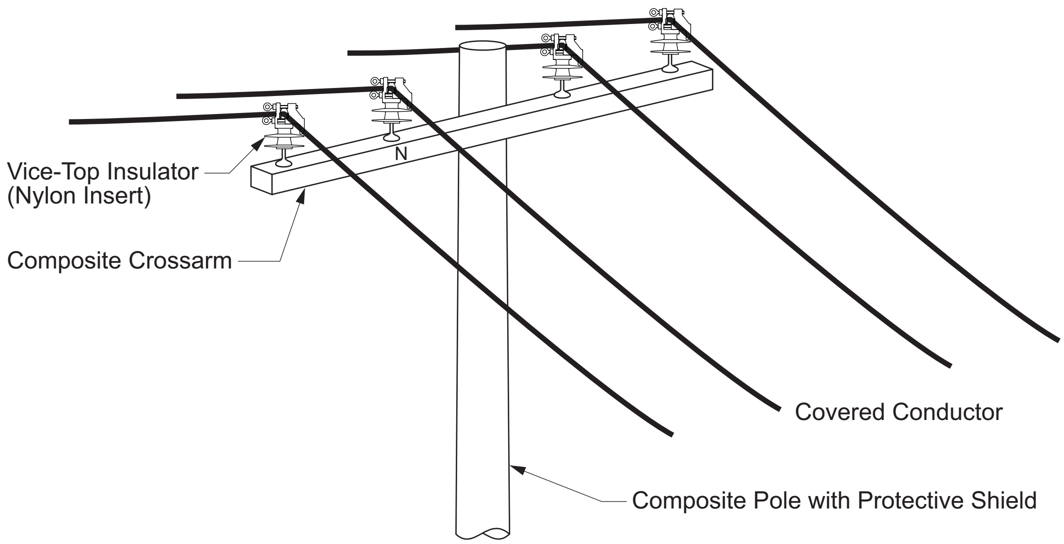
CC 140 Neutrals in Covered Conductor Systems

Scope CC 140.1 Covered Conductor Neutrals

Use covered neutrals for covered conductor systems. The same nominal kV rated insulator can be used on all conductors provided that the neutral is identified with an “N” sign (SAP 10135124). If the same insulator is used on all conductors (A, B, C, and Neutral), the “N” sign shall be used on every crossarm to identify the neutral.

Figure CC 140–1: 4-Wire Construction with Neutral Identification



Refer to DDS-10 for grounding and neutral applications.

See GR 110 for establishing neutral grounds in a 4-wire system.

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CC 150 Covered Conductor Installation Materials and Equipment

Scope CC 150.1 Covered Conductor Insulator

Vice-Top Polymer Pin-Type Line Insulators with Nylon Inserts are required for use with covered conductors. If covered conductors use equipment that has a different material than the covering, such as porcelain insulators or metallic inserts, the voltage gradient will cause tracking on the covering due to dielectric incompatibility. Tracking will erode the covering over time. To prevent damage on the covered conductor, polymer insulators and nylon inserts shall be used.

Do not strip the covering when installing the covered conductor on the insulator.

Covered conductor systems do not require wildlife hoods on the insulator.

See Scope GR 200.5 for Polymer Pin-Type Line Insulators — Vice-Top, Nylon Inserts applications.

Figure CC 150–1: Covered Conductor on Vice-Top, Nylon Insert Insulator

Scope CC 150.2 Dead-Ending Covered Conductors

Covered conductor systems in a High Fire Risk Areas (HFRA) shall be constructed with composite crossarms. In non-HFRA, wood crossarms are acceptable.

See CO 200 and CO 201 for dead-ending tables for wood crossarms and composite crossarms, respectively.

See CO 207 for dead-ending covered conductors.

See CO 211 and CO 212 for dead-ending wood crossarm and composite crossarm construction, respectively.

Dead-ends shall be covered with a Dead End Clamp in covered conductor systems. Covering dead-ends will ensure that stripped portions of the covered conductor at the dead-end will be protected from contact that could lead to phase-to-phase or phase-to-ground faults (see Table DC 535–1 for the Dead End Clamp).

Figure CC 150–2: 4-Wire Covered Conductor Dead-end Construction

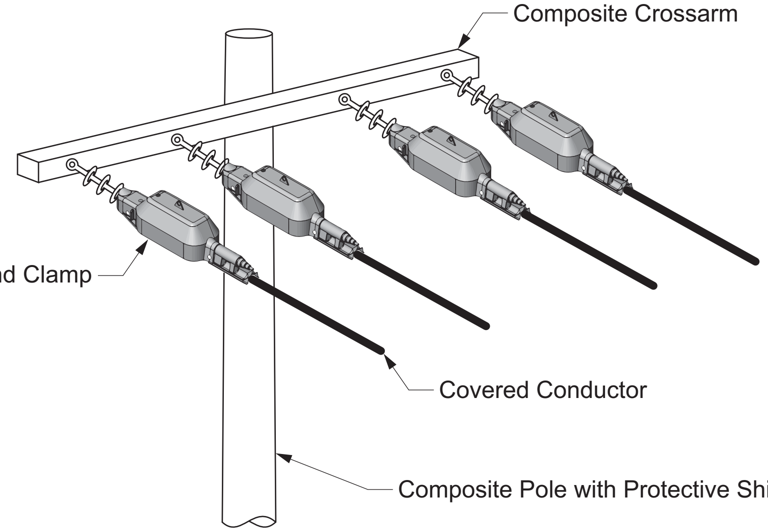
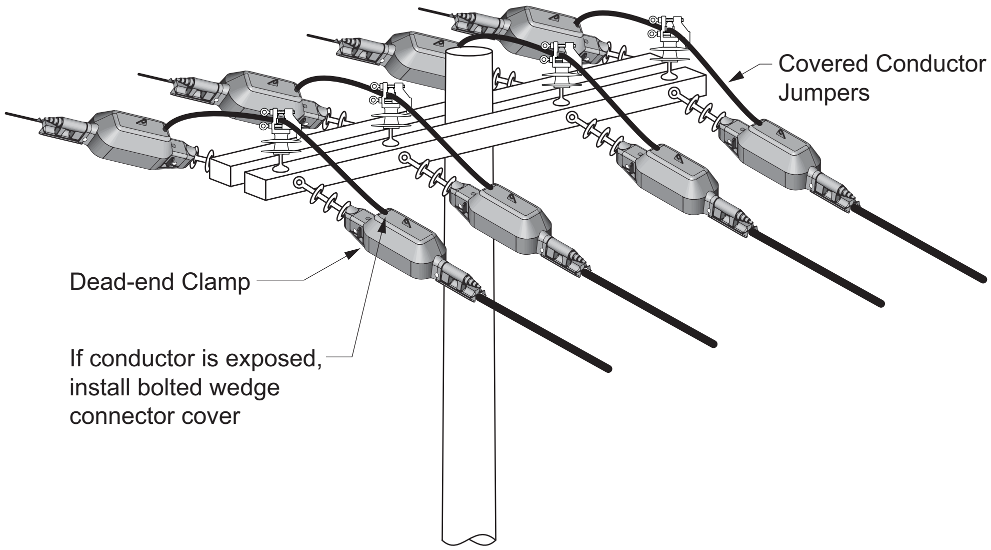


Figure CC 150–3: 4-Wire Covered Conductor Double Dead-end Construction



Scope CC 150.3 Covered Conductor Tap Connections

Bolted wedge connectors shall be used for tap connections in covered conductor systems. This includes overhead line taps, underground risers, and equipment taps.

Parallel grooves and hot line clamps shall not be used in covered conductor systems.

Bolted wedge connects shall be covered with a connector cover. See Table CO 420–1 for the connector cover appropriate for each size connector.

See CO 420 for Bolted Wedge Connector information.

Figure CC 150–4: Connector Cover Installed at Dead-End Tap

Scope CC 150.4 Wildlife Cover Requirements for Covered Conductor Systems

1.0 General Information

Covered Conductor systems shall be an all-covered system. This means that wildlife covers shall be used on dead-ends, terminations, connectors, and equipment bushings. By covering other equipment, contact with object faults may be prevented not only with the conductor, but with other energized sources as well.

See DC 535 for more information on required Wildlife-Safe Power Line Construction and material codes for wildlife covers referenced in the following sections.

2.0 Dead-ends

Dead-ends shall be covered with Dead-end clamps. Covering dead-ends will ensure that stripped portions of the covered conductor at the dead-end will be protected from contact that could lead to phase-to-phase or phase-to-ground faults.

All exposed conductor at the dead-ends shall be covered. If the dead-end clamp is insufficient, then additional covers, such as the split tube, must be used to cover any exposed conductor.

3.0 Connectors

Connectors shall be covered in covered conductor systems. Connector covers minimize the risk of contact-related faults at the connection point.

Bolted wedge covers shall be used for bolted wedge connectors. While bolted wedge covers are preferred, the use of pothead covers are allowed.

4.0 Jumpers/Taps

When making connections, jumpers shall be covered conductor of equal or greater ampacity. Protective Ground Wire (PGW) may be used to connect to equipment with the exception of terminations/potheads. However, PGW shall not be used for line connections in covered conductor systems due to their limited current carrying capacity. It is not necessary to cover PGW with a split tube.

5.0 Equipment

All overhead equipment shall utilize appropriate wildlife covers.

For structures with Switches, dead-end covers are required for dead-ends at the Switch and for below the arm construction. Covered conductor shall be used as jumpers.

Insulator covers are not required on covered conductor systems.

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CC 170 Splicing Covered Conductors

Scope CC 170.1 Compression Splices and Splice Covering Kit

1.0 Aluminum Splices and Splice Covering Kit

1.1 Application

To be used on aluminum conductors of distribution voltages 17 kV and below.

Splices on Covered Conductors must be covered. See Table CC 170–2 for appropriate splice covering kit.

Table CC 170–1: ACSR Covered Conductor Full and Partial Tension Splices

Wire Size	Splice SAP	MD-6 Die No. & SAP	Y34A Die No. & SAP	Y35-Y39-12HA Die No. & SAP	UT-15 Die No. & SAP	Number of Crimps per End
1/0-AWG (6/1)	10112092	W-702 SAP 10148865	N/A	U-247 SAP 10148910	See Note 1	MD6=14 Others=7
336.4 kcmil (18/1)	10112095	N/A	N/A	U-655 SAP 10148913	See Note 1	Overlap
336.4 kcmil (30/7)	10112041	N/A	N/A	B20AH-14AH SAP 10148918 B10SH SAP 10145917	See Note 1	Overlap
653.9 kcmil (18/3)	10112096 See Note 2	N/A	N/A	N/A	15C140R SAP 10148896	6

Note(s):

1. Use adapter die SAP 10148852 to fit Y35, Y39, or 12HA dies in UT-15 tool.
2. Partial Tension Splice, 93 percent rated breaking strength (RBS), or 13,800 lb.

Table CC 170–2: 17 kV Aluminum Splice Covering Kit

SAP	Conductor Size (AWG)	Conductor Type	Splice Tube Length (in)
10211073	1/0	ACSR	30
10211073	336.4	ACSR	30
10211075	653.9	ACSR	36

Table CC 170–3: 35 kV Aluminum Splice Covering Kit

SAP	Conductor Size (AWG)	Conductor Type	Splice Tube Length (in)
10212076	1/0	ACSR	30
10212076	336.4 (18×1)	ACSR	30
10212077	336.4 (30×7)	ACSR	36
10212077	653.9	ACSR	36

2.0 Copper Splices and Splice Covering Kit

2.1 Application

To be used on copper covered conductors of distribution voltages 17 kV and below. Splices on covered conductors must be covered. See Table CC 170-3 for appropriate splice covering kit.

See Table CO 410-1 for appropriate splices and applicable tools and die for the copper covered conductors.

Table CC 170–4: Copper Splice Covering Kit

SAP	Conductor Size (AWG)	Conductor Type	Splice Tube Length (in)
10211072	#2	HDCU	22
10211072	2/0	HDCU	22
10211072	4/0	HDCU	22

Scope CC 170.2 Cable Preparation, Splicing, and Installation of Splice Covering

1.0 Cable Preparation and Splicing

Covered Conductors are spliced and tapped at in the same manner as bare wire, except the conductor must be stripped first. Splices must be covered in a covered conductor system.

1.1 Remove the conductor covering, including the conductor shield using an approved stripping tool. The length of conductor stripped on each side should be half the length of the splice plus Dimension “A” (see Table CC 170–5) on each end (see Figure CC 170–2).

CAUTION Care should be taken to ensure that the conductor strands are not nicked or damaged.

Figure CC 170–1: Compression Splice

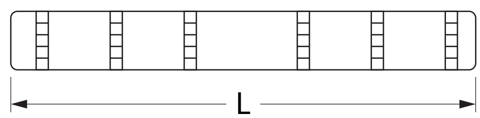


Figure CC 170–2: Cable Preparation

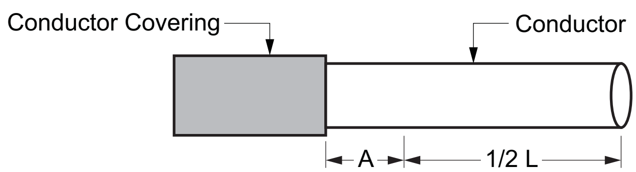


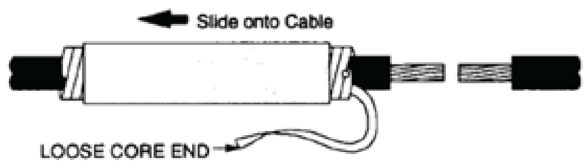
Table CC 170–5: Cable Prep Dimension “A”

Conductor (AWG)	Conductor Type	Dimension “A” (in)
1/0	ACSR	0.75
336.4 (18/1)	ACSR	0.75
653.9	ACSR	3.5
#2	HDCU	0.75
2/0	HDCU	0.75
4/0	HDCU	0.75

1.2 Clean the outer surface of the cable covering for a length of 10-inches on each side using the cleaning pad provided in the kit. After cleaning, wipe surfaces dry with clean cloth.

1.3 Slip the cold shrink tube over one of the cable ends and push back far enough to be out of the way during the crimping and taping process.

Figure CC 170–3: Cold Shrink Tube



1.4 Using a marking tape, mark the conductor covering "B" inches back from the conductor end on both sides (see Figure CC 170–4).

Figure CC 170–4: Marker Tape

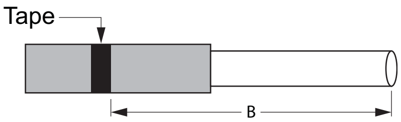
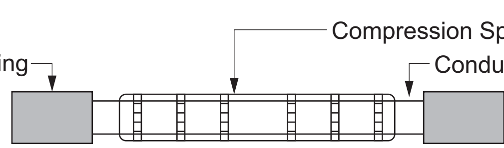


Table CC 170–6: Cable Prep Dimension "B"

Conductor (AWG)	Conductor Type	Dimension "B" (in)
1/0	ACSR	15
336.4 (18/1)	ACSR	15
653.9	ACSR	18
#2	HDCU	11
2/0	HDCU	11
4/0	HDCU	11

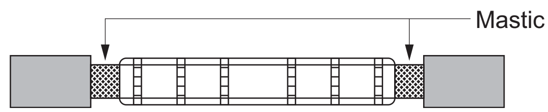
1.5 Slide ends of conductor all the way into the connector body and crimp using Table CC 170–1 as a reference for the number of crimps and the tool and die set. Keep connector as straight as possible.



2.0 Installation of Splice Covering

2.1 Install each of the two provided mastic strips on each end of the splice between the end of the splice body and the cable covering to fill this space. Stretch the mastic just to fill the space without overlapping the splice body or conductor covering. Use all the mastic provided.

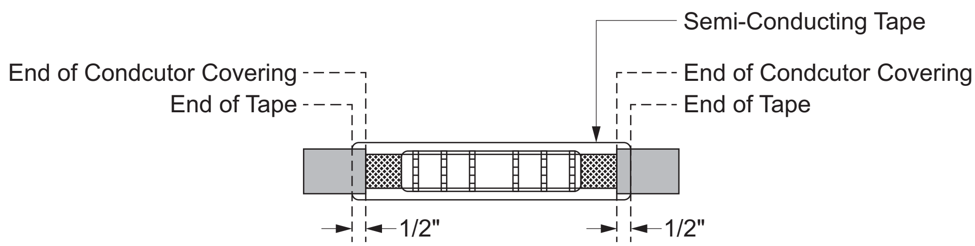
Figure CC 170–5: Mastic Application



2.2 Semi-conducting Tape

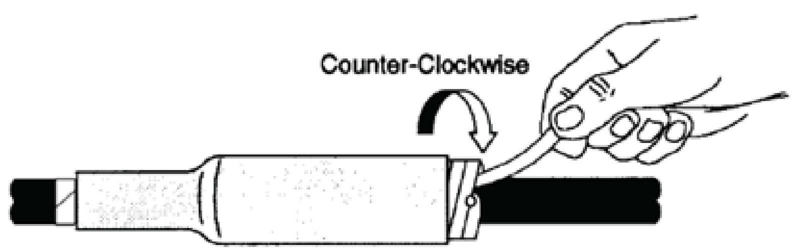
Beginning 1/2 inch over the cable insulation, apply a half-lapped layer of Semi-Conducting Tape across the connector to 1/2 inch over the insulation on the other side of the splice.

Figure CC 170–6: Semi-Conducting Tape



2.3 Position cold shrink splice tube over connection. Align leading edge of rubber (not core) with the mark. Remove core ribbon slowly by pulling, while unwinding the loose core ribbon end in a counter-clockwise direction

Figure CC 170–7: Cold Shrink Application



Note(s):

1. Splices for adjacent conductors should not be installed next to each other. Splices should be staggered by at least 18 inches end to end.
2. Conductor Splices should not be installed closer than 5 feet from a corner structure. Ensure that all tree limbs and branches are trimmed away from the area of the conductor splices. Tree limb contact on splice covering should be avoided.

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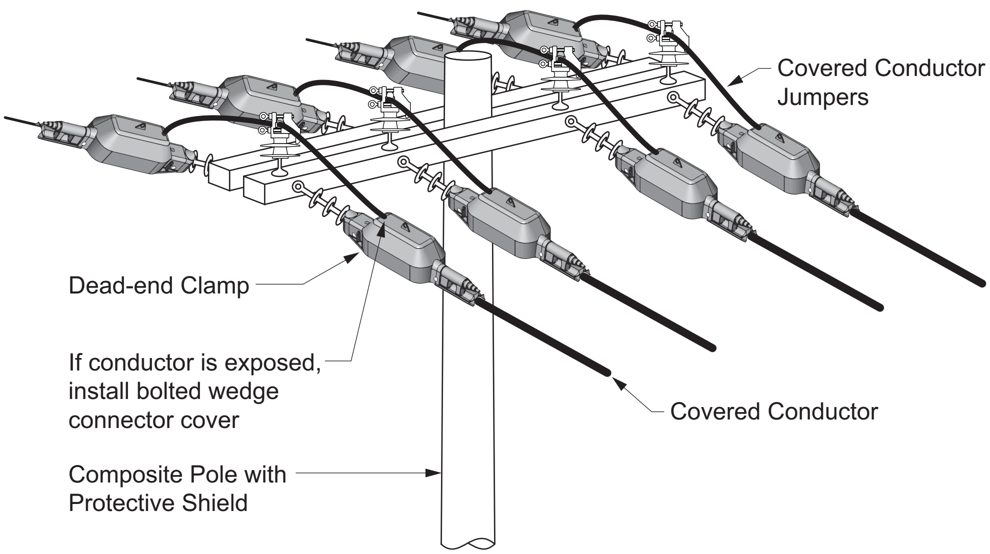
CC 180 Transitioning to Bare Wire

Scope CC 180.1 Transitioning from Covered Conductor to Bare Wire

Covered Conductors must be dead-ended at a dead-end pole when transitioning to bare wire. Splices are not to be used when transitioning from a covered conductor system to bare wire system.

If overhead equipment is located at a pole transition from bare wire to covered conductor, the equipment is considered part of the covered conductor system, therefore, surge arrester requirements for covered conductor systems apply (see CC 130).

Figure CC 180–1: Covered Conductor to Bare Wire Transition



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CC 190 Vibration Dampers Requirements in Covered Conductor Systems

Scope CC 190.1 Applications for Vibration Dampers in Covered Conductor Systems

1.0 General Information

Dampers are intended to reduce Aeolian vibration (high frequency, low amplitude vibration) caused by wind blowing on overhead conductors. Aeolian vibration is generally produced by wind velocities below 15 MPH. Over time, Aeolian vibration can be associated with abrasion or fatigue failures, which are associated with loose connections between the conductor and hardware and strand breakage, respectively.

See CO 460 for bare wire applications.

2.0 Application

Two types of dampers are approved for applications in covered conductor systems: spiral vibration dampers and Stockbridge dampers. Vibration dampers shall be installed on every span in light loading areas. Vibration dampers will be installed in heavy loading areas when vibration on conductor is observed. For the 336 (30/7) ACSR covered conductor, vibration dampers shall be installed in both light loading and heavy loading areas. The damper type to be applied will depend on the diameter of the conductor. Vibration dampers are only required on full tension spans and will not be required on reduced tension spans. See Table CC 190–1 for Damper Application Requirements.

Figure CC 190–1: Spiral Vibration Damper

Figure CC 190–2: Stockbridge Damper

Table CC 190–1: Damper Information and Requirements

SAP	Covered Conductor	Damper Type	Required Application	Dampers Required Per Phase[a/]
10214215[b/]	17 kV 1/0 ACSR 17 kV #2 Copper 17 kV 2/0 Copper	Spiral Vibration Damper	Every span in light loading areas	Span < 590 ft: 1 Damper Span 591–1,185 ft: 2 Dampers Span 1,186–1,780 ft: 3 Dampers
10214216[c/]	17 kV 4/0 Copper	Spiral Vibration Damper	Every span in light loading areas	Span < 1,200 ft: 2 Dampers
10214493	17 kV 336 (18/1) ACSR	Stockbridge Damper	Every span in light loading areas	Span < 889 ft: 2 Dampers
10214494	17 kV 336 (30/7) ACSR	Stockbridge Damper	Every span in light loading areas and heavy loading areas	Span < 680 ft: 2 Dampers
10214495	17 kV 653 ACSR	Stockbridge Damper	Every span in light loading areas	Span < 500 ft: 2 Dampers
10214496	35 kV 1/0 ACSR	Stockbridge Damper	Every span in light loading areas	Span < 655 ft: 2 Dampers
10214497	35 kV 336 (18/1) ACSR	Stockbridge Damper	Every span in light loading areas	Span < 705 ft: 2 Dampers
10214495	35 kV 336 (30/7) ACSR	Stockbridge Damper	Every span in light loading areas and heavy loading areas	Span < 525 ft: 2 Dampers
10214499	35 kV 653 ACSR	Stockbridge Damper	Every span in light loading areas	Span < 755 ft: 2 Dampers

[a/] For span lengths greater than maximum length provided per conductor, contact Linear Asset Engineering.

[b/] A maximum of 2 dampers can be interlaced for Spiral Vibration Damper SAP 10214215.

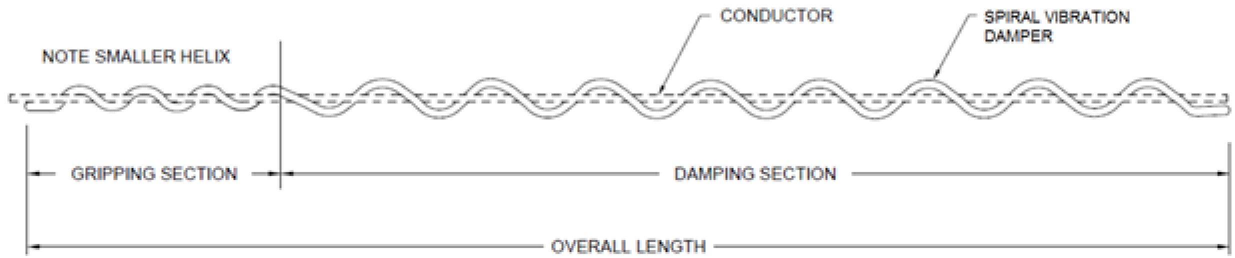
[c/] Spiral Vibration Damper SAP 10214216 cannot be interlaced. If two dampers are needed, dampers must be installed adjacent to each other, with the ends of each damper at least 6 inches apart.

What's Changed? Maximum allowable span length in the "dampers required per phase" column has been changed for several types of conductor. The SAP number for 35 kV 336 (30/7) ACSR has been changed.

Scope CC 190.2 Installation of Spiral Vibration Dampers in Covered Conductor Systems

1.0 Spiral Vibration Damper Installation

Figure CC 190–3: Spiral Vibration Dampers



The following are installation procedures for the spiral vibration damper on covered conductor systems

STEP 1. See Table CC 190–1 to ensure the appropriate damper is selected.

STEP 2. Position the damper with the gripping section situated toward the closest support point.

STEP 3. Install the spiral vibration damper onto the conductor by wrapping the damping section onto the conductor in a clockwise fashion. Maintain a minimum of 6 inches from dead-end or insulator conductor clamp. If a splice is installed within 9 feet of the insulator or dead-end, place the damper at least 6 inches away from the splice on the side opposite to the structure, or on the other end of the span.

STEP 4. Wrap the gripping section in a counter-clockwise fashion.

STEP 5. Make sure the gripping section is properly seated on the conductor.

Figure CC 190–4: Installed Spiral Vibration Dampers on Covered Conductor

Figure CC 190–5: Installation of Spiral Vibration Dampers on Covered Conductor

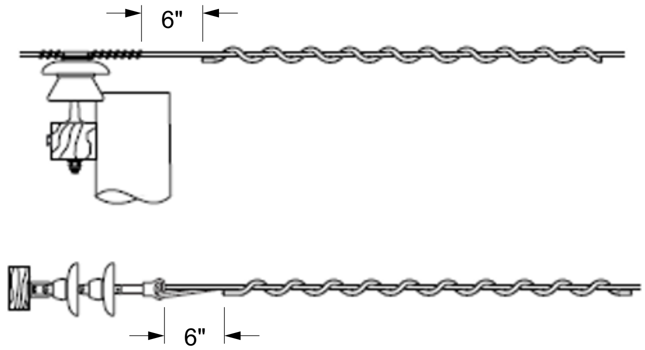


Figure CC 190–6: Spiral Vibration Damper Subset

Vibration Dampers Requirements in Covered Conductor Systems

Approved by: RR

What's Changed? Figure CC 190-5 and CC 190-6 were added to demonstrate the correct installation of spiral vibration dampers.

Effective Date: 10-29-2021

Figure CC 190–7: Examples of Spiral Vibration Damper Placement

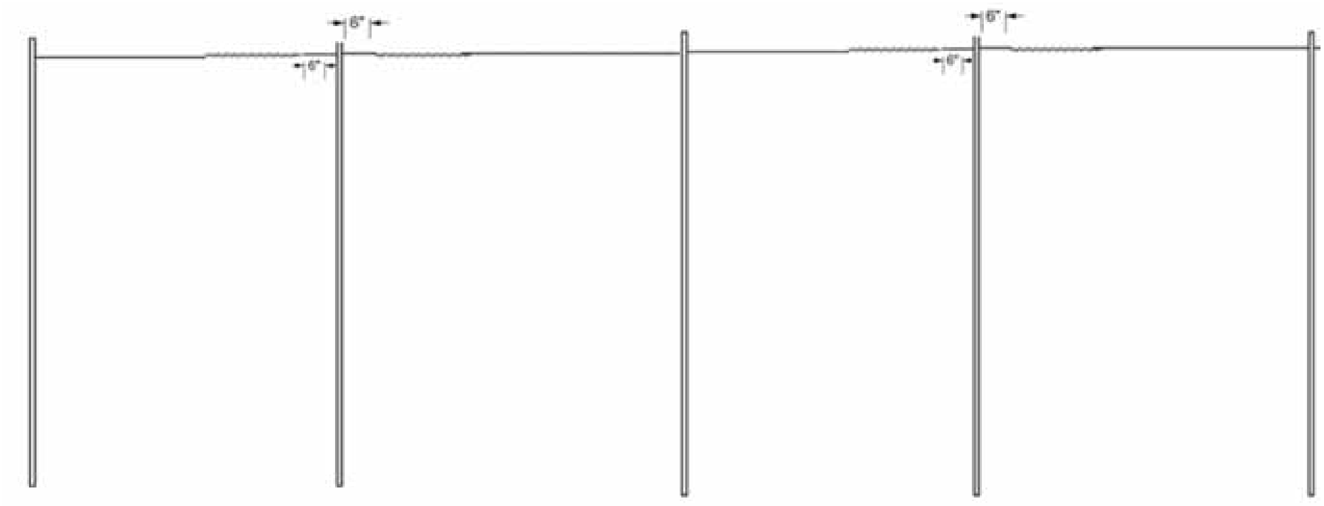


Figure CC 190–7.1: Spiral Vibration Damper Placement Example 1

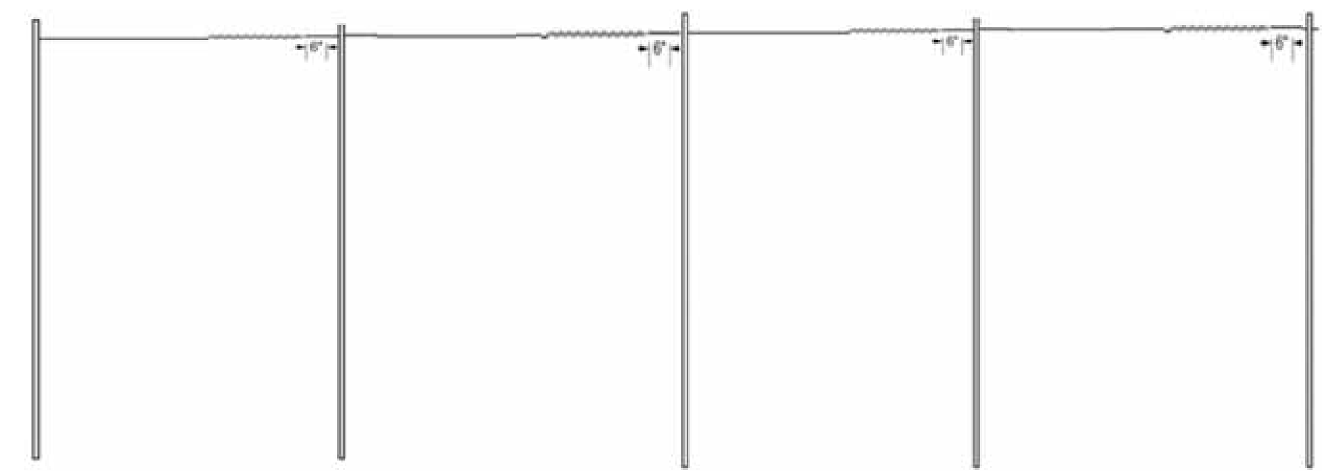


Figure CC 190–7.2: Spiral Vibration Damper Placement Example 2

Scope CC 190.3 Installation of Stockbridge Dampers in Covered Conductor Systems

1.0 Stockbridge Dampers

1.1 Spiral Rod Stockbridge Damper

Spiral rod Stockbridge dampers are identified by the spiral rod wrapping around the covered conductor.

1.2 Shear Bolt Stockbridge Damper

Shear bolt Stockbridge dampers are identified by the shear bolt in the middle of the clamp. The shear bolt mechanism provides the optimal torque to install vibration dampers.

NOTE Shear bolt Stockbridge damper installation is not approved for high contamination areas.

See High Contamination Map Figure GR 215–1 for details. See Table CC 190–1 for damper application requirements.

Figure CC 190–8: Stockbridge Dampers

Spiral Rod Vibration Damper
Shear Bolt Vibration Damper

2.0 Stockbridge Damper Installation

2.1 Spiral Rod Stockbridge Damper Installation

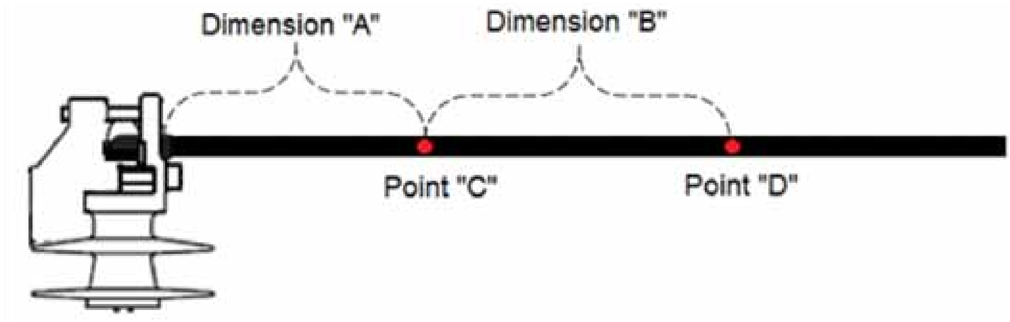
The following are installation procedures for the Spiral Rod Stockbridge vibration damper on covered conductor systems.

STEP 1. Measure and mark the appropriate distance for the first damper from the end of the insulator or dead-end insulator. See Dimension “A” in Table CC 190–2 and Figure CC 190–9.

STEP 2. Measure and mark the appropriate placement for the second damper in reference to the first damper mark. See Dimension “B” in Table CC 190–2 and Figure CC 190–9.

What’s Changed? Added Section 1.0 to describe the two types of Stockbridge dampers used: Spiral rod and Shear bolt Stockbridge dampers. Title was changed to specify that the installation instructions are for Spiral Rod Stockbridge dampers. Minor syntax changes in Step 4.

Figure CC 190–9: Spiral Rod and Shear Bolt Stockbridge Damper Dimension Requirements



STEP 3. For the first damper, hang the damper clamp such that the middle of the clamp lines up with the Point “C” as shown in Figure CC 190–9.

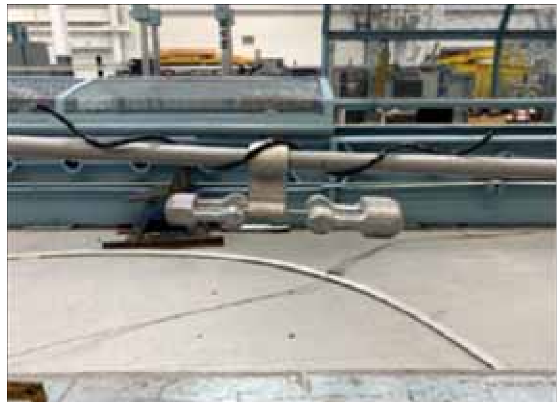
STEP 4. Begin installing the first attachment rod on the damper clamp. All rods shall be installed on the “inside” of the location nub, on the larger part of the clamp. Locate the color code in the middle of the attachment rod, and line it up with the nub. Begin wrapping the rod onto the conductor in a left-hand lay direction. See Table CC 190–2 for the rod color code and Figure CC 190–10.

Table CC 190–2: Stockbridge Damper Dimension Requirements

Covered Conductor Size	Rod Color Code[a/]	Distance from Insulator Dimension “A” (in)	Distance from 1st Damper Dimension “B” (in)
17 kV 336 (18/1) ACSR	Green	24	26
17 kV 336 (30/7 ACSR)	Green	25	27
17 kV 653 ACSR	Orange	23	31
35 kV 1/0 ACSR	Green	19	26
35 kV 336 (18/1) ACSR	Orange	26	32
35 kV (30/7) ACSR	Orange	28	32
35 kV 653 ACSR	Black	30	38

[a/] The rod color code is based on the conductor diameter range the rod can accommodate. Ensure that the rod is marked with the correct color code before installation.

Figure CC 190–10: First Attachment Rod Placement

STEP 5. Fully install the first attachment rod, ensuring that both rod ends are fully snapped in.

STEP 6. Install the second rod like how the first rod was installed. Locate the color code and position it so it lines up with the first rod color code and the locating nub. Please note that the color code may be on the inside of the rod, and not visible from the outside after placing it properly. Fully install the second rod, ensuring that both rod ends are fully snapped in (see Figure CC 190–11).

Figure CC 190–11: Second Attachment Rod Placement


STEP 7. Repeat STEP 6 (Sheet 8) for the remaining two rods, for a total of (4) attachment rods per damper, ensuring that the color codes line up and that the rods are pushed against each other as much as possible. Due to the profile of the clamp there may be gaps between the rods at the clamp; this is acceptable. Ensure that all rod ends are fully snapped in (see Figure CC 190–12).

Figure CC 190–12: Completed Attachment Rod Placement

STEP 8. Repeat STEPS 3 (Sheet 7) to 7 (Sheet 8) for the second damper. The second damper will be placed on Point “D” as shown in Figure CC 190–9.

Figure CC 190–13: Installed Spiral Rod Stockbridge Damper

2.2 Shear Bolt Stockbridge Installation

Figure CC 190–14: Shear Bolt Stockbridge Damper

The following are installation procedures for Shear Bolt Stockbridge vibration dampers.

STEP 1. Obtain the damper spacing from Table CC 190–2.

STEP 1.1 Measure and mark out the appropriate distance for the first damper from the end of the insulator. See Dimension "A" in Table CC 190–2 and Figure CC 190–9.

STEP 1.2 Measure and mark out the appropriate distance for the second damper in reference to the first damper mark. See Dimension "A" in Table CC 190–2 and Figure CC 190–9.Measure and mark out the appropriate distance for the second damper in reference to the first damper mark. See Dimension "A" in Table CC 190–2 and Figure CC 190–9.

STEP 2. The bolt on the clamp should be loosened to allow space for the conductor.

STEP 3. Hang the damper on the conductor at the spacing determined in Step 1, and then tighten down the bolt.

STEP 4. Tighten the bolt until the breakaway head shears off for proper attachment of the damper.

Note(s):

1. Shear bolt Stockbridge damper installation is not approved for high contamination areas. See High Contamination Map Figure GR 215–1 for details.

Figure CC 190–15: Examples of Stockbridge Damper Placement

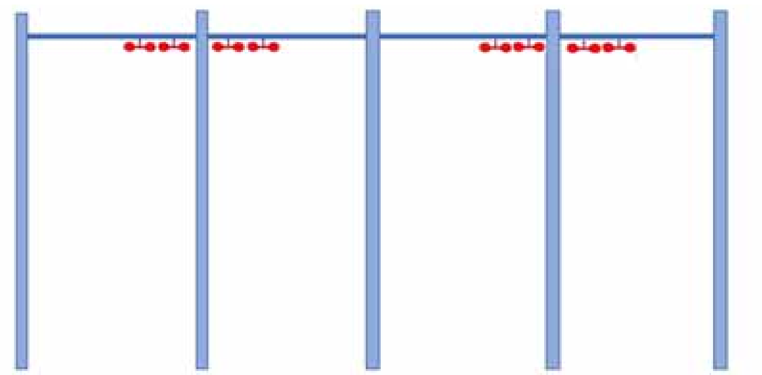


Figure CC 190–15.1: Stockbridge Damper Placement Example 1

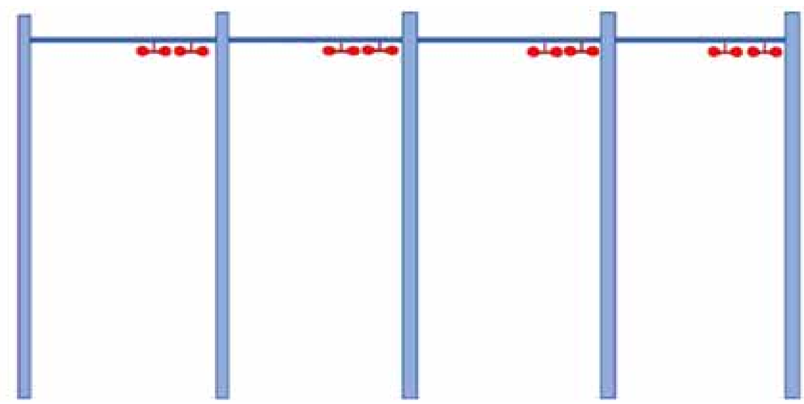


Figure CC 190–15.2: Stockbridge Damper Placement Example 2

Note(s):

1. The pair of Stockbridge dampers can be placed on either side of the span. Both dampers must be placed on the same side.

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DOH–CO: Conductors and Splices

TABLE OF CONTENTS

STANDARD **TITLE**

Standard	**Title**

STANDARD		TITLE

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CO 100 Installation of Conductors and Connectors

Scope CO 100.1 Installation of Conductors and Connectors

1.0 Sagging

Aluminum and ACSR conductors have a tendency to creep or stretch under prolonged tension greater than 20 percent of the conductor's ultimate strength. For a conductor installed with less sag than that specified for given span length and temperature, stretching may start immediately or it may occur later when a drop in temperature further tightens the conductor. This may cause relaxation of pressure in connections. Relaxation can, over a period of time, produce overheating in connections. For this reason, it is important to install aluminum and ACSR conductors with the correct sag for the temperature at the time of installation.

Aluminum conductor tends to vibrate more than copper, and the damage caused by vibration increases with the tension. The damage may not be apparent, but is cumulative and may, years after installation of the conductor, cause failure. The most serious damage is actual breaking of the conductor, but lesser damage may be loosening of connectors, chafing of tie wires, or the loosening of nuts on dead-ends or armbolts.

Distribution lines crossing under or in line with transmission lines shall be sagged so that minimum required clearances will be maintained at all temperatures according to sag charts.

2.0 Greasing

Corrosion is aluminum's worst enemy and moisture in contact with aluminum greatly speeds the corrosion process. Inhibitor compounds prevent the entrance and entrapment of moisture and thus prevent corrosion. This is the purpose of factory-greased ACSR conductor. An appropriate inhibitor shall be applied to all connectors and conductor after cleaning and to all connectors and splices after installation.

3.0 Electrical Connections—Splices and Taps (New and existing conductors)

Oxygen in air reacts with aluminum very rapidly to form aluminum oxide, a film highly resistant to electrical current. For this reason CLEANLINESS is the most important requirement for good low resistance connections.

Copper also corrodes in the atmosphere, but copper oxide, unlike aluminum oxide, dissolves in water. This copper solution accelerates the corrosion of aluminum. To prevent it from flowing over the aluminum, the aluminum conductor shall always be placed on top in copper-to-aluminum connections.

To make and maintain reliable connections, adhere to the following procedure:

STEP 1. Clean new and existing conductor using the proper tools until bright on all external surfaces. It is recommended to have 1–2 inches of clean conductor on both ends of the connector after it is applied. If burrs or pits exist on the conductor, they should be removed with emery cloth prior to wire brushing. Evidence of conductor cleaning and greasing shall be visible from the ground.

STEP 2. Apply inhibitor grease to the conductor immediately after cleaning and coat the interior surface of the connector (if not prefilled) with the same compound.

STEP 3. Apply the proper number of connectors or splices of the correct size and material.

STEP 4. Connections shall be made on conductor tails (that is, dead-end tails) where possible.

4.0 Connectors

The following list presents the order of which connectors are preferred for use from greatest to least, with each associated required/alternate application for each connector. See CO 300 and CO 305 for SAP numbers.

4.1 Bolted Wedge (see CO 420)

- Required for all primary voltage connections in covered conductor systems
- Preferred for the following connections regardless of HFRA designation:
  - — Overhead mainline to mainline
  - — Overhead mainline to UG mainline risers
  - — Tap line and/or branch line connections
  - — Apparatus connections/taps such as transformers, voltage regulators, capacitor banks, and overhead switches

4.2 Parallel Groove

- Alternative primary voltage connector when unable to install bolted wedge connector due to work methods, lack of proper tooling (live-line tools) or lack of bucket truck access.

NOTE

If rubber/leather gloves can be used or if the line is de-energized upon installation, then the appropriate bolted wedge connector shall be used. If use of a hot-stick is deemed necessary, then the parallel groove is an acceptable alternative.

- Applicable secondary voltage connections

4.3 Vise-Type (Copper-to-Copper Only)

- All copper-to-copper connections in non-HFRA where bolted wedge or parallel grooves are not being used.
- Applicable copper-to-copper secondary voltage connections
- Grounding connections for lightning arresters and potheads

4.4 Hot Line Clamp

- Hot line clamps shall only be used for the following applications:
  - — Potential Transformers in non-HFRA
  - — Lightning Arresters in HFRA and non-HFRA

Remaining connectors (such as split-bolt and two-bolt) shall be used as detailed in CO 300 and CO 305.

5.0 Taping Over Connectors

Taping over connectors shall be required only at the load end of service and secondary conductors and connectors. The 3M 33 tape (SAP 10116921) shall be used exclusively. Preinsulated compression connectors require no additional taping.

5.1 Installation

STEP 1. The tape shall be applied in successive half-lapped, level layers until buildup is reached.

STEP 1.1 To eliminate voids in critical areas, stretch the tape during installation.

STEP 2. Tape past any bare conductor and or connectors.

STEP 3. Tape is not required on the neutral conductor.

STEP 3.1 Equipment bushing connections, such as the connections on transformers, do not require taping.

STEP 3.2 Power Transformer (PT) neutral grounding connections do not require taping.

6.0 Splicing

Splicing aluminum/ACSR or copper conductors shall be performed as shown in CO 410. New Construction and repairs shall be limited to 2 splices in each conductor per span.

Copper compression splices shall be used on copper conductors.

Aluminum compression splices (single-sleeve) shall be used on aluminum conductors.

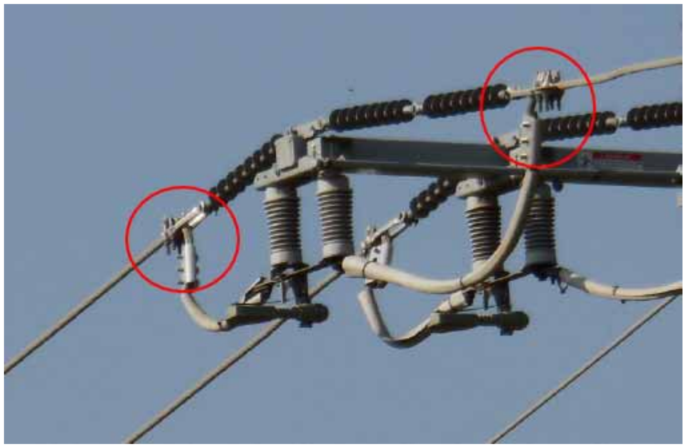
Automatic splices, so as long as they do not exceed the appropriate number of splices per span, may be retrofitted with the Clampstar Splice Shunt (see CO 460). Non-compression (not including automatic splices) splices shall be replaced whenever work activities allow for their removal.

7.0 Dead-Ending

Dead-ending of aluminum or ACSR conductors shall be performed as shown later in CO Sections 200 through 215. Full tension and slackspans will be dead-ended on silicone (polymer) dead-end insulators, See CO Section for crossarm requirements.

When dead-ending, the tail of the conductor shall be oriented in the direction that the conductor is intended to be routed. Efforts should be made to ensure that the tail and/or connector does not make contact with the dead-end rails/legs. For example, for overhead switch dead-ending, the dead-end tail shall be oriented downward, towards the termination pad of the switch (see Figure CO 100–1).

Figure CO 100–1: Example of Correct Dead-end Tail Orientation



See index of slack span dead-end construction. Do not use aluminum dead-end devices on copper conductors or bronze and copper devices on ACSR or aluminum conductors.

8.0 Apparatus Leads

Leads from aluminum conductors to such items as cutouts, transformers, potheads, and so forth, which have copper or copper alloy terminals, even if these terminals are plated, shall be copper wire leads. Such copper wire leads shall then be connected to the aluminum wire.

9.0 Preformed Tie Wires

Preformed ties shall be used for all voltage classifications above 4 kV (#4, 1/0, and 336.4 kcmil) on ACSR at each single insulator support, with the following exceptions:

1. Taps
2. Jumpers
3. 653.9 kcmil 18/3 ACSR
4. Insulators with universal conductor clamps
5. Covered conductors

CO 104 Distribution Conductors General Information

Scope CO 104.1 General Information for Copper and Aluminum Overhead Conductors

1.0 Standard Sizes

The following sizes of bare and covered copper and aluminum conductors are in general use by the Company for overhead distribution lines.

Due to the corrosive environment in the beach areas within ONE MILE of the ocean, only bare or covered copper conductor sizes 4/0 and smaller, greased bare ACSR conductor sizes 336.4 and larger should be used for overhead construction. Any specific area that experiences accelerated corrosion because of unique circumstances should contact Field Engineering for review.

1.1 Copper

A. Hard drawn, bare — Material Standard Specification No. 7

1. #6 and #4 solid
2. #4, #2, 2/0, and 4/0 stranded

B. THW Moisture Resistant

1. Soft drawn, #8 solid
2. Soft drawn, #6, #4, and #2 stranded
3. Soft drawn, 2/0 and 4/0 stranded

C. Triplex — Material Standard Specification No. 233

1. #6, #4, and #2

1.2 Aluminum

A. ACSR - Material Standard Specification No. 232

1. #4, 1/0, 336.4 kcmil, and 653.9 kcmil stranded

B. Weather-Resisting - Material Standard Specification No. 234, FOR REFERENCE ONLY

1. #6 solid
2. #2, 1/0, 4/0, 500 kcmil, and 750 kcmil stranded

C. Multiplex - Material Standard Specification No. 233

1. Duplex: #6 and #4 stranded

2. Triplex: #4, #2, 1/0, and 4/0 stranded

3. Quadruplex: #4, 1/0, and 4/0 stranded

D. CLP Insulated Cable - Material Standard Specification No. 238

1. 3-1/C: (2-#2, 1-#4); (2-1/0, 1-#2); (2-4/0, 1-1/0); (2-350, 1-4/0); (2-700, 1-350)

2. 4-1/C: (3-1/0, 1-#2); (3-4/0, 1-1/0); (3-350 kcmil, 1-4/0); (3-700 kcmil,1-350 kcmil)

2.0 Determination of Conductor Size

In order to determine the proper size of conductor to use, the following factors should be known:

1. Line voltage and number of phases
2. Total load to be supplied (including future)
3. Power factor of load
4. Length of line
5. Configuration and spacing of conductors
6. Permissible voltage drop

The proper size of conductor is determined by consideration of the above factors and also the "economic" loading of the conductors. The conductor must be capable of carrying presently-known load currents without excessive voltage drop. Just as important, the conductor should be capable of carrying the anticipated future loads. The recommended conductor size for the best "economic" loading is given in the Distribution Design Standards (DDS-2).

Bare wire shall be used on Primary Voltage circuits wherever practical. Covered wire should normally be used on secondary voltage circuits.

Bare and covered aluminum and copper wire shall not be installed adjacent to each other on the same end of a crossarm, but bare wire may be used on one end of the arm, and covered wire on the other end where the two classifications are separated by 30 inches. The minimum spacing for bare wire is 20 inches for spans up to 205 feet. (Exception: Spacing of less than 20 inches may be used in special cases.)

***Note:** Where copper and aluminum conductors are used on the same circuit, existing voltage drop tables do not apply.*

3.0 Tie Wires

3.1 Aluminum

A. #4 through 336.4 kcmil ACSR aluminum conductors shall be protected by aluminum armor rod where the conductor is attached to pin or post-type insulators. Aluminum conductors shall be tied to insulators with special aluminum tie wire as shown in the CO Section.

Note: On ACSR conductor sizes #4 through 336.4 kcmil #4 aluminum tie wire shall be used.

B. 653.9 kcmil ACSR conductor shall be clamped to post-type insulators as shown in the CO Section, without armor rod.

Note: Exception: Where Universal Clamps and Covered Conductors are used.

3.2 Bare Copper Wire Solid or Stranded

A. On all bare copper conductors, solid or stranded, the tie wires shall be soft drawn copper wire purchased specifically for this purpose. The size and strength of the tie wire shall be #6 AWG soft drawn copper for conductor sizes #6 and #4, and #4 AWG soft drawn copper for conductor sizes #2 AWG and larger.

B. On High Voltage distribution lines, of over 5000 V phase-to-phase, conductors shall be tied to the insulators as shown in the CO Section. (See Index.)

C. On distribution lines of 5000 V or less phase-to-phase, conductors shall be tied to the insulators as shown in the CO Section.

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CO 106 Characteristics of Overhead Aluminum Conductor

Scope CO 106.1 Overhead Aluminum Conductor Physical and Electrical Properties

Standard Sizes and Uses

Table CO 106–1: Aluminum Conductor Steel Reinforced (ACSR)

Size AWG OR kcmil	Current Capacity (A)	Number of Strands	Copper Equivalent AWG OR kcmil	Overall Diameter (in)	Resistance (ohms/1,000 ft)	Ultimate Strength (lb)	Weight (lb/1,000 ft)	
							Ungreased	Greased
#4	160	6/1	6	0.250	0.4240	1,830	57.6	58.0
#2	210	6/1	4	0.316	0.2670	2,790	91.6	62.3
1/0	280	6/1	2	0.398	0.1680	4,280	145.6	146.8
4/0	415	6/1	2/0	0.563	0.0843	8,420	291.1	293.9
336.4	605	18/1	4/0	0.6835	0.0524	8,625	365.2	381.0
653.9	920	18/3	500	0.953	0.0267	14,850	677.0	709.0

Table CO 106–2: All-Aluminum Weather Resistant (WR), High Density (HD), and CLP Insulated Cable

Size AWG or kcmil	Current Capacity (A)	Number of Strands	Type Cover	Copper Equivalent AWG or kcmil	Overall Diameter (in)	Resistance (ohms/1,000 ft)	Ultimate Strength (lb)	Weight (lb/1,000 ft)	Standard Length (ft)
#6 Dupl.	80	1	HD	8	0.450	0.6610	1,170	73	500
#4 Dupl.	110	7	HD	6	0.565	0.4160	1,830	118	500
#6 Tripl.[2.]	80	1	HD	8	0.545	0.6610	1,170	112	500
#4 Tripl.	110	7	HD	6	0.640	0.4160	1,830	180	500
#2 Tripl.	145	7	HD	4	0.760	0.2667	2,790	270	500
1/0 Tripl.	190	7	HD	2	0.980	0.1677	4,280	431	1,000
4/0 Tripl.	300	19	HD	2/0	1.320	0.0836	8,420	812	1,000
#4 Quad.	100	7	HD	6	0.720	0.4160	1,830	238	1,000
1/0 Quad.	180	19	HD	2	1.120	0.1677	4,280	568	1,000
4/0 Quad.	275	19	HD	2/0	1.490	0.0836	8,420	812	1,000
#6[2.]	85	1	WR	8	0.256	0.6610	466	46	2,400
#2[2.]	140	7	WR	4	0.386	0.2667	1,090	105	1,000
1/0[2.]	190	7	WR	2	0.493	0.1677	1,775	171	3,100
4/0[2.]	280	7	WR	2/0	0.647	0.0836	3,475	306	1,800
500[2.]	490	37	WR	314	1.02	0.03468	9,010	684	1,000
750[2.]	640	61	WR	472	1.265	0.02312	13,520	1,002	1,000
4/0	280	19	CLP	2/0	0.684	0.0836	2,500	283	2,000
350	390	37	CLP	220	0.869	0.04955	4,030	452	1,500
700	610	61	CLP	440	1.182	0.2476	7,975	852	1,000

Note(s):

1. CLP cable is packaged 3-1/C for 3Ø and 4-1/C for 3Ø with neutral.
2. Conductor(s) no longer a Customer Service standard.
3. The tables above provide technical data for conductors only. The mention of “copper equivalent” is for ampacity purposes only. Mixed conductors (that is, copper and ACSR) shall not be used within the same span.

Scope CO 106.2 Overhead Copper Conductor Physical and Electrical Properties

Table CO 106–3: Hard-Drawn Bare Copper Wire and Cable

Conductor Size		Current Capacity (A)	Number of Strands	Wire/Strand Diameter (in)	Overall Diameter (in)	Ultimate Strength (lb)	Conductor Weight (lb)		Feet Per Pound	AC Resistance Per 1,000 ft (ohms)
AWG	kcmil						Per 1,000 ft	Per Mile		
8	16.51	105	1	0.1285	0.1285	826	49.97	263.8	20.01	0.6443
6	26.25	140	1	0.1620	0.1620	1,280	79.46	419.6	12.584	0.4052
4	41.74	190	1	0.2043	0.2043	1,970	126.4	667.1	7.912	0.2548
4	41.74	200	3	0.1180	0.254	1,879	127.6	673.8	7.836	0.2574
4	41.74	195	7	0.0772	0.232	1,938	128.9	680.5	7.757	0.2599
2	66.37	260	7	0.0974	0.292	3,045	204.9	1,082	4.880	0.1635
2/0	133.1	405	7	0.1379	0.414	5,927	410.9	2,169	2.433	0.08166
4/0	211.6	540	7	0.1739	0.522	9,154	653.3	3,450	1.530	0.05149
—	250	600	19	0.1147	0.574	11,360	771.9	4,076	1.295	0.04365
—	350	740	19	0.1357	0.679	15,590	1,081	5,706	0.925	0.03135
—	500	920	37	0.1162	0.813	22,510	1,544	8,151	0.648	0.02219
—	750	1,175	61	0.1109	0.998	34,090	2,316	12,230	.0432	0.01520
—	1,000	1,430	61	0.1280	1.152	45,030	3,088	16,300	0.324	0.01179

Table CO 106–4: #8 to 1000 kcmil Soft-Drawn THW Wire and Cable

Conductor Size		Current Capacity (A)	Number of Strands	Wire/Strand Diameter (in)	Overall Diameter (in)	Ultimate Strength (lb)	Conductor Weight (lb)		Feet Per Pound	AC Resistance Per 1,000 ft (ohms)
AWG	kcmil						Per 1,000 ft	Per Mile		
8	16.51	65	1	0.1285	0.249	456	71	375	14.085	0.6443
6	26.25	95	7	0.0612	0.310	832	111	586	9.009	0.4100
4	41.74	125	7	0.0772	0.360	1,320	164	866	6.098	0.2590
2	66.37	170	7	0.0974	0.410	2,110	248	1,309	4.032	0.1620
2/0	133.1	265	19	0.0837	0.580	4,230	488	2,577	2.049	0.1020
4/0	211.6	360	19	0.1055	0.680	6,453	747	3,944	1.339	0.0509
—	250	405	37	0.0822	0.760	7,940	892	4,710	1.121	0.0433
—	300	445	37	0.0900	0.810	9,520	1,056	5,576	0.947	0.0362
—	500	620	37	0.1162	0.990	15,240	1,707	9,013	0.586	0.0220
—	750	785	61	0.1109	1.210	22,890	2,541	13,416	0.394	0.0150
—	1,000	935	61	0.1280	1.360	30,500	3,345	17,662	0.299	0.01152

Table CO 106–5: Triplex Secondary and Service Drop Wire; Copper Conductor and Copper Neutral

Conductor Size		Current Capacity (A)	Number of Strands	Wire/Strand Diameter (in)	Overall Diameter (in)	Ultimate Strength (lb)	Conductor Weight (lb)		Feet Per Pound	AC Resistance Per 1,000 ft (ohms)
AWG	kcmil						Per 1,000 ft	Per Mile		
6	26.25	95	7	0.0612	0.548	1,280	272	1,436	3.676	0.406
4	41.74	125	7	0.0772	0.646	1,938	427	2,255	2.342	0.254
2	66.37	170	7	0.0974	0.772	3,045	633	3,500	1.508	0.159

Table CO 106–6: Protective Ground Wire

Conductor Size		Current Capacity (A)	Number of Strands	Wire/Strand Diameter (in)	Covering Thickness (in)	Overall Diameter (in)	Conductor Weight (lb)		Feet Per Pound	AC Resistance Per 1,000 ft (ohms)
AWG	kcmil						Per 1,000 ft	Per Mile		
6	26.25	119	1	0.162	0.110	0.382	117	617.8	8.547	0.4188
4	41.74	157	1	0.204	0.110	0.424	170	897.6	5.882	0.2633

CAUTION **In using current capacities as shown above, the full capacity of the wire may be used only where voltage regulation does not require a large size conductor.**

Table CO 106–7: DOH ACSR Conductor Economic Loading — 4 kV, 12 kV, and 16 kV

Conductor Size (AWG or kcmil)	Conductor Economic Loading Range Based on Estimated Annual Peak Demand within Five Years (Amp)	Normal Operating Rating (Amp)	8-Hour Emergency Loading (Amp)
#4	0–55	160	205

= For Reference Only

Note(s):

1. ACSR conductor normal operating rating criteria:
   - Ambient temperature: 40°C
   - Conductor temperature: 90°C
   - Wind speed: 4 ft/s
   - Coefficient of emissivity: 0.5
   - Coefficient of solar absorption: 0.5
   - Latitude: 34°
   - Elevation of conductor above sea level: 0 ft
   - Atmosphere: clear
   - Local sun time: 1:00 p.m.

Table CO 106–8: DOH Copper Conductor Economic Loading — 4 kV, 12 kV, and 16 kV DOH ACSR Conductor Economic Loading — 4 kV, 12 kV, and 16 kV

Conductor Size (AWG or kcmil)	Forecasted Peak Load within 5 Years (Amp)	Normal Operating Rating (Amp)	8-Hour Emergency Loading (Amp)
#4	0–60	195	260

= For Reference Only

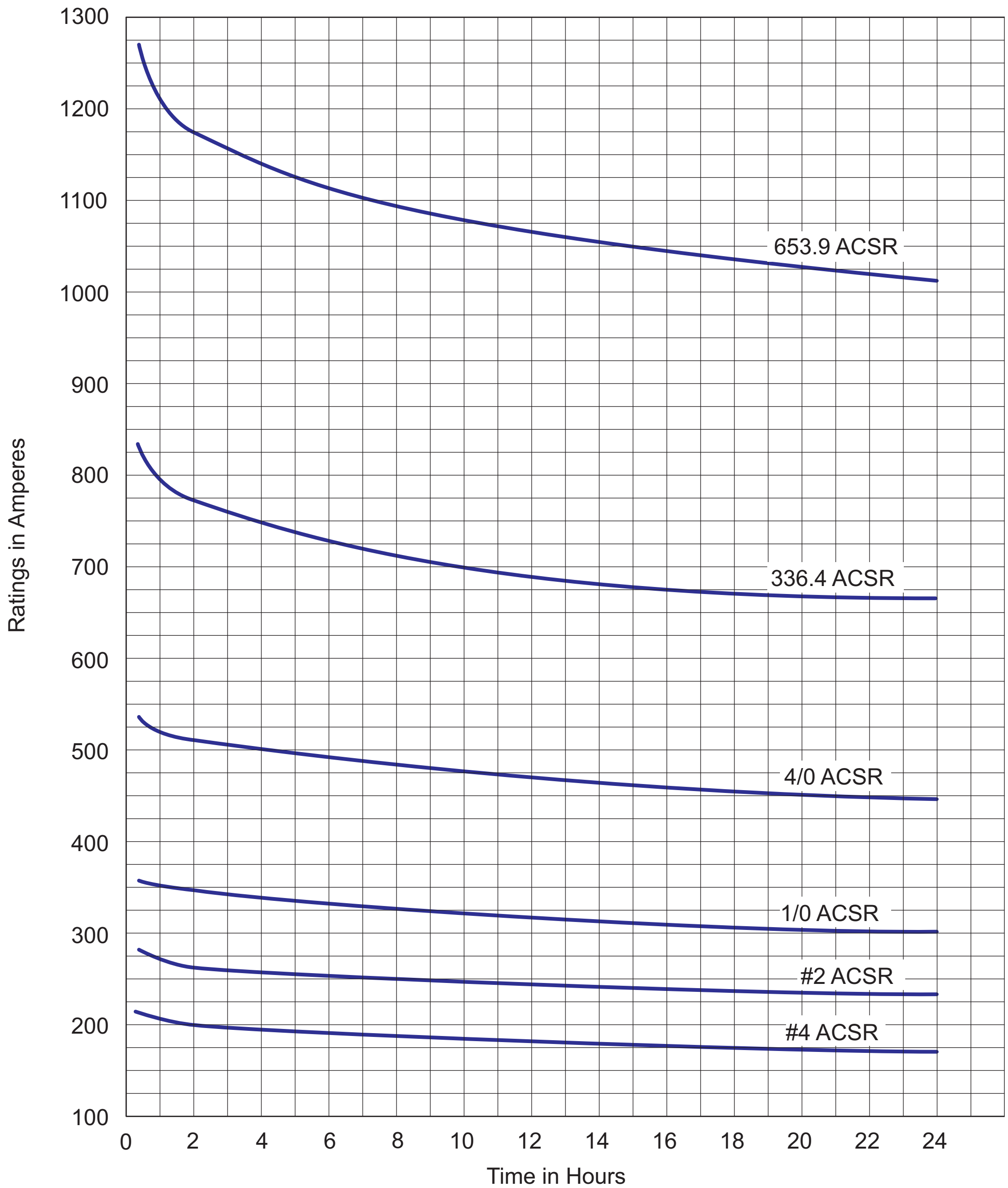
Note(s):

1. Stranded copper conductor thermal rating criteria:
   - Ambient temperature: 40°C
   - Conductor temperature: 85°C
   - Wind speed: 4 ft/s
   - Coefficient of emissivity: 0.5
   - Coefficient of solar absorption: 0.5
   - Latitude: 34°
   - Elevation of conductor above sea level: 0 ft
   - Atmosphere: clear
   - Local sun time: 1:00 p.m.

CO 107 Curves for Short-Time Loadability

Scope CO 107.1 Short-Time Loadability for ACSR Conductors

Figure CO 107–1: Short-Time Loadability for ACSR Conductors

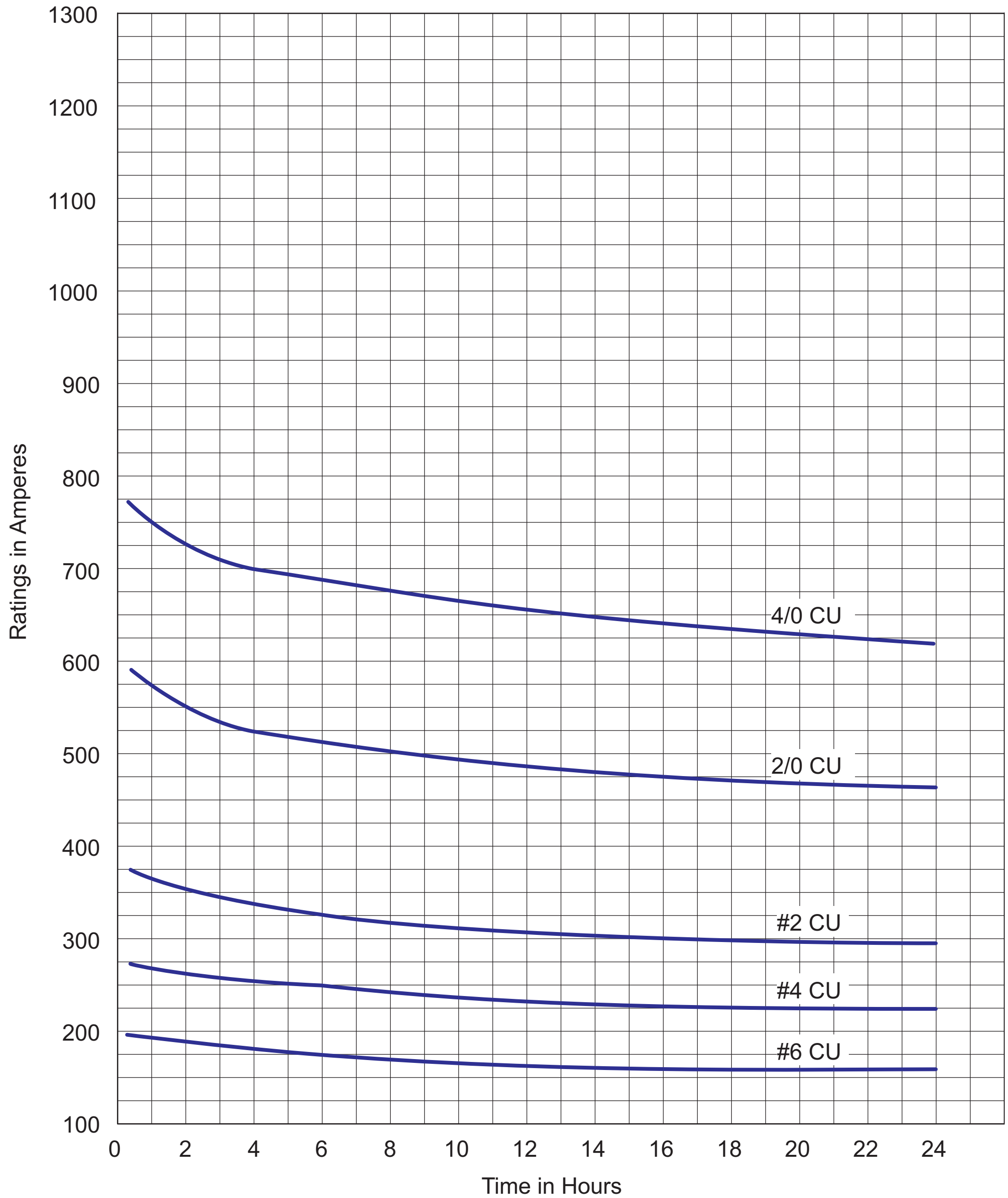


Note(s):

1. These curves are not to be exceeded.
2. Curves based on 40° C ambient temperature and annealing temperature of aluminum.
3. Sags will increase by a maximum of 2 percent of the span length at these current levels.

Scope CO 107.2 Short-Time Loadability for Copper Conductors

Figure CO 107–2: Short-Time Loadability for Copper Conductors



Note(s):

1. These curves are not to be exceeded.
2. Curves based on 40° C ambient temperature and annealing temperature of aluminum.
3. Sags will increase by a maximum of 2 percent of the span length at these current levels.

CO 108 Triplex/Quadruplex Secondary — General Requirements

Scope CO 108.1 General Information for Installation of Triplex and Quadruplex Secondary Conductors

1.0 Conductor

1.1 Secondary conductors are sized based on customer demand, voltage drop, flicker, and motor starting load. Refer to sag charts for stringing conductor.

1.2 Use of copper triplex (squirrel wire) shall be considered in areas experiencing reoccurring secondary/service drop replacements due to rodent damage (chewing). In areas where high vegetation and rodent population exists, preventative measures like using copper secondary conductors shall be employed. Similarly, conductors should be sized based on customer demand, voltage drop, flicker, and motor starting load. See Table CO 106–5 for copper secondary and service drop data. Refer to sag charts for stringing conductor.

2.0 Load

2.1 Care must be taken not to exceed the safe current carrying capacity of Triplex (190 A for 1/0 Al).

2.2 Excessive current can cause the insulation of the phase wires to heat and flow resulting in a reduced insulation level between phase and neutral conductors.

3.0 Maximum Span Lengths

3.1 Span lengths should not exceed 220 feet when installed 6 feet above communication cables on jointly-owned poles.

4.0 Regulation

4.1 Installations of multiplex secondary supply shall be made in accordance with G.O. 95, Rule 54.10, and as described herein.

Note: The above rule also applies when installing 300 V Duplex and 600 V Quadruplex.

5.0 Voltage Drop

5.1 Refer to the *Distribution Design Standards (DDS) Manual* to calculate voltage drop and flicker to determine the proper conductor size.

CO 109 Minimum Size Wire to X-Ray Services

Scope CO 109.1 Minimum Size Wire to X-Ray Services

The service wire size for x-ray apparatus shall be adequate to limit the voltage drop to one percent at full load transformer current in accordance with the following:

1. Where transformer capacity is installed exclusively to serve the x-ray apparatus, the minimum service wire size shall be determined from the following table:

Table CO 109–1: Minimum Size Wire to X-Ray Services — Separate Transformer Installed

Transformer Size kVA	Full Load Current Amperes at 240 V	Maximum Length of Service Wire Sizes (ft)[a/]				
		#6	#2	1/0	4/0	350 kcmil
3	13	140				
5	21	90	200			
7-1/2	31	60	133	194		
10	42	43	98	143	216	264
15	63		66	95	158	178
25	104			58	92	111
37-1/2	156				63	70
50	208				48	53

2. Where no separate transformer is installed to serve the x-ray apparatus exclusively, the capacity reserved for the x-ray shall be considered its kVA rating as given in the following table, from which the minimum service wire size shall be determined.

Table CO 109–2: Minimum Size Wire to X-Ray Services — No Separate Transformer Installed

Rated Output-Milliamps		X-Ray Rating kVA	Maximum Length of Service Wire Sizes (ft)[a/]				
Half-Wave Rectifier	Full-Wave Rectifier		#6	#2	1/0	4/0	350 kcmil
15		2	140				
30		5	90	200			
60	100	10	43	98	143	216	264
100	200	15		66	95	158	178
200	300	25			58	92	111
—	500	37-1/2				63	70

[a/] Table CO 109–1 (Sheet 1) and Table CO 109–2 (Sheet 2) are for aluminum open, triplex or quadruplex service wire. For copper services, use equivalent current carrying wire size.

3. Services larger than standard will be installed only when the customer advances to the Company the cost of the additional labor and material.

CO 110 Stringing Tensions — Table

Scope CO 110.1 ACSR and Copper Stringing Tensions

Table CO 110–1: Stringing Tensions

Stringing Tensions[a/]			
Conductor Type	**Wire Size**		**Rope Tension Per Conductor (lb)**
ACSR	#4 ACSR	For stinging use appropriate 130°F Sag Table.	150
	1/0 ACSR		300
	336.4–18/1 kcmil		750
	653.9–18/3 kcmil		1,600
Covered Conductor	1/0 ACSR		300
	336.4–18/1 kcmil		750
	653.9–18/3 kcmil		1,600
	#2 Copper		400
	2/0 Copper		675
	4/0 Copper		1,100
Copper	#6		150
	#4		250
	#2		400
	2/0		675
	4/0		1,100

[a/] For determining size rope to pull in conductors—these are not guying tensions

Note(s):

1. The above tensions are to be used when calculating the size rope for pulling conductors. **After pulling, the wire shall be sagged at the actual temperature.**

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CO 120 Sag Charts — Directions for Use

Scope CO 120.1 Directions for Use of Sag Charts

In order to choose the sag table most suitable for the particular job at hand, determine the loading district (light or heavy loading) of the line location, the conductor to be used, and the pulling span of the line. Usually the elevation of the service center area traversed by the line, hence the kind of loading (light or heavy) conductor size and kind are known.

Determination of ruling span can best be shown by example:

A 10-pole primary line extension is to be built in a light loading service center area using 336, 4 kcmil ACSR conductor. The span lengths are: 140 feet, 170 feet, 365 feet, 160 feet, 303 feet, 170 feet, 330 feet, 171 feet, 311 feet, and 200 feet. The total length of the line extension is 2,320 feet.

The Maximum Span is 365'

The Average Span is 232'

Ruling Span = Average Span + 2/3 (Maximum Span—Average Span)

= 232' + 2/3 (365'–232')

= 321'

A line with many angles and/or dead-end points may have multiple ruling spans (one for each section of line between dead-ends).

The type of wire indicates that OH Distribution Construction Standard CO 140 for 336.4 ACSR in light loading area shall be used. The ruling span 321 feet dictates that span length 320 feet on the table should be used and the amount of sag shall be selected under the temperature nearest to that temperature at the time of stringing.

Note(s):

1. The choice of span lengths given in the example above is not intended for a guide in selecting span lengths. In new construction all span lengths should be chosen as nearly equal as possible. Generally, span lengths in heavy loading areas should be shorter than in light loading areas.
2. Sag should be measured in a span length as close to the ruling span as possible between dead-end points and if practical at least 2 spans away from the extremities of each section being strung. For line extensions longer than 5 spans the sag should be checked in at least 2 spans.
3. In light loading areas, where any span in a section of line exceeds the ruling span by more than 25 percent or the average span by more than 50 percent, dead-ends shall be installed in and guying (span or ground) placed against this span.
4. In heavy loading areas where any span in a section of line exceeds the ruling span by more than 15 percent, or the average span by more than 30 percent, dead-ends shall be installed in and guying (span or anchor) placed against this span.
5. If short spans are less than 1/2 the average span or less than 1/3 of the average of the long spans on each side of it, dead-ends should be installed and span guying placed in the short span.
6. The sag for sloping spans is defined as the vertical distance between a line joining the two conductor supports and a line parallel thereto which is tangent to the conductor’s curvature. This sag may be read directly from the standard stringing tables by using a so-called equivalent span length which is determined as follows:
7. Equivalent Span = 2 times the Slope Span minus the Level Span

8. Example: If the level distance between the two supports is 500 feet and the distance along the slope is 550 feet, the equivalent span is 2 × 550 – 500 = 600 feet. The sag for a 600-foot span shall then be obtained from the standard stringing tables to determine the sag for the 500-foot sloping span.
9. New conductors, when added, shall be sagged with existing conductors less 10% (to take care of final set, slippage anchor creep, and so on).
10. To determine ground clearances, see the 130 degree final sag curve.
11. When stringing old or prestressed conductors, use 70 degree final sag curve.
12. To determine sags for spans greater than 500 feet, contact Field Engineering office.
13. For guying tensions, see PO Section.

CO 130 Sag Chart #6 Aluminum Duplex

Scope CO 130.1 Sag — Temperature Stringing Table Conductor — Streetlight Secondary 120 V #6 Aluminum Duplex W/ACSR Messenger for Light-Loading Areas

Table CO 130–1: Sag — Temperature Stringing Table Conductor — Streetlight Secondary 120 V #6 Aluminum Duplex w/ACSR Messenger for Light-Loading Areas

Span (ft)	Sag			
	Initial Stringing Sag			Final Sag
	50°F	70°F	90°F	130°F
100	0'-4"	0'-5"	0'-6"	1'-2"
110	0'-5"	0'-6"	0'-7"	1'-6"
120	0'-6"	0'-7"	0'-10"	1'-8"
130	0'-7"	0'-10"	1'-0"	2'-0"
140	0'-8"	0'-11"	1'-2"	2'-2"
150	0'-11"	1'-1"	1'-5"	2'-6"
160	1'-1"	1'-5"	1'-8"	2'-9"
170	1'-4"	1'-7"	2'-0"	3'-2"
180	1'-7"	1'-11"	2'-4"	3'-6"
190	1'-11"	2'-4"	2'-8"	3'-11"
200	2'-2"	2'-7"	3'-0"	4'-4"
210	2'-7"	3'-0"	3'-5"	4'-8"
220	3'-0"	3'-5"	3'-11"	5'-1"
230	3'-5"	3'-11"	4'-4"	5'-7"
240	3'-11"	4'-4"	4'-10"	6'-1"
250	4'-5"	4'-10"	5'-2"	6'-7"
260	4'-11"	5'-4"	5'-10"	7'-1"
270	5'-5"	5'-10"	6'-4"	7'-7"
280	6'-0"	6'-5"	6'-10"	8'-2"
290	6'-6"	7'-0"	7'-5"	8'-8"
300	7'-1"	7'-7"	8'-0"	9'-4"

1.0 Guying

For wood poles at corner and dead-end locations, block and key. See PO Section.

Conductor tension for guying is 386 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 132 Sag Chart #4 Aluminum Duplex ACSR Messenger

Scope CO 132.1 Sag — Temperature Stringing Table Conductor — Streetlight Secondary 120 V #4 Aluminum Duplex W/ACSR Messenger for Light-Loading Areas

Table CO 132–1: Sag — Temperature Stringing Table Conductor — Streetlight Secondary 120 V #4 Aluminum Duplex w/ACSR Messenger for Light-Loading Areas

Span (ft)	Sag			
	Initial Stringing Sag			Final Sag
	50°F	70°F	90°F	130°F
100	0'-4"	0'-5"	0'-6"	1'-2"
110	0'-5"	0'-6"	0'-7"	1'-5"
120	0'-6"	0'-7"	0'-8"	1'-7"
130	0'-7"	0'-8"	0'-10"	2'-0"
140	0'-8"	0'-10"	1'-0"	2'-0"
150	0'-10"	0'-11"	1'-2"	2'-4"
160	0'-11"	1'-1"	1'-5"	2'-7"
170	1'-1"	1'-4"	1'-7"	2'-10"
180	1'-2"	1'-6"	1'-11"	3'-1"
190	1'-6"	1'-10"	2'-1"	3'-5"
200	1'-8"	2'-0"	2'-5"	3'-10"
210	1'-11"	2'-4"	2'-8"	4'-1"
220	2'-2"	2'-8"	3'-1"	4'-6"
230	2'-7"	3'-0"	3'-5"	4'-11"
240	2'-11"	3'-5"	3'-10"	5'-4"
250	3'-4"	3'-8"	4'-2"	5'-8"
260	3'-8"	4'-1"	4'-7"	6'-1"
270	4'-1"	4'-7"	5'-0"	6'-6"
280	4'-6"	5'-0"	5'-6"	7'-0"
290	5'-0"	5'-6"	6'-0"	7'-6"
300	5'-4"	5'-11"	6'-5"	8'-0"

1.0 Guying

Conductor tensions for guying is 604 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor to ground clearances.

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CO 134 Sag Charts #4 and #2 Aluminum Triplex

Scope CO 134.1 Sag — Temperature Stringing Table #4 and #2 Aluminum Triplex for Light-Loading Areas

Table CO 134–1: Sag — Temperature Stringing Table #4 and #2 Aluminum Triplex for Light-Loading Areas

Conductor Type	Span (ft)	Sag			
		Initial Stringing Sag			Final Sag
		50°F	70°F	90°F	130°F
#4 Triplex	100	1'-4"	1'-6"	1'-8"	2'-4"
	120	2'-0"	2'-2"	2'-6"	3'-0"
	140	2'-10"	3'-0"	3'-2"	3'-11"
	160	3'-10"	4'-0"	4'-2"	4'-10"
	180	4'-10"	5'-0"	5'-2"	5'-11"
	200	6'-0"	6'-2"	6'-5"	7'-1"
	220	7'-4"	7'-6"	7'-8"	8'-5"
	240	8'-11"	9'-0"	9'-2"	9'-11"
	260	10'-4"	10'-6"	10'-10"	11'-6"
#2 Triplex	100	1'-2"	1'-5"	1'-7"	2'-0"
	120	1'-10"	2'-0"	2'-2"	2'-10"
	140	2'-6"	2'-8"	2'-11"	3'-7"
	160	3'-4"	3'-7"	3'-10"	4'-6"
	180	4'-4"	4'-6"	4'-8"	5'-5"
	200	5'-4"	5'-6"	5'-10"	6'-6"
	220	6'-6"	6'-8"	6'-11"	7'-8"
	240	7'-8"	8'-0"	8'-2"	9'-0"
	260	9'-1"	9'-4"	9'-7"	10'-5"

1.0 Guying

Conductor tensions for guying #4 aluminum triplex is 484 lb.

Conductor tensions for guying #2 aluminum triplex is 761 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 136 Sag Charts 1/0 and 4/0 Aluminum Triplex

Scope CO 136.1 Sag — Temperature Stringing Table 1/0 and 4/0 Aluminum Triplex for Light-Loading Areas

Table CO 136–1: Sag — Temperature Stringing Table 1/0 and 4/0 Aluminum Triplex for Light-Loading Areas

Conductor Type	Span (feet)	Sag			
		Initial Stringing Sag			Final Sag
		50°F	70°F	90°F	130°F
1/0 Triplex w/ACSR Messenger	100	0'-5"	0'-6"	0'-8"	1'-4"
	120	0'-7"	0'-10"	0'-11"	1'-8"
	140	0'-11"	1'-1"	1'-4"	2'-2"
	160	1'-2"	1'-5"	1'-8"	2'-8"
	180	1'-6"	1'-10"	2'-1"	3'-2"
	200	2'-0"	2'-4"	2'-7"	3'-9"
	220	2'-6"	2'-10"	3'-2"	4'-6"
	240	3'-0"	3'-5"	3'-10"	5'-2"
	260	3'-8"	4'-1"	4'-6"	5'-11"
	280	4'-5"	4'-10"	5'-4"	6'-8"
	300	5'-2"	5'-7"	6'-1"	7'-7"
	320	6'-0"	6'-5"	6'-11"	8'-6"
	340	6'-10"	7'-5"	7'-10"	9'-5"
4/0 Triplex w/ACSR Messenger	100	0'-5"	0'-6"	0'-7"	1'-4"
	120	0'-7"	0'-8"	0'-10"	1'-7"
	140	0'-10"	0'-11"	1'-1"	2'-1"
	160	1'-0"	1'-2"	1'-6"	2'-6"
	180	1'-4"	1'-6"	1'-10"	3'-0"
	200	1'-7"	1'-11"	2'-2"	3'-6"
	220	2'-0"	2'-4"	2'-8"	4'-0"
	240	2'-5"	2'-10"	3'-2"	4'-7"
	260	2'-11"	3'-4"	3'-8"	5'-2"
	280	3'-5"	3'-11"	4'-4"	5'-11"
	300	4'-0"	4'-6"	5'-0"	6'-7"
	320	4'-7"	5'-1"	5'-7"	7'-4"
	340	5'-4"	5'-10"	6'-4"	8'-1"

1.0 Guying

Conductor tensions for guying 1/0 aluminum triplex is 1,415 lb.

Conductor tensions for guying 4/0 aluminum triplex is 2,780 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 138 Sag Charts 1/0 and 4/0 Aluminum Quadruplex

Scope CO 138.1 Sag — Temperature Stringing Table 1/0 and 4/0 Aluminum Quadruplex for Light-Loading Areas

Table CO 138–1: Sag — Temperature Stringing Table 1/0 and 4/0 Aluminum Quadruplex for Light-Loading Areas

Conductor Type	Span (ft)	Sag			
		Initial Stringing Sag			Final Sag
		50°F	70°F	90°F	130°F
1/0 Quadruplex	100	0'-7"	0'-8"	0'-11"	1'-6"
	120	0'-117"	1'-0"	1'-2"	2'-0"
	140	1'-2"	1'-6"	1'-8"	2'-7"
	160	1'-8"	2'-0"	2'-2"	3'-2"
	180	2'-2"	2'-6"	2'-9"	3'-11"
	200	2'-11"	3'-2"	3'-6"	4'-7"
	220	3'-7"	4'-0"	4'-4"	5'-5"
	240	4'-5"	4'-9"	5'-2"	6'-4"
	260	5'-4"	5'-8"	6'-2"	7'-4"
4/0 Quadruplex	100	0'-6"	0'-7"	0'-10"	1'-5"
	120	0'-10"	0'-11"	1'-2"	1'-11"
	140	1'-2"	1'-2"	1'-6"	2'-4"
	160	1'-5"	1'-7"	1'-11"	2'-11"
	180	1'-10"	2'-2"	2'-5"	3'-5"
	200	2'-4"	2'-7"	2'-11"	4'-0"
	220	2'-10"	3'-2"	3'-6"	4'-8"
	240	3'-5"	3'-10"	4'-2"	5'-5"
	260	4'-2"	4'-6"	4'-11"	6'-2"

1.0 Guying

Conductor tensions for guying 1/0 aluminum triplex is 1,415 lb.

Conductor tensions for guying 4/0 aluminum triplex is 2,780 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 140 Sag Chart #4—336 ACSR

Scope CO 140.1 Sag — Temperature Stringing Table #4 — 336 ACSR for Light-Loading Areas

Table CO 140–1: Sag — Temperature Stringing Table #4 — 336 ACSR for Light-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-2"	0'-4"	0'-5"	0'-7"	0'-5"	1'-5"
120	0'-4"	0'-5"	0'-6"	0'-10"	0'-7"	1'-8"
140	0'-5"	0'-6"	0'-8"	1'-0"	0'-10"	2'-0"
160	0'-6"	0'-7"	0'-11"	1'-4"	1'-0"	2'-4"
180	0'-7"	0'-10"	1'-1"	1'-6"	1'-2"	2'-8"
200	0'-8"	1'-0"	1'-4"	1'-10"	1'-5"	3'-1"
220	0'-11"	1'-2"	1'-7"	2'-1"	1'-8"	3'-5"
240	1'-1"	1'-5"	1'-10"	2'-5"	2'-0"	3'-10"
260	1'-4"	1'-7"	2'-1"	2'-10"	2'-4"	4'-2"
280	1'-6"	1'-11"	2'-6"	3'-1"	2'-7"	4'-8"
300	1'-8"	2'-2"	2'-10"	3'-6"	3'-0"	5'-1"
320	1'-11"	2'-6"	3'-1"	3'-11"	3'-4"	5'-7"
340	2'-2"	2'-10"	3'-6"	4'-4"	3'-8"	6'-1"
360	2'-6"	3'-1"	3'-11"	4'-8"	4'-1"	6'-6"
380	2'-10"	3'-6"	4'-4"	5'-2"	4'-6"	7'-1"
400	3'-2"	3'-11"	4'-8"	5'-0"	5'-0"	7'-7"
420	3'-6"	4'-4"	5'-2"	6'-1"	5'-5"	8'-1"
440	3'-11"	4'-8"	5'-8"	6'-7"	5'-11"	8'-8"
460	4'-4"	5'-2"	6'-2"	7'-1"	6'-5"	9'-2"
480	4'-10"	5'-8"	6'-8"	7'-8"	7'-0"	9'-10"
500	5'-5"	6'-4"	7'-4"	8'-2"	7'-8"	10'-5"

1.0 Guying

Conductor tensions for guying #4 is 604 lb.

Conductor tensions for guying 1/0 is 1,415 lb.

Conductor tensions for guying 336.4 is 2,846 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 140.2 Sag and Tensions — Temperature Stringing Table 1/0 ACSR Covered Conductor for Light-Loading Areas

Table CO 140–2: Sag — Temperature Stringing Table 17 kV 1/0 ACSR Covered Conductor for Light-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-3"	0'-3"	0'-4"	0'-4"	0'-5"	0'-10"
120	0'-4"	0'-5"	0'-6"	0'-6"	0'-7"	1'-2"
140	0'-6"	0'-7"	0'-8"	0'-9"	0'-10"	1'-6"
160	0'-8"	0'-9"	0'-10"	1'-0"	1'-1"	1'-11"
180	0'-10"	1'-0"	1'-1"	1'-3"	1'-5"	2'-5"
200	1'-1"	1'-3"	1'-5"	1'-7"	1'-9"	2'-10"
220	1'-5"	1'-7"	1'-9"	2'-0"	2'-2"	3'-4"
240	1'-8"	1'-11"	2'-2"	2'-5"	2'-7"	3'-10"
260	2'-1"	2'-3"	2'-7"	2'-11"	3'-1"	4'-5"
280	2'-5"	2'-9"	3'-1"	3'-6"	3'-7"	5'-0"
300	2'-11"	3'-3"	3'-7"	4'-0"	4'-2"	5'-8"
320	3'-5"	3'-9"	4'-2"	4'-8"	4'-9"	6'-4"
340	4'-0"	4'-5"	4'-10"	5'-4"	5'-5"	7'-0"
360	4'-7"	5'-0"	5'-6"	6'-0"	6'-1"	7'-9"
380	5'-3"	5'-9"	6'-3"	6'-9"	6'-10"	8'-7"
400	5'-11"	6'-6"	7'-0"	7'-7"	7'-7"	9'-5"
420	6'-9"	7'-3"	7'-10"	8'-5"	8'-5"	10'-3"
440	7'-6"	8'-1"	8'-8"	9'-3"	9'-4"	11'-2"
460	8'-5"	9'-0"	9'-7"	10'-2"	10'-3"	12'-1"
480	9'-4"	9'-11"	10'-6"	11'-2"	11'-2"	13'-1"
500	10'-3"	10'-11"	11'-6"	12'-2"	12'-2"	14'-1"

Table CO 140–3: Tension — Temperature Stringing Table 17 kV 1/0 ACSR Covered Conductor for Light-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	1,445	1,299	1,146	989	868	437
120	1,419	1,273	1,122	968	858	447
140	1,389	1,244	1,095	945	848	458
160	1,356	1,213	1,067	921	837	468
180	1,321	1,180	1,038	898	826	479
200	1,285	1,146	1,008	876	815	497
220	1,248	1,112	980	855	805	514
240	1,210	1,079	953	836	796	529
260	1,172	1,047	928	820	788	542
280	1,136	1,016	905	805	780	554
300	1,100	988	884	793	773	565
320	1,067	961	866	782	767	575
340	1,036	938	850	773	761	584
360	1,007	916	835	765	756	592
380	980	896	822	758	751	599
400	956	879	811	752	747	606
420	934	863	801	747	744	612
440	914	850	793	743	740	618
460	896	837	785	739	737	623
480	880	826	778	736	735	628
500	866	816	772	733	732	632

Note(s): This table shall not be used for new installation or re-conductoring.

Table CO 140–4: Sag — Temperature Stringing Table 35 kV 1/0 ACSR Covered Conductor for Light-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-5"	0'-6"	0'-6"	0'-7"	0'-8"	1'-2"
120	0'-7"	0'-8"	0'-9"	0'-11"	1'-0"	1'-8"
140	0'-10"	1'-0"	1'-1"	1'-3"	1'-4"	2'-1"
160	1'-2"	1'-4"	1'-6"	1'-8"	1'-9"	2'-7"
180	1'-6"	1'-8"	1'-11"	2'-2"	2'-3"	3'-2"
200	2'-0"	2'-2"	2'-5"	2'-8"	2'-9"	3'-9"
220	2'-6"	2'-9"	3'-0"	3'-3"	3'-5"	4'-6"
240	3'-1"	3'-4"	3'-8"	4'-0"	4'-1"	5'-2"
260	3'-8"	4'-0"	4'-4"	4'-8"	4'-10"	6'-0"
280	4'-5"	4'-9"	5'-2"	5'-6"	5'-7"	6'-9"
300	5'-3"	5'-7"	6'-0"	6'-4"	6'-5"	7'-8"
320	6'-1"	6'-6"	6'-11"	7'-3"	7'-4"	8'-8"
340	7'-0"	7'-5"	7'-10"	8'-3"	8'-4"	9'-8"
360	8'-0"	8'-5"	8'-11"	9'-4"	9'-5"	10'-8"
380	9'-1"	9'-6"	10'-0"	10'-5"	10'-6"	11'-10"
400	10'-3"	10'-8"	11'-1"	11'-7"	11'-8"	13'-0"
420	11'-5"	11'-11"	12'-4"	12'-9"	12'-10"	14'-3"
440	12'-8"	13'-2"	13'-7"	14'-1"	14'-2"	15'-6"
460	14'-0"	14'-6"	14'-11"	15'-5"	15'-6"	16'-11"
480	15'-5"	15'-11"	16'-4"	16'-10"	16'-10"	18'-3"
500	16'-10"	17'-4"	17'-10"	18'-3"	18'-4"	19'-9"

Table CO 140–5: Tension — Temperature Stringing Table 35 kV 1/0 ACSR Covered Conductor for Light-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	1,397	1,254	1,109	963	864	482
120	1,355	1,215	1,075	937	855	509
140	1,309	1,174	1,041	913	846	540
160	1,262	1,133	1,008	891	838	566
180	1,215	1,093	978	873	831	589
200	1,169	1,057	952	858	824	608
220	1,126	1,023	929	846	819	626
240	1,087	994	910	836	814	641
260	1,051	968	893	827	810	654
280	1,020	946	879	821	807	665
300	992	926	867	815	804	675
320	969	910	857	811	801	684
340	948	896	849	807	799	692
360	930	884	842	804	797	699
380	915	873	835	801	795	706
400	902	864	830	799	794	711
420	890	856	825	797	792	716
440	880	849	821	795	791	721
460	871	843	817	793	790	725
480	863	838	814	792	789	729
500	856	833	811	791	788	732
Note(s): This table shall not be used for new installation or re-conductoring.						

1.0 Guying

Conductor tensions for guying 1/0 Covered Conductor is 1,415 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 140.3 Sag — Temperature Stringing Table 336 ACSR Covered Conductor for Light-Loading Areas

Table CO 140–6: Sag — Temperature Stringing Table 17 kV 336 ACSR Covered Conductor for Light-Loading Areas

	Sag					
	Initial Stringing Sag				Final Sag	
Span (ft)	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-3"	0'-3"	0'-4"	0'-5"	0'-6"	1'-4"
120	0'-4"	0'-5"	0'-6"	0'-7"	0'-9"	1'-8"
140	0'-6"	0'-6"	0'-8"	0'-10"	0'-11"	2'-0"
160	0'-7"	0'-9"	0'-10"	1'-1"	1'-3"	2'-5"
180	0'-9"	0'-11"	1'-1"	1'-4"	1'-6"	2'-10"
200	1'-0"	1'-2"	1'-4"	1'-8"	1'-10"	3'-3"
220	1'-2"	1'-5"	1'-8"	2'-0"	2'-3"	3'-8"
240	1'-5"	1'-8"	2'-0"	2'-5"	2'-7"	4'-2"
260	1'-9"	2'-0"	2'-4"	2'-9"	3'-0"	4'-8"
280	2'-0"	2'-4"	2'-9"	3'-3"	3'-6"	5'-3"
300	2'-4"	2'-9"	3'-2"	3'-8"	4'-0"	5'-9"
320	2'-9"	3'-1"	3'-7"	4'-2"	4'-6"	6'-4"
340	3'-1"	3'-7"	4'-1"	4'-8"	5'-0"	7'-0"
360	3'-7"	4'-1"	4'-7"	5'-3"	5'-7"	7'-7"
380	4'-0"	4'-7"	5'-2"	5'-10"	6'-2"	8'-3"
400	4'-6"	5'-1"	5'-9"	6'-6"	6'-10"	9'-0"
420	5'-1"	5'-9"	6'-5"	7'-1"	7'-6"	9'-8"
440	5'-8"	6'-4"	7'-1"	7'-9"	8'-2"	10'-5"
460	6'-3"	7'-0"	7'-9"	8'-6"	8'-11"	11'-3"
480	6'-11"	7'-8"	8'-6"	9'-3"	9'-8"	12'-0"
500	7'-8"	8'-5"	9'-3"	10'-0"	10'-5"	12'-10"

Table CO 140–7: Tension — Temperature Stringing Table 17 kV 336 ACSR Covered Conductor for Light-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	3,072	2,625	2,151	1,663	1,443	551
120	3,054	2,611	2,145	1,675	1,465	630
140	3,032	2,594	2,138	1,686	1,487	702
160	3,007	2,574	2,129	1,698	1,509	769
180	2,979	2,552	2,120	1,709	1,530	831
200	2,948	2,528	2,109	1,719	1,550	888
220	2,914	2,502	2,098	1,728	1,569	941
240	2,877	2,475	2,086	1,737	1,586	990
260	2,838	2,447	2,074	1,745	1,602	1,037
280	2,797	2,417	2,062	1,752	1,617	1,079
300	2,755	2,388	2,050	1,758	1,631	1,119
320	2,712	2,359	2,038	1,764	1,644	1,157
340	2,668	2,330	2,027	1,769	1,656	1,192
360	2,625	2,302	2,015	1,774	1,667	1,224
380	2,582	2,275	2,005	1,778	1,677	1,255
400	2,540	2,248	1,995	1,781	1,686	1,284
420	2,499	2,224	1,985	1,785	1,694	1,310
440	2,460	2,200	1,976	1,788	1,702	1,336
460	2,422	2,178	1,967	1,790	1,709	1,359
480	2,387	2,157	1,959	1,793	1,716	1,381
500	2,353	2,137	1,952	1,795	1,722	1,402
Note(s): This table shall not be used for new installation or re-conductoring.						

Table CO 140–8: Sag — Temperature Stringing Table 35 kV 336 ACSR Covered Conductor for Light-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-4"	0'-5"	0'-6"	0'-7"	0'-8"	1'-5"
120	0'-6"	0'-7"	0'-8"	0'-10"	0'-11"	1'-10"
140	0'-8"	0'-9"	0'-11"	1'-1"	1'-3"	2'-3"
160	0'-10"	1'-0"	1'-2"	1'-5"	1'-7"	2'-8"
180	1'-1"	1'-3"	1'-6"	1'-10"	2'-0"	3'-2"
200	1'-5"	1'-7"	1'-11"	2'-3"	2'-5"	3'-8"
220	1'-9"	2'-0"	2'-4"	2'-8"	2'-11"	4'-3"
240	2'-1"	2'-5"	2'-9"	3'-2"	3'-5"	4'-10"
260	2'-6"	2'-10"	3'-3"	3'-8"	4'-0"	5'-5"
280	3'-0"	3'-4"	3'-9"	4'-3"	4'-7"	6'-1"
300	3'-6"	3'-11"	4'-5"	4'-11"	5'-2"	6'-9"
320	4'-0"	4'-6"	5'-0"	5'-6"	5'-10"	7'-6"
340	4'-8"	5'-2"	5'-8"	6'-3"	6'-7"	8'-3"
360	5'-3"	5'-10"	6'-5"	7'-0"	7'-4"	9'-1"
380	6'-0"	6'-7"	7'-2"	7'-9"	8'-2"	9'-11"
400	6'-9"	7'-4"	8'-0"	8'-7"	9'-0"	10'-10"
420	7'-7"	8'-2"	8'-10"	9'-5"	9'-10"	11'-9"
440	8'-5"	9'-1"	9'-9"	10'-4"	10'-9"	12'-8"
460	9'-4"	10'-0"	10'-8"	11'-4"	11'-9"	13'-8"
480	10'-3"	10'-11"	11'-8"	12'-4"	12'-9"	14'-8"
500	11'-3"	12'-0"	12'-8"	13'-4"	13'-9"	15'-9"

Table CO 140–9: Tension — Temperature Stringing Table 35 kV 336 ACSR Covered Conductor for Light-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	3,058	2,620	2,165	1,712	1,501	706
120	3,031	2,601	2,161	1,735	1,536	800
140	2,999	2,578	2,155	1,756	1,568	884
160	2,961	2,552	2,148	1,775	1,599	961
180	2,919	2,522	2,138	1,792	1,626	1,030
200	2,872	2,490	2,128	1,807	1,651	1,094
220	2,823	2,457	2,117	1,820	1,674	1,151
240	2,771	2,423	2,105	1,832	1,694	1,204
260	2,718	2,389	2,094	1,841	1,713	1,252
280	2,665	2,356	2,082	1,849	1,729	1,297
300	2,613	2,325	2,071	1,856	1,744	1,337
320	2,563	2,294	2,061	1,862	1,757	1,374
340	2,515	2,266	2,051	1,868	1,769	1,408
360	2,470	2,240	2,041	1,872	1,780	1,440
380	2,428	2,216	2,033	1,876	1,790	1,469
400	2,389	2,193	2,024	1,879	1,798	1,495
420	2,353	2,173	2,017	1,882	1,806	1,520
440	2,320	2,154	2,010	1,885	1,813	1,543
460	2,290	2,137	2,004	1,887	1,820	1,564
480	2,263	2,122	1,998	1,889	1,826	1,583
500	2,238	2,108	1,992	1,891	1,831	1,601
Note(s): This table shall not be used for new installation or re-conductoring.						

1.0 Guying

Conductor tensions for guying 336 Covered Conductor is 2,846 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 142 Sag Chart 653 ACSR

Scope CO 142.1 Sag — Temperature Stringing Table 653 ACSR for Light-Loading Areas

Table CO 142–1: Sag — Temperature Stringing Table 653 ACSR for Light-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-4"	0'-6"	0'-10"	1'-2"	0'-11"	1'-10"
120	0'-6"	0'-8"	1'-1"	1'-6"	1'-2"	2'-2"
140	0'-7"	0'-11"	1'-4"	1'-10"	1'-5"	2'-7"
160	0'-10"	1'-2"	1'-7"	2'-1"	1'-8"	3'-0"
180	1'-0"	1'-5"	2'-0"	2'-6"	2'-1"	3'-6"
200	1'-2"	1'-8"	2'-4"	2'-11"	2'-5"	3'-11"
220	1'-6"	2'-1"	2'-8"	3'-4"	2'-10"	4'-5"
240	1'-10"	2'-5"	3'-1"	3'-8"	3'-2"	4'-11"
260	2'-1"	2'-10"	3'-6"	4-1"	3'-7"	5'-5"
280	2'-6"	3'-2"	3'-11"	4'-7"	4'-1"	6'-0"
300	2'-11"	3'-7"	4'-5"	5'-1"	4'-7"	6'-6"
320	3'-4"	4'-1"	4'-11"	5'-7"	5'-1"	7'-1"
340	3'-10"	4'-7"	5'-5"	6'-2"	5'-7"	7'-8"
360	4'-4"	5'-1"	6'-0"	6'-8"	6'-1"	8'-4"
380	4'-10"	5'-8"	6'-6"	7'-3"	6'-8"	9'-0"
400	5'-4"	6'-4"	7'-1"	8'-0"	7'-4"	9'-7"
420	5'-11"	6'-11"	7'-10"	8'-7"	8'-0"	10'-4"
440	6'-6"	7'-6"	8'-5"	9'-4"	8'-7"	11'-0"
460	7'-2"	8'-2"	9'-1"	10'-0"	9'-4"	11'-10"
480	7'-11"	8'-11"	9'-10"	10'-8"	10'-0"	12'-6"
500	8'-7"	9'-7"	10'-6"	11'-6"	10'-10"	13'-4"

1.0 Guying

Conductor tensions for guying is 2,846 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 142.2 Sag — Temperature Stringing Table 653 ACSR Covered Conductor for Light-Loading Areas

Table CO 142–2: Sag — Temperature Stringing Table 17 kV 653 ACSR Covered Conductor for Light-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-6"	0'-8"	1'-0"	1'-3"	1'-1"	1'-8"
120	0'-8"	0'-11"	1'-3"	1'-7"	1'-5"	2'-2"
140	0'-11"	1'-3"	1'-7"	1'-11"	1'-9"	2'-9"
160	1'-3"	1'-7"	1'-11"	2'-4"	2'-2"	3'-4"
180	1'-6"	1'-11"	2'-4"	2'-9"	2'-8"	3'-10"
200	1'-11"	2'-4"	2'-9"	3'-3"	3'-2"	4'-5"
220	2'-4"	2'-10"	3'-3"	3'-9"	3'-8"	5'-0"
240	2'-9"	3'-4"	3'-10"	4'-4"	4'-3"	5'-8"
260	3'-4"	3'-10"	4'-5"	4'-11"	4'-10"	6'-4"
280	3'-11"	4'-6"	5'-0"	5'-7"	5'-6"	7'-0"
300	4'-6"	5'-1"	5'-8"	6'-3"	6'-2"	7'-9"
320	5'-2"	5'-10"	6'-5"	7'-0"	6'-11"	8'-7"
340	5'-11"	6'-7"	7'-2"	7'-9"	7'-9"	9'-5"
360	6'-6"	7'-0"	7'-4"	8'-0"	8'-3"	9'-9"
380	7'-3"	7'-10"	8'-2"	8'-10"	9'-2"	10'-8"
400	8'-2"	8'-9"	9'-1"	9'-9"	10'-0"	11'-7"
420	9'-1"	9'-8"	10'-0"	10'-8"	11'-0"	12'-7"
440	10'-0"	10'-8"	11'-0"	11'-8"	12'-0"	13'-7"
460	11'-1"	11'-8"	12'-0"	12'-8"	13'-1"	14'-8"
480	12'-1"	12'-9"	13'-1"	13'-9"	14'-2"	15'-10"
500	13'-3"	13'-11"	14'-3"	14'-11"	15'-4"	17'-0"

Table CO 142–3: Tension — Temperature Stringing Table 17 kV 653 ACSR Covered Conductor for Light-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	2,495	1,762	1,261	972	1,148	736
120	2,550	1,870	1,400	1,112	1,257	814
140	2,580	1,952	1,515	1,234	1,351	885
160	2,589	2,013	1,609	1,340	1,432	950
180	2,584	2,059	1,686	1,430	1,503	1,034
200	2,568	2,092	1,750	1,508	1,564	1,112
220	2,545	2,115	1,803	1,576	1,618	1,183
240	2,519	2,132	1,846	1,634	1,665	1,248
260	2,491	2,143	1,882	1,684	1,706	1,308
280	2,464	2,151	1,912	1,728	1,742	1,364
300	2,437	2,155	1,937	1,765	1,775	1,414
320	2,411	2,158	1,958	1,798	1,803	1,461
340	2,388	2,159	1,976	1,827	1,829	1,503
360	3,306	2,257	2,159	1,991	1,921	1,629
380	3,271	2,248	2,159	2,004	1,936	1,662
400	3,239	2,239	2,158	2,015	1,950	1,691
420	3,209	2,231	2,156	2,025	1,963	1,719
440	3,183	2,223	2,155	2,033	1,974	1,744
460	3,158	2,216	2,153	2,040	1,984	1,766
480	3,136	2,210	2,152	2,047	1,993	1,787
500	3,116	2,204	2,150	2,052	2,001	1,807

Note(s): This table shall not be used for new installation or re-conductoring.

Table CO 142–4: Sag — Temperature Stringing Table 35 kV 653 ACSR Covered Conductor for Light-Loading Areas

	Sag					
	Initial Stringing Sag				Final Sag	
Span (ft)	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-7"	0'-10"	1'-1"	1'-4"	1'-2"	1'-10"
120	0'-10"	1'-1"	1'-5"	1'-8"	1'-7"	2'-5"
140	1'-2"	1'-6"	1'-9"	2'-1"	2'-0"	3'-0"
160	1'-6"	1'-10"	2'-3"	2'-7"	2'-6"	3'-6"
180	1'-11"	2'-4"	2'-9"	3'-1"	3'-0"	4'-2"
200	2'-5"	2'-10"	3'-3"	3'-8"	3'-8"	4'-9"
220	3'-0"	3'-5"	3'-10"	4'-3"	4'-3"	5'-6"
240	3'-7"	4'-1"	4'-6"	5'-0"	5'-0"	6'-3"
260	4'-3"	4'-9"	5'-3"	5'-8"	5'-9"	7'-0"
280	5'-0"	5'-6"	6'-0"	6'-6"	6'-6"	7'-10"
300	5'-10"	6'-4"	6'-10"	7'-4"	7'-4"	8'-9"
320	6'-8"	7'-3"	7'-9"	8'-3"	8'-3"	9'-9"
340	7'-7"	8'-2"	8'-8"	9'-2"	9'-3"	10'-9"
360	8'-7"	9'-2"	9'-8"	10'-3"	10'-3"	11'-9"
380	9'-8"	10'-3"	10'-9"	11'-3"	11'-4"	12'-11"
400	10'-9"	11'-4"	11'-11"	12'-5"	12'-6"	14'-1"
420	11'-11"	12'-6"	13'-1"	13'-7"	13'-8"	15'-3"
440	13'-2"	13'-9"	14'-4"	14'-10"	15'-0"	16'-7"
460	14'-6"	15'-1"	15'-7"	16'-2"	16'-3"	17'-11"
480	15'-10"	16'-5"	17'-0"	17'-6"	17'-8"	19'-3"
500	17'-3"	17'-10"	18'-5"	19'-0"	19'-1"	20'-9"

Table CO 142–5: Tension — Temperature Stringing Table 35 kV 653 ACSR Covered Conductor for Light-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	2,592	1,924	1,458	1,166	1,300	843
120	2,624	2,020	1,594	1,314	1,413	929
140	2,628	2,087	1,701	1,437	1,508	1,031
160	2,613	2,132	1,785	1,539	1,588	1,130
180	2,587	2,162	1,851	1,623	1,656	1,220
200	2,555	2,182	1,903	1,694	1,714	1,301
220	2,521	2,194	1,945	1,753	1,763	1,374
240	2,488	2,201	1,978	1,802	1,805	1,439
260	2,457	2,204	2,004	1,844	1,842	1,498
280	2,428	2,206	2,026	1,879	1,873	1,551
300	2,403	2,206	2,044	1,909	1,901	1,598
320	2,380	2,205	2,058	1,935	1,925	1,641
340	2,359	2,203	2,071	1,957	1,946	1,680
360	2,341	2,201	2,081	1,976	1,964	1,715
380	2,325	2,199	2,089	1,993	1,980	1,747
400	2,311	2,197	2,096	2,008	1,995	1,776
420	2,298	2,195	2,103	2,020	2,008	1,802
440	2,287	2,193	2,108	2,032	2,019	1,826
460	2,277	2,191	2,113	2,042	2,029	1,848
480	2,268	2,189	2,117	2,051	2,039	1,867
500	2,260	2,187	2,120	2,059	2,047	1,886

Note(s): This table shall not be used for new installation or re-conductoring.

1.0 Guying

Conductor tensions for guying 653.9 Covered Conductor is 2,846 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 146 Sag Chart #8 Copper Duplex

Scope CO 146.1 Sag — Temperature Stringing Table #8 M.H.D. Copper Wire Duplex with Polyethylene Insulation for Light-Loading Areas

Table CO 146–1: Sag — Temperature Stringing Table #8 M.H.D. Copper Wire Duplex with Polyethylene Insulation for Light-Loading Areas

Span (ft)	Sag			
	50°F	70°F	90°F	130°F
100	0'-9"	1'-0"	1'-2"	1'-7"
110	0'-11"	1'-2"	1'-4"	1'-9"
120	1'-1"	1'-4"	1'-7"	2'-0"
130	1'-4"	1'-7"	1'-10"	2'-3"
140	1'-7"	1'-10"	2'-1"	2'-6"
150	1'-10"	2'-1"	2'-5"	2'-9"
160	2'-1"	2'-4"	2'-9"	3'-1"
170	2'-5"	2'-8"	3'-1"	3'-5"
180	2'-9"	3'-0"	3'-5"	3'-10"
190	3'-1"	3'-5"	3'-9"	4'-3"
200	3'-6"	3'-10"	4'-2"	4'-8"
210	3'-11"	4'-3"	4'-7"	5'-1"
220	4'-4"	4'-8"	5'-0"	5'-6"
230	4'-10"	5'-2"	5'-6"	6'-0"

1.0 Guying

None—for service to one streetlight only.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 148 Sag Chart #6 — 4/0 Copper

Scope CO 148.1 Sag — Temperature Stringing Table #6 — 4/0 Copper for Light Loading Areas

Table CO 148–1: Sag — Temperature Stringing Table #6 — 4/0 Copper for Light Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-5"	0'-6"	0'-8"	0'-11"	0'-10"	1'-6"
120	0'-7"	0'-8"	0'-11"	1'-2"	1'-0"	1'-11"
140	0'-8"	0'-11"	1'-2"	1'-6"	1'-4"	2'-2"
160	0'-11"	1'-2"	1'-6"	1'-10"	1'-8"	2'-8"
180	1'-2"	1'-6"	1'-11"	2'-2"	2'-1"	3'-1"
200	1'-6"	1'-11"	2'-4"	2'-8"	2'-6"	3'-7"
220	1'-11"	2'-4"	2'-8"	3'-1"	3'-0"	4'-1"
240	2'-4"	2'-10"	3'-2"	3'-7"	3'-6"	4'-8"
260	2'-11"	3'-4"	3'-8"	4-2"	4'-0"	5'-4"
280	3'-4"	3'-10"	4'-4"	4'-10"	4'-7"	5'-11"
300	3'-10"	4'-5"	4'-11"	5'-5"	5'-2"	6'-7"
320	4'-6"	5'-0"	5'-7"	6'-1"	5'-11"	7'-4"
340	5'-2"	5'-8"	6'-2"	6'-10"	6'-8"	8'-0"
360	5'-11"	6'-5"	7'-0"	7'-6"	7'-4"	8'-10"
380	6'-7"	7'-1"	7'-10"	8'-4"	8'-0"	9'-7"
400	7'-5"	8'-0"	8'-7"	9'-1"	8'-11"	10'-6"
420	8'-2"	8'-10"	9'-6"	10'-0"	9'-10"	11'-5"
440	9'-0"	9'-8"	10'-4"	10'-11"	10'-8"	12'-4"
460	10'-0"	10'-8"	11'-4"	11'-10"	11'-7"	13'-2"
480	11'-0"	11'-8"	12'-2"	12'-11"	12'-7"	14'-4"
500	12'-0"	12'-6"	13'-4"	13'-10"	13'-7"	15'-4"

1.0 Guying

Conductor tensions for guying #6 is 320 lb.

Conductor tensions for guying #4 is 484 lb.

Conductor tensions for guying #2 is 761 lb.

Conductor tensions for guying 2/0 is 1,482 lb.

Conductor tensions for guying 4/0 is 2,288 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor to ground clearances.

Scope CO 148.2 Sag — Temperature Stringing Table #2 Copper Covered Conductor for Light-Loading Areas

Table CO 148–2: Sag — Temperature Stringing Table 17 kV #2 Copper Covered Conductor for Light-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-7"	0'-8"	0'-10"	1'-0"	0'-9"	1'-3"
120	0'-10"	1'-0"	1'-2"	1'-4"	1'-0"	1'-8"
140	1'-2"	1'-4"	1'-6"	1'-9"	1'-5"	2'-2"
160	1'-6"	1'-9"	2'-0"	2'-3"	1'-10"	2'-8"
180	2'-0"	2'-3"	2'-6"	2'-9"	2'-4"	3'-2"
200	2'-6"	2'-9"	3'-1"	3'-4"	2'-10"	3'-10"
220	3'-1"	3'-4"	3'-8"	4'-0"	3'-6"	4'-6"
240	3'-8"	4'-0"	4'-4"	4'-8"	4'-2"	5'-2"
260	4'-5"	4'-9"	5'-1"	5'-5"	4'-10"	5'-11"
280	5'-2"	5'-6"	5'-10"	6'-3"	5'-8"	6'-9"
300	5'-11"	6'-4"	6'-9"	7'-1"	6'-6"	7'-7"
320	6'-10"	7'-3"	7'-7"	8'-0"	7'-5"	8'-6"
340	7'-9"	8'-2"	8'-7"	9'-0"	8'-4"	9'-6"
360	8'-9"	9'-2"	9'-7"	10'-0"	9'-4"	10'-7"
380	9'-10"	10'-3"	10'-8"	11'-1"	10'-5"	11'-8"
400	11'-0"	11'-5"	11'-10"	12'-3"	11'-7"	12'-9"
420	12'-2"	12'-7"	13'-0"	13'-5"	12'-9"	14'-0"
440	13'-5"	13'-10"	14'-3"	14'-8"	14'-0"	15'-3"
460	14'-8"	15'-2"	15'-7"	16'-0"	15'-3"	16'-7"
480	16'-0"	16'-6"	16'-11"	17'-4"	16'-8"	18'-0"
500	17'-6"	17'-11"	18'-4"	18'-9"	18'-1"	19'-5"

Table CO 148–3: Tension — Temperature Stringing Table 17 kV #2 Copper Covered Conductor for Light-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	708	592	490	407	553	313
120	694	588	497	424	553	341
140	679	584	503	438	552	364
160	665	580	509	451	552	385
180	652	577	514	462	552	402
200	640	574	518	472	552	418
220	630	571	522	480	552	431
240	621	569	525	487	552	443
260	613	567	527	494	551	453
280	606	565	530	499	551	462
300	600	563	532	504	551	470
320	595	562	534	508	551	477
340	590	561	535	512	551	483
360	587	560	536	515	551	488
380	583	559	538	518	551	493
400	580	559	539	521	551	498
420	578	558	540	523	551	502
440	575	557	541	525	551	505
460	573	557	541	527	551	508
480	572	556	542	529	551	511
500	570	556	543	530	551	514
Note(s): This table shall not be used for new installation or re-conductoring.						

1.0 Guying

Conductor tensions for guying #2 copper covered conductor is 925 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 148.3 Sag — Temperature Stringing Table 2/0 Copper Covered Conductor for Light-Loading Areas

Table CO 148–4: Sag — Temperature Stringing Table 17 kV 2/0 Copper Covered Conductor for Light-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-6"	0'-7"	0'-9"	0'-11"	0'-8"	1'-2"
120	0'-8"	0'-10"	1'-0"	1'-2"	0'-11"	1'-6"
140	1'-0"	1'-2"	1'-4"	1'-7"	1'-2"	1'-11"
160	1'-3"	1'-6"	1'-8"	2'-0"	1'-6"	2'-4"
180	1'-7"	1'-10"	2'-1"	2'-5"	1'-11"	2'-10"
200	2'-0"	2'-3"	2'-7"	2'-10"	2'-4"	3'-4"
220	2'-5"	2'-9"	3'-0"	3'-4"	2'-10"	3'-10"
240	2'-11"	3'-3"	3'-7"	3'-11"	3'-4"	4'-5"
260	3'-5"	3'-9"	4'-1"	4'-6"	3'-10"	5'-0"
280	3'-11"	4'-4"	4'-9"	5'-1"	4'-5"	5'-8"
300	4'-7"	4'-11"	5'-4"	5'-9"	5'-1"	6'-4"
320	5'-2"	5'-7"	6'-0"	6'-6"	5'-9"	7'-0"
340	5'-10"	6'-4"	6'-9"	7'-2"	6'-5"	7'-9"
360	6'-7"	7'-1"	7'-6"	8'-0"	7'-2"	8'-7"
380	7'-4"	7'-10"	8'-4"	8'-9"	8'-0"	9'-5"
400	8'-2"	8'-8"	9'-2"	9'-8"	8'-10"	10'-3"
420	9'-0"	9'-6"	10'-0"	10'-6"	9'-8"	11'-2"
440	9'-11"	10'-6"	11'-0"	11'-6"	10'-7"	12'-1"
460	10'-11"	11'-5"	11'-11"	12'-5"	11'-7"	13'-1"
480	11'-10"	12'-5"	12'-11"	13'-5"	12'-6"	14'-1"
500	12'-11"	13'-5"	14'-0"	14'-6"	13'-7"	15'-2"

Table CO 148–5: Tension — Temperature Stringing Table 17 kV 2/0 Copper Covered Conductor for Light-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	1,432	1,189	970	789	1,112	590
120	1,426	1,198	997	833	1,128	651
140	1,420	1,207	1,023	873	1,144	706
160	1,414	1,216	1,047	909	1,159	755
180	1,408	1,225	1,069	942	1,174	799
200	1,402	1,233	1,090	972	1,187	839
220	1,396	1,240	1,109	1,000	1,198	876
240	1,391	1,247	1,126	1,024	1,209	909
260	1,386	1,253	1,141	1,047	1,219	938
280	1,381	1,259	1,155	1,067	1,228	966
300	1,377	1,264	1,168	1,086	1,236	990
320	1,373	1,269	1,180	1,103	1,243	1,013
340	1,370	1,273	1,190	1,118	1,249	1,034
360	1,366	1,277	1,200	1,132	1,255	1,053
380	1,363	1,281	1,209	1,145	1,260	1,070
400	1,361	1,284	1,216	1,157	1,265	1,086
420	1,358	1,287	1,224	1,167	1,269	1,101
440	1,356	1,290	1,230	1,177	1,273	1,115
460	1,354	1,292	1,237	1,186	1,277	1,127
480	1,353	1,294	1,242	1,195	1,280	1,139
500	1,351	1,297	1,247	1,202	1,283	1,149
Note(s): This table shall not be used for new installation or re-conductoring.						

1.0 Guying

Conductor tensions for guying 2/0 copper covered conductor is 1,800 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 148.4 Sag — Temperature Stringing Table 4/0 Copper Covered Conductor for Light-Loading Areas

Table CO 148–6: Sag - Temperature Stringing Table 17 kV 4/0 Copper Covered Conductor for Light-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-6"	0'-7"	0'-8"	0'-10"	0'-7"	1'-2"
120	0'-8"	0'-10"	1'-0"	1'-2"	0'-10"	1'-6"
140	0'-11"	1'-1"	1'-3"	1'-6"	1'-2"	1'-11"
160	1'-2"	1'-5"	1'-8"	1'-11"	1'-6"	2'-3"
180	1'-6"	1'-9"	2'-0"	2'-4"	1'-10"	2'-9"
200	1'-10"	2'-1"	2'-5"	2'-9"	2'-2"	3'-2"
220	2'-3"	2'-6"	2'-10"	3'-2"	2'-8"	3'-8"
240	2'-8"	3'-0"	3'-4"	3'-8"	3'-1"	4'-3"
260	3'-1"	3'-6"	3'-10"	4'-3"	3'-7"	4'-9"
280	3'-7"	4'-0"	4'-5"	4'-10"	4'-1"	5'-4"
300	4'-2"	4'-7"	5'-0"	5'-5"	4'-8"	6'-0"
320	4'-9"	5'-2"	5'-7"	6'-0"	5'-3"	6'-7"
340	5'-4"	5'-9"	6'-3"	6'-8"	5'-11"	7'-3"
360	6'-0"	6'-5"	6'-11"	7'-5"	6'-7"	8'-0"
380	6'-8"	7'-2"	7'-7"	8'-1"	7'-3"	8'-9"
400	7'-4"	7'-10"	8'-4"	8'-10"	8'-0"	9'-6"
420	8'-1"	8'-8"	9'-2"	9'-8"	8'-9"	10'-4"
440	8'-11"	9'-5"	10'-0"	10'-6"	9'-7"	11'-2"
460	9'-9"	10'-3"	10'-10"	11'-4"	10'-5"	12'-0"
480	10'-7"	11'-2"	11'-8"	12'-3"	11'-3"	12'-11"
500	11'-6"	12'-1"	12'-7"	13'-2"	12'-2"	13'-10"

Table CO 148–7: Tension — Temperature Stringing Table 17 kV 4/0 Copper Covered Conductor for Light-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	2,224	1,834	1,484	1,196	1,716	887
120	2,226	1,858	1,535	1,271	1,752	986
140	2,229	1,883	1,584	1,341	1,787	1,076
160	2,231	1,907	1,630	1,405	1,821	1,158
180	2,234	1,931	1,674	1,463	1,853	1,232
200	2,237	1,953	1,714	1,518	1,883	1,300
220	2,239	1,975	1,752	1,568	1,911	1,363
240	2,242	1,995	1,787	1,614	1,937	1,420
260	2,244	2,014	1,819	1,656	1,961	1,474
280	2,246	2,031	1,849	1,695	1,983	1,523
300	2,248	2,047	1,876	1,731	2,003	1,568
320	2,250	2,062	1,901	1,764	2,022	1,610
340	2,252	2,076	1,925	1,795	2,039	1,648
360	2,253	2,089	1,946	1,823	2,055	1,684
380	2,255	2,100	1,966	1,850	2,069	1,718
400	2,256	2,111	1,985	1,874	2,082	1,748
420	2,257	2,121	2,002	1,897	2,094	1,777
440	2,258	2,131	2,018	1,917	2,105	1,804
460	2,260	2,139	2,032	1,937	2,116	1,829
480	2,261	2,147	2,046	1,955	2,125	1,852
500	2,261	2,154	2,058	1,972	2,134	1,874

Note(s): This table shall not be used for new installation or re-conductoring.

3.0 Guying

Conductor tensions for guying 4/0 copper covered conductor is 2,780 lb.

4.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 150 Sag Chart #4 Copper and #4 ACSR

Scope CO 150.1 Sag — Temperature Stringing Table #4 Copper and #4 ACSR for Heavy-Loading Areas

Table CO 150–1: Sag — Temperature Stringing Table #4 Copper and #4 ACSR for Heavy-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-6"	0'-10"	1'-0"	1'-4"	1'-1"	1'-10"
120	0'-11"	1'-2"	1'-6"	1'-10"	1'-7"	2'-5"
140	1'-6"	1'-10"	2'-1"	2'-5"	2'-4"	3'-0"
160	2'-2"	2'-5"	2'-10"	3'-1"	3'-0"	3'-8"
180	2'-11"	3'-4"	3'-7"	3'-11"	3'-8"	4'-6"
200	3'-10"	4'-1"	4'-6"	4'-10"	4'-7"	5'-5"
220	4'-10"	5'-1"	5'-5"	5'-8"	5'-7"	6'-5"
240	5'-10"	6'-2"	6'-6"	6'-10"	6'-8"	7'-6"
260	7'-0"	7'-4"	7'-7"	8'-0"	7'-10"	8'-8"
280	8'-2"	8'-7"	8'-11"	9'-2"	9'-1"	9'-11"
300	9'-7"	9'-11"	10'-2"	10'-6"	10'-5"	11'-4"
320	11'-0"	11'-5"	11'-8"	12'-0"	11'-10"	12'-8"
340	12'-7"	12'-11"	13'-2"	13'-6"	13'-5"	14'-4"
360	14'-2"	14'-6"	14'-10"	15'-1"	15'-0"	15'-11"
380	15'-11"	16'-2"	16'-6"	16'-10"	16'-8"	17'-7"
400	17'-8"	18'-0"	18'-4"	18'-7"	18'-6"	19'-5"
420	19'-7"	19'-11"	20'-2"	20'-6"	20'-5"	21'-4"
440	21'-7"	21'-11"	22'-2"	22'-6"	22'-5"	23'-4"
460	23'-8"	24'-0"	24'-4"	24'-7"	24'-6"	25'-5"
480	25'-10"	26'-2"	27'-0"	27'-4"	26'-7"	27'-7"
500	28'-1"	28'-5"	28'-8"	29'-1"	28'-11"	29'-11"

1.0 Guying

Conductor tensions for guying #4 copper is 484 lb.

Conductor tensions for guying #4 ACSR is 604 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 152 Sag Chart #2 Copper

Scope CO 152.1 Sag — Temperature Stringing Table #2 Copper for Heavy-Loading Areas

Table CO 152–1: Sag — Temperature Stringing Table #2 Copper for Heavy-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	1'-2"	1'-7"	1'-11"	2'-2"	1'-11"	2'-8"
120	1'-8"	2'-1"	2'-6"	2'-10"	2'-6"	3'-5"
140	2'-4"	2'-8"	3'-1"	3'-6"	3'-1"	4'-1"
160	2'-11"	3'-5"	3'-10"	4'-2"	3'-10"	4'-11"
180	3'-8"	4'-2"	4'-7"	5'-0"	4'-7"	5'-8"
200	4'-6"	5'-0"	5'-6"	5'-11"	5'-5"	6'-8"
220	5'-5"	6'-0"	6'-5"	6'-11"	6'-5"	7'-8"
240	6'-5"	7'-0"	7'-6"	7'-11"	7'-5"	8'-8"
260	7'-6"	8'-1"	8'-7"	9-1"	8'-6"	9'-11"
280	8'-8"	9'-4"	9'-10"	10'-4"	9'-8"	11'-1"
300	10'-0"	10'-6"	11'-1"	11'-7"	11'-0"	12'-5"
320	11'-5"	11'-11"	12'-5"	12'-11"	12-5"	13'-10"
340	12'-10"	13'-5"	13'-11"	14'-5"	13'-10"	15'-4"
360	14'-4"	14'-11"	15'-5"	15'-11"	15'-5"	16'-11"
380	16'-0"	16'-6"	17'-1"	17'-7"	17'-0"	18'-6"
400	17'-8"	18'-2"	18'-10"	19'-4"	18'-8"	20'-4"
420	19'-6"	20'-0"	20'-7"	21'-1"	20'-6"	22'-1"
440	21'-4"	21'-11"	22'-6"	23'-0"	22'-5"	24'-0"
460	23'-4"	23'-11"	24'-5"	25'-0"	24'-5"	26'-0"
480	25'-5"	25'-11"	26'-6"	27'-0"	26'-4"	28'-0"
500	27'-5"	28'-1"	28'-7"	29'-2"	28'-7"	30'-2"

1.0 Guying

Conductor tensions for guying is 761 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 152.2 Sag — Temperature Stringing Table #2 Copper Covered Conductor for Heavy Loading Areas

Table CO 152–2: Sag — Temperature Stringing Table 17 kV #2 Copper Covered Conductor for Heavy-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	1'-4"	1'-6"	1'-9"	1'-11"	1'-8"	2'-2"
120	2'-1"	2'-4"	2'-6"	2'-8"	2'-5"	2'-11"
140	3'-0"	3'-3"	3'-5"	3'-7"	3'-4"	3'-11"
160	4'-1"	4'-3"	4'-6"	4'-8"	4'-5"	5'-0"
180	5'-4"	5'-6"	5'-8"	5'-11"	5'-8"	6'-2"
200	6'-8"	6'-10"	7'-1"	7'-3"	7'-0"	7'-7"
220	8'-2"	8'-5"	8'-7"	8'-9"	8'-6"	9'-1"
240	9'-10"	10'-0"	10'-3"	10'-5"	10'-2"	10'-9"
260	11'-8"	11'-10"	12'-0"	12'-3"	12'-0"	12'-6"
280	13'-7"	13'-9"	14'-0"	14'-2"	13'-11"	14'-6"
300	15'-8"	15'-11"	16'-1"	16'-3"	16'-0"	16'-7"
320	18'-0"	18'-2"	18'-4"	18'-7"	18'-3"	18'-10"
340	20'-4"	20'-7"	20'-9"	21'-0"	20'-8"	21'-3"
360	22'-11"	23'-2"	23'-4"	23'-6"	23'-3"	23'-10"
380	25'-8"	25'-10"	26'-1"	26'-3"	26'-0"	26'-7"
400	28'-7"	28'-9"	28'-11"	29'-2"	28'-11"	29'-6"
420	31'-7"	31'-10"	32'-0"	32'-2"	31'-11"	32'-6"
440	34'-10"	35'-0"	35'-3"	35'-5"	35'-2"	35'-9"
460	38'-2"	38'-5"	38'-7"	38'-9"	38'-6"	39'-1"
480	41'-9"	41'-11"	42'-2"	42'-4"	42'-1"	42'-8"
500	45'-5"	45'-8"	45'-10"	46'-0"	45'-9"	46'-4"

Table CO 152–3: Tension — Temperature Stringing Table 17 kV #2 Copper Covered Conductor for Heavy-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	295	259	232	211	241	185
120	271	248	230	214	236	194
140	257	241	228	217	232	200
160	248	237	227	218	230	205
180	243	234	226	219	229	208
200	239	232	225	220	228	211
220	236	230	225	220	227	213
240	234	229	225	221	226	214
260	232	228	224	221	226	216
280	231	227	224	221	225	217
300	230	227	224	221	225	217
320	229	226	224	222	225	218
340	228	226	224	222	225	219
360	227	226	224	222	224	219
380	227	225	224	222	224	219
400	227	225	224	222	224	220
420	226	225	224	222	224	220
440	226	225	223	222	224	220
460	226	225	223	222	224	221
480	225	224	223	222	224	221
500	225	224	223	222	224	221

Note(s): This table shall not be used for new installation or re-conductoring.

1.0 Guying

Conductor tensions for guying #2 copper covered conductor is 925 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 154 Sag Chart #4 Aluminum Duplex

Scope CO 154.1 Sag — Temperature Stringing Table Streetlight Secondary 120 V #4 Aluminum Duplex for Heavy-Loading Areas

Table CO 154–1: Sag — Temperature Stringing Table Streetlight Secondary 120 V #4 Aluminum Duplex for Heavy-Loading Areas

Span (ft)	Sag			
	Initial Stringing Sag			Final Sag
	50°F	70°F	90°F	130°F
100	1'-7"	1'-10"	2'-0"	2'-7"
110	2'-0"	2'-4"	2'-6"	3'-0"
120	2'-7"	2'-10"	3'-0"	3'-7"
130	3'-2"	3'-5"	3'-7"	4'-2"
140	3'-10"	4'-0"	4'-2"	4'-10"
150	4'-6"	4'-8"	4'-11"	5'-5"
160	5'-2"	5'-5"	5'-7"	6'-2"
170	6'-0"	6'-1"	6'-4"	6'-11"
180	6'-10"	7'-0"	7'-1"	7'-8"
190	7'-7"	7'-10"	8'-0"	8'-7"
200	8'-6"	8'-8"	8'-11"	9'-6"
210	9'-6"	9'-7"	9'-10"	10'-5"
220	10'-6"	10'-7"	10'-10"	11'-5"
230	11'-6"	11'-8"	11'-11"	12'-5"
240	12'-7"	12'-10"	12'-11"	13'-6"
250	13'-8"	13'-11"	14'-1"	14'-8"
260	14'-11"	15'-1"	15'-3"	15'-10"
270	16'-1"	16'-4"	16'-6"	17'-0"
280	17'-5"	17'-6"	17'-8"	18'-4"
290	18'-8"	18'-11"	19'-0"	19'-7"
300	20'-0"	20'-2"	20'-5"	21'-0"

1.0 Guying

Conductor tensions for guying is 604 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 155 Sag Charts #4 and #2 Aluminum Triplex

Scope CO 155.1 Sag — Temperature Stringing Table #4 and #2 Aluminum Triplex for Heavy-Loading Areas

Table CO 155–1: Sag — Temperature Stringing Table #4 and #2 Aluminum Triplex for Heavy-Loading Areas

Conductor Type	Span (ft)	Sag			
		Initial Stringing Sag			Final Sag
		50°F	70°F	90°F	130°F
#4 Triplex	100	2'-10"	2'-11"	3'-1"	3'-6"
	120	4'-2"	4'-4"	4'-6"	4'-11"
	140	5'-10"	6'-0"	6'-1"	6'-6"
	160	7'-8"	7'-10"	8'-0"	8'-5"
	180	9'-10"	10'-0"	10'-1"	10'-6"
	200	12'-2"	12'-5"	12'-6"	12'-11"
	220	14'-11"	15'-0"	15'-1"	15'-7"
	240	17'-8"	17'-11"	18'-0"	18'-4"
	260	20'-11"	21'-0"	21'-1"	21'-7"
#2 Triplex	100	1'-11"	2'-1"	2'-4"	2'-10"
	120	2'-11"	3'-1"	3'-4"	3'-10"
	140	4'-1"	4'-4"	4'-6"	5'-0"
	160	5'-6"	5'-7"	5'-10"	6'-5"
	180	7'-0"	7'-2"	7'-5"	7'-11"
	200	8'-8"	8'-11"	9'-1"	9'-8"
	220	10'-7"	10'-10"	11'-0"	11'-7"
	240	12'-8"	12'-11"	13'-1"	13'-8"
	260	15'-0"	15'-2"	15'-5"	15'-11"

1.0 Guying

Conductor tensions for guying #4 aluminum triplex is 484 lb.

Conductor tensions for guying #2 aluminum triplex is 761 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 156 Sag Charts 1/0 and 4/0 Triplex

Scope CO 156.1 Sag — Temperature Stringing Table 1/0 and 4/0 Triplex for Heavy-Loading Areas

Table CO 156–1: Sag — Temperature Stringing Table 1/0 and 4/0 Triplex for Heavy Loading Areas

Conductor Type	Span (ft)	Sag			
		Initial Stringing Sag			Final Sag
		50°F	70°F	90°F	130°F
#1/0 Triplex	100	0'-11"	1'-1"	1'-4"	2'-0"
	120	1'-6"	1'-8"	2'-0"	2'-8"
	140	2'-2"	2'-6"	2'-10"	3'-6"
	160	3'-1"	3'-5"	3'-8"	4'-6"
	180	4'-1"	4'-5"	4'-8"	5'-6"
	200	5'-4"	5'-6"	5'-10"	6'-7"
	220	6'-6"	6'-10"	7'-1"	7'-11"
	240	7'-11"	8'-2"	8'-5"	9'-4"
	260	9'-5"	9'-8"	9'-11"	10'-10"
#4/0 Triplex	100	0'-7"	0'-10"	1'-0"	1'-10"
	120	1'-0"	1'-2"	1'-5"	2'-4"
	140	1'-5"	1'-8"	2'-0"	2'-11"
	160	1'-11"	2'-4"	2'-7"	3'-6"
	180	2'-7"	2'-11"	3'-4"	4'-4"
	200	3'-4"	3'-8"	4'-0"	5'-1"
	220	4'-2"	4'-6"	4'-11"	6'-0"
	240	5'-1"	5'-6"	5'-10"	7'-0"
	260	6'-1"	6'-6"	6'-11"	8'-0"

1.0 Guying

Conductor tension for guying 1/0 aluminum triplex is 1,415 lb.

Conductor tension for guying 4/0 aluminum triplex is 2,780 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 158 Sag Charts 1/0 and 4/0 Quadruplex

Scope CO 158.1 Sag — Temperature Stringing Table 1/0 and 4/0 Quadruplex for Heavy-Loading Areas

Table CO 158–1: Sag — Temperature Stringing Table 1/0 and 4/0 Quadruplex for Heavy-Loading Areas

Conductor Type	Span (ft)	Sag			
		Initial Stringing Sag			Final Sag
		50°F	70°F	90°F	130°F
1/0 Quadruplex w/ACSR Messenger	100	1'-4"	1'-6"	1'-8"	2'-4"
	120	2'-2"	2'-4"	2'-6"	3'-2"
	140	3'-0"	3'-2"	3'-6"	4'-2"
	160	4'-2"	4'-4"	4'-6"	5'-2"
	180	5'-4"	5'-7"	5'-10"	6'-6"
	200	6'-8"	6'-11"	7'-2"	7'-11"
	220	8'-2"	8'-6"	8'-8"	9'-5"
	240	9'-11"	10'-2"	10'-5"	11'-2"
	260	11'-8"	12'-0"	12'-2"	12'-11"
4/0 Quadruplex w/ACSR Messenger	100	0'-11"	1'-2"	1'-4"	2'-0"
	120	1'-4"	1'-7"	1'-10"	2'-7"
	140	1'-11"	2'-2"	2'-6"	3'-4"
	160	2'-8"	3'-0"	3'-2"	4'-2"
	180	3'-6"	3'-10"	4'-2"	5'-0"
	200	4'-5"	4'-8"	5'-0"	5'-11"
	220	5'-6"	5'-10"	6'-2"	7'-0"
	240	6'-7"	6'-11"	7'-2"	8'-2"
	260	7'-11"	8'-2"	8'-6"	9'-6"

1.0 Guying

Conductor tension for guying 1/0 aluminum quadruplex is 1,415 lb.

Conductor tension for guying 4/0 aluminum quadruplex is 2,780 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 160 Sag Chart 2/0 and 4/0 Copper

Scope CO 160.1 Sag — Temperature Stringing Table 2/0 and 4/0 Copper for Heavy-Loading Areas

Table CO 160–1: Sag — Temperature Stringing Table 2/0 and 4/0 Copper for Heavy-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	1'-0"	1'-5"	1'-10"	2'-1"	1'-10"	2'-7"
120	1'-5"	1'-10"	2'-4"	2'-7"	2'-2"	3'-2"
140	1'-10"	2'-4"	2'-8"	3'-1"	2'-8"	3'-10"
160	2'-2"	2'-10"	3'-4"	3'-8"	3'-2"	4'-5"
180	2'-10"	3'-4"	3'-11"	4'-4"	3'-10"	5'-1"
200	3'-4"	3'-11"	4'-6"	5'-0"	4'-5"	5'-10"
220	3-11"	4'-7"	5'-2"	5'-8"	5'-1"	6'-7"
240	4'-7"	5'-4"	5'-11"	6'-6"	5'-10"	7'-5"
260	5'-4"	6'-0"	6'-8"	7-2"	6'-7"	8'-4"
280	6'-1"	6'-10"	7'-6"	8'-1"	7'-5"	9'-1"
300	7'-0"	7'-8"	8'-5"	9'-0"	8'-4"	10'-1"
320	7'-11"	8'-7"	9'-4"	9'-11"	9-2"	11'-1"
340	8'-10"	9'-7"	10'-4"	10'-11"	10'-2"	12'-1"
360	9'-10"	10'-7"	11'-4"	12'-0"	11'-2"	13'-2"
380	10'-11"	11'-8"	12'-5"	13'-1"	12'-3"	14'-4"
400	12'-0"	12'-10"	13'-6"	14'-2"	13'-5"	15'-6"
420	13'-2"	14'-0"	14'-8"	15'-5"	14'-7"	16'-8"
440	14'-5"	15'-2"	16'-0"	16'-8"	15'-11"	18'-0"
460	15'-8"	16'-6"	17'-4"	18'-0"	17'-2"	19'-4"
480	17'-1"	17'-11"	18'-7"	19'-5"	18'-7"	20'-8"
500	18'-6"	19'-4"	20'-1"	20'-10"	20'-0"	22'-2"

1.0 Guying

Conductor tensions for guying 2/0 is 1,482 lb.

Conductor tensions for guying 4/0 is 2,288 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 160.2 Sag — Temperature Stringing Table 2/0 Copper Covered Conductor for Heavy Loading Areas

Table CO 160–2: Sag — Temperature Stringing Table 17 kV 2/0 Copper Covered Conductor for Heavy-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-10"	1'-0"	1'-2"	1'-5"	1'-1"	1'-8"
120	1'-3"	1'-6"	1'-8"	1'-11"	1'-7"	2'-3"
140	1'-9"	2'-0"	2'-3"	2'-6"	2'-2"	2'-10"
160	2'-5"	2'-8"	3'-0"	3'-2"	2'-10"	3'-7"
180	3'-2"	3'-5"	3'-9"	4'-0"	3'-7"	4'-4"
200	4'-0"	4'-4"	4'-7"	4'-10"	4'-5"	5'-3"
220	4'-11"	5'-3"	5'-6"	5'-9"	5'-5"	6'-2"
240	6'-0"	6'-3"	6'-7"	6'-10"	6'-5"	7'-3"
260	7'-1"	7'-5"	7'-8"	8'-0"	7'-6"	8'-5"
280	8'-3"	8'-7"	8'-11"	9'-2"	8'-9"	9'-7"
300	9'-7"	9'-11"	10'-2"	10'-6"	10'-1"	10'-11"
320	11'-0"	11'-3"	11'-7"	11'-11"	11'-6"	12'-4"
340	12'-6"	12'-9"	13'-1"	13'-5"	12'-11"	13'-10"
360	14'-1"	14'-4"	14'-8"	15'-0"	14'-6"	15'-5"
380	15'-9"	16'-0"	16'-4"	16'-8"	16'-2"	17'-1"
400	17'-6"	17'-10"	18'-1"	18'-5"	18'-0"	18'-10"
420	19'-4"	19'-8"	20'-0"	20'-3"	19'-10"	20'-9"
440	21'-4"	21'-7"	21'-11"	22'-3"	21'-9"	22'-8"
460	23'-4"	23'-8"	24'-0"	24'-3"	23'-10"	24'-9"
480	25'-6"	25'-10"	26'-1"	26'-5"	26'-0"	26'-11"
500	27'-9"	28'-1"	28'-4"	28'-8"	28'-3"	29'-2"

Table CO 160–3: Tension — Temperature Stringing Table 17 kV 2/0 Copper Covered Conductor for Heavy-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	852	697	584	501	631	411
120	800	681	592	525	629	447
140	760	669	598	543	628	476
160	731	660	603	556	627	498
180	710	653	606	567	626	517
200	694	648	609	576	626	532
220	682	644	611	583	625	544
240	672	641	613	588	625	554
260	665	638	614	593	625	562
280	659	636	615	596	625	569
300	655	635	616	599	624	575
320	651	633	617	602	624	580
340	648	632	618	604	624	585
360	645	631	618	606	624	589
380	643	630	619	608	624	592
400	641	630	619	609	624	595
420	639	629	620	611	624	597
440	638	629	620	612	624	599
460	636	628	620	613	624	601
480	635	628	620	613	624	603
500	634	627	621	614	624	605
Note(s): This table shall not be used for new installation or re-conductoring.						

1.0 Guying

Conductor tensions for guying 2/0 copper covered conductor is 1,800 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 160.3 Sag — Temperature Stringing Table 4/0 Copper Covered Conductor for Heavy Loading Areas

Table CO 160–4: Sag — Temperature Stringing Table 17 kV 4/0 Copper Covered Conductor for Heavy-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-8"	0'-10"	1'-1"	1'-3"	1'-0"	1'-7"
120	1'-0"	1'-3"	1'-6"	1'-8"	1'-4"	2'-1"
140	1'-6"	1'-8"	2'-0"	2'-2"	1'-10"	2'-7"
160	1'-11"	2'-3"	2'-6"	2'-9"	2'-4"	3'-2"
180	2'-6"	2'-10"	3'-1"	3'-5"	3'-0"	3'-10"
200	3'-2"	3'-6"	3'-9"	4'-1"	3'-7"	4'-6"
220	3'-10"	4'-2"	4'-6"	4'-10"	4'-4"	5'-3"
240	4'-8"	5'-0"	5'-4"	5'-8"	5'-2"	6'-1"
260	5'-6"	5'-10"	6'-3"	6'-6"	6'-0"	7'-0"
280	6'-5"	6'-10"	7'-2"	7'-6"	7'-0"	8'-0"
300	7'-6"	7'-10"	8'-2"	8'-6"	8'-0"	9'-0"
320	8'-6"	8'-11"	9'-3"	9'-7"	9'-1"	10'-1"
340	9'-8"	10'-1"	10'-5"	10'-9"	10'-3"	11'-3"
360	10'-11"	11'-3"	11'-8"	12'-0"	11'-5"	12'-6"
380	12'-2"	12'-7"	12'-11"	13'-4"	12'-9"	13'-10"
400	13'-6"	13'-11"	14'-4"	14'-8"	14'-1"	15'-2"
420	15'-0"	15'-4"	15'-9"	16'-1"	15'-6"	16'-8"
440	16'-6"	16'-10"	17'-3"	17'-7"	17'-0"	18'-2"
460	18'-1"	18'-5"	18'-10"	19'-2"	18'-7"	19'-9"
480	19'-8"	20'-1"	20'-6"	20'-10"	20'-3"	21'-5"
500	21'-5"	21'-10"	22'-2"	22'-7"	22'-0"	23'-2"

Table CO 160–5: Tension — Temperature Stringing Table 17 kV 4/0 Copper Covered Conductor for Heavy-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	1,478	1,191	975	820	1,075	658
120	1,433	1,192	1,011	877	1,096	730
140	1,394	1,193	1,040	923	1,113	790
160	1,362	1,194	1,063	961	1,127	841
180	1,335	1,194	1,082	992	1,137	884
200	1,314	1,195	1,098	1,018	1,146	920
220	1,296	1,195	1,111	1,040	1,153	951
240	1,282	1,195	1,121	1,058	1,159	978
260	1,271	1,196	1,130	1,074	1,164	1,001
280	1,262	1,196	1,138	1,087	1,168	1,021
300	1,254	1,196	1,144	1,099	1,171	1,038
320	1,247	1,196	1,150	1,108	1,174	1,053
340	1,242	1,196	1,155	1,117	1,176	1,066
360	1,237	1,196	1,159	1,124	1,178	1,078
380	1,233	1,196	1,162	1,131	1,180	1,088
400	1,230	1,196	1,165	1,137	1,182	1,097
420	1,227	1,197	1,168	1,142	1,183	1,105
440	1,224	1,197	1,171	1,146	1,184	1,112
460	1,222	1,197	1,173	1,150	1,185	1,119
480	1,220	1,197	1,175	1,154	1,186	1,124
500	1,218	1,197	1,176	1,157	1,187	1,130

Note(s): This table shall not be used for new installation or re-conductoring.

1.0 Guying

Conductor tensions for guying 4/0 copper covered conductor is 2,780 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 162 Sag Chart 1/0 ACSR

Scope CO 162.1 Sag — Temperature Stringing Table 1/0 ACSR for Heavy-Loading Areas

Table CO 162–1: Sag — Temperature Stringing Table 1/0 ACSR for Heavy-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-4"	0'-4"	0'-6"	0'-10"	0'-7"	1'-6"
120	0'-5"	0'-6"	0'-10"	1'-1"	0'-11"	1'-11"
140	0'-7"	0'-10"	1'-2"	1'-7"	1'-5"	2'-5"
160	0'-11"	1'-2"	1'-8"	2'-1"	1'-11"	3'-0"
180	1'-4"	1'-10"	2'-4"	2'-8"	2'-5"	3'-7"
200	1'-11"	2'-5"	2'-11"	3'-5"	3'-1"	4'-4"
220	2'-7"	3'-2"	3'-8"	4'-1"	3'-10"	5'-1"
240	3'-5"	4'-0"	4'-6"	4'-11"	4'-8"	5'-11"
260	4'-4"	4'-11"	5'-4"	5-10"	5'-6"	6'-10"
280	5'-4"	5'-10"	6'-4"	6'-8"	6'-6"	7'-10"
300	6'-4"	6'-10"	7'-3"	7'-10"	7'-6"	8'-10"
320	7'-5"	7'-11"	8'-5"	8'-11"	8-7"	9'-11"
340	8'-7"	9'-1"	9'-7"	10'-0"	9'-8"	11'-1"
360	9'-10"	10'-4"	10'-10"	11'-4"	11'-0"	12'-4"
380	11'-1"	11'-7"	12'-1"	12'-7"	12'-4"	13'-7"
400	12'-6"	13'-0"	13'-6"	13'-11"	13'-8"	15'-0"
420	14'-0"	14'-5"	14'-11"	15'-5"	15'-1"	16'-5"
440	15'-6"	16'-0"	16'-5"	16'-11"	16'-7"	17'-11"
460	17'-1"	17'-6"	18'-0"	18'-6"	18'-2"	19'-6"
480	18'-8"	19'-2"	19'-8"	20'-1"	19'-11"	21'-2"
500	20'-6"	20'-11"	21'-5"	21'-11"	21'-7"	22'-11"

1.0 Guying

Conductor tensions for guying is 1,415 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 162.2 Sag — Temperature Stringing Table 1/0 ACSR Covered Conductor for Heavy-Loading Areas

Table CO 162–2: Sag — Temperature Stringing Table 17 kV 1/0 ACSR Covered Conductor for Heavy-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-6"	0'-7"	0'-9"	0'-11"	0'-11"	1'-5"
120	0'-9"	1'-0"	1'-2"	1'-5"	1'-5"	1'-11"
140	1'-3"	1'-6"	1'-9"	2'-1"	2'-0"	2'-7"
160	1'-10"	2'-2"	2'-6"	2'-9"	2'-9"	3'-4"
180	2'-8"	3'-0"	3'-4"	3'-7"	3'-6"	4'-2"
200	3'-7"	3'-11"	4'-3"	4'-6"	4'-5"	5'-1"
220	4'-7"	4'-11"	5'-3"	5'-6"	5'-6"	6'-2"
240	5'-8"	6'-0"	6'-4"	6'-8"	6'-7"	7'-3"
260	6'-11"	7'-3"	7'-7"	7'-11"	7'-10"	8'-6"
280	8'-3"	8'-7"	8'-11"	9'-2"	9'-2"	9'-10"
300	9'-8"	10'-0"	10'-4"	10'-7"	10'-7"	11'-3"
320	11'-2"	11'-6"	11'-10"	12'-2"	12'-1"	12'-9"
340	12'-10"	13'-2"	13'-5"	13'-9"	13'-8"	14'-5"
360	14'-6"	14'-10"	15'-2"	15'-6"	15'-5"	16'-2"
380	16'-4"	16'-8"	17'-0"	17'-4"	17'-3"	18'-0"
400	18'-3"	18'-7"	18'-11"	19'-3"	19'-2"	19'-11"
420	20'-4"	20'-8"	21'-0"	21'-3"	21'-2"	21'-11"
440	22'-5"	22'-9"	23'-1"	23'-5"	23'-4"	24'-1"
460	24'-8"	25'-0"	25'-4"	25'-8"	25'-7"	26'-4"
480	27'-0"	27'-4"	27'-8"	28'-0"	27'-11"	28'-8"
500	29'-6"	29'-10"	30'-1"	30'-5"	30'-4"	31'-1"

Table CO 162–3: Tension — Temperature Stringing Table 17 kV 1/0 ACSR Covered Conductor for Heavy-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	755	608	476	373	402	257
120	653	527	426	352	371	263
140	558	463	390	337	350	268
160	485	417	366	327	336	272
180	434	387	349	320	327	276
200	400	366	338	315	320	278
220	377	351	329	311	315	280
240	360	340	323	308	311	282
260	348	332	318	306	308	283
280	339	326	314	304	306	284
300	332	321	311	302	304	285
320	327	318	309	301	303	286
340	322	314	307	300	302	287
360	319	312	305	299	301	287
380	316	310	304	299	300	288
400	313	308	303	298	299	288
420	311	306	302	297	298	289
440	309	305	301	297	298	289
460	308	304	300	297	297	289
480	306	303	300	296	297	289
500	305	302	299	296	297	290

Note(s): This table shall not be used for new installation or re-conductoring.

Table CO 162–4: Sag — Temperature Stringing Table 35 kV 1/0 ACSR Covered Conductor for Heavy-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-10"	1'-0"	1'-3"	1'-5"	1'-4"	1'-10"
120	1'-5"	1'-8"	1'-10"	2'-1"	2'-0"	2'-7"
140	2'-2"	2'-5"	2'-8"	2'-11"	2'-10"	3'-5"
160	3'-1"	3'-4"	3'-7"	3'-10"	3'-9"	4'-4"
180	4'-2"	4'-5"	4'-7"	4'-10"	4'-9"	5'-5"
200	5'-4"	5'-7"	5'-10"	6'-0"	6'-0"	6'-8"
220	6'-7"	6'-10"	7'-1"	7'-4"	7'-3"	7'-11"
240	8'-1"	8'-4"	8'-7"	8'-9"	8'-9"	9'-5"
260	9'-7"	9'-10"	10'-1"	10'-4"	10'-3"	11'-0"
280	11'-4"	11'-7"	11'-10"	12'-1"	12'-0"	12'-8"
300	13'-2"	13'-5"	13'-8"	13'-11"	13'-10"	14'-6"
320	15'-1"	15'-4"	15'-7"	15'-10"	15'-9"	16'-6"
340	17'-2"	17'-5"	17'-8"	17'-11"	17'-10"	18'-7"
360	19'-5"	19'-8"	19'-11"	20'-2"	20'-1"	20'-9"
380	21'-9"	22'-0"	22'-3"	22'-6"	22'-5"	23'-2"
400	24'-3"	24'-6"	24'-9"	25'-0"	24'-11"	25'-8"
420	26'-10"	27'-1"	27'-4"	27'-7"	27'-6"	28'-3"
440	29'-8"	29'-11"	30'-2"	30'-4"	30'-4"	31'-0"
460	32'-6"	32'-9"	33'-0"	33'-3"	33'-2"	33'-11"
480	35'-7"	35'-10"	36'-1"	36'-4"	36'-3"	37'-0"
500	38'-9"	39'-0"	39'-3"	39'-6"	39'-5"	40'-2"

Table CO 162–5: Tension — Temperature Stringing Table 35 kV 1/0 ACSR Covered Conductor for Heavy-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	664	558	474	409	429	313
120	576	503	445	399	413	324
140	516	466	426	392	402	333
160	477	442	413	388	395	339
180	452	426	404	384	390	344
200	435	415	398	382	387	349
220	422	407	393	380	384	352
240	413	401	389	379	382	355
260	407	396	387	378	380	357
280	401	393	385	377	379	358
300	397	390	383	376	378	360
320	394	387	381	376	377	361
340	391	385	380	375	377	362
360	389	384	379	375	376	363
380	387	382	378	374	375	364
400	385	381	378	374	375	365
420	384	380	377	374	375	365
440	383	379	376	374	374	366
460	382	379	376	373	374	366
480	381	378	376	373	374	367
500	380	378	375	373	374	367
Note(s): This table shall not be used for new installation or re-conductoring.						

1.0 Guying

Conductor tensions for guying 1/0 Covered Conductor is 1,415 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 164 Sag Chart 336 ACSR

Scope CO 164.1 Sag — Temperature Stringing Area 336 ACSR for Heavy-Loading Areas

Table CO 164–1: Sag — Temperature Stringing Area 336 ACSR for Heavy-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-4"	0'-6"	0'-10"	1'-2"	0'-11"	1'-10"
120	0'-6"	0'-8"	1'-1"	1'-6"	1'-2"	2'-2"
140	0'-8"	1'-0"	1'-5"	1'-11"	1'-7"	2'-8"
160	0'-11"	1'-4"	1'-10"	2'-4"	1'-11"	3'-2"
180	1'-2"	1'-8"	2'-4"	2'-8"	2'-5"	3'-8"
200	1'-7"	2'-2"	2'-8"	3'-2"	2'-11"	4'-2"
220	2'-1"	2'-8"	3'-4"	3'-10"	3'-5"	4'-10"
240	2'-7"	3'-2"	3'-10"	4'-5"	4'-0"	5'-6"
260	3'-2"	3'-10"	4'-6"	5'-0"	4'-7"	6'-2"
280	3'-10"	4'-6"	5'-1"	5'-8"	5'-4"	6'-11"
300	4'-6"	5'-2"	5'-10"	6'-5"	6'-0"	7'-8"
320	5'-4"	6'-0"	6'-7"	7'-2"	6'-10"	8'-6"
340	6'-1"	6'-10"	7'-5"	8'-0"	7'-7"	9'-4"
360	6'-11"	7'-7"	8'-3"	8'-11"	8'-6"	10'-2"
380	7'-10"	8'-5"	9'-2"	9'-10"	9'-5"	11'-2"
400	8'-10"	9'-6"	10'-2"	10'-10"	10'-4"	12'-2"
420	9'-10"	10'-6"	11'-2"	11'-10"	11'-5"	13'-2"
440	10'-10"	11'-7"	12'-2"	12'-11"	12'-5"	14'-4"
460	11'-11"	12'-8"	13'-5"	14'-0"	13'-6"	15'-5"
480	13'-1"	13'-10"	14'-6"	15'-2"	14'-8"	16'-7"
500	14'-4"	15'-0"	15'-8"	16'-4"	15'-11"	17'-10"

1.0 Guying

Conductor tensions for guying is 2,846 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 164.2 Sag — Temperature Stringing Table 336 ACSR Covered Conductor for Heavy-Loading Areas

Table CO 164–2: Sag — Temperature Stringing Table 17 kV 336 (18/1) ACSR Covered Conductor for Heavy-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-6"	0'-8"	0'-11"	1'-2"	1'-0"	1'-9"
120	0'-8"	0'-11"	1'-3"	1'-7"	1'-4"	2'-3"
140	1'-0"	1'-4"	1'-8"	2'-1"	1'-9"	2'-9"
160	1'-5"	1'-9"	2'-2"	2'-7"	2'-3"	3'-4"
180	1'-11"	2'-4"	2'-9"	3'-2"	2'-10"	3'-11"
200	2'-6"	2'-11"	3'-4"	3'-9"	3'-5"	4'-8"
220	3'-1"	3'-7"	4'-1"	4'-6"	4'-2"	5'-4"
240	3'-10"	4'-4"	4'-10"	5'-3"	4'-11"	6'-2"
260	4'-7"	5'-2"	5'-7"	6'-1"	5'-9"	7'-0"
280	5'-6"	6'-0"	6'-6"	7'-0"	6'-7"	7'-11"
300	6'-5"	6'-11"	7'-5"	7'-11"	7'-6"	8'-11"
320	7'-5"	7'-11"	8'-5"	8'-11"	8'-6"	9'-11"
340	8'-6"	9'-0"	9'-6"	10'-0"	9'-7"	11'-0"
360	9'-7"	10'-2"	10'-8"	11'-2"	10'-9"	12'-2"
380	10'-9"	11'-4"	11'-10"	12'-4"	11'-11"	13'-5"
400	12'-1"	12'-7"	13'-1"	13'-7"	13'-3"	14'-8"
420	13'-5"	13'-11"	14'-5"	15'-0"	14'-7"	16'-0"
440	14'-9"	15'-4"	15'-10"	16'-4"	16'-0"	17'-5"
460	16'-3"	16'-9"	17'-4"	17'-10"	17'-5"	18'-11"
480	17'-9"	18'-4"	18'-10"	19'-5"	19'-0"	20'-6"
500	19'-5"	19'-11"	20'-6"	21'-0"	20'-7"	22'-1"

Table CO 164–3: Tension — Temperature Stringing Table 17 kV 336 (18/1) ACSR Covered Conductor for Heavy-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	1,573	1,132	802	605	752	408
120	1,477	1,090	818	650	776	463
140	1,383	1,055	831	687	796	512
160	1,297	1,026	841	716	811	554
180	1,225	1,003	849	740	823	590
200	1,166	985	855	760	833	622
220	1,119	970	860	777	841	650
240	1,083	959	864	790	848	674
260	1,054	949	868	802	853	695
280	1,030	942	870	812	858	714
300	1,012	936	873	820	862	730
320	997	930	875	828	865	744
340	984	926	877	834	867	757
360	974	922	878	839	870	768
380	965	919	879	844	872	778
400	957	917	880	848	874	787
420	951	914	881	852	875	795
440	945	912	882	855	876	802
460	941	910	883	858	878	809
480	936	909	884	860	879	815
500	933	907	884	863	880	820
Note(s): This table shall not be used for new installation or re-conductoring.						

1.0 Guying

Conductor tensions for guying 336 (18/1) Covered Conductor is 2,846 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

Table CO 164–4: Sag — Temperature Stringing Table 35 kV 336 (18/1) ACSR Covered Conductor for Heavy-Loading Areas

	Sag					
	Initial Stringing Sag				Final Sag	
Span (ft)	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-8"	0'-10"	1'-1"	1'-4"	1'-2"	1'-11"
120	1'-0"	1'-3"	1'-7"	1'-10"	1'-8"	2'-5"
140	1'-5"	1'-9"	2'-1"	2'-5"	2'-2"	3'-1"
160	2'-0"	2'-4"	2'-8"	3'-0"	2'-9"	3'-9"
180	2'-7"	3'-0"	3'-4"	3'-9"	3'-6"	4'-6"
200	3'-4"	3'-9"	4'-1"	4'-6"	4'-3"	5'-3"
220	4'-2"	4'-7"	5'-0"	5'-4"	5'-1"	6'-2"
240	5'-1"	5'-6"	5'-11"	6'-3"	6'-0"	7'-1"
260	6'-1"	6'-6"	6'-11"	7'-3"	7'-0"	8'-2"
280	7'-2"	7'-7"	8'-0"	8'-4"	8'-1"	9'-3"
300	8'-3"	8'-9"	9'-2"	9'-6"	9'-3"	10'-5"
320	9'-6"	10'-0"	10'-5"	10'-9"	10'-6"	11'-8"
340	10'-10"	11'-3"	11'-9"	12'-1"	11'-10"	13'-0"
360	12'-3"	12'-8"	13'-1"	13'-6"	13'-3"	14'-6"
380	13'-9"	14'-2"	14'-7"	15'-0"	14'-9"	16'-0"
400	15'-4"	15'-9"	16'-2"	16'-7"	16'-4"	17'-7"
420	17'-0"	17'-5"	17'-10"	18'-3"	18'-0"	19'-3"
440	18'-8"	19'-2"	19'-7"	20'-0"	19'-9"	21'-0"
460	20'-6"	21'-0"	21'-5"	21'-10"	21'-7"	22'-10"
480	22'-5"	22'-10"	23'-4"	23'-9"	23'-6"	24'-9"
500	24'-5"	24'-10"	25'-3"	25'-9"	25'-5"	26'-9"

Table CO 164–5: Tension — Temperature Stringing Table 35 kV 336 (18/1) ACSR Covered Conductor for Heavy-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	1,555	1,184	916	741	853	529
120	1,457	1,153	937	790	883	594
140	1,371	1,127	952	828	906	648
160	1,300	1,106	963	858	924	694
180	1,245	1,090	972	881	938	733
200	1,202	1,077	978	900	949	766
220	1,170	1,066	983	915	958	794
240	1,144	1,058	987	928	965	818
260	1,124	1,052	990	938	971	839
280	1,108	1,046	993	947	976	857
300	1,095	1,042	995	954	980	872
320	1,085	1,038	997	960	983	885
340	1,076	1,035	998	965	986	897
360	1,069	1,033	1,000	969	988	907
380	1,063	1,030	1,001	973	990	916
400	1,057	1,028	1,002	977	992	924
420	1,053	1,027	1,002	980	994	931
440	1,049	1,025	1,003	982	995	937
460	1,046	1,024	1,004	985	997	943
480	1,043	1,023	1,004	987	998	948
500	1,040	1,022	1,005	988	999	953

Note(s): This table shall not be used for new installation or re-conductoring.

1.0 Guying

Conductor tensions for guying 336.4 (18/1) Covered Conductor is 2,846 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

Table CO 164–6: Sag — Temperature Stringing Table 17 kV 336 (30/7) ACSR Covered Conductor for Heavy-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-3"	0'-3"	0'-4"	0'-4"	0'-5"	0'-7"
120	0'-4"	0'-5"	0'-5"	0'-6"	0'-7"	0'-11"
140	0'-6"	0'-6"	0'-8"	0'-9"	0'-10"	1'-3"
160	0'-8"	0'-9"	0'-10"	1'-0"	1'-1"	1'-7"
180	0'-10"	1'-0"	1'-1"	1'-4"	1'-5"	2'-0"
200	1'-1"	1'-3"	1'-5"	1'-8"	1'-9"	2'-5"
220	1'-4"	1'-7"	1'-10"	2'-1"	2'-1"	2'-11"
240	1'-8"	1'-11"	2'-3"	2'-7"	2'-7"	3'-5"
260	2'-0"	2'-4"	2'-8"	3'-1"	3'-1"	4'-0"
280	2'-6"	2'-10"	3'-2"	3'-7"	3'-7"	4'-7"
300	2'-11"	3'-4"	3'-9"	4'-2"	4'-2"	5'-3"
320	3'-6"	3'-11"	4'-4"	4'-10"	4'-9"	5'-11"
340	4'-1"	4'-6"	5'-0"	5'-6"	5'-5"	6'-7"
360	4'-8"	5'-2"	5'-8"	6'-3"	6'-1"	7'-4"
380	5'-5"	5'-11"	6'-5"	7'-0"	6'-10"	8'-2"
400	6'-1"	6'-8"	7'-3"	7'-9"	7'-8"	9'-0"
420	6'-11"	7'-6"	8'-0"	8'-7"	8'-6"	9'-10"
440	7'-9"	8'-4"	8'-11"	9'-6"	9'-4"	10'-9"
460	8'-8"	9'-3"	9'-10"	10'-5"	10'-3"	11'-8"
480	9'-7"	10'-2"	10'-9"	11'-4"	11'-2"	12'-8"
500	10'-6"	11'-2"	11'-9"	12'-4"	12'-2"	13'-8"

Table CO 164–7: Tension — Temperature Stringing Table 17 kV 336 (30/7) ACSR Covered Conductor for Heavy Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	4,107	3,591	3,072	2,557	2,349	1,501
120	4,008	3,497	2,987	2,487	2,313	1,510
140	3,895	3,391	2,894	2,415	2,276	1,521
160	3,773	3,279	2,797	2,343	2,239	1,532
180	3,643	3,162	2,701	2,276	2,202	1,544
200	3,510	3,045	2,608	2,214	2,168	1,557
220	3,375	2,930	2,521	2,161	2,136	1,570
240	3,242	2,821	2,442	2,115	2,108	1,582
260	3,113	2,720	2,371	2,076	2,082	1,595
280	2,991	2,627	2,310	2,043	2,059	1,608
300	2,878	2,543	2,256	2,016	2,038	1,620
320	2,773	2,469	2,210	1,994	2,020	1,632
340	2,679	2,404	2,171	1,975	2,005	1,644
360	2,595	2,347	2,136	1,960	1,991	1,655
380	2,520	2,297	2,107	1,947	1,978	1,665
400	2,455	2,253	2,082	1,936	1,967	1,675
420	2,397	2,215	2,060	1,926	1,957	1,684
440	2,346	2,182	2,040	1,918	1,949	1,693
460	2,301	2,153	2,024	1,912	1,941	1,701
480	2,262	2,127	2,009	1,906	1,934	1,709
500	2,227	2,104	1,996	1,900	1,928	1,716
Note(s): This table shall not be used for new installation or re-conductoring.						

1.0 Guying

Conductor tensions for guying 336.4 (30/7) Covered Conductor is 5,000 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

Table CO 164–8: Sag — Temperature Stringing Table 35 kV 336 (30/7) ACSR Covered Conductor for Heavy-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-4"	0'-4"	0'-5"	0'-6"	0'-6"	0'-10"
120	0'-6"	0'-6"	0'-7"	0'-9"	0'-9"	1'-2"
140	0'-8"	0'-9"	0'-10"	1'-0"	1'-1"	1'-6"
160	0'-11"	1'-0"	1'-2"	1'-5"	1'-5"	2'-0"
180	1'-2"	1'-4"	1'-7"	1'-9"	1'-10"	2'-6"
200	1'-6"	1'-9"	2'-0"	2'-3"	2'-3"	3'-0"
220	1'-11"	2'-2"	2'-6"	2'-9"	2'-9"	3'-7"
240	2'-4"	2'-8"	3'-0"	3'-4"	3'-4"	4'-3"
260	2'-11"	3'-3"	3'-7"	4'-0"	4'-0"	4'-11"
280	3'-6"	3'-10"	4'-3"	4'-8"	4'-7"	5'-7"
300	4'-2"	4'-6"	4'-11"	5'-4"	5'-4"	6'-4"
320	4'-10"	5'-3"	5'-9"	6'-2"	6'-1"	7'-2"
340	5'-8"	6'-1"	6'-6"	7'-0"	6'-11"	8'-1"
360	6'-6"	6'-11"	7'-5"	7'-10"	7'-9"	9'-0"
380	7'-4"	7'-10"	8'-4"	8'-9"	8'-8"	9'-11"
400	8'-4"	8'-9"	9'-3"	9'-9"	9'-8"	10'-11"
420	9'-4"	9'-10"	10'-3"	10'-9"	10'-8"	12'-0"
440	10'-4"	10'-10"	11'-4"	11'-10"	11'-9"	13'-1"
460	11'-6"	12'-0"	12'-6"	13'-0"	12'-11"	14'-3"
480	12'-8"	13'-2"	13'-8"	14'-2"	14'-1"	15'-5"
500	13'-10"	14'-4"	14'-11"	15'-5"	15'-3"	16'-8"

Table CO 164–9: Tension — Temperature Stringing Table 35 kV 336 (30/7) ACSR Covered Conductor for Heavy Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	4,026	3,519	3,016	2,526	2,347	1,554
120	3,899	3,403	2,917	2,455	2,315	1,578
140	3,760	3,279	2,817	2,388	2,283	1,604
160	3,614	3,153	2,719	2,327	2,254	1,628
180	3,466	3,030	2,629	2,275	2,227	1,653
200	3,320	2,914	2,548	2,231	2,203	1,677
220	3,181	2,807	2,477	2,196	2,182	1,699
240	3,051	2,711	2,417	2,167	2,164	1,720
260	2,932	2,628	2,366	2,144	2,148	1,741
280	2,826	2,555	2,323	2,126	2,135	1,759
300	2,734	2,493	2,286	2,111	2,123	1,777
320	2,653	2,439	2,256	2,099	2,112	1,793
340	2,582	2,393	2,230	2,088	2,104	1,808
360	2,522	2,354	2,208	2,080	2,096	1,822
380	2,470	2,320	2,189	2,073	2,089	1,835
400	2,425	2,291	2,172	2,067	2,083	1,847
420	2,386	2,265	2,158	2,062	2,078	1,858
440	2,352	2,243	2,146	2,058	2,073	1,868
460	2,323	2,224	2,135	2,055	2,069	1,877
480	2,297	2,207	2,126	2,052	2,065	1,885
500	2,274	2,192	2,117	2,049	2,062	1,893
Note(s): This table shall not be used for new installation or re-conductoring.						

1.0 Guying

Conductor tensions for guying 336.4 (30/7) Covered Conductor is 5,000 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 166 Sag Chart 654 ACSR

Scope CO 166.1 Sag — Temperature Stringing Table 654 ACSR for Heavy-Loading Areas

Table CO 166–1: Sag — Temperature Stringing Table 654 ACSR for Heavy-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	0'-8"	1'-1"	1'-5"	1'-8"	1'-6"	2'-2"
120	1'-0"	1'-5"	1'-10"	2'-1"	1'-11"	2'-8"
140	1'-5"	1'-10"	2'-2"	2'-7"	2'-4"	3'-2"
160	1'-10"	2'-4"	2'-9"	3'-1"	2'-10"	3'-10"
180	2'-4"	2'-10"	3'-2"	3'-7"	3'-4"	4'-5"
200	2'-10"	3'-4"	3'-10"	4'-2"	3'-11"	5'-1"
220	3'-5"	4'-0"	4'-6"	4'-11"	4'-7"	5'-10"
240	4'-1"	4'-7"	5'-1"	5'-7"	5'-4"	6'-6"
260	4'-10"	5'-5"	5'-11"	6-5"	6'-0"	7'-4"
280	5'-7"	6'-2"	6'-8"	7'-2"	6'-10"	8'-2"
300	6'-5"	7'-0"	7'-6"	8'-0"	7'-8"	9'-1"
320	7'-4"	7'-11"	8'-6"	9'-0"	8-7"	10'-0"
340	8'-4"	8'-11"	9'-5"	9'-11"	9'-6"	11'-0"
360	9'-4"	9'-11"	10'-5"	11'-0"	10'-7"	12'-1"
380	10'-5"	11'-0"	11'-6"	12'-1"	11'-7"	13'-2"
400	11'-6"	12'-1"	12'-8"	13'-2"	12'-10"	14'-5"
420	12'-8"	13'-4"	13'-10"	14'-5"	14'-0"	15'-7"
440	13'-11"	14'-6"	15'-1"	15'-8"	15'-2"	16'-10"
460	15'-2"	15'-10"	16'-5"	17'-0"	16'-6"	18'-2"
480	16'-7"	17'-2"	17'-10"	18'-4"	17'-11"	19'-7"
500	18'-0"	18'-7"	19'-2"	19'-10"	19'-4"	21'-0"

1.0 Guying

Conductor tensions for guying is 3,267 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 166.2 Sag — Temperature Stringing Table 654 ACSR Covered Conductor for Heavy-Loading Areas

Table CO 166–2: Sag — Temperature Stringing Table 17 kV 654 ACSR Covered Conductor for Heavy-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	1'-0"	1'-3"	1'-7"	1'-9"	1'-6"	2'-1"
120	1'-5"	1'-8"	2'-0"	2'-3"	2'-0"	2'-8"
140	1'-10"	2'-2"	2'-6"	2'-10"	2'-6"	3'-4"
160	2'-4"	2'-9"	3'-1"	3'-5"	3'-1"	4'-0"
180	3'-0"	3'-4"	3'-9"	4'-1"	3'-9"	4'-9"
200	3'-8"	4'-1"	4'-5"	4'-10"	4'-6"	5'-6"
220	4'-5"	4'-10"	5'-3"	5'-7"	5'-3"	6'-4"
240	5'-3"	5'-8"	6'-1"	6'-6"	6'-2"	7'-3"
260	6'-2"	6'-7"	7'-0"	7'-5"	7'-1"	8'-3"
280	7'-2"	7'-7"	8'-0"	8'-5"	8'-1"	9'-3"
300	8'-3"	8'-8"	9'-1"	9'-6"	9'-2"	10'-5"
320	9'-5"	9'-10"	10'-3"	10'-8"	10'-4"	11'-7"
340	10'-7"	11'-1"	11'-6"	11'-11"	11'-7"	12'-10"
360	11'-8"	12'-2"	12'-4"	12'-10"	12'-8"	13'-9"
380	13'-1"	13'-6"	13'-9"	14'-2"	14'-0"	15'-2"
400	14'-6"	15'-0"	15'-2"	15'-8"	15'-6"	16'-7"
420	16'-0"	16'-6"	16'-9"	17'-2"	17'-0"	18'-2"
440	17'-8"	18'-1"	18'-4"	18'-9"	18'-8"	19'-9"
460	19'-4"	19'-9"	20'-0"	20'-5"	20'-4"	21'-6"
480	21'-1"	21'-6"	21'-9"	22'-3"	22'-1"	23'-3"
500	22'-11"	23'-4"	23'-7"	24'-1"	23'-11"	25'-1"

Table CO 166–3: Tension — Temperature Stringing Table 17 kV 654 ACSR Covered Conductor for Heavy-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	1,229	954	791	685	818	596
120	1,275	1,036	883	778	898	664
140	1,303	1,097	957	856	963	723
160	1,319	1,142	1,016	921	1,016	782
180	1,328	1,177	1,063	975	1,059	839
200	1,333	1,203	1,101	1,021	1,095	890
220	1,336	1,223	1,132	1,058	1,124	934
240	1,337	1,239	1,158	1,090	1,149	972
260	1,337	1,251	1,179	1,117	1,169	1,006
280	1,337	1,261	1,196	1,140	1,187	1,036
300	1,337	1,270	1,211	1,160	1,202	1,063
320	1,336	1,276	1,224	1,176	1,214	1,086
340	1,336	1,282	1,234	1,191	1,225	1,106
360	3,354	1,310	1,287	1,243	1,257	1,158
380	3,346	1,312	1,291	1,251	1,263	1,172
400	3,340	1,314	1,294	1,258	1,268	1,185
420	3,334	1,315	1,297	1,264	1,273	1,196
440	3,329	1,316	1,300	1,269	1,278	1,206
460	3,324	1,317	1,302	1,274	1,282	1,215
480	3,320	1,318	1,304	1,278	1,285	1,223
500	3,316	1,318	1,306	1,281	1,288	1,230

Note(s): This table shall not be used for new installation or re-conductoring.

Table CO 166–4: Sag — Temperature Stringing Table 35 kV 654 ACSR Covered Conductor for Heavy-Loading Areas

Span (ft)	Sag					
	Initial Stringing Sag				Final Sag	
	50°F	70°F	90°F	110°F	70°F	130°F
100	1'-2"	1'-5"	1'-8"	1'-11"	1'-8"	2'-3"
120	1'-7"	1'-11"	2'-2"	2'-5"	2'-2"	2'-11"
140	2'-2"	2'-6"	2'-9"	3'-0"	2'-9"	3'-7"
160	2'-9"	3'-1"	3'-5"	3'-9"	3'-6"	4'-4"
180	3'-6"	3'-10"	4'-2"	4'-6"	4'-3"	5'-2"
200	4'-4"	4'-8"	5'-0"	5'-4"	5'-1"	6'-0"
220	5'-3"	5'-7"	6'-0"	6'-3"	6'-0"	7'-0"
240	6'-3"	6'-8"	7'-0"	7'-4"	7'-1"	8'-1"
260	7'-4"	7'-9"	8'-1"	8'-5"	8'-2"	9'-3"
280	8'-6"	8'-11"	9'-3"	9'-8"	9'-5"	10'-5"
300	9'-10"	10'-2"	10'-7"	10'-11"	10'-8"	11'-9"
320	11'-2"	11'-7"	11'-11"	12'-4"	12'-1"	13'-2"
340	12'-8"	13'-0"	13'-5"	13'-9"	13'-6"	14'-7"
360	14'-2"	14'-7"	14'-11"	15'-4"	15'-1"	16'-2"
380	15'-10"	16'-3"	16'-7"	17'-0"	16'-9"	17'-10"
400	17'-7"	17'-11"	18'-4"	18'-8"	18'-6"	19'-7"
420	19'-5"	19'-9"	20'-2"	20'-6"	20'-3"	21'-5"
440	21'-4"	21'-8"	22'-1"	22'-5"	22'-3"	23'-4"
460	23'-4"	23'-8"	24'-1"	24'-6"	24'-3"	25'-5"
480	25'-5"	25'-10"	26'-2"	26'-7"	26'-4"	27'-6"
500	27'-7"	28'-0"	28'-5"	28'-9"	28'-6"	29'-8"

Table CO 166–5: Tension — Temperature Stringing Table 35 kV 654 ACSR Covered Conductor for Heavy-Loading Areas

Span (ft)	Tension (lb)					
	Initial Stringing Tension				Final Tension	
	50°F	70°F	90°F	110°F	70°F	130°F
100	1,358	1,105	942	829	949	698
120	1,395	1,182	1,035	928	1,031	774
140	1,414	1,236	1,106	1,007	1,096	854
160	1,424	1,275	1,161	1,071	1,147	923
180	1,429	1,304	1,204	1,123	1,188	982
200	1,431	1,325	1,238	1,165	1,221	1,033
220	1,432	1,341	1,264	1,199	1,248	1,076
240	1,432	1,353	1,286	1,227	1,270	1,114
260	1,431	1,363	1,303	1,250	1,288	1,146
280	1,430	1,371	1,318	1,270	1,303	1,174
300	1,429	1,377	1,330	1,287	1,316	1,198
320	1,428	1,382	1,340	1,301	1,327	1,219
340	1,428	1,386	1,348	1,313	1,336	1,237
360	1,427	1,390	1,355	1,323	1,344	1,253
380	1,426	1,393	1,361	1,332	1,351	1,268
400	1,425	1,395	1,367	1,340	1,357	1,280
420	1,425	1,397	1,371	1,347	1,363	1,291
440	1,424	1,399	1,375	1,353	1,367	1,301
460	1,424	1,401	1,379	1,358	1,371	1,310
480	1,423	1,402	1,382	1,363	1,375	1,318
500	1,423	1,404	1,385	1,367	1,378	1,325

Note(s): This table shall not be used for new installation or re-conductoring.

1.0 Guying

Conductor tensions for guying 653.9 Covered Conductor is 3,267 lb.

2.0 Ground Clearance

Use 130°F sags when calculating conductor-to-ground clearances.

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CO 168 Reduce Tension Span Sag Charts — Directions for Use

Scope CO 168.1 Directions for Use of Sag Charts

Unguyed (or Slack) Spans may be considered when the use of downguys or span guys is not feasible. The resultant (bending) moment created by the unguyed strain must be equaled or exceeded by the usable pole strength. A breast block and pole key (PO Section) must be installed on all unguyed dead-end and angle poles.

Reduced tension unguyed spans where the resultant moment exceeds either the usable pole strength or the pole key resisting moment based on the soil condition, the strain should be guyed or the resultant moment reduced. The moment may be reduced by reducing the height of the conductors while maintaining General Order 95 (G.O. 95) clearances.

Reduced tension guyed spans may be considered when a full tension down guy lead is not feasible (that is, easement issue, obstruction).

Three types of tables are presented in this section:

1.0 Sag Charts — These tables provide stringing sags for installation of conductors.

2.0 Stringing Tension Table — These tables are For Reference Only and shall not be used for new installation or re-conductoring.

3.0 Span Tension Tables — These tables provide Guyed or Unguyed span tensions to be used for hand calculations. Unguyed span tensions are to be used for breast block and key load calculations. Guyed span tensions are to be used for down guy calculations.

Reduced tension Span Tensions have been determined by engineering in the following Tension Table and Figures. Table CO 168–36 and Table CO 168–40 are used to illustrate and document the values used in SPIDA. Only commonly used conductors and sizes are represented in the tables as examples, though all conductors and sizes are in SPIDA.

Figure CO 168–1: Reduced Tension Unguyed Span Example

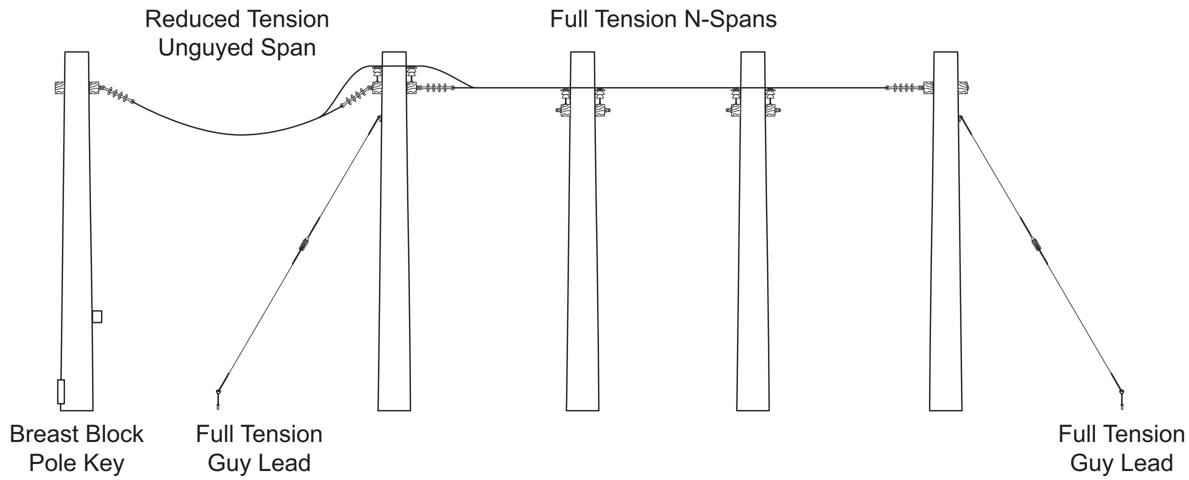

Figure CO 168–2: Reduced Tension Guyed Span Example

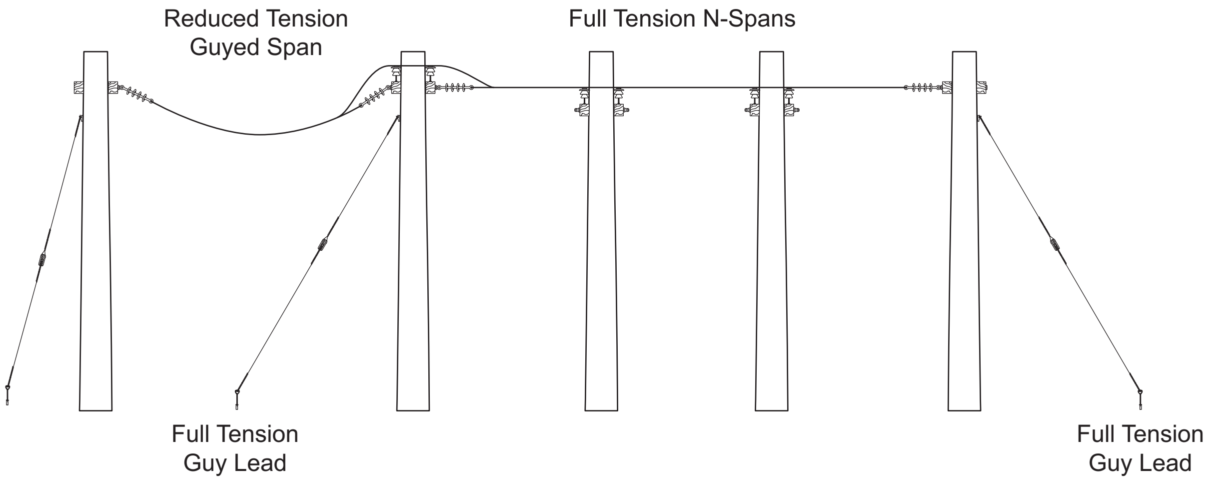

Table CO 168–1: Percent Full Tension of Conductor Light-Loading Areas

Bare ACSR Conductor			
	0–120 feet	121–160 feet	161–200 feet
Guyed new and existing	20%	20%	20%
Unguyed existing[a/]	10%	10%	—[b/]
Unguyed new	10%	N/A	N/A
Bare Copper Conductor			
	0–120 feet	121–160 feet	161–200 feet
Guyed new and existing	15%	30%	30%
Unguyed existing[b/]	15%	30%	—[b/]
Unguyed new	15%	N/A	N/A
ACSR MultiPlex Conductor			
	0–120 feet	121–160 feet	161–200 feet
Guyed new and existing	50%	50%	—[c/]
Unguyed existing[b/]	25%	50%	—[c/]
Unguyed new	25%	N/A	N/A

a/ This includes existing construction that requires rebuilding or pole replacement. When practicable, consider adding a guy (reduced tension) to the pole or additional poles to reduce span lengths.
b/ Unguyed existing and rebuild spans for all conductor sizes exceeding 160 feet shall be guyed and considered reduced tension guyed spans.
c/ All multiplex conductor sizes exceeding 160 feet shall be full tension and guyed.

Note(s):

1. This table applies to reduced tension guyed and reduced tension unguyed spans. See Figure CO 168–1 and Figure CO 168–2, other deign configurations may apply.
2. ACSR and Copper Covered Conductors are not included in Table CO 168–1 because their reduced sags are calculated through a different method, making the information given in Table CO 168–1 not applicable.

Table CO 168–2: Percent Full Tension of Conductor Heavy — Loading Areas

Bare ACSR Conductor			
	Size	0–120 feet	121–160 feet
Guyed new and existing	#4 – 1/0	50%	50%
	336 – 653	25%	25%
Unguyed existing[a/]	#4 – 1/0	50%	50%
	336 – 653	25%	25%
Unguyed new	#4 – 1/0	50%	N/A
	336 – 653	25%	N/A
Bare Copper Conductor			
	Size	0–120 feet	121–160 feet
Guyed new and existing	#6 – #2	70%	70%
	2/0	40%	40%
	4/0	30%	30%
Unguyed existing[a/]	#6 – #2	70%	70%
	2/0	40%	40%
	4/0	30%	30%
Unguyed new	#6 – #2	70%	N/A
	2/0	40%	N/A
	4/0	30%	N/A
Aluminum Duplex (AD) and Aluminum Triplex (AT) Conductor			
	Size	0–120 feet	121–160 feet
Guyed new and existing	#6 AD – #2 AT	75%	75%
	1/0 AT	50%	50%
	4/0 AT	30%	30%
Unguyed existing and rebuild[a/]	#6 AD – #2 AT	75%	75%
	1/0 AT	50%	50%
	4/0 AT	30%	30%
Unguyed new	#6 AD – #2 AT	75%	N/A
	1/0 AT	50%	N/A
	4/0 AT	30%	N/A
Aluminum Quadruplex (AQ) Conductor			
	Size	0–120 feet	121–160 feet
Guyed new and existing	#4	75%	75%
	1/0	50%	50%
	4/0	30%	30%
Unguyed existing[a/]	#4	75%	75%
	1/0	50%	50%
	4/0	30%	30%
Unguyed new	#4	75%	N/A
	1/0	50%	N/A
	4/0	30%	N/A

[a/] This includes existing construction that requires rebuilding or pole replacement. When practicable, consider adding a guy (reduced tension) to the pole or additional poles to reduce span lengths.

Note(s):

1. This table applies to reduced tension guyed and reduced tension unguyed spans. See Figure CO 168–1 and Figure CO 168–2, other deign configurations may apply.
2. ACSR and Copper Covered Conductors are not included in Table CO 168–2 because their reduced sags are calculated through a different method, making the information given in Table CO 168–2 not applicable.

Scope CO 168.2 Sag Chart for New and Existing Reduced Tension Guyed Primary #4 — 653 ACSR for Light-Loading Areas

Table CO 168–3: Sag Chart for New and Existing Reduced Tension Guyed Primary #4 — 653 ACSR for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
#4 ACSR[a/]	60	1'-0"	1'-2"
	80	1'-6"	1'-7"
	100	2'-0"	2'-6"
	120	3'-0"	3'-4"
	140	4'-0"	4'-1"
	160	5'-0"	5'-4"
	180	6'-0"	6'-6"
	200	7'-6"	8'-0"
1/0 ACSR	60	1'-0"	1'-2"
	80	1'-6"	1'-7"
	100	2'-0"	2'-6"
	120	2'-6"	2'-8"
	140	3'-0"	3'-6"
	160	3'-6"	4'-3"
	180	4'-6"	5'-4"
	200	5'-6"	6'-4"
336 ACSR	60	1'-0"	1'-2"
	80	1'-6"	1'-7"
	100	2'-0"	2'-6"
	120	2'-6"	2'-8"
	140	3'-0"	3'-6"
	160	3'-6"	4'-3"
	180	4'-6"	5'-4"
	200	5'-6"	6'-4"
653 ACSR	60	1'-0"	1'-2"
	80	1'-6"	2'-0"
	100	2'-0"	2'-6"
	120	3'-0"	3'-6"
	140	4'-0"	4'-6"
	160	5'-0"	5'-6"
	180	6'-0"	6'-8"
	200	7'-6"	8'-4"

[a/] Not approved for new construction.

Note(s):

1. Use on all 2.4 kV through 33 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

1.0 Guyed Span Tensions

1.1 Conductor Tensions for Guying are 20 Percent of Full Tension for 0 to 200 Feet

- Conductor tension for guying #4 ACSR is 120 lb
- Conductor tension for guying 1/0 ACSR is 285 lb
- Conductor tension for guying 336 ACSR is 570 lb
- Conductor tension for guying 653 ACSR is 653 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.3 Sag Chart for New and Existing Reduced Tension Guyed Primary 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas

Table CO 168–4: Sag Chart for New and Existing Reduced Tension Guyed Primary 17 kV 1/0 — 653 ACSR Covered Conductors for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
1/0 ACSR	50	2'-0"	2'-1"
	75	3'-0"	3'-2"
	100	3'-5"	3'-9"
	125	4'-4"	4'-9"
	150	5'-2"	5'-8"
	175	6'-0"	6'-7"
	200	6'-9"	7'-7"
336 ACSR	50	2'-0"	2'-1"
	75	3'-0"	3'-2"
	100	3'-6"	3'-10"
	125	4'-4"	4'-10"
	150	5'-2"	5'-10"
	175	6'-0"	6'-10"
	200	6'-10"	7'-10"
653 ACSR	50	2'-0"	2'-2"
	75	3'-0"	3'-3"
	100	3'-6"	3'-10"
	125	4'-4"	4'-10"
	150	5'-2"	5'-10"
	175	6'-0"	6'-10"
	200	6'-10"	7'-10"

Note(s):

1. Use on all 2.4 kV through 17 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

Table CO 168–5: Stringing Tension Table for New and Existing Reduced Tension Guyed Primary 17 kV 1/0 — 653 ACSR Covered Conductors for Light-Loading Areas

Conductor Type	Span (ft)	Initial Tension	Final Tension (lb)
		50–110°F	130°F
1/0 ACSR	50	45	43
	75	68	64
	100	104	95
	125	130	118
	150	156	142
	175	183	165
	200	210	189
336 ACSR	50	91	86
	75	136	127
	100	208	188
	125	261	232
	150	314	277
	175	367	323
	200	420	370
653 ACSR	50	154	144
	75	231	215
	100	353	320
	125	443	397
	150	533	474
	175	624	549
	200	715	626
Note(s): This table shall not be used for new installation or re-conductoring.			

Table CO 168–6: Sag Chart for New and Existing Reduced Tension Guyed Primary 35 kV 1/0 — 653 ACSR Covered Conductors for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
1/0 ACSR	50	2'-0"	2'-1"
	75	3'-0"	3'-2"
	100	3'-5"	3'-10"
	125	4'-3"	4'-9"
	150	5'-1"	5'-9"
	175	5'-11"	6'-8"
	200	6'-9"	7'-8"
336 ACSR	50	2'-0"	2'-2"
	75	3'-0"	3'-3"
	100	3'-6"	3'-11"
	125	4'-4"	4'-11"
	150	5'-2"	5'-10"
	175	5'-10"	6'-8"
	200	6'-8"	7'-7"
653 ACSR	50	2'-0"	2'-2"
	75	3'-0"	3'-3"
	100	3'-6"	3'-10"
	125	4'-4"	4'-10"
	150	5'-2"	5'-11"
	175	6'-0"	6'-10"
	200	6'-10"	7'-10"

Table CO 168–7: Stringing Tension Table for New and Existing Reduced Tension Guyed Primary 35 kV 1/0 — 653 ACSR Covered Conductors for Light-Loading Areas

Conductor Type	Span (ft)	Initial Tension	Final Tension (lb)
		50–110°F	130°F
1/0 ACSR	50	73	69
	75	110	102
	100	168	152
	125	211	190
	150	255	227
	175	299	265
	200	344	302
336 ACSR	50	127	119
	75	191	177
	100	292	259
	125	367	323
	150	442	388
	175	527	466
	200	605	533
653 ACSR	50	195	183
	75	294	273
	100	450	404
	125	565	501
	150	681	597
	175	798	697
	200	916	797
Note(s): This table shall not be used for new installation or re-conductoring.			

1.0 Guyed Span Tensions

Table CO 168–8: Guyed Span Tensions: 17 kV 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR	50	94
	75	140
	100	215
	125	267
	150	320
	175	371
	200	423
336 ACSR	50	148
	75	222
	100	342
	125	426
	150	511
	175	594
	200	678
653 ACSR	50	218
	75	326
	100	504
	125	629
	150	754
	175	878
	200	1002

Table CO 168–9: Guyed Span Tensions: 35 kV 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR	50	137
	75	204
	100	312
	125	387
	150	463
	175	537
	200	611
336 ACSR	50	198
	75	296
	100	456
	125	568
	150	680
	175	1506
	200	1708
653 ACSR	50	271
	75	406
	100	626
	125	782
	150	937
	175	1091
	200	1245

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.4 Sag Chart for New and Existing Reduced Tension Guyed Primary #6 — 4/0 Copper for Light-Loading Areas

Table CO 168–10: Sag Chart for New and Existing Reduced Tension Guyed Primary #6 — 4/0 Copper for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#6 Copper	60	1'-6"	1'-8"
	80	2'-6"	2'-8"
	100	3'-6"	4'-0"
	120	5'-0"	6'-0"
	140	4'-0"	4'-2"
	160	5'-0"	5'-6"
	180	6'-0"	6'-10"
	200	7'-6"	8'-3"
#4 Copper	60	1'-6"	1'-6"
	80	2'-6"	2'-8"
	100	3'-6"	4'-0"
	120	5'-6"	5'-6"
	140	3'-6"	4'-0"
	160	4'-6"	4'-4"
	180	6'-0"	6'-6"
	200	7'-0"	7'-8"
#2 Copper	60	1'-6"	1'-7"
	80	2'-6"	2'-6"
	100	3'-6"	3'-7"
	120	4'-6"	5'-0"
	140	3'-6"	4'-0"
	160	4'-6"	5'-0"
	180	5'-6"	6'-0"
	200	6'-6"	7'-2"
2/0 Copper	60	1'-6"	1'-7"
	80	2'-0"	2'-1"
	100	3'-0"	3'-1"
	120	4'-6"	4'-7"
	140	3'-6"	3'-8"
	160	4'-0"	4'-6"
	180	5'-0"	5'-6"
	200	6'-0"	6'-6"
4/0 Copper	60	1'-6"	1'-6"
	80	2'-0"	2'-0"
	100	3'-0"	3'-1"
	120	4'-6"	4'-7"
	140	3'-6"	3'-8"
	160	4'-0"	4'-6"
	180	4'-6"	5'-6"
	200	6'-0"	6'-6"

Note(s):

1. Use on all 2.4 kV through 33 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

1.0 Guyed Span Tensions

1.1 Conductor Tensions for Guying are 15 Percent of Full Tension for 60 to 120 Feet

- Conductor tension for guying #6 Copper is 45 lb
- Conductor tension for guying #4 Copper is 73 lb
- Conductor tension for guying #2 Copper is 115 lb
- Conductor tension for guying 2/0 Copper is 223 lb
- Conductor tension for guying 4/0 Copper is 345 lb

1.2 Conductor Tensions for Guying are 30 Percent of Full Tension for 121 to 200 Feet

- Conductor tension for guying #6 Copper is 90 lb
- Conductor tension for guying #4 Copper is 145 lb
- Conductor tension for guying #2 Copper is 228 lb
- Conductor tension for guying 2/0 Copper is 445 lb
- Conductor tension for guying 4/0 Copper is 685 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.5 Sag Chart for New and Existing Reduced Tension Guyed Primary #2 — 4/0 Copper Covered Conductor for Light Loading Areas

Table CO 168–11: Sag Chart for New and Existing Reduced Tension Guyed Primary 17 kV #2 — 4/0 Copper Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
#2 Copper	50	2'-0"	2'-2"
	75	3'-0"	3'-3"
	100	3'-6"	3'-10"
	125	4'-4"	4'-9"
	150	5'-2"	5'-9"
	175	6'-0"	6'-8"
	200	6'-11"	7'-8"
2/0 Copper	50	2'-0"	2'-2"
	75	3'-0"	3'-3"
	100	3'-6"	3'-10"
	125	4'-4"	4'-9"
	150	5'-3"	5'-9"
	175	6'-1"	6'-8"
	200	6'-11"	7'-8"
4/0 Copper	50	2'-0"	2'-2"
	75	3'-0"	3'-3"
	100	3'-6"	3'-10"
	125	4'-4"	4'-9"
	150	5'-3"	5'-9"
	175	6'-1"	6'-8"
	200	6'-11"	7'-8"

Note(s):

1. Use on all 2.4 kV through 17 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

Table CO 168–12: Stringing Tension Table for New and Existing Reduced Tension Guyed Primary 17 kV #2 — 4/0 Copper Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Initial Tension (lb)	Final Tension (lb)
		50–110°F	130°F
#2 Copper	50	50	46
	75	75	70
	100	115	104
	125	144	130
	150	173	156
	175	202	182
	200	232	208
2/0 Copper	50	88	81
	75	132	122
	100	201	182
	125	251	228
	150	302	274
	175	352	319
	200	403	365
4/0 Copper	50	131	121
	75	196	182
	100	299	272
	125	374	340
	150	449	408
	175	524	476
	200	599	544
Note(s): This table shall not be used for new installation or re-conductoring.			

1.0 Guyed Span Tensions

Table CO 168–13: Guyed Span Tensions: 17 kV #2 — 4/0 Copper Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
#2 Copper	50	87
	75	130
	100	198
	125	247
	150	295
	175	343
	200	391
2/0 Copper	50	123
	75	184
	100	283
	125	353
	150	423
	175	492
	200	562
4/0 Copper	50	165
	75	248
	100	381
	125	476
	150	570
	175	665
	200	759

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.6 Sag Chart for New and Existing Reduced Tension Guyed #6 — 1/0 Aluminum Duplex and Triplex for Light-Loading Areas

Table CO 168–14: Sag Chart for New and Existing Reduced Tension Guyed #6 — 1/0 Aluminum Duplex and Triplex for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#6 Aluminum Duplex	60	8"	1'-0"
	80	1'-2"	1'-7"
	100	1'-10"	2'-4"
	120	2'-9"	3'-4"
	140	3'-9"	4'-4"
	160	5'-0"	5'-6"
#4 Aluminum Duplex	60	6"-0"	1'-0"
	80	1'-0"	1'-6"
	100	1'-6"	2'-2"
	120	2'-4"	2'-10"
	140	3'-2"	3'-10"
	160	4'-0"	4'-10"
#4 Aluminum Triplex	60	8"-0"	1'-1"
	80	1'-2"	1'-9"
	100	1'-10"	2'-6"
	120	2'-9"	3'-4"
	140	3'-9"	4'-4"
	160	4'-10"	5'-6"
#2 Aluminum Triplex	60	10"-0"	1'-1"
	80	1'-4"	1'-10"
	100	2'-0"	2'-6"
	120	2'-10"	3'-6"
	140	3'-10"	4'-6"
	160	5'-0"	5'-6"
1/0 Aluminum Triplex	60	7"-0"	1'-0"
	80	1'-0"	1'-6"
	100	1'-6"	2'-2"
	120	2'-0"	2'-10"
	140	2'-10"	3'-8"
	160	3'-6"	4'-7"

1.0 Guyed Span Tensions

1.1 Conductor Tensions for Guying are 50 Percent of Full Tension for 0 to 160 Feet

- Conductor tension for guying #6 Aluminum Duplex is 193 lb
- Conductor tension for guying #4 Aluminum Duplex is 302 lb
- Conductor tension for guying #4 Aluminum Triplex is 302 lb
- Conductor tension for guying #2 Aluminum Triplex is 380 lb
- Conductor tension for guying 1/0 Aluminum Triplex is 707 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.7 Sag Chart for New and Existing Reduced Tension Guyed #4 — 4/0 Aluminum Quadruplex for Light-Loading Areas

Table CO 168–15: Sag Chart for New and Existing Reduced Tension Guyed #4 — 4/0 Aluminum Quadruplex for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
#4 Aluminum Quadruplex	60	10"-0"	1'-3"
	80	1'-6"	2'-0"
	100	2'-3"	2'-10"
	120	3'-3"	3'-10"
	140	4'-4"	5'-0"
	160	5'-9"	6'-4"
#1/0 Aluminum Quadruplex	60	8"-0"	1'-4"
	80	1'-2"	1'-9"
	100	1'-9"	2'-6"
	120	2'-6"	3'-10"
	140	3'-6"	4'-2"
	160	4'-6"	5'-2"
#4/0 Aluminum Quadruplex	60	7"-0"	1'-0"
	80	1'-0"	1'-7"
	100	1'-6"	2'-3"
	120	2'-2"	3'-0"
	140	2'-10"	3'-9"
	160	3'-8"	4'-7"

1.0 Guying Span Tensions

1.1 Conductor Tensions for Guying are 50 Percent of Full Tension for 0 to 160 Feet

- Conductor tension for guying #4 Aluminum Quadruplex is 302 lb
- Conductor tension for guying 1/0 Aluminum Quadruplex is 707 lb
- Conductor tension for guying 4/0 Aluminum Quadruplex is 1,390 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.8 Sag Chart for New Reduced Tension Unguyed #4 — 653 ACSR for Light-Loading Areas

Table CO 168–16: Sag Chart for New Reduced Tension Unguyed #4 — 653 ACSR for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#4 ACSR[a/]	60	1'-6"	1'-8"
	80	2'-6"	2'-9"
	100	4'-0"	4'-1"
	120	5'-6"	5'-8"
1/0 ACSR	60	1'-6"	1'-7"
	80	2'-0"	2'-3"
	100	3'-0"	3'-3"
	120	4'-0"	4'-5"
336 ACSR	60	1'-6"	1'-7"
	80	2'-0"	2'-3"
	100	3'-0"	3'-3"
	120	4'-0"	4'-5"
653 ACSR	60	1'-6"	1'-9"
	80	2'-6"	2'-9"
	100	4'-0"	4'-1"
	120	5'-6"	5'-8"

[a/] Not approved for new construction.

Note(s):

1. Use on all 2.4 kV through 33 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

1.0 New Unguyed Span Tensions

1.1 Conductor Tensions are 10 Percent of Full Tension for 0 to 120 Feet

- Conductor tension for #4 ACSR is 60 lb
- Conductor tension for 1/0 ACSR is 142 lb
- Conductor tension for 336 ACSR is 285 lb
- Conductor tension for 653 ACSR is 327 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.9 Sag Chart for New Reduced Tension Unguyed 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas

Table CO 168–17: Sag Chart for New Reduced Tension Unguyed 17 kV 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
1/0 ACSR	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-7"
	125	9'-4"	9'-6"
336 ACSR	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
653 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"

Note(s):

1. Use on all 2.4 kV through 17 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

Table CO 168–18: Stringing Tension Table for New Reduced Tension Unguyed 17 kV 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Initial Tension	Final Tension
		50–110°F	130°F
1/0 ACSR	50	24	24
	75	36	36
	100	49	48
	125	61	60
336 ACSR	50	49	48
	75	74	72
	100	98	96
	125	123	120
653 ACSR	50	83	82
	75	125	123
	100	167	163
	125	208	204
Note(s): This table shall not be used for new installation or re-conductoring.			

Table CO 168–19: Sag Chart for New Reduced Tension Unguyed 35 kV 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
1/0 ACSR	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-7"
	125	9'-4"	9'-6"
336 ACSR	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
653 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"

Table CO 168–20: Stringing Tension Table for New Reduced Tension Unguyed 35 kV 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Initial Tension 50–110°F	Final Tension 130°F
1/0 ACSR	50	39	39
	75	59	58
	100	79	77
	125	98	96
336 ACSR	50	69	68
	75	103	101
	100	137	135
	125	172	168
653 ACSR	50	106	104
	75	159	156
	100	212	207
	125	265	259

Note(s): This table shall not be used for new installation or re-conductoring.

What's Changed? Made For Reference Only.

Approved by: RR

Effective Date: 04-30-2021

1.0 New Unguyed Span Tensions

Table CO 168–21: New Unguyed Span Tensions: 17 kV 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR	50	49
	75	74
	100	99
	125	124
336 ACSR	50	77
	75	116
	100	155
	125	194
653 ACSR	50	114
	75	171
	100	227
	125	284

Table CO 168–22: New Unguyed Span Tensions: 35 kV 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR	50	72
	75	108
	100	144
	125	180
336 ACSR	50	104
	75	155
	100	207
	125	259
653 ACSR	50	142
	75	212
	100	283
	125	354

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.10 Sag Chart for New Reduced Tension Unguyed #6 — 4/0 Copper for Light-Loading Areas

Table CO 168–23: Sag Chart for New Reduced Tension Unguyed #6 — 4/0 Copper for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#6 Copper	60	1'-6"	1'-8"
	80	2'-6"	2'-8"
	100	3'-6"	4'-0"
	120	5'-0"	6'-0"
#4 Copper	60	1'-6"	1'-6"
	80	2'-6"	2'-8"
	100	3'-6"	4'-0"
	120	5'-6"	5'-6"
#2 Copper	60	1'-6"	1'-7"
	80	2'-6"	2'-6"
	100	3'-6"	3'-7"
	120	4'-6"	5'-0"
2/0 Copper	60	1'-6"	1'-7"
	80	2'-0"	2'-1"
	100	3'-0"	3'-1"
	120	4'-6"	4'-7"
4/0 Copper	60	1'-6"	1'-6"
	80	2'-0"	2'-0"
	100	3'-0"	3'-1"
	120	4'-6"	4'-7"

Note(s):

1. Use on all 2.4 kV through 33 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

1.0 New Unguyed Span Tensions

1.1 Conductor Tensions are 15 Percent of Full Tension for 0 to 120 Feet

- Conductor tension for #6 Copper is 45 lb
- Conductor tension for #4 Copper is 73 lb
- Conductor tension for #2 Copper is 115 lb
- Conductor tension for 2/0 Copper is 223 lb
- Conductor tension for 4/0 Copper is 345 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.11 Sag Chart for New Reduced Tension Unguyed #2 — 4/0 Copper Covered Conductor for Light-Loading Areas

Table CO 168–24: Sag Chart for New Reduced Tension Unguyed 17 kV #2 — 4/0 Copper Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
#2 Copper	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
2/0 Copper	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
2/0 Copper	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"

Note(s):

1. Use on all 2.4 kV through 17 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

Table CO 168–25: Stringing Tension Table for New Reduced Tension Unguyed 17 kV #2 — 4/0 Copper Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Initial Tension	Final Tension
		50–110°F	130°F
#2 Copper	50	27	26
	75	41	40
	100	54	53
	125	68	66
2/0 Copper	50	47	46
	75	71	70
	100	95	93
	125	119	116
2/0 Copper	50	71	69
	75	106	104
	100	141	138
	125	177	173
Note(s): This table shall not be used for new installation or re-conductoring.			

1.0 New Unguyed Span Tensions

Table CO 168–26: New Unguyed Span Tensions: 17 kV #2 — 4/0 Copper Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
#2 Copper	50	46
	75	69
	100	92
	125	114
2/0 Copper	50	65
	75	97
	100	130
	125	162
4/0 Copper	50	87
	75	131
	100	174
	125	218

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.12 Sag Chart for New Reduced Tension Unguyed #6 — 1/0 Aluminum Duplex and Triplex for Light-Loading Areas

Table CO 168–27: Sag Chart for New Reduced Tension Unguyed #6 — 1/0 Aluminum Duplex and Triplex for Light- Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#6 Aluminum Duplex	60	1'-6"	1'-8"
	80	2'-6"	2'-10"
	100	4'-0"	4'-6"
	120	5'-6"	6'-0"
#4 Aluminum Duplex	60	1'-6"	1'-7"
	80	2'-6"	2'-6"
	100	3'-6"	3'-7"
	120	4'-6"	5'-0"
#4 Aluminum Triplex	60	1'-6"	1'-8"
	80	2'-6"	2'-7"
	100	4'-0"	4'-2"
	120	5'-6"	6'-0"
#2 Aluminum Triplex	60	1'-6"	1'-8"
	80	2'-6"	4'-0"
	100	4'-0"	4'-2"
	120	5'-6"	6'-0"
1/0 Aluminum Triplex	60	1'-6"	1'-7"
	80	2'-0"	2'-2"
	100	3'-0"	3'-3"
	120	4'-0"	4'-6"

1.0 New Unguyed Span Tensions

1.1 Conductor Tensions are 25 Percent of Full Tension for 0 to 120 Feet

- Conductor tension for #6 Aluminum Duplex is 97 lb
- Conductor tension for #4 Aluminum Duplex is 150 lb
- Conductor tension for #4 Aluminum Triplex is 150 lb
- Conductor tension for #2 Aluminum Triplex is 355 lb
- Conductor tension for 1/0 Aluminum Triplex is 695 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.13 Sag Chart for New Reduced Tension Unguyed #4 — 4/0 Aluminum Quadruplex for Light-Loading Areas

Table CO 168–28: Sag Chart for New Reduced Tension Unguyed #4 — 4/0 Aluminum Quadruplex for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#4 Aluminum Quadruplex	60	1'-6"	1'-10"
	80	3'-0"	3'-2"
	100	4'-6"	4'-8"
	120	6'-6"	6'-10"
#1/0 Aluminum Quadruplex	60	1'-0"	1'-7"
	80	2'-6"	2'-7"
	100	3'-5"	3'-9"
	120	5'-0"	5'-3"
#4/0 Aluminum Quadruplex	60	1'-6"	1'-7"
	80	2'-0"	2'-3"
	100	3'-0"	3'-3"
	120	4'-0"	4'-5"

1.0 New Unguyed Span Tensions

1.1 Conductor Tensions are 25 Percent of Full Tension for 0 to 120 Feet

- Conductor tension for #4 Aluminum Quadruplex is 150 lb
- Conductor tension for 1/0 Aluminum Quadruplex is 355 lb
- Conductor tension for 4/0 Aluminum Quadruplex is 695 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.14 Sag Chart for Existing and Rebuild Reduced Tension Unguyed #4 — 653 ACSR for Light-Loading Areas

Table CO 168–29: Sag Chart for Existing and Rebuild Reduced Tension Unguyed #4 — 653 ACSR for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#4 ACSR[a/]	60	1'-6"	1'-8"
	80	2'-6"	2'-9"
	100	4'-0"	4'-1"
	120	5'-6"	5'-8"
	140	7'-6"	7'-7"
	160	9'-6"	9'-7"
1/0 ACSR	60	1'-6"	1'-7"
	80	2'-0"	2'-3"
	100	3'-0"	3'-3"
	120	4'-0"	4'-5"
	140	5'-6"	5'-8"
	160	7'-0"	7'-2"
336 ACSR	60	1'-6"	1'-7"
	80	2'-0"	2'-3"
	100	3'-0"	3'-3"
	120	4'-0"	4'-5"
	140	5'-6"	5'-7"
	160	7'-0"	7'-2"
653 ACSR	60	1'-6"	1'-9"
	80	2'-6"	2'-9"
	100	4'-0"	4'-1"
	120	5'-6"	5'-8"
	140	7'-0"	7'-2"
	160	9'-6"	9'-8"

[a/] Not approved for new construction.

Note(s):

1. Use on all 2.4 kV through 33 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

1.0 Existing and Rebuild Unguyed Span Tensions

1.1 Conductor Tensions are 10 Percent of Full Tension for 0 to 160 Feet

- Conductor tension for #4 ACSR is 60 lb
- Conductor tension for 1/0 ACSR is 142 lb
- Conductor tension for 336 ACSR is 285 lb
- Conductor tension for 653 ACSR is 327 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.15 Sag Chart for Existing and Rebuild Reduced Tension Unguyed 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas

Table CO 168–30: Sag Chart for Existing and Rebuild Reduced Tension Unguyed 17 kV 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
1/0 ACSR	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-7"
	125	9'-4"	9'-6"
	150	10'-10"	11'-1"
	175	12'-2"	12'-6"
336 ACSR	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
	150	10'-10"	11'-1"
	175	12'-3"	12'-7"
653 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
	150	10'-10"	11'-2"
	175	12'-3"	12'-7"

Note(s):

1. Use on all 2.4 kV through 17 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

Table CO 168–31: Stringing Tension Table for Existing and Rebuild Reduced Tension Unguyed 17 kV 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas

FOR REFERENCE ONLY

Conductor Type	Span (ft)	Initial Tension (lb)	Final Tension (lb)
		50–110°F	130°F
1/0 ACSR	50	24	24
	75	36	36
	100	49	48
	125	61	60
	150	75	74
	175	91	89
336 ACSR	50	49	48
	75	74	72
	100	98	96
	125	123	120
	150	152	149
	175	184	179
653 ACSR	50	83	82
	75	125	123
	100	167	163
	125	208	204
	150	258	252
	175	312	304

Note(s): This table shall not be used for new installation or re-conductoring.

Table CO 168–32: Sag Chart for Existing and Rebuild Reduced Tension Unguyed 35 kV 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
1/0 ACSR	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-7"
	125	9'-4"	9'-6"
	150	10'-10"	11'-1"
	175	12'-2"	12'-6"
336 ACSR	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
	150	10'-10"	11'-2"
	175	12'-3"	12'-8"
653 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
	150	10'-10"	11'-2"
	175	12'-3"	12'-7"

Table CO 168–33: Stringing Tension Table for Existing and Rebuild Reduced Tension Unguyed 35 kV 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Initial Tension (lb)	Final Tension (lb)
		50–110°F	130°F
1/0 ACSR	50	39	39
	75	59	58
	100	79	77
	125	98	96
	150	122	119
	175	147	144
336 ACSR	50	103	101
	75	137	135
	100	172	168
	125	213	207
	150	257	249
	175	103	101
653 ACSR	50	106	104
	75	159	156
	100	212	207
	125	265	259
	150	328	320
	175	397	385
Note(s): This table shall not be used for new installation or re-conductoring.			

1.0 Existing and Rebuild Unguyed Span Tension

Table CO 168–34: Existing and Rebuild Unguyed Span Tensions: 17 kV 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR	50	49
	75	74
	100	99
	125	124
	150	153
	175	185
336 ACSR	50	77
	75	116
	100	155
	125	194
	150	240
	175	290
653 ACSR	50	114
	75	171
	100	227
	125	284
	150	353
	175	426

Table CO 168–35: Existing and Rebuild Unguyed Span Tensions: 35 kV 1/0 Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR	50	72
	75	108
	100	144
	125	180
	150	223
	175	269
336 ACSR	50	104
	75	155
	100	207
	125	259
	150	321
	175	387
653 ACSR	50	142
	75	212
	100	283
	125	354
	150	439
	175	530

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.16 Sag Chart for Existing and Rebuild Reduced Tension Unguyed #6 — 4/0 Copper for Light-Loading Areas

Table CO 168–36: Sag Chart for Existing and Rebuild Reduced Tension Unguyed #6 — 4/0 Copper for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#6 Copper	60	1'-6"	1'-8"
	80	2'-6"	2'-8"
	100	3'-6"	4'-0"
	120	5'-0"	6'-0"
	140	4'-0"	4'-2"
	160	5'-0"	5'-6"
#4 Copper	60	1'-6"	1'-6"
	80	2'-6"	2'-8"
	100	3'-6"	4'-0"
	120	5'-6"	5'-6"
	140	3'-6"	4'-0"
	160	4'-6"	5'-4"
#2 Copper	60	1'-6"	1'-7"
	80	2'-6"	2'-6"
	100	3'-6"	3'-7"
	120	4'-6"	5'-0"
	140	3'-6"	4'-0"
	160	4'-6"	5'-0"
2/0 Copper	60	1'-6"	1'-7"
	80	2'-0"	2'-1"
	100	3'-0"	3'-1"
	120	4'-6"	4'-7"
	140	3'-6"	3'-8"
	160	4'-0"	4'-6"
4/0 Copper	60	1'-6"	1'-6"
	80	2'-0"	2'-0"
	100	3'-0"	3'-1"
	120	4'-6"	4'-7"
	140	3'-6"	3'-8"
	160	4'-0"	4'-6"

Note(s):

1. Use on all 2.4 kV through 33 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

1.0 Existing and Rebuild Unguyed Span Tensions

1.1 Conductor Tensions are 15 Percent of Full Tension for 60 to 120 Feet

- Conductor tension for #6 Copper is 45 lb
- Conductor tension for #4 Copper is 73 lb
- Conductor tension for #2 Copper is 115 lb
- Conductor tension for 2/0 Copper is 223 lb
- Conductor tension for 4/0 Copper is 345 lb

1.2 Conductor Tensions are 30 Percent of Full Tension for 121 to 200 Feet

- Conductor tension for #6 Copper is 90 lb
- Conductor tension for #4 Copper is 145 lb
- Conductor tension for #2 Copper is 228 lb
- Conductor tension for 2/0 Copper is 445 lb
- Conductor tension for 4/0 Copper is 685 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.17 Sag Chart for Existing and Rebuild Reduced Tension Unguyed #2 — 4/0 Copper Covered Conductor for Light-Loading Areas

Table CO 168–37: Sag Chart for Existing and Rebuild Reduced Tension Unguyed 17 kV #2 — 4/0 Copper Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	**130°F**
#2 Copper	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
	150	10'-10"	11'-2"
	175	12'-3"	12'-7"
2/0 Copper	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
	150	10'-10"	11'-2"
	175	12'-3"	12'-7"
4/0 Copper	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
	150	10'-10"	11'-2"
	175	12'-3"	12'-7"

Note(s):

1. Use on all 2.4 kV through 17 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

Table CO 168–38: Stringing Tension Table for Existing and Rebuild Reduced Tension Unguyed 17 kV #2 — 4/0 Copper Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Initial Tension (lb)	Final Tension (lb)
		50–110°F	130°F
#2 Copper	50	27	26
	75	41	40
	100	54	53
	125	68	66
	150	84	82
	175	101	99
2/0 Copper	50	47	46
	75	71	70
	100	95	93
	125	119	116
	150	147	144
	175	177	173
4/0 Copper	50	71	69
	75	106	104
	100	141	138
	125	177	173
	150	219	214
	175	264	258
Note(s): This table shall not be used for new installation or re-conductoring.			

1.0 Existing and Rebuild Unguyed Span Tension

Table CO 168–39: Sag Chart for Existing and Rebuild Reduced Tension Unguyed 17 kV #2 — 4/0 Copper Covered Conductor for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
#2 Copper	50	46
	75	69
	100	92
	125	114
	150	142
	175	171
2/0 Copper	50	65
	75	97
	100	130
	125	162
	150	201
	175	243
4/0 Copper	50	87
	75	131
	100	174
	125	218
	150	270
	175	326

2.0 Ground Clearances

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.18 Sag Chart for Existing and Rebuild Reduced Tension Unguyed #6 — 4/0 Aluminum Duplex and Triplex for Light-Loading Areas

Table CO 168–40: Sag Chart for Existing and Rebuild Reduced Tension Unguyed #6 — 4/0 Aluminum Duplex and Triplex for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
#6 Aluminum Duplex	60	1'-6"	1'-8"
	80	2'-6"	2'-10"
	100	4'-0"	4'-6"
	120	5'-6"	6'-0"
	140	3'-10"	4'-4"
	160	5'-0"	5'-7"
#4 Aluminum Duplex	60	1'-6"	1'-7"
	80	2'-6"	2'-6"
	100	3'-6"	3'-7"
	120	4'-6"	5'-0"
	140	3'-0"	3'-10"
	160	4'-0"	4'-10"
#4 Aluminum Triplex	60	1'-6"	1'-8"
	80	2'-6"	2'-7"
	100	4'-0"	4'-2"
	120	5'-6"	6'-0"
	140	3'-8"	4'-4"
	160	4'-10"	5'-6"
#2 Aluminum Triplex	60	1'-6"	1'-8"
	80	2'-6"	4'-0"
	100	4'-0"	4'-2"
	120	5'-6"	6'-0"
	140	3'-10"	4'-2"
	160	5'-0"	5'-7"
1/0 Aluminum Triplex	60	7"-0"	1'-0"
	80	1'-0"	1'-6"
	100	1'-6"	2'-2"
	120	2'-0"	2'-10"
	140	2'-10"	3'-8"
	160	3'-6"	4'-7"
1/0 Aluminum Duplex	60	1'-6"	1'-7"
	80	2'-0"	2'-2"
	100	3'-0"	3'-3
	120	4'-0"	4'-6"
	140	2'-10"	3'-8"
	160	3'-7"	4'-7"
4/0 Aluminum Duplex	60	1'-0"	1'-3"
	80	1'-6"	2'-0"
	100	2'-6"	2'-9"
	120	3'-6"	3'-8"
	140	2'-3"	3'-4"
	160	3'-0"	4'-0"

1.0 Existing and Rebuild Unguyed Span Tensions

1.1 Conductor Tensions are 25 Percent of Full Tension for 0 to 120 Feet

- Conductor tension for #6 Aluminum Duplex is 97 lb
- Conductor tension for #4 Aluminum Duplex is 150 lb
- Conductor tension for #4 Aluminum Triplex is 150 lb
- Conductor tension for #2 Aluminum Triplex is 190 lb
- Conductor tension for 1/0 Aluminum Triplex is 355 lb
- Conductor tension for 4/0 Aluminum Triplex is 695 lb

1.2 Conductor Tensions are 50 Percent of Full Tension for 121 to 160 Feet

- Conductor tension for #6 Aluminum Duplex is 193 lb
- Conductor tension for #4 Aluminum Duplex is 302 lb
- Conductor tension for #4 Aluminum Triplex is 302 lb
- Conductor tension for #2 Aluminum Triplex is 380 lb
- Conductor tension for 1/0 Aluminum Triplex is 707 lb
- Conductor tension for 4/0 Aluminum Triplex is 1,390 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.19 Sag Chart for New and Existing Reduced Tension Guyed #4 — 653 ACSR for Heavy-Loading Areas

Table CO 168–41: Sag Chart for New and Existing Reduced Tension Guyed #4 — 653 ACSR for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#4 ACSR[a/]	60	1'-3"	1'-6"
	80	2'-2"	2'-6"
	100	3'-6"	3'-7"
	120	4'-10"	5'-2"
	140	6'-10"	7'-0"
	160	8'-9"	9'-0"
#2 ACSR[a/]	60	1'-3"	1'-6"
	80	2'-0"	2'-4"
	100	3'-0"	3'-4"
	120	4'-5"	4'-7"
	140	5'-10"	6'-2"
	160	7'-8"	8'-0"
1/0 ACSR	60	1'-0"	1'-1"
	80	1'-2"	1'-6"
	100	1'-10"	2'-4"
	120	2'-7"	3'-0"
	140	3'-6"	4'-0"
	160	4'-7"	5'-0"
336 ACSR	60	1'-3"	1'-6"
	80	2'-0"	2'-4"
	100	2'-10"	3'-3"
	120	4'-0"	4'-5"
	140	5'-4"	5'-8"
	160	6'-8"	7'-2"
653 ACSR	60	1'-6"	1'-9"
	80	2'-3"	2'-6"
	100	3'-4"	3'-7"
	120	5'-6"	5'-8"
	140	6'-0"	6'-5"
	160	7'-0"	8'-2"

[a/] Not approved for new construction.

Note(s):

1. a/Use on all 2.4 kV through 33 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

1.0 Guyed Span Tensions

1.1 Conductor Tensions for Guying are 50 Percent of Full Tension for 0 to 160 Feet

- Conductor tension for guying #4 ACSR is 302 lb
- Conductor tension for guying #2 ACSR is 380 lb
- Conductor tension for guying 1/0 ACSR is 707 lb

1.2 Conductor Tensions for Guying are 25 Percent of Full Tension for 0 to 160 Feet

- Conductor tension for guying 336 ACSR is 710 lb
- Conductor tension for guying 653 ACSR is 815 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.20 Sag Chart for New and Existing Reduced Tension Guyed 1/0— 653 ACSR Covered Conductor for Heavy-Loading Areas

Table CO 168–42: Sag Chart for New and Existing Reduced Tension Guyed 17 kV 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
1/0 ACSR	50	2'-0"	2'-1"
	75	3'-0"	3'-2"
	100	3'-5"	3'-9"
	125	4'-4"	4'-9"
	150	5'-2"	5'-8"
	175	6'-0"	6'-7"
336 (18/1) ACSR	50	2'-0"	2'-1"
	75	3'-0"	3'-2"
	100	3'-6"	3'-10"
	125	4'-4"	4'-10"
	150	5'-2"	5'-10"
	175	6'-0"	6'-10"
336 (30/7) ACSR	50	2'-0"	2'-1"
	75	3'-0"	3'-2"
	100	3'-6"	3'-9"
	125	4'-4"	4'-8"
	150	5'-2"	5'-7"
	175	6'-0"	6'-6"
653 ACSR	50	2'-0"	2'-2"
	75	3'-0"	3'-3"
	100	3'-6"	3'-10"
	125	4'-4"	4'-10"
	150	5'-2"	5'-10"
	175	6'-0"	6'-10"

Note(s):

1. Use on all 2.4 kV through 17 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

Table CO 168–43: Stringing Tension Table for New and Existing Reduced Tension Guyed 17 kV 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Tension (lb) 50–110°F	Final Tension (lb) 130°F
1/0 ACSR	50	45	43
	75	68	64
	100	104	95
	125	130	118
	150	156	142
	175	183	165
336 (18/1) ACSR	50	91	86
	75	136	127
	100	208	188
	125	261	232
	150	314	277
	175	367	323
336 (30/7) ACSR	50	117	111
	75	176	167
	100	269	251
	125	337	314
	150	405	376
	175	473	439
653 ACSR	50	154	144
	75	231	215
	100	353	320
	125	443	397
	150	533	474
	175	624	549

Note(s): This table shall not be used for new installation or re-conductoring.

Table CO 168–44: Sag Chart for New and Existing Reduced Tension Guyed 35 kV 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
1/0 ACSR	50	2'-0"	2'-1"
	75	3'-0"	3'-2"
	100	3'-5"	3'-10"
	125	4'-3"	4'-9"
	150	5'-1"	5'-9"
	175	5'-11"	6'-8"
336 (18/1) ACSR	50	2'-0"	2'-2"
	75	3'-0"	3'-3"
	100	3'-6"	3'-11"
	125	4'-4"	4'-11"
	150	5'-2"	5'-10"
	175	5'-10"	6'-8"
336 (30/7) ACSR	50	2'-0"	2'-1"
	75	3'-0"	3'-2"
	100	3'-6"	3'-9"
	125	4'-4"	4'-8"
	150	5'-2"	5'-7"
	175	6'-0"	6'-6"
653 ACSR	50	2'-0"	2'-2"
	75	3'-0"	3'-3"
	100	3'-6"	3'-10"
	125	4'-4"	4'-10"
	150	5'-2"	5'-11"
	175	6'-0"	6'-10"

Table CO 168–45: Stringing Tension Table for New and Existing Reduced Tension Guyed 35 kV 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Tension (lb) 50–110°F	Final Tension (lb) 130°F
1/0 ACSR	50	73	69
	75	110	102
	100	168	152
	125	211	190
	150	255	227
	175	299	265
336 (18/1) ACSR	50	127	119
	75	191	177
	100	292	259
	125	367	323
	150	442	388
	175	527	466
336 (30/7) ACSR	50	154	147
	75	232	220
	100	355	331
	125	446	414
	150	535	496
	175	625	579
653 ACSR	50	195	183
	75	294	273
	100	450	404
	125	565	501
	150	681	597
	175	798	697
Note(s): This table shall not be used for new installation or re-conductoring.			

1.0 Guyed Span Tensions

Table CO 168–46: Guyed Span Tensions: 17 kV 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR	50	229
	75	340
	100	514
	125	633
	150	750
	175	864
336 (18/1) ACSR	50	313
	75	467
	100	719
	125	892
	150	1,062
	175	1,230
336 (30/7) ACSR	50	338
	75	506
	100	779
	125	970
	150	1,158
	175	1,346
653 ACSR	50	414
	75	617
	100	958
	125	1,191
	150	1,422
	175	1,651

Table CO 168–47: Guyed Span Tensions: 35 kV 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR	50	291
	75	431
	100	648
	125	798
	150	943
	175	1,086
336 (18/1) ACSR	50	386
	75	575
	100	883
	125	1,094
	150	1,302
	175	1,506
336 (30/7) ACSR	50	411
	75	616
	100	948
	125	1,179
	150	1,406
	175	1,630
653 ACSR	50	491
	75	732
	100	1,135
	125	1,410
	150	1,683
	175	1,952

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.21 Sag Chart for New and Existing Reduced Tension Guyed #6 — 4/0 Copper for Heavy-Loading Areas

Table CO 168–48: Sag Chart for New and Existing Reduced Tension Guyed #6 — 4/0 Copper for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
#6 Copper[a/]	60	1'-6"	1'-10"
	80	2'-10"	3'-0"
	100	4'-4"	4'-6"
	120	6'-0"	6'-6"
	140	N/A[b/]	N/A[b/]
	160	N/A[b/]	N/A[b/]
#4 Copper[a/]	60	1'-3"	1'-6"
	80	2'-0"	2'-5"
	100	3'-2"	3'-6"
	120	4'-6"	5'-0"
	140	6'-3"	6'-7"
	160	N/A	N/A[b/]
#2 Copper[a/]	60	1'-0"	1'-7"
	80	1'-6"	2'-0"
	100	2'-4"	2'-9"
	120	3'-4"	3'-9"
	140	4'-6"	5'-0"
	160	5'-10"	6'-4"
2/0 Copper	60	1'-2"	1'-6"
	80	2'-0"	2'-3"
	100	2'-10"	3'-3"
	120	4'-0"	4'-6"
	140	5'-4"	5'-9"
	160	6'-10"	7'-4"
4/0 Copper	60	1'-2"	1'-6"
	80	1'-8"	2'-0"
	100	2'-5"	2'-10"
	120	3'-4"	3'-10"
	140	4'-6"	4'-10"
	160	5'-8"	6'-3"

[a/] Not approved for new construction.
[b/] Excessive sagging, use full tension.

Note(s):

1. Use on all 2.4 kV through 33 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

1.0 Guyed Span Tensions

1.1 Conductor Tensions for Guying are 70 Percent of Full Tension for 60 to 160 Feet

- Conductor tension for guying #6 Copper is 225 lb
- Conductor tension for guying #4 Copper is 340 lb
- Conductor tension for guying #2 Copper is 533 lb

1.2 Conductor Tensions for Guying are 40 Percent of Full Tension for 60 to 160 Feet

- Conductor tension for guying 2/0 Copper is 593 lb

1.3 Conductor Tensions for Guying are 30 Percent of Full Tension for 60 to 160 Feet

- Conductor tension for guying 4/0 Copper is 915 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.22 Sag Chart for New and Existing Reduced Tension Guyed #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas

Table CO 168–49: Sag Chart for New and Existing Reduced Tension Guyed 17 kV #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
#2 Copper	50	2'-0"	2'-2"
	75	3'-0"	3'-3"
	100	3'-6"	3'-10"
	125	4'-4"	4'-9"
	150	5'-2"	5'-9"
	175	6'-0"	6'-8"
2/0 Copper	50	2'-0"	2'-2"
	75	3'-0"	3'-3"
	100	3'-6"	3'-10"
	125	4'-4"	4'-9"
	150	5'-3"	5'-9"
	175	6'-1"	6'-8"
4/0 Copper	50	2'-0"	2'-2"
	75	3'-0"	3'-3"
	100	3'-6"	3'-10"
	125	4'-4"	4'-9"
	150	5'-3"	5'-9"
	175	6'-1"	6'-8"

Note(s):

1. Use on all 2.4 kV through 17 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

Table CO 168–50: Stringing Tension Table for New and Existing Reduced Tension Guyed 17 kV #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Tension (lb)	Final Tension (lb)
		50–110°F	130°F
#2 Copper	50	50	46
	75	75	70
	100	115	104
	125	144	130
	150	173	156
	175	202	182
2/0 Copper	50	88	81
	75	132	122
	100	201	182
	125	251	228
	150	302	274
	175	352	319
4/0 Copper	50	131	121
	75	196	182
	100	299	272
	125	374	340
	150	449	408
	175	524	476
Note(s): This table shall not be used for new installation or re-conductoring.			

1.0 Guyed Span Tensions

Table CO 168–51: Guyed Span Tensions: 17 kV #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
#2 Copper	50	216
	75	321
	100	483
	125	594
	150	703
	175	810
2/0 Copper	50	267
	75	398
	100	608
	125	753
	150	896
	175	1036
4/0 Copper	50	322
	75	481
	100	738
	125	917
	150	1093
	175	1268

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.23 Sag Chart for New and Existing Reduced Tension Guyed #6 — 1/0 Aluminum Duplex and Triplex for Heavy-Loading Areas

Table CO 168–52: Sag Chart for New and Existing Reduced Tension Guyed #6 — 1/0 Aluminum Duplex and Triplex for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#6 Aluminum Duplex	60	1'-6"	1'-8"
	80	2'-6"	2'-10"
	100	4'-0"	4'-6"
	120	6'-0"	6'-3"
	140	8'-3"	8'-6"
	160	11'-0"	11'-1"
#4 Aluminum Duplex	60	1'-0"	1'-3"
	80	1'-8"	2'-2"
	100	2'-9"	3'-3"
	120	4'-4"	4'-6"
	140	5'-10"	6'-3"
	160	7'-6"	8'-0"
#4 Aluminum Triplex	60	1'-0"	1'-3"
	80	2'-0"	2'-4"
	100	3'-0"	3'-6"
	120	4'-6"	4'-7"
	140	6'-5"	6'-8"
	160	8'-6"	8'-9"
#2 Aluminum Triplex	60	1'-0"	1'-5"
	80	2'-0"	2'-3"
	100	3'-0"	3'-6"
	120	4'-5"	4'-9"
	140	6'-0"	6'-4"
	160	7'-10"	8'-3"
1/0 Aluminum Triplex	60	1'-3"	1'-5"
	80	2'-0"	2'-4"
	100	3'-0"	3'-6"
	120	4'-6"	4'-8"
	140	6'-10"	6'-4"
	160	7'-9"	8'-3"
4/0 Aluminum Triplex	60	1'-6"	1'-8"
	80	2'-5"	2'-8"
	100	3'-8"	3'-10"
	120	5'-3"	5'-6"
	140	7'-0"	7'-4"
	160	9'-0"	9'-6"

1.0 Guyed Span Tensions

1.1 Conductor Tensions for Guying are 75 Percent of Full Tension for 0 to 160 Feet

- Conductor tension for guying #6 Aluminum Duplex is 290 lb
- Conductor tension for guying #4 Aluminum Duplex is 453 lb
- Conductor tension for guying #4 Aluminum Triplex is 453 lb
- Conductor tension for guying #2 Aluminum Triplex is 570 lb

1.2 Conductor Tensions for Guying are 50 Percent of Full Tension for 0 to 160 Feet

- Conductor tension for guying 1/0 Aluminum Triplex is 707 lb

1.3 Conductor Tensions for Guying are 30 Percent of Full Tension for 0 to 160 Feet

- Conductor tension for guying 4/0 Aluminum Triplex is 835 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.24 Sag Chart for New and Existing Reduced Tension Guyed #4 — 4/0 Aluminum Quadruplex for Heavy-Loading Area

Table CO 168–53: Sag Chart for New and Existing Reduced Tension Guyed #4 — 4/0 Aluminum Quadruplex for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#4 Aluminum Quadruplex	60	1'-2"	1'-6"
	80	2'-3"	2'-6"
	100	3'-6"	3'-10"
	120	5'-3"	5'-6"
	140	7'-0"	7'-5"
	160	9'-4"	9'-8"
#1/0 Aluminum Quadruplex	60	1'-4"	1'-7"
	80	2'-2"	2'-7"
	100	3'-5"	3'-10"
	120	5'-0"	5'-5"
	140	6'-9"	7'-0"
	160	8'-9"	9'-2"
#4/0 Aluminum Quadruplex	60	1'-7"	1'-10"
	80	2'-0"	3'-0"
	100	4'-3"	4'-6"
	120	6'-0"	6'-3"
	140	8'-0"	8'-4"
	160	10'-5"	10'-9"

1.0 Guyed Span Tensions

1.1 Conductor Tensions for Guying are 75 Percent of Full Tension for 0 to 160 Feet

- Conductor tension for guying #4 Aluminum Quadruplex is 453 lb

1.2 Conductor Tensions for Guying are 50 Percent of Full Tension for 0 to 160 Feet

- Conductor tension for guying 1/0 Aluminum Quadruplex is 707 lb

1.3 Conductor Tensions for Guying are 39 Percent of Full Tension for 0 to 160 Feet

- Conductor tension for guying 4/0 Aluminum Quadruplex is 835 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.25 Sag Chart for New Reduced Tension Unguyed #4 — 653 ACSR for Heavy-Loading Areas

Table CO 168–54: Sag Chart for New Reduced Tension Unguyed #4 — 653 ACSR for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
#4 ACSR[a/]	60	1'-3"	1'-6"
	80	2'-2"	2'-6"
	100	3'-6"	3'-7"
	120	4'-10"	5'-2"
#2 ACSR[a/]	60	1'-3"	1'-6"
	80	2'-0"	2'-4"
	100	3'-0"	3'-4"
	120	4'-5"	4'-7"
1/0 ACSR	60	1'-0"	1'-1"
	80	1'-2"	1'-6"
	100	1'-10"	2'-4"
	120	2'-7"	3'-0"
336 ACSR	60	1'-3"	1'-6"
	80	2'-0"	2'-4"
	100	2'-10"	3'-3"
	120	4'-0"	4'-5"
653 ACSR	60	1'-6"	1'-9"
	80	2'-3"	2'-6"
	100	3'-4"	3'-7"
	120	5'-6"	5'-8"

[a/] Not approved for new construction.

Note(s):

1. Use on all 2.4 kV through 33 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

1.0 New Unguyed Span Tensions

1.1 Conductor Tensions are 50 Percent of Full Tension for 0 to 120 Feet

- Conductor tension for #4 ACSR is 302 lb
- Conductor tension for #2 ACSR is 380 lb
- Conductor tension for 1/0 ACSR is 707 lb

1.2 Conductor Tensions are 25 Percent of Full Tension for 0 to 120 Feet

- Conductor tension for 336 ACSR is 710 lb
- Conductor tension for 653 ACSR is 815 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.26 Sag Chart for New Reduced Tension Unguyed 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Table CO 168–55: Sag Chart for New Reduced Tension Unguyed 17 kV 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
1/0 ACSR	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-7"
	125	9'-4"	9'-6"
336 ACSR	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-7"
	125	9'-4"	9'-7"
336 (30/7) ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-7"
	125	9'-4"	9'-6"
653 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"

Note(s):

1. Use on all 2.4 kV through 17 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

Table CO 168–56: Stringing Tension Table for New Reduced Tension Unguyed 17 kV 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Tension (lb)	Final Tension (lb)
		50–110°F	130°F
1/0 ACSR	50	24	24
	75	36	36
	100	49	48
	125	61	60
336 ACSR	50	49	48
	75	74	72
	100	98	96
	125	123	120
336 (30/7) ACSR	50	63	62
	75	95	94
	100	127	125
	125	159	156
653 ACSR	50	83	82
	75	125	123
	100	167	163
	125	208	204

Note(s): This table shall not be used for new installation or re-conductoring.

Table CO 168–57: Sag Chart for New Reduced Tension Unguyed 35 kV 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
1/0 ACSR	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-7"
	125	9'-4"	9'-6"
336 ACSR	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
336 (30/7) ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-7"
	125	9'-4"	9'-6"
653 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"

Table CO 168–58: Stringing Tension Table for New Reduced Tension Unguyed 35 kV 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Tension	Final Tension
		50–110°F	130°F
1/0 ACSR	50	39	39
	75	59	58
	100	79	77
	125	98	96
336 ACSR	50	69	68
	75	103	101
	100	137	135
	125	172	168
336 (30/7) ACSR	50	84	82
	75	125	124
	100	167	165
	125	209	206
653 ACSR	50	106	104
	75	159	156
	100	212	207
	125	265	259
Note(s): This table shall not be used for new installation or re-conductoring.			

1.0 New Unguyed Span Tensions

Table CO 168–59: New Unguyed Span Tensions: 17 kV 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR	50	119
	75	179
	100	238
	125	297
336 ACSR	50	160
	75	240
	100	320
	125	399
336 (30/7) ACSR	50	176
	75	263
	100	351
	125	438
653 ACSR	50	210
	75	315
	100	420
	125	525

Table CO 168–60: New Unguyed Span Tensions: 35 kV 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR	50	152
	75	228
	100	303
	125	378
336 ACSR	50	198
	75	296
	100	395
	125	493
336 (30/7) ACSR	50	214
	75	320
	100	427
	125	534
653 ACSR	50	250
	75	375
	100	499
	125	623

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.27 Sag Chart for New Reduced Tension Unguyed #6 — 4/0 Copper for Heavy-Loading Areas

Table CO 168–61: Sag Chart for New Reduced Tension Unguyed #6 — 4/0 Copper for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#6 Copper[a/]	60	1'-6"	1'-10"
	80	2'-10"	3'-0"
	100	4'-4"	4'-6"
	120	6'-0"	6'-6"
#4 Copper[a/]	60	1'-3"	1'-6"
	80	2'-0"	2'-5"
	100	3'-2"	3'-6"
	120	4'-6"	5'-0"
#2 Copper[a/]	60	1'-0"	1'-7"
	80	1'-6"	2'-0"
	100	2'-4"	2'-9"
	120	3'-4"	3'-9"
2/0 Copper	60	1'-2"	1'-6"
	80	2'-0"	2'-3"
	100	2'-10"	3'-3"
	120	4'-0"	4'-6"
4/0 Copper	60	1'-2"	1'-6"
	80	1'-8"	2'-0"
	100	2'-5"	2'-10"
	120	3'-4"	3'-10"

[a/] Not approved for new construction.

Note(s):

1. Use on all 2.4 kV through 33 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

1.0 New Unguyed Span Tensions

1.1 Conductor Tensions are 70 Percent of Full Tension for 60 to 120 Feet

- Conductor tension for #6 Copper is 225 lb
- Conductor tension for #4 Copper is 340 lb
- Conductor tension for #2 Copper is 533 lb

1.2 Conductor Tensions are 40 Percent of Full Tension for 60 to 120 Feet

- Conductor tension for 2/0 Copper is 593 lb

1.3 Conductor Tensions are 30 Percent of Full Tension for 60 to 120 Feet

- Conductor tension for 4/0 Copper is 915 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.28 Sag Chart for New Reduced Tension Unguyed #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas

Table CO 168–62: Sag Chart for New Reduced Tension Unguyed 17 kV #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
#2 Copper	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
2/0 Copper	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
2/0 Copper	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"

Note(s):

1. Use on all 2.4 kV through 17 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

Table CO 168–63: Stringing Tension Table for New Reduced Tension Unguyed 17 kV #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Tension	Final Tension
		50–110°F	130°F
#2 Copper	50	27	26
	75	41	40
	100	54	53
	125	68	66
2/0 Copper	50	47	46
	75	71	70
	100	95	93
	125	119	116
2/0 Copper	50	71	69
	75	106	104
	100	141	138
	125	177	173
Note(s): This table shall not be used for new installation or re-conductoring.			

What's Changed? Made For Reference Only.

1.0 New Unguyed Span Tensions

Table CO 168–64: New Unguyed Span Tensions: 17 kV #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
#2 Copper	50	114
	75	170
	100	227
	125	283
2/0 Copper	50	139
	75	209
	100	278
	125	347
4/0 Copper	50	167
	75	250
	100	333
	125	417

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.29 Sag Chart for New Reduced Tension Unguyed #6 — 1/0 Aluminum Duplex and Triplex for Heavy-Loading Areas

Table CO 168–65: Sag Chart for New Reduced Tension Unguyed #6 — 1/0 Aluminum Duplex and Triplex for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
#6 Aluminum Duplex	60	1'-6"	1'-8"
	80	2'-6"	2'-10"
	100	4'-0"	4'-6"
	120	6'-0"	6'-3"
#4 Aluminum Duplex	60	1'-0"	1'-3"
	80	1'-8"	2'-2"
	100	2'-9"	3'-3"
	120	4'-4"	4'-6"
#4 Aluminum Triplex	60	1'-0"	1'-3"
	80	2'-0"	2'-4"
	100	3'-0"	3'-6"
	120	4'-6"	4'-7"
#2 Aluminum Triplex	60	1'-0"	1'-5"
	80	2'-0"	2'-3"
	100	3'-0"	3'-6"
	120	4'-5"	4'-9"
1/0 Aluminum Triplex	60	1'-3"	1'-5"
	80	2'-0"	2'-4"
	100	3'-0"	3'-6"
	120	4'-6"	4'-8"
1/0 Aluminum Triplex	60	1'-6"	1'-8"
	80	2'-5"	2'-8"
	100	3'-8"	3'-10"
	120	5'-3"	5'-6"
4/0 Aluminum Triplex	60	1'-6"	1'-8"
	80	2'-5"	2'-8"
	100	3'-8"	3'-10"
	120	5'-3"	5'-6"

1.0 New Unguyed Span Tensions

1.1 Conductor Tensions are 75 Percent of Full Tension for 0 to 120 Feet

- Conductor tension for #6 Aluminum Duplex is 290 lb
- Conductor tension for #4 Aluminum Duplex is 453 lb
- Conductor tension for #4 Aluminum Triplex is 453 lb
- Conductor tension for #2 Aluminum Triplex is 570 lb

1.2 Conductor Tensions are 50 Percent of Full Tension for 0 to 120 Feet

- Conductor tension for 1/0 Aluminum Triplex is 707 lb

1.3 Conductor Tensions are 30 Percent of Full Tension for 0 to 120 Feet

- Conductor tension for 4/0 Aluminum Triplex is 835 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.30 Sag Chart for New Reduced Tension Unguyed #4 — 4/0 Aluminum Quadruplex for Heavy-Loading Areas

Table CO 168–66: Sag Chart for New Reduced Tension Unguyed #4 — 4/0 Aluminum Quadruplex for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#4 Aluminum Quadruplex	60	1'-2"	1'-6"
	80	2'-3"	2'-6"
	100	3'-6"	3'-10"
	120	5'-3"	5'-6"
#1/0 Aluminum Quadruplex	60	1'4"	1'-7"
	80	2'-2"	2'-7"
	100	3'-5"	3'-10"
	120	5'-0"	5'-5"
#4/0 Aluminum Quadruplex	60	1'-7"	1'-10"
	80	2'-0"	3'-0"
	100	4'-3"	4'-6"
	120	6'-0"	6'-3"

1.0 New Unguyed Span Tensions

1.1 Conductor Tensions are 75 Percent of Full Tension for 0 to 120 Feet

- Conductor tension for #4 Aluminum Quadruplex is 453 lb

1.2 Conductor Tensions are 50 Percent of Full Tension for 0 to 120 Feet

- Conductor tension for 1/0 Aluminum Quadruplex is 707 lb

1.3 Conductor Tensions are 30 Percent of Full Tension for 0 to 120 Feet

- Conductor tension for 4/0 Aluminum Quadruplex is 835 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.31 Sag Chart for Existing and Rebuild Reduced Tension Unguyed #4 — 653 ACSR for Heavy-Loading Areas

Table CO 168–67: Sag Chart for Existing and Rebuild Reduced Tension Unguyed #4 — 653 ACSR for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
#4 ACSR[a/]	60	1'-3"	1'-6"
	80	2'-2"	2'-6"
	100	3'-6"	3'-7"
	120	4'-10"	5'-2"
	140	6'-10"	7'-0"
	160	8'-9"	9'-0"
#2 ACSR[a/]	60	1'-3"	1'-6"
	80	2'-0"	2'-4"
	100	3'-0"	3'-4"
	120	4'-5"	4'-7"
	140	5'-10"	6'-2"
	160	7'-8"	8'-0"
1/0 ACSR	60	1'-0"	1'-1"
	80	1'-2"	1'-6"
	100	1'-10"	2'-4"
	120	2'-7"	3'-0"
	140	3'-6"	4'-0"
	160	4'-7"	5'-0"
336 ACSR	60	1'-3"	1'-6"
	80	2'-0"	2'-4"
	100	2'-10"	3'-3"
	120	4'-0"	4'-5"
	140	5'-4"	5'-8"
	160	6'-8"	7'-2"
653 ACSR	60	1'-6"	1'-9"
	80	2'-3"	2'-6"
	100	3'-4"	3'-7"
	120	5'-6"	5'-8"
	140	6'-0"	6'-5"
	160	7'-10"	8'-2"

[a/] Not approved for new construction.

Note(s):

1. Use on all 2.4 kV through 33 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

1.0 Existing and Rebuild Unguyed Span Tensions

1.1 Conductor Tensions are 50 Percent of Full Tension for 0 to 160 Feet

- Conductor tension for #4 ACSR is 302 lb
- Conductor tension for #2 ACSR is 380 lb
- Conductor tension for 1/0 ACSR is 707 lb

1.2 Conductor Tensions are 25 Percent of Full Tension for 0 to 160 Feet

- Conductor tension for 336 ACSR is 710 lb
- Conductor tension for 653 ACSR is 815 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.32 Sag Chart for Existing and Rebuild Reduced Tension Unguyed 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Table CO 168–68: Sag Chart for Existing and Rebuild Reduced Tension Unguyed 17 kV 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
1/0 ACSR	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-7"
	125	9'-4"	9'-6"
	150	10'-10"	11'-1"
	175	12'-2"	12'-6"
336 ACSR	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
	150	10'-10"	11'-1"
	175	12'-3"	12'-7"
336 (30/7) ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-7"
	125	9'-4"	9'-6"
	150	10'-10"	11'-1"
	175	12'-3"	12'-6"
653 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
	150	10'-10"	11'-2"
	175	12'-3"	12'-7"

Note(s):

1. Use on all 2.4 kV through 17 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

Table CO 168–69: Stringing Tension Table for Existing and Rebuild Reduced Tension Unguyed 17 kV 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Tension (lb)	Final Tension (lb)
		50–110°F	130°F
1/0 ACSR	50	24	24
	75	36	36
	100	49	48
	125	61	60
	150	75	74
	175	91	89
336 ACSR	50	49	48
	75	74	72
	100	98	96
	125	123	120
	150	152	149
	175	184	179
336 (30/7) ACSR	50	63	62
	75	95	94
	100	127	125
	125	159	156
	150	197	193
	175	237	233
653 ACSR	50	83	82
	75	125	123
	100	167	163
	125	208	204
	150	258	252
	175	312	304

Note(s): This table shall not be used for new installation or re-conductoring.

Table CO 168–70: Sag Chart for Existing and Rebuild Reduced Tension Unguyed 35 kV 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
1/0 ACSR	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-7"
	125	9'-4"	9'-6"
	150	10'-10"	11'-1"
	175	12'-2"	12'-6"
336 ACSR	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
	150	10'-10"	11'-2"
	175	12'-3"	12'-8"
336 (30/7) ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-7"
	125	9'-4"	9'-6"
	150	10'-10"	11'-1"
	175	12'-3"	12'-6"
653 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
	150	10'-10"	11'-2"
	175	12'-3"	12'-7"

Table CO 168–71: Stringing Tension Table for Existing and Rebuild Reduced Tension Unguyed 35 kV 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Tension (lb)	Final Tension (lb)
		50–110°F	130°F
1/0 ACSR	50	39	39
	75	59	58
	100	79	77
	125	98	96
	150	122	119
	175	147	144
336 ACSR	50	103	101
	75	137	135
	100	172	168
	125	213	207
	150	257	249
	175	103	101
336 (30/7) ACSR	50	84	82
	75	125	124
	100	167	165
	125	209	206
	150	259	255
	175	313	308
653 ACSR	50	106	104
	75	159	156
	100	212	207
	125	265	259
	150	328	320
	175	397	385
Note(s): This table shall not be used for new installation or re-conductoring.			

1.0 Existing and Rebuild Unguyed Span Tensions

Table CO 168–72: Existing and Rebuild Unguyed Span Tensions: 17 kV 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR	50	119
	75	179
	100	238
	125	297
	150	368
	175	443
336 ACSR	50	160
	75	240
	100	320
	125	399
	150	495
	175	598
336 (30/7) ACSR	50	176
	75	263
	100	351
	125	438
	150	543
	175	656
653 ACSR	50	210
	75	315
	100	420
	125	525
	150	651
	175	787

Table CO 168–73: Existing and Rebuild Unguyed Span Tensions: 35 kV 1/0 Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR	50	152
	75	228
	100	303
	125	378
	150	468
	175	564
336 ACSR	50	198
	75	296
	100	395
	125	493
	150	611
	175	738
336 (30/7) ACSR	50	214
	75	320
	100	427
	125	534
	150	662
	175	799
653 ACSR	50	250
	75	375
	100	499
	125	623
	150	773
	175	934

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.33 Sag Chart for Existing and Rebuild Reduced Tension Unguyed #6 — 4/0 Copper for Heavy-Loading Areas

Table CO 168–74: Sag Chart for Existing and Rebuild Reduced Tension Unguyed #6 — 4/0 Copper for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
#6 Copper[a/]	60	1'-6"	1'-10"
	80	2'-10"	3'-0"
	100	4'-4"	4'-6"
	120	6'-0"	6'-6"
	140	N/A[b/]	N/A[b/]
	160	N/A[b/]	N/A[b/]
#4 Copper[a/]	60	1'-3"	1'-6"
	80	2'-0"	2'-5"
	100	3'-2"	3'-6"
	120	4'-6"	5'-0"
	140	6'-3"	6'-7"
	160	N/A[b/]	N/A[b/]
#2 Copper[a/]	60	1'-0"	1'-7"
	80	1'-6"	2'-0"
	100	2'-4"	2'-9"
	120	3'-4"	3'-9"
	140	4'-6"	5'-0"
	160	5'-10"	6'-4"
2/0 Copper	60	1'-2"	1'-6"
	80	2'-0"	2'-3"
	100	2'-10"	3'-3"
	120	4'-0"	4'-6"
	140	5'-4"	5'-9"
	160	6'-10"	7'-4"
4/0 Copper	60	1'-2"	1'-6"
	80	1'-8"	2'-0"
	100	2'-5"	2'-10"
	120	3'-4"	3'-10"
	140	4'-6"	4'-10"
	160	5'-8"	6'-3"

[a/] Not approved for new construction.
[b/] Excessive sagging, use full tension.

Note(s):

1. Use on all 2.4 kV through 33 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

1.0 Existing and Rebuild Unguyed Span Tensions

1.1 Conductor Tensions are 70 Percent of Full Tension for 60 to 160 Feet

- Conductor tension for #6 Copper is 225 lb
- Conductor tension for #4 Copper is 340 lb
- Conductor tension for #2 Copper is 533 lb

1.2 Conductor Tensions are 40 Percent of Full Tension for 60 to 160 Feet

- Conductor tension for 2/0 Copper is 593 lb

1.3 Conductor Tensions are 30 Percent of Full Tension for 60 to 160 Feet

- Conductor tension for 4/0 Copper is 915 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.34 Sag Chart for Existing and Rebuild Reduced Tension Unguyed #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas

Table CO 168–75: Sag Chart for Existing and Rebuild Reduced Tension Unguyed 17 kV #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
#2 Copper	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
	150	10'-10"	11'-2"
	175	12'-3"	12'-7"
2/0 Copper	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
	150	10'-10"	11'-2"
	175	12'-3"	12'-7"
4/0 Copper	50	3'-9"	3'-10"
	75	5'-7"	5'-9"
	100	7'-6"	7'-8"
	125	9'-4"	9'-7"
	150	10'-10"	11'-2"
	175	12'-3"	12'-7"

Note(s):

1. Use on all 2.4 kV through 17 kV systems. 36-inch minimum mid span conductor spacing depending on deviation angle may require more than 36-inch pin spacing to achieve 36-inch conductor spacing.

Table CO 168–76: Stringing Tension Table for Existing and Rebuild Reduced Tension Unguyed 17 kV #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Tension (lb)	Final Tension (lb)
		50–110°F	130°F
#2 Copper	50	27	26
	75	41	40
	100	54	53
	125	68	66
	150	84	82
	175	101	99
2/0 Copper	50	47	46
	75	71	70
	100	95	93
	125	119	116
	150	147	144
	175	177	173
4/0 Copper	50	71	69
	75	106	104
	100	141	138
	125	177	173
	150	219	214
	175	264	258
Note(s): This table shall not be used for new installation or re-conductoring.			

1.0 Existing and Rebuild Unguyed Span Tensions

Table CO 168–77: Existing and Rebuild Unguyed Span Tensions: 17 kV #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
#2 Copper	50	114
	75	170
	100	227
	125	283
	150	350
	175	422
2/0 Copper	50	139
	75	209
	100	278
	125	347
	150	430
	175	519
4/0 Copper	50	167
	75	250
	100	333
	125	417
	150	517
	175	624

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

Scope CO 168.35 Sag Chart for Existing and Rebuild Reduced Tension Unguyed #6 — 4/0 Aluminum Duplex and Triplex for Heavy-Loading Areas

Table CO 168–78: Sag Chart for Existing and Rebuild Reduced Tension Unguyed #6 — 4/0 Aluminum Duplex and Triplex for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
#6 Aluminum Duplex	60	1'-6"	1'-8"
	80	2'-6"	2'-10"
	100	4'-0"	4'-6"
	120	6'-0"	6'-3"
	140	8'-3"	8'-6"
	160	11'-0"	11'-1"
#4 Aluminum Duplex	60	1'-0"	1'-3"
	80	1'-8"	2'-2"
	100	2'-9"	3'-3"
	120	4'-4"	4'-6"
	140	5'-10"	6'-3"
	160	7'-6"	8'-0"
#4 Aluminum Triplex	60	1'-0"	1'-3"
	80	2'-0"	2'-4"
	100	3'-0"	3'-6"
	120	4'-6"	4'-7"
	140	6'-5"	6'-8"
	160	8'-6"	8'-9"
#2 Aluminum Triplex	60	1'-0"	1'-5"
	80	2'-0"	2'-3"
	100	3'-0"	3'-6"
	120	4'-5"	4'-9"
	140	6'-0"	6'-4"
	160	7'-10"	8'-3"
1/0 Aluminum Triplex	60	1'-3"	1'-5"
	80	2'-0"	2'-4"
	100	3'-0"	3'-6"
	120	4'-6"	4'-8"
	140	6'-10"	6'-4"
	160	7'-9"	8'-3"
4/0 Aluminum Triplex	60	1'-6"	1'-8"
	80	2'-5"	2'-8"
	100	3'-8"	3'-10"
	120	5'-3"	5'-6"
	140	7'-0"	7'-4"
	160	9'-0"	9'-6"

1.0 Existing and Rebuild Unguyed Span Tensions

1.1 Conductor Tensions are 75 Percent of Full Tension for 0 to 160 Feet
- Conductor tension for #6 Aluminum Duplex is 290 lb
- Conductor tension for #4 Aluminum Duplex is 453 lb
- Conductor tension for #4 Aluminum Triplex is 453 lb
- Conductor tension for #2 Aluminum Triplex is 570 lb

1.2 Conductor Tensions are 50 Percent of Full Tension for 0 to 160 Feet
- Conductor tension for 1/0 Aluminum Triplex is 707 lb

1.3 Conductor Tensions are 30 Percent of Full Tension for 0 to 160 Feet
- Conductor tension for 4/0 Aluminum Triplex is 835 lb

2.0 Ground Clearance

Per G.O. 95, use 130°F sags when calculating conductor-to-ground clearances.

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CO 200 Dead-Ending Tables

Scope CO 200.1 Crossarm Requirements for Dead-Ending All Sizes of Copper and ACSR Conductors

Table CO 200–1: Crossarm Requirements for Dead-Ending All Sizes of Copper and ACSR Conductors

Wire Size	6 Conductor X-Arm Matl. (SAP 10060240) 10' Arm	4 Conductor X-Arm Matl. (SAP 10060240) 10' Arm	4 Conductor X-Arm (SAP 10060237) 8' Arm	2 Conductor X-Arm Matl. (SAP PENDING) 5' Arm	3 Conductor X-Arm Matl. (SAP 10060240) 10' Arm	3 Conductor X-Arm Matl. (SAP 10060237) 8' Arm
#4 ACSR	Double Arm	Double Arm	Double Arm	Single Arm	Single Arm[3.]	Single Arm[3.]
#2 ACSR	Double Arm	Double Arm	Double Arm	Single Arm	Double Arm	Single Arm[3.]
1/0 ACSR	Figure CO 211–1.1	Double Arm	Double Arm	Double Arm	Double Arm	Double Arm
4/0 ACSR	Figure CO 211–1.2	Figure CO 211–1.3 Figure CO 211–1.4	Figure CO 211–1.3	—	Figure CO 211–1.1	Figure CO 211–1.1
336.4 kcmil ACSR	Figure CO 211–1.2	Figure CO 211–1.3 Figure CO 211–1.4	Figure CO 211–1.3	—	Figure CO 211–1.1	Figure CO 211–1.1
653.9 kcmil ACSR	Figure CO 211–1.2	Figure CO 211–1.2 Figure CO 211–1.3	Figure CO 211–1.2	—	Figure CO 211–1.3	Figure CO 211–1.3
#6 Copper	Double Arm	Double Arm	Single Arm[3.]	Single Arm	Single Arm[3.]	Single Arm[3.]
#4 Copper	Double Arm	Double Arm	Double Arm	Single Arm	Single Arm[3.]	Single Arm[3.]
#2 Copper	Double Arm	Double Arm	Double Arm	Single Arm	Double Arm	Double Arm
2/0 Copper	Figure CO 211–1.2 Figure CO 211–1.3	Figure CO 211–1.1	Figure CO 211–1.1	—	Double Arm	Double Arm
4/0 Copper	Figure CO 211–1.2	Figure CO 211–1.2 Figure CO 211–1.3 Figure CO 211–1.4	Figure CO 211–1.2	—	Figure CO 211–1.1	Figure CO 211–1.1

Note(s):

1. Maximum of 3-space bolts on either end of arm. Dead-end on space bolts 2/0 and 4/0 copper: 1/0 and 4/0 ACSR, 336.4 kcmil, and 653.9 kcmil ACSR.
2. See CO 211 for special dead-end construction relating to Figure CO 211–1.1, Figure CO 211–1.2, Figure CO 211–1.3, and Figure CO 211–1.4.
3. NOT APPROVED FOR HEAVY LOADING.
4. This table applies to both bare wire and covered conductors.

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CO 201 Composite Arm Dead-Ending Tables

Scope CO 201.1 Composite Crossarm Requirements for Dead-Ending All Sizes of Copper and ACSR Conductors

Table CO 201–1: Composite Crossarm Requirements for Dead-Ending All Sizes of Copper and ACSR Conductors

Wire Size	Full Tension	Reduced Tension Guyed	Reduced Tension Un-guyed
#4 ACSR	SIngle Arm[a/]	SIngle Arm[a/]	Single Arm
#2 ACSR	SIngle Arm[a/]	SIngle Arm[a/]	Single Arm
1/0 ACSR	Double Arm	Double Arm	Single Arm
4/0 ACSR	Double Arm	Double Arm	Double Arm
336.4 kcmil ACSR	Double Arm	Double Arm	Double Arm
653.9 kcmil ACSR	Double Arm	Double Arm	Double Arm
#6 Copper	SIngle Arm[a/]	SIngle Arm[a/]	Single Arm
#4 Copper	SIngle Arm[a/]	SIngle Arm[a/]	Single Arm
#2 Copper	Double Arm	Double Arm	Single Arm
2/0 Copper	Double Arm	Double Arm	Double Arm
4/0 Copper	Double Arm	Double Arm	Double Arm

[a/] Double Arms may be installed on a project needed basis.

Note(s):

1. See CO 212 for composite crossarm configurations.
2. This table applies to both bare wire and covered conductors.
3. See CC 121 and CO 168 for reduced tension spans.
4. When re-conductoring with covered conductor in HFRA, Double Composite Arms shall be used for all conductor sizes (see Table CO 201–1).

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CO 205 Dead-Ending — All Aluminum and ACSR

Scope CO 205.1 Dead-Ending Method for All Aluminum and ACSR Conductors

1.0 Dead-Ending Method for All Aluminum and ACSR Conductors — Automatic

Figure CO 205–1: Automatic

1.1 Application

#2, 1/0, and 4/0 weather resistant aluminum and ACSR secondaries on racks.

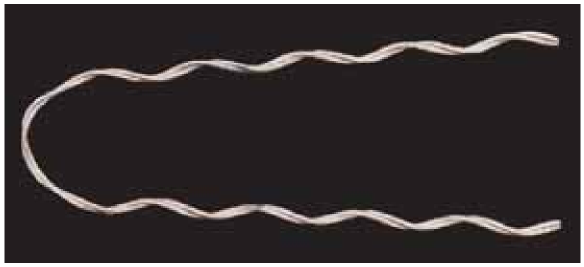
1.2 Material

Table CO 205–1: Conductor Range and SAP Numbers for Automatic

Conductor Range	SAP
#2	10067541
1/0	10067476
1/0 ACSR	10067478
4/0	10067477

2.0 Dead-Ending Method for All Aluminum and ACSR Conductors — Service Drop Grip

Figure CO 205–2: Service Drop Grip



2.1 Application

Triplex aluminum service drops.

2.2 Material

Table CO 205–2: Conductor Range and SAP Numbers for Service Drop Grip

Conductor Range	SAP
#6 Str Al or ACSR	10067963
#4 Str Al or ACSR	10067966
1/0 Al or ACSR	10067964
4/0 Al or ACSR	10067968
#2 Str Al or ACSR	10067967

CO 207 Dead-Ending — Aluminum and Copper

Scope CO 207.1 Dead-Ending Methods

1.0 Dead-Ending Method — Quadrant Clamp

Figure CO 207–1: Quadrant Clamp

1.1 Application

Use in heavy loading areas above 5,000 feet, and specially engineered long span distribution lines — over 400 feet (typically above 336 30/7 Oriole ACSR).

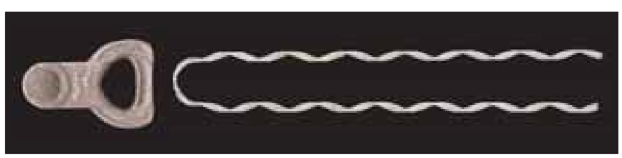
Table CO 207–1: Conductor Range and SAP Numbers

Conductor Range	Conductor Type	SAP
#6 Sol. to 4/0	Cu	10214153[a/]
#4 and 1/0 ACSR	Al	10067489
336.4 kcmil 30/7	Al	10067492
653.9 kcmil	Al	10067495

[a/] Quadrant clamp may also be used in place of rigid automatic dead-ends in high-contamination areas.

2.0 Dead-Ending Method — Preformed Dead-End Grip

Figure CO 207–2: Preformed Dead-End Grip



2.1 Application

Use where other dead-ending devices are not available for de-energized work.

Table CO 207–2: Conductor Range and SAP Numbers

Conductor Range for Preformed Grips	Color Code	SAP
#4	Orange	10067950
#2	Red	10067841
1/0	Yellow	10067952
4/0	Pink	10067953
336.4 kcmil	Red	10067954

Note(s):

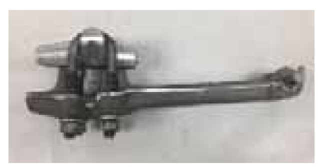
1. Use Thimble Dead-End, SAP 10067656, for #4 - 336.4 kcmil.
2. Not to be used for #4 3-stranded copperweld conductor. See CO 215 for dead-ending copperweld.

3.0 Dead-Ending Method — Clamps

3.1 Application

Use on all de-energized or energized conductors.

Table CO 207–3: Conductor Range and SAP Numbers for Clamps

Conductor Range	Type of Clamp	Type of Conductor	SAP	Photo
336.4 kcmil	Flip-Top	ACSR only	10067487	
653.9 kcmil	Flip-Top	ACSR only	10067488	
#6 - 2/0	Side Opening	ACSR/CU	10067485	
4/0 - 336.4 kcmil	Side Opening	ACSR/CU	10067490	

Note(s):

1. Dead End Clamps that are used on ACSR/CU must have Tin Plated, (TP) stamped on the clamp.

3.2 Recommended torques on clamps are:

Table CO 207–4: Recommended Torque on Clamps

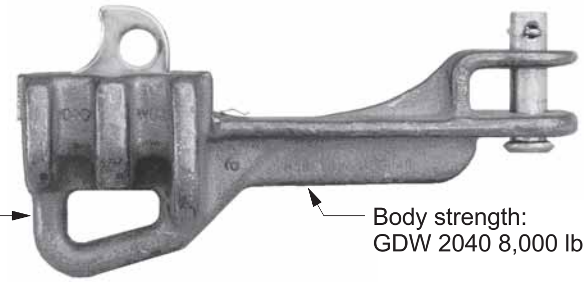
Size	MIN	MAX
3/8" Bolt	20 ft-lb	30 ft-lb
1/2" Bolt	25 ft-lb	35 ft-lb
5/8" Bolt	35 ft-lb	45 ft-lb

Scope CO 207.2 Automatic Wedge Straight Line Clamp

1.0 Automatic Wedge Straight Line Clamp

1.1 Preferred Application

Use on de-energized or energized conductors shown in Table CO 207–5 (Sheet 4).



Jaws Shown Closed

Jaws Shown Locked Open

Table CO 207–5: Conductor Range

SAP	Catalog Number	Minimum	Inches	MAX	Inches
10067431[a/]	GDW 2040	#4 Str. AAC #4 AAAC #4 ACSR #4 Str. Cu	0.23	4/0 Str. AAC 4/0 AAAC 4/0 ACSR 3/0 Str. Cu	0.57
10067410	GDW 795A	4/0 ACSR 4/0 AAC 4/0 AAAC	0.52	653 ACSR 653 AAC 653 AAAC	1.1

[a/] Plated aluminum jaws for use on copper or aluminum

Note(s):

1. Due to the corrosive environment in the beach areas, **DO NOT** use within **ONE MILE** of the ocean.
2. Prior to reuse of the dead-ends, a thorough inspection should be made of the entire body and the wedge jaws. The jaws should be cleaned of all foreign material.
3. Do not use on copperweld conductors and aerial cable messenger. See CO 215 for dead-ending copperweld.
4. To be used on full tension spans only.

CO 209 Dead-Ending — ACSR and Copper

Scope CO 209.1 Typical Dead-Ending Methods to Prevent Radio Interference

1.0 Dead-Ending Methods to Prevent Radio Interference

1.1 Application

The insulator materials shown below will be used to prevent radio interference in 12 kV through 33 kV known radio interference problem areas for the following conditions:

Slack spans—all conductor sizes.

A. Full tension dead-ends #4 str through #2 str Cu and #4 through 1/0 ACSR in California Light-Loading Areas only.

B. For copper sizes below #4 str, use automatic rigid bail dead-end with clamp top insulator adapter (also use RIV clips between bail and adapter).

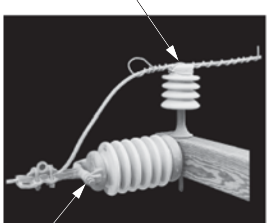
C. Use post insulator extension bracket when clamp top insulators are used for dead-ending and are mounted on double or triple crossarm assemblies.

1.2 The insulator materials shown below will be used for existing construction only.

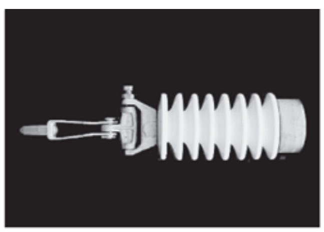
1.3 For new construction, composite-type insulators will be used to prevent radio interference. See GR 210 for details.

Figure CO 209–1: Dead-End Insulator Materials

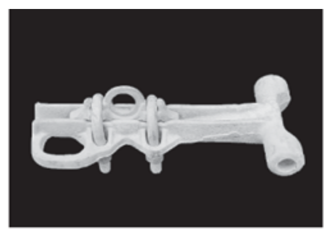
Clamp Top Line Post Insulator
SAP 10116417–12 kV
SAP 10116424–16 kV
SAP 10116425–33 kV



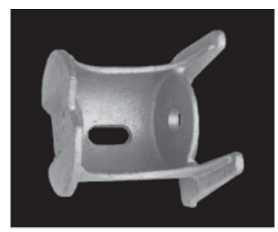
Tighten locking stud finger tight plus one quarter turn only—then lock in place.



Clamp Top Insulator Adapter
SAP 10068600

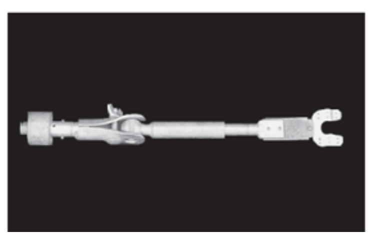


Slack Span
Dead-end Clamp

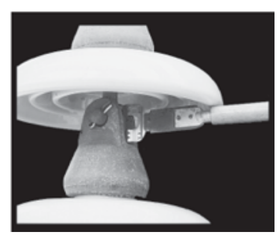


Post Insulator Extension Bracket
SAP 10067364

New Flange Type RIV Clip
SAP 10067683
This type of RIV elimination will be used where it is impractical to change out Dead-end insulators.



Static Clip Installation Tool
SAP 10148168



Insert RIV clip between metal hardware on existing 6" bell Dead-end for RIV suppression.

Table CO 209–1: Dead-end Clamps

Conductor Size	Clamp Material	Application and Maximum Tension	Dead-End Clamp SAP
#4 str–#2 str Cu & 4–1/0 ACSR	Galvanized Steel	1,415 lb California Light-Loading Areas only. Full tension.	10067502
2/0 ACSR or 2/0 Cu	Galvanized Steel	600 lb slack spans only.	10067502
336.4 ACSR 4/0 Cu or 4/0 ACSR	Galvanized Steel	600 lb slack spans only.	10067497
653.9 ACSR	Aluminum	600 lb slack spans only.	10067501

CO 211 Dead-Ending — Wood Crossarm Construction

Scope CO 211.1 Wood Crossarm Construction Requirements for Dead-Ending Conductors

Figure CO 211–1: Wood Crossarm Construction Requirements for Dead-Ending Conductors

Figure CO 211–1.1
(See Note 5)

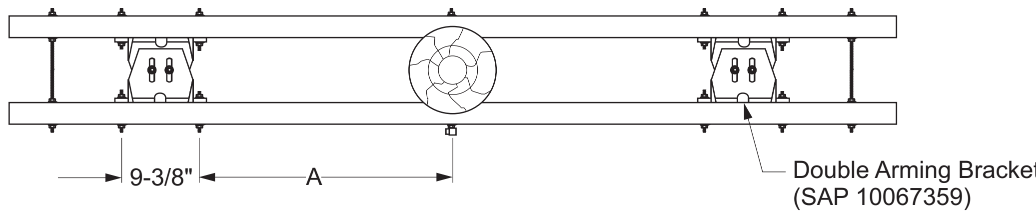


Figure CO 211–1.2
(See Note 6)

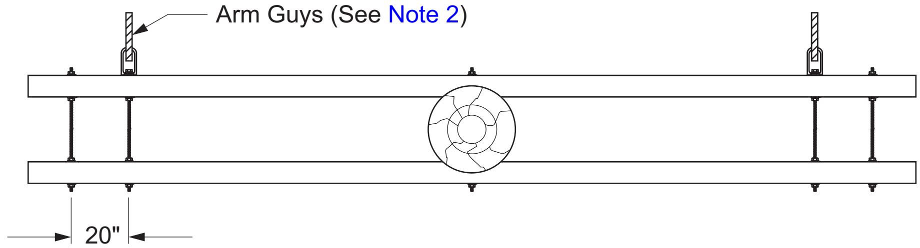


Figure CO 211–1.3
(See Note 7)

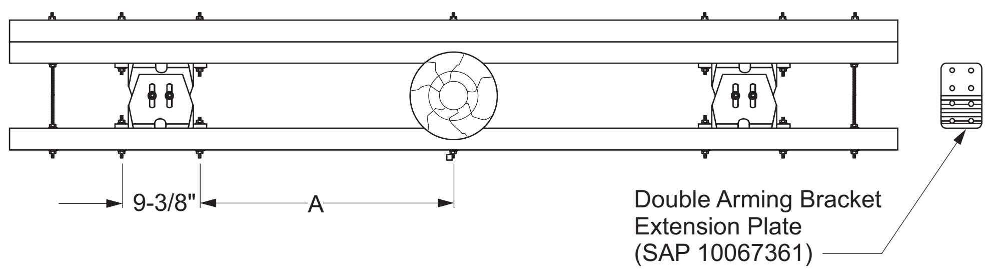
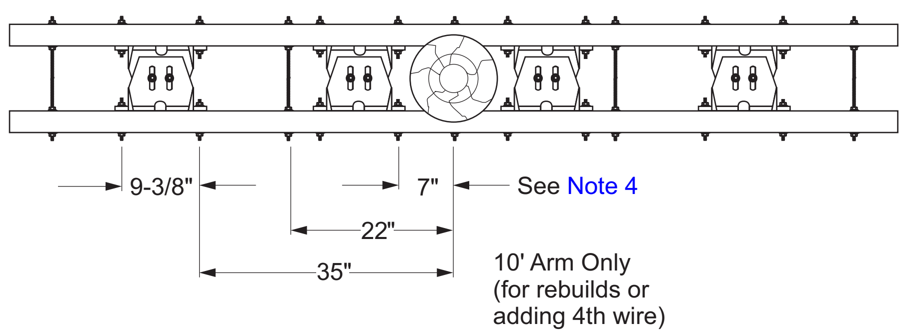


Figure CO 211–1.4
(See Note 8)



Note(s):

1. Double arming brackets may be used on poles with diameters of 6-3/4 inches to 10-1/2 inches. For poles with diameters of 10-1/2 inches to 17-1/2 inches, use extension plate with double arming brackets.
2. Arm guys shall be 3/8 inch backed up by 3/8-inch anchor guys, as per PO 320.
3. For Figure CO 211–1.1, Figure CO 211–1.3, and Figure CO 211–1.4, use anchor guys only.

4. As shown below, a 7-inch measurement on Figure CO 211–1.4 may be increased for large diameter poles.

Dimension A	
8' Arm	27"
10' Arm	35"

5. Applicable to conductor sizes: 1/0 ACSR, 4/0 ACSR, 336.4 kcmil ACSR, 2/0 Cu, 4/0 Cu
6. Applicable to conductor sizes: 4/0 ACSR, 336.4 kcmil ACSR, 653.9 kcmil, 2/0 Cu, 4/0 Cu
7. Applicable to conductor sizes: 4/0 ACSR, 336.4 kcmil ACSR, 653.9 kcmil, 2/0 Cu, 4/0 Cu
8. Applicable to conductor sizes: 4/0 ACSR, 336.4 kcmil ACSR, 4/0 Cu

CO 212 Dead-Ending — Composite Crossarm Construction

Scope CO 212.1 Composite Crossarm Construction Requirements for Dead-Ending Conductors

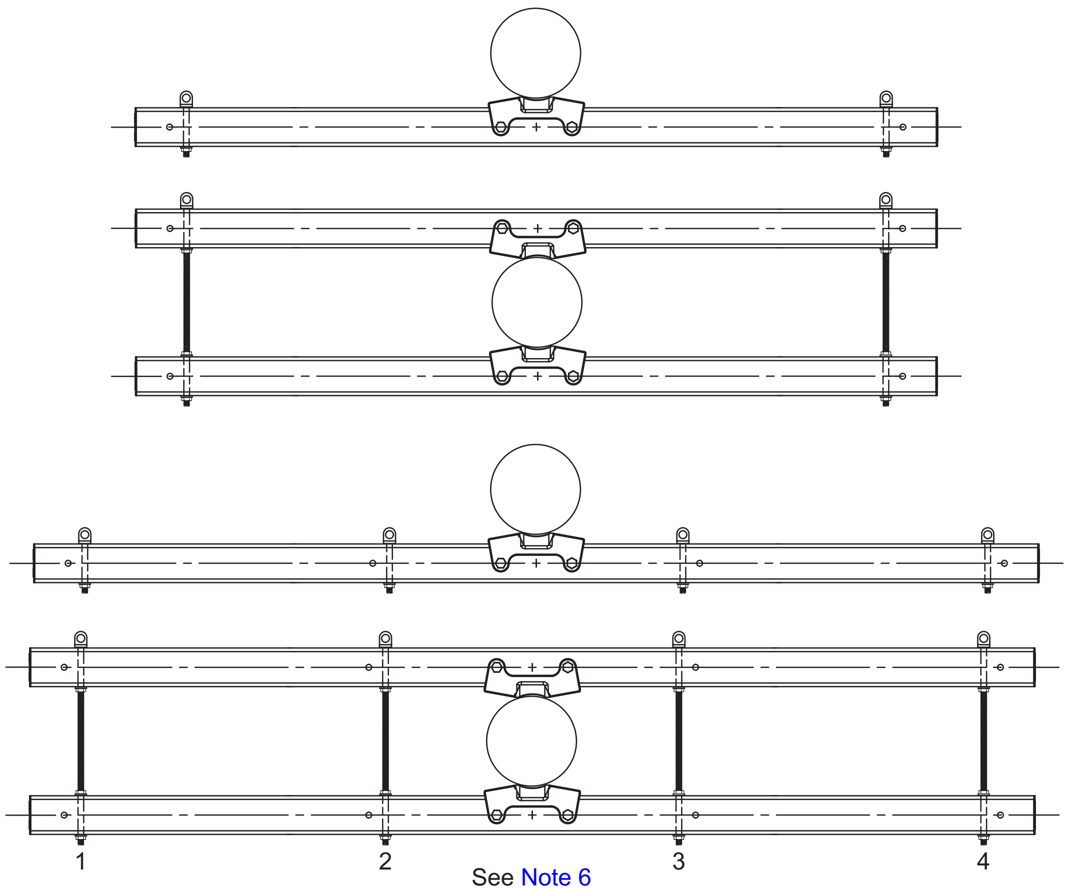
Figure CO 212–1: Composite Crossarm Construction Requirements for Dead-Ending Conductors

Figure CO 212–1.1: 8 ft Single

Figure CO 212–1.2: 8 ft Double

Figure CO 212–1.3: 10 & 12 ft Single

Figure CO 212–1.4: 10 & 12 ft Double



Note(s):

1. Mount arm bracket to pole with 3/4-inch bolts and spring washers.
2. Use 4" × 4" × 1/4" square flat washer (SAP 10071859) on all crossarm bolts.
3. Use spring washers on all crossarm and hardware bolts. Tighten only until spring washer fully compresses (30 ft. lbs). Do not over tighten.
4. Triple arm construction is not required when using composite crossarms.
5. Double arming brackets shall not be used on composite crossarms.
6. DA bolt is required for positions 1 and 4 for all types of installations. For 3-wire configurations utilizing positions 2 or 3, DA bolt is only needed when conductor is dead-ended to it.
7. These requirements are applicable when dead-ending bare or covered conductors, as shown on Figure CO 212–1.

CO 215 Dead-Ending — Copper Conductors

Scope CO 215.1 Typical Dead-Ending for Copper Conductors

1.0 Copper Automatic Dead-Ends Rigid Bail (for Pin and Clevis Insulators)

1.1 Application

To be used on copper conductors in light or moderate contamination areas. See GR 215. Not to be reused.

Table CO 215–1: Copper Automatic Dead-Ends Rigid Bail (Light/Moderate Contamination Areas)

Copper/Copperweld Conductors Only			
Wire Size			
Copperweld	Solid Copper	Stranded Copper	SAP
6 SOL	#6	#8	10067513
—	#4	#6	10067514
—	—	#4	10067515
—	#2	#3	10067516
—	#1	#2	10067517
—	3/0	2/0	10067518
—	—	4/0	10067519
4A	—	—	10067508
6A	—	—	10067509

Figure CO 215–1: Copper Automatic Dead-Ends Rigid Bail (for Pin and Clevis Insulators)

1.2 Application

To be used on copper conductors in high-contamination areas. Galvanized quadrant clamps (pistol grips) may be used in lieu of rigid automatic dead-ends in high-contamination areas. See CO 207 for quadrant clamps. See GR 215. Not to be reused.

Table CO 215–2: Copper Automatic Dead-Ends Rigid Bail (High-Contamination Areas)

Wire Size		SAP
Solid	Stranded	
8	#8	10067512
6	8	10067520
4	#6 Cu, 8A CW	10067521
—	4	10067522
2	—	10067523
—	2	10067524
—	1/0	10067525

2.0 Flexible Bail (For Spool or Streetlight Insulators)

2.1 Application

To be used on copper conductors. Not to be reused.

Table CO 215–3: Flexible Bail (for Spool or Streetlight Insulators)

Copper/Copperweld Conductors Only			
Wire Size			SAP
Copperweld	Solid Copper	Stranded Copper	
N/A	#6	#8	10067531
—	#4	#6	10067532
6A	—	#4	10067533
—	#2	#3	10067534
4A	#1	#2	10067535
—	3/0	2/0	10067536
—	—	4/0	10067537

Figure CO 215–2: Flexible Bail (for Spool or Streetlight Insulators)

What's Changed? Updated SAP numbers for flexible bail automatic dead-ends.

CO 217 Dead-ending Method—Sectionalizer Links (Isolators)

Scope CO 217.1 Typical Construction for Sectionalizer Links/Isolators

1.0 Secondary Sectionalizer Links/Isolators

To sectionalize, or Isolate secondary circuits with wire sizes up to 3/0, use SAP 10068250 (see Figure CO 217–1).

Figure CO 217–1: Secondary Sectionalizer Link/Isolator

Note(s):

1. To be used on voltages up to 480 Volts only.
2. Fits wire size up to 3/0.

2.0 Primary Sectionalizer Links/Isolators

To sectionalize, or Isolate primary circuits with wire sizes between 4/0 to 653MCM, use Table CO 217–1 below and select the appropriately sized Dead-end Shoes for the application per Table CO 207–3. See Figure CO 217–3 for construction details.

To sectionalize, or Isolate primary circuits with wire sizes up to 3/0, use SAP 10068251. Approved conductor size ranges from #6 to 3/0 (see Figure CO 217–2).

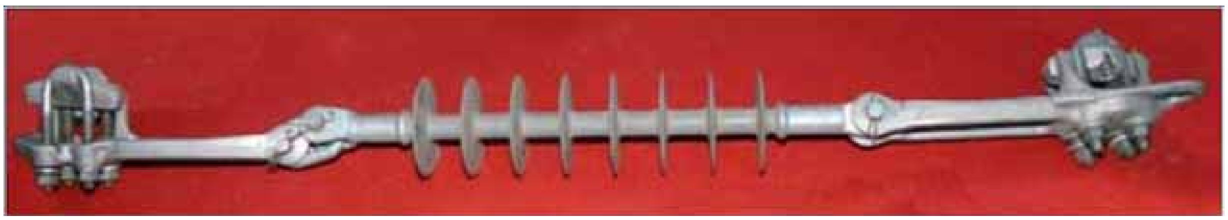
Figure CO 217–2: Primary Sectionalizer Link (up to 3/0; Max 25 kV)

FOR REFERENCE ONLY

Table CO 217–1: Primary Sectionalizer (4/0 to 653; Max 33 kV)

Description	SAP
33 kV Dead-End Insulator	10116432
Chain Link Oval Eye	10068257
4/0 to 336 Dead-End Shoe	10067487
653 Dead-End Shoe	10067488

Figure CO 217–3: Primary Sectionalizer (4/0 to 653)



CO 300 Copper-to-Copper Connectors

Scope CO 300.1 Copper-to-Copper Connectors

1.0 Split Bolts

1.1 Application

Secondary copper-to-copper connections, in non-High Fire Risk Areas (HFRA).

Grounding connections for lightning arresters and potheads.

Material:

Table CO 300–1: Split Bolts (Copper-to-Copper Connections Only)

Equal Size Run and Tap		MIN Tap with MAX Cable Run	SAP
MIN	MAX		
#10 Str.	#8 Str.	#14 Str.	10111553
#8 Str.	#6 SOL	#14 Str.	10111554
#8 Str.	#4 SOL	#14 Str.	10111555
#6 Str.	#2 SOL	#14 Str.	10111556
#6 Str.	#2 Str.	#14 Str.	10111557
#2 Str.	2/0 Str.	#14 Str.	10111559

Figure CO 300–1: Split Bolts

2.0 Two Bolt

2.1 Application

Secondary copper-to-copper connections, in non-HFRA.

Material:

Table CO 300–2: Two Bolts

Copper-to-Copper Connections Only				
Run		Tap		
MIN	MAX	MIN	MAX	SAP
#2 Str.	2/0 Str.	#6 Str.	2/0 Str.	10111579
1/0 Str.	4/0 Str.	#6 Str.	4/0 Str.	10111580
4/0 Str.	350 kcmil	#4 Str.	350 kcmil	10111581
400 kcmil	500 kcmil	#4 Str.	500 kcmil	10111582
600 kcmil	800 kcmil	3/0 Str.	800 kcmil	10111583
750 kcmil	1000 kcmil	3/0 Str.	1000 kcmil	10111584

Figure CO 300–2: Two Bolt

3.0 Vise Type

3.1 Application

Copper-to-copper connections for all distribution voltages in non-HFRA when Bolted Wedge or Parallel Groove connectors are not being used.

Grounding connections for lightning arresters and potheads (all applications).

Material:

Table CO 300–3: Vise Type (Copper-to-Copper Connections Only)

MIN	MAX	SAP
#8 Sol	#4 Str	10111595
#5 Sol	#2 Str	10111602
#3 Sol	2/0 Str	10111603
#1 Sol	4/0 Str	10111604

Figure CO 300–3: Vise Type

4.0 Parallel Groove

4.1 Application

Copper-to-copper connections in HFRA when Bolted Wedge connectors are not being used.

Material:

Table CO 300–4: Parallel Groove (Copper-to-Copper Connections Only)

Run		Tap		
MIN	MAX	MIN	MAX	SAP
#6	2/0 Str.	#6	2/0 Str.	10213604
#6	4/0 Str.	#6	4/0 Str.	10111472

Figure CO 300–4: Parallel Groove

5.0 Hot Line Clamp

5.1 Application

Hot Line Clamps for primary distribution connections shall only be used on:

- Potential Transformers
- Lightning Arresters in HFRA and non-HFRA

Material:

Table CO 300–5: Hot Line Clamp (Copper-to-Copper Connections Only)

Conductor Range				
Copper		Copper		
Run		Tap		
MIN	MAX	MIN	MAX	SAP
#8 SOL	2/0 Str.	#8 SOL	2/0 Str.	10111542[a/b/]
#6 SOL	400	#6 SOL	4/0 Str.	10111543[b/]

[a/] Figure CO 300–5: Hot Line Clamp
[b/] Clamp uses 11/16 inch tap nut.

Figure CO 300–5: Hot Line Clamp

CO 305 Connectors — Copper-to-Aluminum and Aluminum-to-Aluminum

Scope CO 305.1 Connectors — Copper-to-Aluminum and Aluminum-to-Aluminum

1.0 Connectors — Copper-to-Aluminum and Aluminum-to-Aluminum

Figure CO 305–1: Insulated Service Sleeves

Table CO 305–1: Insulated Service Sleeves

Service Conductor		Customer's Conductors				Crimps Per End	
		Copper					
Aluminum	Color Code	Solid	Strand	Color Code	SAP	OH-25	MD-6
#6 Solid	Green	#8	#10	Brown	10112111	1	3
#6 Solid	Green	#6	#8	Green	10112112	1	3
#6 Solid	Green	#4	#5 & 6	Blue	10112114	1	3
#6 Solid	Green	#2	#3 & 4	Orange	10112116	1	3
#6 Solid	Green	—	#1 & 2	Red	10112118	1	3
#6 Solid	Green	—	1/0	Yellow	10112119	1	3
#6 Str. or ACSR	Blue	#8	#10	Brown	10112113	1	3
#6 Str. or ACSR	Blue	#4	#5 & 6	Blue	10112115	1	3
#6 Str. or ACSR	Blue	—	#1 & 2	Red	10112120	1	3
#6 Str. or ACSR	Blue	—	1/0	Yellow	10112121	1	3
#4 Str. or ACSR	Orange	#8	#10	Brown	10112110	1	3
#4 Str. or ACSR	Orange	#4	#5 & 6	Blue	10112117	1	3
#4 Str. or ACSR	Orange	#2	#3 & 4	Orange	10112122	1	3
#4 Str. or ACSR	Orange	—	1/0	Yellow	10112123	1	3
#1 & 2 Str. or ACSR	Red	#8	#10	Brown	10112126	1	3
#1 & 2 Str. or ACSR	Red	#2	#3 & 4	Orange	10112124	1	3
#1 & 2 Str. or ACSR	Red	—	#1 & 2	Red	10112125	1	3
#1 & 2 Str. or ACSR	Red	—	1/0	Yellow	10112127	1	3
1/0 Str. or ACSR	Yellow	—	1/0	Yellow	10112128	1	3

1.1 Application

A. Load end of triplex or quadruplex service conductors #6 through 1/0.

B. Pole top on a pole with a single service.

C. Due to the inrush of large 3Ø motors and pumps, the use of insulated service sleeves is restricted to the maximum horsepower as listed in the table below:

Table CO 305–2: Maximum 3-Phase Horsepower Rating Using Insulated Service Sleeve Connectors

Size Quadruplex (AWG)	Current Capacity (A)	Maximum 3Ø Horsepower Rating Using Insulated Service Sleeve Connectors		
		208 V	240 V	480 V
#4	100	15	15	30
1/0	180	20	20	50

Note(s):

1. Install with a mechanical compression tool.
2. DO NOT USE on UNINSULATED conductors.
3. This IS NOT a tension splice.

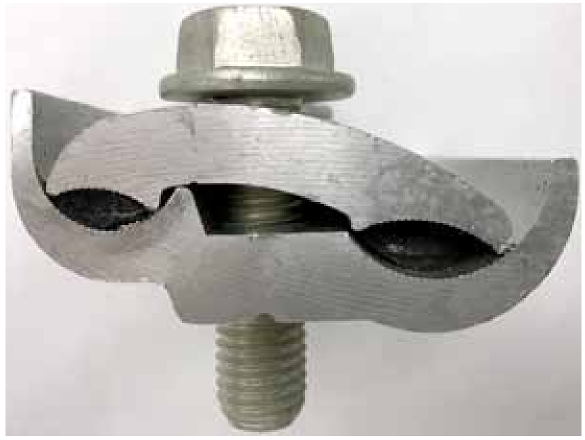
1.2 Approved Tools:

A. Burndy OH-25 Hand Tool (SAP 10148823)

B. Burndy MD-6 (SAP 10148818)

2.0 Parallel Groove

Figure CO 305–2: Parallel Groove



2.1 Application

Alternative primary voltage connector when unable to install bolted wedge connectors due to work methods, lack of proper tooling, or lack of bucket access.

Secondary voltage connections.

Table CO 305–3: Parallel Groove

Conductor Range					
Number Bolts	Run		Tap		SAP
	ACSR	Al or Cu	ACSR	Al or Cu	
1[a/]	#6 - 1/0	#8 - 1/0	#6 - 1/0	#8 - 1/0	10112373
1	#6 - 2/0	#6 SOL - 2/0 Str.	#6 - 2/0	#6 SOL - 2/0 Str.	10112370
1	#6 - 2/0 (6/1)	#6 SOL - 3/0 Str.	#6 - 2/0 (6/1)	#6 SOL - 3/0 Str.	10112357
1	3/0 - 397.5 18/1	3/0 - 400	#6 - 2/0	#6 SOL - 2/0 Str.	10112369
3	3/0 - 397.5 18/1	3/0 - 400	3/0 - 397.5 18/1	3/0 - 400	10112368
1	397.5 18/1 - 795 26/7	450 - 1000	#6 - 2/0	#6 SOL - 2/0 Str.	10112374
2	397.5 18/1 - 795 26/7	450 - 1000	3/0 - 397.5 18.1	3/0 - 400	10112371
3	397.5 18/1 - 795 26/7	450 - 1000	397.5 18/1 - 795 26/7	450 - 1000	10112372

[a/] To be used on 0–5,000 V only.

3.0 Two-Bolt

Figure CO 305–3: Two-Bolt

3.1 Application

Secondary connections larger than 4/0 all-aluminum or 4/0 ACSR.

Table CO 305–4: Two Bolts

Conductor								
Copper and Aluminum				ACSR				
Run		Tap		Run		Tap		
MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	SAP
#2 Str.	2/0 Str.	#10 Str.	2/0 Str.	#3 Str.	1/00 Str.	#6 Str.	1/0 Str.	10112425
1/0 Str.	4/0 Str.	#10 Str.	4/0 Str.	1/0 Str.	4/0 Str.	#6 Str.	4/0 Str.	10112426
400 kcmil	500 kcmil	#4 Str.	500 kcmil	336.4 kcmil	397.5 kcmil	#5 Str.	397.5 kcmil	10112427
400 kcmil	800 kcmil	3/0 Str.	800 kcmil	336.4 kcmil	715.5 kcmil	3/0 Str.	715.5 kcmil	10112428
500 kcmil	1000 kcmil	3/0 Str.	1000 kcmil	397.5 kcmil	900 kcmil	3/0 Str.	900 kcmil	10112429

4.0 Hot Line Clamp

Figure CO 305–4: Hot Line Clamp

4.1 Application

Hot line clamps are for primary distribution tap connections shall only be used on:

- Potential Transformers in Non-HFRA
- Lightning Arresters in HFRA and Non-HFRA

Table CO 305–5: Hot Line Clamp
(Aluminum to Aluminum and Aluminum to Copper Connections)

Conductor Range				
ACSR		ACSR (Aluminum)/Copper		
Run		Tap		
MIN	MAX	MIN	MAX	SAP
#8	2/0 Str.	#8	1/0	10111541[a/]
#6	397.5	#6	3/0	10111539[b/c/]
556.5	954	#4	266.8	10111540[a/]

[a/] Clamp uses 11/16 inch tap nut.
[b/] Figure CO 305–4: Hot Line Clamp
[c/] Clamp uses 3/4 inch tap nut.

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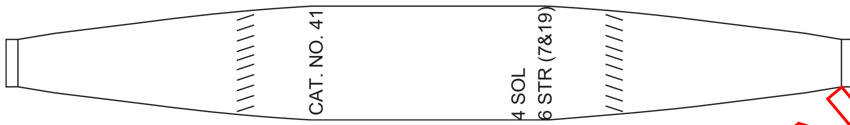
CO 400 Splices — Full Tension — Copper #8 — 250 kcmil

Scope CO 400.1 Full Tension Splice Information for Copper #8 — 250 kcmil Automatic Splices

1.0 Full Tension Splice Information for Copper #8 — 250 kcmil Automatic Splices

Figure CO 400–1: Full Tension — Copper #8 — 250 kcmil Splice



1.1 Application

May be used on all distribution voltages. Not to be reused. FOR EMERGENCY USE ONLY.

Material:

Table CO 400–1: Full Tension — Copper #8 — 250 kcmil Splices

Copper/Copperweld Conductors Only			
Maximum Wire Size			SAP
Copperweld	Solid Cu	Stranded Cu	
		#8	10110794
8A	#4	#6	10110796
	—	#4	10110797
5A	#2	#3	10110798
4A	#1	#2	10110799
	1/0	#1	10110800
	2/0	1/0	10110801
	3/0	2/0	10110802
	—	4/0	10110804
	—	250 kcmil	10110803

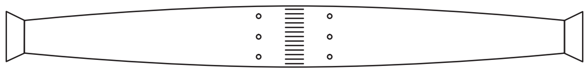
Note(s):

1. Automatic splices shall not be installed for repairs or new construction.

Scope CO 400.2 Full Tension Splice Information for #4 — 336.4 ACSR Automatic Splice

2.0 Full Tension Splice Information for #4 — 336.4 ACSR Automatic Splice

Figure CO 400–2: Full Tension — #4 — 336.4 ACSR Automatic Splice



2.1 Application

For use on emergency work, all voltages/or hotline work on 12 kV, 16 kV, or 33 kV.

Note(s):

1. Automatic splices should be used when compression splice (preferred method) is not available. Not to be reused.

Table CO 400–2: Full Tension — #4 — 336.4 ACSR Automatic Splice

ACSR Sizes	SAP
#4	10112029
#6	10112030
1/0	10112031
2/0	10112032
4/0	10112033
336.4 18/1	10112034

Note(s):

1. Automatic splices shall not be installed for repairs or new construction.

What's Changed? Note 1 was added to state automatic splices shall not be installed for repairs or new construction.

CO 410 Compression Splices

Scope CO 410.1 Tool and Die List for Full Tension Compression Splices

1.0 Tool and Die List for Copper Full Tension Compression Splice

Figure CO 410–1: Copper Full Tension Compression Splice

1.1 Application

To be used on copper conductors of all distribution voltages.

Table CO 410–1: Copper Full Tension Compression Splice

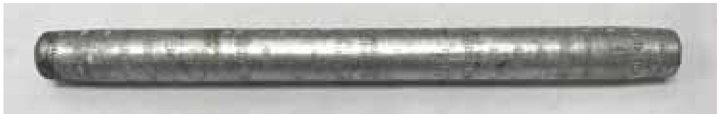
Wire Size	Splice SAP	MD-6 Die Number and SAP	Y34A Die Number and SAP	Y35-Y39-12HA Die Number and SAP	UT-15 Die Number and SAP	Number of Crimps per End
#8 SOL	10110772	W-161 10148858	N/A	N/A	N/A	1
#6 SOL	10110773	W-161 10148858	N/A	N/A	N/A	2
#4 SOL	10110774	W-162 10148861	N/A	N/A	N/A	5
#2 SOL	10110775	W-163 10148862	N/A	N/A	N/A	5
#4-7 Str.	10110776	W-162 10148861	N/A	N/A	N/A	5
#2-7 Str.	10110778	W-163 10148862	N/A	N/A	N/A	5
2/0 Str.	10110779	W-166 10148863	A166/A26YD 10148874	U-166 10148878	U-166 10148878	MD6=12 Others=6
4/0 Str.	10110781	N/A	A168/A28YD 10148875	U-168 10148880	U-168 10148880	9

Note(s):

1. Use adapter die SAP 10148852 to fit Y35, Y39, or 12HA dies in UT-15 tool.
2. Use adapter die SAP 10148851 to fit Y34A dies in UT-15 tool.

2.0 Tool and Die List for All Aluminum Full Tension Compression Splice

Figure CO 410–2: All Aluminum Full Tension Compression Splice



2.1 Application

Full tension splicing.

Table CO 410–2: All Aluminum Full Tension Compression Splice

Wire Size	Splice SAP	MD-6 Die Number and SAP	Y34A Die Number and SAP	Y35-Y39-12HA Die Number and SAP	UT-15 Die Number and SAP	Number of Crimps per End
#6 SOL	10112143	W-161 10148858	N/A	N/A	N/A	2
#6-7 Str.	10112144	W-161 10148858	N/A	N/A	N/A	2
#4-7 Str.	10112145	W-162 10148861	N/A	N/A	N/A	4
#2-7 Str.	10112146	W-163 10148862	N/A	N/A	N/A	5
#1/0-7 Str.	10112147	BG 10148818	N/A	N/A	N/A	8
4/0 7 Str.	10112148	N/A	A249 10148887	U-249 10148909	See Note 1 See Note 2	6
477 kcmil	10111998	N/A	N/A	15CA106H 10148853	See Note 1	Overlap

Note(s):

1. Use adapter die SAP 10148852 to fit Y35, Y39, or 12HA dies in UT-15 tool.
2. Use adapter die SAP 10148851 to fit Y34A dies in UT-15 tool.

Scope CO 410.2 Tool and Die List for Full and Partial Tension Compression and Repair Splices

1.0 Tool and Die List for ACSR Full and Partial Tension Compression and Repair Splices (Single Sleeve)

Figure CO 410–3: ACSR Full Tension Compression and Repair Splices (Single Sleeve)

1.1 Application

May be used on distribution voltages.

Table CO 410–3: ACSR Full and Partial Tension Compression and Repair Splices (Single Sleeve)

Wire Size	Splice SAP	Repair Splice SAP	MD-6 Die Number and SAP	Y35-Y39-12HA Die Number and SAP	UT-15 Die Number and SAP	Number of Crimps per End
#4 (6/1)	10112090	10212509	W-687 10148864	U-243 10148908	See Note 1	MD6=12 Others=6
#2 (6/1)	10112091	10212510	W-687 10148864	U-243 10148908	See Note 1	MD6=14 Others=7
1/0 (6/1)	10112092	10212511	W-702 10148865	U-247 10148910	See Note 1	MD6=14 Others=7
2/0 (6/1)	10112093	10212512	N/A	U-659 10148911	See Note 1	Overlap
4/0 (6/1)	10112094	10212513	N/A	U-654 10148912	See Note 1	Overlap
336.4 kcmil (18/1)	10112095	10212514	N/A	U-655 10148913	See Note 1	Overlap
653.9 kcmi l (18/3)	10112096	10213524	N/A	N/A	15C140R 10148896 See Note 2	22

Note(s):

1. Use adapter die SAP 10148852 to fit Y35, Y39, or 12HA dies in UT-15 tool.
2. Partial Tension Splice, 93 percent Rated Breaking Strength, (RBS), or 13,800 lb.

2.0 Tool and Die List for All Aluminum Partial Tension Compression Splice for Use on Aluminum or ACSR (Services/Jumpers)

Figure CO 410–4: All Aluminum Compression Splice for Use on Aluminum or ACSR-Partial Tension (Services/Jumpers)

2.1 Application

May be used on all distribution voltages.

Table CO 410–4: All Aluminum Partial Tension Compression Splice for Use on Aluminum or ACSR (Services/Jumpers)

Wire Size	Splice SAP	MD-6 Die Number and SAP	Y34A Die Number and SAP	Y35-Y39-12HA Die Number and SAP	UT-15 Die Number and SAP	Number of Crimps per End
#6 (6/1)	10112129	W-162 10148861	N/A	N/A	N/A	2
#4 (6/1)	10112130	W-162 10148861	N/A	N/A	N/A	4
#4 (6/1)	10112005	W-687 10148864	N/A	U-243 10148908	See Note 1	3
1/0 (6/1)	10112007	W-702 10148865	N/A	U-247 10148910	See Note 1	MD6=4 Others=3

Note(s):

1. Use adapter die SAP 10148852 to fit Y35, Y39, or 12HA dies in UT-15 tool.

Scope CO 410.3 Instructions for Installing Full Tension, Double-Sleeve, Compression Splices for ACSR Conductors

1.0 Instructions for Installing Full Tension, Double-Sleeve, Compression Splices for ACSR Conductors

Figure CO 410–5: Instructions for Installing Full Tension, Double-Sleeve, Compression Splices for ACSR Conductors

To be installed on de-energized conductors only.

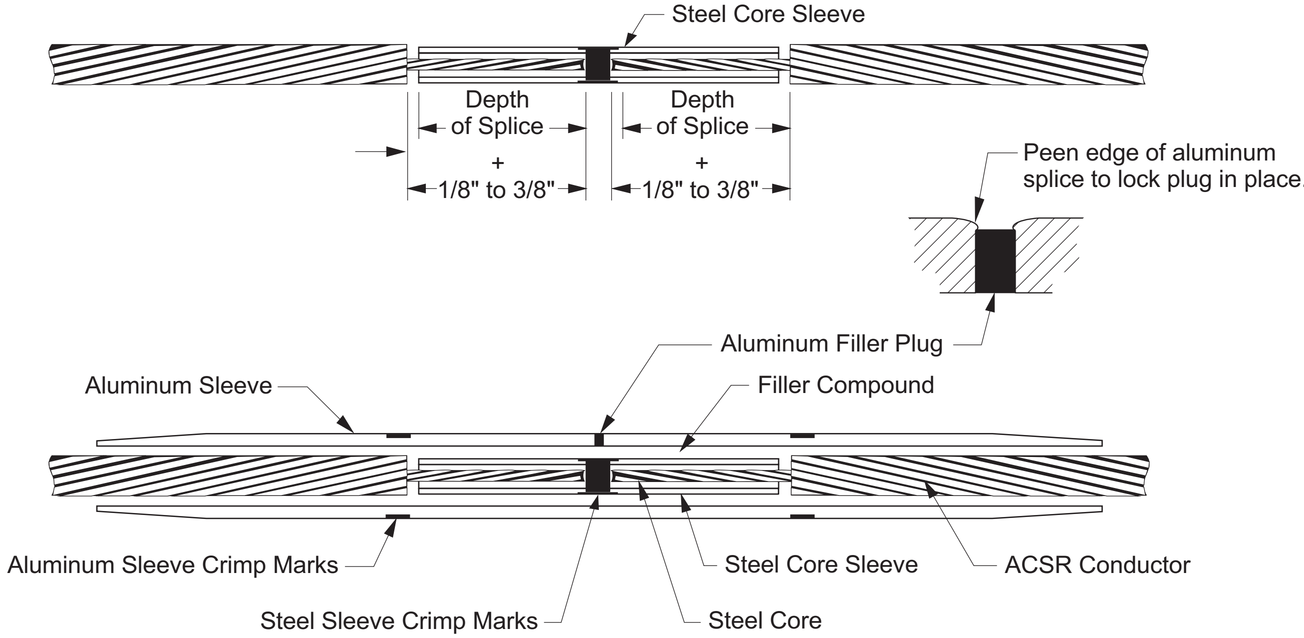


Table CO 410–5: Instructions for Installing Full Tension, Double-Sleeve, Compression Splices for ACSR Conductors

Conductor Size	SAP	Sleeve	Die SAP	UT-15	Y35-39
336.4-30x7	10112041	Aluminum Sleeve	10148918 10148917	B20AH-14AH[a/] B105H[a/]	B20AH-14AH B10SH

[a/] May be used in UT-15 with adapter die SAP 10148852.

Note(s):

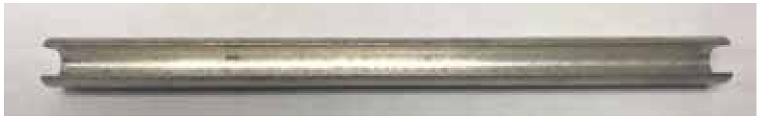
1. Surfaces of the conductor shall be cleaned of all foreign matter before splicing. Use a wire brush before applying a coat of filler compound (SAP 10064145).
2. The ends of conductor strands shall be examined for defects (burrs, nicks, and so forth) and the strands shall be counted to verify that they have the correct number for the subject conductor. The conductor ends shall be cut beyond any damaged or missing strands; The aluminum sleeve shall be thoroughly cleaned inside and out before it is slipped over the conductor ends.

3. Loose strands shall be tightened by having the outer layer twisted in the direction of the lay, and shall be bound with binding wire along the entire length over which strands have been tightened so as to prevent unravelling.
4. To allow for elongation of the steel sleeve during crimping, the aluminum strands shall be removed to a point not more than 3/8 inch nor less than 1/8 inch beyond the ends of the steel core sleeve.
5. The outer layers of aluminum strands shall be cut using a hack saw or an approved cable cutting tool. The inner layer shall be nicked only, with cutting completed by breaking the strands. The saw shall not touch the steel core. All cuts shall be square when finished.
6. The ends of the steel core shall be centered in the steel core sleeve with all binding removed from the steel core.
7. On Alcoa and Fargo steel core splices, pressing shall start adjacent to the center mark on each sleeve and continue to the ends leaving no space between presses.
8. The correct die shall be selected each time by matching the index numbers stamped on both the sleeve and die set.
9. After the wire binding has been removed from the aluminum strands, the aluminum sleeve shall be centered over the steel sleeve. Any looseness in the strands shall be worked into the sleeve and the conductor tightly bound with wire just outside each sleeve end. A double check shall be made of the correct position of the aluminum sleeve over the core splice by marking with tape the points where the ends of the sleeve should fall.
10. Before pressing, the space between the steel and aluminum sleeves shall be filled with filler compound using a caulking gun. Grease shall be forced into the filling hole until it comes out at each end of the sleeve. Using a hammer and punch, the aluminum plug shall then be driven into the fill hole and locked in place by peening the edge of the hole opening over it.
11. On Alcoa and Fargo splices, pressing of the aluminum sleeve shall start at the ends of the steel core (at the marks on sleeve) and continue toward the ends. Pressing shall be continuous, leaving no space between presses.
12. Should there be any indication of the splice bending during pressing operations, the press shall be reversed in direction for each compression.
13. At the completion of pressing operations, all wrapping, binding, and excess grease shall be removed.
14. The conductor strands shall be snugly seated after the splice is completed. Slight bends in the splice can be removed with a hammer, by using a hardwood block above and below the splice to protect the splice from direct blows of the hammer.
15. A parallel groove clamp may be substituted wherever wire binding is specified.

Scope CO 410.4 ACSR Repair Splice for #4, 1/0, and 336.4 ACSR

1.0 ACSR Repair Splice for #4, 1/0, and 336.4 ACSR

Figure CO 410–6: ACSR Repair Splice for #4, 1/0, and 336.4 ACSR



1.1 Application

Used to repair damaged #4, 1/0, and 336.4 ACSR conductors. The U-shaped splice completely encloses all strands and restores full load rating to Al/ACSR conductors with burned or mechanically damaged strands. The splice is not to be used on conductors where the steel core of an ACSR conductor has been damaged, or where more than 1/3 of the conductor strands have been damaged.

The splice is designed to be applied without cutting the conductor (requiring bypasses, wire grips or hot hoists).

1.2 Installation

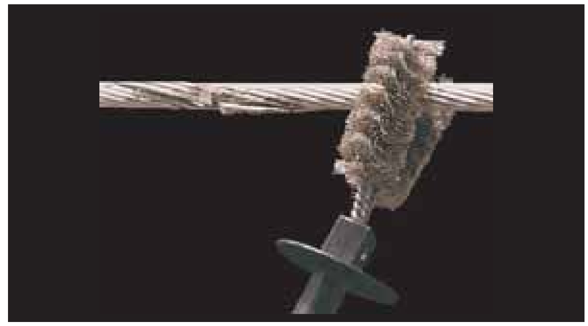
A. Inspect the damaged conductor. The steel core must be undamaged and no more than 1/3 of the conductor strands damaged.

B. Select the splice, correct die, and the crimping tool from the table.

Conductor Size	SAP	Length (in)	Die	
			MD-6	12HA, UT-15, Y-35
#4 ACSR	10111822	7	W-163	U-163
1/0 ACSR	10111823	8	W-165, W-166	U-165, U-166
336.4 ACSR	10111824	12	—	U-655

C. Reseat the damaged strands to the line. This may take a little time and may involve trimming a few strands. Damage to the conductor (including any necessary trimming) must not exceed 1 inch in length.

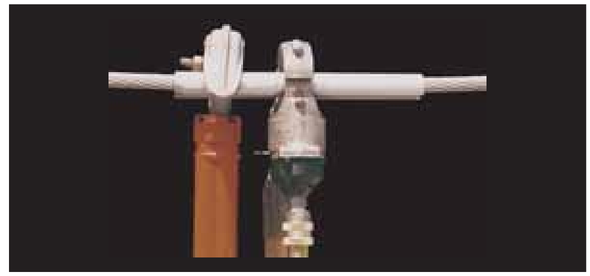
D. Properly clean and grease conductor. This step is very important to ensure a good electrical splice.

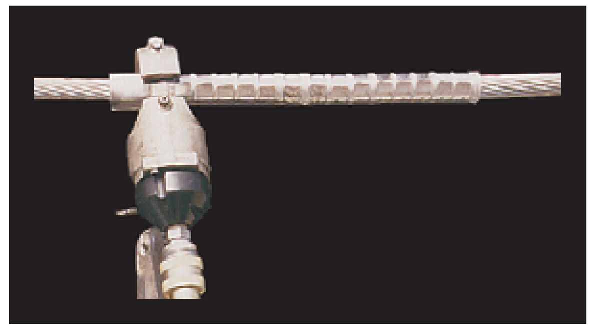


E. Install splice — generally install the U-shaped splice on top of the conductor and center on the damaged area, so that the open side of the splice is pointed down. A duckbill ground clamp is used to install the splice onto the conductor.

F. Position the splice so that the opened side of the splice is pointing towards the upper or lower die. Do not install the splice so that the opened side of the splice is pointing towards the seam between the upper and lower die.

G. Start crimps at center of splice, working towards each end. Space each crimp approximately 1/16 inch–1/8 inch apart. It is not necessary to rotate crimps around the splice while crimping.





H. Finished splice.

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CO 420 Bolted Wedge Connector

Scope CO 420.1 ACSR - ACSR, ACSR - CU and CU - CU Bolted Wedge Connectors

Figure CO 420–1: ACSR - ACSR

Figure CO 420–2: ACSR - CU

Figure CO 420–3: CU - CU

1.0 General Information — Bolted Wedge Connector

The bolted wedge connector consists of two parts: the “C” member and the “interface”.

1.1 “C” Member

A heat treated spring-like “C” member exerts continuous pressure on the conductors once the shear bolt is tightened. The bolted wedge connector can be removed by loosening the bolt without damaging the conductors.

Figure CO 420–4: “C” Member

1.2 Interface

The interface is stamped with the corresponding conductor sizes for each side.

Figure CO 420–5: Interface

Figure CO 420–6: Stamped Interface

2.0 Application

Bolted Wedge Connectors are for primary distribution tap connections on overhead line taps, underground risers and equipment taps. Applications may include High Fire Risk Areas (HFRA) as clearing around the structures is not required (that is, exempt by California Department of Forestry).

2.1 Typical Applications

- Overhead main line to main line
- Overhead main line to UG main line risers
- Transformers and Transformer Banks (CU)
- Voltage Regulators (CU)
- Capacitor Banks (CU)
- OH Switches

Various sizes of bolted wedge connector are available for use on SCE's ACSR and Copper conductors and are all installed in the same manner per Table CO 420–1.

For detailed installation of connectors (see CO 100). When the main conductor is ACSR and tap conductor is CU, ACSR shall always be placed on top of CU.

Figure CO 420–7: ACSR on Top of CU

Table CO 420–1: Bolted Wedge Connectors

Conductor Range (in)							
Run			Tap				
ACSR	CU	Ø	ACSR	CU	Ø	Connector	Connector Cover
Size	Size	Range	Size	Size	Range	SAP #	SAP #
653.9		.953	653.9		.953	10212171	10212441
653.9		.953	336.4		.684–.741	10212172	10212442
653.9		.953	4/0	4/0	.522–.563	10212173	10212442
653.9		.953	1/0	2/0	.398–.414	10212174	10212442
653.9		.953	#4, #2	#6 Sol, #4, #2	.162–.316	10212175	10212442
336.4		.684–.741	336.4		.684–.741	10211096	10212442
336.4		.684–.741	4/0	4/0	.522 –.592	10211200	10212442
336.4		.684–.741	1/0	2/0	.398–.414	10211097	10212442
336.4 (30/7) *		.741	#2	#2	.292–.316	10211619	10212442
336 (30/7)		.741	#4	#6 Sol, #4	.162–.250	10211098	10212442
336.4 (18/1)		.684	#4, #2	#6 Sol, #4, #2	.162 –.316	10211098	10212442
4/0		.563	4/0	4/0	.522–.563	10211201	10212442
4/0		.563	#2, 1/0	2/0	.316 –.414	10211202	10212442
4/0		.563	#4	#6 Sol, #4, #2	.162 –.292	10211203	10212442
	4/0	.522	#4		.250	10211203	10212442
1/0	2/0	.398–.414	1/0		.398	10211099	10212442
1/0		.398	#4, #2	#6 Sol, #4, #2	.162 –.316	10211100	10212442
	2/0	.414	#4, #2		.250–.316	10211100	10212442
	4/0	.522	—	4/0	.522	10211101	10212442
	4/0	.522	—	2/0	.414	10211102	10212442
	4/0	.522	—	#6 Sol, #4, #2	.162–.292	10211103	10212442
	4/0	.522	#2, 1/0		.316–.398	10213121	10212442
	2/0	.414	—	2/0	.414	10211104	10212442
	2/0	.414	—	#6 Sol, #4, #2	.162 –.292	10211105	10212442
	#6 Sol, #4	.162 –.232	—	#6 Sol, #4	.162 –.232	10211106	10212442
	#2	.292	—	#6 Sol, #4, #2	.162 –.292	10212440	10212442
#2		.316	—	#6 Sol, #4 Sol	.162 –.204	10213122	10212442
#4		.250	#4	#6 Sol, #4	.162 –.250	10213122	10212442
#2		.316	#4	#4	.232–.250	10213123	10212442
	#2	.292	#4		.250	10213123	10212442
#2		.316	#2	#2	.292–.316	10213124	10212442

Note(s):

1. All conductors in Table CO 420–1 are stranded unless notes as solid (Sol).

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CO 450 Insulated Overhead Wire Spacers

Scope CO 450.1 Insulated Overhead Wire Spacers for 4 kV, 12 kV, 16 kV, and 34.5 kV Systems

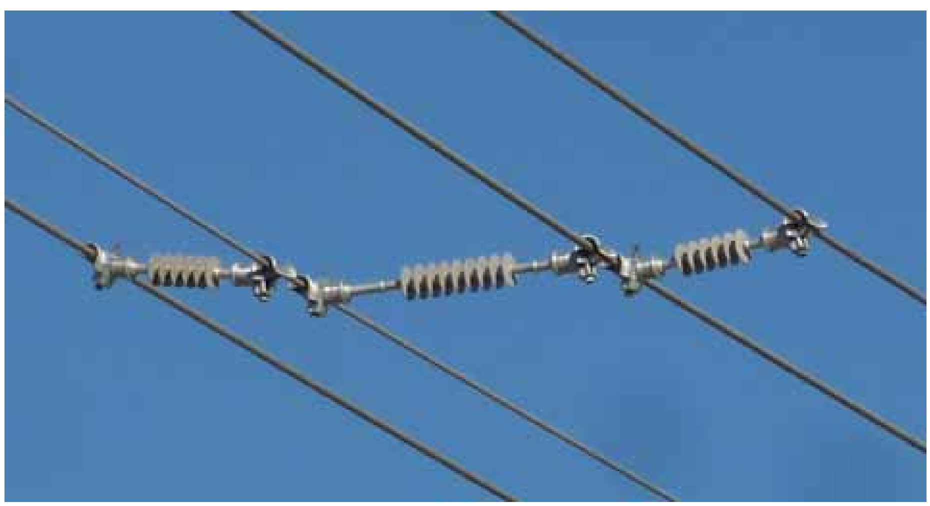
1.0 Installation

1. Line guard or armor rod protection shall be installed on all conductors that the wire spacers are to be attached to per Table 450–2 and Table 450–3. Maximum conductor sizes for wire spacers is 653 ACSR. More than one spacer can fit on a line guard or armor rod.
2. One set of spacers installed on a line span in horizontal configuration should be applied at the lowest point of sag, typically in the middle of the span.

NOTE The lowest point of sag in an incline span will be closer to the lower pole.

3. Two sets of spacers installed on a line span in horizontal configuration should be applied at 1/3 of the span length from each pole.
4. Spacers are not required on covered conductor.
5. Ensure there is proper vertical clearance between conductors as part of line spacer installation as sag can change with the installed weight of the spacer. Clearances to check may include separation between other conductors, communication, vegetation, and above grade distances.
6. Line spacers shall NOT be installed for spans transitioning to or already in a ridge pin configuration (see DC 535).
7. Spacers require bucket truck access for installation.

Figure 450–1: Insulated Overhead Wire Spacers Installed on a Horizontal 4-Conductor System



2.0 Application

Table 450–1: Insulated Overhead Wire Spacer SAP Numbers and Conductor Range

Spacer Length (in)	MAX Voltage (kV)	Standard SAP	Standard Weight (lb)	ACSR Range	CU Range	Lightweight SAP	Lightweight Weight (lb)	ACSR Range	CU Range
23	25	10116357	7.2	2/0-653	2/0 to 4/0	10213526	3.1	#4 to 1/0	#6 Sol to #2 Str/4A Cwld
35	35	10116358	10.3			10213527	4.1		
53		10116359	9.0			10213528	4.9		
71		10116360	12.2			10213529	5.8		

Note(s):
1. The distance between two phase will dictate the length of the spacer used.
2. Select spacer that slightly pulls the conductors together rather than pushing them apart.

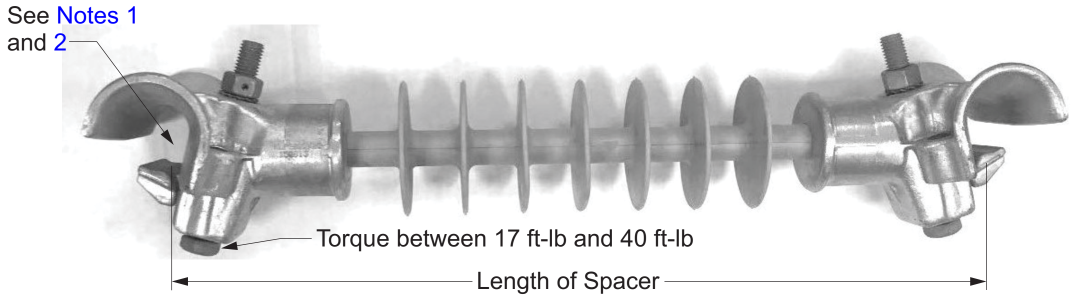
Table 450–2: Line Guard SAP Numbers and Requirements

Conductor Size	SAP	Line Guard	Spacer Type
#6 Sol, Cu	10212369	Required	Lightweight
#4 Sol, Cu	10212370	Required	Lightweight
#4 ACSR-6/1	10068425	Required	Lightweight
#2 ACSR-6/1	10068380	Required	Lightweight
1/0 ACSR-6/1	10068426	Required	Lightweight
4/0 ACSR-6/1	10068427	Optional	Standard
336.4 ACSR-18/1	10068428	Optional	Standard
336.4 ACSR-30/7	10068419	Optional	Standard
653.9 ACSR-18/3	10068420	Optional	Standard

Table 450–3: Armor Rod SAP Numbers and Requirements

Conductor size	SAP	Armor Rod	Spacer Type
#6 Sol Cu	10212369	Required	Lightweight
#4 Sol Cu/8A Cwld	10068381	Required	Lightweight
#4 Str. Cu/6A Cwld	10212637	Required	Lightweight
#2 Sol Cu	10212638	Required	Lightweight
#2 Str. Cu/4A Cwld	10068382	Required	Lightweight
2/0 Cu	10068383	Optional	Standard
4/0 Cu	10068384	Optional	Standard

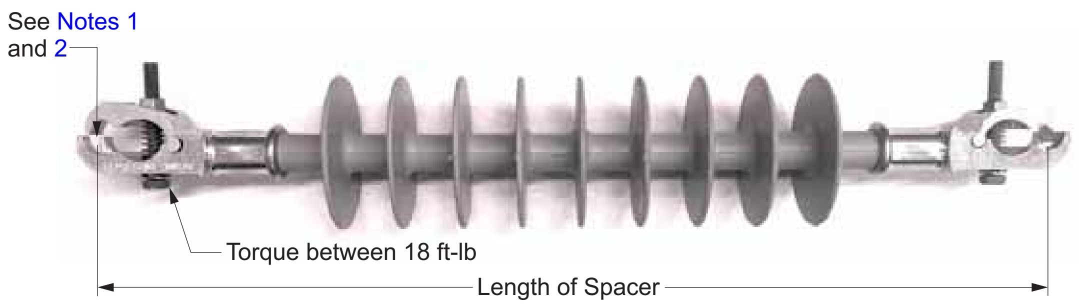
Figure 450–2: 23 Inch Insulated Overhead Wire Spacer



Note(s):

1. 23-inch spacer not applicable for 34.5 kV.
2. Conductor Range: 2/0 to 653 ACSR and 2/0 to 4/0 Cu.

Figure 450–3: 23 Inch Insulated Overhead Wire Spacer



Note(s):

1. 23-inch spacer not applicable for 34.5 kV.
2. Conductor Range: #4 to 1/0 ACSR and #6 Sol to #2 Str Cu/4A Cwld.

3.0 Horizontal Construction Installation Information

1. The line spacer on spans up to 400 feet shall be installed at the center for 3 or 4 wire systems as is shown in Figure 450–4 and Figure 450–5. If mid-span is not accessible, see Paragraph 2 (Page 5).

Figure 450–4: 3-Wire Installation Up To 400' Application (Overhead View)

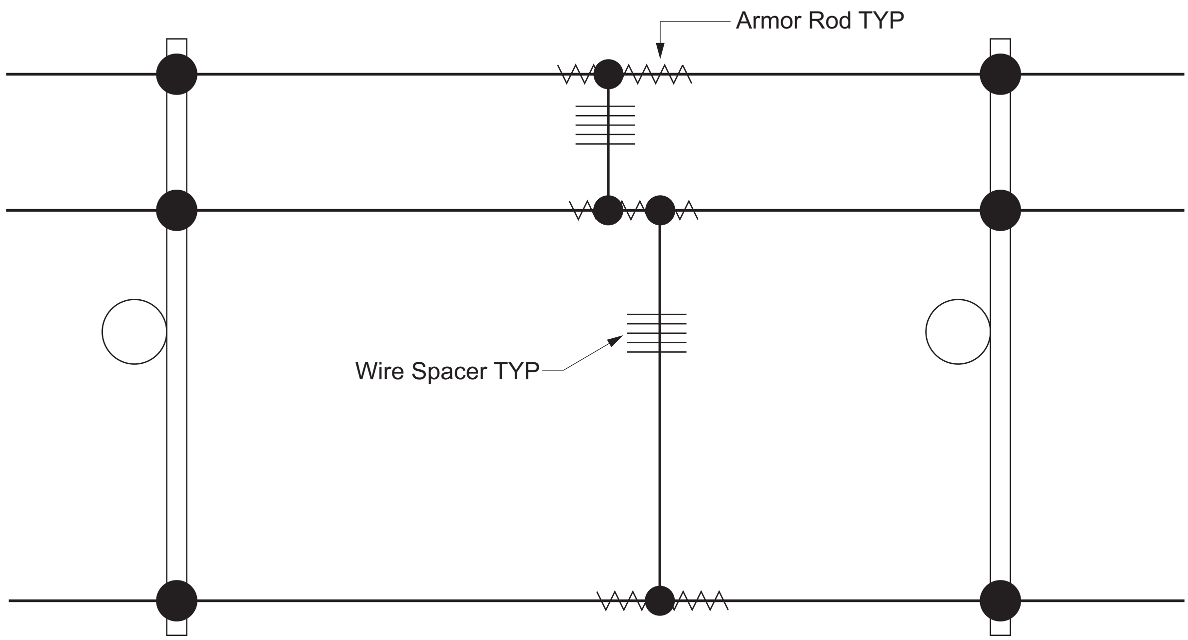
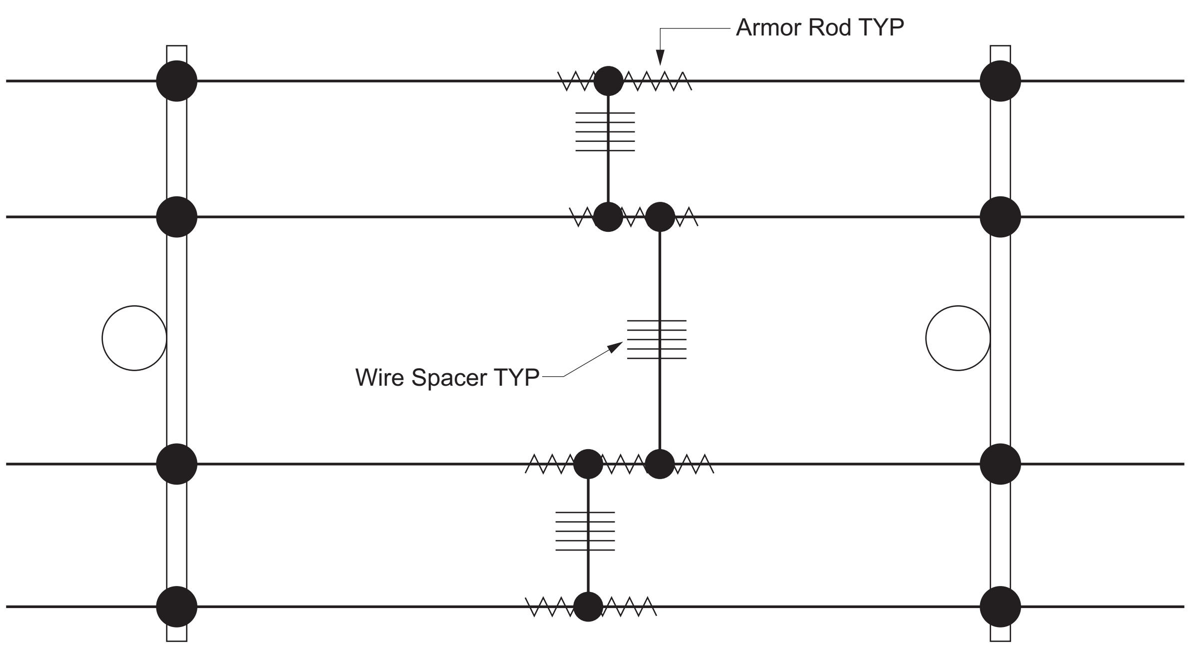


Figure 450–5: 4-Wire Installation Up To 400' Application (Overhead View)



2. The line spacer on spans over 400 feet or where the mid-span is not accessible shall be installed at 1/3 of the target span length from each pole for 3 or 4 wire systems as shown in Figure 450–6 and Figure 450–7.

Figure 450–6: 3-Wire Installation Over 400' (Overhead View)

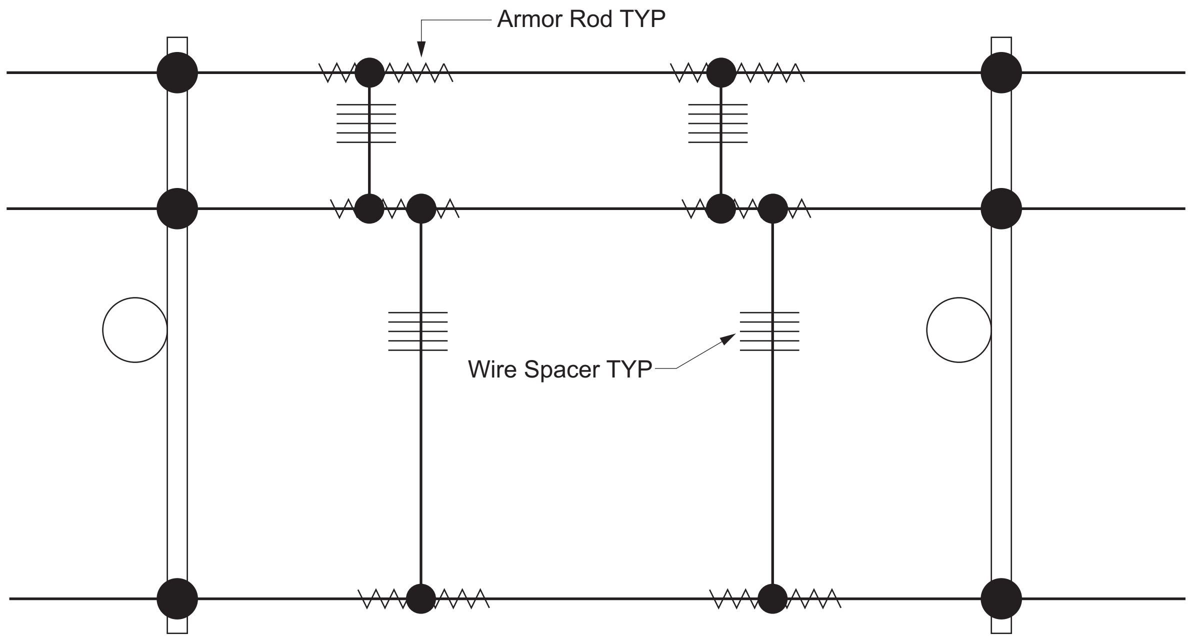
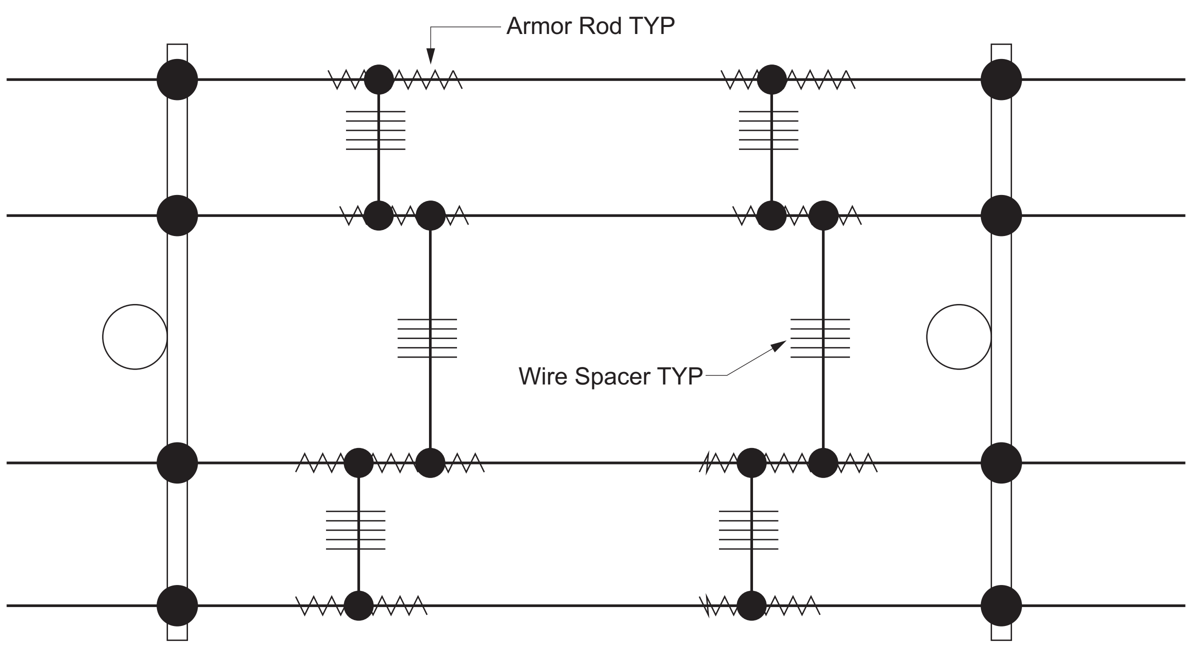


Figure 450–7: 4-Wire Installation Over 400' (Overhead View)



4.0 Vertical Construction Installation Information

1. Spacers installed on a line span in vertical configuration must be applied according to the following rules to prevent traveling wave/galloping problems as shown in Figure 450–8.
   - Maximum distance between spacers must be less than 240 feet.
   - Maximum distance from the pole to the first spacer must be less than or equal to 100 feet.
   - Adjacent subspans (for example, distance between adjacent spacers) must differ in length by at least 10 feet.
   - No more than two subspans in a given span can have the same length.

   The number of spacers required per conductor pair per span length are given in Table 450–4.

Figure 450–8: Vertical Configuration Line Guard or Armor Rod Installation (Side View)

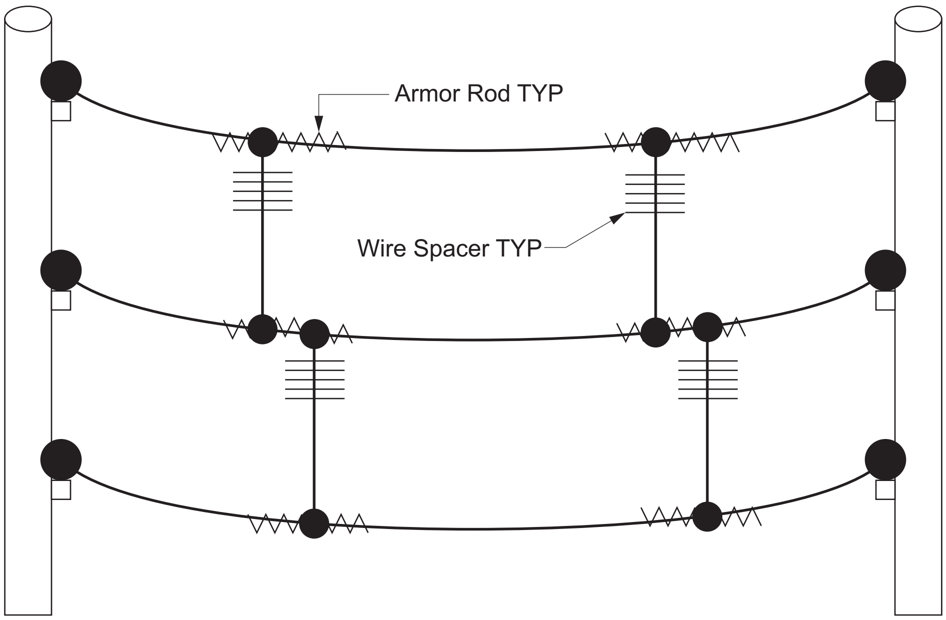


Table 450–4: Number of Spacers for Vertical Construction Based on Span Length

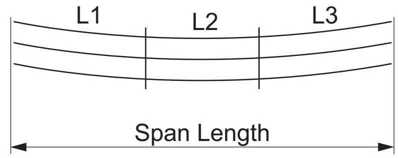
Span Length	No. of Spacers Required per Conductor Pair
190–400[a/]	2
410–590	3

[a/] For span lengths greater than 590 feet, contact Linear & Structural Strategies.

Note(s):
1. See Paragraph 1 (Page 6) for application to mitigate conductor galloping.
2. On a three wire system, assuming from the topmost conductor to the bottom most conductor, the following labeling, 123,the conductor pairs are defined as 1-2 and 2-3. For four wire (1234), the conductor pairs are 1-2, 2-3, and 3-4.

Table 450–5: Span Lengths from 190 ft to 400 ft (Vertical Configuration)

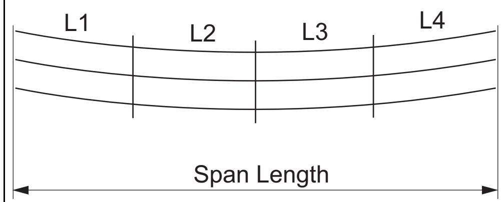
Two Spacers Per Conductor Pair Per Span



Span Length	L1	L2	L3
190	60	90	40
200	60	90	50
210	60	90	60
220	65	90	65
230	70	90	70
240	75	90	75
250	75	95	80
260	80	100	80
270	85	100	85
280	85	105	90
290	90	110	90
300	90	115	95
310	95	120	95
320	95	130	95
330	95	140	95
340	95	145	100
350	95	155	100
360	100	160	100
370	100	170	100
380	100	180	100
390	100	190	100
400	100	200	100

Table 450–6: Span Lengths from 410 ft to 590 ft (Vertical Configuration)

Three Spacers Per Conductor Pair Per Span



Span Length	L1	L2	L3	L4
410	80	110	140	80
420	80	120	140	80
430	85	120	140	85
440	90	120	140	90
450	95	120	140	95
460	100	120	140	100
470	100	120	150	100
480	100	130	150	100
490	100	130	160	100
500	100	140	160	100
510	100	140	170	100
520	100	150	170	100
530	100	150	180	100
540	100	160	180	100
550	100	160	190	100
560	100	170	190	100
570	100	170	200	100
580	100	180	200	100
590	100	190	200	100

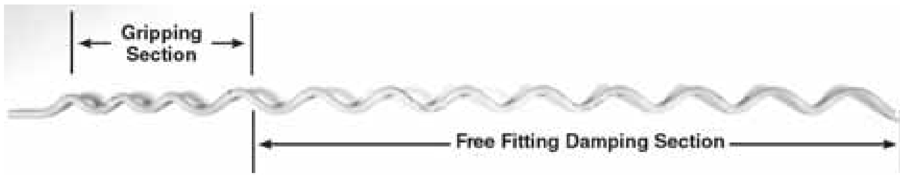
Note(s):

1. On a three wire system, assuming from the topmost conductor to the bottom most conductor, the following labeling, 123, the conductor pairs are defined as 1-2 and 2-3. For four wire (1234), the conductor pairs are 1-2, 2-3, and 3-4.

CO 460 Bare Wire System Installation Procedures for Spiral Vibration Dampers

Scope CO 460.1 Bare Wire System Installation Procedures for Spiral Vibration Dampers

Figure 460–1: Spiral Vibration Dampers



1.0 Bare Wire System Application

Use of the Spiral Vibration Dampers is intended to reduce Aeolian vibration (high frequency, low amplitude vibration) caused by wind blowing across overhead conductors. Aeolian vibration is generally produced by wind velocities below 15 MPH. Spiral Vibration Dampers shall be installed on spans 300 feet or greater for new construction or during planned maintenance activities. Spiral vibration dampers are not placement specific and may be installed on either end of the span.

Vibration dampers are not required in heavy loading areas, due to low conductor tensions when no ice is on the conductor. Vibration dampers will be installed in heavy loading areas if vibration of conductor is observed.

See CC 190 for Covered Conductor System application and installation procedures.

Table CO 460–1: SAP Numbers and Applicable Bare Conductor Sizes

SAP	Applicable Bare Conductor Size
10068551	#6 ACSR (Turkey) #4 Cu
10068553	#4 ACSR (Swan) #2 ACSR (Sparrow) #2 Cu
10068554	1/0 ACSR (Raven) 2/0 Cu
10068555	4/0 ACSR (Penguin) 4/0 Cu
10068556	336 ACSR (Merlin and Oriole)

Note(s):

1. For conductor sizes larger than 336 ACSR, transmission style stock-bridge dampers should be considered. Contact Transmission Engineering.

2.0 Installation

STEP 1. Choose the Spiral Vibration Damper that fits the conductor it will be installed on (see Table CO 460–1).

STEP 2. Inspect the conductor for strand damage and, if present, determine whether the Spiral Vibration Damper can be installed beyond the damaged area. If the conductor is in good shape proceed to Step 3.

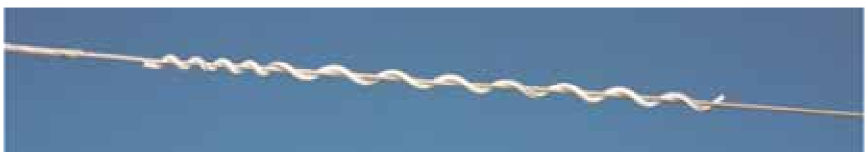
STEP 3. Install the spiral vibration damper onto the conductor by wrapping one side of the gripping section onto the conductor in a clockwise fashion. Maintain a minimum of 6 inches from dead-end or insulator conductor clamp.

STEP 4. Continue wrapping the damping section clockwise as well.

STEP 5. Make sure the damper is properly seated on the conductor at both ends.

STEP 6. A maximum of three Spiral Vibration Dampers can be interlaced, forming a subset, if setting 6 inches apart is not achievable (see Figure 460–3).

Figure 460–2: Complete Installation of Vibration Dampers



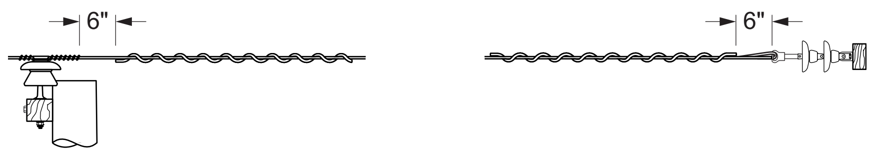


Figure 460–2.1: Two Vibration Dampers Per Conductor — Span Length 300'–800'

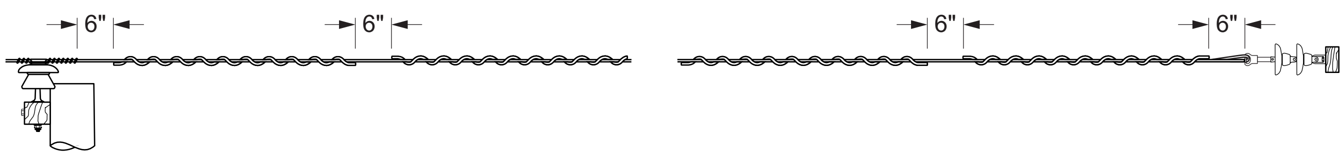


Figure 460–2.2: Four Vibration Dampers Per Conductor — Span Length 801'–2,400'

NOTE Treat suspension construction the same as pin and insulator.

Figure 460–3: Spiral Vibration Damper Subset

Note(s):

1. Up to three dampers can interlaced to form a subset for conductor sizes up to 1/0 ACSR or 2/0 Cu. For conductors larger than 1/0 ACSR or 2/0 Cu, only two dampers may be interlaced to form a subset.

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CO 470 ClampStar® Splice Shunt

Scope CO 470.1 Installation Procedures for ClampStar® Splice Shunt

Figure CO 470–1: ClampStar® Splice Shunt

1.0 General Information

The ClampStar® splice shunt is intended to be installed around automatic splices on overhead conductors. The unit is pre-greased and does not require the conductor to be greased separately.

Table CO 470–1: ClampStar® Splice Shunt SAP Numbers

Conductor Size	Conductor Type	SAP
#6 AWG – #2 AWG	Al/Cu	10204662
1/0 AWG – 4/0 AWG	Al/Cu	10204663
3/0 AWG – 477 kcmil	Al	10204664
#6 AWG – #2 AWG	Al	10205274

2.0 Installation: Live Line Tool or Rubber Gloves

STEP 1. Verify the correct ClampStar® splice shunt has been selected, and is appropriate for the application.

STEP 1.1 The conductor range is stamped on the ClampStar® (See Figure CO 470–2).

STEP 1.2 The clearance length is identified in inches by the last three digits of the ClampStar® part number.

STEP 1.3 Bi-metal ClampStars® are stamped with a “P” for use on aluminum or copper conductors.

Figure CO 470–2: ClampStar® Conductor Range

STEP 2. Remove the rubber “O” rings wrapped around the nuts prior to installation.

STEP 3. Inspect the ClampStar® keepers to ensure they are open sufficiently to fit over the conductor. The keepers are spring-loaded to hold them open during installation.

STEP 4. Inspect the areas to be clamped for strand damage. If present, ensure the length of the ClampStar® is sufficient for installation beyond the damaged area.

STEP 5. Clean the conductor contact areas thoroughly with a wire brush to remove oxides and other foreign material.

STEP 6. Center the ClampStar® unit over the splice or damaged strands and place the clamps on the conductor. Make sure the conductor is properly seated in the conductor grooves at both ends.

STEP 7. If using a Live Line Tool, partially tighten all nuts on the ClampStar®. Ensure all keepers are fully seated and the unit is positioned as desired. If using rubber gloves, start at the innermost nut on one end of the ClampStar® unit and hand tighten each nut in order, working towards the end.

NOTE

To avoid moving the bucket on longer units, complete the tightening sequence on one end prior to moving to the other end of the ClampStar® unit.

STEP 8. On the final pass, starting at the inner most nut, increase torque until the shear-nut breaks off (see Figure CO 470–3 for shear nut details).

STEP 8.1 Continue outward until all nuts are sheared.

STEP 8.2 Additional tightening of (or tampering with) the permanent nuts after shear is not recommended.

NOTE

To avoid moving the bucket on longer units, complete the tightening sequence on one end prior to moving to the other end of the ClampStar® unit.

Figure CO 470–3: Shear Nut

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CO 480 Torque Recommendations for Bolted Connectors

Scope CO 480.1 Torque Recommendations for Bolted Connectors

1.0 Application

Tightening Bolted Connectors to the manufacturers recommended torque value ensures that a good electrical and mechanical connection is made. Only use an approved torque wrench per Table CO 480–1, (from the current Tool Catalog).

Table CO 480–1: Current Approved Torque Wrenches

SAP	Drive (in)	Length (in)	Torque
10147386	3/8	—	100 to 1,000 in-lb
10147776	3/8	—	10 to 100 ft-lb
10147772	3/8	—	10 to 200 ft-lb
10147773	1/2	18-3/4	30 to 50 ft-lb
10147778	1/2	21	0 to 250 ft-lb
10147434	1/2	24-1/2	50 to 250 ft lb

Figure CO 480–1: Current Approved Torque Wrench

1.1 Recommended Torque Rating Table

Table CO 480–2 shows recommended torque ratings for different bolt sizes and bolt materials.

Table CO 480–2: Recommended Torque Rating

Bolt Size (in)	Bolt Material			
	Steel or Silicon Bronze		Aluminum	
	(in-lb)	(ft-lb)	(in-lb)	(ft-lb)
5/16-18	180	15	120	10
3/8-16	240	20	168	14
1/2-13	480	40	300	25
5/8-11	660	55	480	40
3/4-10	1050	87.5	650	55

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CO 500 Insulator Ties Copper and Aluminum

Scope CO 500.1 Wire Length and Method of Securing the Conductor to the Insulator

Figure CO 500–1: Side Tie — Single Arm

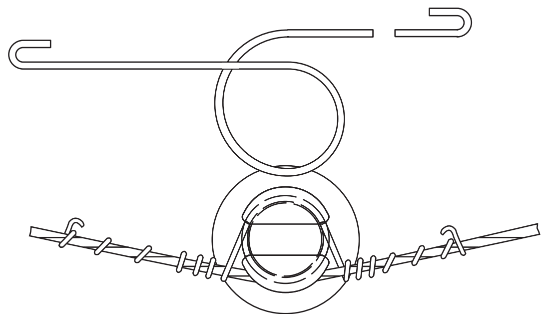


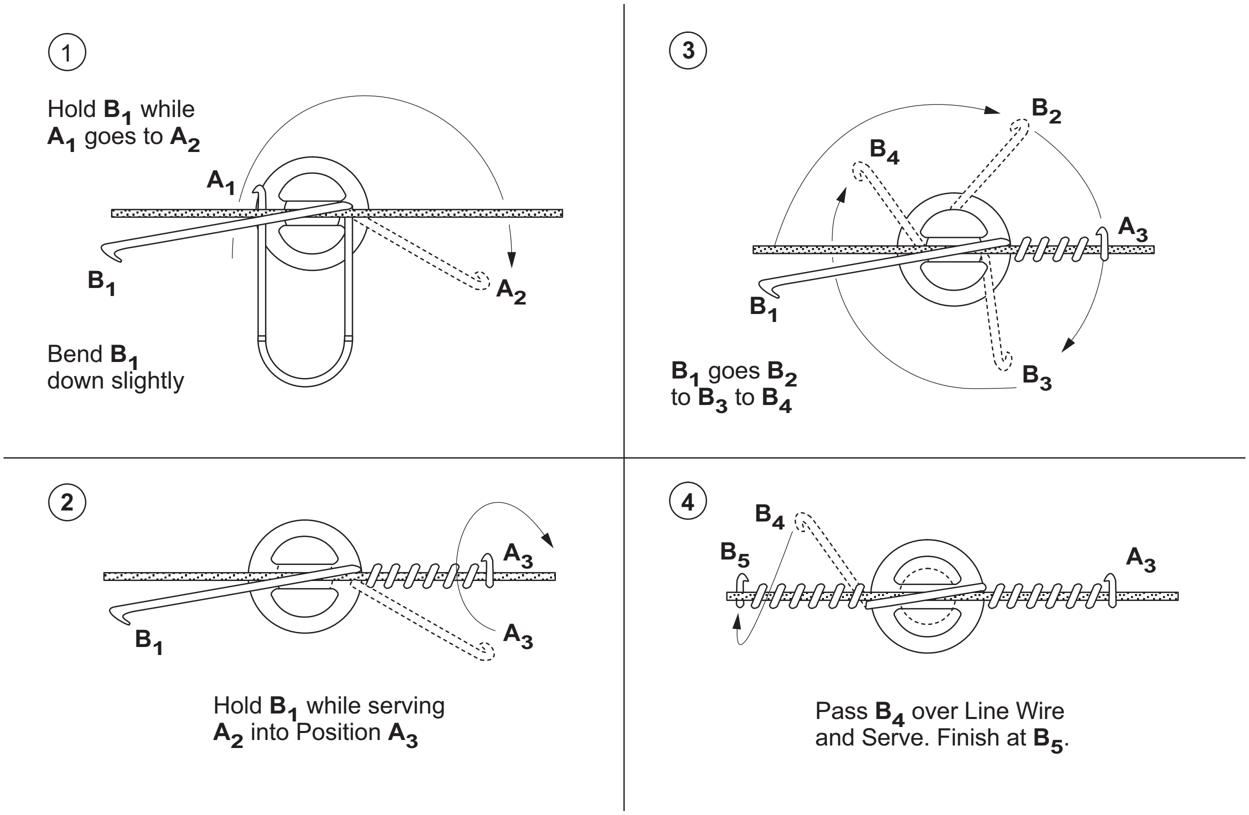
Table CO 500–1: Side Tie — Single Arm

Wire Size	Length of Wire	Size Tie Wire
#4 ACSR	5'-3"	#4 Al
#2 ACSR	5'-6"	
1/0 ACSR	6'-0"	
4/0 ACSR	6'-6"	
336.4 kcmil 18/1	7'-0"	

Note(s):

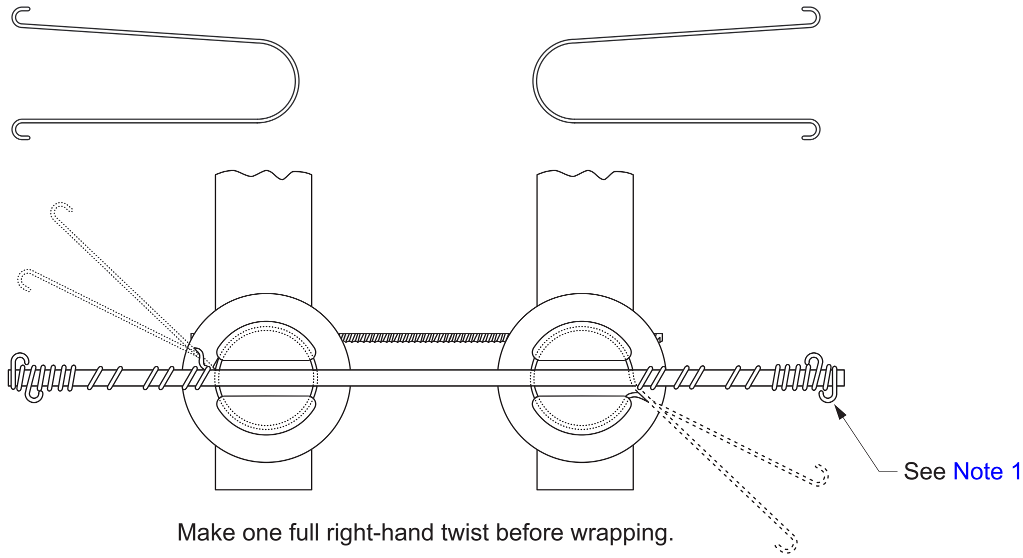
1. Not for use with Covered Conductors.

Figure CO 500–2: Top Tie — Single Arm



Scope CO 500.2 Insulator Ties Copper and Aluminum

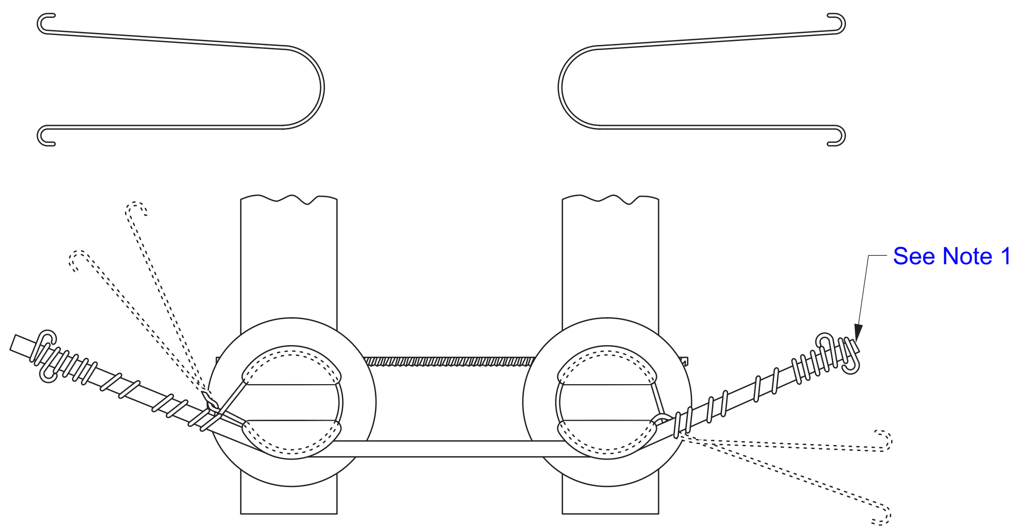
Figure CO 500–3: Top Tie — Double Arm



Note(s):

1. End of wire should be bent back firmly against conductor to prevent radio interference.

Figure CO 500–4: Side Tie — Double Arm



Note(s):

1. End of wire should be bent back firmly against conductor to prevent radio interference.

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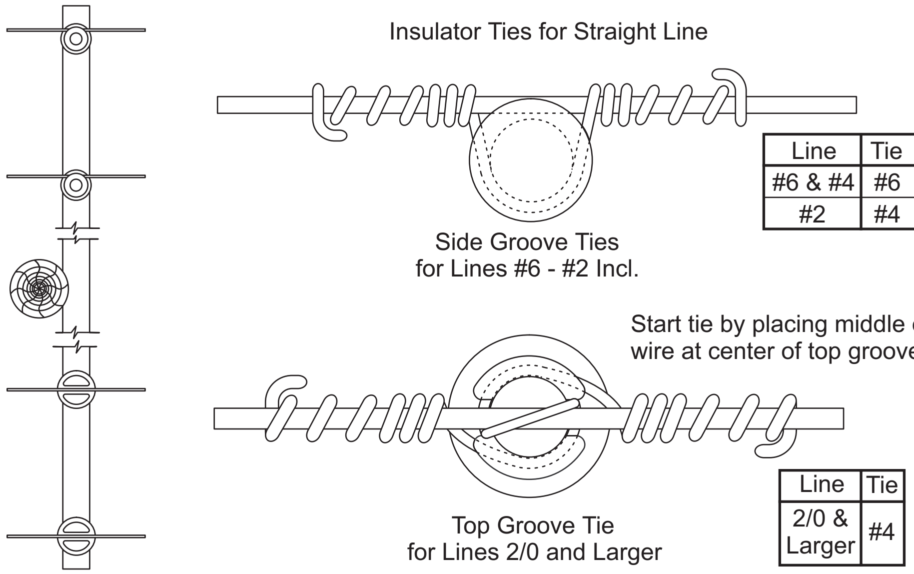
CO 505 Insulator Ties Using Weather-Resistant Copper Conductor 0–5 kV

Scope CO 505.1 Typical Insulator Ties Using Weather-Resistant Copper Conductor 0–5 kV

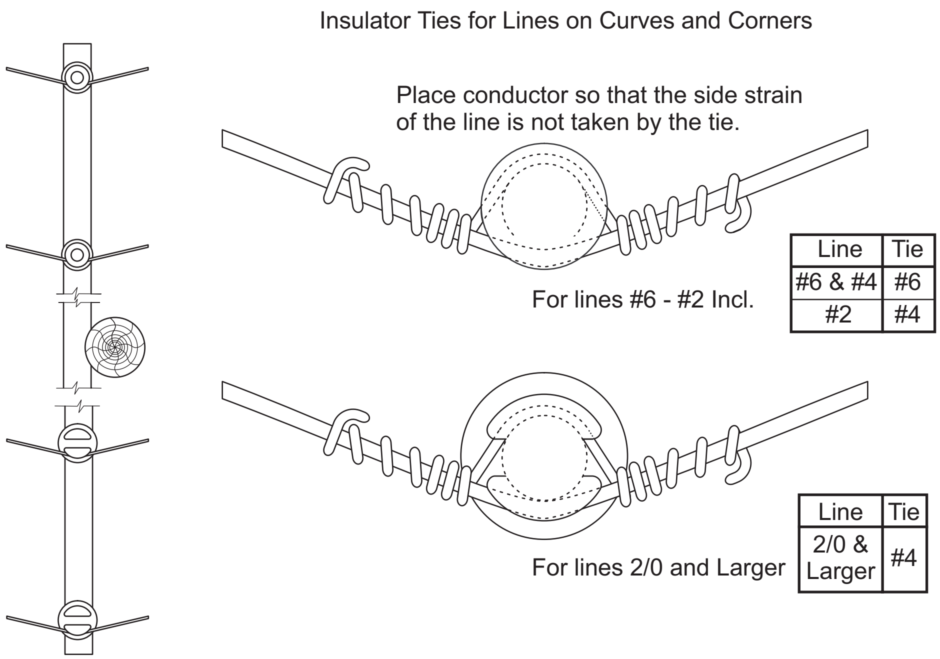
Figure CO 505–1: Insulator Ties for Straight Line



Line	Tie
#6 & #4	#6
#2	#4

Line	Tie
2/0 & Larger	#4

Figure CO 505–2: Insulator Ties for Lines on Curves and Corners



Line	Tie
#6 & #4	#6
#2	#4

Line	Tie
2/0 & Larger	#4

Note(s):

1. Tie must not be reused. All ties for weather-resistant conductors to be made from weather-resistant copper wire.
2. Not used with Covered Conductors.

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CO 510 Insulator Conductor Clamps

Scope CO 510.1 Applications and SAP Numbers for Insulator Conductor Clamps

1.0 #4 through 336.4 kcmil ACSR Universal Conductor Clamps

Figure CO 510–1: #4 through 336.4 kcmil ACSR Universal Conductor Clamps

1.1 Application

Hot Work – Conductors — #4 through 336.4 kcmil

Cold Work – New construction of #4 through 336.4 kcmil ACSR in close proximity to existing energized conductors.

1.2 Conductor Range:

Small Groove – #4 ACSR through 1/0 ACSR

Large Groove – 4/0 ACSR through 336.4 kcmil 30/7

Table CO 510–1: #4 through 336.4 kcmil ACSR Universal Conductor Clamps

Clamp SAP	Insulator SAP
10067564	10116367
	10116371
10067570	10116388

Note(s):

1. Not to be used on angles or copper wire, or covered conductor.

2.0 653.9 ACSR Universal Conductor Clamp for California Light Loading Only

2.1 Application

Hot Work – All installations

Cold Work – Reconductors only

2.2 Conductor Range:

Small Groove – 477 ACSR

Large Groove – 653.9 ACSR or 795 Al

Note(s):

1. See exhibit above.

3.0 Clamp for Clamp Top Post Insulators

Figure CO 510–2: Clamp for Clamp Top Post Insulators

Table CO 510–2: Clamp for Clamp Top Post Insulators

Conductor Type	Clamp Range (in)	W/Armor Rod	W/O Armor Rod	Clamp SAP	
ACSR	.25–.75	#4-1/0	#4-336.4	—	10067577
	.60–1.06	336.4	653.9	10067576	—
Copper	.25–.56	#6 Sol–#2 Str.	#2 Str.–4/0	10067574	—
	.35–.84	2/0–4/0	#2 Str.–4/0	10067575	—

Note(s):

1. Not to use with Covered Conductor.
2. Armor rod may be used with clamps.
3. For deviation angles, see DC 575.

What's Changed? Updated Table CO 510-2 and corresponding notes.

CO 515 Universal Conductor Clamps — Angle Pins

Scope CO 515.1 Typical Universal Conductor Clamps — Angle Pins

1.0 Universal Conductor Clamps — Angle Pins

Figure CO 515–1: Universal Conductor Clamps — Angle Pins

1.1 Application

A. #4–336.4 kcmil Clamp

1. Hot Work — Conductors — #4 through 336.4 kcmil
2. Cold Work — New construction of #4 through 336.4 kcmil in close proximity to existing energized conductors.

B. 477–653.9 kcmil Clamp

1. Hot Work — All installations
2. Cold Work — Re-conductoring only

Table CO 515–1: Universal Conductor Clamps — Angle Pins

#4–336.4 kcmil ACSR Heavy and Light Loading	477–653.9 kcmil ACSR Light Loading	Insulator SAP
Clamp SAP	Clamp SAP	
10067566	10067567	10116383 10116386 Pending 10116388 10116395 10116399

Note(s):

1. See GR Section for insulators.
2. Not for use with covered conductors.

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CO 520 Grip-Type Conductor Clamps

Scope CO 520.1 Typical Grip-Type Conductor Clamps

1.0 F-Neck Side Tie

Figure CO 520–1: F-Neck Side Tie

1.1 Application (to be used on the following insulators):

12 kV	10116383 10116386	To be used for single arm angle construction only.
12-, 16-, & 33- kV	10116395 10116397 10116399	May be used for horizontal insulator construction or single arm angle construction.

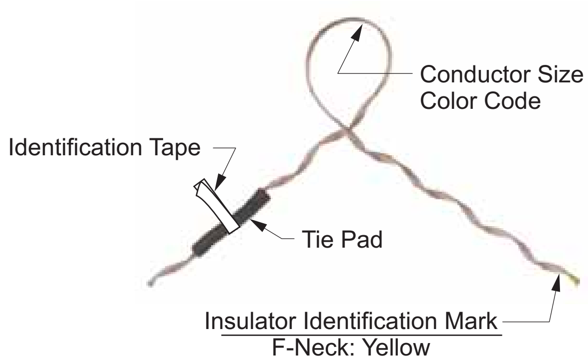
Table CO 520–1: Conductor Size and Color Codes for F-Neck Side Tie

Conductor Size	SAP	Insulator Neck Color Code (2-7/8")	Conductor Size Color Code
4 ACSR	10109437	Yellow	Orange
1/0 ACSR	10109442		Yellow
336 kcmil ACSR	10109443		Brown

Note(s):

1. These ties are **NOT** to be re-used.
2. **NOT** to be used on jumper taps or covered conductors.
3. For angle pole limitations, see DC Section.
4. **NOT** to be used in areas of known ice and snow loading.
5. See GR Section for correct insulator.

Figure CO 520–2: Manufactured Preformed Side Tie (with Pad as Received in Field)



2.0 F-Neck Tie

Figure CO 520–3: F-Neck Tie

2.1 Application (To be used on the following insulators)

12 kV: 10116383, 10116386, 10116395

16–33 kV: 10116397, 10116399

Table CO 520–2: Conductor Size and Color Codes for F-Neck Tie

Conductor Size	SAP	Insulator Neck Color Code (2-7/8")	Conductor Size Color Code
4 ACSR	10109438	Yellow	Black
1/0 ACSR	10109441		Green
336 kcmil ACSR	10109444		Red

3.0 J-Neck Tie

3.1 Application (to be used on the following insulators):

12–16 kV — SAP 10116388
16–33 kV — SAP 10116390

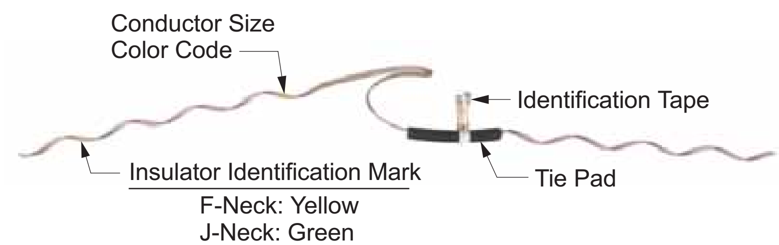
Table CO 520–3: Conductor Size and Color Codes for J-Neck Tie

Conductor Size	SAP	Insulator Neck Color Code (2-7/8")	Conductor Size Color Code
4 ACSR	10109439	Green	Black
1/0 ACSR	10109440		Green
336 kcmil ACSR	10109445		Red

Note(s):

1. These ties are **NOT** to be re-used.
2. **NOT** to be used on jumper taps or covered conductors.
3. For angle pole limitations see DC Section.
4. **NOT** to be used in areas of known ice and snow loading.

Figure CO 520–4: Manufactured Preformed Distribution Tie — Previously Titled "Urban Tie" (with Pads as Received in Field)



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CO 600 Terminating Large Copper and Aluminum Services

Scope CO 600.1 Method of Dead-Ending All-Aluminum and Copper Conductors

1.0 Kellems-Grip

Figure CO 600–1: Kellems-Grip

1.1 Application

4/0, 500 kcmil, and 750 kcmil weather resistant all-aluminum wire, 2/0, 4/0, 350 kcmil, and 700 kcmil 600 volt CLP insulated aluminum and 250, 300, 500, and 1,000 kcmil copper cable service drops.

1.2 Material:

Table CO 600–1: Kellems-Grip

Aluminum Conductor		
Size	**Safe Loading**	**SAP**
4/0 WR	560#	10068490
500 kcmil WR	1,000#	10068492
750 kcmil WR	1,000#	Pending
2/0 600 V CLP Cable	560#	10068489
4/0 600 V CLP Cable	560#	10068490
350 kcmil 600 V CLP Cable	750#	10068491
700 kcmil 600 V CLP Cable	1,000#	Pending
Copper Conductor (Weather Resistant)		
Size	**Safe Loading**	**SAP**
250–300 kcmil	560#	10068496
500 kcmil	560#	10068497
1000 kcmil	1,000#	10068498

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CO 700 Span Lengths, Minimum Conductor Spacing, Composite and Wood Crossarm Pre-Drilled Holes

Scope CO 700.1 Span Lengths and Minimum Conductor Spacing

Table CO 700–1: Span Lengths and Minimum Conductor Spacing

Span in Length (ft)	Minimum Conductor Spacing (in)
0 to 150	13-1/4
151 to 205	19-7/8
206 to 305	27-3/4
306 to 440	32
441 to 500	39-3/4
501 to 660	48

Scope CO 700.2 Composite Crossarm Pre-Drilled Holes

Figure CO 700–1: 5' Tangent Composite Crossarm Pre-Drilled Holes (SAP 10211425)

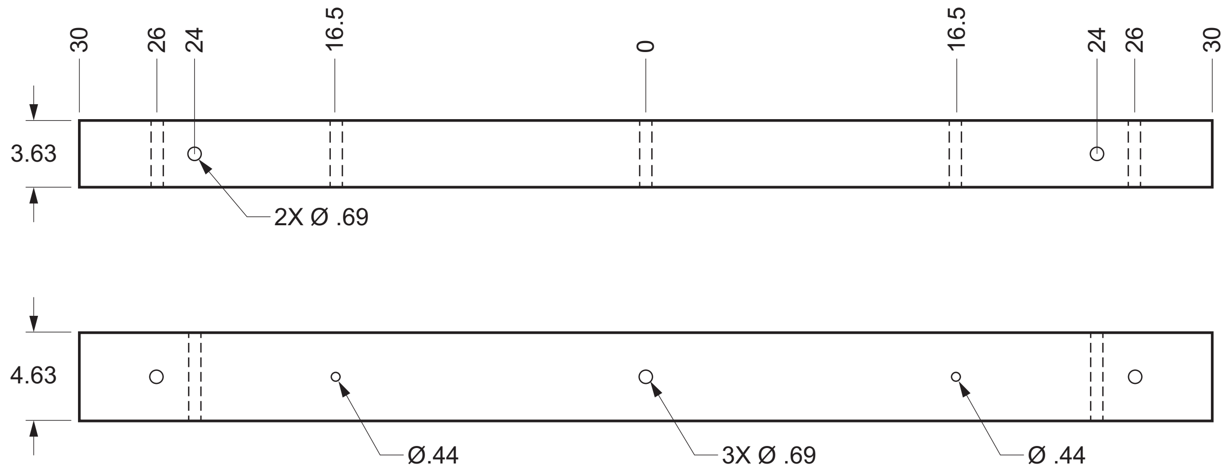


Figure CO 700–2: 8' Dead-End Composite Crossarm Pre-Drilled Holes (SAP 10060796)

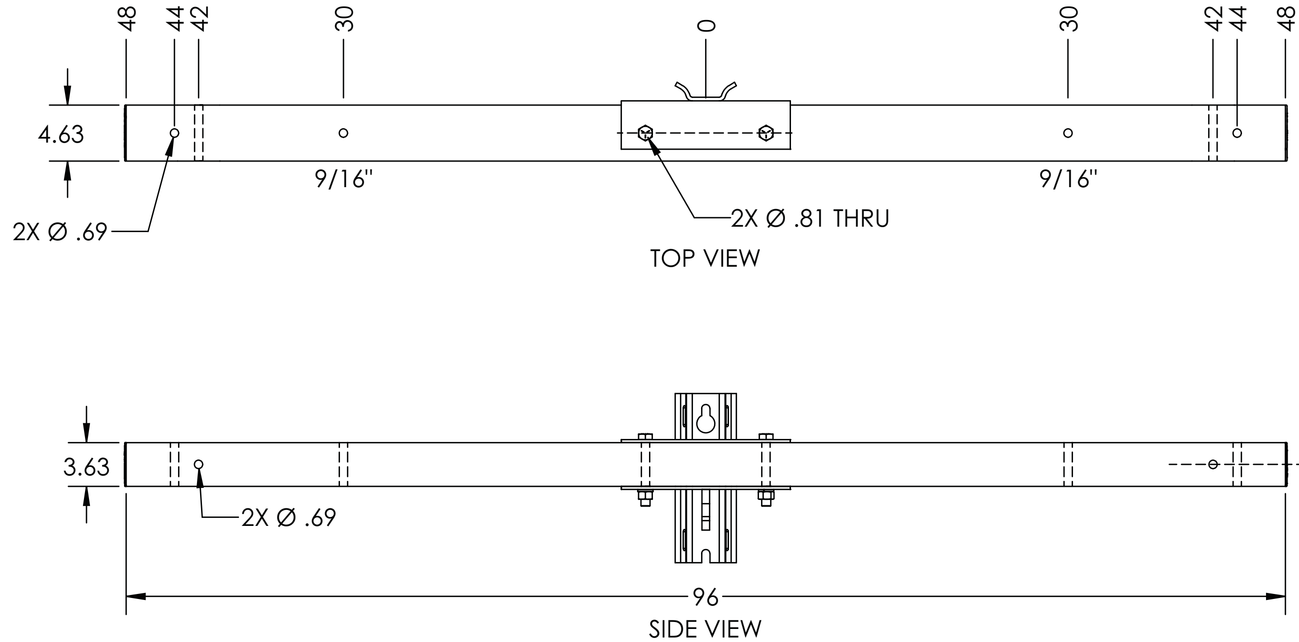


Figure CO 700–3: 8' Tangent Composite Crossarm Pre-Drilled Holes (SAP 10060793)

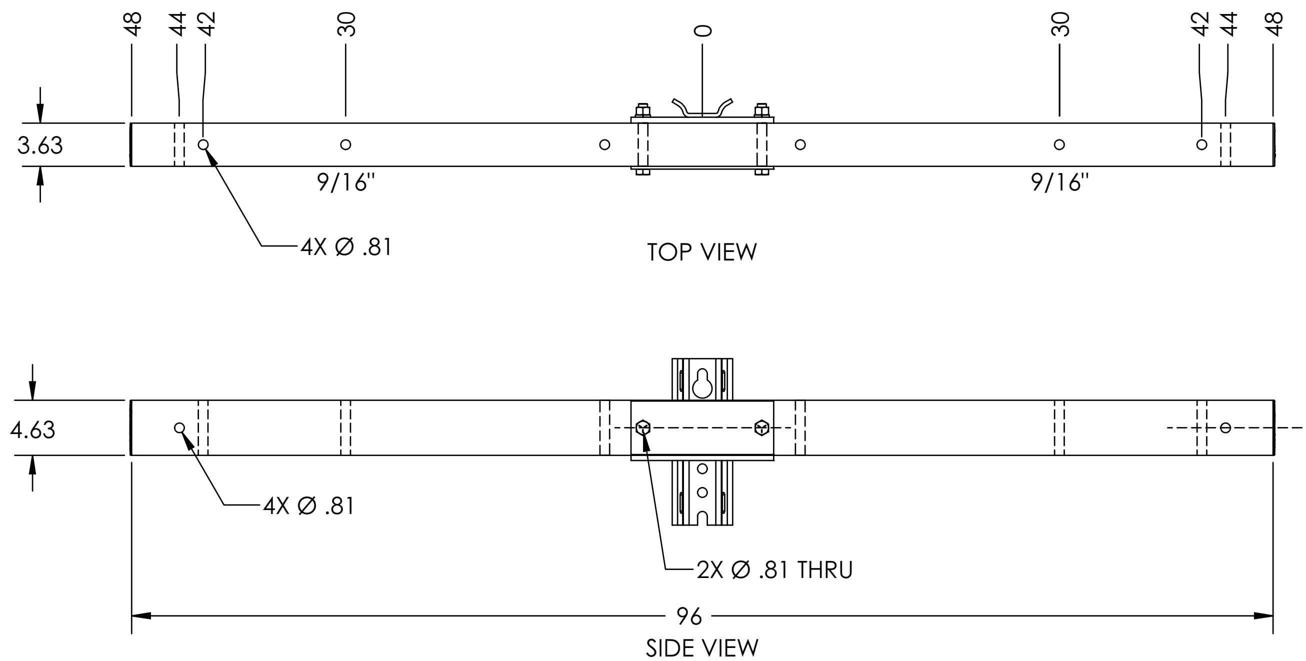


Figure CO 700–4: 10' Dead-End Composite Crossarm Pre-Drilled Holes (SAP 10060797)

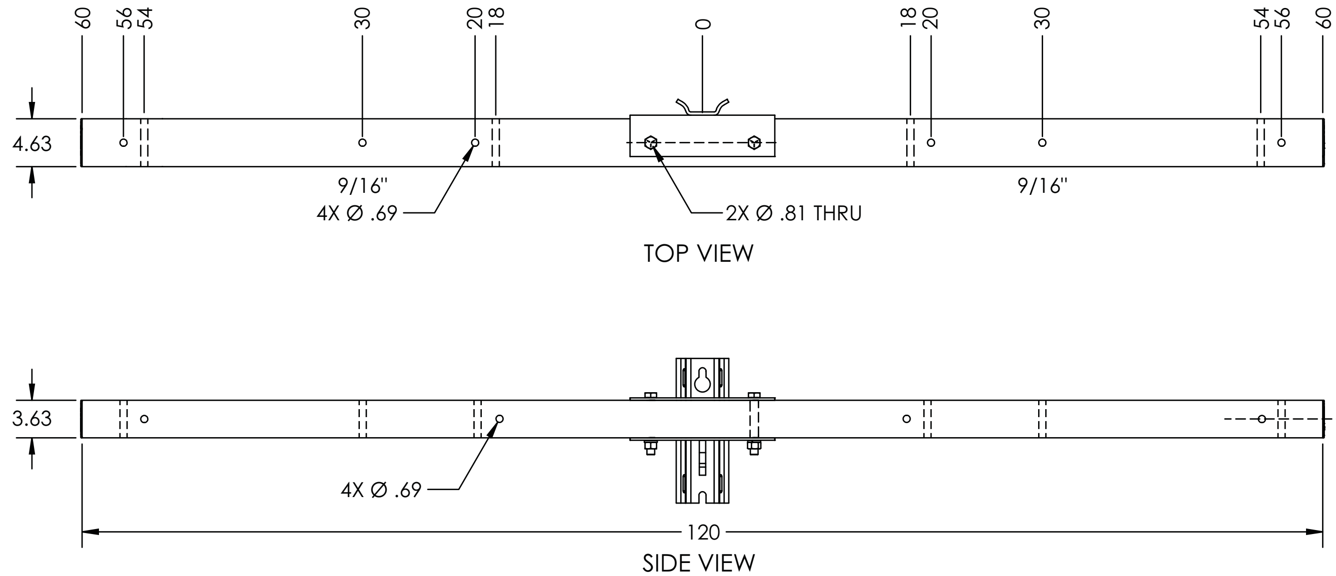
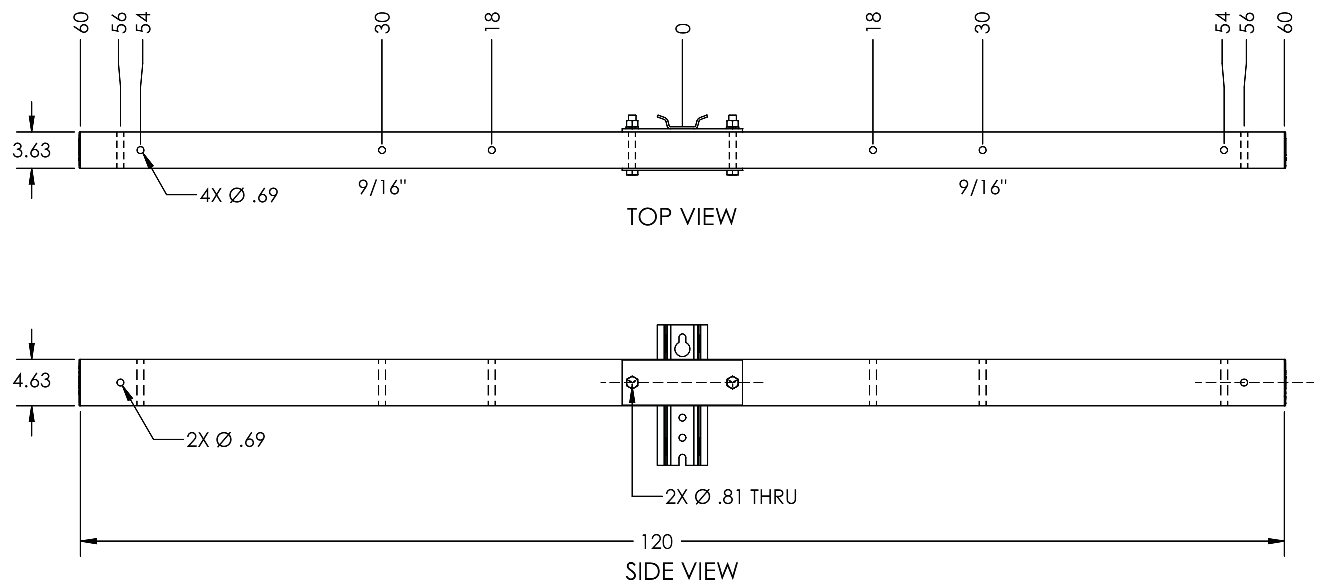


Figure CO 700–5: 10' Tangent Composite Crossarm Pre-Drilled Holes (SAP 10060794)



CO 700 Sheet 4 of 12 DOH	**Span Lengths, Minimum Conductor Spacing, Composite and Wood Crossarm Pre-Drilled Holes**	Approved by:
	What's Changed? Updated Figures CO 700-4 and CO 700- 5 to show additional pre-drilled holes to accommodate a V-brace on crossarm.	Effective Date: 01-29-2021

Figure CO 700–6: 12' Dead-End Composite Crossarm Hole Drilling (SAP 10060798)

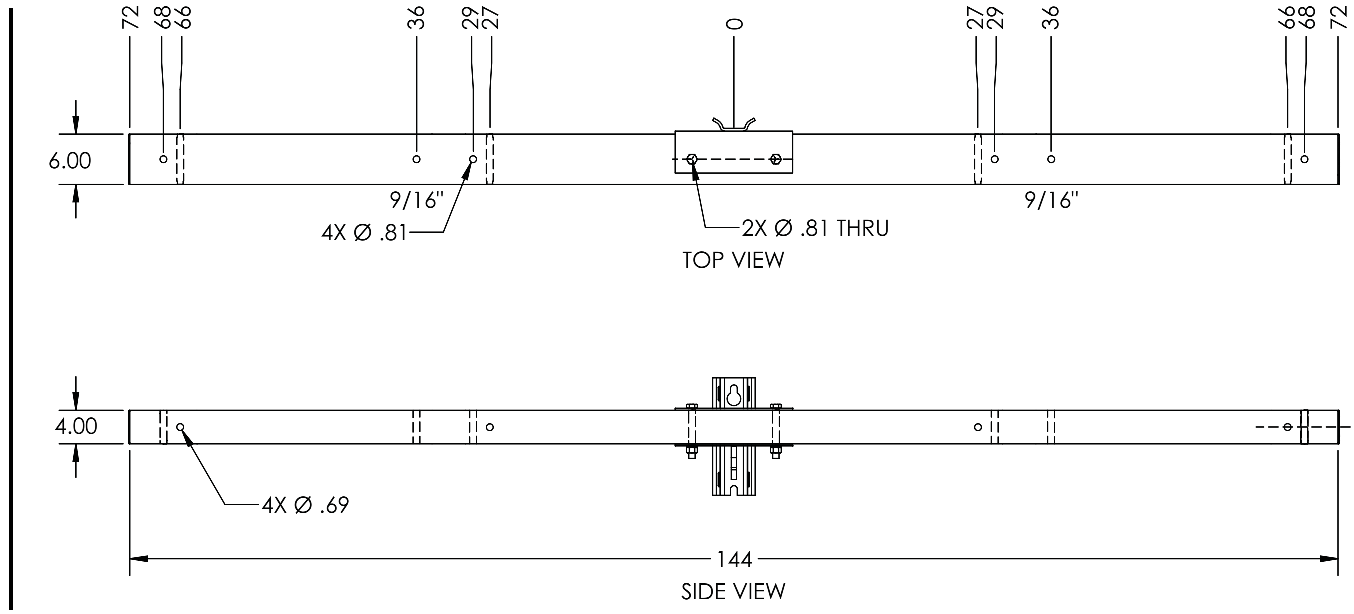


Figure CO 700–7: 12' Tangent Composite Crossarm Hole Drilling (SAP 10060795)

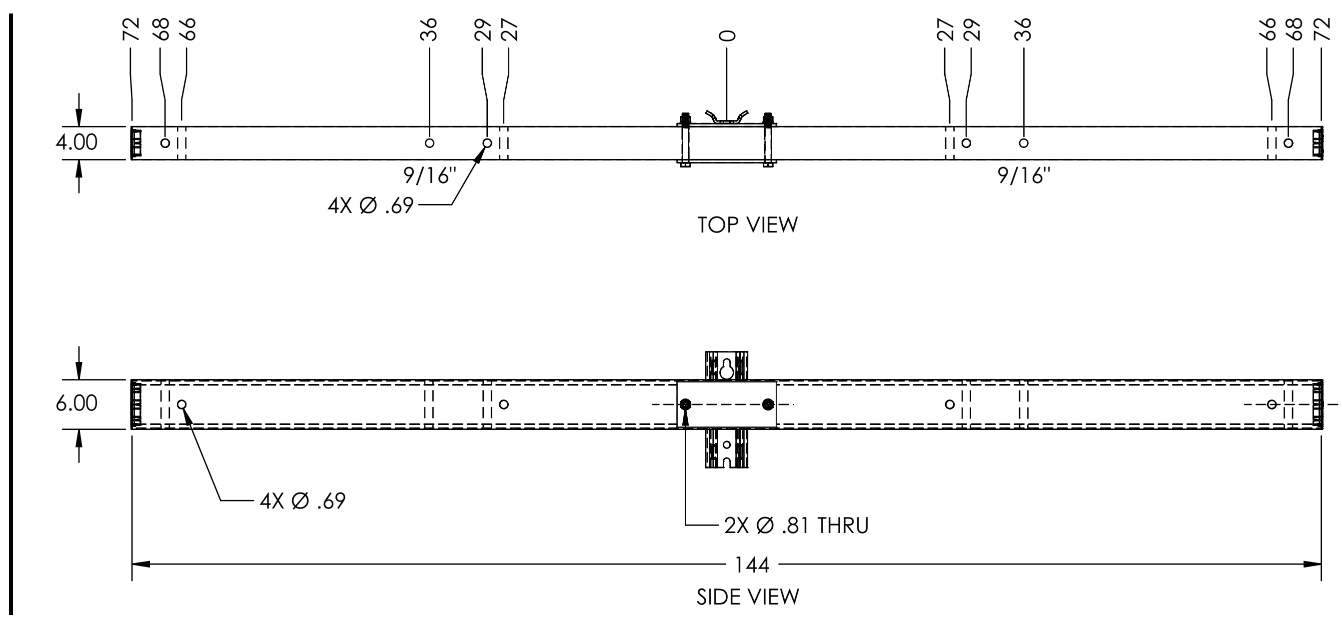


Figure CO 700–8: 10' Tangent Alley Composite Crossarm Pre-Drilled Holes (SAP 10211423)

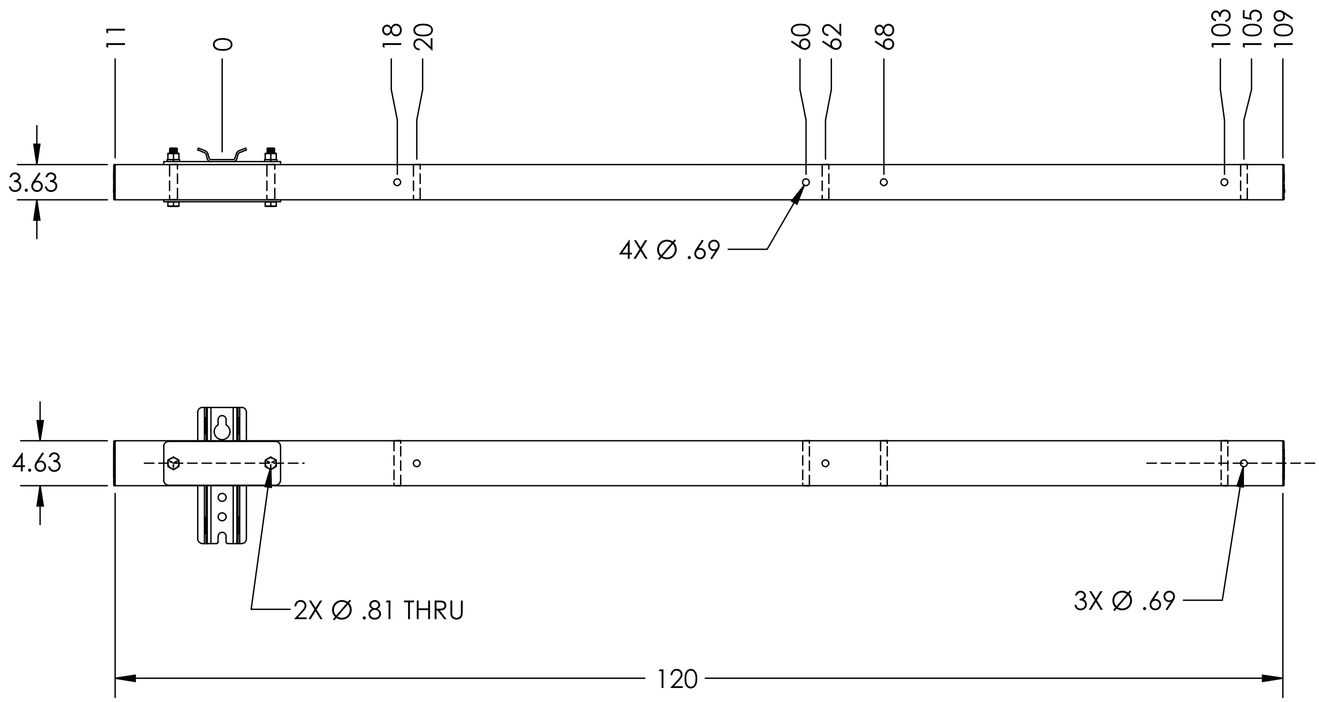


Figure CO 700–9: 12' Tangent Alley Composite Crossarm Pre-Drilled Holes (SAP 10211424)

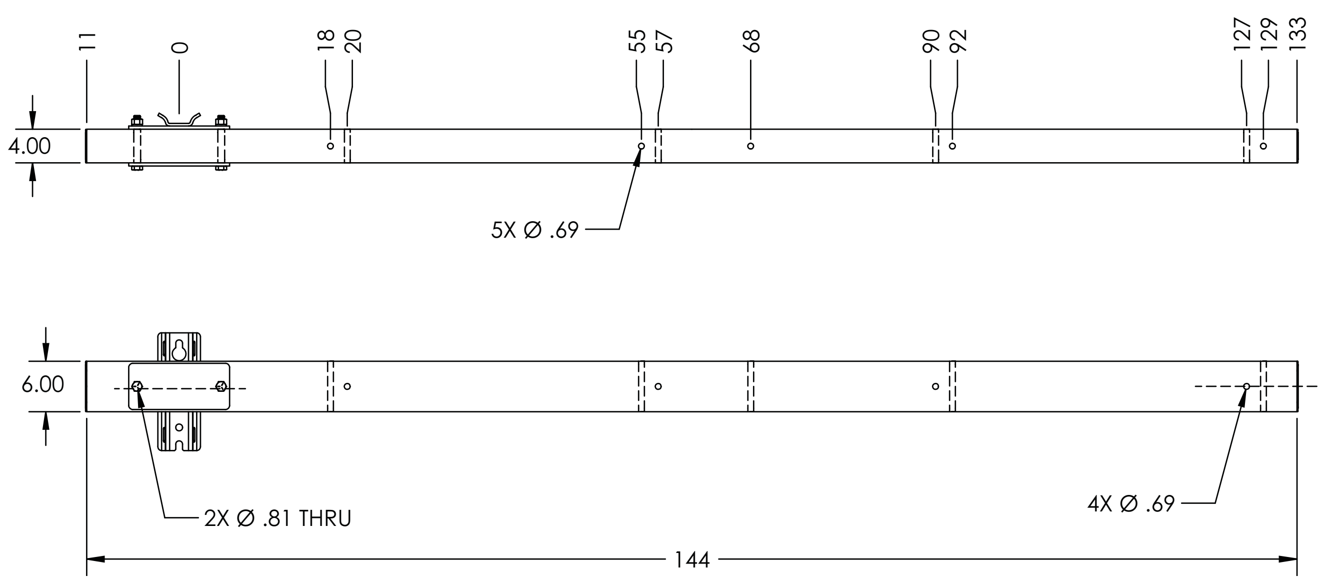


Figure CO 700–10: 20' Dead-End Composite Crossarm Pre-Drilled Holes (SAP 10208513)

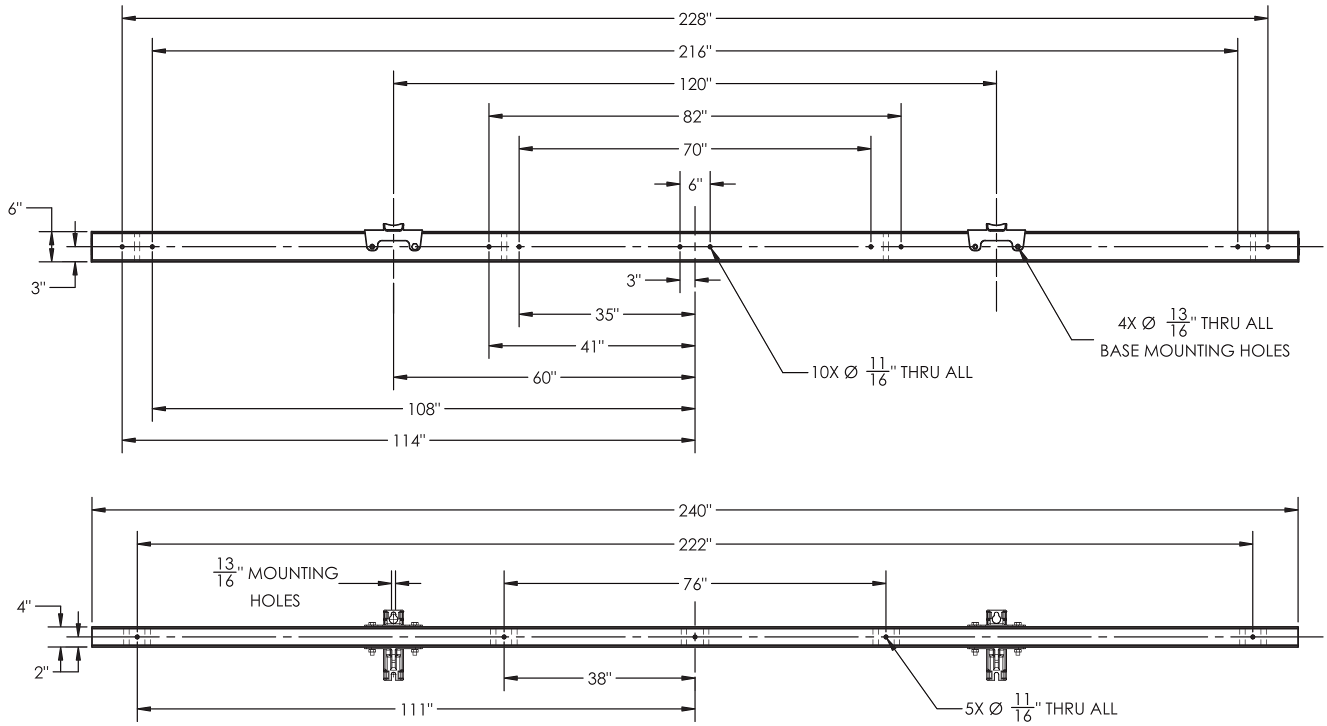
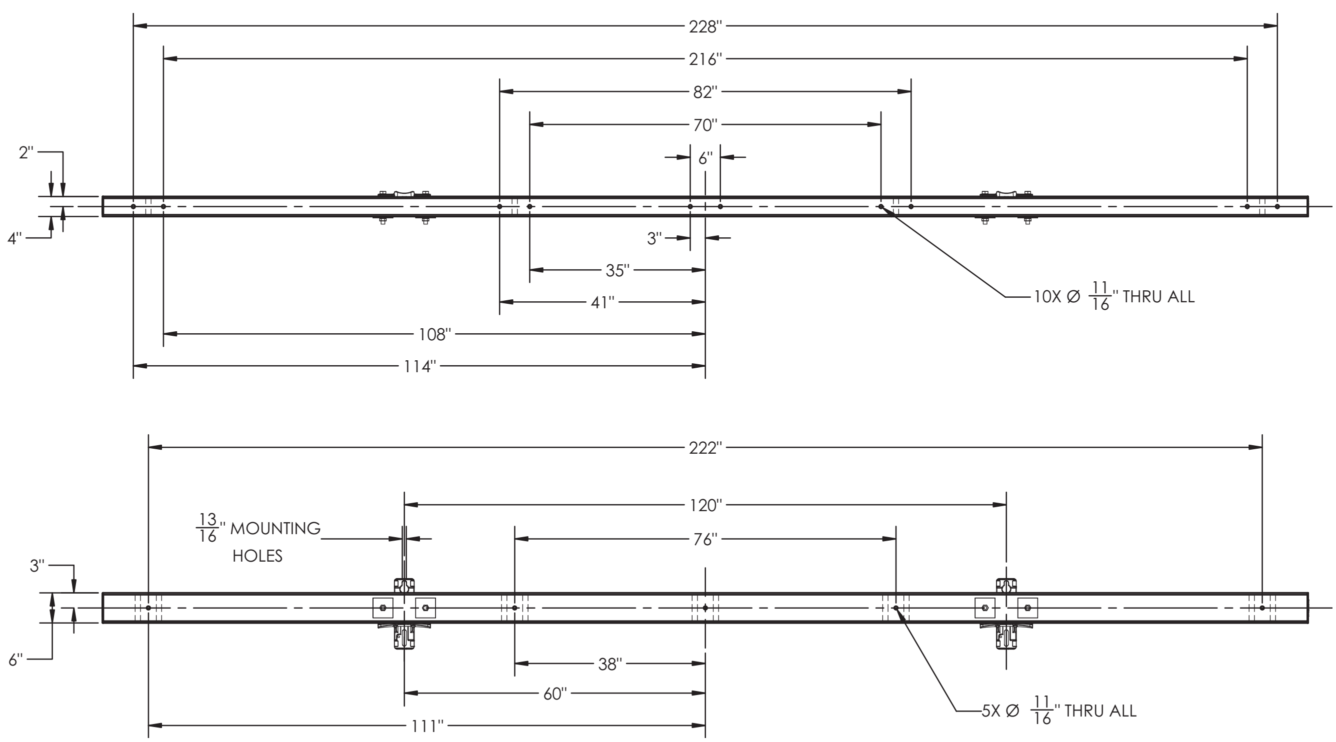


Figure CO 700–11: 20' Tangent Composite Crossarm Pre-Drilled Holes (SAP 10208033)



Scope CO 700.3 8' and 10' Composite Crossarm Mounting Bracket Details

Figure CO 700–12: PUPI Dead-End Mounting Bracket Detail

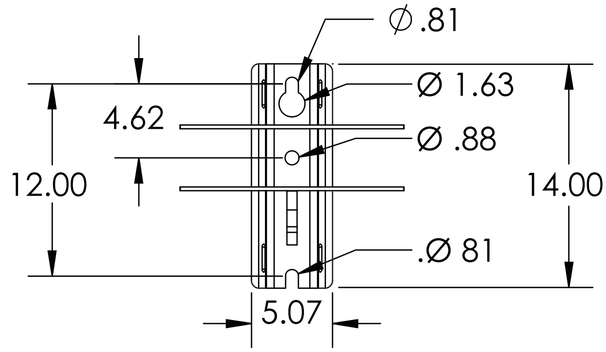


Figure CO 700–13: MacLean Dead-End Mounting Bracket Detail

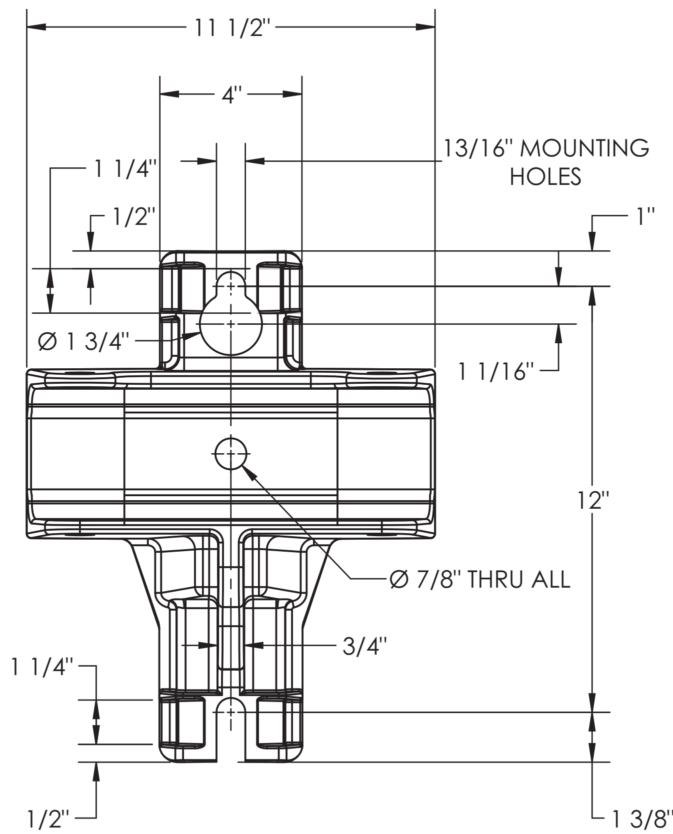


Figure CO 700–14: PUPI Tangent Mounting Bracket Detail

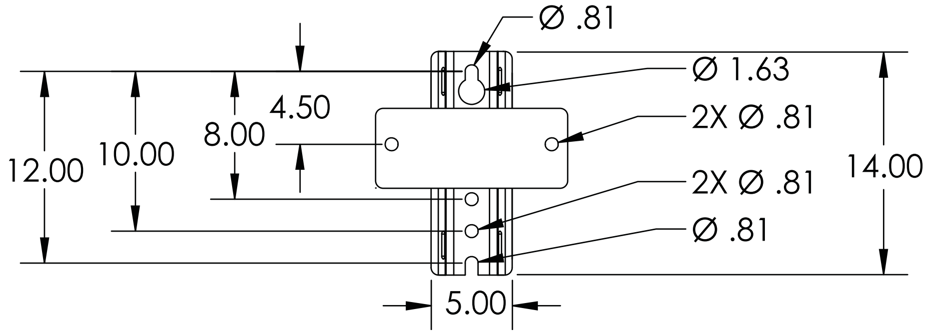
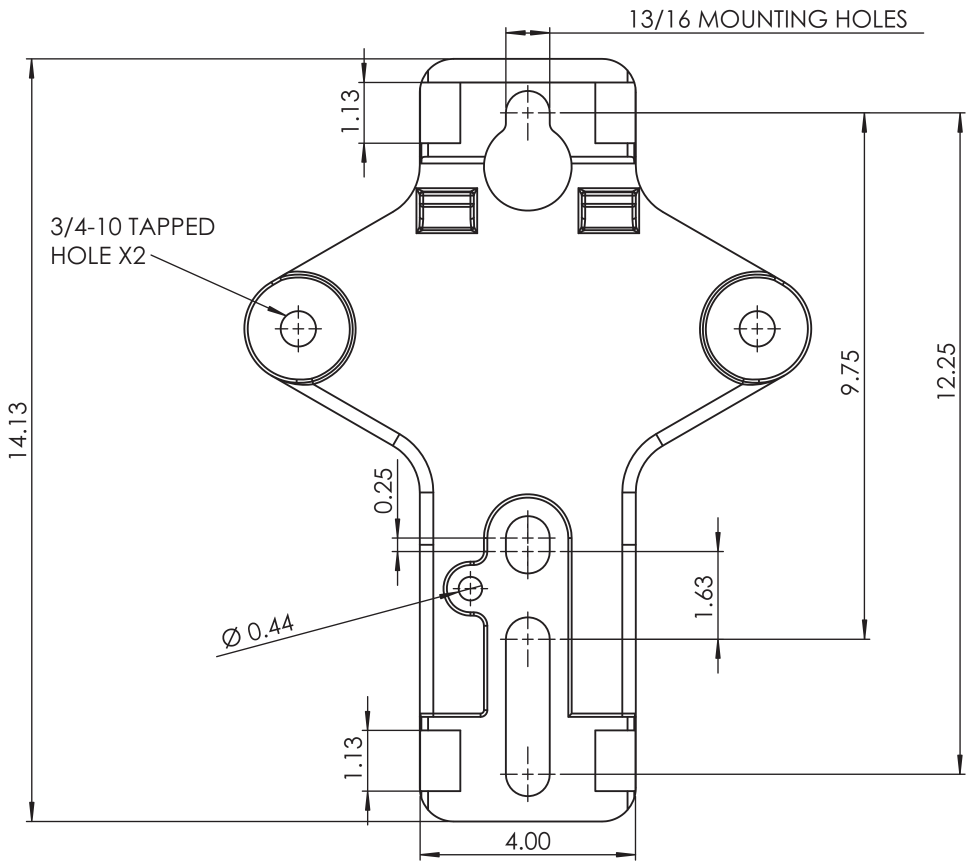


Figure CO 700–15: MacLean Tangent Mounting Bracket Detail



Scope CO 700.4 12' and 20' Composite Crossarm Mounting Bracket Details

Figure CO 700–16: PUPI Dead-End Mounting Bracket Detail

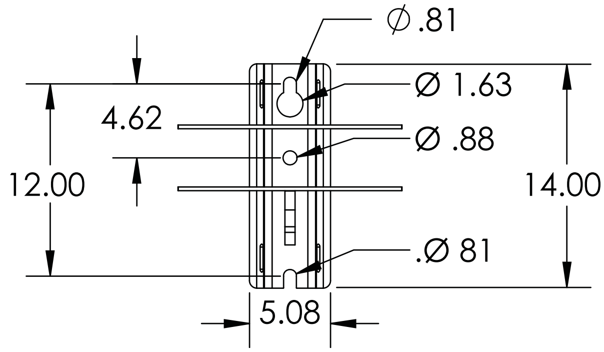
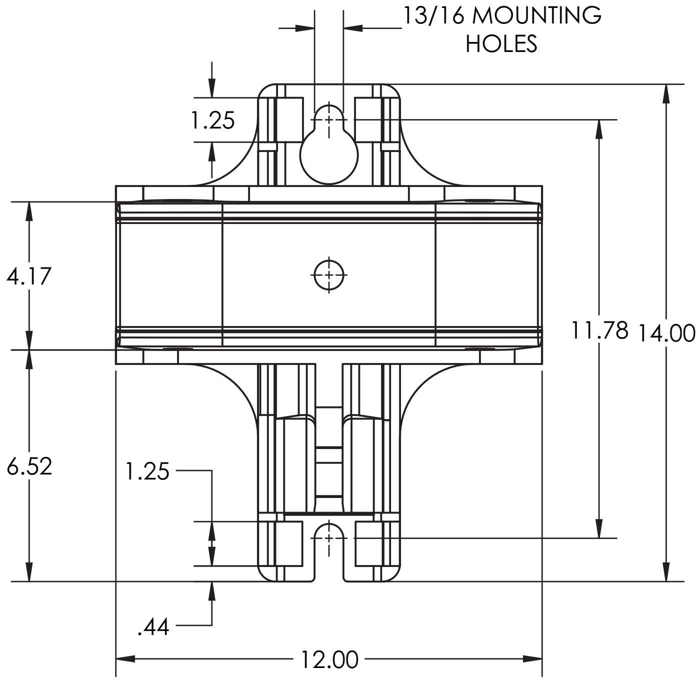


Figure CO 700–17: MacLean Dead-End Mounting Bracket Detail



Span Lengths, Minimum Conductor Spacing, Composite and Wood Crossarm Pre-Drilled Holes	Approved by:
What's Changed?	Effective Date: 01-29-2021

Figure CO 700–18: PUPI Tangent Mounting Bracket Detail

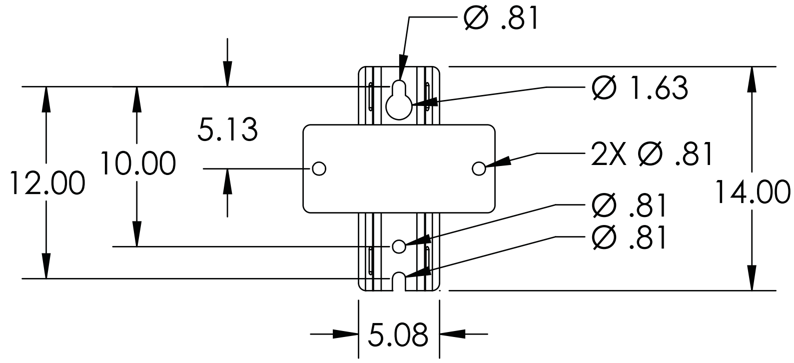
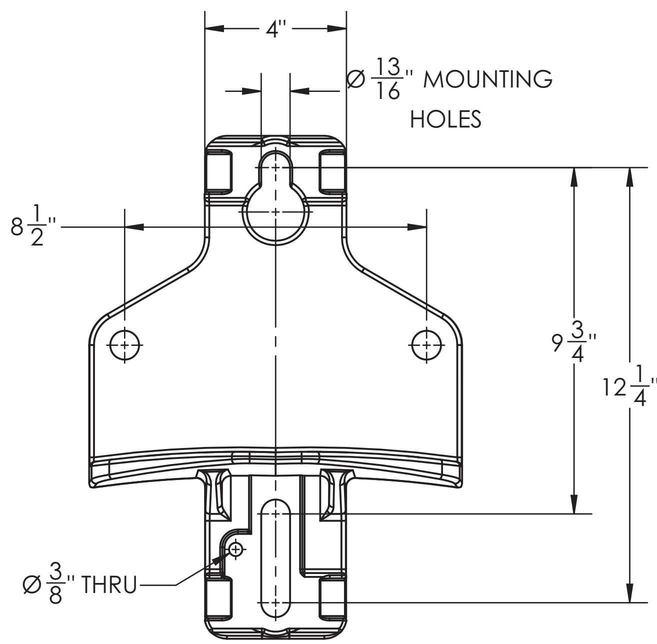


Figure CO 700–19: MacLean Tangent Mounting Bracket Detail



Scope CO 700.5 Wood Crossarm Pre-Drilled Holes

Figure CO 700–20: 5' Wood Crossarm Pre-Drilled Holes (SAP 10060238)

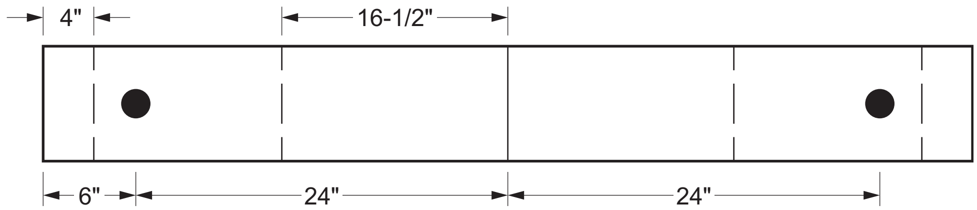


Figure CO 700–21: 8' Wood Crossarm Pre-Drilled Holes (SAP 10060237)

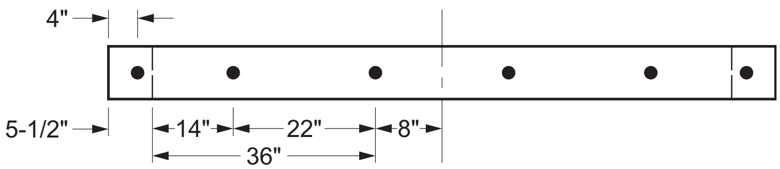


Figure CO 700–22: 10' Wood Crossarm Pre-Drilled Holes (SAP 10060240)

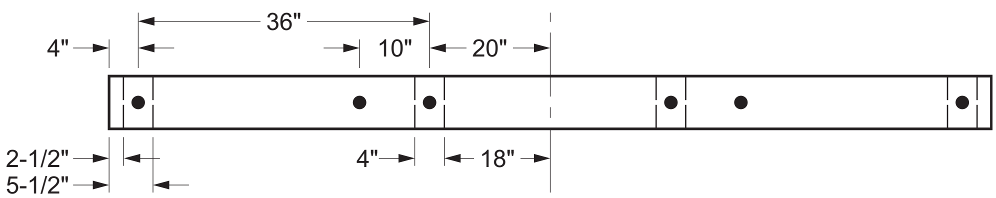
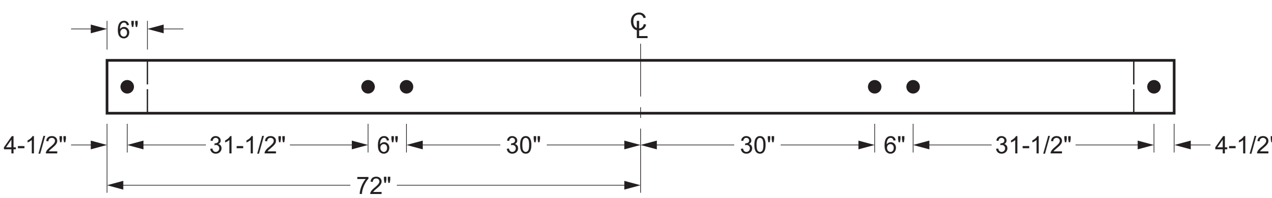


Figure CO 700–23: 12' Wood Crossarm Pre-Drilled Holes (SAP 10060209)



Span Lengths, Minimum Conductor Spacing, Composite and Wood Crossarm Pre-Drilled Holes

Approved by:

What's Changed?

Effective Date: 01-29-2021

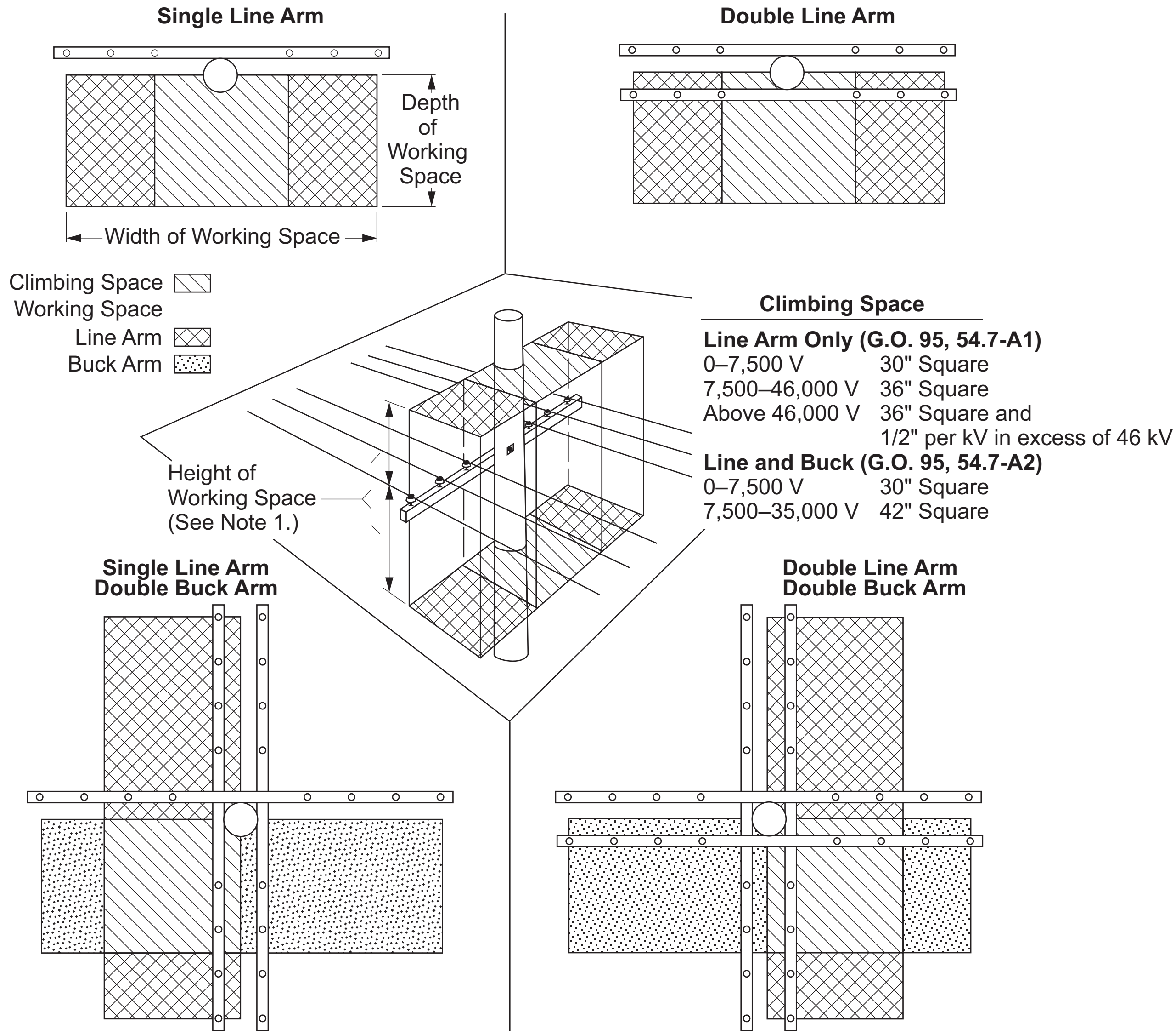
DOH–DC: Distribution Construction

TABLE OF CONTENTS

DC 100 Climbing/Working Space — General

Scope DC 100.1 General Climbing and Working Space Requirements for Crossarm Construction

Figure DC 100–1: General Climbing and Working Space Requirements for Crossarm Construction



Note(s):

1. The vertical dimensions of working space above and below supply conductor levels energized above 750 V shall be equal to the entire vertical distance between the supply conductors involved (that is, the entire vertical distance between a 750–20000 V level and a 0–750 V level).
2. The width of the working space where crossarms are involved shall be the distance between outside pin positions.
3. Installation of allowable climbing space obstructions should be avoided.

Scope DC 100.2 Climbing and Working Space without Crossarms

Figure DC 100–2: Climbing and Working Space without Crossarms

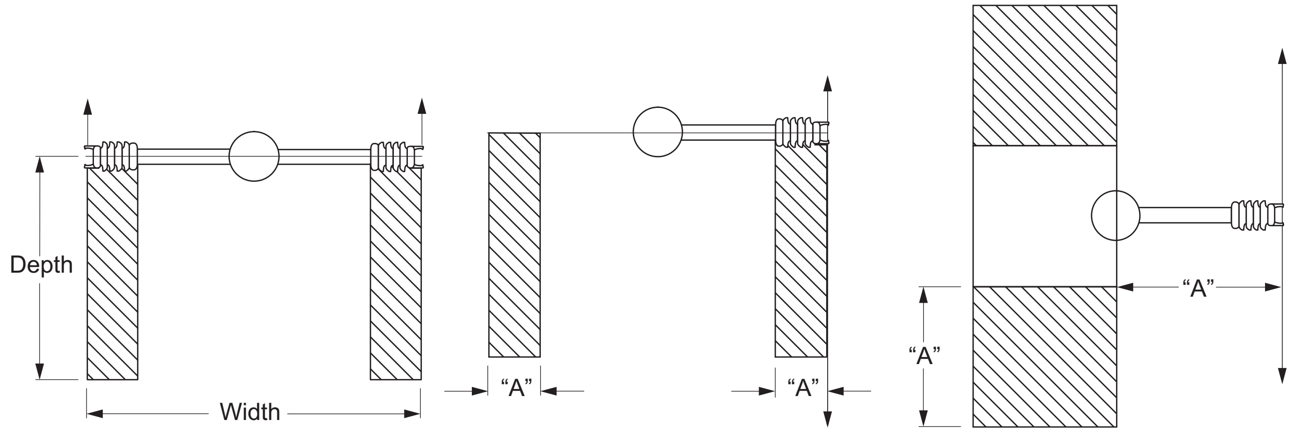


Figure DC 100–2.1 **Figure DC 100–2.2** **Figure DC 100–2.3**

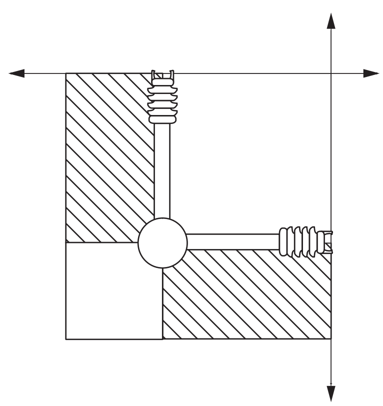


Figure DC 100–2.4

Climbing Space for Armless Construction
(More Than 750 Volts)
G.O. 95, 54.11-F

750–46,000 V	36" Square
46,000–75,000 V	48" Square
More than 75,000 V	48" Square Plus 1/2" per kV in Excess of 46,000 V

Distance "A" is equal to the measurement from the edge of the climbing space to the outermost position of the conductor support involved.

Note(s):

1. Dimensions of Work Space: The vertical dimensions of working space above and below any conductor level shall be equal to the vertical clearances between conductors specified in G.O. 95, Table 2, Cases 8 to 14 inclusive, for the voltages involved.

   The width of the working space where crossarms are not involved (for example, vertical and triangular construction without crossarms) shall extend from the climbing space to the outermost conductor position on the conductor support involved. The depth of the working space shall have the same dimension as the climbing space and shall be measured from the centerline of pole (see Figure DC 100–2.1 [Sheet 2]). When conductors are located on one side of the pole only (for example, vertical construction) the dimensions of working space shall be applied as illustrated in Figure DC 100–2.2 (Sheet 2) and Figure DC 100–2.3 (Sheet 2). When climbing space is located in a quadrant, working space shall be applied as illustrated in Figure DC 100–2.4 (Sheet 2).
2. Allowable Working Space Obstructions: G.O. 95, 54.7-B2.

Scope DC 100.3 Climbing Space and Horizontal Conductor Spacing

Figure DC 100–3: Climbing Space and Horizontal Conductor Spacing

Minimum Climbing Space
and Horizontal Conductor Spacing
G.O. 95: Table 1, Case 8 and Table 2, Case 15

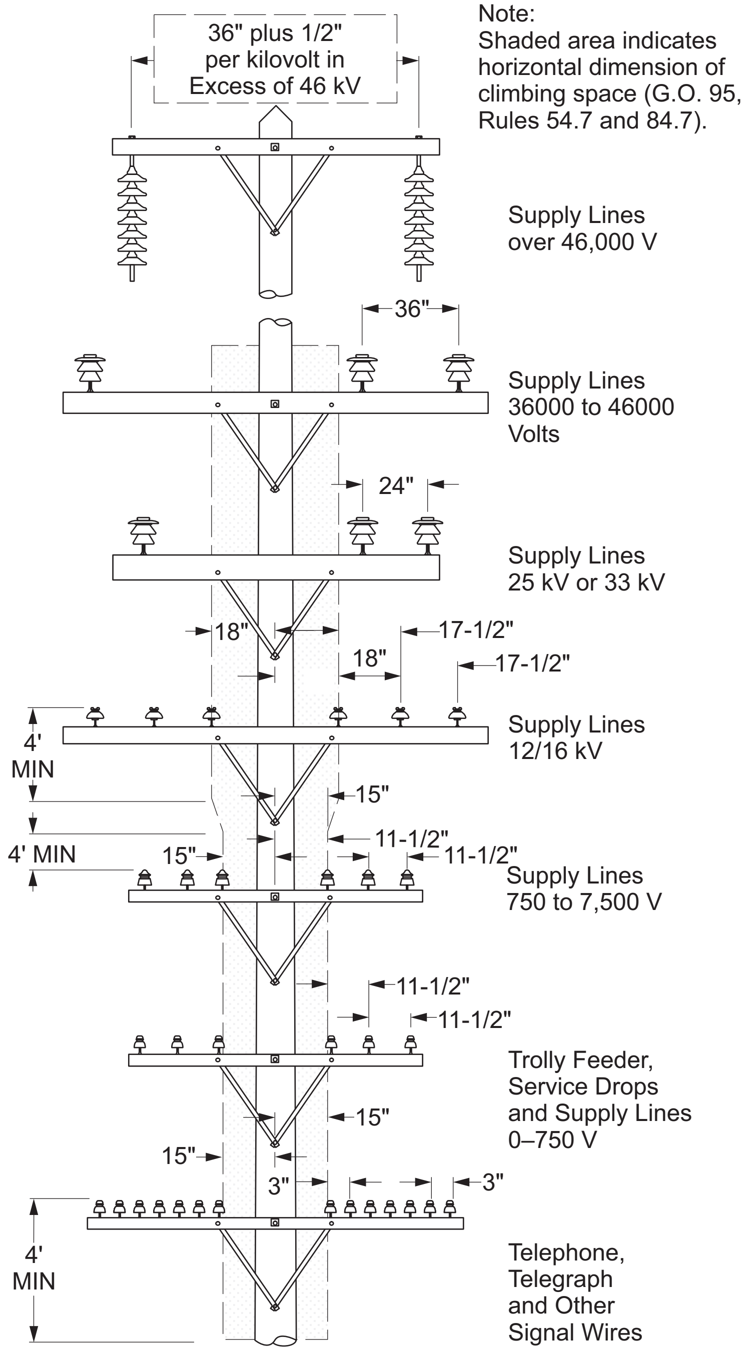
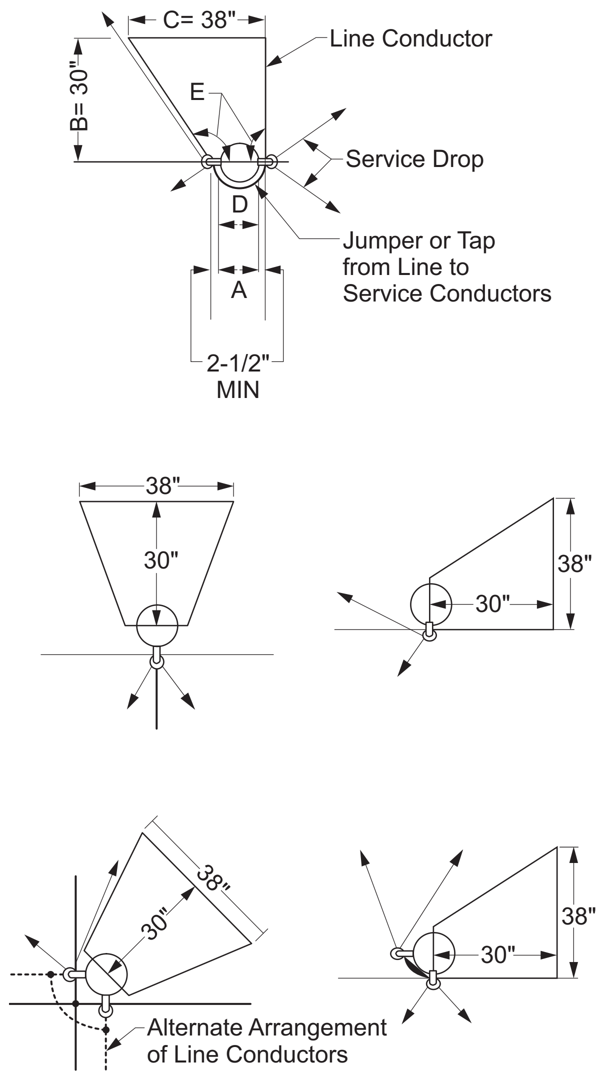


Figure DC 100–4: Secondary Line/Service Drop Configurations

Climbing Space Low Voltage Racks
0–750 V
G.O. 95, Rule 54.9

Secondary Line
Service Drop

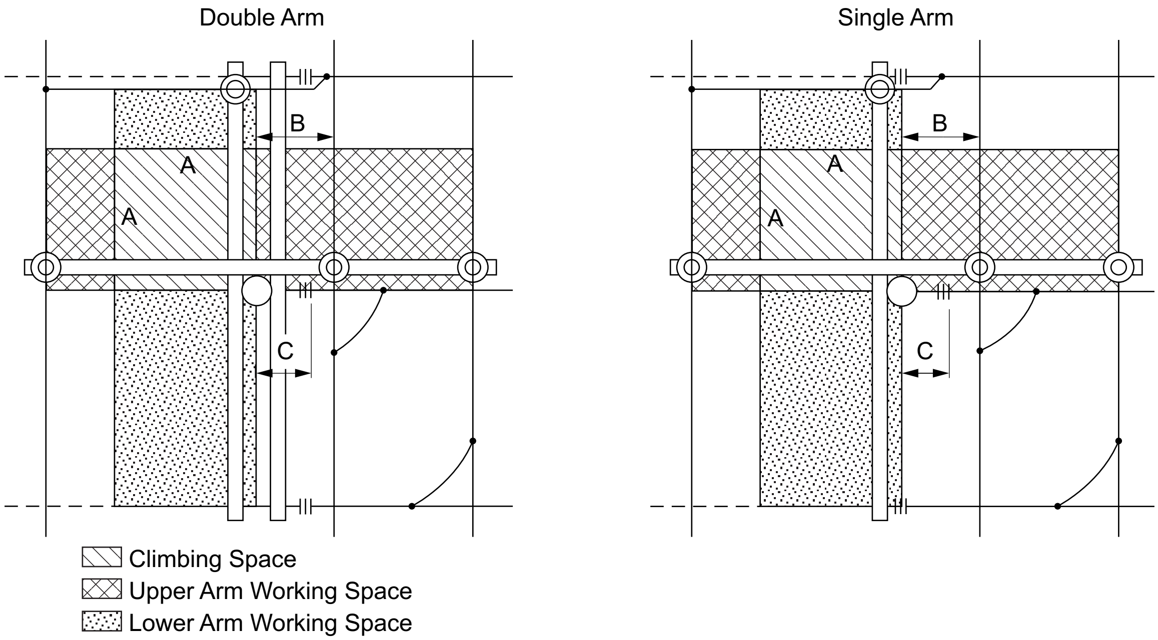
A = D + 5" = D + 2 x 2-1/2"
B = 38" MIN
C = 38" MIN
D = Pole DIA
E = Not Less than 90°

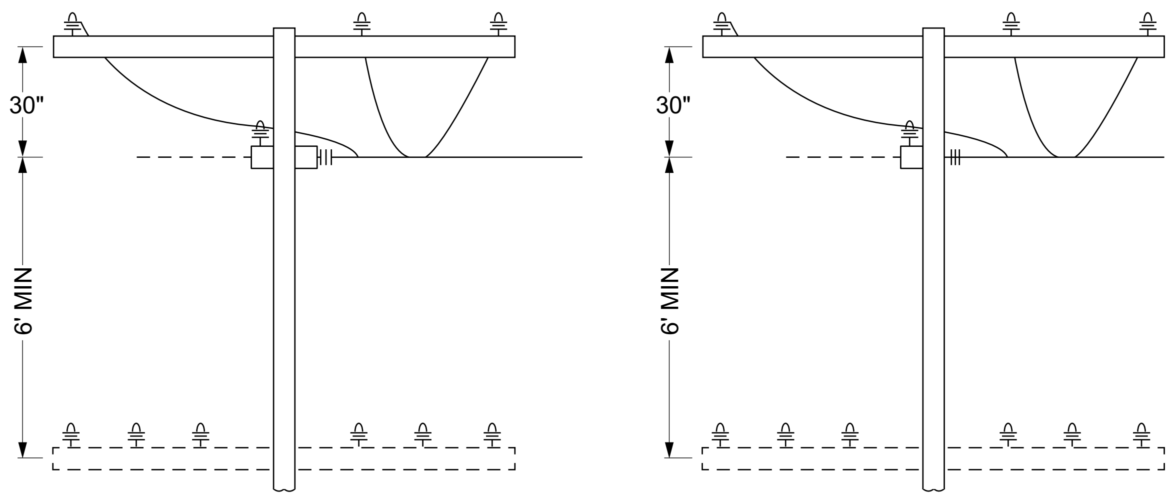


DC 110 Climbing/Working Space 3-Wire Corner

Scope DC 110.1 Climbing/Working Space 3-Wire Corner

Figure DC 110–1: Climbing/Working Space 3-Wire Corner





Dimensions	
A	36"
B	20" MIN
C	18" MIN

Permitted by G.O. 95, Rule 54.7-A3

Note(s):

1. A single-phase tap may be pulled in as shown by dotted lines.
2. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.

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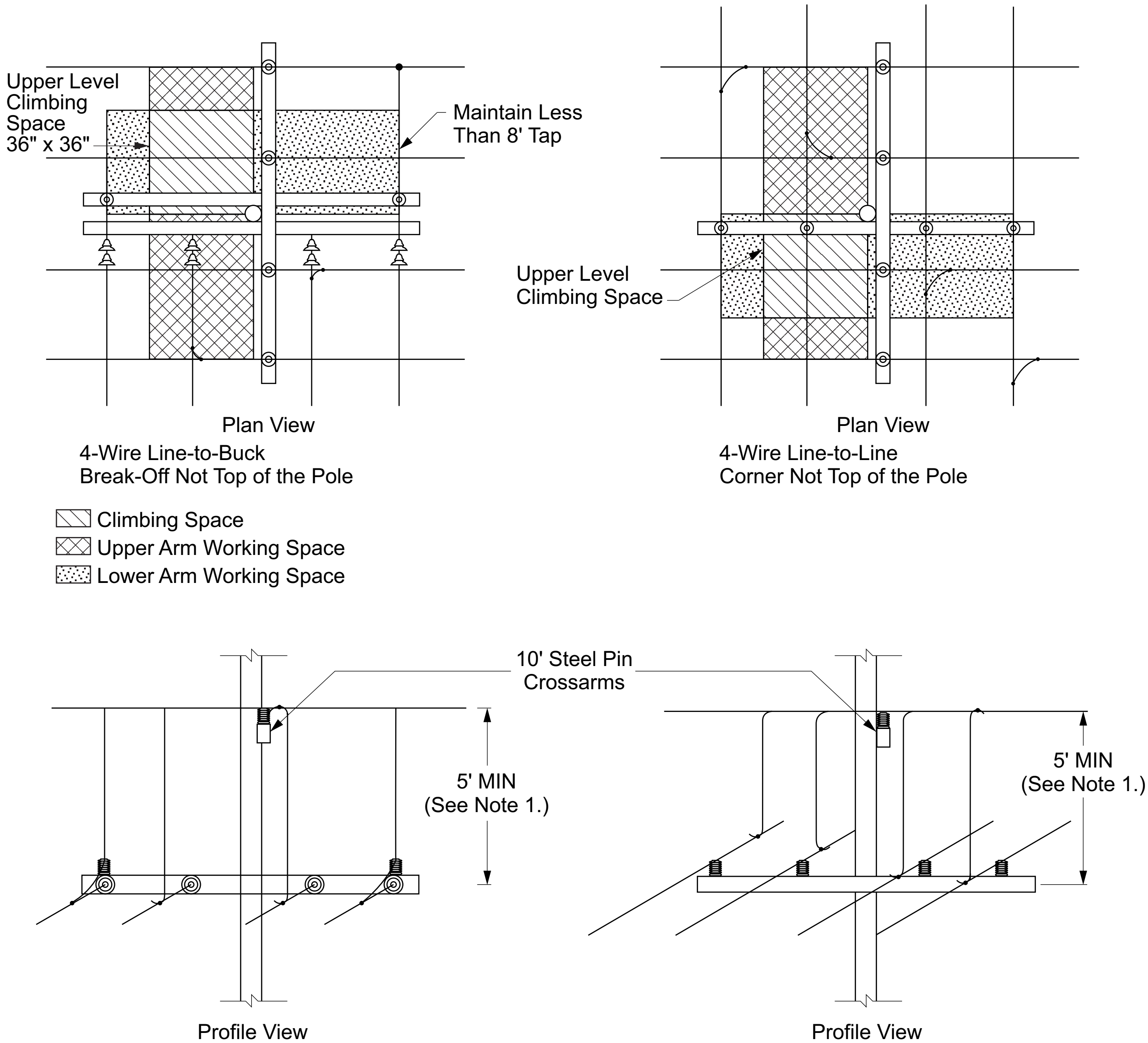
DC 120 Climbing/Working Space 4-Wire Corner

Scope DC 120.1 Climbing/Working Space 4-Wire Corner

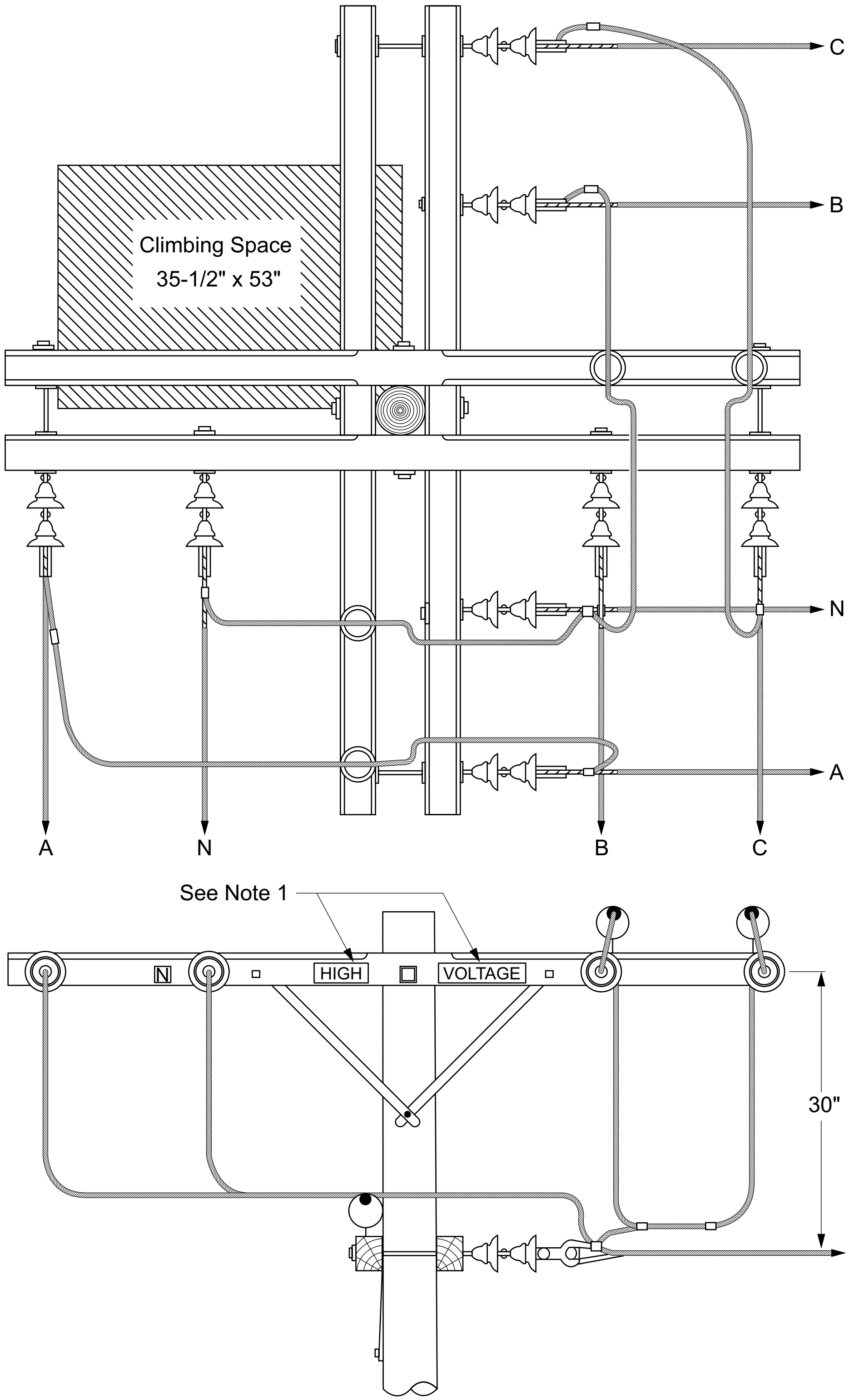
Figure DC 120–1: Climbing/Working Space 4-Wire Corner



Note(s):

1. May be reduced to 4 feet on existing (old) construction.
2. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.

Figure DC 120–2: Climbing/Working Space 4-Wire Corner



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.

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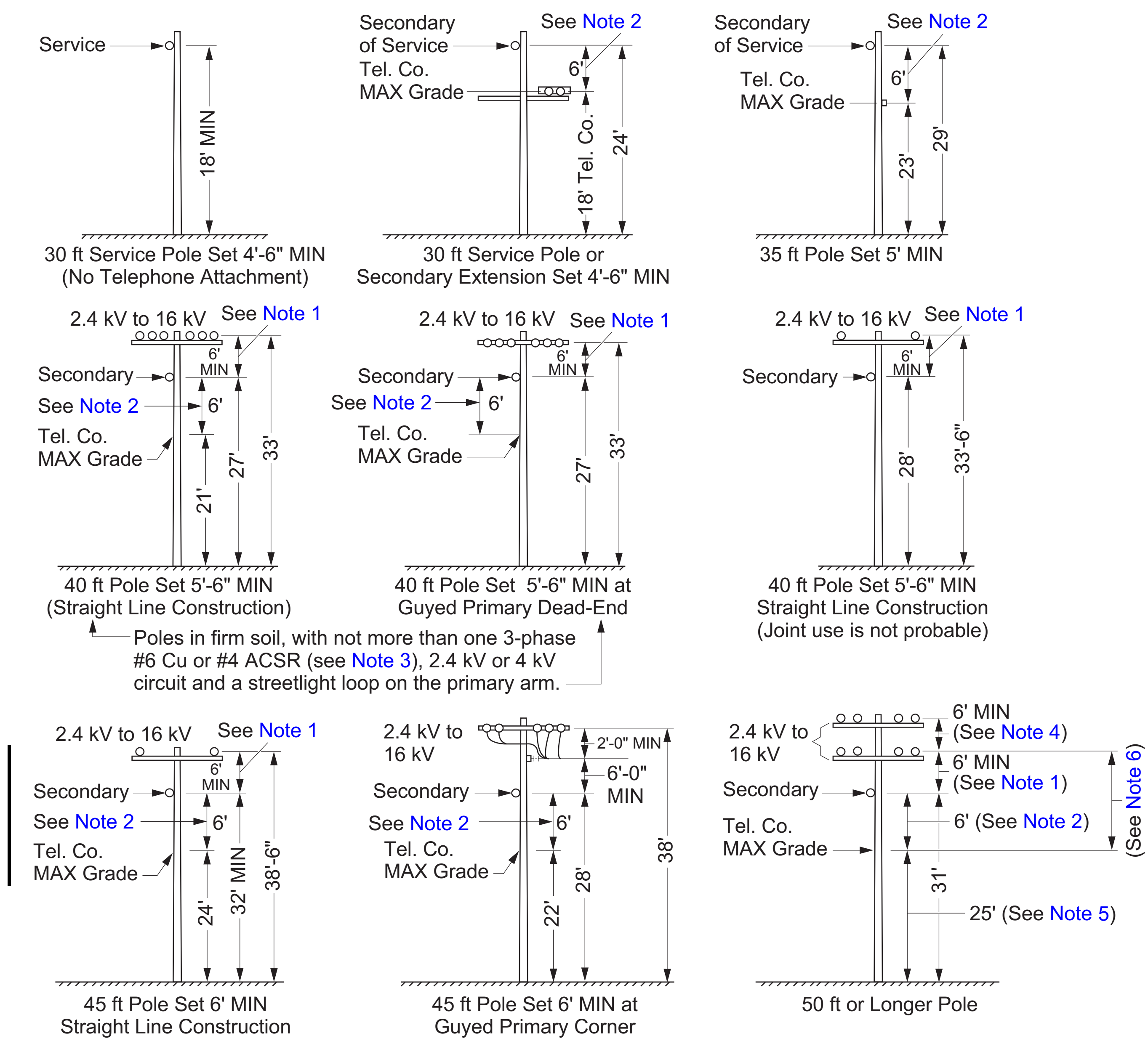
DC 200 Typical Poleheads/Clearances

Scope DC 200.1 Polehead, Conductor Clearances, and Grade Clearances for Various Sizes of Poles

Figure DC 200–1: Polehead, Conductor Clearances, and Grade Clearances for Various Sizes of Poles



Note(s):

1. The 6-foot minimum distance between primary and secondary conductor require lowering of secondary conductor.
2. Clearance between secondary and communication circuits of existing poles may be reduced from 6 feet to 4 feet with the installation of a guard arm.
3. Not approved for use on new construction.
4. A 6-foot clearance between primary circuits will be used on new line construction and on pole replacements when minimum sag requirements per Section CO can be maintained. Clearance may be reduced on existing installations.
5. This clearance will increase incrementally with taller poles.
6. If no secondary is present or anticipated, clearance between primary and communication circuits may be reduced per G.O. 95.

Figure DC 200–2: Typical Polehead Clearances

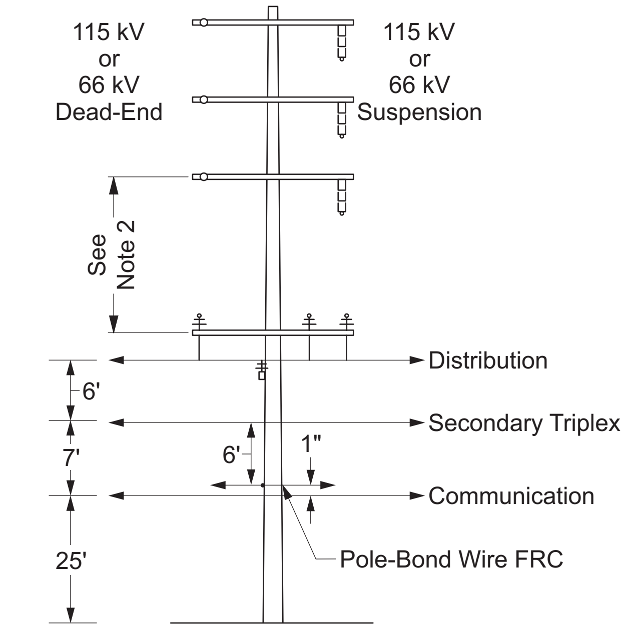


Figure 1

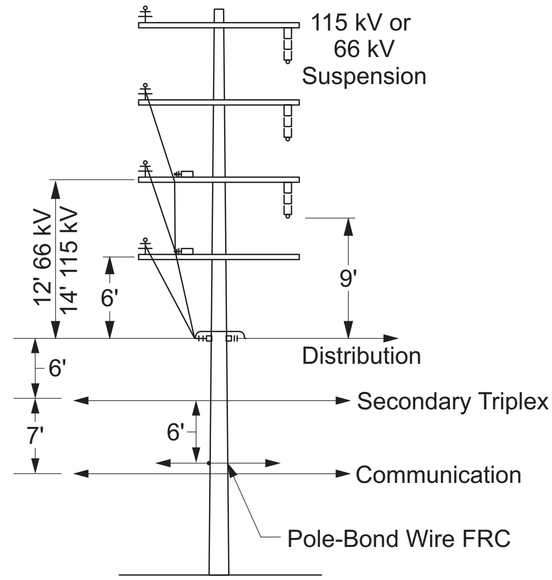


Figure 2

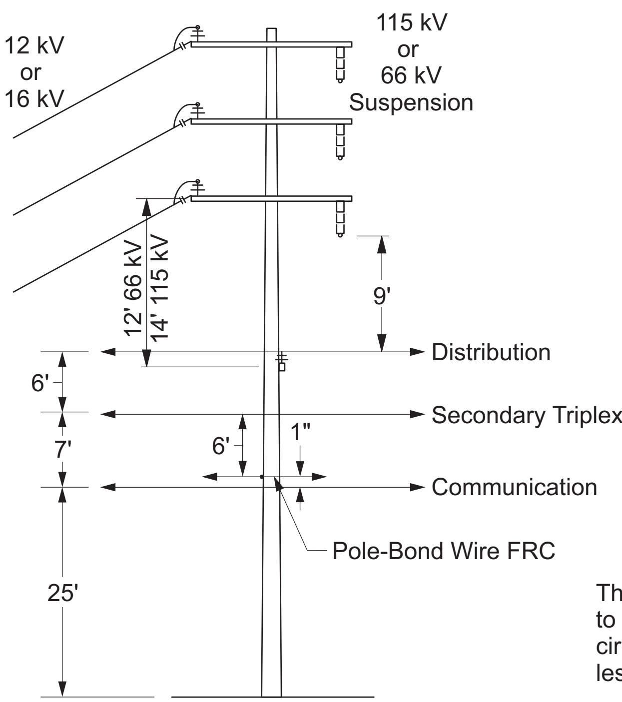


Figure 3

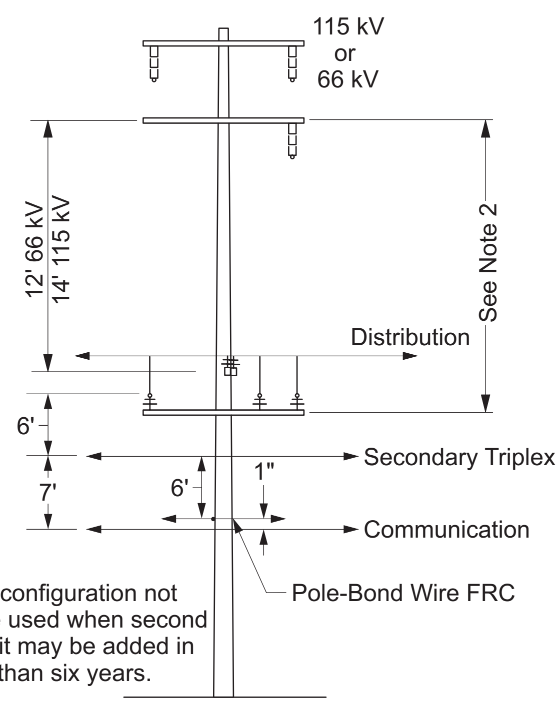


Figure 4

Note(s):

1. The distance between the pole-bond wire FRC and the lowest supply conductor can be reduced from six feet to four feet with installation of a guard arm.
2. Use the distance value listed in Table DC 200–1 plus three feet for 55/66 kV circuits and applicable span length. Use the distance value listed in Table DC 200–1 plus four feet for 115 kV circuits and applicable span length.

Figure DC 200–3: Typical Polehead Clearances

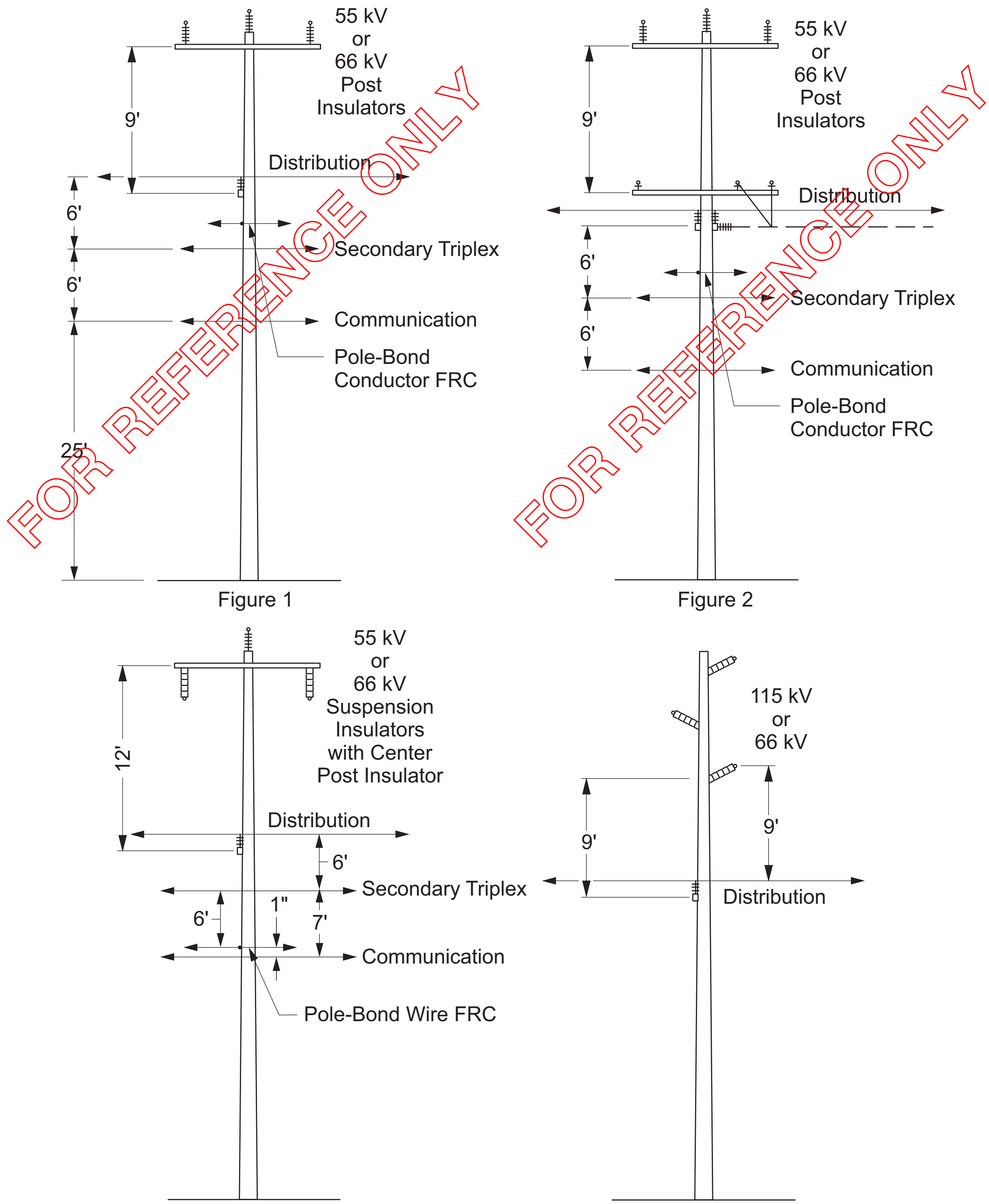


Figure 3

Figure 4

Note(s):

1. The distance between the pole-bond wire FRC and the lowest supply conductor can be reduced from six feet to four feet with installation of a guard arm.

Figure DC 200–4: Typical Polehead Clearances

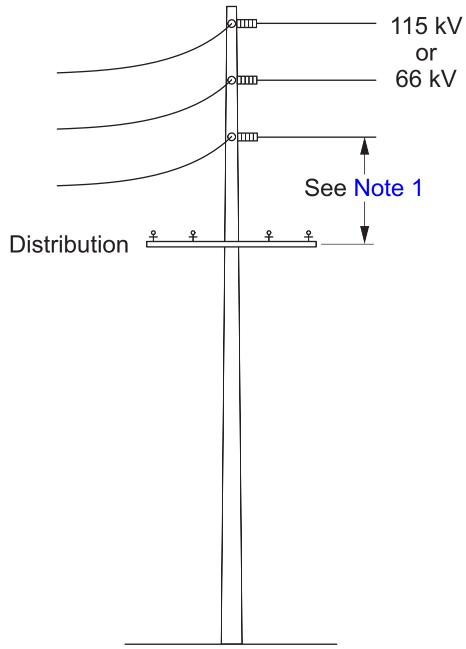


Figure 1

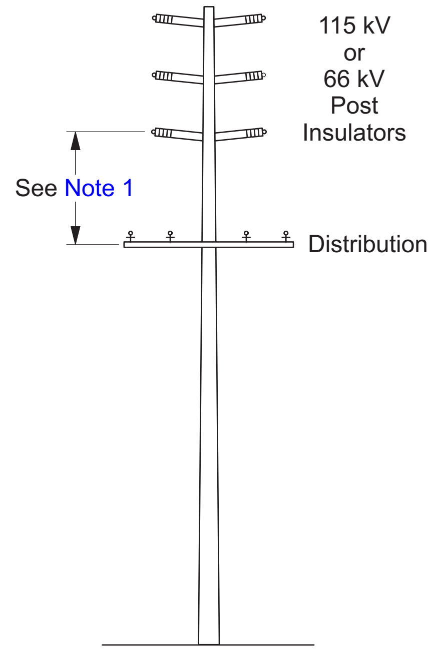


Figure 2

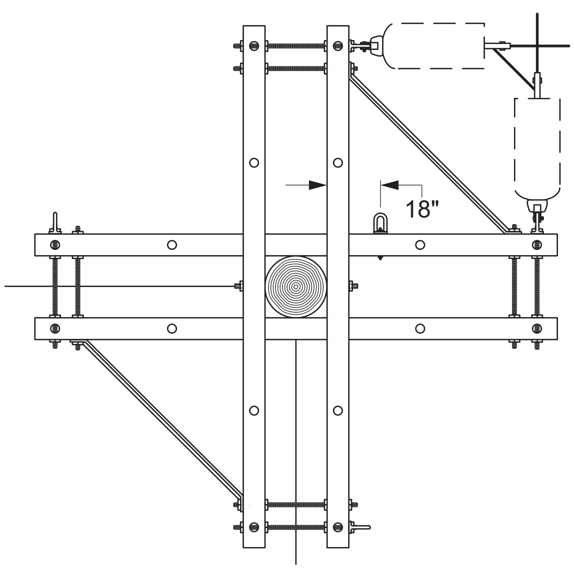


Figure 3

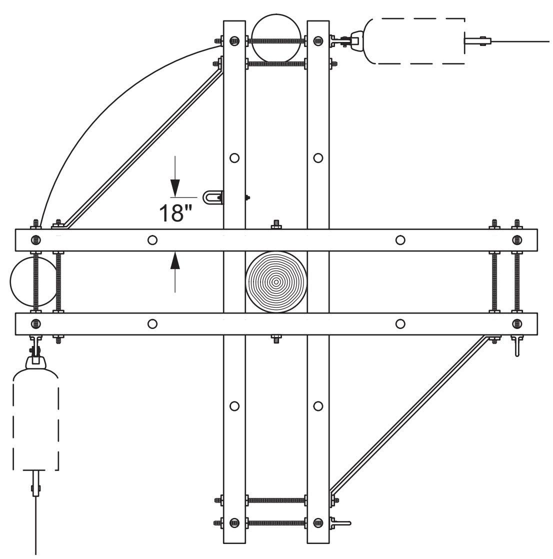


Figure 4

Note(s):

1. Use the distance value listed in Table DC 200–1 for the applicable voltage and span length.

Table DC 200–1: Minimum Vertical Transmission Conductor Separation from Distribution Conductor at Each Structure on Both Sides of the Subject Span

Voltage	≤ 200 ft	200 to 220 ft	220 to 240 ft	240 to 260 ft	260 to 280 ft	280 to 300 ft	300 to 320 ft	320 to 340 ft	340 to 360 ft	> 360 ft
66 kV	10	11	11	12	12	13	13	14	14	Contact Engineering
115 kV	12	13	13	14	14	15	16	16	17	

Note(s):

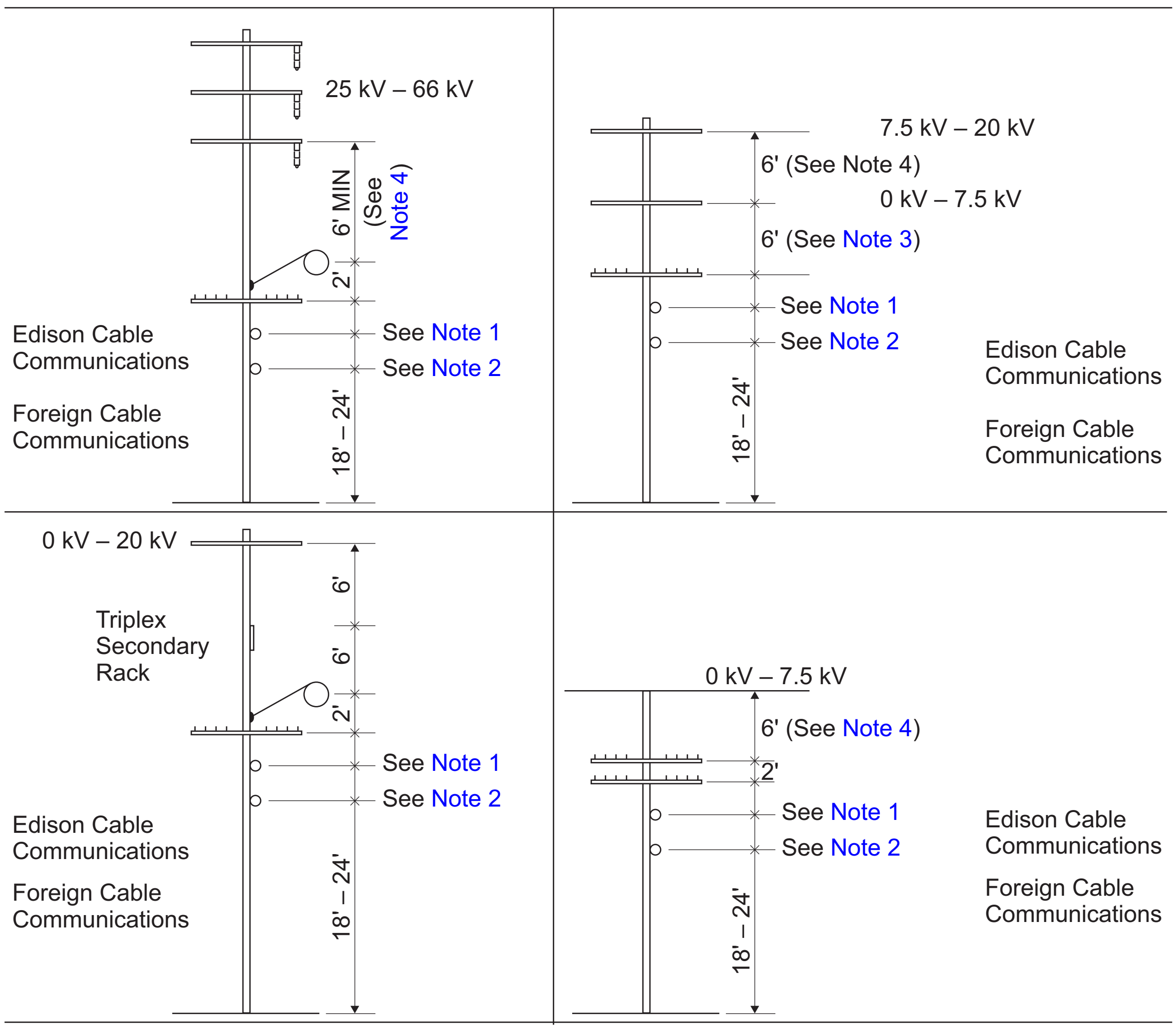
1. The table values are applicable for underbuild circuits attached to transmission poles. Attached crossings use the distance shown in the figures or greater if underbuild exists above the crossing. Unattached crossings shall maintain conductor clearances defined by G.O. 95.

DC 220 Typical Poleheads/Clearances — Wire Line Communication

Scope DC 220.1 Typical Poleheads/Clearances — Wire Line Communication

Figure DC 220–1: Typical Poleheads/Clearances — Wire Line Communication

Typical support clamps used by Edison Company.



Note(s):

1. Usually 2 feet below open wire crossarm; always as per General Order (G.O.) 95, Rule 87.4-C3.
2. Not less than 1 foot above foreign utility recorded joint pole grade.

3. Clearance between secondary and communication circuits of existing poles may be reduced from 6 feet to 4 feet with the installation of a guard arm.
4. A minimum 6-foot clearance between primary, secondary, and/or communication circuits will be applied for new line construction and on pole replacements when minimum sag requirements per CO Section can be maintained. When there are no secondary lines present, and it is anticipated that there will be an addition of secondary lines or other equipment, then a 12-foot clearance will be applied between primary and communication circuits for new and replacement poles. Clearances may be reduced per G.O. 95 for existing arm construction or if there will not be an addition of secondary lines or other equipment.

What's Changed? Revised Note 6 for clarity for clearances on transmission poles between primary, secondary, and communication lines.

DC 222 Non-SCE Antennas

Scope DC 222.1 Non-SCE Antennas

1.0 General Information

1.1 This standard applies to non-SCE antennas (antennas) affixed to distribution poles supporting SCE lines, streetlights, secondary risers, and guys (facilities).

1.2 This is a construction standard and is not intended to endorse or assure the installation of antennas on SCE poles.

1.3 This standard, including the Figures and Notes, supplement the minimum requirements established in the California Public Utilities Commissions' General Order (G.O.) 95, including Rule 94 and all other applicable rules. If an SCE standard and a G.O. 95 rule conflict, the more stringent of the two shall be applied.

1.4 For policies related to the construction and maintenance of antennas on distribution poles, refer to Distribution Design Standard, DDS-10, Section 5.7 G.

2.0 Support Elements

2.1 Cables, messengers, ground and bond wires, and incidental wiring associated with antennas shall meet the requirements for Class C circuits as specified in G.O. 95, except as modified by this standard.

2.2 Incidental wiring and miscellaneous equipment associated with antennas shall be installed in a workman like fashion so as to not interfere with workers ascending or descending the pole, or nearby communication and/or SCE facilities.

2.3 Hardware (for example, brackets, crossarms, braces) associated with antennas affixed above SCE facilities shall (at a minimum) meet the material strength requirements and safety factors for Grade "A" construction as specified in Section IV of G.O. 95.

A. Hardware associated with pole mounted antennas shall be reviewed and approved by SCE prior to construction.

1. Crossarms supporting antennas above 2.4–33 kV lines are prohibited.

2. Crossarms supporting antennas above 120–480 V lines and guys shall extend no more than 5 feet horizontally from the centerline of the support pole.
   - The maximum allowable crossarm length is 10 feet.

2.4 Hardware associated with antennas affixed below distribution facilities shall (at a minimum) meet the material strength requirements and safety factors for Grade "C" construction as specified in Section IV of G.O. 95.

2.5 Pole-top extensions meeting the requirements of Scope PO 150.1 may be utilized to support antennas above 120–480 V lines and atop guy poles.

2.6 Pull boxes, handholes, and other subsurface enclosures shall be situated so as to not interfere with down guys, guy anchors, vehicle and pedestrian traffic.

2.7 Pedestals and above ground equipment shall be situated so as to not interfere with down guys, guy anchors, vehicle and pedestrian traffic.

3.0 Clearances

3.1 Figures DC 222–1, DC 222–2, DC 222–3, and DC 222–4 specify the required minimum vertical, horizontal and/or radial clearances.

3.2 Antennas affixed above or below lines or guys, shall maintain clearances from unattached electric and communication lines in accordance with G.O. 95, Rule 38, Table 2, Case 3, Columns A–K.

- Pole-top antennas placed on distribution poles up to 33 kV lines are addressed by this standard.
- Pole-top antennas above 33 kV transmission lines are prohibited.

3.3 Antennas affixed below lines shall not be installed directly below polemounted streetlight fixtures nor interfere with the intended illumination pattern.

3.4 Approved antenna equipment (for example, light wave converters, amplifiers, grounding devices, batteries) affixed to the support pole shall meet the follow requirements:

A. Vertical clearance above the ground line (lowest part): 8 feet (MIN)

B. Vertical clearance above the ground line (upper most part): 16 feet (MAX)

C. Maximum dimensions of equipment (separate or combined): 72" × 30" × 18".

D. Weight of equipment: No maximum is prescribed, however, vertical loading must be calculated and the support pole appropriately sized.

E. Equipment measuring 36" × 30" × 18" or larger, (separately or combined) shall be installed with one or more bracket(s) and provide at least 6 inches of horizontal separation (measured from the surface of the pole to the nearest part of the equipment) to provide adequate space for workers ascending and descending the pole to place their hands or safety straps.

4.0 Marking

4.1 Antenna owner/operators shall provide, and update as necessary, accurate information regarding compliance with the Federal Communications Commission's Maximum Permissible Exposure (MPE) limits as set forth in Title 47 of the Code of Federal Regulations (CFR) for each antenna site.

4.2 Antenna owner/operators shall install signs or decals made of weather, corrosion, and Ultraviolet (UV) resistant materials. At a minimum, each sign or decal shall indicate the antenna owner/operator name; emergency 24-hour contact number; unique identifier for the antenna site; and SCE equipment catalog number (for pole-top installations).

4.3 Affix required signs/decals at two locations on the support structure so they are clearly visible:

A. 3–4 feet below the antenna (measured from the top of the sign).

B. 8–10 feet above the ground (measured from the bottom of the sign).

4.4 When the modifying an existing antenna site that requires the replacement or modification of existing markings the antenna owner/operator shall:

A. Notify SCE and all other pole occupants in writing and place new signs/decals that include the information listed in 4.2 (above) and as listed below:

1. The applicable FCC exposure category (General Population/Uncontrolled or Occupational/Controlled); and

2. FCC's recommended minimum approach distance.

5.0 Climbing Space

5.1 Where antennas are installed above lines or guys, climbing space shall be established and maintained in accordance with G.O. 95, Rule 54.7-A from the ground line to the bottom of the antenna hardware.

5.2 Where antennas are installed below lines or guys, climbing space shall be established and maintained in accordance with G.O. 95, Rule 84.7-A from the ground line to within 6 feet of the nearest line or guy.

5.3 Directional antennas shall be installed and oriented in a manner that limits RF energy within the climbing space.

6.0 Cable Risers and Grounds

6.1 Where antennas are installed above lines and guys atop wood or other nonmetallic poles, associated cable risers and vertical grounds shall be:

A. Adequately supported;

B. Encased in Schedule 40 PVC conduit;

C. Installed outside the climbing space; and

D. Meet the requirements of G.O. 95 Rule 54.6-D 1, 2, 3, and 5.

6.2 On wood poles, where one riser is present, one additional cable riser may be affixed directly to the pole, provided the climbing space is not impaired.

A. Appropriately sized galvanized pipe straps (with not less than three straps per each 10 feet length of conduit), and size 16D nails or equivalent lags shall be utilized.

6.3 On wood poles, where two or more risers are present, any additional risers shall be installed with unistrut or power-strut riser supports in accordance with DUG CR 110.2.

6.4 On Light Weight Steel poles where antenna risers are installed, unistrut or power-strut supports shall be utilized in accordance with DUG CR 141 (refer to DUG Figure CR 141-2).

6.5 Cables emanating from a pole top antenna riser or transitioning from a vertical run that extends to an adjacent pole or building shall be:

A. Bonded to the support pole's existing communication cables and messengers;

B. Effectively grounded in accordance with G.O. 95 Rule 83.4; and

C. Marked in accordance with G.O. 95 Rule 91.5

D. Where a guard arm is present, the bottom of the riser shall extend at least one foot below the guard arm.

6.6 Unprotected (bare) ground wires, connectors and associated grounding equipment installed on nonmetallic poles shall be installed outside the climbing space.

A. Unprotected (bare) ground wires installed on wood poles shall be covered with Schedule 40 PVC conduit or its equivalent wood or PVC molding.

7.0 Stepping

7.1 On joint use wood poles, stepping is not required.

7.2 On joint use composite or Light Weight Steel poles, where risers (of any kind) are present, the necessity of permanent pole steps shall be determined by SCE if requested by the incoming wireless carrier.

8.0 Cable/Messenger Mounted

8.1 Cable/messenger mounted antennas shall be installed with at least:

A. Six (6) feet of horizontal clearance measured from the nearest part of the antenna to the surface of the pole.

B. Four (4) feet of vertical clearance below 120–480 V lines.

C. 10 feet of vertical clearance below 2.4–33 kV lines (where no 120–480 V lines are present).

D. Six (6) feet of horizontal clearance from self-supporting streetlights.

8.2 The maximum length of a cable/messenger mounted antennas is 3 feet

8.3 Cable/messenger mounted antennas shall not be installed below pole mounted streetlight fixtures nor interfere with the intended illumination pattern.

9.0 Emergency RF/Power Shut-Off Device

9.1 Antennas affixed to poles supporting lines, and/or guys, shall be installed with a device that disconnects all RF energy.

A. This device may be affixed to the support pole, above ground communication equipment, or contained in a subsurface enclosure but must be located no more than 20 feet from the pole supporting the antenna and within line-of-sight.

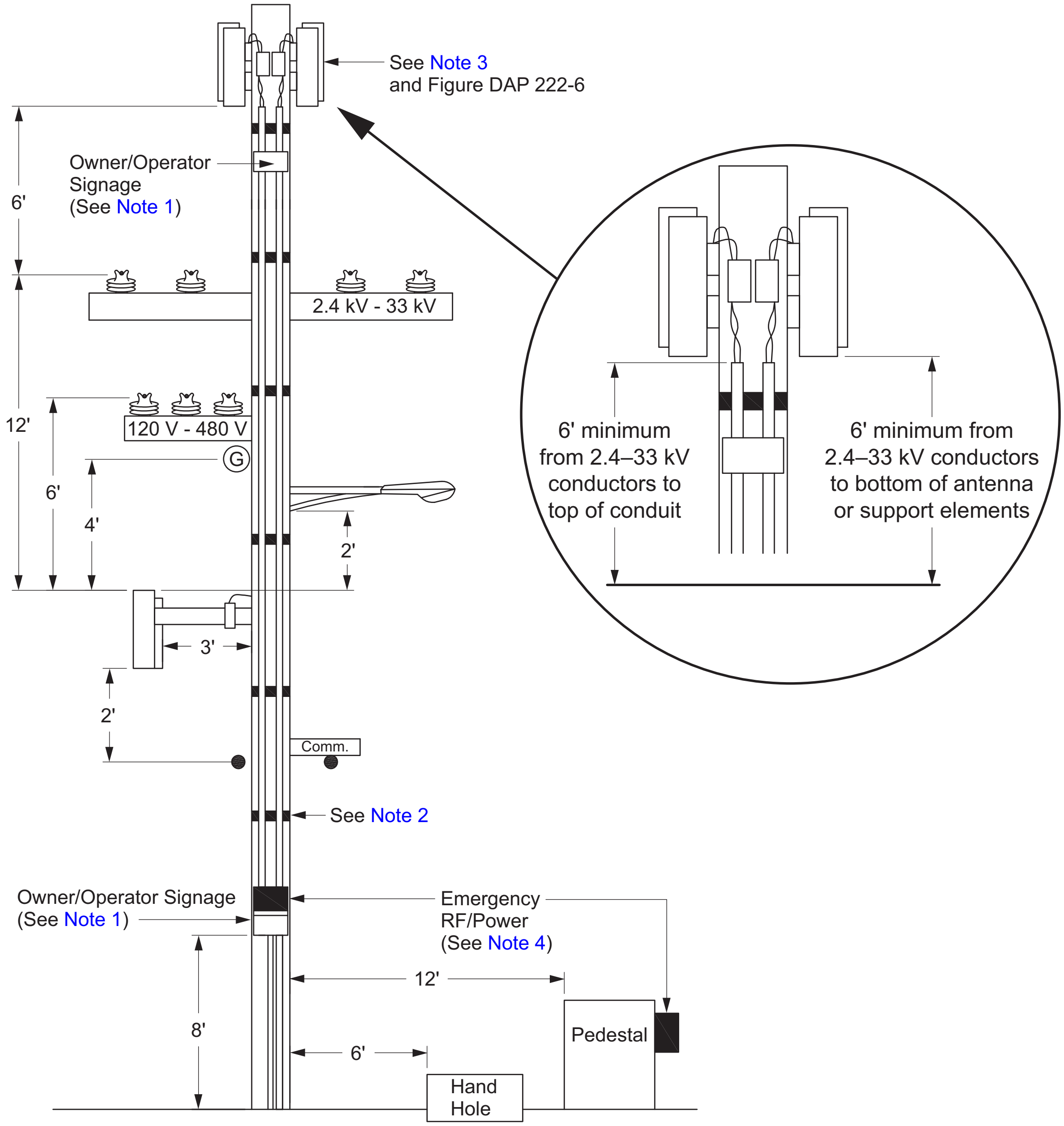
- For routine and emergency RF/Power Shut-Off protocols refer to DOM MO-1.

B. Each device shall be permanently marked with a weather and UV resistant sign or decal that reads: SCE Emergency RF/Power Shut-Off Switch.

- See Figure DC 222–5.

C. For non-metered cellular service equipment details, refer to DAP, AP 800.

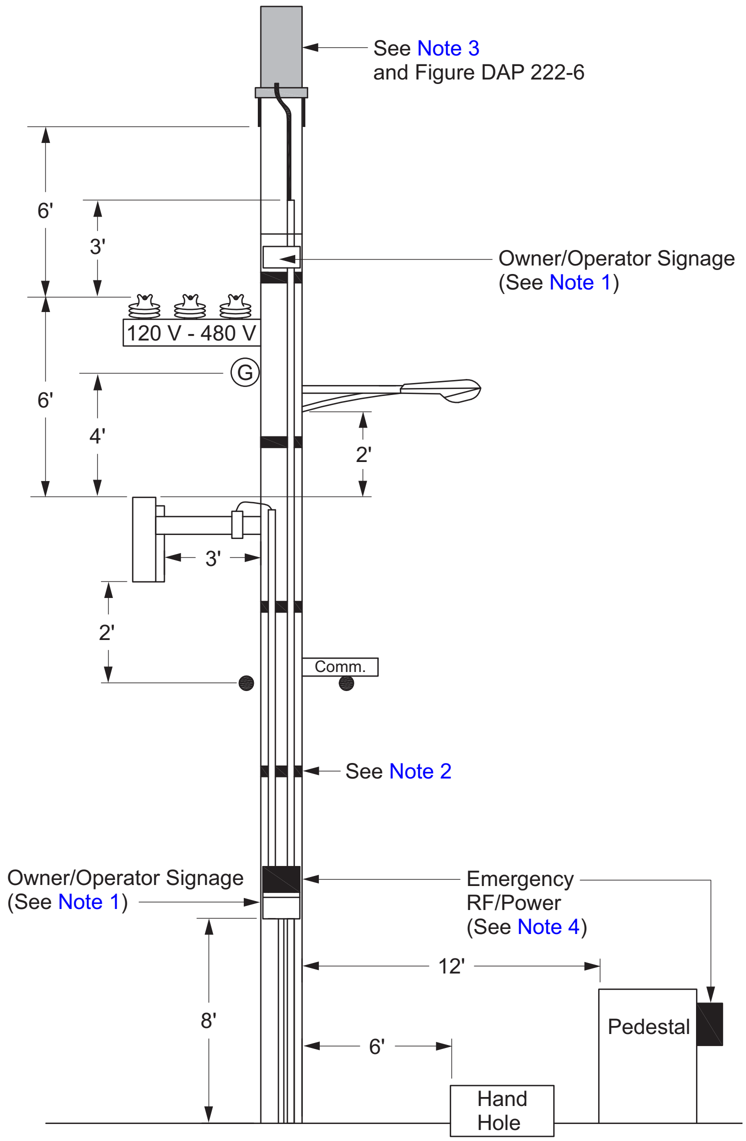
Figure DC 222–1: Typical High Voltage Distribution Pole Non-SCE Antennas



Note(s):

1. Antenna markings shall be affixed so as to be clearly visible, at two locations on the support structure. 3–4 feet below the antenna (measured from the top of the sign), and 8–10 feet above the ground (measured from the bottom of the sign).
2. On wood poles, where two or more risers are present, any additional riser shall be installed with unistrut or power-strut supports in accordance with DUG CR 110.2. For SCE LV conduit only, refer to DUG CR 150 for placement of riser conduit warning labels.
3. Antennas atop HV distribution poles — no specified horizontal clearance between the pole and antenna.
4. The preferred location of RF/Power Shutoff Switch is the customer's pedestal, however, at SCE's discretion; the device may be affixed on the antenna pole (for non-metered cellular service equipment details, refer to DAP, AP 800).
5. Clearance dimensions shown are the required minimum vertical, horizontal, and/or radial clearances.

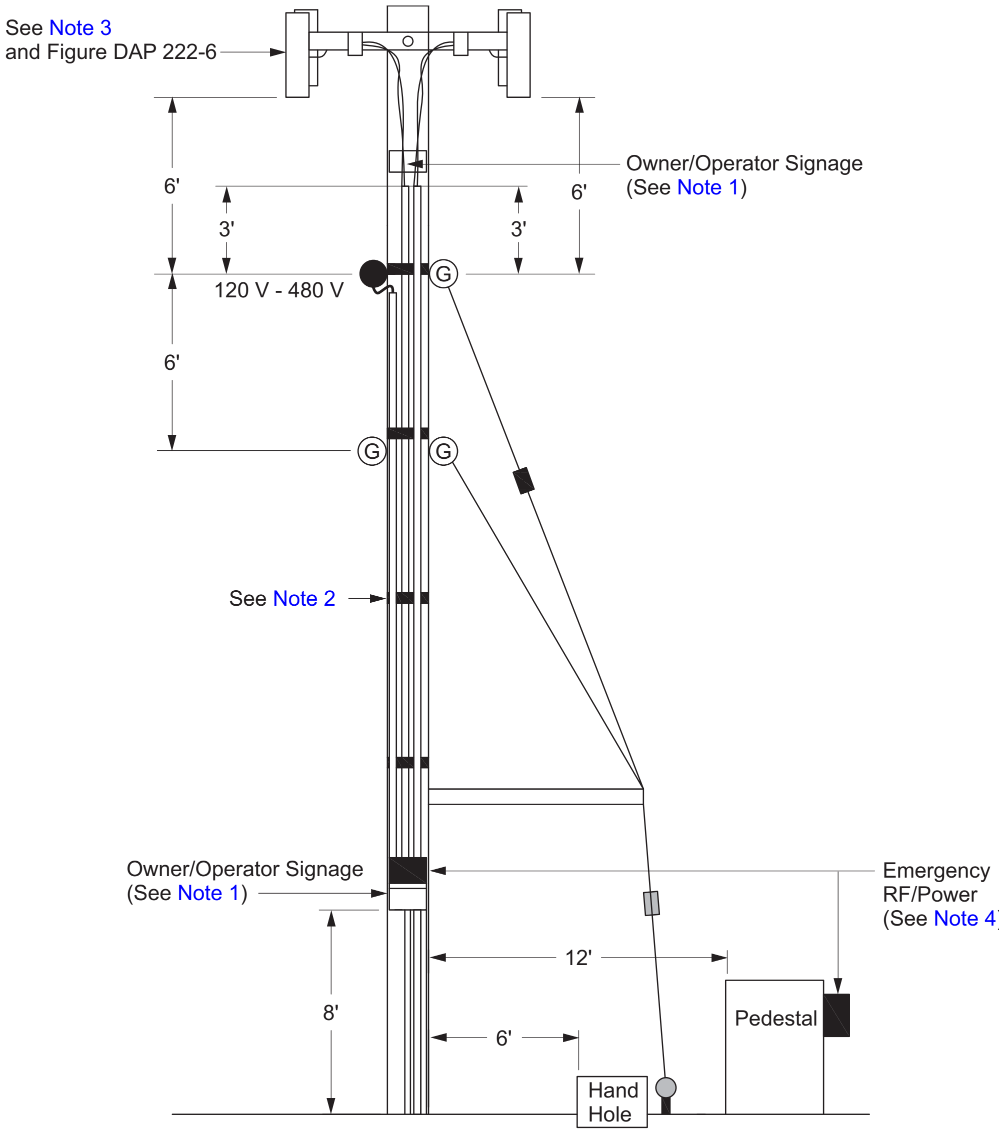
Figure DC 222–2: Typical Low Voltage Distribution Pole with Non-SCE Antenna



Note(s):

1. Antenna markings shall be affixed so as to be clearly visible, at two locations on the support structure. 3–4 feet below the antenna (measured from the top of the sign), and 8–10 feet above the ground (measured from the bottom of the sign).
2. On wood poles, where two or more risers are present, any additional riser shall be installed with unistrut or power-strut supports in accordance with DUG CR 110.2.
3. Antennas atop LV distribution poles — no specified horizontal clearance between the pole and antenna.
4. The preferred location of RF/Power Shutoff Switch is the customer's pedestal, however, at SCE's discretion; the device may be affixed on the antenna pole (for non-metered cellular service equipment details, refer to DAP, AP 800.
5. Clearance dimensions shown are the required minimum vertical, horizontal, and/or radial clearances.

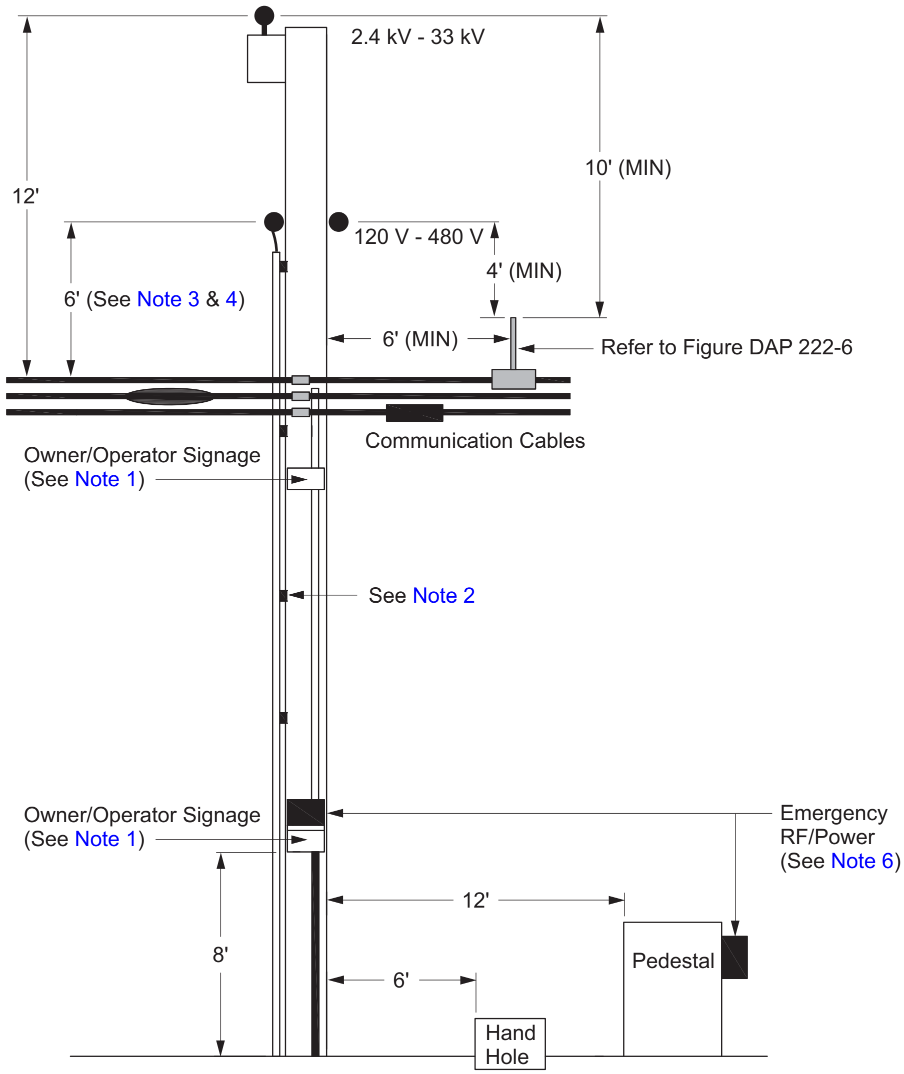
Figure DC 222–3: Typical Guy Pole Non-SCE Antennas



Note(s):

1. Antenna markings shall be affixed so as to be clearly visible, at two locations on the support structure. 3–4 feet below the antenna (measured from the top of the sign), and 8–10 feet above the ground (measured from the bottom of the sign).
2. On wood poles, where two or more risers are present, any additional riser shall be installed with unistrut or power-strut supports in accordance with DUG CR 110.2.
3. Antennas atop guy poles — no specified horizontal clearance between the pole and antenna.
4. The preferred location of RF/Power Shutoff Switch is the customer's pedestal, however, at SCE's discretion; the device may be affixed on the antenna pole (for non-metered cellular service equipment details, refer to DAP, AP 800).
5. Clearance dimensions shown are the required minimum vertical, horizontal, and/or radial clearances.
6. Antennas may only be affixed at the top under a pole license agreement.

Figure DC 222–4: HV Distribution Pole with Cable/Strand Mounted Omni Antenna

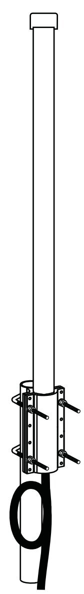


Note(s):

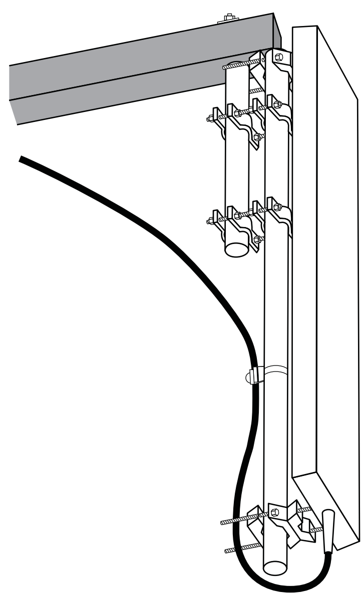
1. Antenna markings shall be affixed so as to be clearly visible, at two locations on the support structure. 3–4 feet below the antenna (measured from the top of the sign), and 8–10 feet above the ground (measured from the bottom of the sign).
2. On wood poles, where two or more risers are present, any additional riser shall be installed with unistrut or power-strut supports in accordance with DUG CR 110.2.
3. Unguarded communication cables below distribution lines (120–480 V) require 6 feet vertical clearance (measured from centerline of conductor to centerline of nearest communication cable).
4. Guarded communication cables below distribution lines (120–480 V) require 4 feet vertical clearance (measured from centerline of conductor to centerline of nearest communication cable).
5. Cable/strand mounted antennas: Maximum length — 3 feet.
6. The preferred location of RF/Power Shutoff Switch is the customer's pedestal, however, at SCE's discretion; the device may be affixed on the antenna pole (for non-metered cellular service equipment details, refer to DAP, AP 800).
7. Clearance dimensions shown are the required minimum vertical, horizontal, and/or radial clearances.

Figure DC 222–5: Emergency RF/Power Shut-Off Switch

Figure DC 222–6: Omni-Directional Antenna and Directional Antenna



Omni-Directional Antenna

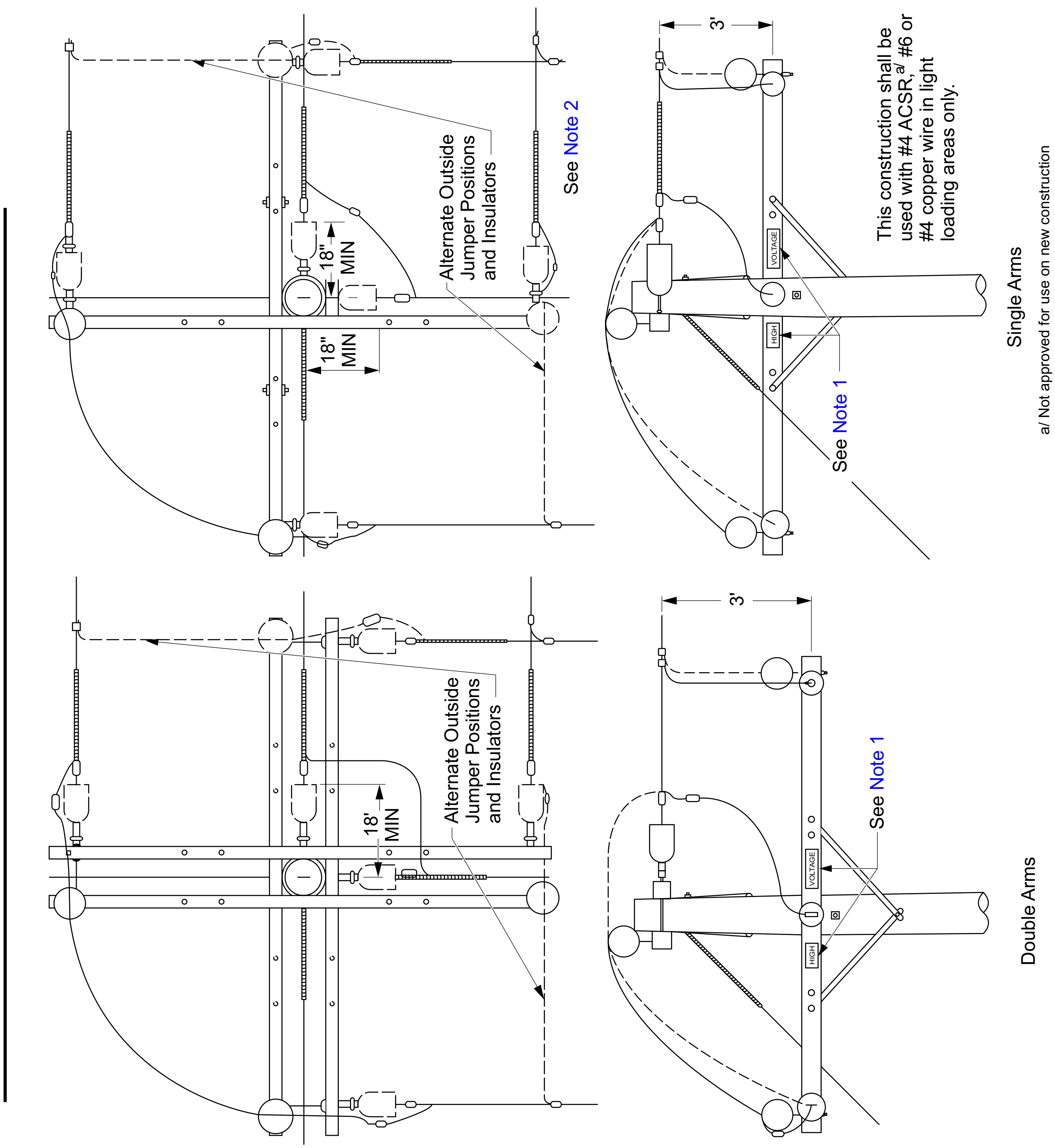


Directional Antenna

DC 230 Centerline Dead-Ending 3-Wire Corner

Scope DC 230.1 Centerline Dead-Ending 3-Wire Corner

Figure DC 230–1: Centerline Dead-Ending 3-Wire Corner



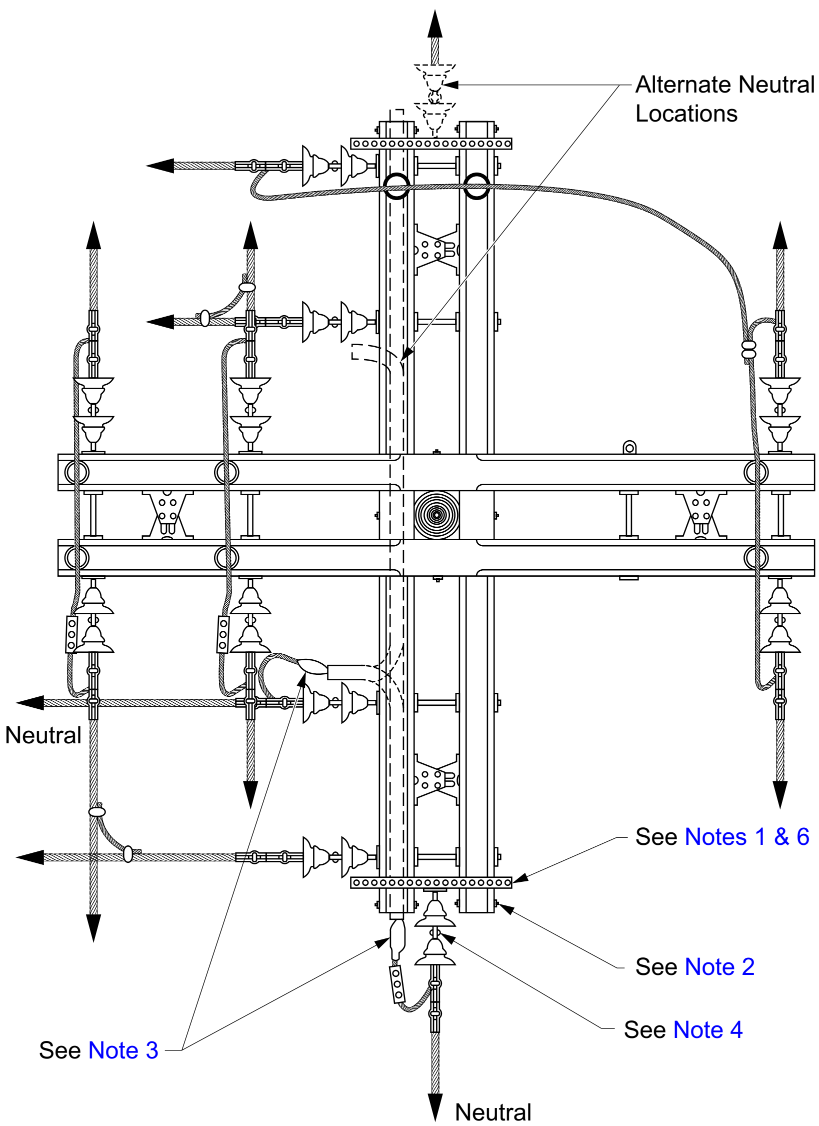
Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. For number and type of insulators, see GR Section.
3. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.

DC 240 Blackwell Corner 12/16 kV 3/4 Wire Alternate Method (for Existing Installations)

Scope DC 240.1 Blackwell Corner 12/16 kV 3/4 Wire Alternate Method (for Existing Installations)

Figure DC 240–1: Blackwell Corner 12/16 kV 3/4 Wire Alternate Method (for Existing Installations)



Note(s):

1. DA bracket SAP 10068501.
2. Install split bolts outside DA bracket.
3. Two-inch PVC with coupling and elbow. Leave enough room outside PVC to install heat shrink on #350 12/17-kV kcmil CLP cable. (Remove concentric neutral wires.)
4. Install RIV CLIPS in insulator clevis. Install shackle SAP 10068446 (Rainmaker).

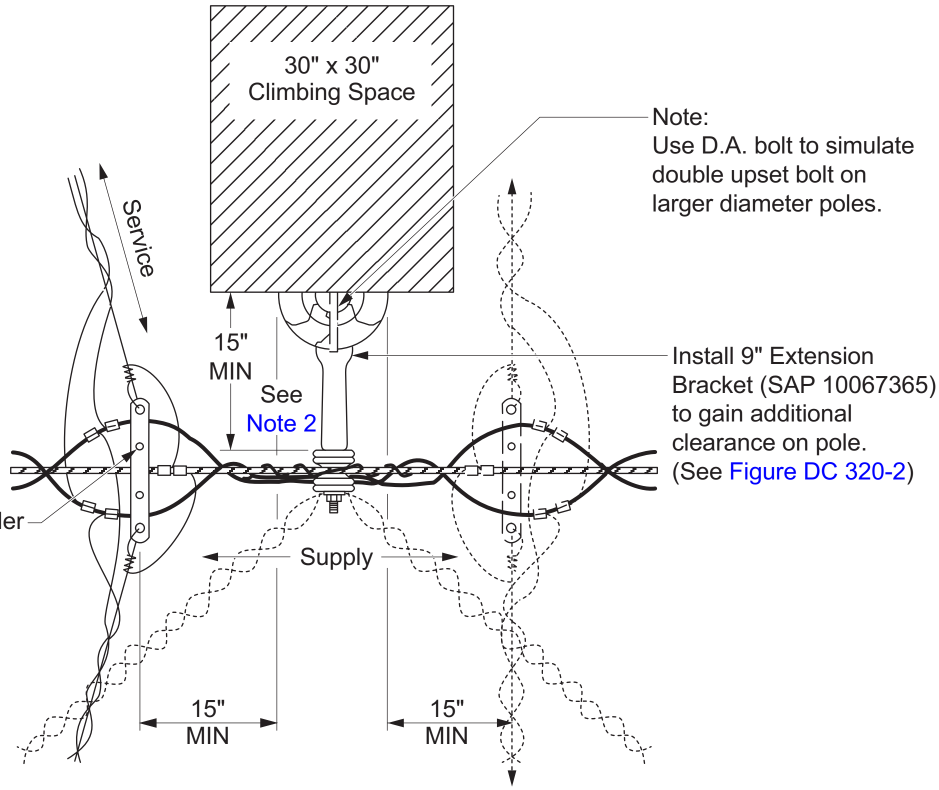
5. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
6. Sandwich reinforcing plate SAP 10213418 between DA bracket and arms.

DC 320 Triplex/Straight Line Construction

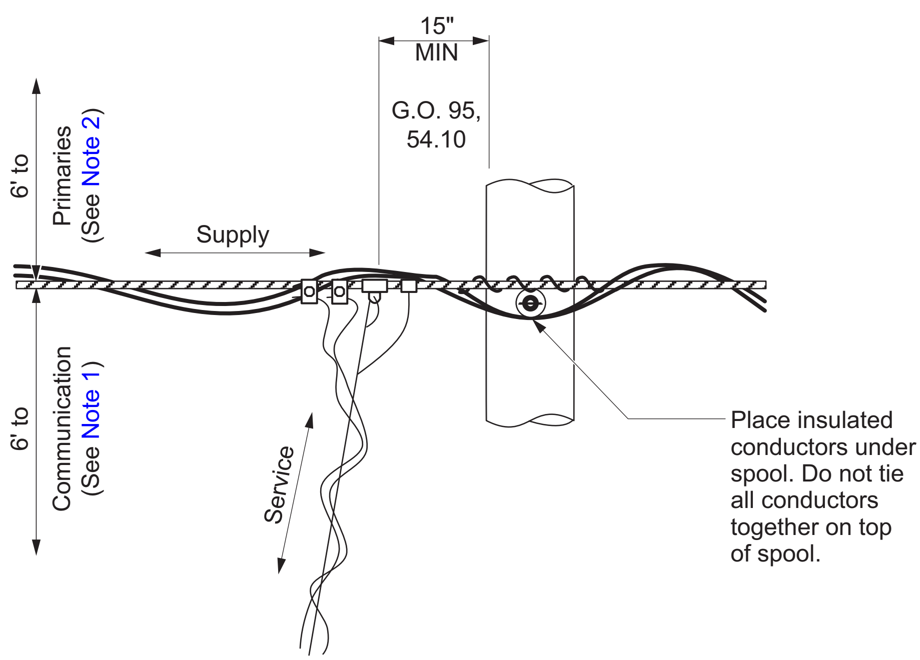
Scope DC 320.1 Typical Straight Line Construction for Triplex Conductors

Figure DC 320–1: Triplex/Straight Line Construction

Important Note:
Service drops attached to triplex messengers must be a minimum of 15" from the centerline of the pole. However, to prevent distortion of insulation on supply phase conductors, spacers may be placed 30–40" out from centerline of pole.



See G.O. 95, 54.10 for complete vertical clearance requirements.



Note(s):

1. May be reduced to 4 feet with installation of guard arm above communication cables attached to surface of the pole.
2. May be reduced to 4 feet with installation of a guard arm, or covered with suitable protection, or installed 15 inches or more from center of pole.

Figure DC 320–2: Rack Secondary Spreader for Mid-span Service

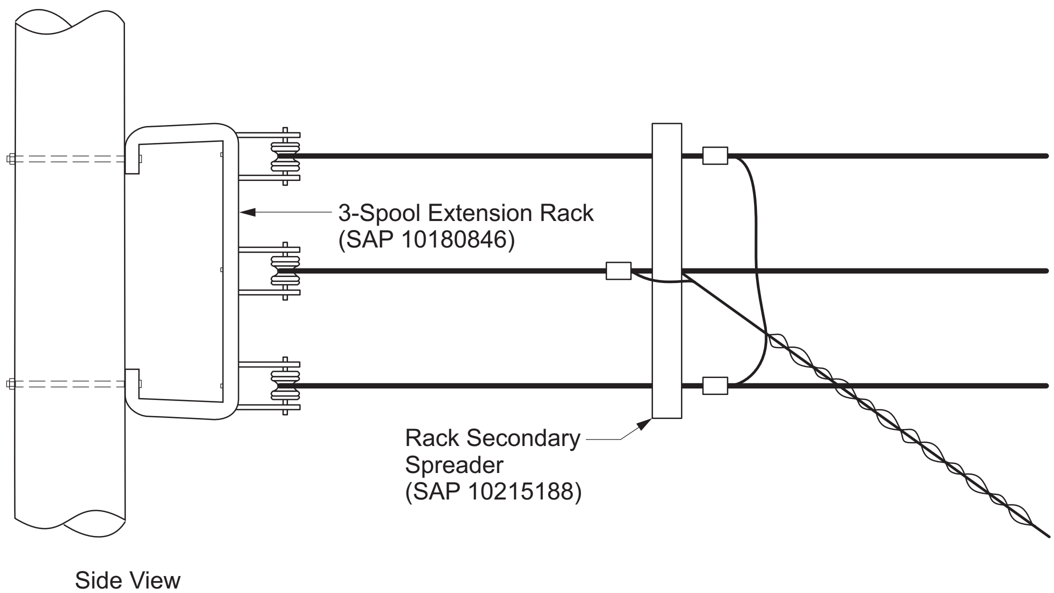
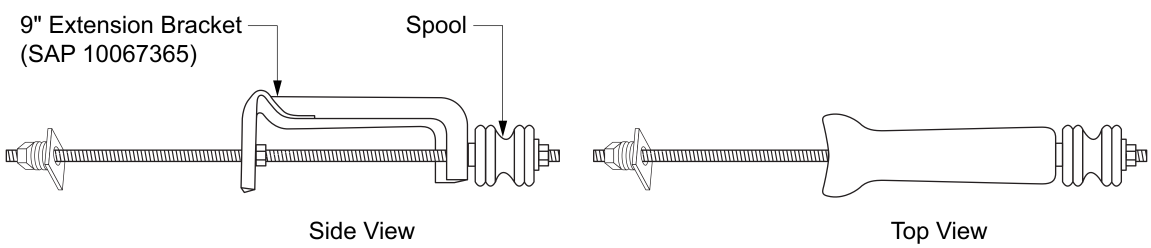


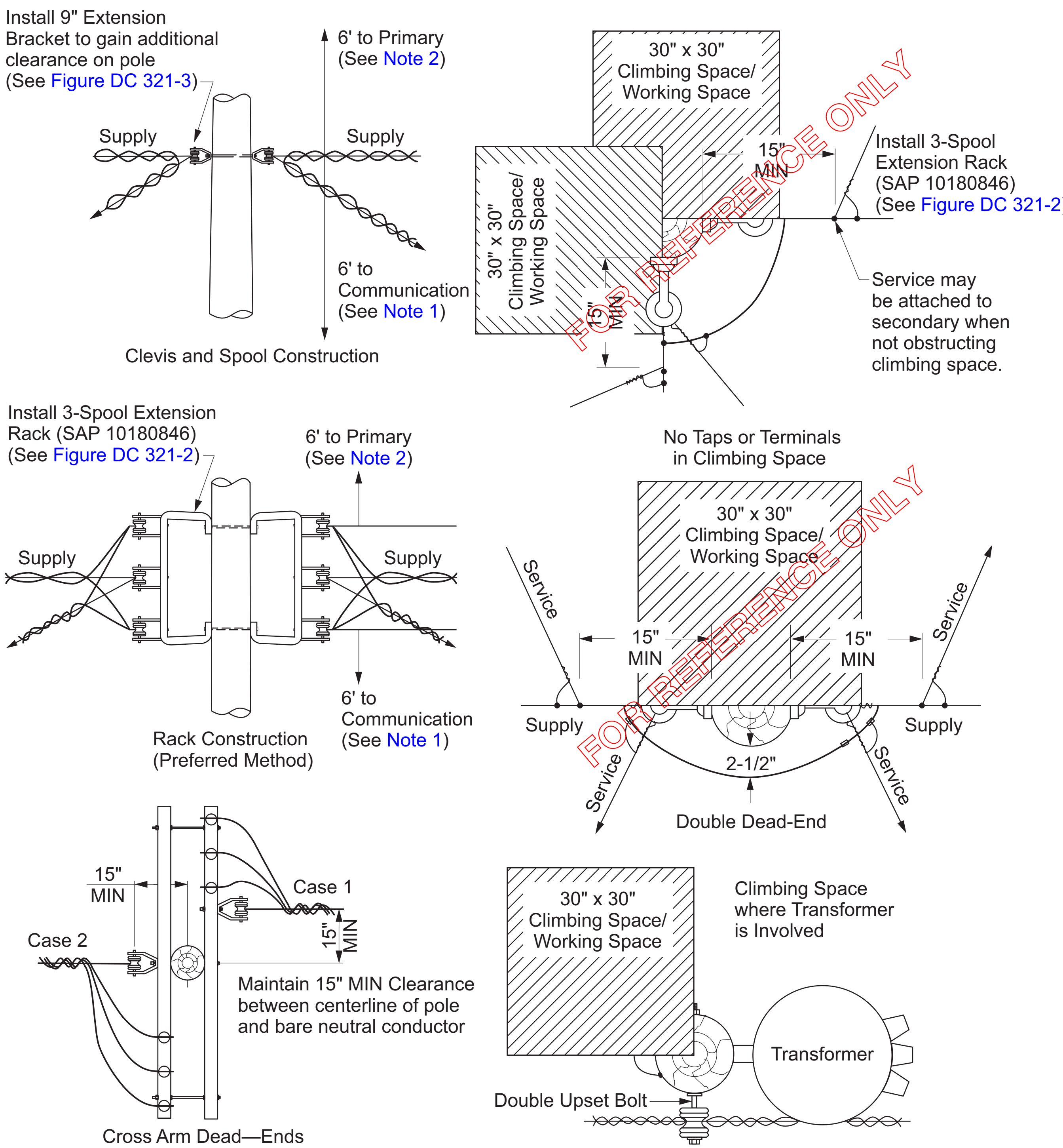
Figure DC 320–3: 9-inch Extension Bracket



DC 321 Triplex/Dead-ends/Corners

Scope DC 321.1 Typical Secondary Construction for Triplex/Dead-Ends/Corners

Figure DC 321–1: Triplex/Dead-ends/Corners



Note(s):

1. May be reduced to 4 feet with installation of guard arm above communication cables attached to surface of the pole.
2. May be reduced to 4 feet with installation of guard arm, or covered with suitable protection, or installed 15 inches or more from center of pole.

Figure DC 321–2: 3-Spool Extension Rack

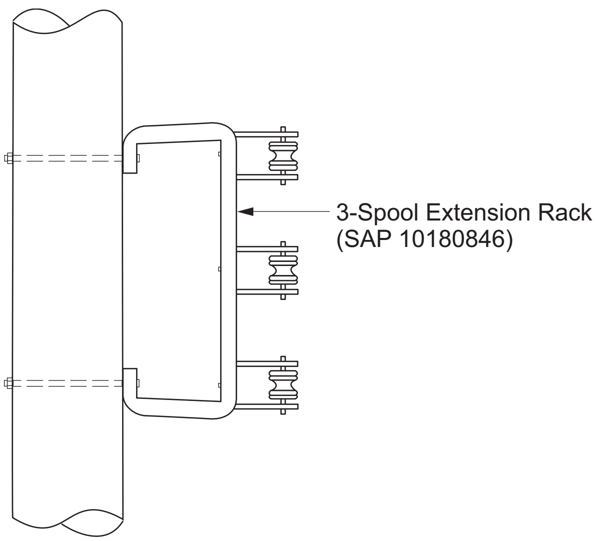


Figure DC 321–2.1: 3-Spool Extension Rack

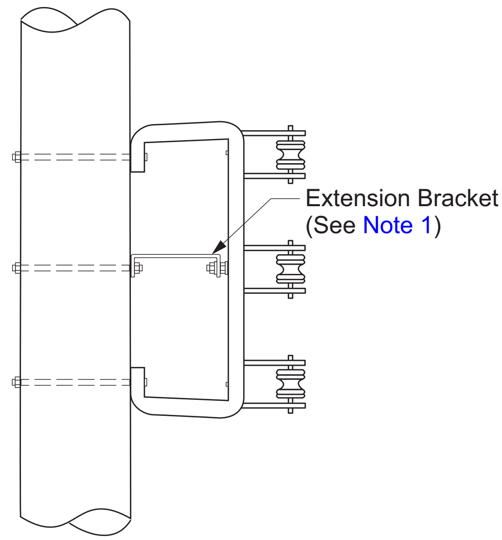


Figure DC 321–2.2: 3-Spool Extension Rack with Extension Bracket

Note(s):

1. Use the extension bracket (SAP 10209938) on center position when 1/0, 4/0 triplex, quadruplex, and 4/0 WAL is dead-ended.

Figure DC 321–3: 3-Spool Extension Rack Extension Bracket

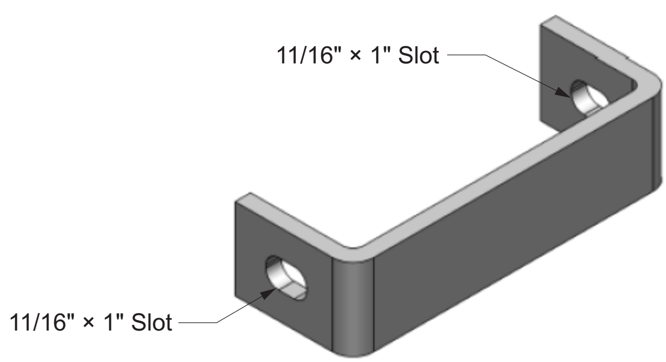
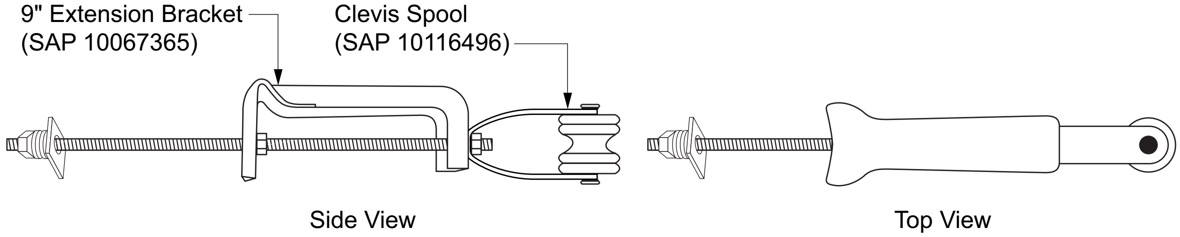


Figure DC 321–4: 9-Inch Angle Extension Bracket with Clevis Spool



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DC 322 Triplex/Angle Construction

Scope DC 322.1 Angle Construction

Figure DC 322–1: Angle Construction for Clevis Spool or 9-inch Extension Bracket with Clevis Spool

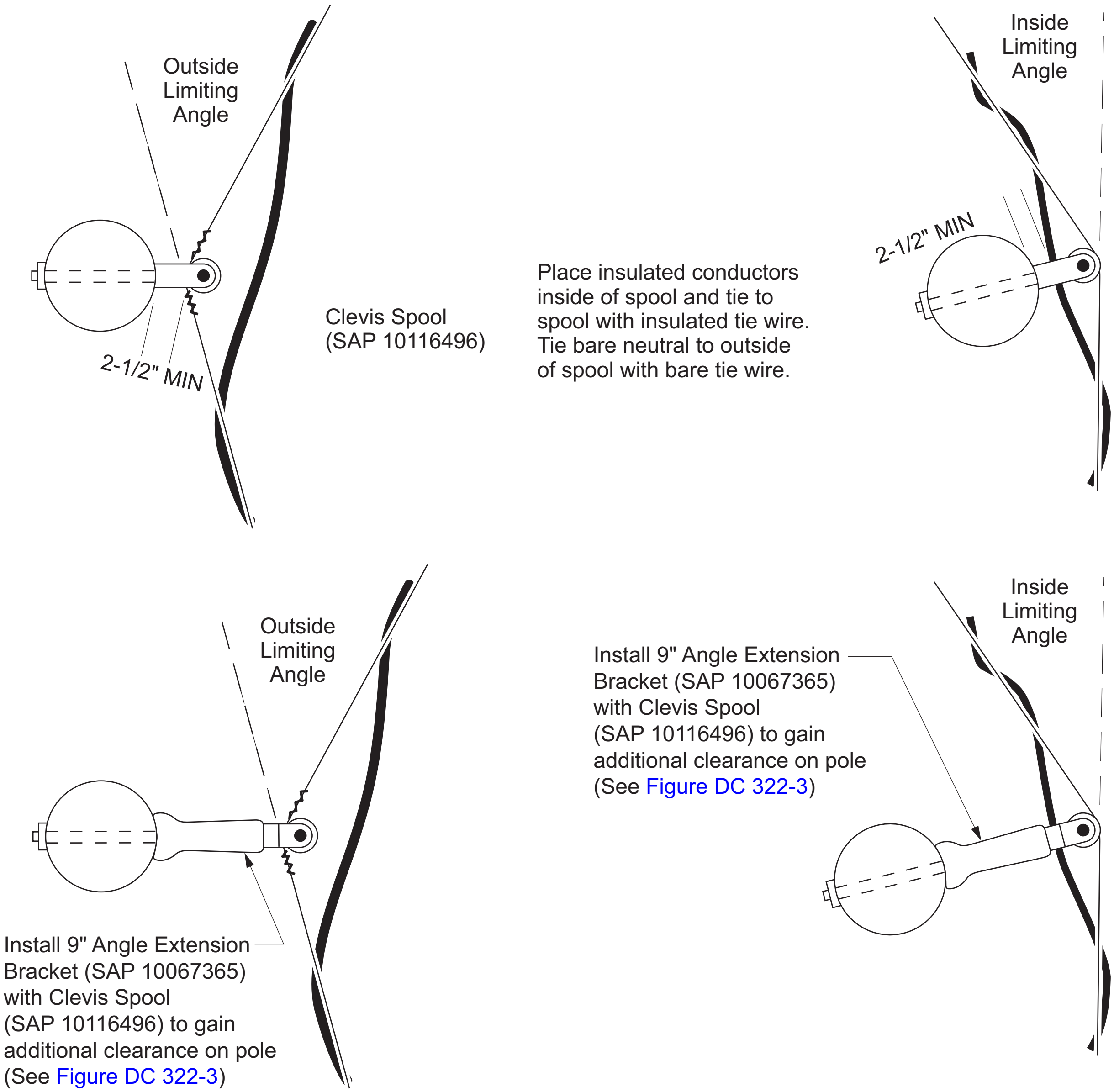


Table DC 322–1: Limiting Angle on Spool

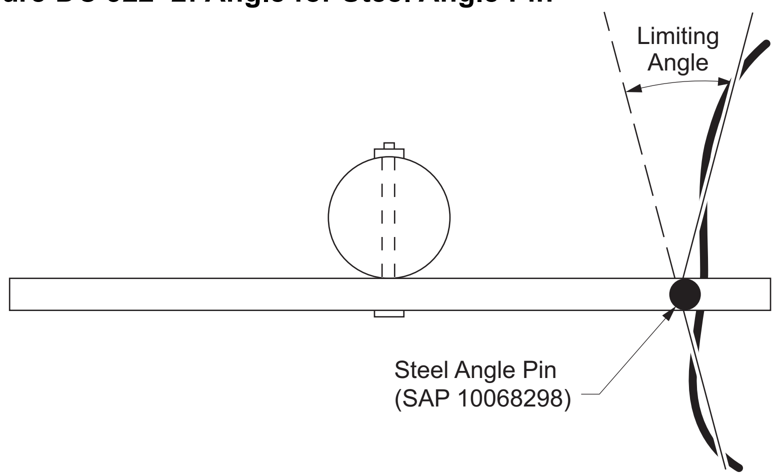
Conductor Size		Limiting Angle	
Al	Cu	Outside Degree	Inside Degree
1/0	—	40	30
4/0	—	20	20

Table DC 322–2: Angle on Crossarm

Conductor Size		Limiting Angle	
Al	Cu	Single Arm Degree	Double Arm Degree
1/0	—	15 MAX	30 MAX
4/0	—	7 MAX	15 MAX

Figure DC 322–2: Angle for Steel Angle Pin

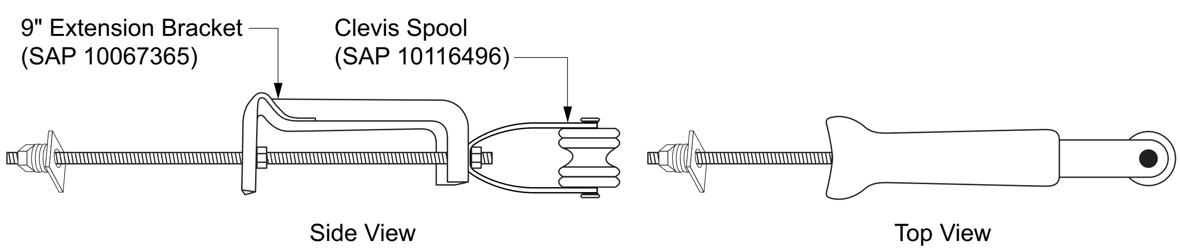
On double arms, use double pins. Where the limiting angle is exceeded, use double dead-end construction.



Note(s):

1. For guying line angles, see PO Section.

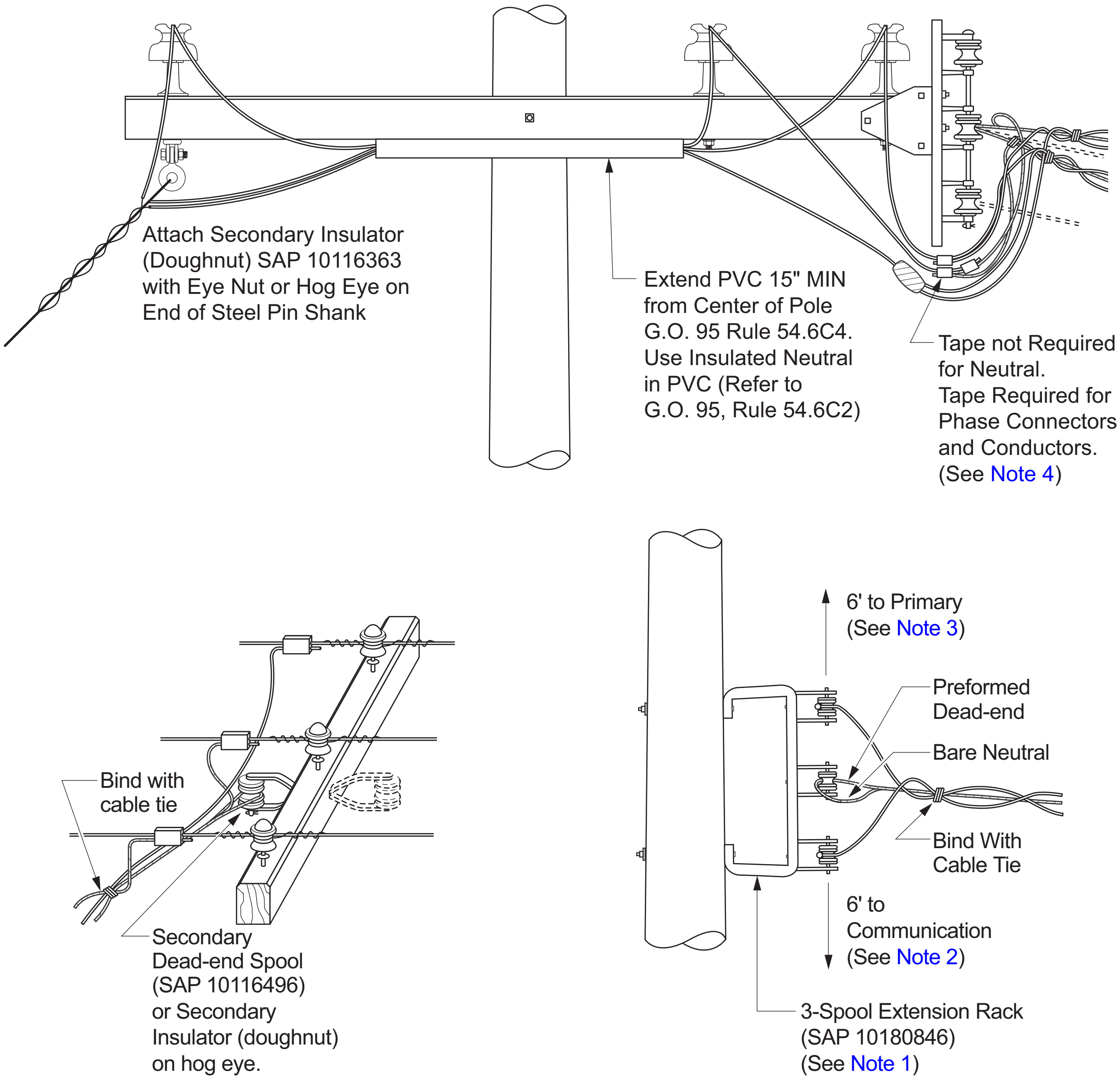
Figure DC 322–3: 9-Inch Angle Extension Bracket with Clevis Spool



DC 323 Triplex/Service Terminations

Scope DC 323.1 Triplex/Service Terminations

Figure DC 323–1: Triplex/Service Terminations



Note(s):

1. Use extension bracket (SAP 10209938) on center position when 1/0 or 4/0 triplex is dead-ended. See Figure DC 321–2.2 and Figure DC 321–3.
2. May be reduced to 4 feet with installation of guard arm above communication cables attached to surface of the pole.
3. May be reduced to 4 feet with installation of a guard arm, or covered with suitable protection, or installed 15 inches or more from center of pole.
4. Use SAP 10116921 for the tape. See CO 100, Section 5.0 for more details.

DC 324 Triplex/Splicing Method

Scope DC 324.1 Triplex/Splicing Method

1.0 Splicing of Triplex

1.1 Splices shall be made as shown in the illustration below.

1.2 In general, splicing of triplex should be avoided except for the following reasons:

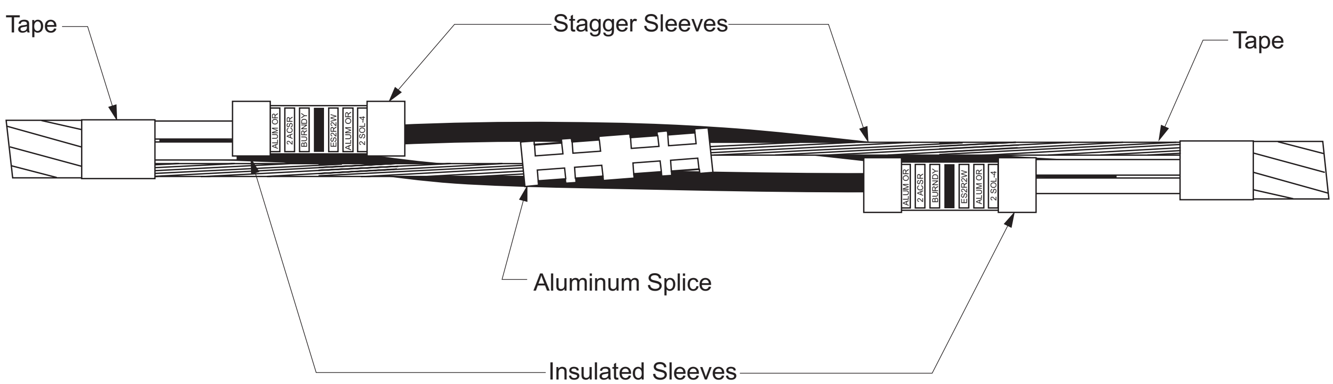
A. Triplex may be spliced when an existing service is relocated.

B. Triplex lengths greater than 30 feet may be spliced, but there should not be more than one splice per service.

1.3 Triplex lengths less than 30 feet shall be salvaged. Short lengths of the insulated portion of #6 triplex may be cut up into tie wire lengths.

1.4 Triplex ACSR neutral shall be spliced with compression (full/limited tension) splice per CO 410.

Figure DC 324–1: Triplex/Splicing Method



2.0 Splicing of Quadruplex

2.1 Insulated service sleeves **ARE NOT** approved for splicing of Quadruplex services.

2.2 If splicing of Quadruplex service **CANNOT BE AVOIDED**, the **NEUTRAL ACSR** conductor shall be spliced with compression (full tension/limited tension) splices per CO 410. Phase conductors may be spliced with compression (**ALL ALUMINUM**) splices per CO 410.1, CO 410.2 and CO 305.

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DC 325 Secondary Aluminum/Dead-End/Splicing Material

Scope DC 325.1 Secondary Aluminum Supply Dead-End Grips and Splices

Table DC 325–1: Secondary Aluminum Supply Dead-Ends

Triplex Cond. Size (AWG)	Automatic Bail Dead-Ends	Preform Dead-Ends
	SAP	SAP
#6 Sol. Ins. Cond. with #6 ACSR Neutral	—	10067951
#4 Str. Ins. Cond. with #4 ACSR Neutral	—	10067950
#2 Str. Ins. Cond. with #2 ACSR Neutral	10067541	—
1/0 Ins. Cond. with 1/0 ACSR Neutral	10067478	10067952
4/0 Ins. Cond. with 4/0 ACSR Neutral	10067479	10067953

Table DC 325–2: Secondary Aluminum Supply Splices

Cond. Size (AWG)	Splice	
	Automatic[a/]	Compression
	ACSR Neutral	Aluminum Cond.
	SAP	SAP
#6	—	10112144
#4	—	10112145
#2	10112030	10112146
1/0	10112031	10112147
4/0	10112033	10112148

[a/] For Reference Only

Note(s):

1. Stagger and tape compression splices on insulated aluminum conductors.
2. No splices are permitted in slack spans.
3. Where mid-span services are involved, use only splices listed above. **Do not use preformed type splices.**

What's Changed? The complete standard was updated to clarify and provide information for secondary aluminum dead-end grips and splices.

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DC 400 Distribution Circuits 0–750 V Secondaries

Scope DC 400.1 Distribution Circuits 0–750 V Secondaries

1.0 Single-Phase Lighting Secondaries

Single-phase lighting secondaries are 120/240-volt 3-wire with the neutral wire grounded at the transformer installation and at each customer's service. Refer to Distribution Apparatus Construction Standards (DAP) for grounding secondaries and for methods of supplying 120/240-volt service from single-phase transformers. Where strain insulator dead-ends are used, the secondaries should be properly phased. If the adjacent transformers are connected to different primary phases, an open span should separate the secondaries.

Certain sizes of conductors are most commonly used for lighting secondaries: 1/0 aluminum or #2 copper in all residential areas except those designed for minimum service, and 4/0 aluminum or 2/0 copper where the initial installation requires transformers larger than 25 kVA.

2.0 Banking of Single-Phase Lighting Secondaries

Note: Secondary banking is included here for reference only. All new installations will be radial in nature and follow instructions for single-phase lighting secondaries.

The major benefits to be obtained from the interconnection of the secondaries of adjacent distribution transformers, commonly referred to as banking, are the reduction of light flicker by improvement in the instantaneous voltage regulation, the possibility of increasing the average loading of transformers without increasing the peak loading, and the improvement in service continuity.

The straight-line type of secondary bank (as opposed to the grid type) shall be used with secondary interrupting devices at the transformers. Conventional, Type CP, or Type CSP transformers may be used with external secondary fuses. Type CPB and CSPB transformers provide two secondary circuits, each protected by a separate breaker within the transformer case, and no external secondary fuses are required. Types CPB and CSPB transformers should not be installed in locations where the load is not approximately equally divided on each of the two secondary breakers.

If a transformer is to be installed at the end of a secondary with load in one direction only, use a Type CP, CSP, or a conventional Type transformer with fused secondaries. The Type CP transformer is essentially the same as Type CPB, except that there is only one breaker in the CP. The Type CSP (current and surge protected) is similar to the Type CP except that surge arresters are connected to the primary terminals as an integral part of the transformer.

All transformers banked together shall be connected to the same primary phase and be set on the same primary tap.

Transformer size 5 kVA through 50 kVA may be used in secondary banks. However, it is very important that there be not more than one size difference between adjacent transformers in order to prevent excessive overload when the adjacent larger transformer is disconnected from the primary by fuse blowing. A group of transformers banked together should not exceed 100 kVA total nameplate capacity on 4 kV circuits of 300 kVA on 12 kV and 16 kV circuits in order for the three-phase primary feeder load not to be excessively unbalanced.

A sign "*Banked Secs.*" shall be installed at each transformer connected to a banked secondary system. The sign shall be installed on the fuse-hold arm if one is present, facing the climbing space. Otherwise the sign shall be on the primary-line arm facing the climbing space.

3.0 Three-Phase Power Secondaries

Three-phase power secondaries are 240 volts and 480 volts and are 3-wire in all cases; 120/208- and 277/480-volt secondaries, which are permitted in certain areas, are 4-wire (refer to DAP for grounding secondaries). The size of secondary conductors for power secondaries varies from #2 aluminum or #4 copper upwards. Secondaries for large power loads at 480 volts are not usually extended along overhead pole lines. Such a power bank is generally located adjacent to the point of service.

In commercial or other areas where distributed small power loads may be expected, the size of conductors most commonly used for power secondaries is 1/0 aluminum or # 2 copper. Three-phase power banks in such cases should be of sufficient size, and so located as to take maximum advantage of the 1/0 aluminum or # 2 copper secondaries and diversity of load. Separate power banks for small individual loads are to be avoided wherever possible.

4.0 Six-Wire Secondary Systems

SCE standard practices require separate secondaries for light and power where both classes of service are needed; that is, 3-wire for single-phase and 3-wire for three-phase power, even though both circuits are serviced from the same transformer bank. This is necessary to avoid as much as possible the voltage fluctuations in the light service caused by varying power loads and to provide better voltage regulation for the light service.

5.0 120/208Y Volt, 4-Wire Secondary System

This is a special combination light and power system which is used only in certain designated areas. Three-phase power is supplied from the 3-phase wires at 208 volts. Single-phase lighting is supplied between phase wires and the neutral at 120 volts. The possibility of voltage fluctuations in the lighting service caused by varying power loads is much greater in this 4-wire system than in the standard 6-wire system. The neutral conductor of a 120/208Y volt, 4-wire secondary system shall have a current carrying capacity of approximately one of the three phase conductors.

6.0 120/240 V Volt 4-Wire Delta-Combination 1Ø and 3Ø Service

Service may be supplied at 120/240 volts, 4-wire delta connected where the company does not maintain 4-wire secondary polyphase mains and provided: (1) the installation includes at least one motor rated in excess of 10 hp; (2) the unbalance between phases is less than 100 kW; and (3) the customer provides space acceptable to the company on his premises to accommodate the installation of the company's facilities. For details of connections and ground requirements, see GR Section.

7.0 Secondary Rack Construction

Secondary rack construction shall be generally used for residential construction whenever possible, but shall not be used where power secondaries are probable. Rack construction is preferred because it is generally cheaper and quicker to install, looks better because of the elimination of the service buck arm, eliminates the crossing of service drop secondaries, and reduces the secondary reactance voltage drop due to a closer spacing of the secondary conductors. In general, 40-foot poles will be used for straight line rack construction. At primary corners or taps, 45-foot poles will be used. Weather-resistant aluminum or copper wire shall be used for all rack conductors. The span length is limited to 200 feet using racks with 8-inch spacing between conductors. Refer to General Order (G.O.) 95, Rule 54.9 D. 120/240-volt rack secondary neutrals shall always be placed in the middle position of the rack. On poles jointly used, four feet is the minimum vertical clearance permitted between the lowest conductor on the secondary rack and communication conductors below the rack. For details of the various conditions and types of construction, see DC Section and Distribution Apparatus Construction Standards (DAP).

8.0 Triplex Secondary

See DC Section for the general requirements and application of triplex secondaries.

9.0 Services

Materials, Sizes, Lengths, Splicing: Two- or three-wire service drops, 0–750 V, shall be aluminum or copper with weather-resisting covering as required by G.O. 95, Rule 54.8A. Rule 49.4B and Table 8 in G.O. 95 specifies minimum conductor sizes and Rule 49.4C(7) specifies service drop strengths. The maximum length of service drops shall depend upon the slope or grade of ground, intervening trees or other obstructions, and the size of conductors required, but should not exceed 150 feet. Aluminum and copper service drop conductors shall be spliced with compression type splices, never with Western Union or automatic splices.

10.0 Clearance of Service Conductors

Clearance of service conductors above ground, over driveways and streets, above buildings and portions of buildings, and so forth, and clearances from other conductors from other poles, from racks, and so on, is specified in G.O. 95, Rule 54.8. Further information on clearances may be found in the Electrical Service Requirements (ESR) Manual.

11.0 Overhead Service Construction Methods

Services shall be run from line and service racks as shown in the Distribution Apparatus Construction Standards (DAP) and DC Section. Open services from buck arms shall, where possible, employ the seven pin construction shown in the DC Section in order to have a minimum number of service drop crossovers. Care shall be exercised in order that service drop conductors do not impair the climbing space on poles. Each service drop shall have one point of building attachment only.

Refer to the Distribution Design Standards (DDS) Manual for proper sizing of service wire and voltage drop calculation.

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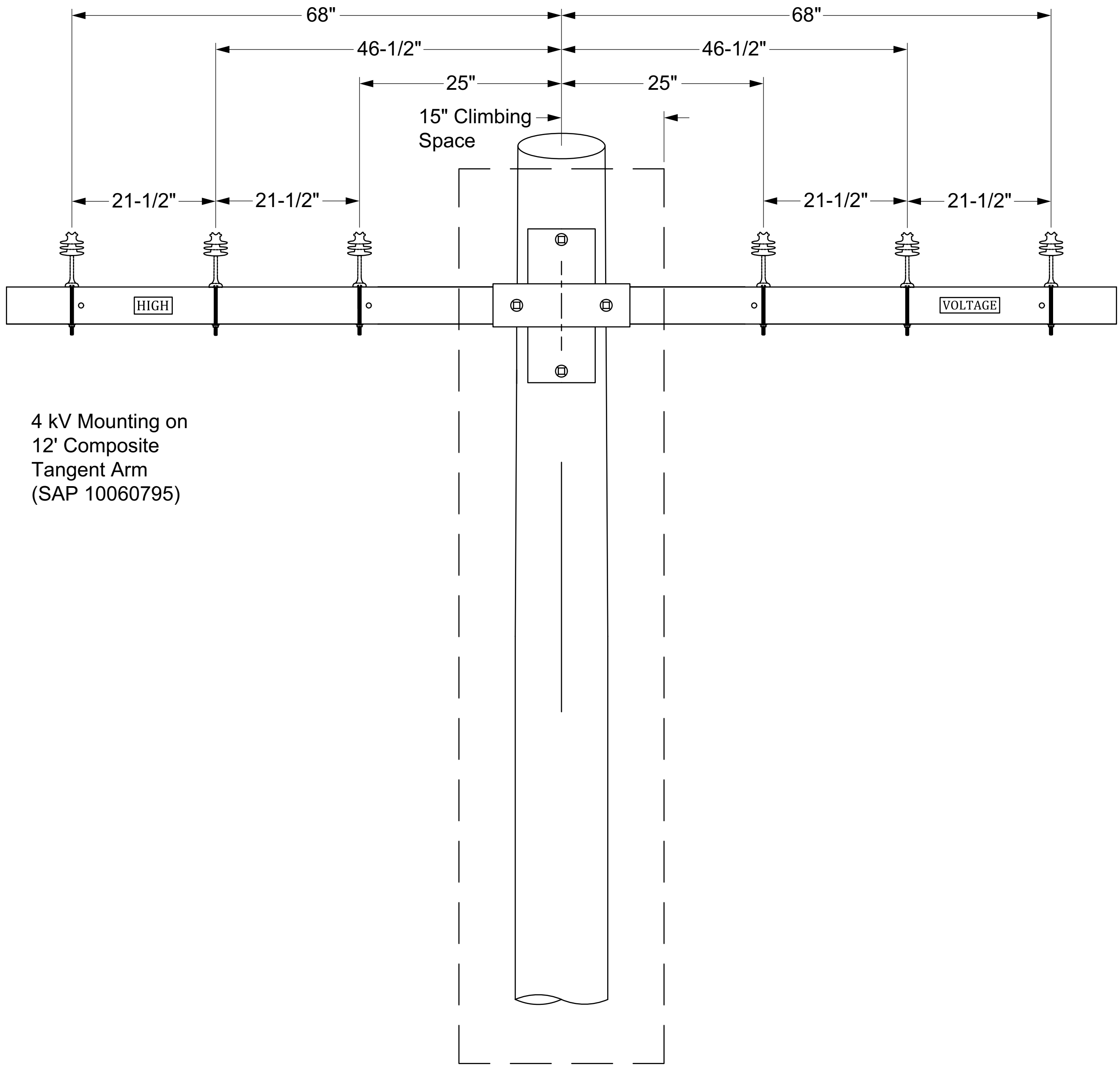
DC 410 0–7500 V Straight-Line Pole — Typical

Scope DC 410.1 Typical Pole Configurations for 0–7500 V Straight-Line Construction

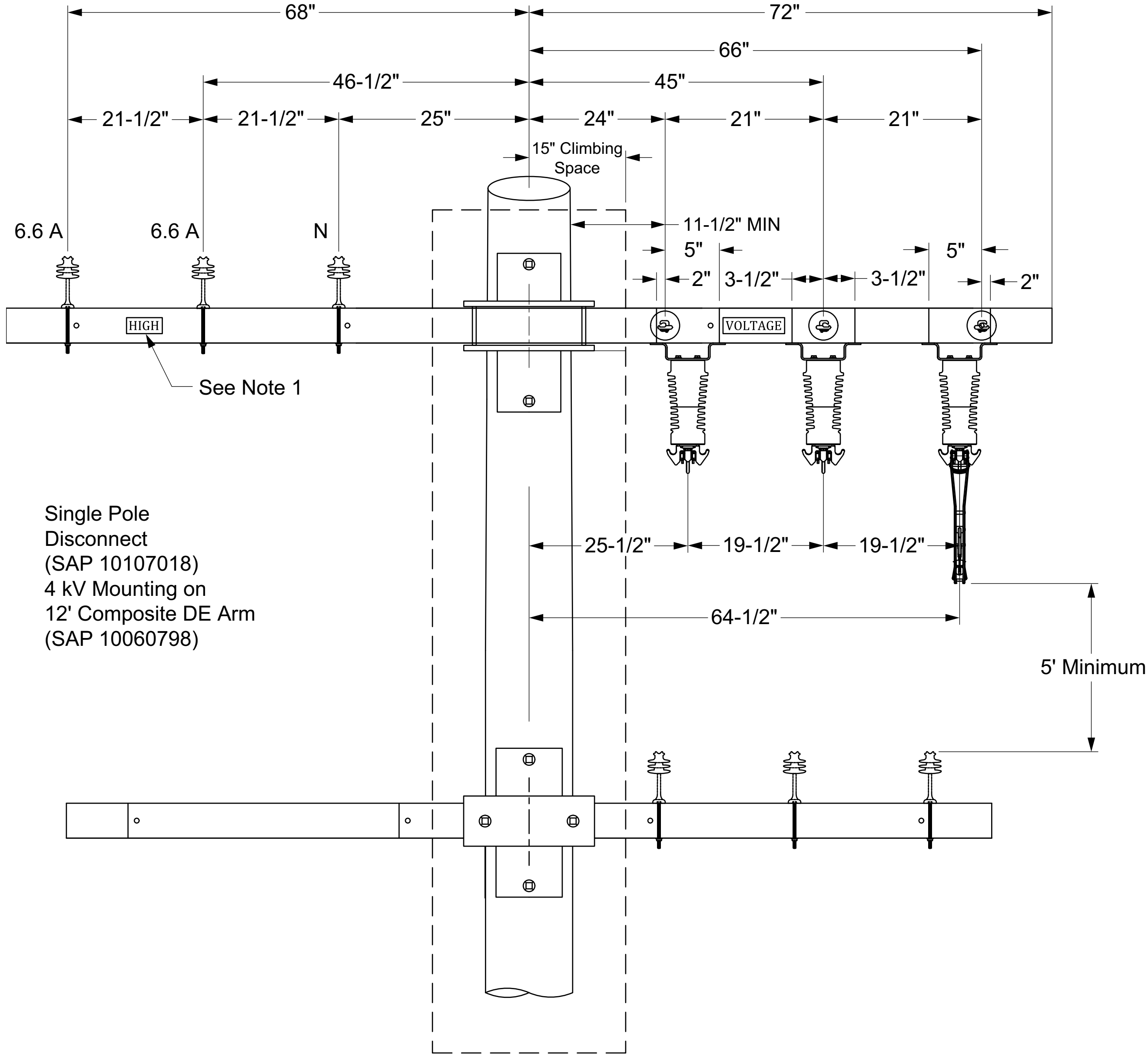
Figure DC 410–1: Typical Pole Configurations for 0–7500 V Straight-Line Construction



Note(s):

1. Use 12 foot crossarms (SAP 10060795). Contact Engineering for solutions where climbing space cannot be maintained for angle pin construction through 4 kV conductor level.
2. See additional notes at end of this section.

Figure DC 410–2: Typical Pole Configurations for 0–7500 V Straight-Line Construction



0–7500 V Straight-Line Pole — Typical

What's Changed?

Approved by: RR

Effective Date: 10-29-2021

Table DC 410–1: Jumper Wire and Connectors

Bare Overhead Primary Wire	Covered Jumper Recommended	Primary Connector	Switch Terminal Connector
653 ACSR (SAP 10109419)	653 ACSR (SAP 10210585)	Bolted Wedge (SAP 10212171), alt. Parallel Groove (SAP 10112372)	Hylug Aluminum, 1 ea. (SAP 10112306)
336 ACSR (SAP 10109415) 18/1 Merlin	653 ACSR (SAP 10210585)	Bolted Wedge (SAP 10212172), alt. Parallel Groove (SAP 10112371)	Hylug Aluminum, 1 ea. (SAP 10112306)
336 ACSR (SAP 10109416) 30/7 Oriole	653 ACSR (SAP 10210585)	Bolted Wedge (SAP 10212172), alt. Parallel Groove (SAP 10112371)	Hylug Aluminum, 1 ea. (SAP 10112306)
4/0 Al (SAP 10109414)	336 ACSR (SAP 10210584)	Bolted Wedge (SAP 10211200), alt. Parallel Groove (SAP 10112368)	Hylug Aluminum, 1 ea. (SAP 10112305)
4/0 Cu (SAP 10109332)	336 ACSR (SAP 10210584)	Bolted Wedge (SAP 10211200), alt. Parallel Groove (SAP 10112368)	Hylug Aluminum, 1 ea. (SAP 10112305)
2/0 Cu (SAP 10109331)	4/0 Cu (SAP 10211031)	Bolted Wedge (SAP 10211102), alt. Parallel Groove (SAP 10112369)	Hylug Copper, 1 ea. (SAP 10210867)
1/0 ACSR (SAP 10109412)	336 ACSR (SAP 10210584)	Bolted Wedge (SAP 10211097), alt. Parallel Groove (SAP 10112369)	Hylug Aluminum, 1 ea. (SAP 10112305)
#2 Str. ACSR (SAP 10109389)	1/0 ACSR (SAP 10210583)	Bolted Wedge (SAP 10211100), Parallel Groove (SAP 10112370)	Hylug Aluminum, 1 ea. (SAP 10210622)
#4 Str. ACSR (SAP 10109411)	1/0 ACSR (SAP 10210583)	Bolted Wedge (SAP 10211100), alt. Parallel Groove (SAP 10112370)	Hylug Aluminum, 1 ea. (SAP 10210622)
#2 Cu (SAP 10109330) [non-coastal]	1/0 ACSR (SAP 10210583)	Bolted Wedge (SAP 10211100), alt. Parallel Groove (SAP 10112370)	Hylug Aluminum, 1 ea. (SAP 10210622)
#2 Cu (SAP 10109330) [coastal]	2/0 Cu (SAP 10211030)	Bolted Wedge (SAP 10211105), alt. Parallel Groove (SAP 10111472)	Hylug Copper, 1 ea. (SAP 10210868)
#4 Cu (SAP 10109329) [non-coastal]	1/0 ACSR (SAP 10210583)	Bolted Wedge (SAP 10211100), alt. Parallel Groove (SAP 10112370)	Hylug Aluminum, 1 ea. (SAP 10210622)
#4 Cu (SAP 10109329) [coastal]	#2 Cu (SAP 10211032)	Bolted Wedge (SAP 10212440), alt. Parallel Groove (SAP 10213604)	Hylug Copper, 1 ea. (SAP 10210869)
#6 Cu (SAP 10109315) [non-coastal]	1/0 ACSR (SAP 10210583)	Bolted Wedge (SAP 10211100), alt. Parallel Groove (SAP 10112370)	Hylug Aluminum, 1 ea. (SAP 10210622)
#6 Cu (SAP 10109315) [coastal]	#2 Cu (SAP 10211032)	Bolted Wedge (SAP 10212440), alt. Parallel Groove (SAP 10213604)	Hylug Copper, 1 ea. (SAP 10210869)
Covered Overhead Primary Wire	**Covered Jumper Recommendation**	**Primary Connector**	**Switch Terminal Connector**
653 ACSR (SAP 10210585)	653 ACSR (SAP 10210585)	Bolted Wedge (SAP 10212171), alt. Parallel Groove (SAP 10112372)	Hylug Aluminum, 1 ea. (SAP 10112306)
336 ACSR (SAP 10210584) 18/1 Merlin	336 ACSR (SAP 10210584)	Bolted Wedge (SAP 10211096), alt. Parallel Groove (SAP 10112368)	Hylug Aluminum, 1 ea. (SAP 10112305)
336 ACSR (SAP 10212540) 30/7 Oriole	336 ACSR (SAP 10210584)	Bolted Wedge (SAP 10211096), alt. Parallel Groove (SAP 10112368)	Hylug Aluminum, 1 ea. (SAP 10112305)
4/0 Cu (SAP 10211031)	4/0 Cu (SAP 10211031)	Bolted Wedge (SAP 10211101), alt. Parallel Groove (SAP 10111472)	Hylug Copper, 1 ea. (SAP 10210867)
2/0 Cu (SAP 10211030)	2/0 Cu (SAP 10211030)	Bolted Wedge (SAP 10211104), alt. Parallel Groove (SAP 10111472)	Hylug Copper, 1 ea. (SAP 10210868)
1/0 ACSR (SAP 10210583)	1/0 ACSR (SAP 10210583)	Bolted Wedge (SAP 10211099), alt. Parallel Groove (SAP 10112370)	Hylug Aluminum, 1 ea. (SAP 10210622)
#2 Cu (SAP 10211032)	#2 Cu (SAP 10211032)	Bolted Wedge (SAP 10212440), alt. Parallel Groove (SAP 10112373)	Hylug Copper, 1 ea. (SAP 10210869)

What's Changed? Updated Table DC 410-1 pertaining to jumper wire and connectors requirements.

Table DC 410–2: Insulators

Phase to Phase Voltage	Quantity Insulator Per Phase Per Side of Switch	SAP
4 kV & 12 kV	3	10116431
16 kV	2	10116332

Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings. In all instances (Non-Eagle and Eagle Zones), Wildlife Hoods shall be installed as the minimum required spacing of 36 inches between insulators is not met.
3. See DAP AP 335.1 and DAP AP 335.2 for hardware, crossarm mounting methods, and alternative form factors.

DC 415 0–7500 V Angle Pole — Typical

Scope DC 415.1 0–7500 V Angle Pole — Typical

Figure DC 415–1: 0–7500 V Angle Pole — Typical

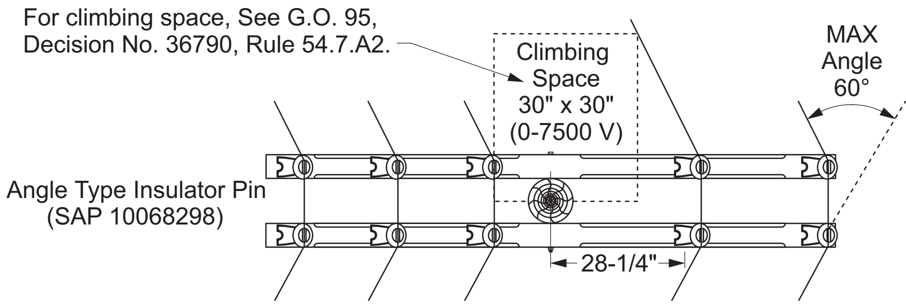


Table DC 415–1: 0–7500 V Angle Pole — Typical — Five Wires Maximum

Limiting Angles			
Conductor Size		**Limiting Angle in Line**	
ACSR	**Cu**	**Single Arm (MIN/MAX)**	**Double Arm (MAX)**
#4[a/]	#6	30°–50°	60°
	#4	20°–40°	60°
1/0	#2	15°–30°	60°
	2/0	7°–15°	30°
336.4 kcmil	4/0	5°–10°	22°

[a/] Not approved for use on new construction.

Figure DC 415–2: 0–7,500V Angle Pole — Typical — Five Wires Maximum

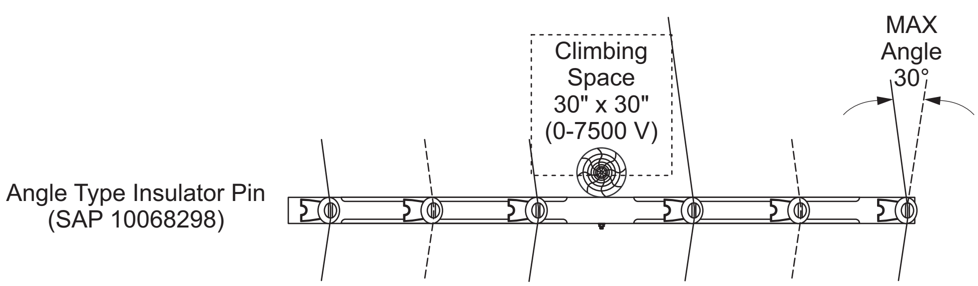


Table DC 415–2: 0–7500 V Angle Pole — Typical — Limiting Angles

Conductor Size		Limiting Angle in Line Single Arm (MIN/MAX)
ACSR	Cu	
1/0	#2	15°–30°
	2/0	7°–15°
336.4 kcmil	4/0	5°–10°

Note(s):

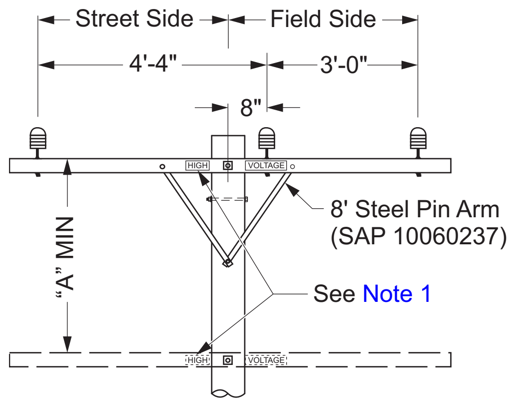
1. Universal conductor clamps are not recommended for 4 kV angle installations.
2. If angle of line exceeds maximum, use dead-end construction.
3. For type of insulator, see GR Section.
4. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.

DC 500 Rural, Standard, and Long Span Construction for 3-Wire 12 kV, 16 kV, and 33 kV Horizontal Configuration

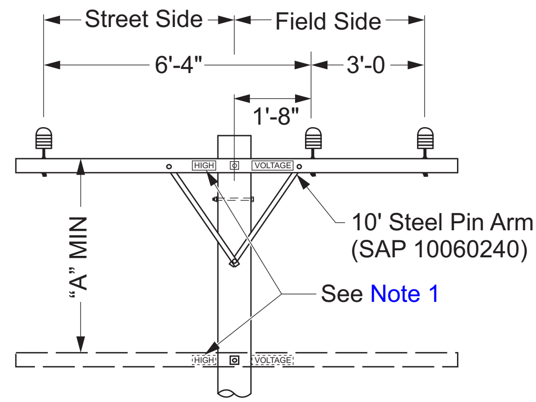
Scope DC 500.1 Typical Pole Configurations for Straight Line Rural, Standard, and Long Span Horizontal Construction 12 kV, 16 kV, and 33 kV 3-Wire Circuit

Figure DC 500–1: Typical Pole Configurations for Straight Line Rural, Standard and Long Span, Horizontal Construction 12 kV, 16 kV, and 33 kV 3-Wire Circuit

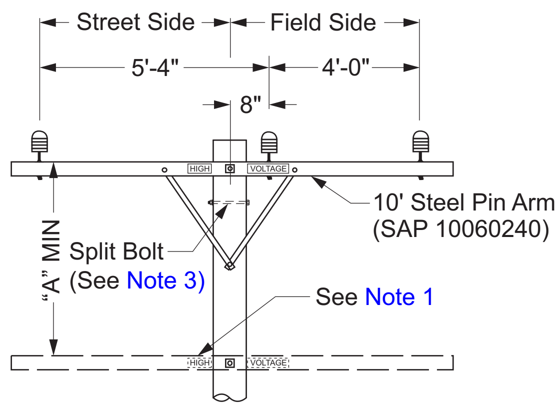
Rural Construction
Maximum Span 440 ft (See Note 5)



Standard Construction
Maximum Span 440 ft



Long Span Construction
Maximum Span 660 ft
This construction is for use where 0-7500 volt circuits are unlikely.



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Use V-braces for wire size larger than #2 copper and 1/0 ASCR.
3. Use split bolts above or below cross-arm within 6 inches of through bolt with 336 and 653 kcmil ACSR. If a side guy is attached, the guy assembly bolt will function as a split bolt.
4. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
5. Use 8 foot crossarm for existing construction only. Use 10 foot crossarm for retrofits or new construction in rural areas. New construction must maintain a radial clearance from vegetation per CPUC G.O. 95 Rule 35 and PRC 4293.

Table DC 500–1: Minimum Conductor Spacing Dimension "A"

Top Circuit kV	Lower Circuit kV		
	0–7.5	**12 or 16**	**33**
33	6'	6'	6'
12 or 16	6'[a/b/]	6'[a/b/]	—

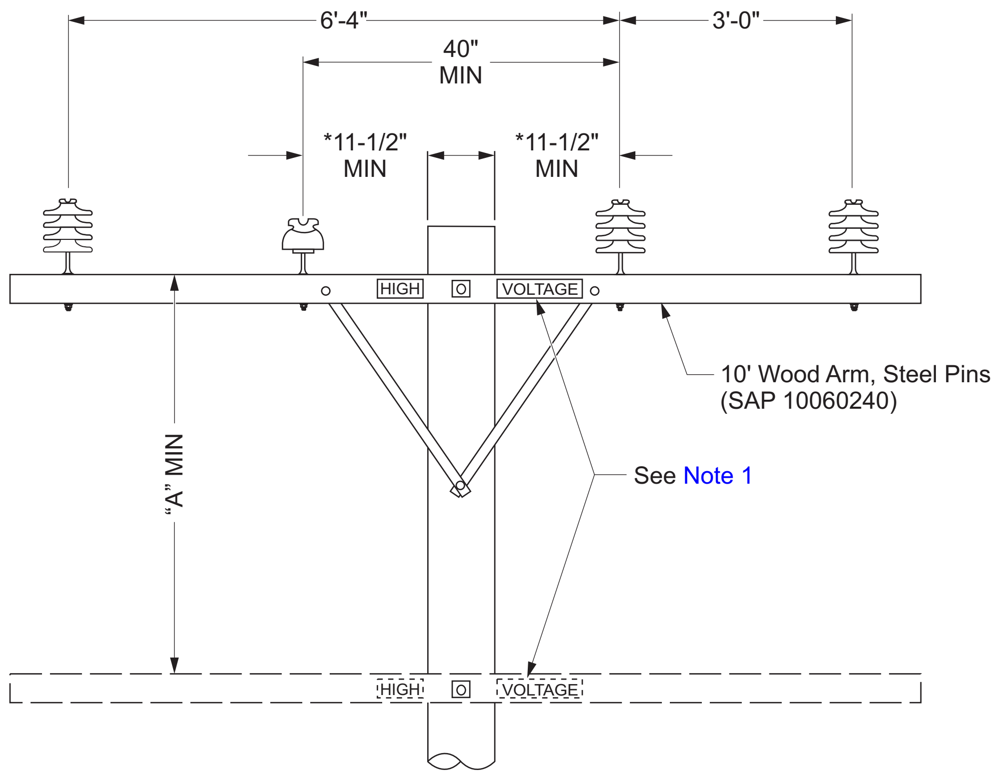
a/ A 6-foot clearance between primary circuits will be used on new line construction and on pole replacements when minimum sag requirements per Section CO can be maintained.

b/ Clearance may be reduced to 5 feet on existing installations.

DC 510 12/16 kV 4-Wire Straight Line — Typical

Scope DC 510.1 Typical Pole Configuration for Straight Line Horizontal Construction — 12/16 kV — 4-Wire Circuit

Figure DC 510–1: Typical Pole Configuration for Straight Line Horizontal Construction — 12/16 kV — 4-Wire Circuit



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Use V-braces for wire sizes larger than #2 copper and 1/0 ACSR.
3. Use split bolt above or below crossarm within 6 inches of through bolt when V-braces are used. If a side guy is attached below the crossarm, the guy assembly bolt will function as a split bolt.
4. With transmission above, large poles may require one of the following in order to maintain 11-1/2 inches:
   a. Use angle pins on straight line poles.
   b. Move pin position 3-1/2 inches out. (Maintain 1-inch air space from V-braces by cutting pin bolt.) A minimum of 32 inches phase clearance is allowable on span lengths 440 feet or less.
   c. Use 12-foot pre-drill crossarm (SAP 10060209) if angle pins or relocating pins do not provide adequate clearance. On angle poles, maintain 11-1/2 inches clearance from conductor to face of pole.
5. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.

Table DC 510–1: Minimum Conductor Spacing for Dimension "A"

Top Circuit kV	Lower Circuit kV		
	0–7.5	12 or 16	33
33	6'	6'	6'
12 or 16	6'[a/b/]	6'[a/b/]	—

[a/] A 6-foot clearance between primary circuits will be used on new line construction and on pole replacements when minimum sag requirements per CO Section can be maintained.

[b/] Clearance may be reduced to 5 feet on existing installations.

Figure DC 510–2: 3Ø Single Circuit 12/16 kV 4-Wire

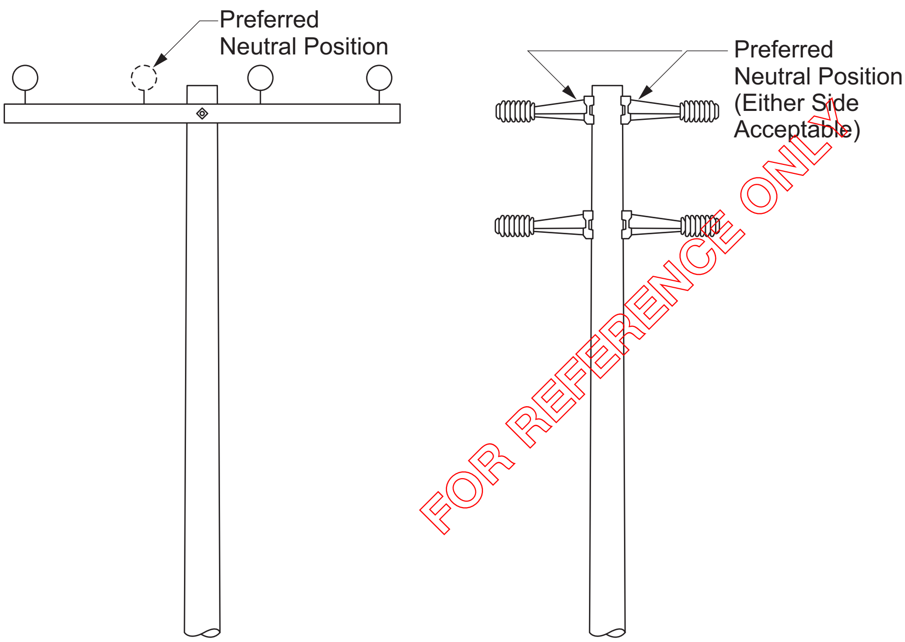
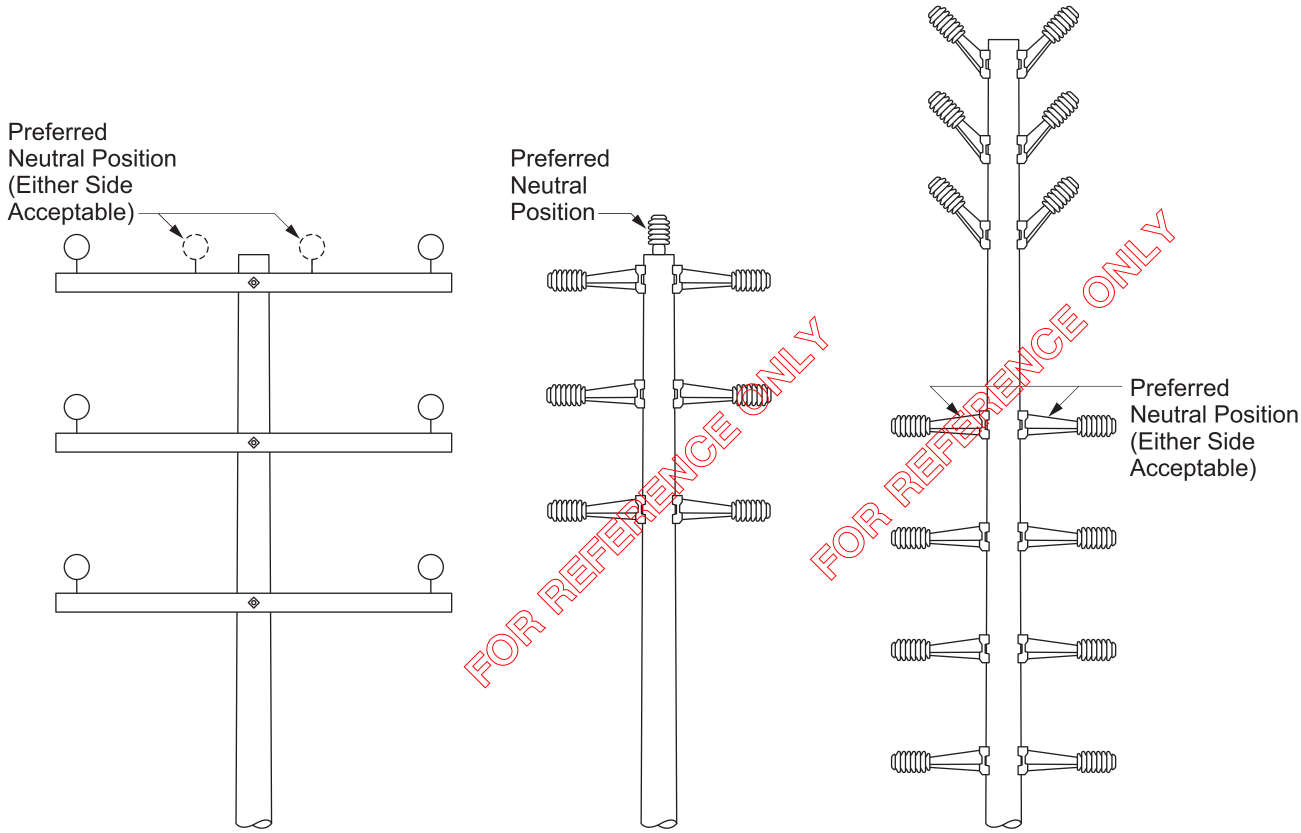


Figure DC 510–3: 3Ø Double Circuit 12/16 kV 4-Wire



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DC 520 Distribution Circuit — Heavy-Loading Areas above 5,000 Feet Elevation

Scope DC 520.1 Construction Requirements for Heavy-Loading Areas above 5,000 Feet Elevation — All Distribution Primary Voltages Construction General Requirements

This page provides general requirements to be used in heavy loading areas above 5,000 feet where higher strengths are required to eliminate damage to pole lines caused by extremely heavy ice formation on conductors, or extreme shock loads due to ice or snow "unloading." (Normal "heavy-loading" areas are between 3,000 feet and 5,000 feet elevation.)

1.0 High-Voltage Conductors

The following standard conductor sizes shall be used in these areas for all distribution primary voltages construction. Bare wire and covered conducted are allowed. See Table DC 520–1 for bare wire and Table CC 110–2 and Table CC 110–4 for covered conductor:

Table DC 520–1: All Distribution Primary Voltages Standard Conductor Sizes

ACSR Size (Non-Greased)	SAP	Diameter (in)	Ultimate Strength (lb)	Weight (lb/1,000 ft)	Ampacity (Amp)
1/0 ACSR 6/1	10109412	0.398	4,280	145.6	280
336 kcmil 18/1	10109415	0.684	8,625	365.2	605
336 kcmil 30/7[a/]	10109416	0.741	17,300	527.1	605
653 kcmil 18/3	10109419	0.953	14,850	677.0	920

[a/] 30/7 should be used on long span construction. Contact Transmission Engineering.

Greased ACSR conductors should **NOT** be used in these areas. Use sag tables and guying tensions for these conductors at heavy loading conditions which are provided for in CO Section.

2.0 Poles

Conductor loading for these areas is shown in this section so that the PO Section and PLM may be used in computing pole loading and pole strength.

3.0 Line Construction

Provisions are made for pole head configuration on straight line or angle poles in these areas, associated materials are also shown.

4.0 Pole-Line Hardware

See Figure DC 520–1.

4.1 Due to high mechanical strengths required in these areas, the following practices should be followed:

A. Use preformed or quadrant dead-ends.

B. Anchor Guys: Avoid long leads wherever practical (keep angle to the pole at 45 degrees or less) to avoid heavy icing conditions.

C. Insulators: Use minimum size 1-3/8-inch threaded steel pin construction on all distribution primary voltages. On all conductor sizes use polymer pin-type vise-top insulators (see GR 200) or polymer post-type clamp top or trunnion top insulators (see GR 205).

D. Crossarm Braces: Use V-braces attached to the pole with 5/8-inch bolts for all distribution primary voltages construction.

E. Split Bolts: Use split bolts on crossarms and poles wherever unbalanced tensions are applied (for example, dead-ends, angles, service poles, and so forth).

F. Spring Washers: Wherever spring or helical washers are used, apply them to the "nut" end of the bolt and preferably on the wood or pole side.

G. Triplex Conductors: When triplex services or secondaries are dead-ended, use a single spool SAP 10116496, or if secondary rack is used, install a back-up bolt at the center position.

5.0 Deviation Angle

Table DC 520–2: Limiting Deviation Angle for Construction in Heavy-Loading Areas above 5,000 Feet (All Distribution Voltages)

Conductor Size ACSR	Limiting Deviation Angle[a/] (in Degrees)			
	Steel Pin Type Insulator		Post Type Insulator	
	Single Arm	Double Arm	Single Arm	Double Arm
653.9 (18 × 3)	3	6	9	18
1/0 (7 × 1)	10	20	25	50
336.4 (30 × 7)	3	6	7	14
336.4 (18 × 1)	6	12	15	30

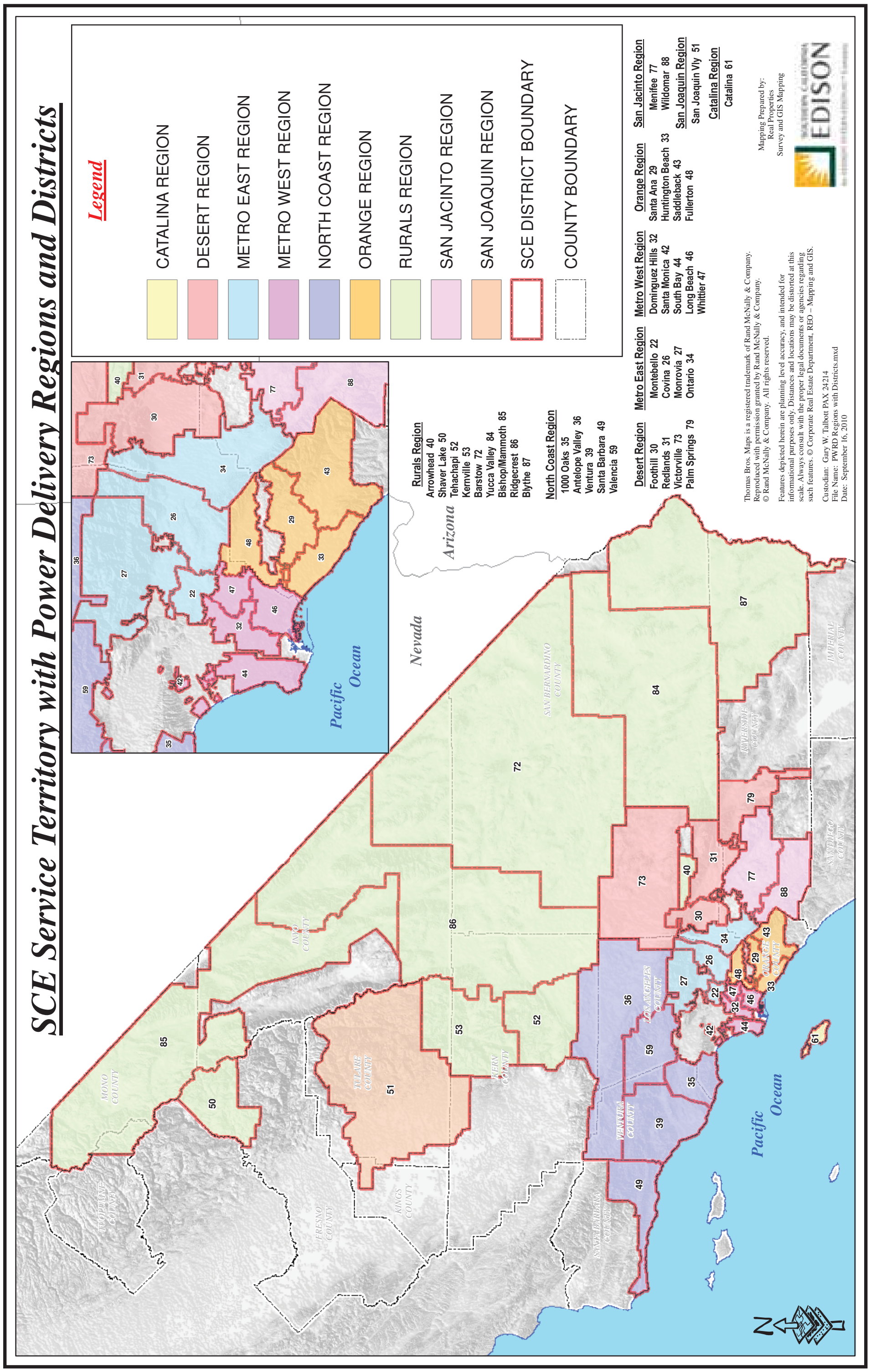
[a/] If angle of line exceeds above limits, use dead-end construction.

Limiting Deviation Angle = Angle at which side tension does not exceed G.O. 95 safety factor for insulators and hardware.

What's Changed? Added Section 5.0 on Deviation Angle and added Table DC 520-2.

Scope DC 520.2 Territory Map of Heavy-Loading Areas above 5,000 Feet Elevation

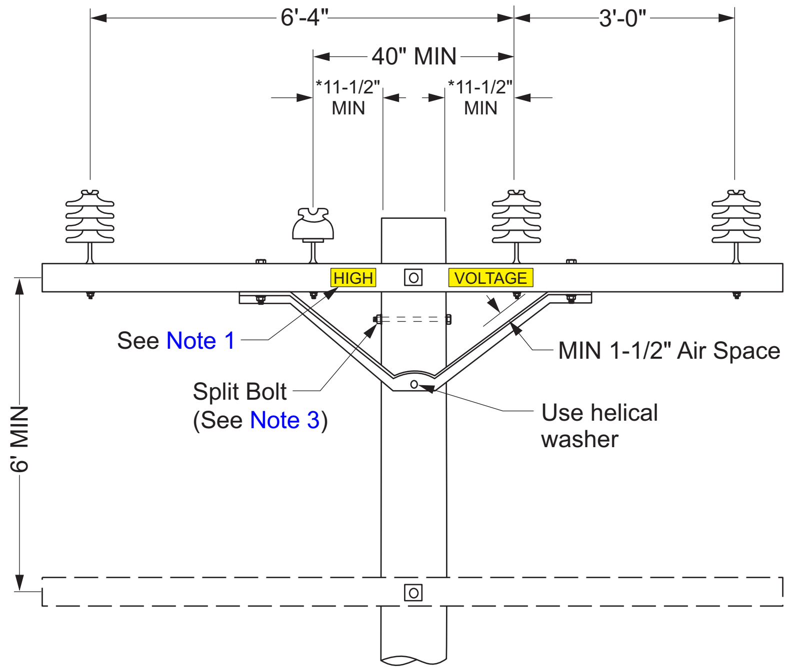
Figure DC 520–1: Territory Map of Heavy-Loading Areas above 5,000 Feet Elevation



Approved by:	Distribution Circuit — Heavy-Loading Areas above 5,000 Feet Elevation	DC 520
Effective Date: 04-30-2021	**What's Changed?**	Sheet 3 of 11 DOH

Scope DC 520.3 Typical Construction Practices for 3-Wire and 4-Wire — Heavy Loading above 5,000 Feet Elevation

Figure DC 520–2: Typical Construction Practices for 3-Wire and 4-Wire — Heavy Loading above 5,000 Feet Elevation



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
3. Use split bolts above or below crossarm within 6 inches of through bolt. If a side guy is attached below the crossarm, the guy assembly bolt will function as a split bolt.

Table DC 520–3: Maximum Span Length for 3-Wire and 4-Wire — Heavy Loading above 5,000 Feet Elevation

Maximum Span Length		
Conductor Size	**Single Arm (ft)**	**Double Arm (ft)**
1/0 6/1 ACSR	200	400
336 kcmil 18/1 ACSR	150	300
336 kcmil 30/7 ACSR	125	250[a/]
653 kcmil 18/3 ACSR	100	200[a/]

[a/] May exceed allowable strength moment for certain size. Special jobs will require larger diameter poles.

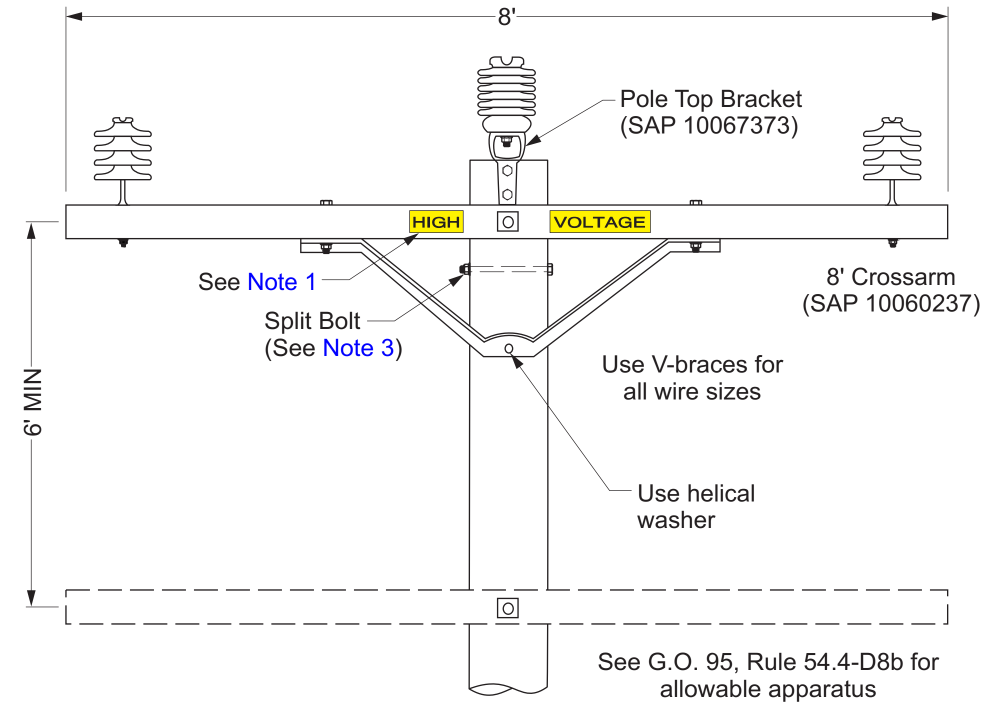
With transmission above, large poles may require one of the following in order to maintain 11-1/2 inches:

Note(s):

1. Use angle pins on straight line poles.
2. Move pin position 3-1/2 inches out (maintain 1-inch air space on V-brace by cutting pin bolt short). A minimum of 32 inches phase clearance is allowable on span lengths 440 feet or less.
3. Use 12-foot pre-drilled crossarm (SAP 10060209) if angle pins or relocating pins do not provide adequate clearance.
4. On angle poles maintain a clearance of 11-1/2 inches from conductor to face of pole.
5. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.

Scope DC 520.4 Typical Horizontal 3-Wire Straight Line Configuration — Heavy Loading above 5,000 Feet Elevation

Figure DC 520–3: Typical Horizontal 3-Wire Straight Line Configuration — Heavy Loading above 5,000 Feet Elevation



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
3. Use split bolts above or below crossarm within 6 inches of through bolt. If a side guy is attached below the crossarm, the guy assembly bolt will function as a split bolt.
4. If additional vertical clearance is needed, see Figure DC 535–7 and Figure DC 535–8.

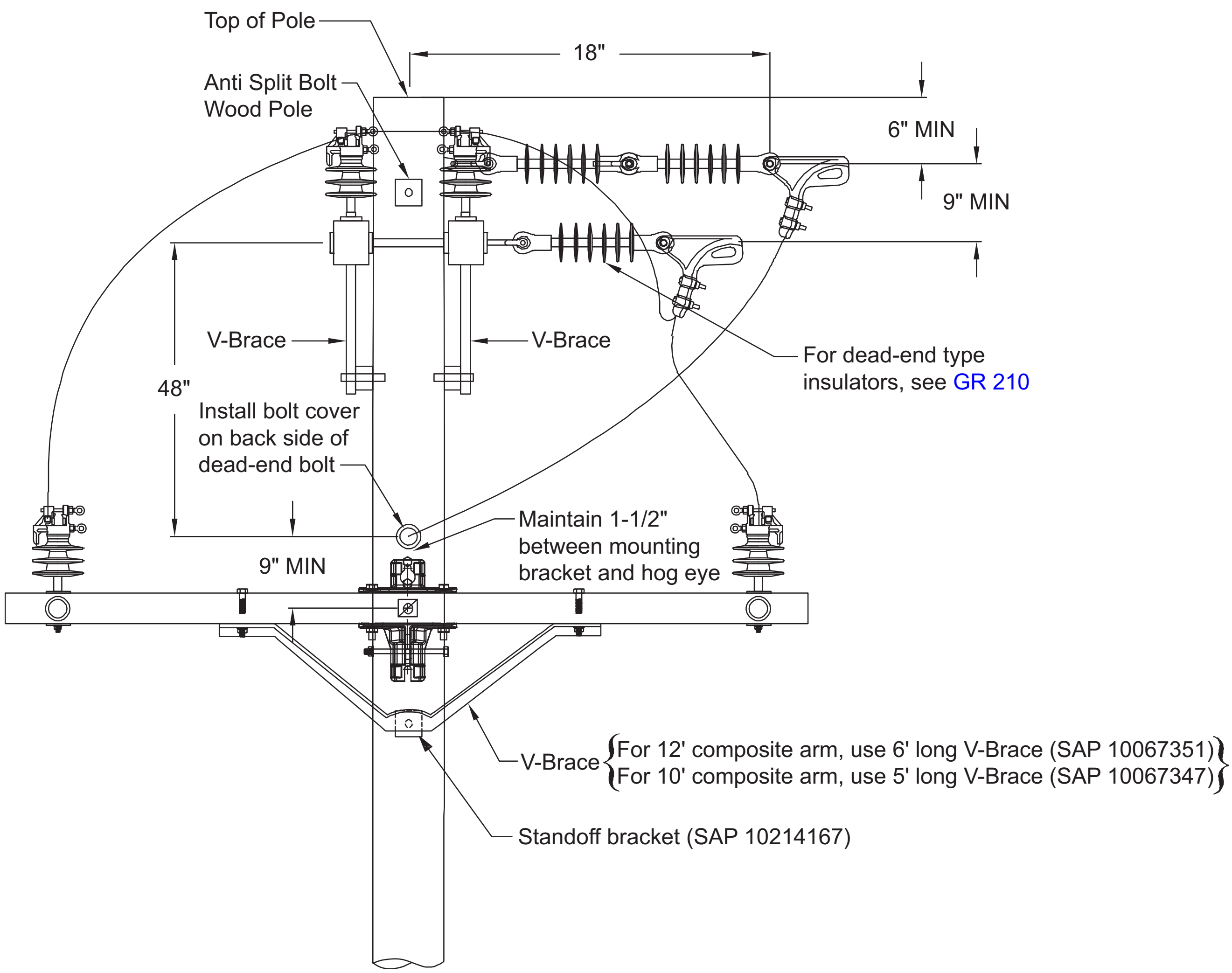
Table DC 520–4: Maximum Span Length for Horizontal 3-Wire Straight Line Configuration — Heavy Loading above 5,000 Feet Elevation

Maximum Span Length		
Conductor Size	**Single Arm (ft)**	**Double Arm (ft)**
1/0 6/1 ACSR	200	400
336 kcmil 18/1 ACSR	180	360
336 kcmil 30/7 ACSR	175	350[a/]
653 kcmil 18/3 ACSR	125	200

[a/] May exceed allowable strength moment for certain pole size. Special jobs will require larger diameter poles.

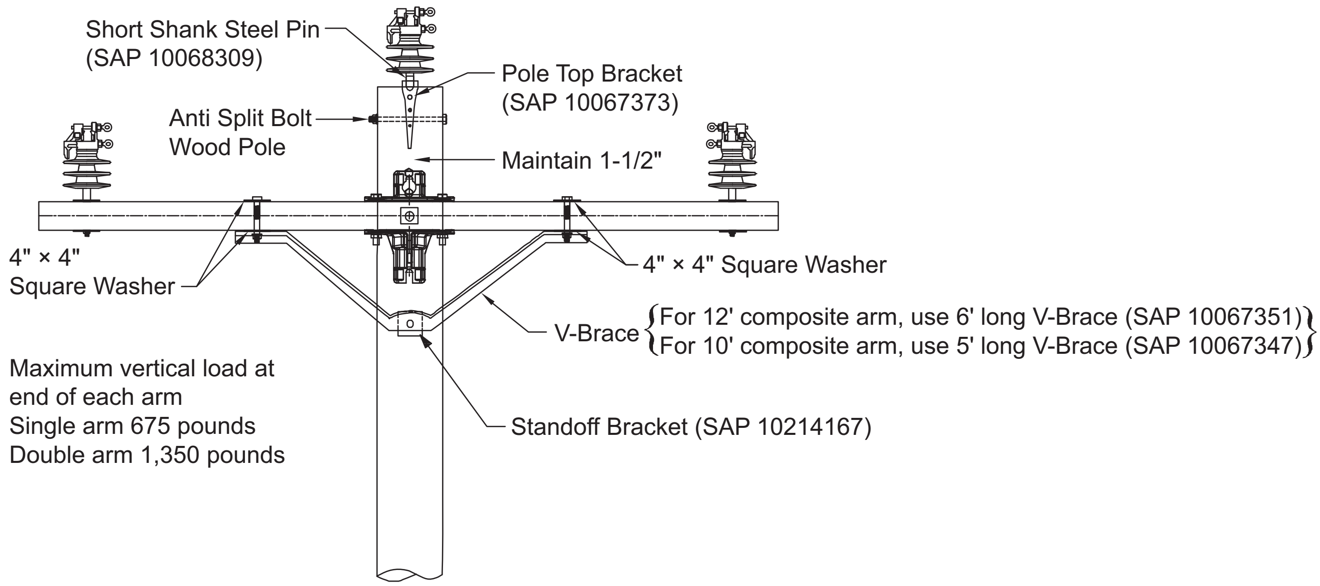
Scope DC 520.5 Composite Arms Above 5,000 feet Corner Pole 3-Wire Construction with V-Brace Covered Conductor

Figure DC 520–4: Composite Arms Above 5,000 feet Corner Pole 3-Wire Construction with V-Brace Covered Conductor



Scope DC 520.6 Composite Arms Above 5,000 feet 3-Wire Ridge Pin Construction with V-Braces Covered Conductor 10 feet Composite Arm Polymer Pin Type Insulator

Figure DC 520–5: Composite Arms Above 5,000 feet 3-Wire Ridge Pin Construction with V-Braces Covered Conductor 10 feet Composite Arm Polymer Pin Type Insulator

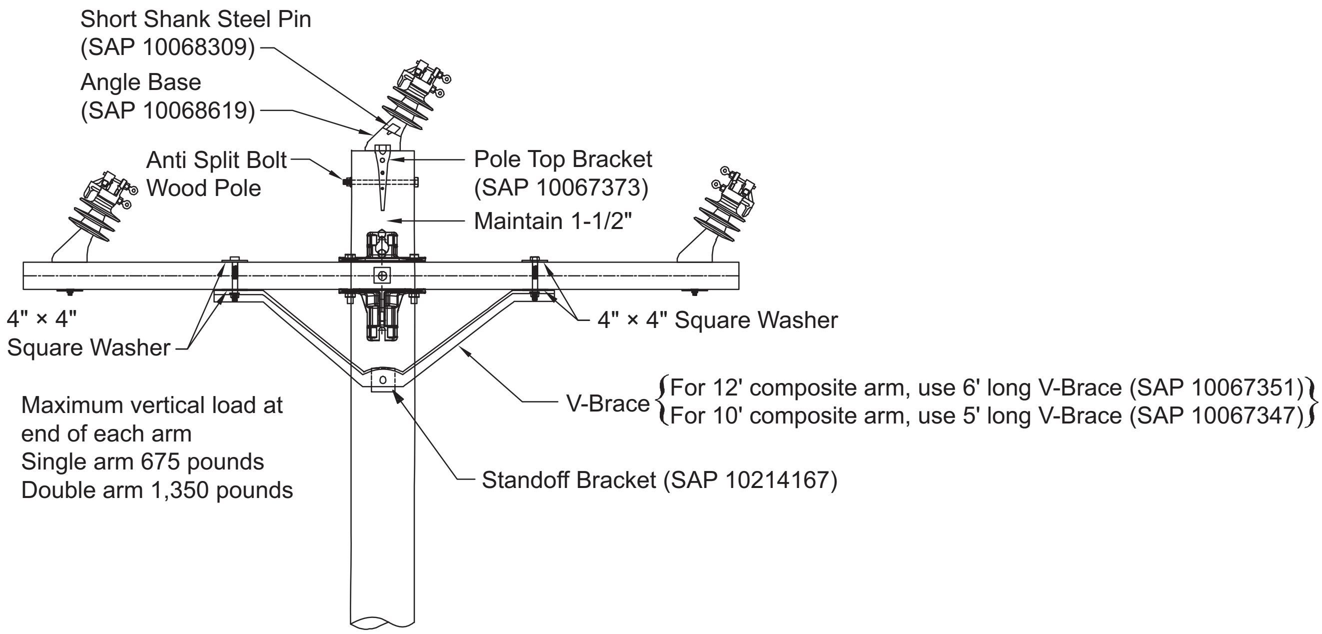


Note(s):

1. Install the crossarm 25 inches from the top of the pole to maintain 1-1/2-inch clearance between the ridge pin and crossarm mounting bracket.
2. Install 4" × 4" Square Washers:
   - Between V-Brace and arm
   - On top side of V-Brace bolt
   - On insulator pin on top and underside of arm
3. Install spring washers on nut end of all bolts.
4. See GR 200 Polymer Pin Type Insulators.
5. See Table DC 520–4 for maximum span lengths.

Scope DC 520.7 Composite Arms Above 5,000 feet 3-Wire Ridge Pin Construction with V-Braces Covered Conductor 10 feet Composite Arm Polymer Pin Type Insulator

Figure DC 520–6: Composite Arms Above 5,000 feet 3-Wire Ridge Pin Construction with V-Braces Covered Conductor 10 feet Composite Arm Polymer Pin Type Insulator

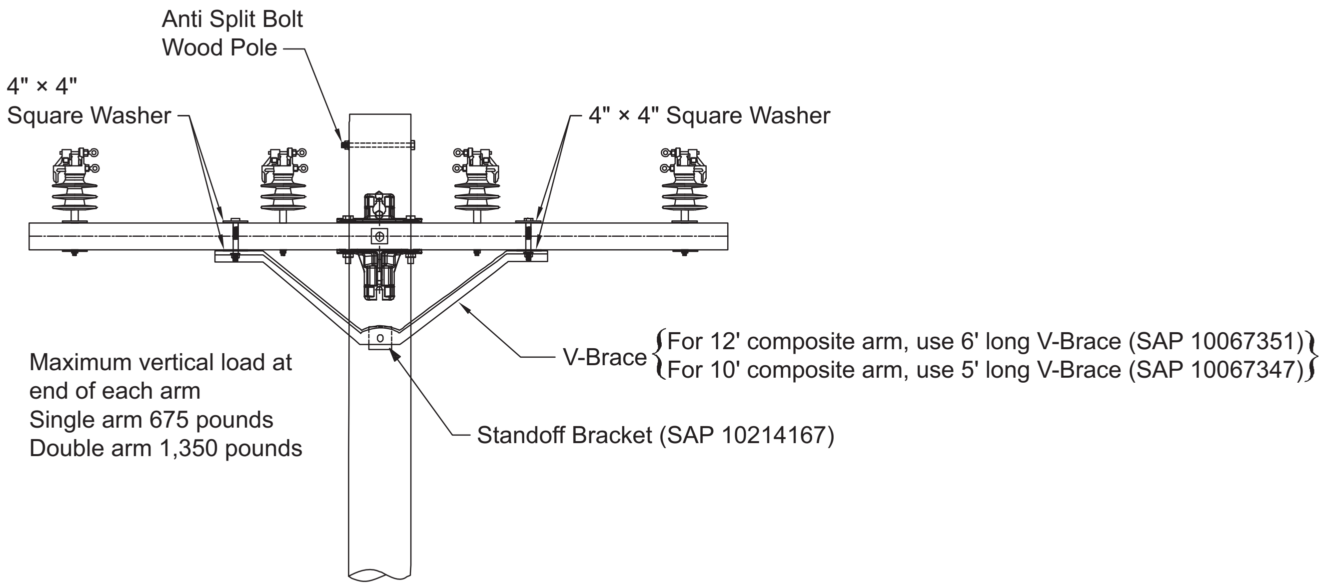


Note(s):

1. Install the crossarm 25 inches from the top of the pole to maintain 1-1/2-inch clearance between the ridge pin and crossarm mounting bracket.
2. Install 4" × 4" Square Washers:
   - Between V-Brace and arm
   - On top side of V-Brace bolt
   - On insulator pin on top and underside of arm
3. Install spring washers on nut end of all bolts.
4. See GR 200 Polymer Pin Type Insulators.
5. See Table DC 520–4 for maximum span lengths.

Scope DC 520.8 **Composite Arms Above 5,000 feet Straight Line 2-, 3-, and 4-Wire Construction with V-Braces Covered Conductor 10 feet Composite Arm Polymer Pin Type Insulator**

Figure DC 520–7: Composite Arms Above 5,000 feet Straight Line 2-, 3-, and 4-Wire Construction with V-Braces Covered Conductor 10 feet Composite Arm Polymer Pin Type Insulator

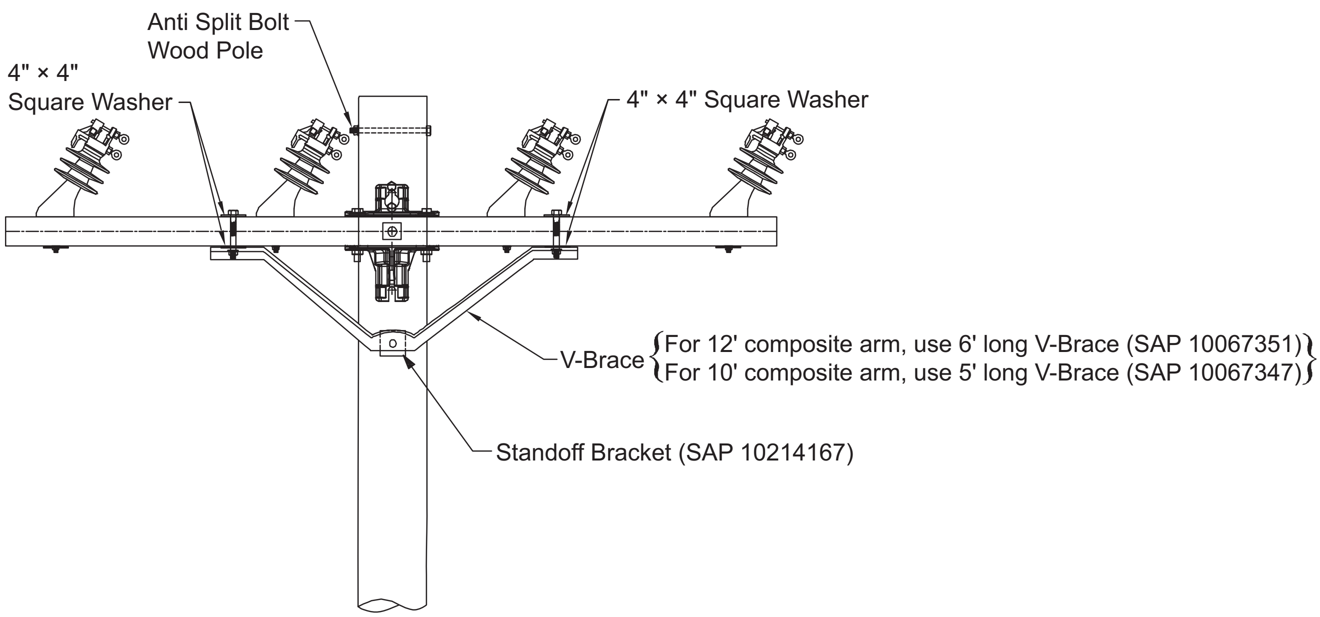


Note(s):

1. Install 4" × 4" Square Washers:
   - Between V-Brace and arm
   - On top side of V-Brace bolt
   - On insulator pin on top and underside of arm
2. Install spring washers on nut end of all bolts.
3. See GR 200 Polymer Pin Type Insulators.
4. See Table DC 520–4 for maximum span lengths.

Scope DC 520.9 Composite Arms Above 5,000 feet 2-, 3-, and 4- wire Construction with V-Braces Covered Conductor 10 feet Composite Arm Polymer Pin Type Insulator

Figure DC 520–8: Composite Arms Above 5,000 feet 2-, 3-, and 4-Wire Construction with V-Braces Covered Conductor 10 feet Composite Arm Polymer Pin Type Insulator



Note(s):

1. Install 4" × 4" Square Washers:
   - Between V-Brace and arm
   - On top side of V-Brace bolt
   - On insulator pin on top and underside of arm
2. Install spring washers on nut end of all bolts.
3. See GR 200 Polymer Pin Type Insulators.
4. See Table DC 520–4 for maximum span lengths.

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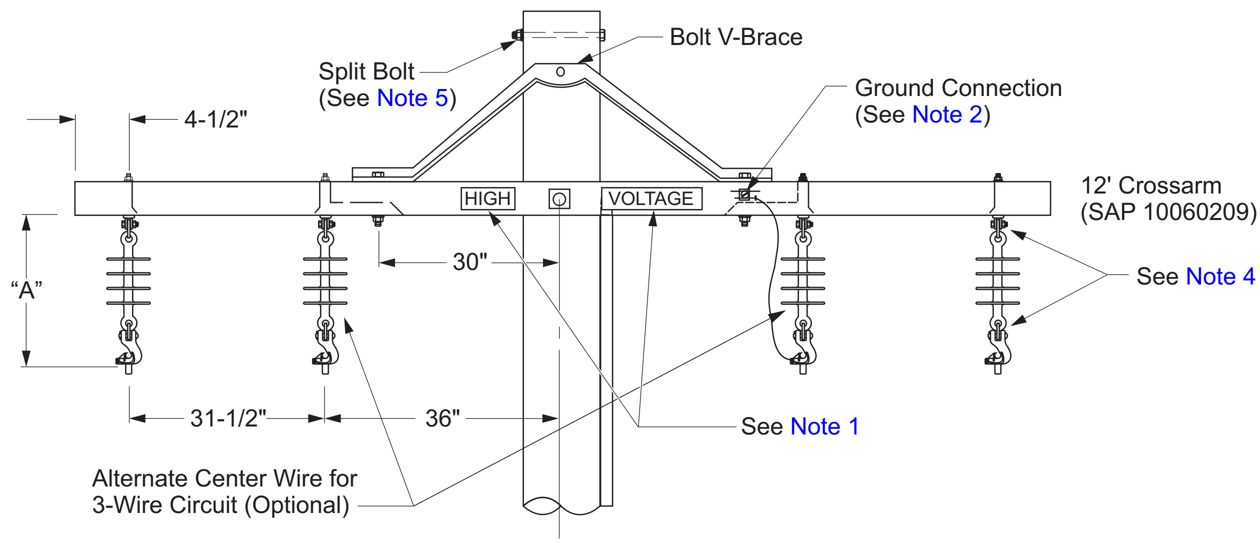
DC 530 All Distribution Voltages 3/4-Wire Suspension Construction

Scope DC 530.1 Distribution Suspension Construction — High-Wind Areas Only

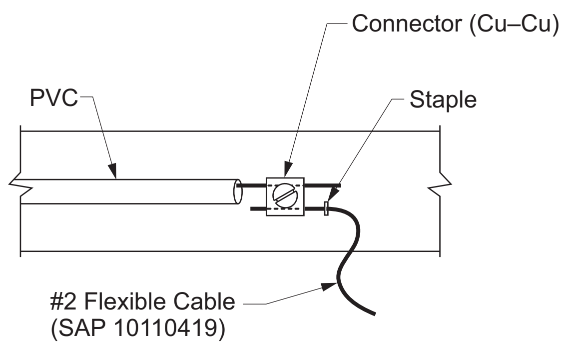
Figure DC 530–1: All Distribution Voltages



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. See Figure DC 530–2.
3. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
4. Install chain shackle (SAP 10068452) between hog eye and dead-end, also between shoe and dead-end.
5. Use split bolt above or below V-brace within 6 inches of V-brace bolt. If a side guy is attached, the guy assembly bolt will function as a split bolt.

Figure DC 530–2: Ground Connection Detail (Opposite Side of Crossarm from Bond)



Note(s):

1. This should only be used on straight line poles.

Table DC 530–1: Table for Dimension “A” — All Distribution Voltages 3/4 Wire Suspension Construction

		SAP	Dimension “A”
2.4–12 kV	1-13" polymer D	10116431	24"
16 kV	1-17" polymer DE	10116332	28"
33 kV	1-22" polymer DE	10116432	33"

Table DC 530–2: Suspension Clamp — 3/4 Wire Suspension Construction — All Distribution Voltages

Suspension Clamp		
	Clamp SAP	
Conductor Size	w/ Line Guard	w/o Line Guard
# 4 ACSR	10067612	(Do Not Use)
1/0 ACSR	10067612	10067612
4/0 ACSR	10067616	10067612
336 kcmil ACSR	10067616	10067612
653 kcmil ACSR	(Do Not Use)	10067616
2 tr CU	10067612	10067611
2/0 CU	(Do Not Use)	10067612
4/0 CU	(Do Not Use)	10067612

Conductor Size	Line Guard
#4 ACSR	10068425
1/0 ACSR	10068426

= For Reference Only

Table DC 530–3: Maximum Span Length — All Distribution Voltages 3/4 Wire Suspension Construction

Maximum Span Length (ft)			
Conductor Size	12 kV	16 kV	33 kV
653 kcmil ACSR	440	440	440
336 kcmil ACSR	440	400	400
1/0 ACSR	400	320	320
No. 4 ACSR	280	180	180

= For Reference Only

Note(s):

1. Twelve foot arms to be drilled in field. Treat all holes with Pole-Nu after drilling.

DC 535 Wildlife-Safe Power Line Construction

Scope DC 535.1 Wildlife-Safe Power Line Construction

1.0 General Information

These standards are intended to protect lines from wildlife by constructing sufficient phase-to-phase and phase-to-ground clearances and by installing approved protective materials on high voltage lines and equipment. In addition, installing wildlife protection on all phases will mitigate other contact-related faults, such as incidental contact of trees and metallic balloons at the pole. Should it be determined at the time of design or construction that undertaking such efforts would compromise public or worker safety, reasonable efforts will be made to construct with the best possible clearances and/or protective materials. For questions or concerns regarding environmental requirements in specific areas or types of environmental risks, contact the Environmental Services Department by phone at (833) 723-2362 or via email at environmentalrequirements@sce.com.

Wildlife protection material is for incidental wildlife contact only. They are not rated for personal protection and should be treated as bare wires.

1.1 New poles, bare and covered conductor lines, equipment, apparatus, and pole replacements shall be constructed per this standard.

A. Standard Construction

- Horizontal phase-to-phase/ground separation of 36 inches and vertical phase-to-phase/ground separation of 36 inches (Measured center of pin to center of pin on a wood/composite arm) (see Figure DC 535–1).

  In the absence of sufficient separation, wildlife protection material shall be used (for example, Wildlife Hoods, Wildlife Hood Extenders, and Protective Tubing).
- In covered conductor systems, wildlife protection material shall be used on all phases as well as the neutral. For example, a 4-wire dead-end construction must have dead-end wildlife protection on all four wires.
- Covered Conductor systems do not require use of wildlife hoods, wildlife hood extenders, and/or protective tubing.
- Dead-ends in covered conductor systems shall be covered with wildlife protection.
- Overhead equipment shall have bushing covers
- Overhead equipment shall be connected with covered conductors
- Overhead arresters shall utilize vendor supplied covers
- All overhead taps, leads, and jumper wires shall utilize covered conductors
- On all riser poles, potheads shall utilize covers and all phase jumpers shall be covered
- All new overhead switches shall be inverted

B. Eagle Zone Construction

Portions of the SCE service territory are designated as Eagle Zones (see Section 5.0):

- In addition to areas defined in Section 5.0, all Public Lands (for example, Forest Service, BLM, NPS, and State Parks) are designated as Eagle Zones.

In addition to the above requirements for Standard Construction, the following applies for Eagle Zone Construction:

- Horizontal phase-to-phase/ground separation of 60 inches (Measured center of pin to center of pin on a wood/composite arm, see Figure DC 535–1) and vertical phase-to-phase/ground separation of 40 inches
- In the absence of sufficient separation, wildlife protection material shall be used (for example, Wildlife Hoods, Wildlife Hood Extenders, and Protective Tubing)
- Covered Conductor systems do not require the use of Wildlife Hoods, Wildlife Hood Extenders, and Protective Tubing.

1.2 Any SCE power line structure involved in the mortality of a protected wildlife species will be evaluated by CES to determine if the SCE power line structure is wildlife safe. As appropriate, poles, lines, equipment, and apparatus involved in avian mortalities will be retrofitted with wildlife protection materials.

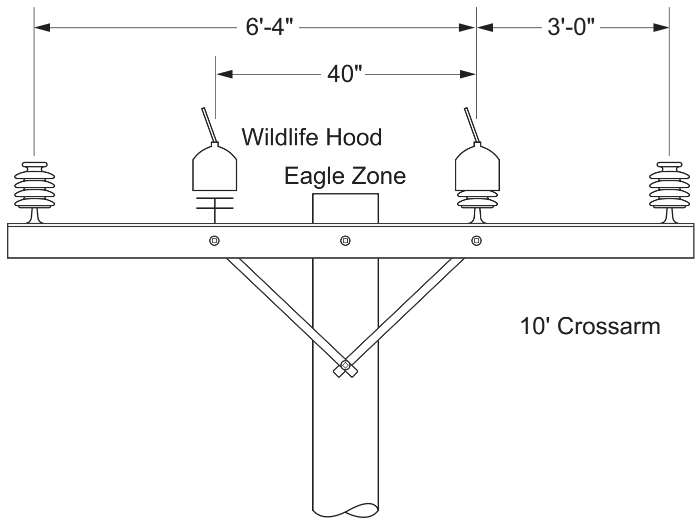
1.3 For the purposes of this standard, wood poles/crossarms and composite poles/crossarms are not considered “grounded”.

1.4 In areas where secondary/service drop conductors have been damaged (chewed or gnawed) by rodents and damage to the conductor has been observed, copper secondary’s shall be utilized in replacement. Aluminum secondary’s/service drops shall be replaced with copper to deter animals from re-visiting the effected line. In areas where high vegetation and rodent population exists, preventative measures like using secondary copper conductors shall be employed during the replacement of aluminum conductors. See CO 108 for requirements.

2.0 Wildlife-Safe Construction for Standard Construction and Eagle Zones

2.1 4/12/16/33 kV, 3-Wire or 4-Wire, Straight-Line Construction

Figure DC 535–1: 4/12/16/33 kV, 3-Wire or 4-Wire, Straight-Line Construction

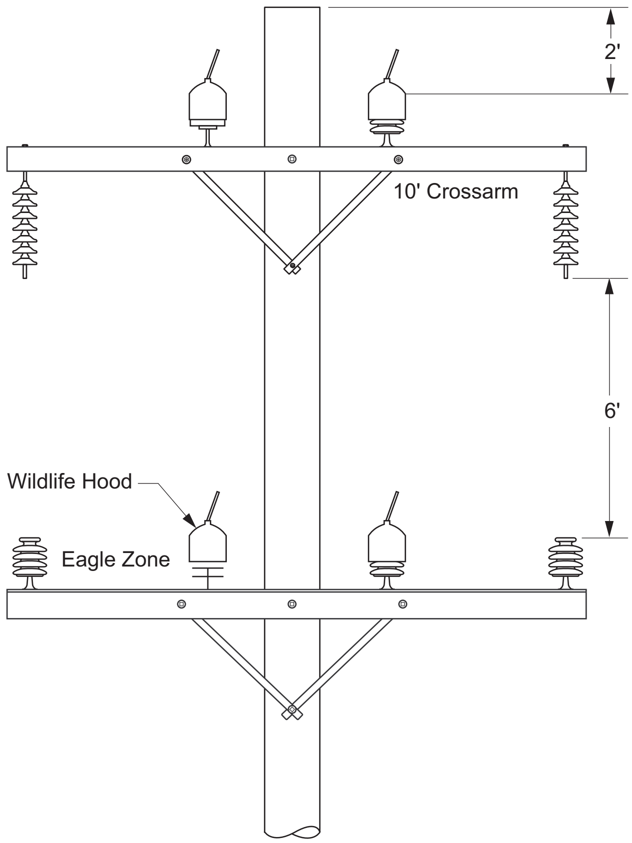


Note(s):

1. Wildlife Hoods shall be trimmed to properly fit double pin insulator application.
2. Wildlife Hoods may be installed on single pin-type insulators with a maximum of six degrees deviation angle. For double pin-type insulators the maximum deviation angle is 12 degrees with wildlife hoods trimmed to fit properly. See DC 585 for determination of deviation angles.
3. In Eagle Zones, a 12 foot crossarm will require wildlife protection material or modifications to the pre-drilled holes for insulator spacing.
4. See DC 510 for construction details.

2.2 4/12/16/33 kV, 3-Wire or 4-Wire, Straight Line Post-Suspension Construction

Figure DC 535–2: 4/12/16/33 kV, 3-Wire or 4-Wire, Straight Line Pin/Post-Suspension Construction

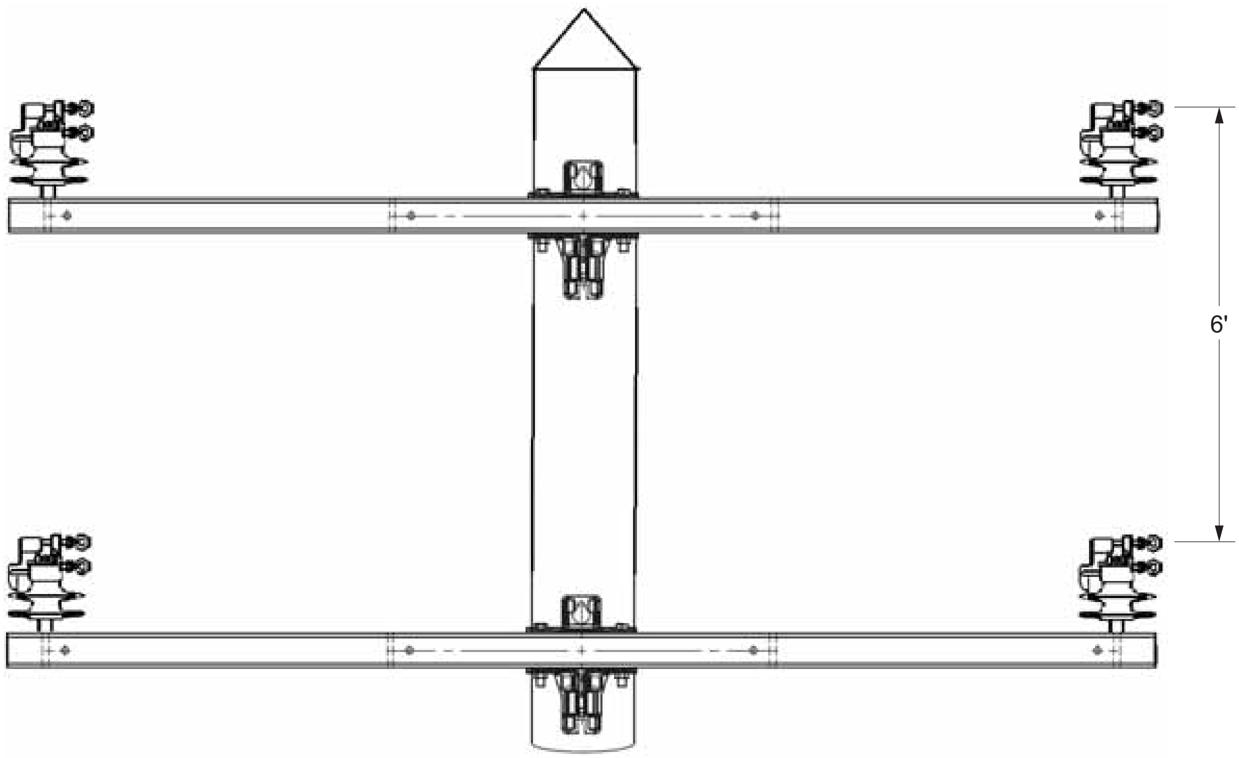


Note(s):

1. See DC 530 for suspension-type construction clearances.
2. In Eagle Zones, a 12 foot crossarm will require wildlife protection material or modifications to the pre-drilled holes for insulator spacing. See CO 700 for conductor spacing on 12 foot crossarms.

2.3 4/12/16/33 kV 3-Wire or 4-Wire, Two Level (Box) Construction

Figure DC 535–3: 4/12/16/33 kV, 3-Wire or 4-Wire, Two Level (Box) Construction

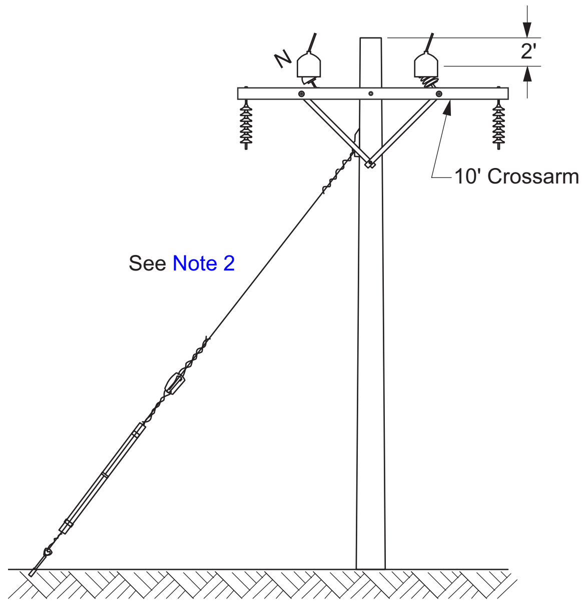


Note(s):

1. In Eagle Zones, a 12 foot crossarm will require wildlife protection material or modifications to the predrilled holes for insulator spacing. See CO 700 for conductor spacing on 12 foot crossarms.
2. Insulators shown are 25 kV polymer vise-top. For 16/25 kV, use 35 kV polymer vise-top insulators (see GR Section).

2.4 4/12/16/33 kV, 3-Wire or 4-Wire, Angle Suspension Construction

Figure DC 535–4: 4/12/16/33 kV, 3-Wire or 4-Wire, Angle Suspension Construction

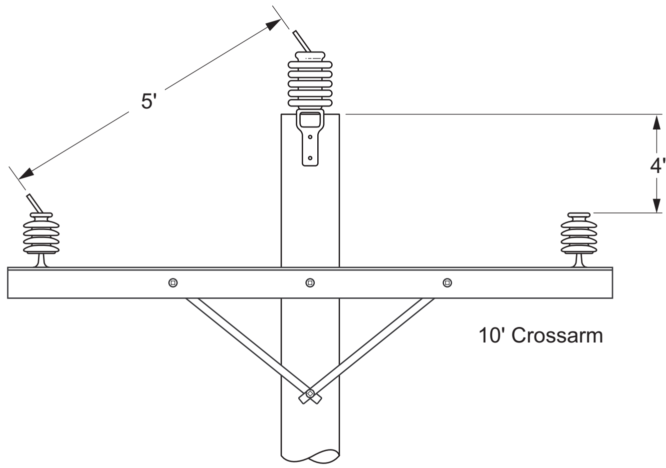


Note(s):

1. See PO 300 for guying requirements.
2. In Eagle Zones, a 12 foot crossarm will require wildlife protection material or modifications to the pre-drilled holes for insulator spacing. See CO 700 for conductor spacing on 12 foot crossarms.

2.5 12/16/33 kV, 3-Wire, Ridge Pin Construction

Figure DC 535–5: 12/16/33 kV, 3-Wire, Ridge Pin Construction

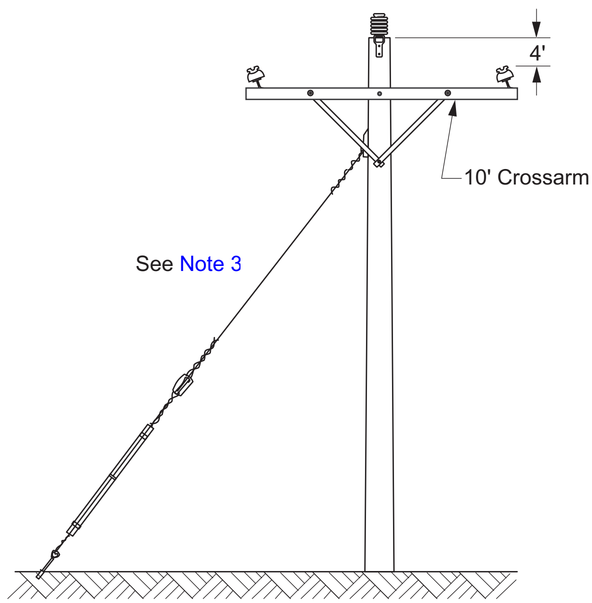


Note(s):

1. 3-Wire, Ridge Pin Construction may also be used for 12/16 kV pole replacements.
2. See DC 500 for construction details.

2.6 12/16/33 kV, 3-Wire, Angled Ridge Pin Construction

Figure DC 535–6: 12/16/33 kV, 3-Wire, Angled Ridge Pin Construction

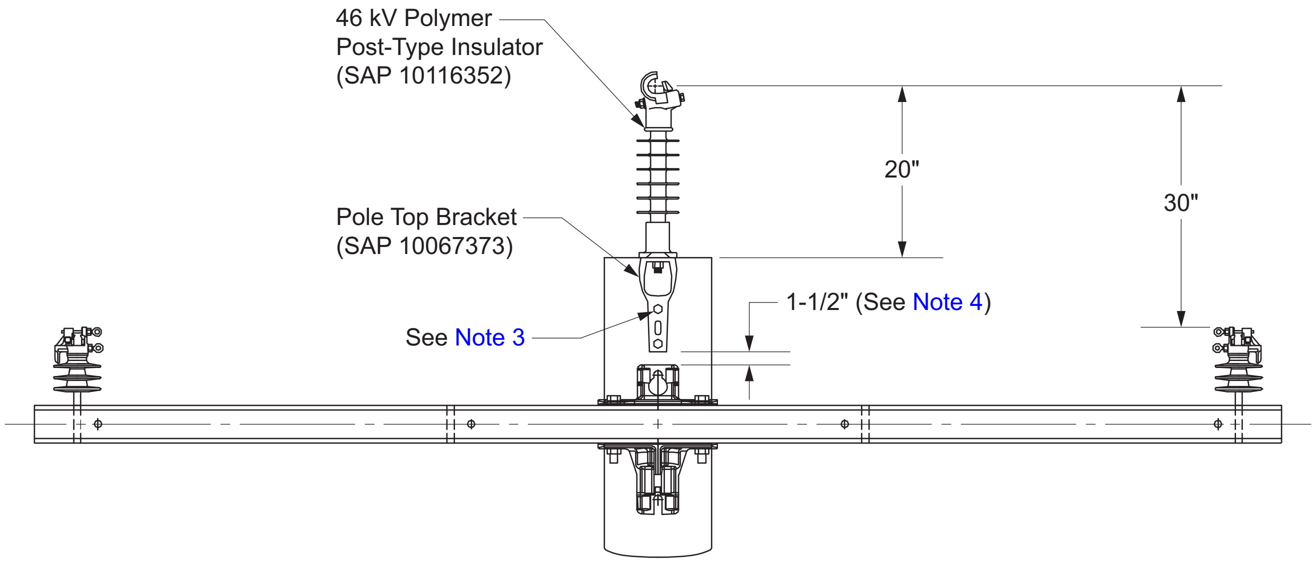


Note(s):

1. 3-Wire, Angled Ridge Pin Construction may also be used for 12/16 kV pole replacements.
2. See PO 300 for guying requirements.

2.7 12/16/33 kV Ridge Pin Construction, 46 kV Post Insulator, Composite Crossarm

Figure DC 535–7: 12/16/33 kV Ridge Pin Construction, 46 kV Post Insulator, Composite Crossarm

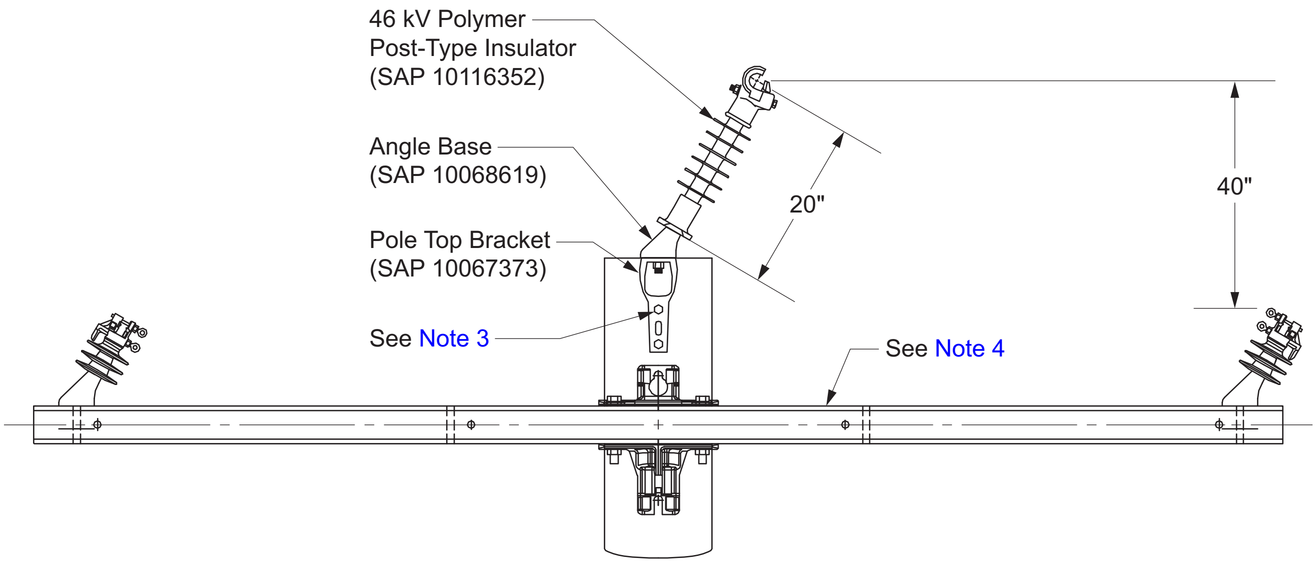


Note(s):

1. Maintain a 30-inch vertical clearance between the pole top conductor and conductors on the crossarm.
2. Use #6 PGW to bond the ridge pin to the crossarm bonding system.
3. Stack curved washers in gain to fill the gap between the Pole Top Bracket and the gain.
4. Install the crossarm 25 inches from the top of the pole to maintain 1-1/2-inch clearance between the ridge pin and crossarm mounting bracket

2.8 12/16/33 kV Ridge Pin Angle Construction, 46 kV Post Insulator, Composite Crossarm

Figure DC 535–8: 12/16/33 kV Ridge Pin Angle Construction, 46 kV Post Insulator, Composite Crossarm

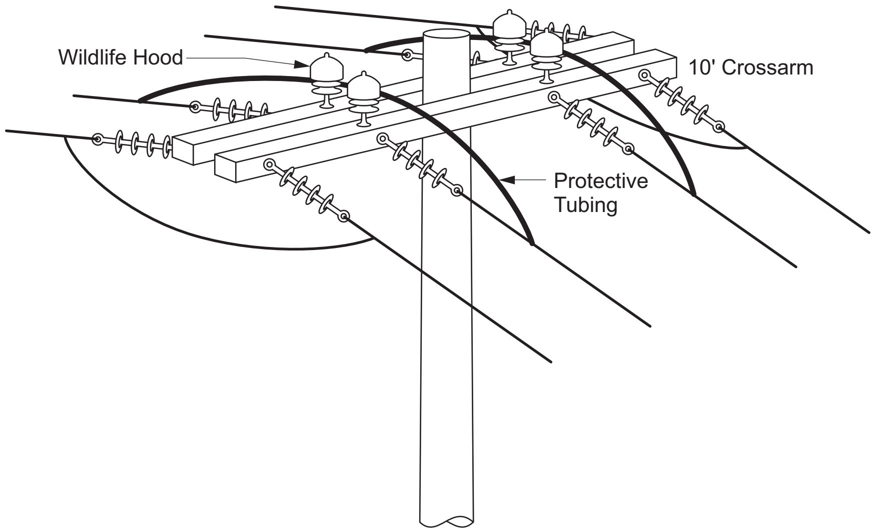


Note(s):

1. Maintain a 40-inch vertical clearance between the pole top conductor and conductors on the crossarm.
2. Use #6 PGW to bond the ridge pin to the crossarm bonding system.
3. Stack curved washers in gain to fill the gap between the Pole Top Bracket and the gain.
4. Install the crossarm 25 inches from the top of the pole.

2.9 3-Wire or 4-Wire, Double Dead-End Construction

Figure DC 535–9: 3-Wire or 4-Wire, Double Dead-End Construction

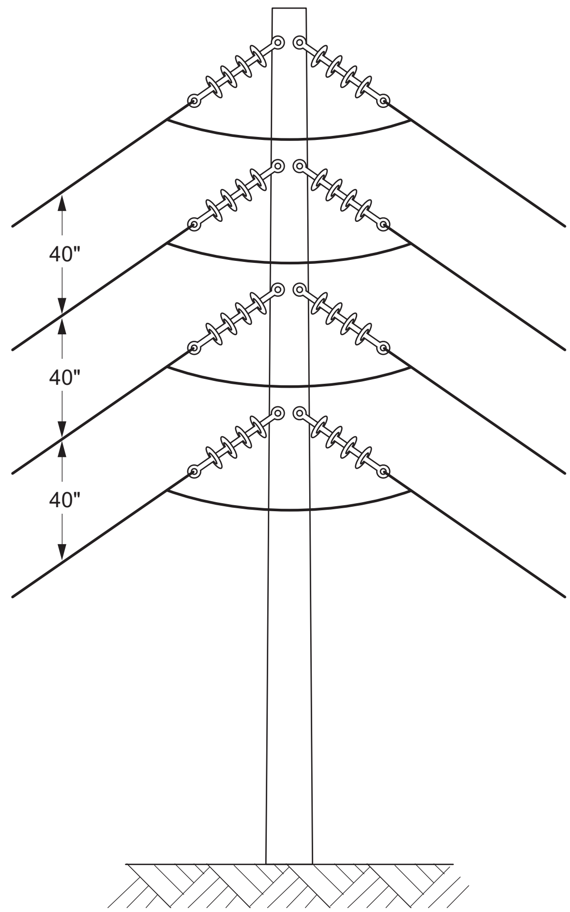


Note(s):

1. Inside phase jumper(s) shall be covered with protective tubing when installed over the crossarms.
2. In Eagle Zones, a 12 foot crossarm will require wildlife protection material or modifications to the pre-drilled holes for insulator spacing.

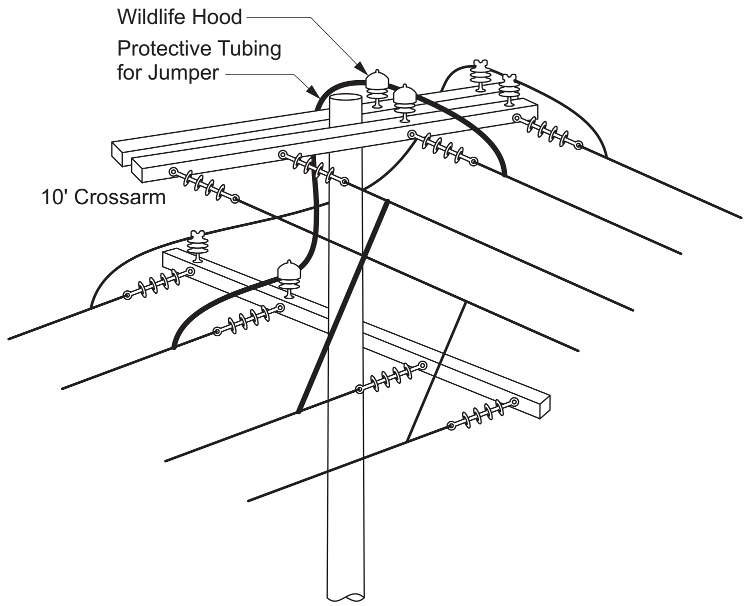
2.10 3-Wire or 4-Wire, Corner Pole, Vertical Construction

Figure DC 535–10: 3-Wire or 4-Wire, Corner Pole, Vertical Construction



2.11 3-Wire or 4-Wire, Corner Pole, Horizontal Construction

Figure DC 535–11: 3-Wire or 4-Wire, Corner Pole, Horizontal Construction



Note(s):

1. Wildlife Hoods shall be trimmed to properly fit double pin insulator application.
2. See DC 110 and DC 120 for proper clearances.
3. In Eagle Zones, a 12 foot crossarm will require wildlife protection material or modifications to the pre-drilled holes for insulator spacing.

2.12 12/16/25/33 kV 3/4-Wire, Transmission Underbuild

Follow DC 530 for suspension construction. If suspension construction is not possible, construct to Figure DC 535–4.

For steel poles utilizing crossarms to support primary conductors with less than 60 inches of horizontal phase-to-phase clearance (Measured center of pin to center of pin, see Figure DC 535–1) or 36 inches of horizontal phase-to-pole clearance (measured to the surface of the pole), all phases shall be covered.

Per GR 111.1, the neutral to pole connection shall be made using a conductor with at least the same ampacity as the primary and/or secondary neutral conductor of the circuit and shall be covered with appropriate protective tubing.

3.0 Wildlife Protection for Apparatus

3.1 Connectors

Connectors shall be installed at a minimum of 40 inches above mounting brackets (for example, cable terminations, arresters, or fuse holders) or wildlife protection materials shall be installed.

3.2 Transformers

Transformers shall have bushing covers for primary transformer bushings (including neutrals) and covered tubing for jumpers between fuse holders. New lightning arresters come from the manufacturer with required protective covering and all high side taps on fuse holders require covered tubing and the wire shall be connected at the top of the fuse holder. Protected Ground Wire (PGW) can be used in these situations. When working on a pole with existing arresters that do not have covers, replace them with new ones that have the required covers.

3.3 Cable Terminations (Potheads)

Cable terminations shall have protective covers over the energized, upper part of the termination, and covered tubing for the termination taps. The jumper or tap area immediately adjacent to the grounded metal termination bracket and crossarm must also be adequately covered. New lightning arresters come from the manufacturer with required protective covering. When working on a pole with existing arresters that do not have covers, replace them with new ones that have the required covers.

3.4 Capacitor Banks

Capacitor banks shall have protective covering. When vendor supplied capacitor units do not include protective covers over energized parts, the exposed areas shall be covered by Field Personnel. Bushing covers and current limiting fuse covers shall be installed on potential transformers and current limiting fuses in the area closest to the high voltage transformer bushings.

3.5 Automatic Reclosers (AR), Remote Control Switches (RCS) and Regulators

ARs and regulators shall have protective covers over exposed bushings. A minimum of three feet of covered tubing shall be installed over the line taps. Bushing covers and current limiting fuse covers shall be installed on potential transformers and current limiting fuses in the area closest to the high voltage transformer bushings.

3.6 Overhead Switches

A. Horizontal Construction

New installations requiring an overhead distribution switch (up to 17 kV class) shall be an inverted Omni-Rupter wildlife-safe switch (refer to DAP AP 336). Center phase leads of the switch shall have protective covering.

38 kV class applications requiring an overhead distribution switch shall be an inverted Alduti-Rupter wildlife-safe switch. For Eagle Zones only, center phase leads of the switch shall have protective covering (refer to DAP AP 338).

B. Vertical Construction

Installations requiring an overhead distribution switch (up to 17 kV class) shall be an inverted Omni-Rupter wildlife-safe switch (refer to DAP AP 336).

4.0 Wildlife Protection Materials

Wildlife protection material is for incidental wildlife contact only. They are not rated for personal protection and should be treated as bare wires.

Bushing covers shall only cover top skirt of the bushing.

Table DC 535–1: Wildlife Protection Material

SAP	Description	Photo
10214746	Transformer Bushing Wildlife Cover w/Handwheel, 4" Max Diameter, Grey Color.	
10067758	Cover, Wildlife, Bushing, to be Used on Transformer Bushing, 3.25" to 4.25" Skirt Diameter, HDPE Material, Grey Color.	
10067783	Cover, Wildlife, Bushing, to be Used on Transformer Bushing, 4.5" Maximum Skirt Diameter, HDPE Material, Grey Color.	

= For Reference Only

What's Changed? Added new transformer bushing cover w/handwheel SAP number and description. SAP 10067758 made For Reference Only.

Table DC 535–1: Wildlife Protection Material *(Continued)*

SAP	Description	Photo
10067753	Cover, Wildlife, Bushing, to be Used on Recloser and Voltage Regulator Bushing, 5.00" to 6.25" Skirt Diameter, HDPE Material, Grey Color.	
10214048	Clip, Anti-Rotation, to be used with Dead-End Clamp Cover SAP 10211487.	
10211487	Cover, Wildlife, Dead-End Clamp, HDPE Material, Grey Color with Anti-Rotation Clip. Note: Anti-Rotation clip is separately coded for retrofit applications. SAP 10214048	
10214588	Dead-End Extension Cover, For Use on Dead-End or Mid-span Ground Locations, 31.5" Long, Grey Color.	
10067793	Cover, Wildlife, Bushing, to be Used on Current Limiting Device, (CLD), Install Either Horizontal or Vertical Position, HDPE Material, Red Color.	
10200065	Cover, Wildlife, to be Used on Terminators/Potheads, can also be used on Bolted Wedge Connectors, 4-1/2" × 8" Outside Dimensions, HDPE Material, Grey Color.	
10211426	Cover, Wildlife, to be Used on Terminators/Potheads, 350–1500 kcmil, 4-1/2" × 16" Outside Dimensions, HDPE Material, Grey Color.	
10212441	Cover, Large, Wildlife, Bolted Wedge Connector, to be used on 653 to 653 ACSR conductors.	

Table DC 535–1: Wildlife Protection Material *(Continued)*

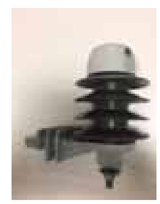
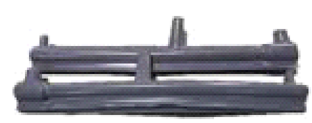
SAP	Description	Photo
10212442	Cover, Small, Wildlife, Bolted Wedge Connector, to be used on all size conductors except 653 to 653ACSR.	
10200066	Cover, Wildlife, Brace Bolt, to be Used on Crossarms with V-braces on Steel Poles, HDPE Material, Grey Color.	
10109289	Cover, Wildlife, Stud, to be Used on Distribution Lightning Arresters, PVC Material, Grey Color.	
10184084	Cover, Wildlife, Body, Insulator, Post Type, to be Used with SAP 10067847 Extenders, Grey Color.	
10067846	Cover, Wildlife, Body, Insulator, Post and Vice-top Type, to be Used with SAP 10067847 Extenders, Grey Color.	
10213525	Cover, Wildlife, Body, Insulator, Trunion Type Post Insulator, to be Used with SAP 10067847 Extenders, Grey Color.	
10067847	Cover, Wildlife, Extenders for 60" Coverage, Set of 2, to be Used with SAP 10184084 or SAP 10067846 Body, Grey Color.	

Table DC 535–1: Wildlife Protection Material *(Continued)*

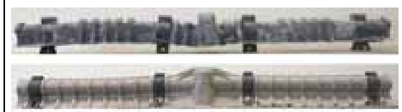
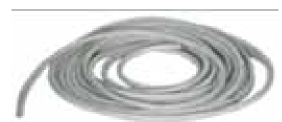
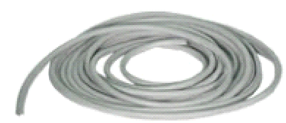
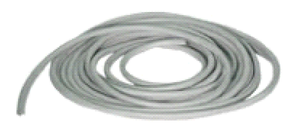
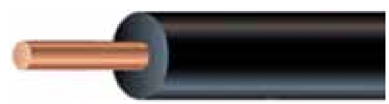
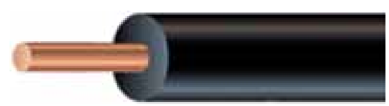
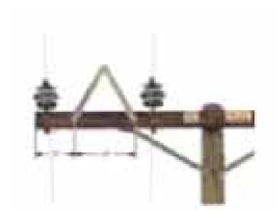
SAP	Description	Photo
10184091	Cover, Wildlife, 1-piece, 60", to be Used with Post and Vice-top Insulators, Grey or Tan Color.	
10184097	Cover, Wildlife, Cutout, Large, HDPE Material, Grey Color.	
10184093	Cover, Wildlife, Cutout — 4 kV, HDPE Material, Grey Color.	
10184094	Cover, Wildlife, Cutout — 12/16 kV, HDPE Material, Grey Color.	
10117060	Tubing, Wildlife, Non-split, to be Used on Capacitor Banks, 5/16" ID × 2' Long, 5/32" Wall Thickness, for #6 AWG Bare Cu — #2 AWG Str., PVC Material, Grey Color.	
10117061	Tubing, Wildlife, Non-split, 0.45" ID × 2' Long, 5/32" Wall Thickness, for #2/0 AWG Bare Cu — 1/0 AWG ACSR, PVC Material, Grey Color.	

Table DC 535–1: Wildlife Protection Material *(Continued)*

SAP	Description	Photo
10117062	Tubing, Wildlife, Non-split, 3/4" ID × 2' Long, 5/32" Wall Thickness, for 336.4 kcmil ACSR, PVC Material, Grey Color.	
10147890	Cover, Wildlife, Stinger, Split, to be Used to Cover Primary Wire, 3/8" ID × 2' Long, (25) Per Box, for #6 AWG — 1/0 ACSR, Ozone Resistant Rubber Material, Grey Color.	
10200336	Cover, Wildlife, Stinger, Split, to be Used to Cover Primary Wire, 3/8" ID × 50' Long Coil, for #6 AWG — 1/0 ACSR, Ozone Resistant Rubber Material, Grey Color.	
10180176	Cover, Wildlife, Stinger, Split, to be Used to Cover Primary Wire, 5/8" ID × 50' Long Coil, for 2/0 — 336.4 kcmil, Ozone Resistant Rubber Material, Grey Color.	
10180177	Cover, Wildlife, Stinger, Split, to be Used to Cover Primary Wire, 3/4" ID × 25' Long Coil, (2) Coils Per Box, for 653 kcmil–750 kcmil, Ozone Resistant Rubber Material, Grey Color.	
10109302	Protected Ground Wire (PGW), LDPE, #6 AWG CU to be used over taps (when applicable), high-side bushing on transformer banks and capacitor banks. See Table CO 106–6 for PGW ampacities.	
10109304	Protected Ground Wire (PGW), LDPE, #4 AWG CU to be used over taps (when applicable), high-side bushing on transformer banks and capacitor banks. See Table CO 106–6 for PGW ampacities.	
10067816	Guard, Wildlife, Triangular, Adjustable, 2-1/4" × 24-1/4", Polyethylene Material, to be Mounted on Crossarms Between Phases. Note(s): Contact Environmental Services for approval.	

5.0 Wildlife and Eagle Zones

5.1 Description

Wildlife protection is a catch all term that over the years has included variants Eagle, Avian, Raptor and/or Critter. Eagle Zones are specific geographical areas that contain high priority protected and endangered species. Measures taken for Wildlife protection may and are typically required in Eagle Zones including:

Wildlife-safe power line construction standards are intended to protect lines from wildlife and vice versa by constructing sufficient phase-to-phase and phase-to-ground clearances as well as installing approved protective materials on high voltages lines and equipment. In addition, installing wildlife covers in the correct application will mitigate other contact-related faults from foreign materials.

While wildlife covers were initially introduced to protect high priority wildlife, additional benefits are procured when discussing wildfire mitigation. By utilizing the correct wildlife covers, electrical events that may result in incandescent particles or other debris will likely be mitigated due to the added fire, track, and arc resistant protection.

See Table DC 535–2 to determine if a district contains Eagle Zones.

5.2 Identification of Eagle Zones

For the most current Eagle Zone maps with the best resolution, please utilize the following interactive mapping systems:

- SCE GeoView (Use the HFRA Layer)
- AGOL

For Reference Only PDF maps can be found in the links below and in the subsequent pages of this chapter.

eWorld.sce.com

PDF Maps of HFRA are accessible via the below link:

https://edisonintl.sharepoint.com/:f:/t/apparatusstandards-TD/EhijW-qs6O9Dv7ZYF8MmDwYBE6E8pzv5iM6CKa0XhkAISA?e=s5Zj3J

The subsequent pages will show HFRA by:

- SCE Service Territory
- SCE Districts
- California Counties

Please find the links to SCE GeoView and AGOL below:

SCE GeoView:

https://scegeoview.sce.com/SCEGeoView/

AGOL:

https://sce2.maps.arcgis.com/home/item.html?id=cb845d68a29a4f8f932fe47b18c57ca8

Table DC 535–2: Districts and Eagle Zone

Region	District #	District Name	Standard Construction	Eagle Zone	Eagle Construction Zone
Catalina	61	Catalina	X	X	Entire island except the portion of the city of Avalon within a line beginning at Crescent Ave. and Claressa Ave.; going south on Claressa Ave. to Tremont St. West on Tremont to Country Club Dr., North on Country Club and Las Lomas to Crescent Ave.; and East to point of origin.
Desert	30	Foothill	X	X	Areas of Foothill district on north of the 210 FWY and West of the 15 FWY.
Desert	31	Redlands	X	X	Outside a boundary starting on: 1. N/E of 215 FWY and Devore Rd. going S/E on Kendall Dr. to Campus Pkwy. 2. Going N/E on Campus Pkwy to W Northpark Blvd. 3. South/East on W Northpark Blvd. to Electric Ave. 4. South on Electric Ave. to 40th St. 5. East on 40th St. to Mountain Ave. 6. South on Mountain Ave. to 39th St. 7. East on 39th St. to Del Rosa Ave. 8. South on Del Rosa Ave. to Foothill Dr. 9. East on Foothill Dr. to Sterling Ave. 10. South on Sterling Ave. to Lynwood Dr. 11. East on Lynwood Dr. to Victoria Ave. 12. South on Victoria Ave. to Highland Ave. 13. East on Highland Ave. to Church St. 14. South on Church St. to side of the Santa Ana River. 15. Santa Ana River East to Crafton 16. South on Crafton to Sand Canyon. 17. East on Sand Canyon to Chapman Heights Rd. 18. West on Chapman heights Rd. to Oak Glen Rd. 19. East on Oak Glen Rd. to Bryant St.

Table DC 535–2: Districts and Eagle Zone *(Continued)*

Region	District #	District Name	Standard Construction	Eagle Zone	Eagle Construction Zone
Desert (cont'd)	31	Redlands	X	X	Outside a boundary starting on: 20. South on Bryant St. to Ave. F. 21. East on Ave. F to Mesa Grande Dr. 22. South Mesa Grande Dr. to County Line Rd. 23. West on County Line Rd. to Fremont St. 24. South on Fremont to Ave L. 25. West on Ave. L to California St. 26. South on California St. to Myrtlewood Dr. 27. West on Myrtlewood Dr. to Calimesa Blvd. 28. South on Calimesa Blvd. to the 10 FWY. 29. West on 10 FWY to Highland Ave. 30. West on Highland Ave. to Smiley Heights Dr. 31. West on Smiley Heights Dr. to Terracina Blvd. 32. North on Terracina Blvd. to Barton Rd. 33. West on Barton Rd. to the district boundary. 34. East of Mt. Vernon Ave. and Washington St. 35. South on Mt. Vernon Ave. to Palmyrita Ave. 36. Undeveloped areas South/East of the intersection of the 215 FWY and 10 FWY.
Desert	73	Victorville (aka High Desert)	X	X	Outside a boundary beginning on the intersection of 15 FWY and Ranchero Rd. 1. North on 15 FWY to 395. 2. North on 395 to Rancho Rd. 3. East on Rancho Rd. to 18 HWY. 4. S/E on 18 HWY to Navajo Rd. 5. South on Navajo Rd. to Bear Valley Rd. 6. West on Bear Valley Rd. to Deep Creek Rd.

Table DC 535–2: Districts and Eagle Zone *(Continued)*

Region	District #	District Name	Standard Construction	Eagle Zone	Eagle Construction Zone
Desert (cont'd)	73	Victorville (aka High Desert)	X	X	Outside a boundary beginning on the intersection of 15 FWY and Ranchero Rd. 7. South of Deep 8 Creep Rd. to Juniper Rd. 8. West on Juniper Rd. to Ranchero Rd. 9. West on Ranchero Rd. to 15 FWY.
Desert	79	Palm Springs	X	X	Outside the boundaries between the 10 FWY and HWY 111.
Metro East	22	Montebello	X	—	—
Metro East	26	Covina	X	X	All areas North of a line beginning at intersection of HWY 39 and Foothill Blvd., proceeding East along Foothill Blvd. to Valley Center, South on Valley Center to Route 66, East on Route 66 to Baseline Rd, East on Baseline Rd. to 210 FWY.
Metro East	27	Monrovia	X	X	All the area North of a line beginning on Encanto Pkwy and Huntington Dr. 1. West on Huntington Dr. to Mountain Ave. 2. North on Mountain Ave. to Foothill Blvd. 3. West on Foothill Blvd. to Michillinda Ave. 4. North on Michillinda Ave. to Park Vista Dr. 5. All Area of Sierra Madre, Altadena, La Canada Flintridge, and La Cresenta.
Metro East	34	Ontario	X	—	All district areas North of the 210 FWY. "Eagle zone with Exceptions" 1. Within the boundaries of Ontario district on South of 60 FWY and West of 71 FWY.

Table DC 535–2: Districts and Eagle Zone *(Continued)*

Region	District #	District Name	Standard Construction	Eagle Zone	Eagle Construction Zone
Metro East (cont'd)	34	Ontario	X	X	Within a boundary beginning on intersection of 71 FWY and Edison. 1. East on Edison Ave. to 15 FWY. 2. South on 15 FWY to Limonite Ave. 3. East on Limonite Ave. to Van Buren Blvd. 4. South on Van Buren Blvd. to Santa Ana River. 5. West on Santa Ana River trail to North Dr. 6. West on North Dr. to California Ave. 7. South on California Ave. to Sixth St. 8. West on Sixth St/Norco Dr./ Corydon Ave. to River Rd. 9. S/E on River Rd. to Lincoln Ave. 10. South on Lincoln Ave. to Foothill Pkwy. 11. East on Foothill Pkwy to 15 FWY. 12. North on 15 FWY to Magnolia Ave. 13. N/E on Magnolia Ave. to Pierce St. 14. South on Pierce St. to Indiana Ave. 15. All undeveloped areas North and West of Lake Matthews.
Metro West	32	Dominguez Hills	X	—	—
Metro West	42	Santa Monica	X	—	—
Metro West	44	South Bay	X	—	—
Metro West	46	Long Beach	X	—	—
Metro West	47	Whittier	X	—	—
North Coast	35	Thousand Oaks	X	X	North of the 101 FWY, and undeveloped areas outside cities of Moorpark, Simi Valley, and Thousand Oaks.

Table DC 535–2: Districts and Eagle Zone *(Continued)*

Region	District #	District Name	Standard Construction	Eagle Zone	Eagle Construction Zone
North Coast	36	Antelope Valley	X	X	Outside a boundary beginning on intersection of Ave. I and 60th St. W. 1. South to 60th St. to W Ave. N. 2. East on W Ave. N to 30th St. 3. South on 30th St. to Rancho Vista Blvd. 4. East on Rancho Vista Blvd. to 20th St. 5. South on 20th St. to Elizabeth Lake Rd. 6. East on Elizabeth Lake Rd. to Tierra Subida Ave. 7. South on Tierra Subida Ave. to Ave. S 8. East on Ave. S to 40th St. 9. North on 40th St. to Ave. I. 10. West on Ave. I to 60th St. Outside a boundary beginning on intersection of 150th St. and Palmdale Blvd. 1. East on Palmdale Blvd to 180th St. 2. North on 180th St. to Ave M 8. 3. West on Ave M 8 to 150th St. 4. South on 150th to Palmdale Blvd.
North Coast	39	Ventura	X	X	North of a line beginning on 33 FWY and Main St. 1. S/E on Main to Telegraph Rd. 2. East on Telegraph Rd. to 118 (Wells Rd.) 3. South on 118 (Wells Rd.) to Railroad 4. South/West on Railroad to 101 FWY 5. S/E on 101 FWY to Beardsley Rd. All undeveloped areas North of City of Camarillo.
North Coast	49	Santa Barbara	X	X	North of a boundary beginning from HWY 192 and HWY 150. 1. West on 192/Cathedral Oaks to 1 FWY.

Table DC 535–2: Districts and Eagle Zone *(Continued)*

Region	District #	District Name	Standard Construction	Eagle Zone	Eagle Construction Zone
North Coast	59	Valencia	X	X	All Area outside the boundaries beginning from intersection of 5 FWY and HWY 14. 1. N/E on 14 to Soledad Canyon Rd. 2. West on Soledad Canyon Rd. to Whites Canyon Rd. 3. North on Whites Canyon Rd./ Plum Canyon Rd. to bouquet Canyon Rd. 4. North on Bouquet Canyon Rd. to Copper Hill Dr. 5. West on Copper Hill Dr. to Newhall Ranch Rd. 6. West on Newhall Ranch Rd. to 5 FWY. 7. Undeveloped areas west of the 5 FWY to HWY 14.
Orange	29	Santa Ana	X	—	—
Orange	33	Huntington Beach	X	—	—
Orange	43	Saddleback	X	X	East of the 241 FWY within the district boundaries. Starting on 241 FWY and Santiago Canyon Rd.
Orange	48	Fullerton	X	—	
Rurals North	50	Shaver Lake	—	X	
Rurals North	52	Tehachapi	X	X	Outside the boundaries beginning from 58 HWY and Tucker Rd. 1. South on Tucker Rd. to Highline Dr. 2. East on Highline Dr. to Dennison Rd. 3. North on Dennison Rd. to 58 HWY. 4. West on 58 HWY to Tucker.
Rurals North	53	Kernville	—	X	All district
Rurals North	85	Bishop/Mammoth	—	X	All district

Table DC 535–2: Districts and Eagle Zone *(Continued)*

Region	District #	District Name	Standard Construction	Eagle Zone	Eagle Construction Zone
Rurals North	86	Ridgecrest	X	X	Outside the boundaries beginning from intersection of Inyokern Rd. and Mahan St. 1. South on Mahan St. to Dolphin Ave. 2. East on Dolphin Ave. to College Heights Blvd. 3. North on College Height Blvd. to Bowman Rd. 4. East on Bowman Rd. to Gateway Blvd. 5. North on Gateway Blvd. to Ridgecrest Blvd. 6. West on Ridgecrest Blvd. to China Lake Blvd. 7. North on China Lake Blvd. to Inyokern Rd. 8. West on Inyokern Rd. to Mahan St.
Rurals South	40	Arrowhead	—	X	All district
Rurals South	72	Barstow	X	X	Outside the boundaries beginning on intersection of Main St. and P St. 1. South on P St. to Linda Vista Ave. 2. East on Linda Vista Ave. to H St. 3. North on H St. to Rimrock Rd. 4. East on Rimrock Rd. to Montana Rd. 5. North on Montana Rd. to Main St. 6. West on Main St. to P St.
Rurals South	84	29 Palms (aka Yucca Valley)	X	X	Outside the boundaries of 29 Palms. 1. Boundary beginning on Intersection of HWY 62 and Encila Ave. 2. North on Encila Ave. to Samarkan Dr. 3. East on Samarkan Dr. to Morongo Rd. 4. South on Morongo Rd. to 2 mile Rd. 5. East on 2 mile Rd. to Utah Trail 6. South on Utah Trail to HWY 62 7. West on Hwy 62 to Encila Ave.

Table DC 535–2: Districts and Eagle Zone *(Continued)*

Region	District #	District Name	Standard Construction	Eagle Zone	Eagle Construction Zone
Rurals South (cont'd)	84	29 Palms (aka Yucca Valley)	X	X	Outside the boundaries of Yucca Valley. 1. Boundary beginning on Intersection of HWY 62 Kickapoo Trail. 2. South on Kickapoo Trail to Golden Bee Dr. 3. East on Golden Bee Dr. to Sage Ave. 4. South on Sage Ave. to San Andreas Rd. 5. East on San Andreas Rd. to Palomar Ave. 6. North on Palomar Ave. to HWY 62. 7. East on HWY 62 to Kickappo trail
Rurals South	87	Blythe	X	X	Outside the boundaries Blythe beginning on: 1. Intersection of Defrain Blvd. and of 10th Ave. 2. South on Defrain Blvd to Seeley Ave. 3. East on Seeley to Intake Blvd. 4. North on Intake Blvd. to 10th Ave. 5. West on 10th Ave to Defrain Blvd.
San Jacinto	77	Menifee (formerly San Jacinto)	X	X	All district under Eagle Zone with exceptions
San Jacinto	88	Wildomar (formerly San Jacinto)	X	X	All district under Eagle Zone with exceptions
San Joaquin	51	San Joaquin	X	X	Outside Boundaries city of Tulare. 1. Intersection of Cartmill Ave. and West St. 2. South on West St. to Bardsley Ave. 3. East on Bardsley Ave. to Mooney Rd. 4. North on Mooney Rd. to Cartmill Ave. 5. West on Cartmill Ave. to West St.

Table DC 535–2: Districts and Eagle Zone *(Continued)*

Region	District #	District Name	Standard Construction	Eagle Zone	Eagle Construction Zone
San Joaquin (cont'd)	51	San Joaquin	X	X	Outside Boundaries city of Visalia. 1. Intersection of Riggin Ave. and Akers St. 2. South on Akers St. to Caldwell Ave. 3. East on Caldwell Ave/Ave 280 to Rd. 140. 4. North on Rd. 140 to Johns Pkwy. 5. West on Johns Pkwy to Riggin Ave. 6. West on Riggin Ave. to Akers St. Outside the Boundaries of city of Hanford. 1. Intersection of Fargo Ave. and 12th Ave. 2. South on 12th Ave. to Hanford Armona Ave. 3. East on Hanford Armona Ave. to 9-1/2 Ave. 4. North on 9-1/2 Ave. to Fargo Ave. 5. West on Fargo Ave. to 12th St. Outside boundaries city of Delano: 1. Intersection of County HWY 44 and Stradley Ave. 2. South on Stradley Ave. to Kernell Ave. 3. East on Kernell Ave. to Browning Rd. 4. North on Browning Rd. to County HWY 44. 5. West on County HWY 44 to Stradley Ave.

Table DC 535–2: Districts and Eagle Zone *(Continued)*

Region	District #	District Name	Standard Construction	Eagle Zone	Eagle Construction Zone
San Joaquin (cont'd)	51	San Joaquin	X	X	Outside boundaries city of Porterville. 1. Intersection of Westfield Ave. and Rd. 224 2. South on Rd. 224 to Poplar Ave. 3. East on Poplar Ave. to Plano St. 4. North on Plano St. to Westfield Ave. 5. West on Westfield Ave. to Rd. 224. Outside boundaries city of Exeter. 1. Intersection of Vine St. and Belmont Rd. 2. South on Belmont Rd. to Glaze Ave. 3. East on Glaze Ave. to 65 HWY. 4. North on 65 HWY to Ave. 276. 5. East on Ave. 275 to Gill Rd. 6. North on Gill Rd. to Palm Dr. 7. West on Palm Dr. to Valencia Dr. 8. North on Valencia Dr. to Sequoia Dr. 9. West on Sequoia Dr. to Rd. 192 10. South on Rd. 192 to Vine St. 11. West on Vine St. to Belmont Rd. Outside boundaries city of Lindsay. 1. Intersection of Tulare Rd. and Westwood Ave. 2. South on Westwood Ave. to Apia St/ Valencia St. 3. East on Apia/Valencia St. to Foothill Ave. 4. North on Foothill Ave. to Fir St. 5. West on Fir St. to Sequoia Ave. 6. South on Sequoia Ave. to Tulare Rd. 7. West on Tulare Rd. to Westwood Ave.

Table DC 535–2: Districts and Eagle Zone *(Continued)*

Region	District #	District Name	Standard Construction	Eagle Zone	Eagle Construction Zone
San Joaquin (cont'd)	51	San Joaquin	X	X	Outside boundaries city of Farmsville. 1. Intersection of Tulare St. and Virginia Ave. 2. North on Virginia Ave. to Ave. 228. 3. East on Ave. 228 to Farmsville Blvd. 4. South on Farmsville Blvd. to Railroad. 5. East on Railroad to Brundage Ave. 6. South on Brundage Ave. to HWY J20. 7. West on HWY J20 to Edge of Orchards. 8. South on Orchards to Tulare St. 9. West on Tulare St. to Virginia Ave.

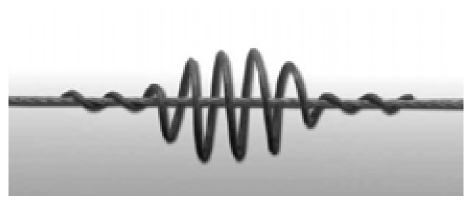
Note(s): Eagle Zones with Exception Rules

1. Standard Construction
   a. Development on both sides of the street or pole line
   b. Less than approximately 40 acres of open space on either side of a street or pole line
   c. Open space such as groomed parkland or golf courses
2. Eagle Construction
   a. Greater than approximately 40 acres of open space on either side of a street or pole line
   b. In situations that aren't clearly defined above as Standard Construction (when in doubt)

6.0 Swan Diverter

Swan Diverters are designed for use on bare conductors to create greater visibility for avian flight paths on overhead lines. Swan Diverters may be used to mark conductors where previous Avian collisions have occurred, where it is determined there is a high risk of Avian collisions with the conductor, or when required by an Agency or Land Manager. Swan Diverters may be installed on covered conductor when required. Consult SCE's Avian Protection Specialist for assistance.

Figure DC 535–12: Swan Diverter



If required, Swan Diverters shall be installed starting 15 feet from the pole, at 15 foot intervals, per Figure DC 535–13.

Figure DC 535–13: Swan Diverter Installation

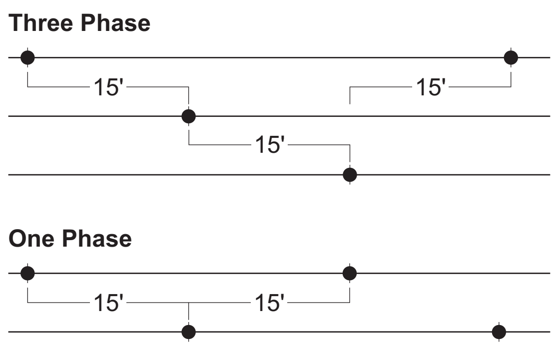


Table DC 535–3: Swan Diverters for Bare Conductor Application

SAP	Conductor Size
10211410	0.175"–0.249"
10211411	0.250"–0.349"
10211412	0.350"–0.449"
10211413	0.450"–0.599"
10211414	0.600"–0.770"
10211415	0.771"–0.858"
10211416	0.859"–0.970"
10211417	0.971"–1.121"
10211418	1.122"–1.306"
10211419	1.307"–1.530"

Note(s):

1. May be installed on covered conductor when required.

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DC 536P Nesting Platform Construction

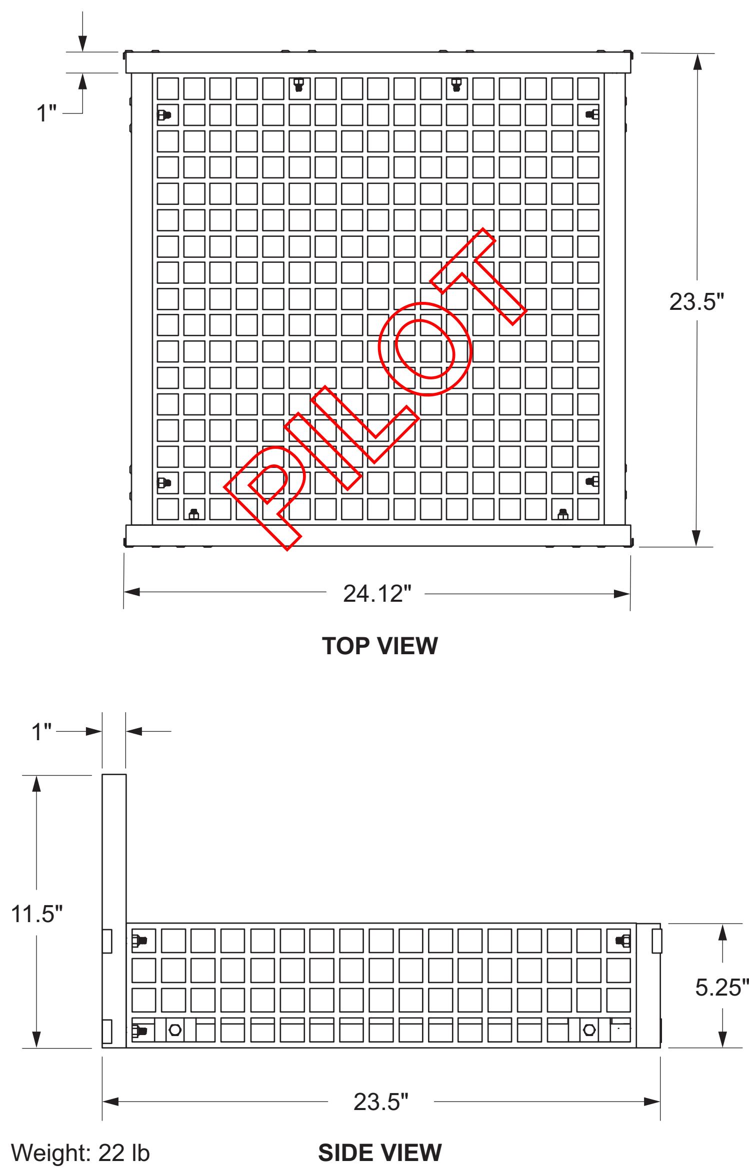
Scope DC 536P.1 Nesting Platform Construction

1.0 General Information

Nesting platforms are intended to mitigate against outages and damage to electrical equipment caused by contact with bird nests. This standard is intended to guide field personnel on the construction of nesting platforms in various configurations that include: on a bare pole, on a pole with existing equipment (transformer, capacitor bank, fuseholder, and so forth), and on a pole top extension.

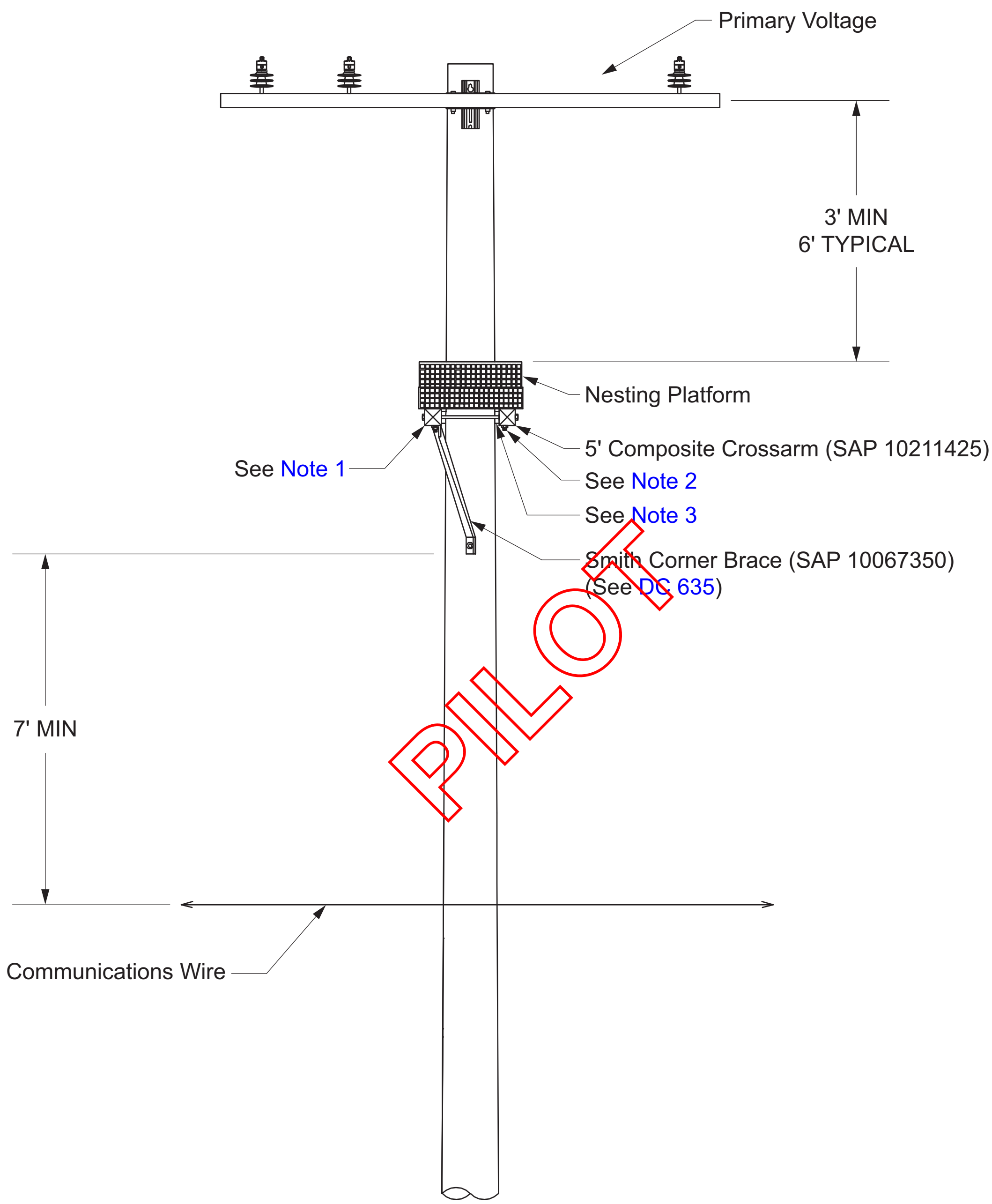
Nine (9) nesting platforms are being piloted in the following districts: San Joaquin, Kernville, and Tehachapi. One or two nesting platforms are installed per district with direction from avian specialists.

Figure DC 536P–1: Nesting Platform Top and Side View



Scope DC 536P.2 Nesting Platform Construction on Bare Pole

Figure DC 536P–2: Nesting Platform on Bare Pole

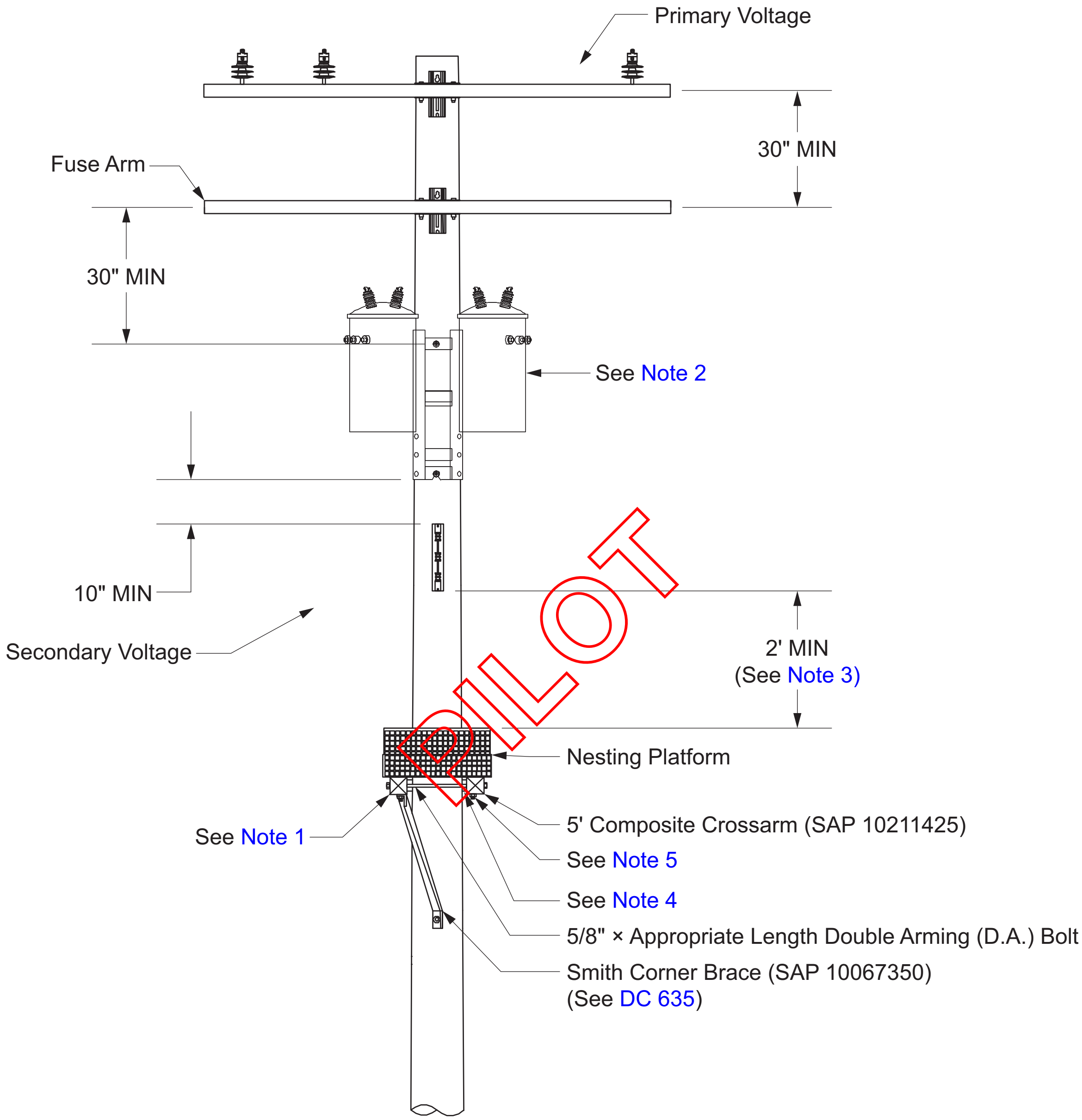


Note(s):

1. Use two (2) 5-foot composite crossarms in alley-arm configuration using one smith corner brace and a 5/8" X appropriate length Double Arming (D.A.) Bolt using 4-inch washers between the base and arm.
2. To fasten nest platform onto crossarm, use two (2) 5/8" X 8" bolts one on each cross arm installed diagonally from each other with a 4-inch washer between the bolt and nesting platform, and between the bolt and crossarm (See Figure DC 536P–5).
3. Ensure that the crossarm attached to the Smith corner brace is flush with the pole.

Scope DC 536P.3 Nesting Platform Construction on Pole with Equipment

Figure DC 536P–3: Nesting Platform on Pole with Equipment

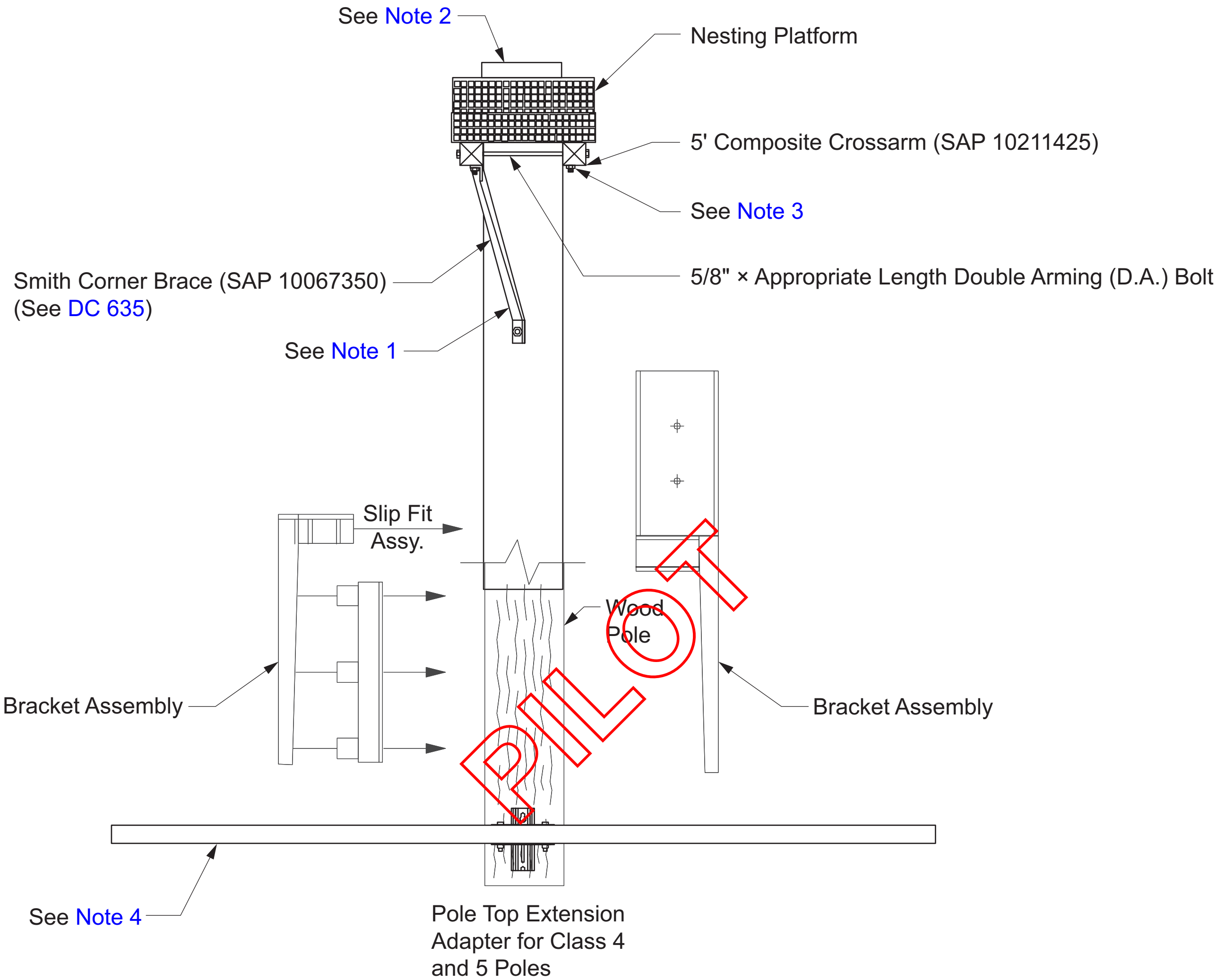


Note(s):

1. Use two (2) 5-foot composite cross arms in alley-arm configuration using one smith corner brace and a 5/8" × appropriate length Double Arming (D.A.) Bolt using 4-inch washers between the base and arm.
2. Transformer used for visual, but use construction methods and clearances per equipment on pole.
3. 2-foot minimum for clearance shall be maintained from nest platform to bottom of equipment or secondary voltage unless stated otherwise in G.O. 95 or other standards.
4. To fasten nest platform, use two (2) 5/8" × 8" bolts one on each cross arm installed diagonally from each other with a 4-inch washer between the bolt and nesting platform, and between the bolt and crossarm (See Figure DC 536P–5).
5. Ensure that the crossarm attached to the Smith corner brace is flush with the pole.

Scope DC 536P.4 Nesting Platform Construction on Pole Top Extension (PTX)

Figure DC 536P–4: Nesting Platform on PTX



Note(s):

1. Use two (2) 5-foot composite cross arms in alley-arm configuration using one smith corner brace and a 5/8" × appropriate length Double Arming (D.A.) Bolt using 4-inch washers between the base and arm.
2. A 7-foot pole top extension (SAP 10067761) is shown (See Scope PO 150.1).
3. To fasten nest platform, use two (2) 5/8" × 8" bolts one on each cross arm installed diagonally from each other with a 4-inch washer between the bolt and nesting platform, and between the bolt and crossarm (See Figure DC 536P–5).
4. In this scenario, the primary voltage crossarm will be below the PTX.

Figure DC 536P–5: Nesting Platform Top and Front View — 8-inch Bolts and 4-inch Square Washers used to Fasten Platform

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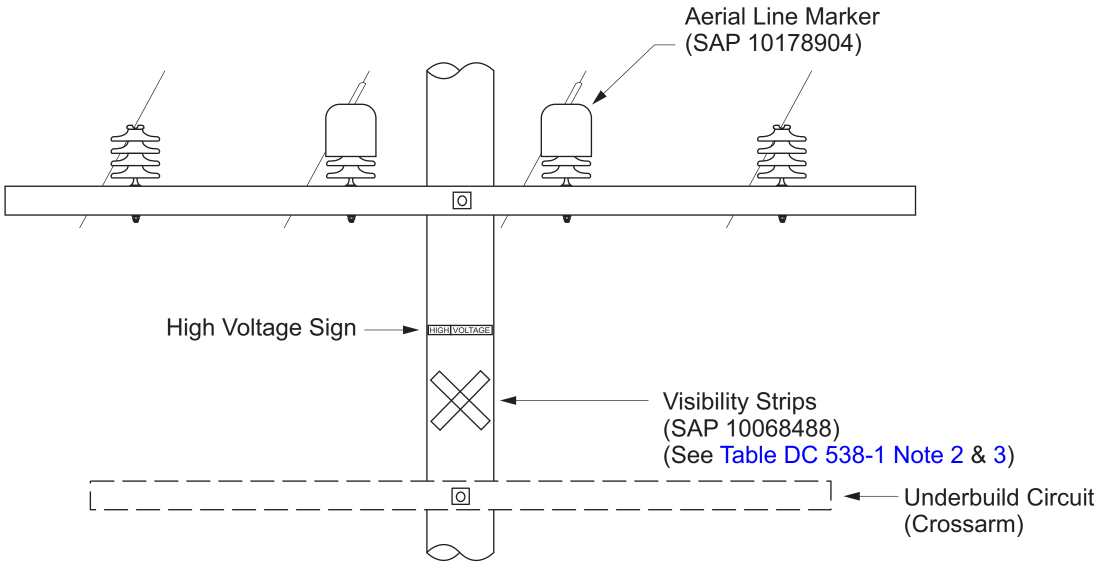
DC 538 Aerial Line Marker

Scope DC 538.1 Aerial Line Marker

Aerial Line Markers (orange-colored hoods) and 'X' Markers (visibility strips configured as an 'X', see Figure DC 538–2) shall be installed on the three distribution poles immediately preceding and following a transmission-distribution line crossing.

Air Ops may designate other locations besides transmission-distribution line crossings where ONLY Aerial Line Markers shall be installed.

Figure DC 538–1: Installation of Aerial Line Marker (Typical)



3-Wire or 4-Wire Construction with Aerial Line Markers

Figure DC 538–2: Distribution Poles that Shall Be Marked at an Overhead Transmission-Distribution Line Crossing

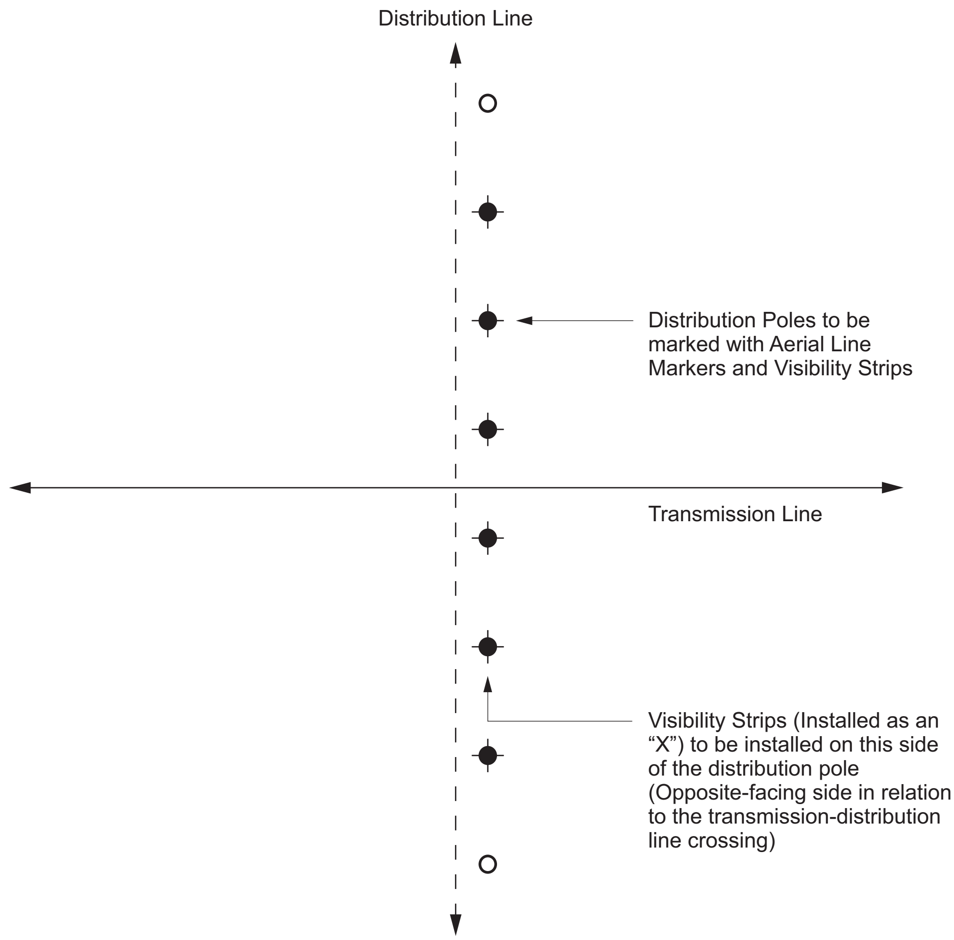
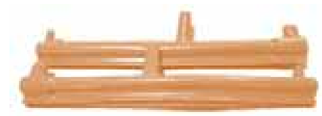


Table DC 538–1: Aerial Line Markers for Distribution Insulators

SAP	Description	Photo
10184087	Cover, Wildlife, Aerial Line Markers, Body, Insulator, Post Type, to be Used with SAP 10178903 Extenders, for Aircraft Operations Visual Aid, Orange Color.	
10184089	Cover, Wildlife, Aerial Line Markers, Body, Insulator, Post and Vice-top Type, to be Used with SAP 10178903 Extenders, for Aircraft Operations Visual Aid, Orange Color.	
10178903	Cover, Wildlife, Aerial Line Markers, Extenders for 60" Coverage, Set of 2, to be Used with SAP 10184087 or SAP 10184089 Body, for Aircraft Operations Visual Aid, Orange Color.	

Note(s):

1. Aerial Line Markers (orange-colored hoods) are only to be installed on distribution poles as agreed upon by Air Ops.
2. Where transmission lines cross over distribution lines, four Visibility Strips (SAP 10068488) shall be installed in an ‘X’ configuration in conjunction with the installation of Aerial Line Markers. The ‘X’ Marker shall be installed on the opposite-facing side of the distribution pole in relation to the transmission-distribution line crossing (see Figure DC 538–2).
3. Air Ops may designate other locations besides transmission-distribution line crossings where ONLY Aerial Line Markers shall be installed. ‘X’ Markers ARE NOT to be used at locations where there are no transmission-distribution line crossings.
4. See PO 120 for HIGH VOLTAGE sign installation requirements.

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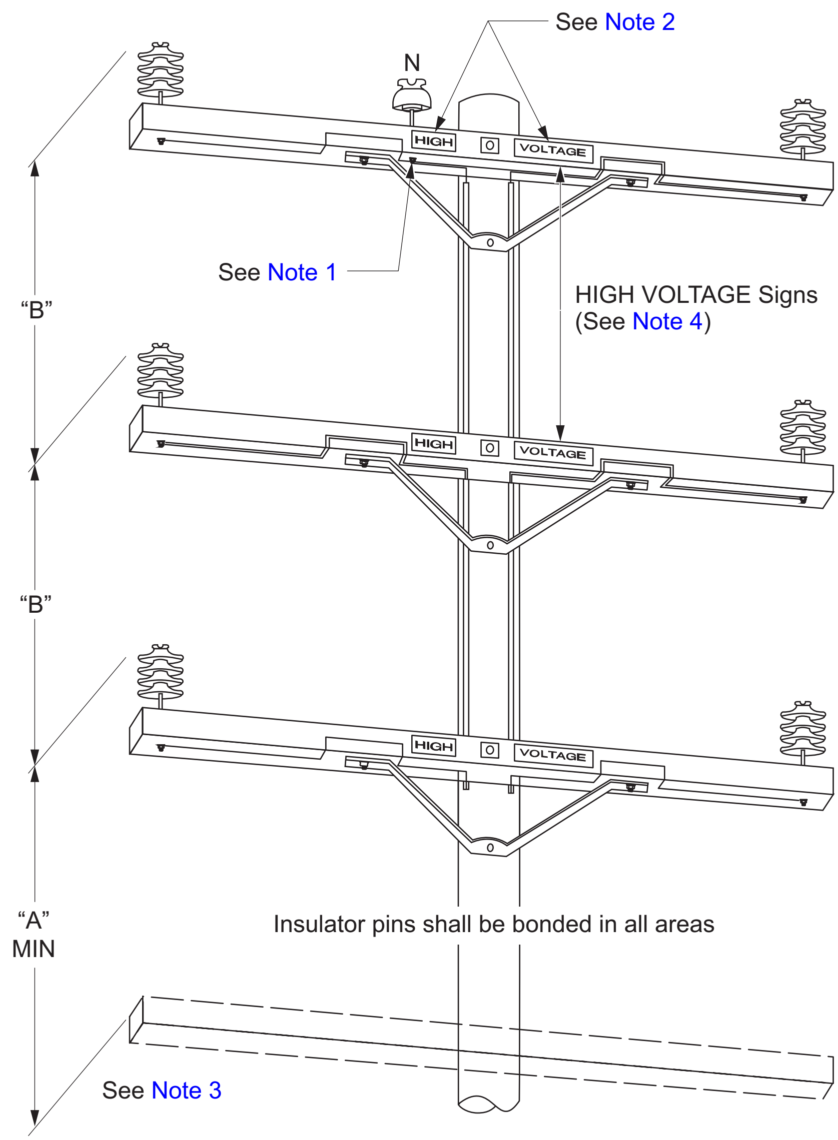
DC 540 12/16/25/33 kV 3/4-Wire Vertical Construction

Scope DC 540.1 Typical Construction for 12/16/25/33 kV 3/4-Wire Vertical Construction

Figure DC 540–1: Typical Construction for 12/16/25/33 kV 3/4-Wire Vertical Construction



Note(s):

1. Bond neutral pin to both circuit bonds except at Grade A crossings, where circuits must be bonded separately. Bond neutral pin to only one (the most convenient) circuit.
2. See PO 120 for HIGH VOLTAGE sign installation requirements.
3. Use flat braces for wire sizes #2 copper or 1/0 ACSR and smaller.
4. See PO Section.
5. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.

Table DC 540–1: Minimum Conductor Spacing for Dimension "A"

Top Circuit kV	Lower Circuit kV		
	0–7.5	**12 or 16**	**25 or 33**
25 or 33	6'	6'	6'
12 or 16	6'[a/ b/]	6'[a/b/]	—

[a/] A 6-foot clearance between primary circuits will be used on new line construction and on pole replacements when minimum sag requirements per CO Section can be maintained.
[b/] Clearance may be reduced to 5 feet on existing installations.

Table DC 540–2: Minimum Conductor Spacing for Dimension "B"

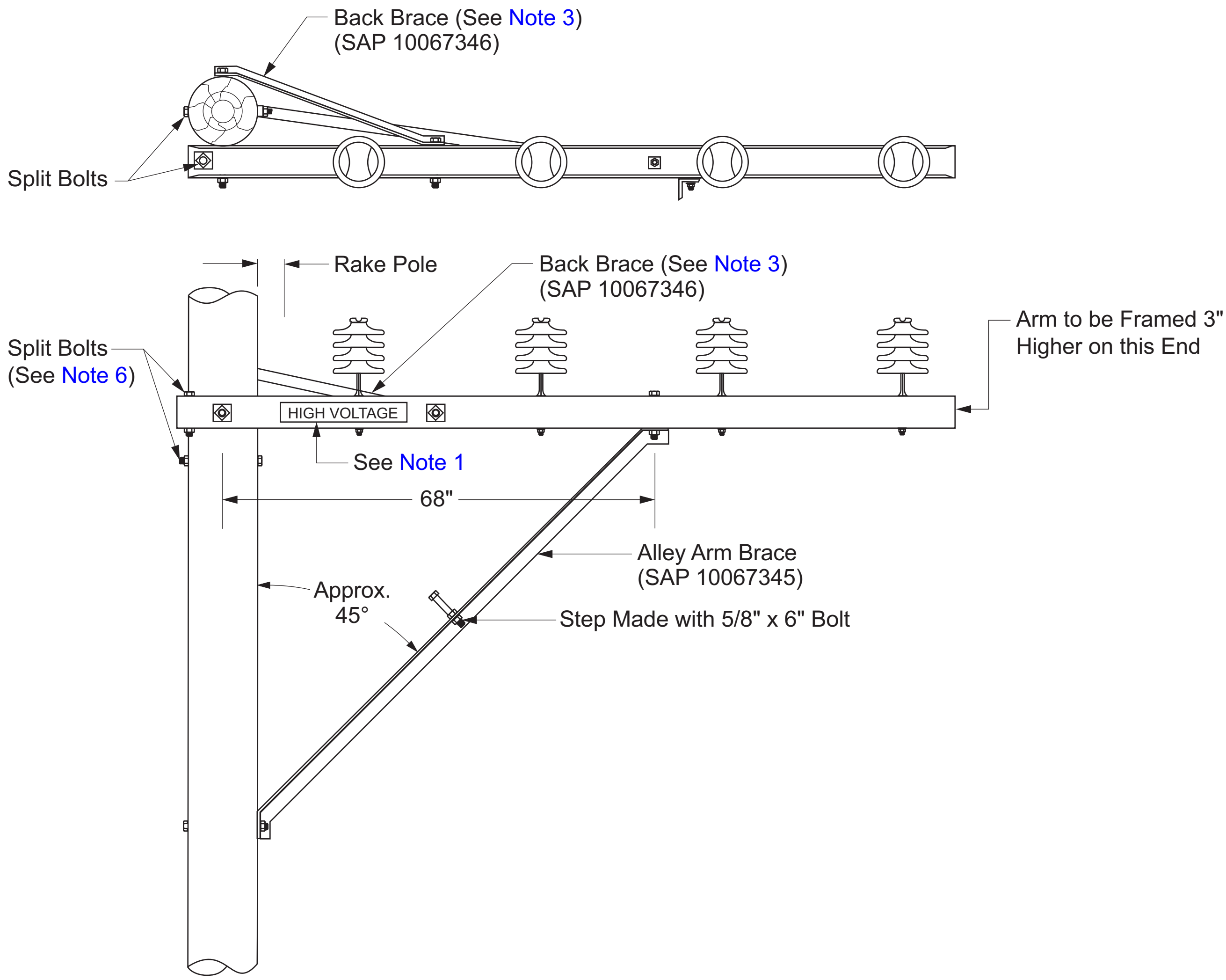
Span Length (ft)	Minimum Conductor Spacing[a/]	
	12/16 kV	**25/33 kV**
0–300	6'-0"[b/]	6'-0"[b/]
301–499	6'-0"[b/]	6'-0"[c/]

[a/] New pole construction, including pole replacements, shall be built to 6-foot clearance between primary circuits when minimum sag requirements (CO Section) can be maintained.
[b/] Clearance may be reduced to 4 feet on existing installations.
[c/] Clearance may be reduced to 5 feet on existing installations.

DC 550 All Distribution Voltages, 3/4-Wire Alley Arm Construction

Scope DC 550.1 All Distribution Voltages, 3/4-Wire Alley Arm Construction

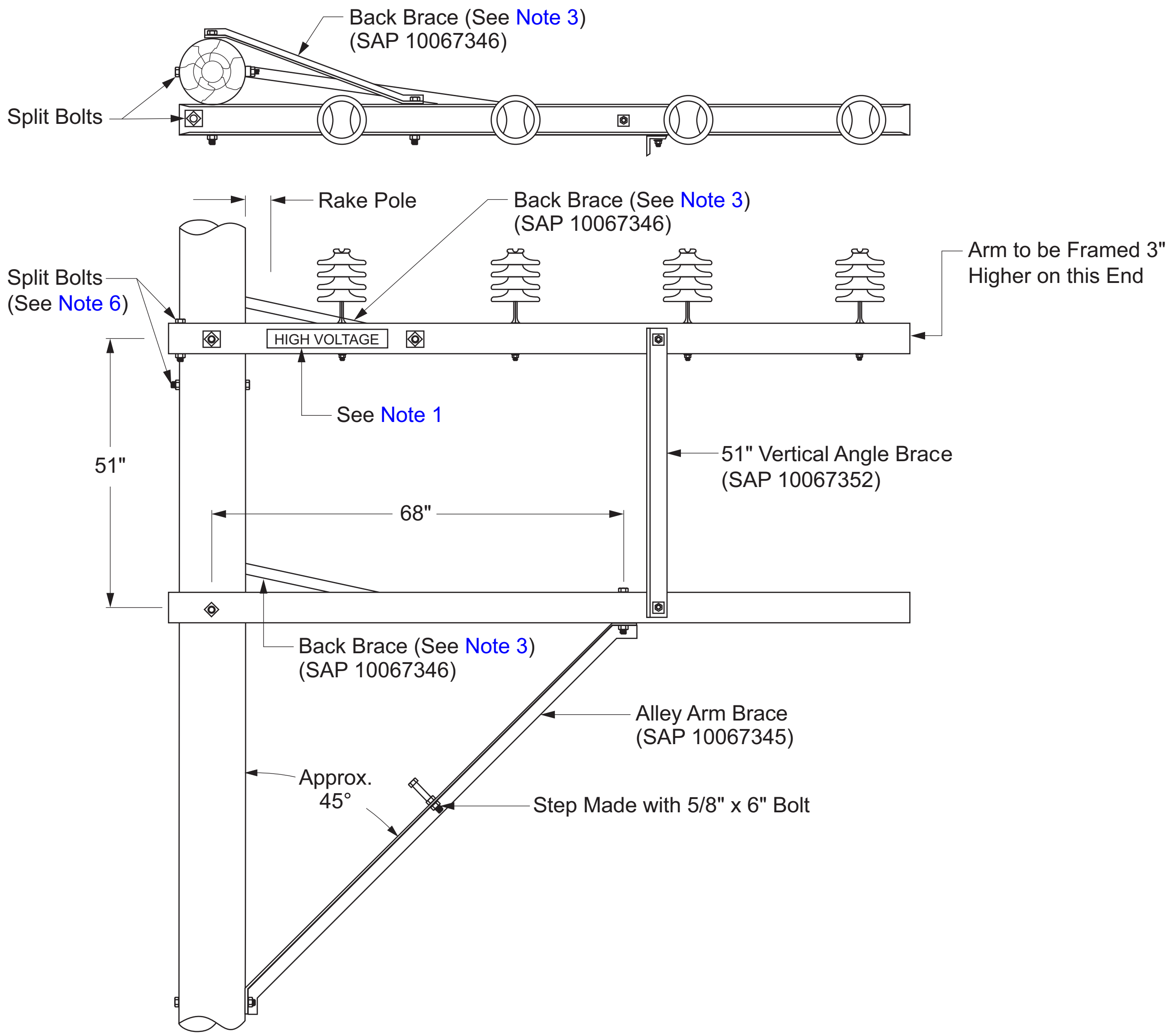
Figure DC 550–1: All Distribution Voltages, 3/4-Wire Alley Arm Construction (Single Arm – Preferred)



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. See DC 575 for limit angles.
3. Use Back Brace on all single Alley Arm installations.
4. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
5. Installation of a working arm should be considered when designing/constructing a pole that does not have bucket truck access.
6. Use split bolts above or below crossarm within 6 inches of through bolt with 336 and 653 ACSR. If a side guy is attached, the guy assembly will function as a split bolt.

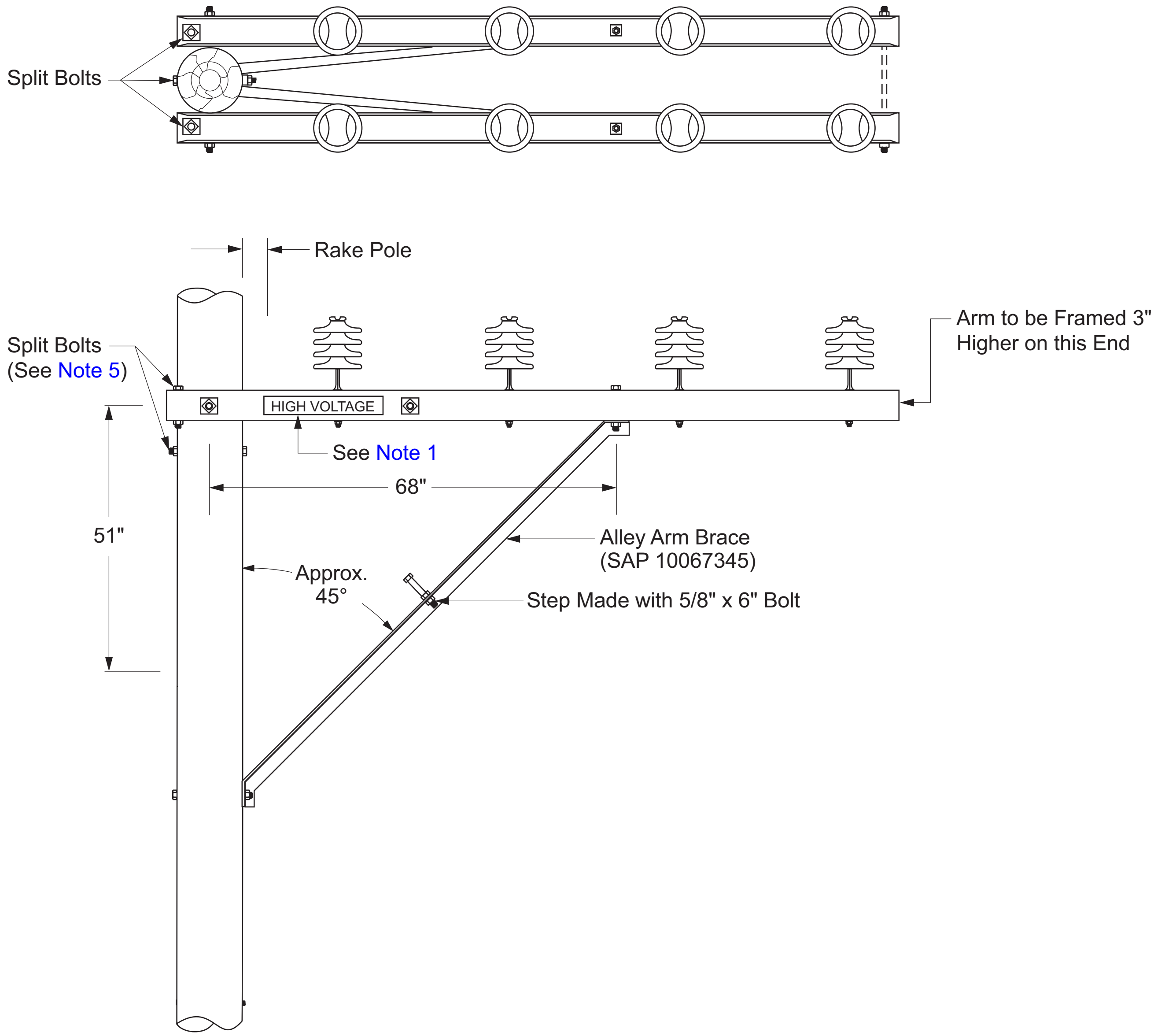
Figure DC 550–2: All Distribution Voltages, 3/4-Wire Alley Arm Construction (Single Arm — Alternate)



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. See DC 575 for limit angles.
3. Use Back Brace on all single Alley Arm installations.
4. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
5. Installation of a working arm should be considered when designing/constructing a pole that does not have bucket truck access.
6. Use split bolts above or below crossarm within 6 inches of through bolt with 336 and 653 ACSR. If a side guy is attached, the guy assembly will function as a split bolt.

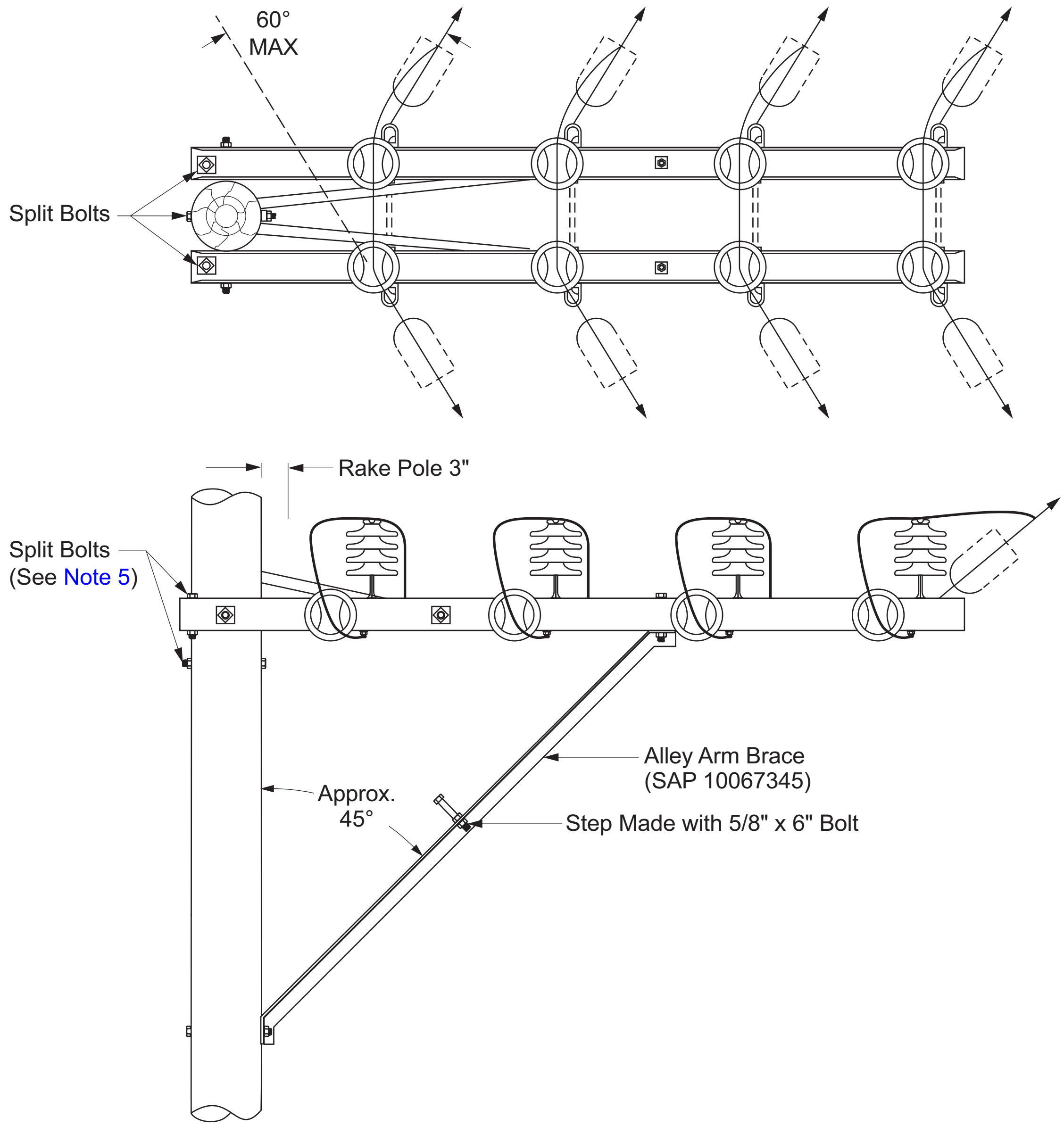
Figure DC 550–3: All Distribution Voltages, 3/4-Wire Alley Arm Construction (Double Arm — Pin and Insulator)



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. See DC 575 for limit angles.
3. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
4. Installation of a working arm should be considered when designing/constructing a pole that does not have bucket truck access.
5. Use split bolts above or below crossarm within 6 inches of through bolt with 336 and 653 ACSR. If a side guy is attached, the guy assembly will function as a split bolt.

Figure DC 550–4: All Distribution Voltages, 3/4-Wire Alley Arm Construction (Double Arm — Double Dead-End)

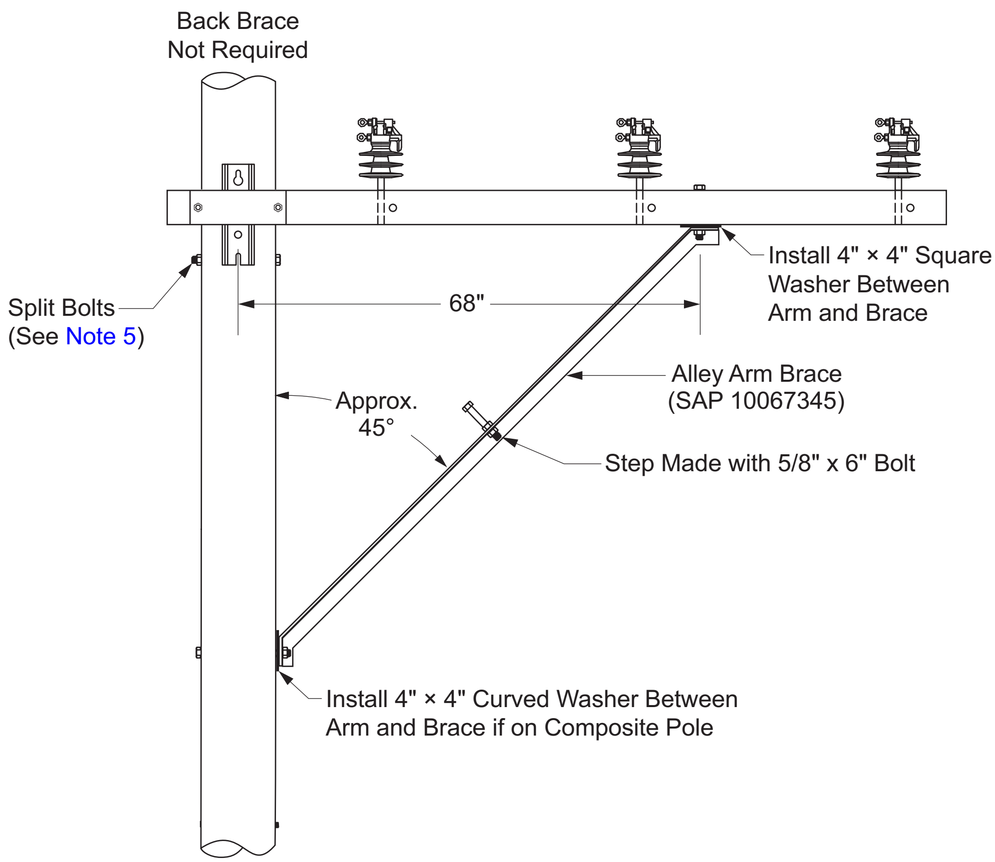


Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. See DC 575 for limit angles.
3. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
4. Installation of a working arm should be considered when designing/constructing a pole that does not have bucket truck access.
5. Use split bolts above or below crossarm within 6 inches of through bolt with 336 and 653 ACSR. If a side guy is attached, the guy assembly will function as a split bolt.

Scope DC 550.2 All Distribution Voltages, 3/4-Wire Composite Alley Arm Construction

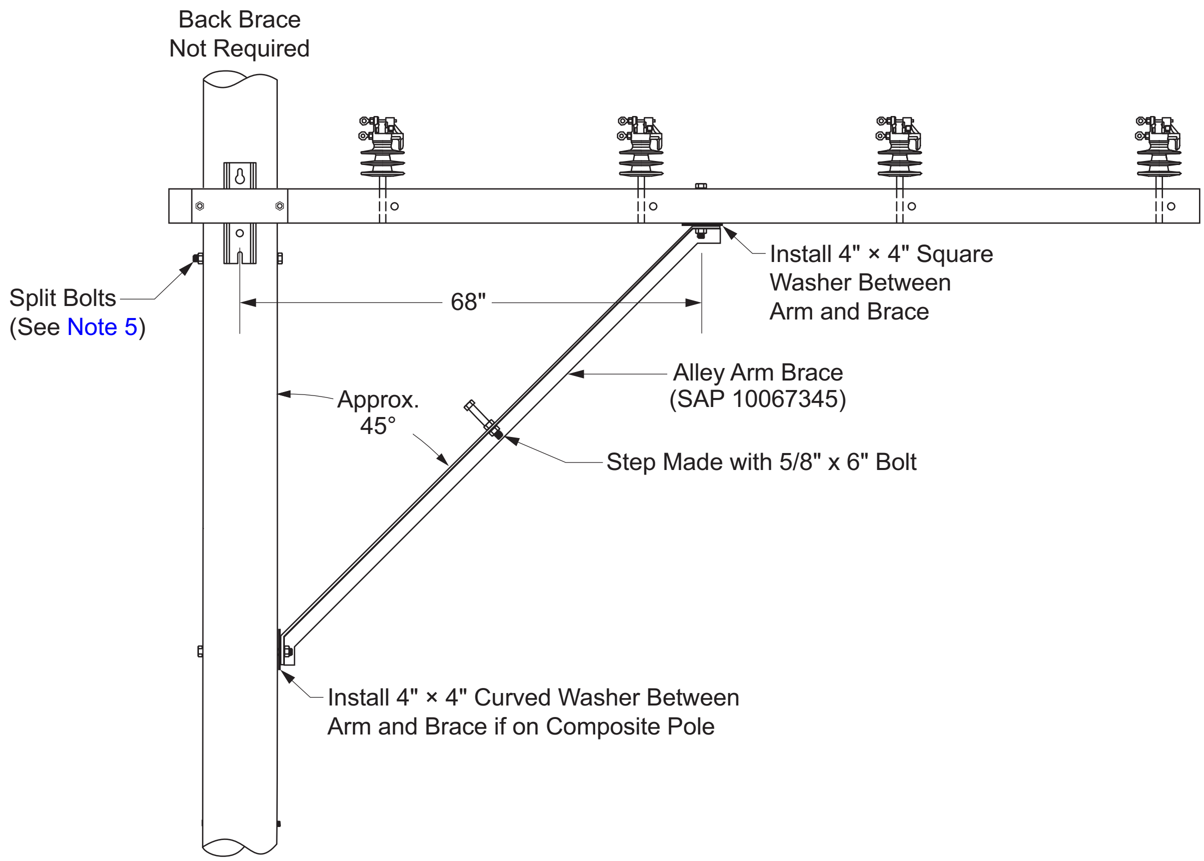
Figure DC 550–5: All Distribution Voltages, 3-Wire Composite Alley Arm Construction — Single 10' Arm



Note(s):

1. See PO 120 for HIGH VOLTAGE sign requirements.
2. See DC 575 for limiting angles.
3. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
4. See Figure DC 550–3 and Figure DC 550–4 for double-arm and double dead-end construction.
5. Use split bolts above or below crossarm within 6 inches of through bolt with 336 and 653 ACSR. If a side guy is attached, the guy assembly will function as a split bolt.

Figure DC 550–6: All Distribution Voltages, 4-Wire Composite Alley Arm Construction — Single 12' Arm



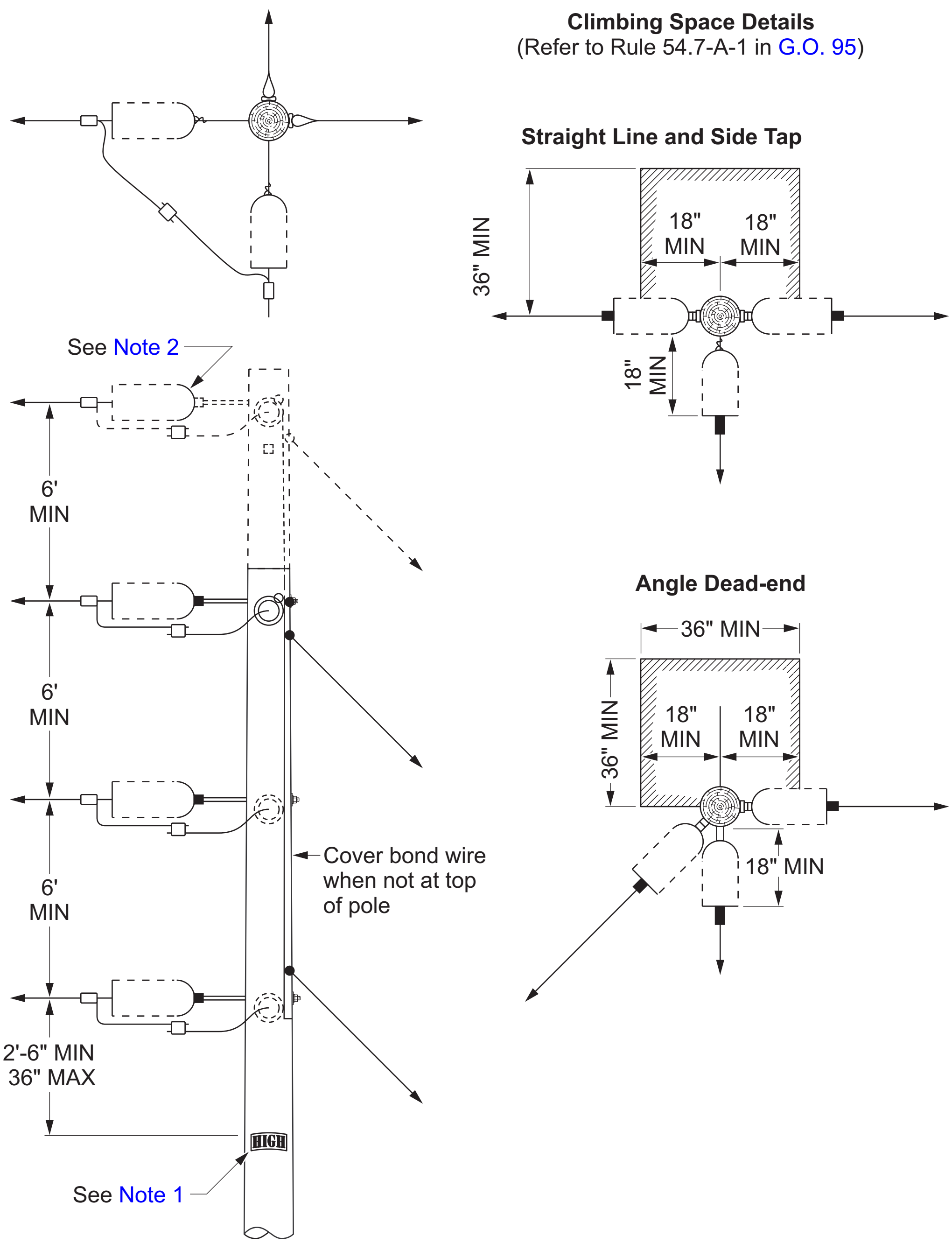
Note(s):

1. See PO 120 for HIGH VOLTAGE sign requirements.
2. See DC 575 for limiting angles.
3. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
4. See Figure DC 550–3 and Figure DC 550–4 for double-arm and double dead-end construction.
5. Use split bolts above or below crossarm within 6 inches of through bolt with 336 and 653 ACSR. If a side guy is attached, the guy assembly will function as a split bolt.

DC 560 12/16/25/33 kV 3/4-Wire Barre Corner Construction

Scope DC 560.1 12/16/25/33 kV 3/4-Wire Barre Corner Construction

Figure DC 560–1: 12/16/25/33 kV 3/4-Wire Barre Corner Construction



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. See GR Section for number and type of insulator in strings.

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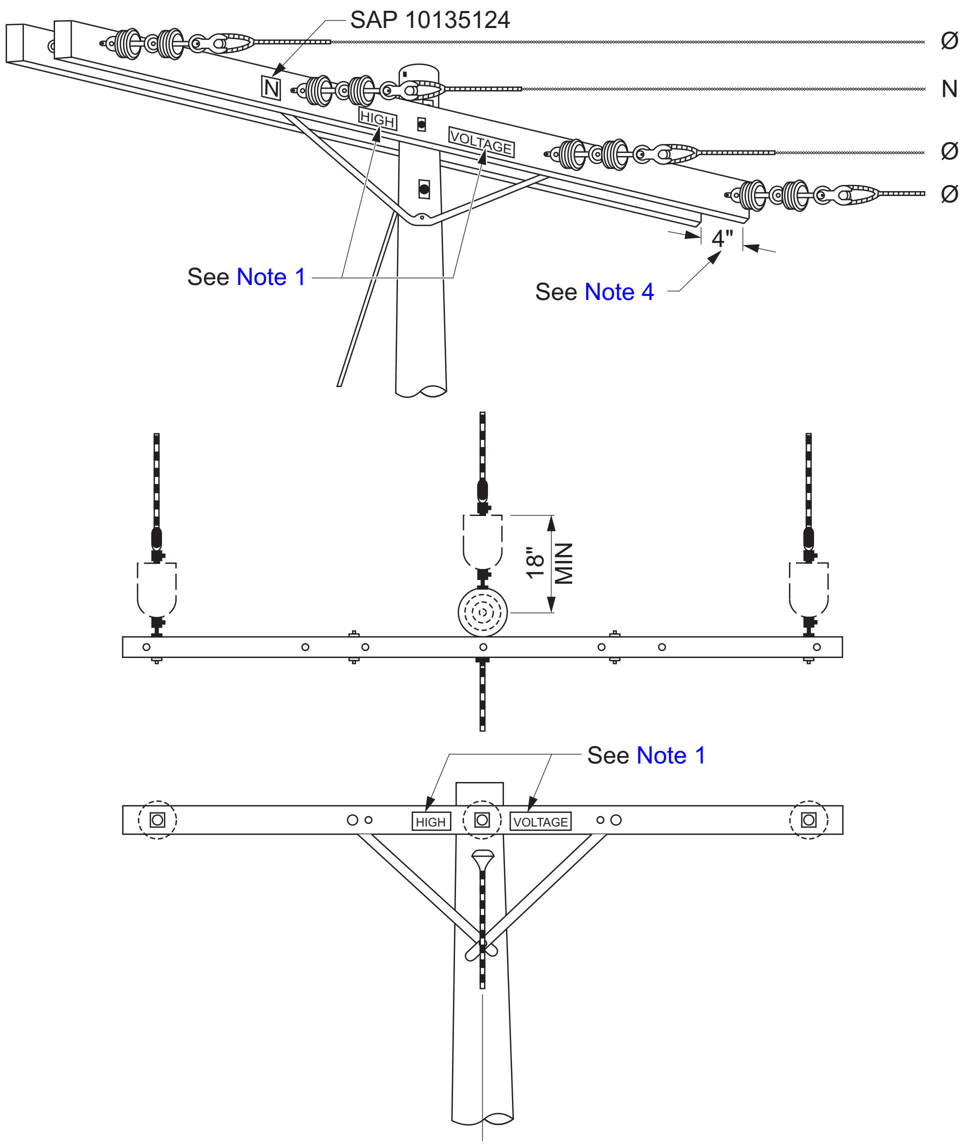
DC 570 4/12/16 kV 3/4-Wire Dead-End Construction

Scope DC 570.1 4/12/16 kV 3/4-Wire Dead-End Construction

Figure DC 570–1: 4/12/16 kV 3/4-Wire Dead-End Construction



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. This construction shall be used only with #6 copper or #4 copper wire in light-loading areas. For larger wire sizes or in heavy-loading areas, crossarms shall be doubled.
3. #4 ACSR is not approved for new construction in light-loading areas.
4. Where crossarm is tripled for dead-ending 653 ACSR with 336 ACSR neutral, move outside Ø in 4 inches to balance arm (arm guys are preferred where possible).
5. For bonding and grounding requirements, number and type of insulators (see GR Section).

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DC 575 12/16/25/33 kV 3/4-Wire Angle Pole Construction

Scope DC 575.1 12/16/25/33 kV 3- or 4-Wire Angle Pole Construction

Figure DC 575–1: Maximum Span 400 Feet — 12/16/25/33 kV 3/4-Wire Angle Pole Construction

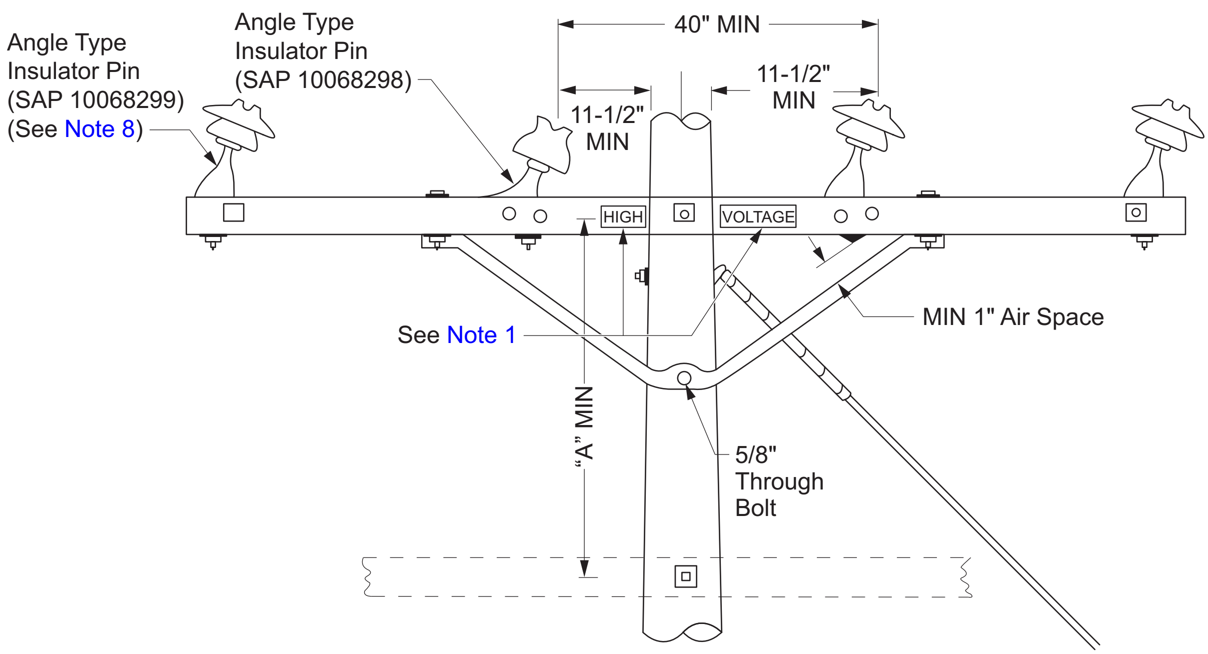


Table DC 575–1: Table for Dimension "A" — 12/16/25/33-kV 3- or 4-Wire Angle Pole Construction

Top Circuit kV	Lower Circuit kV		
	0–7.5	12 or 16	25 or33
25 or33	6'-0"	6'-0"	6'-0"
12 or 16	6'-0"[a/][b/]	6'-0"[a/][b/]	—

[a/] Clearance may be reduced to 5 feet on existing installations.
[b/] For rear property and other inaccessible poles subject to replacement, clearance may be reduced to 5 feet.

Note(s):

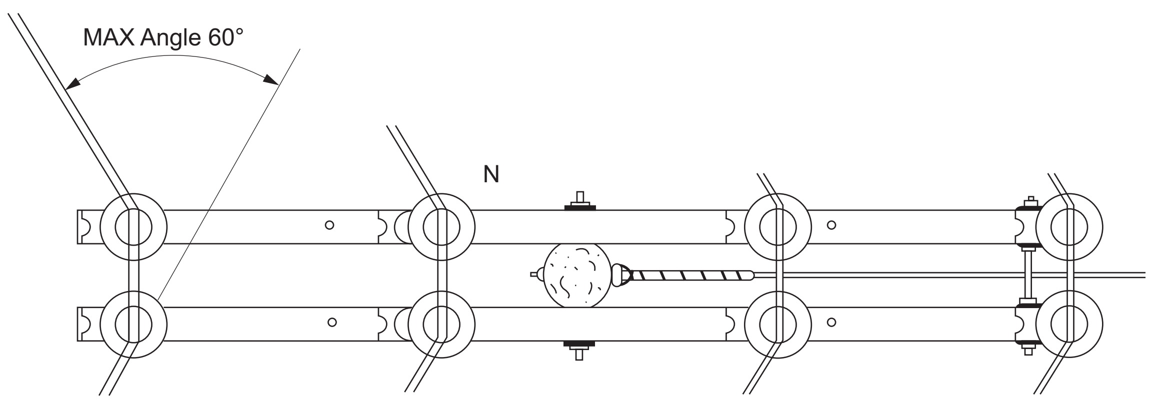
1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. If universal clamps are to be used, see CO Section.
3. Use V-braces for wire sizes larger than #2 copper and 1/0 ACSR.
4. With transmission above, large poles may require one of the following steps to maintain 11-1/2 inches:
   A. Move pin position 3-1/2 inches out. (Maintain 1-inch air space on V-braces by cutting pin-bolt short.)
   B. Use 12-foot predrilled crossarm (SAP 10060209) if angle pins or relocating pins do not provide adequate clearance. A minimum of 32-inch phase clearance is allowable on span lengths of 400 feet or less.

5. Voltage markings as per PO Section.
6. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
7. For 33 kV systems, no fourth wire installation required.
8. Angle Type Insulator Pin (SAP 10068299) is a 1-3/8-inch thread pin. See GR 200 and GR 205 for insulator details.

Table DC 575–2: Limiting Angles and Wire Sizes for Wood and Composite Arms

Conductor Size		Limiting Angle on Arm	
ACSR	Cu	Single Arm	Double Arm
No. 4[a/]	No. 6	45°	60°
No. 2	No. 4	30°	60°
1/0	No. 2	20°	40°
4/0[a/]	2/0	10°	20°
336.4 kcmil	4/0	7°	14°
653.9 kcmil	—	7°	14°

[a/] Not approved for use on new construction.



Note(s):

1. When deviation angle is 60° or less, use double dead-end construction (see DC 580). When deviation angle exceeds 60°, use line and buck “corner” construction.
2. For determination of deviation angle, see DC 585.
3. For bonding, see GR Section.
4. For type of insulator, see GR Section.
5. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
6. The limiting deviation angle is the angle above which side tension exceeds the G.O. 95 Safety Factor for insulators and hardware.

DC 580 12/16/33 kV 3- or 4-Wire Double Dead-End Construction for Wood and Composite Arms

Scope DC 580.1 12/16/33 kV 3- or 4-Wire Double Dead-End Construction for Wood and Composite Arms

1.0 Composite Crossarm Application Criteria

- Tangent and DE composite “crossarm configurations” may be constructed in either single or double configurations.
- Tangent composite crossarms provide greater strength in the vertical direction and are to be applied with insulators installed (pin or post) mounted to the top of the crossarm. Angle pins or angle bases shall only be applicable to tangent composite arms. Angle pins/bases allow a maximum arm width of 4 inches; they will not work on a dead end arm.
- DE composite crossarms provide greater strength in the horizontal directions and shall be used in Dead End configurations per Figure CC 150–2, Figure DC 570–1, where the conductor in full tension is attached to only one side of the crossarm configuration.
- Double dead-end configurations, where the conductor tension is the same on both sides of the arm configuration, tangent composite crossarms are preferred (see Figure CC 150–3, Figure DC 535–9).
- For hill top applications where vertical loads are increased due to a high break over angle, tangent crossarms are preferred where the orientation of the crossarm is in the direction of its maximum strength. In these installations dead end insulators and related construction are preferred to account for the inclination/declination angle at the pole.
- DE or Tangent crossarms may be used in reduced tension spans per detail below, see CO 168 for details on these spans:
  - — DE composite crossarms shall be applied where full tension conductors are attached to the crossarm configuration.
  - — DE composite crossarms are preferred over tangent arms when only reduced tension conductors are attached to the crossarm configuration.

Figure DC 580–1: 12/16/33 kV 3- or 4-Wire Double Dead-End Construction for Wood and Composite Arms

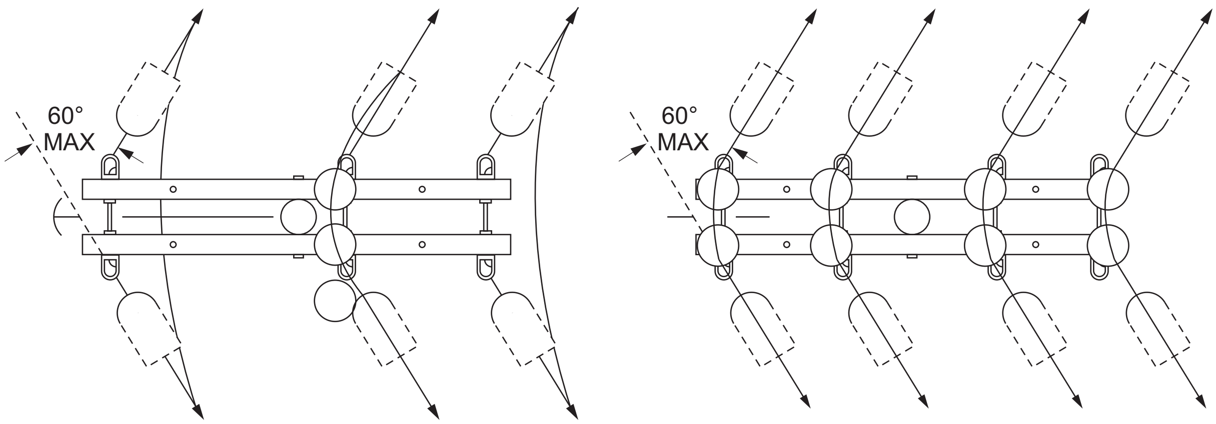
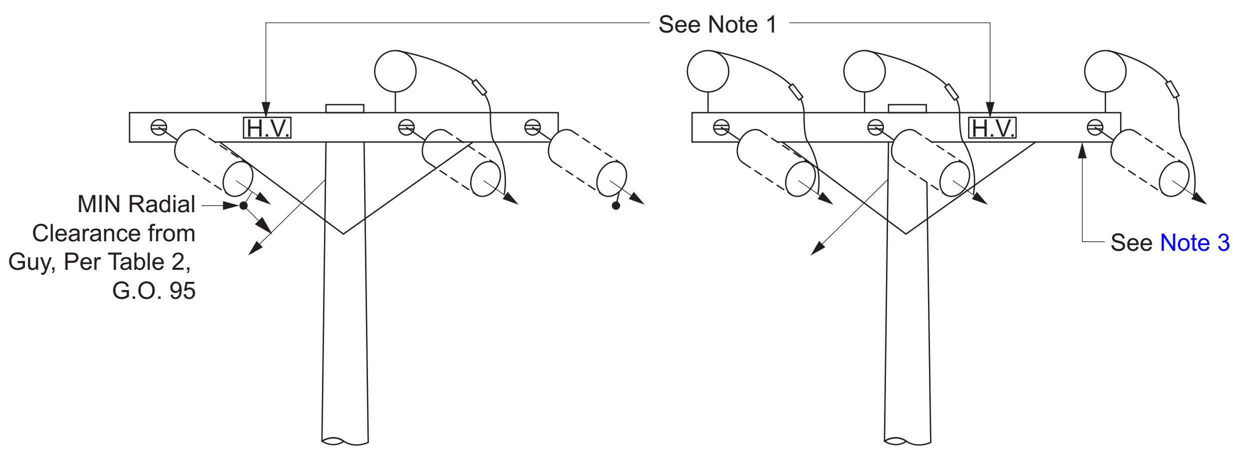


Figure 1 **Figure 2**



Note(s):

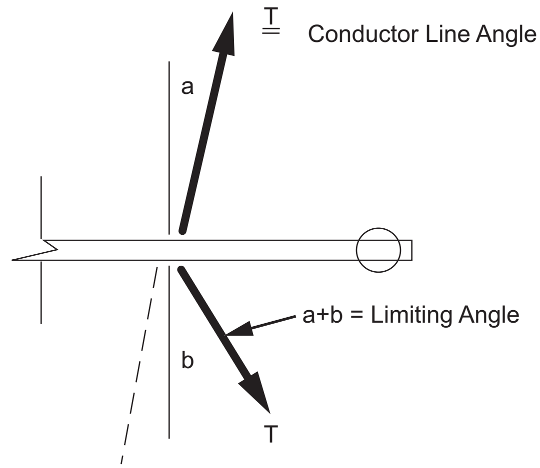
1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Place jumper under arm as in Figure 1 whenever clearance to circuit below is obtainable. If it is not obtainable, Figure 2 may be used.
3. When 33 kV circuits are below 33 kV or higher-voltage circuits, the conductors shall not be less than 24 inches from center of pole to provide climbing space.
4. For dead-end details see CO Section.
5. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.

DC 585 Determination of Deviation Angle

Scope DC 585.1 Determination of Deviation Angle

Limiting Deviation Angle = Angle at which side tension does not exceed G.O. 95 safety factor for insulators and hardware.

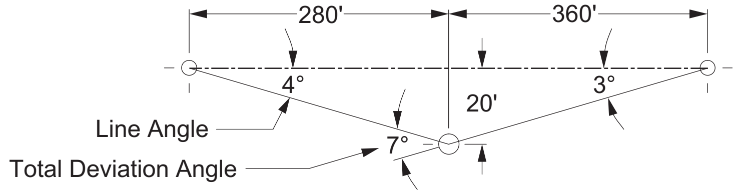
Figure DC 585–1: Determination of Deviation Angle



What's Changed? Removed Table DC 585-1 from this section and moved it to DOH DC 520.

Scope DC 585.2 Determination of Line Angle and Deviation Angle for Use in Switch and Line Pole Angle Determination

Example:



1.0 Problem

For span lengths of 280 feet, and 360 feet and an “out of line” distance of 20 feet, determine the line angle and the total deviation angle.

1.1 Look in the table under a span length of 360 feet for an “out of line” distance CLOSEST to 20 feet (in this case it is 19 feet).

1.2 Look to the left of 19 feet, the line angle is 3°.

1.3 Look in the table under a span length of 280 feet for an “out of line” distance of 20 feet.

1.4 The line angle is 4° for this span.

1.5 The total deviation angle is the SUM of the two line angles 3° + 4° = 7°.

Table DC 585–1: Determination of Line Angle and Deviation Angle for Use in Switch and Line Pole Angle Limitation

DEGREES OF ANGLE / OUT OF LINE DISTANCE

	Span Length (ft)															
	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400
1°	1.5	2.0	2.5	2.8	3.0	3.5	3.8	4.0	4.5	4.8	5.0	5.5	6	6.3	6.6	7
2°	3.5	4.0	5.0	6.0	6.5	7.0	8.0	8.5	9.0	10.0	10.5	11.0	12	12.5	13.0	14
3°	5	6	7.5	8	9.5	10	12	13	14	15	16	17	18	19	20	21
4°	7	8	10.0	11	13.0	14	15	17	18	20	21	22	24	25	27	28
5°	8.5	10	12	14	16	17	19	21	23	25	26	28	30	31	33	35
6°	10.5	13	15	17	19	21	23	25	27	29	32	34	36	38	40	42
7°	12	15	17	20	22	25	27	29	32	34	37	39	42	44	47	49
8°	14	17	19	22	25	28	31	34	37	39	42	45	48	51	53	56
9°	16	19	22	25	29	32	35	38	41	44	48	51	54	57	60	63
10°	18	21	25	28	32	35	39	42	46	49	53	56	60	63	67	71
11°	19	23	27	31	35	39	43	47	51	54	58	62	66	70	74	78
12°	21	26	30	34	38	43	47	51	55	60	64	68	72	77	81	85
13°	23	28	32	37	42	46	51	55	60	65	69	74	78	83	88	92
14°	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
15°	27	32	38	43	48	54	59	64	70	75	80	86	91	96	102	107
16°	29	34	40	46	52	57	63	69	75	80	86	92	97	103	109	115
17°	31	37	43	49	55	61	67	73	79	86	92	98	104	110	116	122
18°	32	39	45	52	58	65	71	78	84	91	97	104	110	117	123	130
19°	34	41	48	55	62	69	76	83	90	96	103	110	117	124	131	138
20°	36	44	51	58	66	73	80	87	95	102	109	116	124	131	138	146
21°	38	46	54	61	69	77	84	92	100	107	115	123	131	138	146	154
22°	40	48	57	65	73	81	89	97	105	113	121	129	137	145	154	162
23°	42	51	59	68	76	85	93	102	110	119	127	136	144	153	161	170
24°	45	53	62	71	80	89	98	107	116	125	134	142	151	160	169	178
25°	47	56	65	75	84	93	103	112	121	131	140	149	159	168	177	187
26°	49	59	68	78	88	98	107	117	127	137	146	156	166	176	185	195
27°	51	61	71	82	92	102	112	122	132	143	153	163	173	183	194	204
28°	53	64	74	85	96	106	117	128	138	149	160	170	181	191	202	213
29°	55	67	78	89	100	111	122	133	144	155	166	177	188	200	211	222
30°	58	69	81	92	104	115	127	139	150	162	173	185	196	208	219	231

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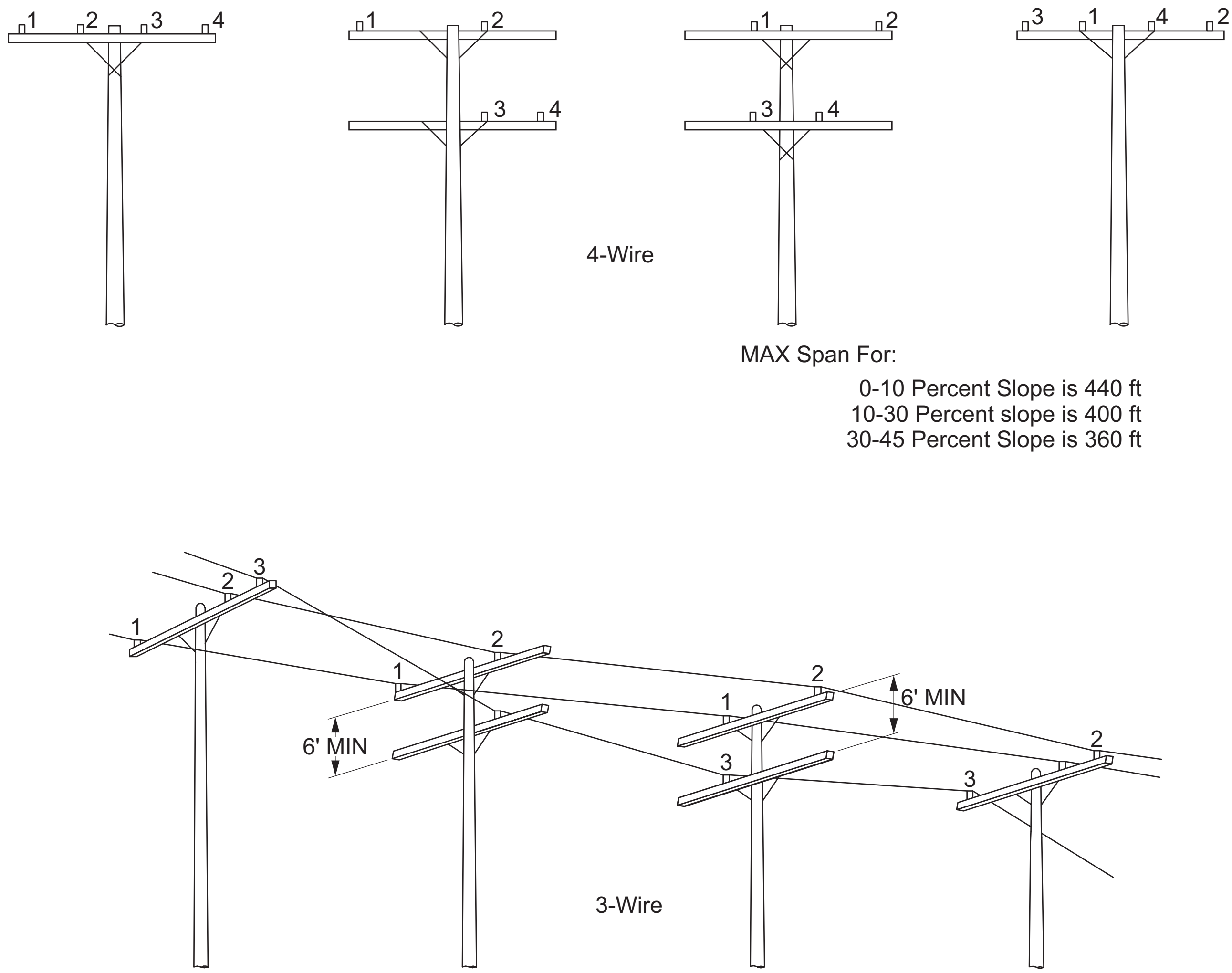
DC 586 3- and 4-Wire Transposition and Transition Construction

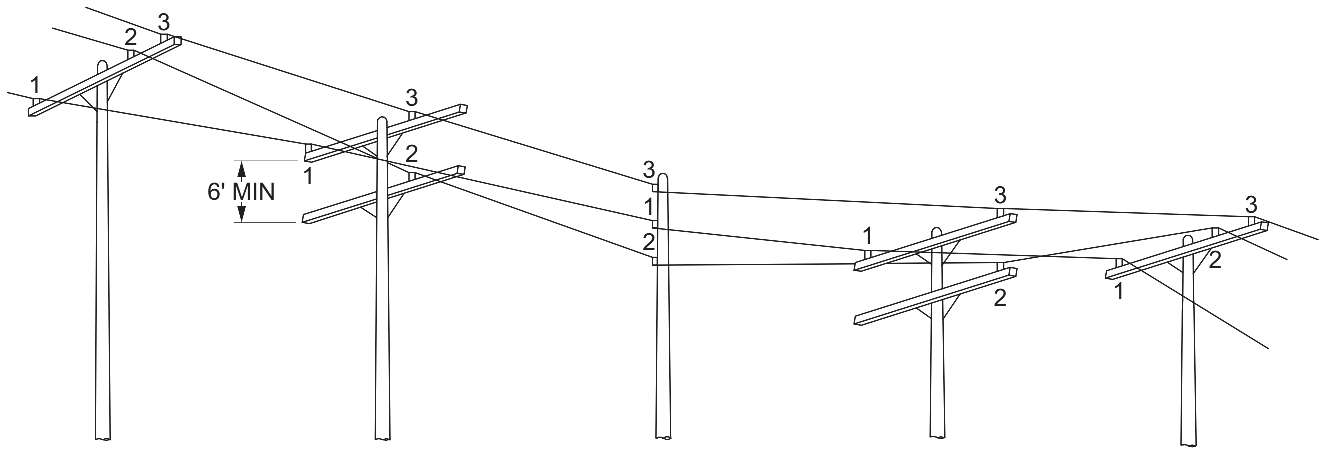
Scope DC 586.1 3- and 4-Wire Transposition Construction

Figure DC 586–1: 3- and 4-Wire Transposition Construction

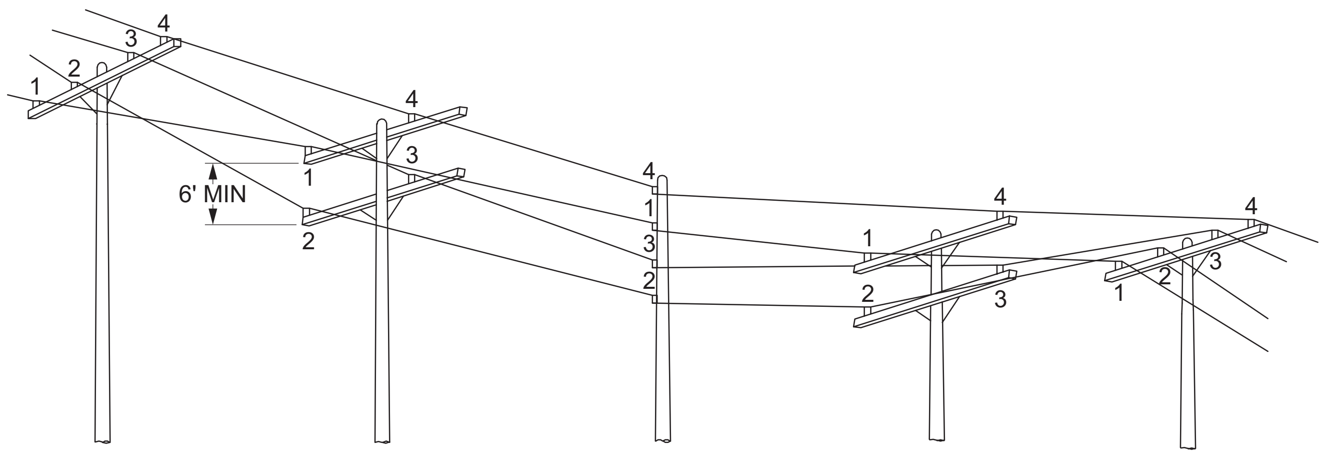


Scope DC 586.2 3- and 4-Wire Transition Construction

Figure DC 586–2: 3- and 4-Wire Transition Construction



3-Wire

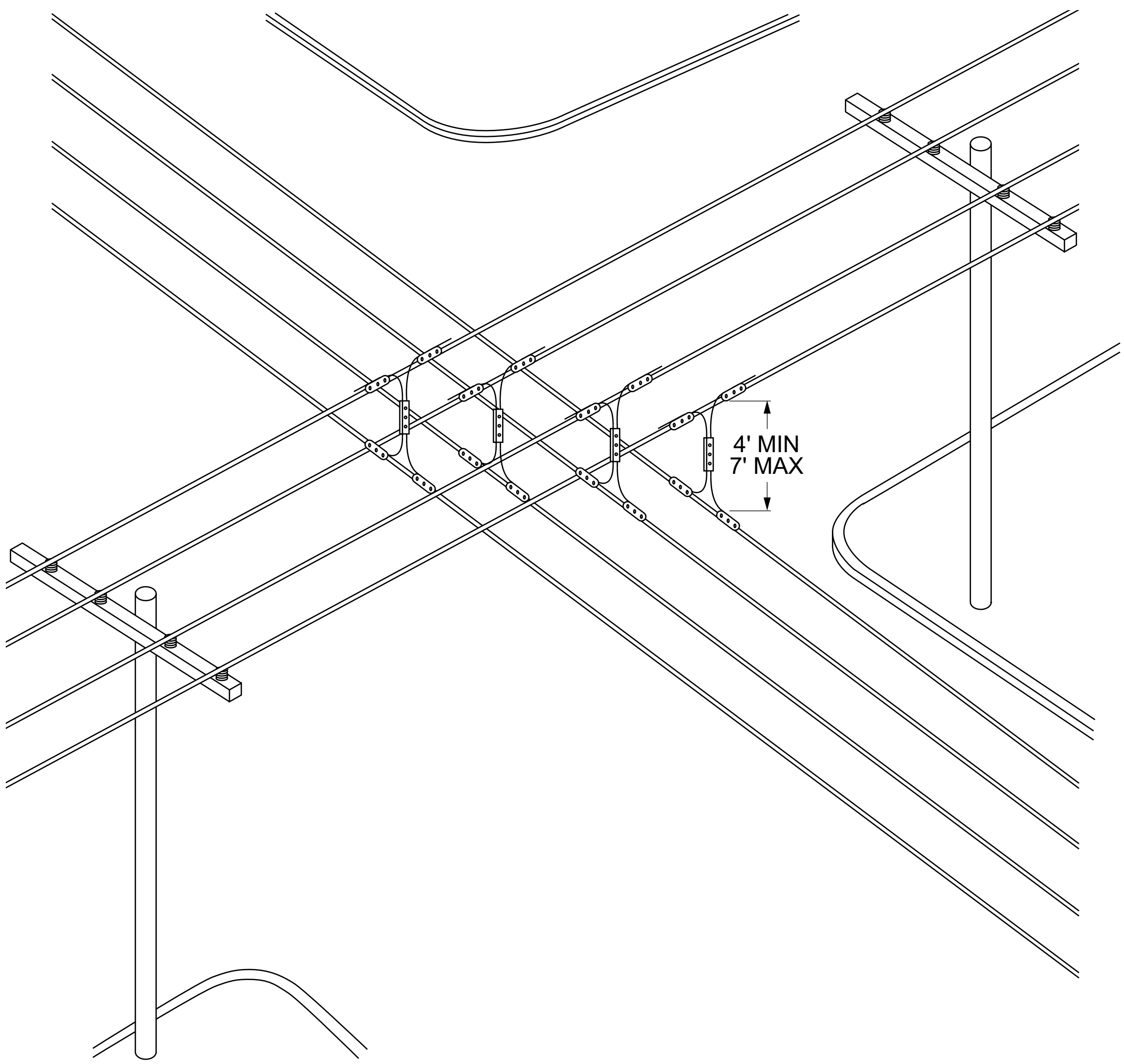


4-Wire

DC 590 Mid-Span Tap Construction

Scope DC 590.1 Mid-Span Tap Construction

Figure DC 590–1: Mid-Span Tap Construction



Note(s):

1. Not to be used in excessive windy areas.
2. Maximum span length in either direction — 300 feet.
3. Minimum line conductor size 1/0 ACSR or 2-Strand copper.

DC 605 Distribution Circuits — High Fire Risk Area Requirements

Scope DC 605.1 2.4 kV through 33 kV Special Overhead Construction Line Requirements for Areas Affected by Dispatchers High Fire Risk

High Fire Risk Areas (HFRA) are basically established by the U.S. Forest Service and the California Division of Forestry, and are outlined by maps maintained by each Customer Service Center. These areas are in two categories: (1) primary watershed areas (forestry areas) and (2) secondary watershed areas and grazing lands. In addition, some high-brush or grass-covered areas may be specified by local fire authorities as high fire-hazard areas.

System Operating Bulletin No. 322 covers the operation of Edison high-voltage circuits in HFRA and is put into effect by the Regional Operations Manager or his/her representative during dry seasons, or at any time the construction and maintenance standards for distribution circuits have been established by the Company, in cooperation with governmental agencies.

1.0 Connectors

All primary line connections shall be bolted wedge connectors where work methods and tooling permit safe installation.

2.0 Transformers

All distribution transformers may be used with the exception of Current and Surge Protected (CSP-type) transformers.

3.0 Avian Protection

See DC 535 for avian protection.

4.0 Fusing 2.4 kV, 4.16 kV, 4.8 kV, 12 kV, 16 kV, 25 kV, and 33 kV (See DAP, and PR Section.)

4.1 Only current-limiting fuses such as the Fault Tamer, X-Limiter, and ELF, and SMU-20 fuses are allowed. See the PR Section for specific fusing requirements.

4.2 For switched or fixed capacitor bank installations, only SMU-20 fuses are allowed (see PR 140).

Scope DC 605.2 Typical Distribution Circuits — Bulletin 322 Requirement

5.0 Poles

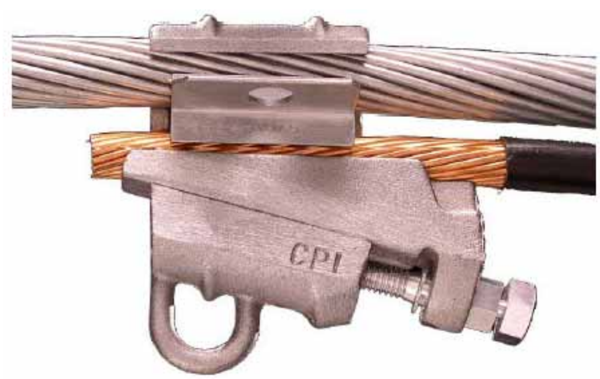
5.1 Firebreak clearings will be maintained around working poles[1/] in primary watershed areas from January 1 to December 31 each year, and around working poles in secondary watershed areas from May 1 to December 31 each year, in accordance with the Power Line Fire Prevention Field Guide and the Customer Service Department Operations and Maintenance Policy and Procedures Manual.

5.2 Fire plating, or fire retardant treatment, may be done at the discretion of the Regional Operation Manager or his/her representative.

The exceptions to the above are listed below and are not considered “Working Poles.” Also, they do not require firebreak clearing.

- Line poles, where conductors are continuous, and any primary ground connections made with bolted wedge connectors
- Dead-end or corner poles with no taps or connections
- Dead-end or corner poles with taps or connections made with bolted wedge connectors

Figure DC 605–1: Bolted Wedge Connectors

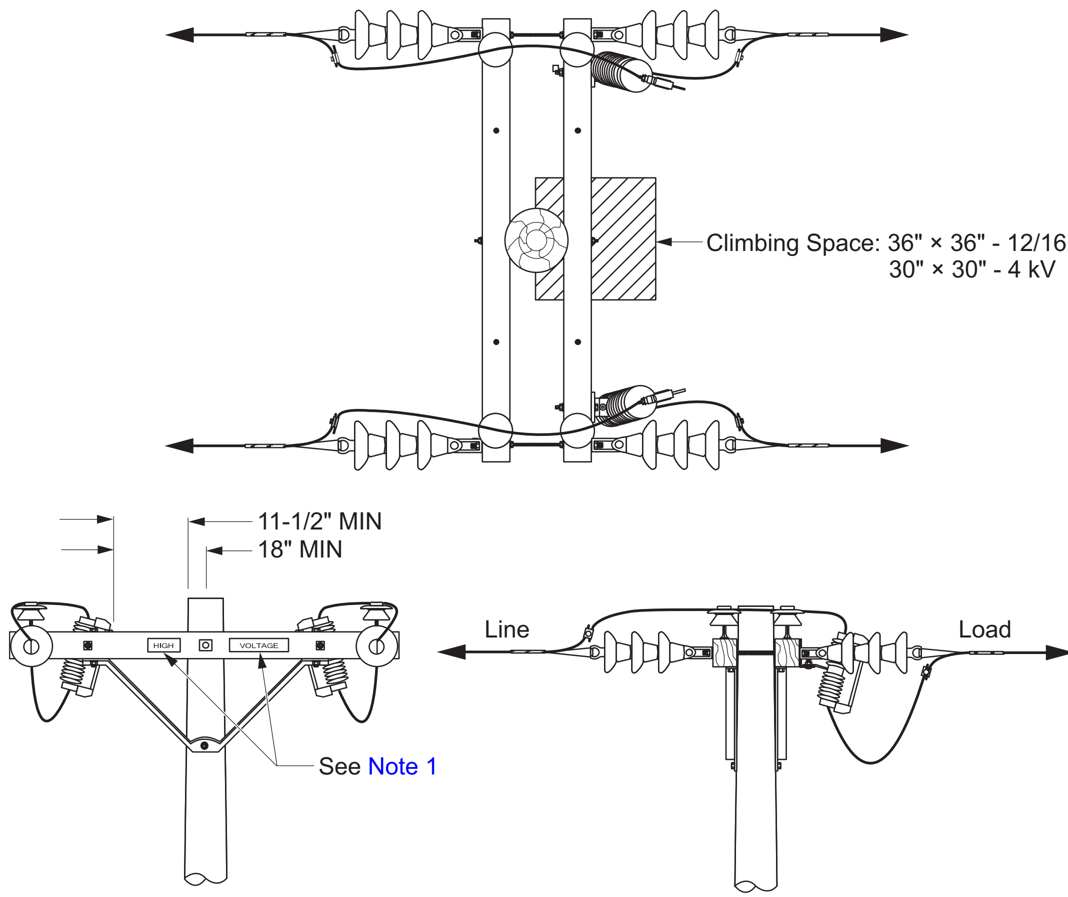


[1/] The term “Working Pole,” means any pole (or tower) with switches, fuses, transformers, surge arresters, dead-ends or corner poles (with taps), or poles with connections other than bolted wedge connectors.

DC 610 4/12/16 kV OH Branch Line Fusing

Scope DC 610.1 Typical Branch Fuse Construction for 1Ø Double Dead-End Straight Line Pole

Figure DC 610–1: 5/8/10-Foot Single or Double Arm Construction

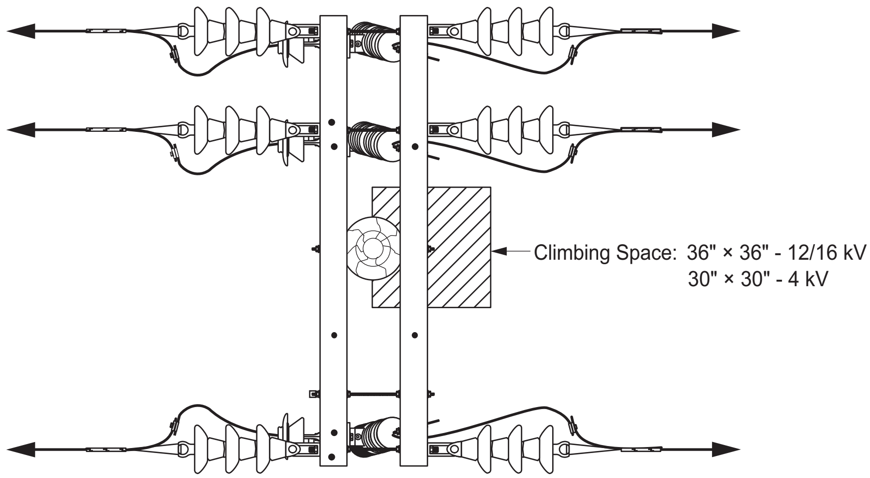


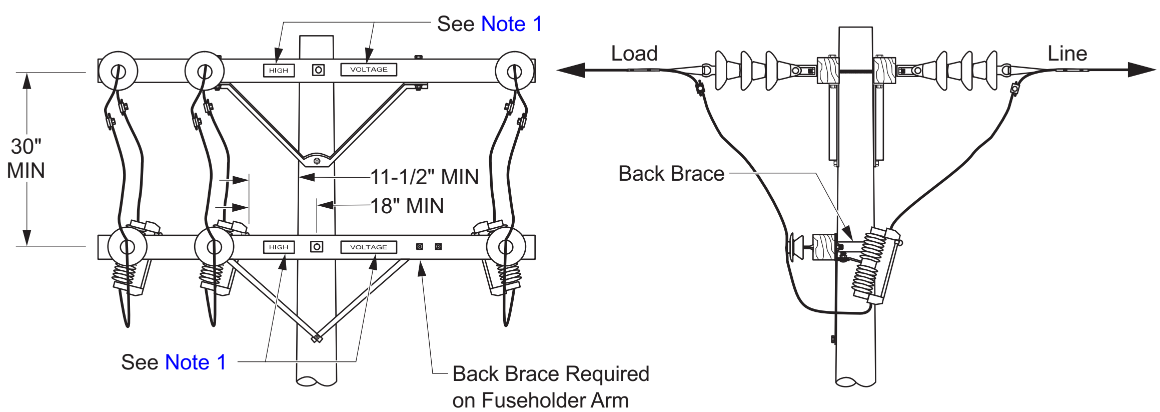
Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Maintain minimum climbing/working space clearances.
   A. Centerline of pole to fuseholder — 18 inches MIN 12/16 kV
   B. Face of pole to fuseholder — 11-1/2 inches MIN 12/16 kV
   C. Centerline of pole to fuseholder — 15 inches MIN 4 kV
   D. Face of pole to fuseholder — 8-1/2 inches MIN 4 kV
3. Lead wire, taps, jumpers, and so on, must maintain a six-inch (minimum) distance from crossarm surfaces and hardware.
4. Bonding and bonded hardware must maintain 1-1/2 inch clearance from unbonded hardware.
5. Clearance pins and insulators may be necessary for over or under arm taps.
6. Line conductors shall connect to the top/line side of the fuseholder. Load conductors shall connect to the bottom/load side of the fuseholder.
7. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
8. Surge Arresters shall be installed when covered conductors are used (see CC 130).

Scope DC 610.2 **Typical Branch Fuse Construction for 3Ø Double Dead-End Straight Line Pole Construction**

Figure DC 610–2: 10-Foot Single or Double Crossarm Construction



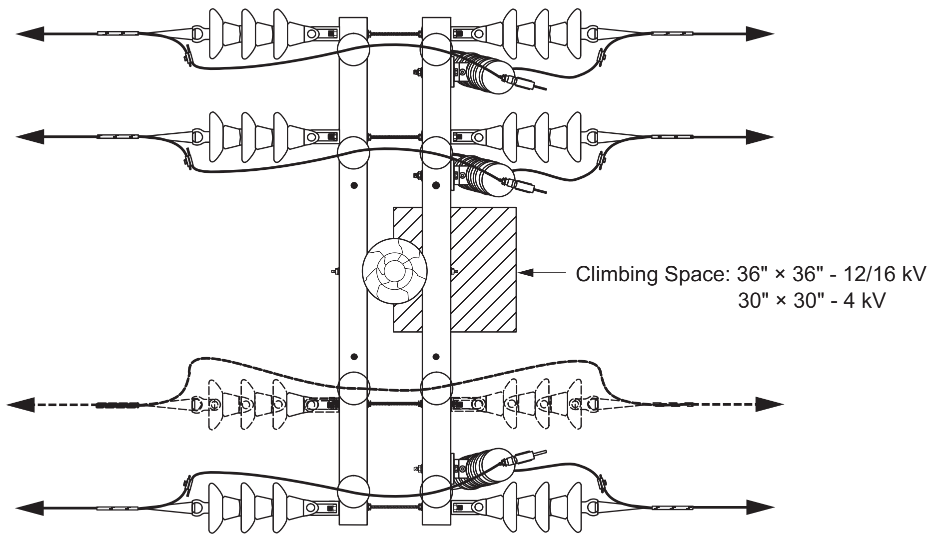


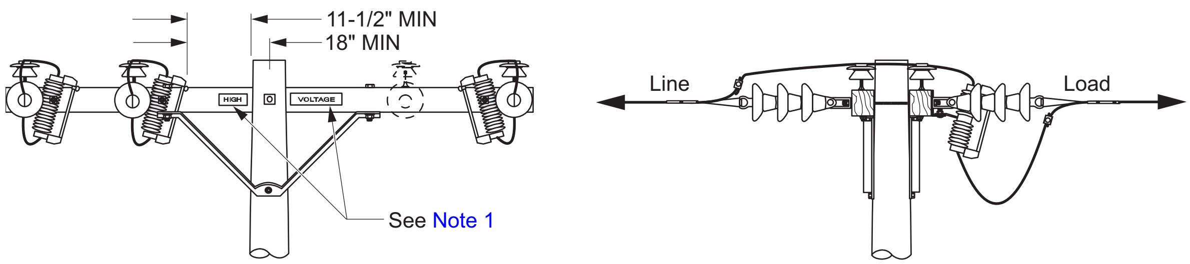
Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Maintain minimum climbing/working space clearances.
   A. Centerline of pole to fuseholder — 18 inches MIN 12/16 kV
   B. Face of pole to fuseholder — 11-1/2 inches MIN 12/16 kV
   C. Centerline of pole to fuseholder — 15 inches MIN 4 kV
   D. Face of pole to fuseholder — 8-1/2 inches MIN 4 kV
3. Lead wire, taps, jumpers, and so on must maintain a six-inch minimum distance from crossarm surfaces and hardware.
4. Bonding and bonded hardware must maintain 1-1/2-inch clearance from unbonded hardware.
5. Clearance pins and insulators may be necessary for over or under arm taps.
6. Line conductors shall connect to the top/line side of the fuseholder. Load conductors shall connect to the bottom/load side of the fuseholder.
7. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
8. Surge Arresters shall be installed when covered conductors are used (see CC 130).

Scope DC 610.3 Typical Branch Fuse Construction for 3Ø 3/4 Wire Double Dead-End Straight Line Pole Construction

Figure DC 610–3: 12-Foot Single or Double Crossarm Construction



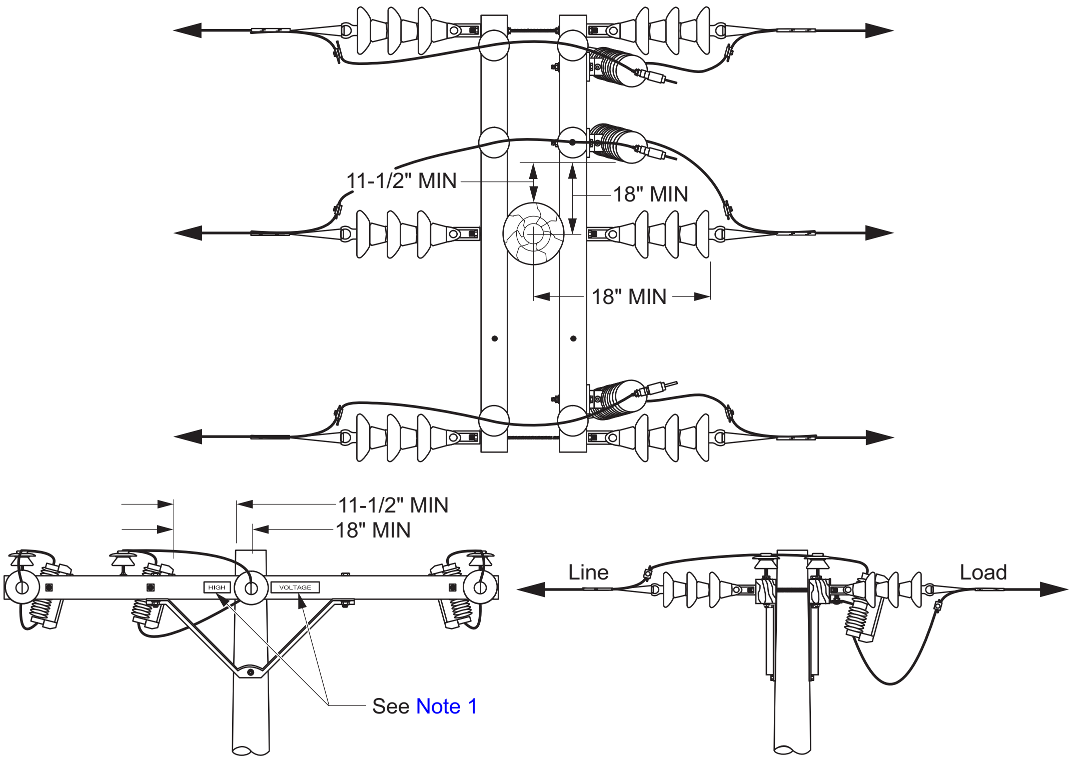


Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Maintain minimum climbing/working space clearances.
   A. Centerline of pole to fuseholder — 18 inches MIN 12/16 kV
   B. Face of pole to fuseholder — 11-1/2 inches MIN 12/16 kV
   C. Centerline of pole to fuseholder — 15 inches MIN 4 kV
   D. Face of pole to fuseholder — 8-1/2 inches MIN 4 kV
3. Lead wire, taps, jumpers, and so on must maintain a six-inch minimum distance from crossarm surfaces and hardware.
4. Bonding and bonded hardware must maintain 1-1/2-inch clearance from unbonded hardware.
5. Clearance pins and insulators may be necessary for over or under arm taps.
6. Line conductors shall connect to the top/line side of the fuseholder. Load conductors shall connect to the bottom/load side of the fuseholder.
7. A 10-foot crossarm cannot be used in this configuration and maintain minimum General Order (G.O.) 95 clearances.
8. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
9. A 12-foot crossarm is applicable with an underground riser. Refer to DUG TP 209-6.
10. Surge Arresters shall be installed when covered conductors are used (see CC 130).

Scope DC 610.4 Typical 12/16 kV Branch Fuse Construction for 3Ø Centerline Double Dead-End Straight Line Pole Construction — Top of Pole Only — 3-Wire Construction

Figure DC 610–4: 10-Foot Single or Double Arm Construction

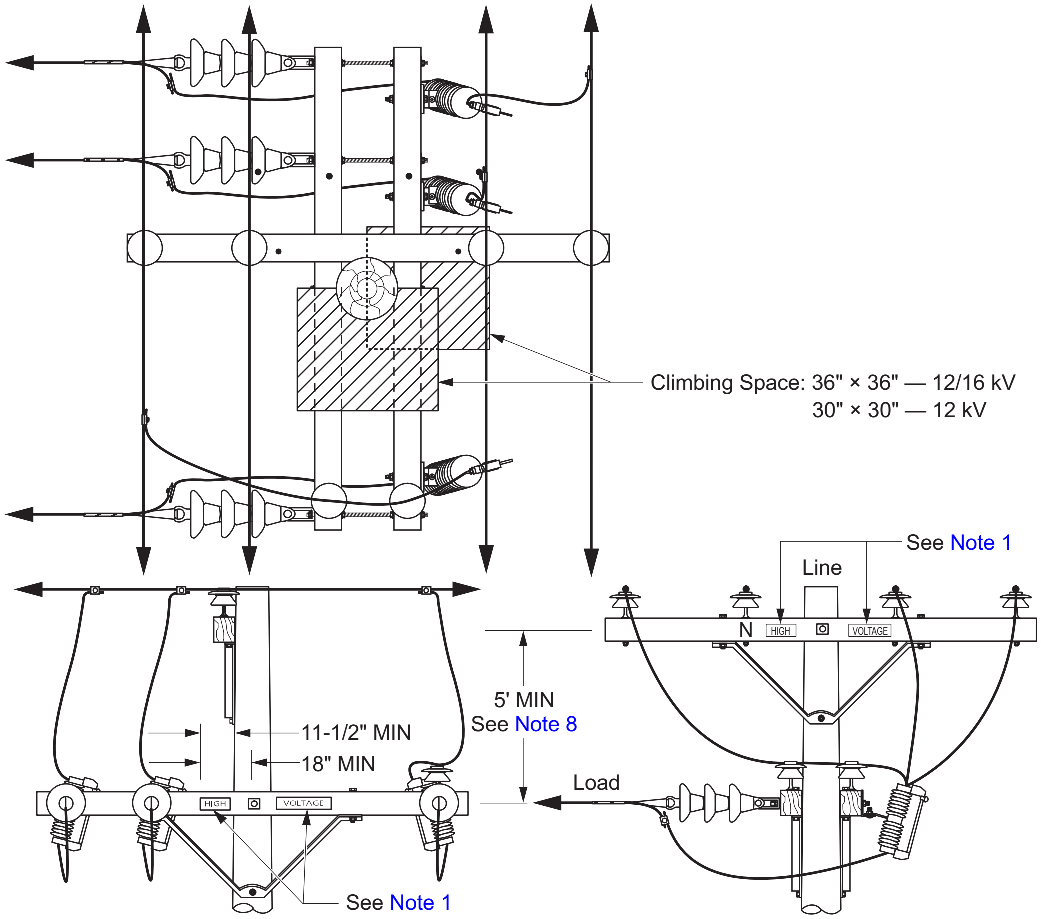


Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Maintain minimum climbing/working space clearances.
   A. Centerline of pole to fuseholder — 18 inches MIN 12/16 kV
   B. Face of pole to fuseholder — 11-1/2 inches MIN 12/16 kV
3. Lead wire, taps, jumpers, and so on must maintain a minimum of six-inch distance from crossarm surfaces and hardware.
4. Bonding and bonded hardware must maintain 1-1/2-inch clearance from unbonded hardware.
5. Clearance pins and insulators may be necessary for over or under arm taps.
6. Line conductors shall connect to the top/line side of the fuseholder. Load conductors shall connect to the bottom/load side of the fuseholder.
7. If a 10-foot crossarm is installed it is necessary to move the center phase to the center pole position to maintain required G.O. 95 clearances.
8. No climbing space is required for top of pole construction.
9. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
10. This configuration is not applicable for an underground riser.
11. Surge Arresters shall be installed when covered conductors are used (see CC 130).

Scope DC 610.5 Typical Branch Fuse Construction for 1Ø/3Ø Break-Off Pole

Figure DC 610–5: 10-Foot Single or Double Arm Construction

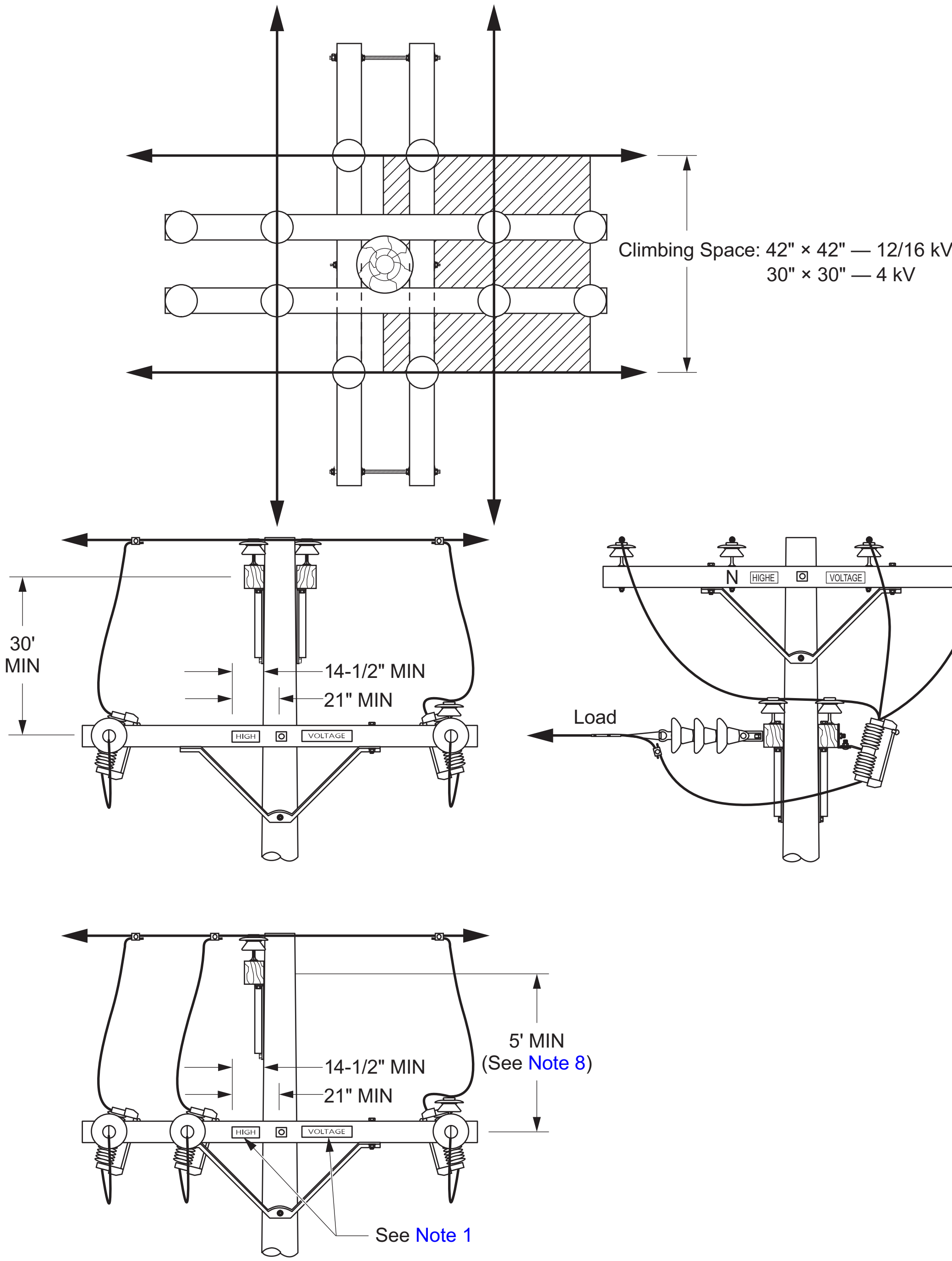


Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Maintain minimum climbing/working space clearances.
   A. Centerline of pole to fuseholder — 18 inches MIN 12/16 kV
   B. Face of pole to fuseholder — 11-1/2 inches MIN 12/16 kV
   C. Centerline of pole to fuseholder — 15 inches MIN 4 kV
   D. Face of pole to fuseholder — 8-1/2 inches MIN 4 kV
3. Lead wire, taps, jumpers, and so on must maintain a 6-inch minimum distance from crossarm surfaces and hardware.
4. Bonding and bonded hardware must maintain 1-1/2-inch clearance from unbonded hardware.
5. Clearance pins and insulators may be necessary for over or under arm taps.
6. Line conductors shall connect to the top/line side of the fuseholder. Load conductors shall connect to the bottom/load side of the fuseholder.
7. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
8. Clearance can be reduced to 4 feet for existing installations.
9. Surge Arresters shall be installed when covered conductors are used (see CC 130).

Scope **DC 610.6** **Typical Branch Fuse Construction for 1Ø/3Ø Break-Off Pole — Top of Pole Only**

Figure DC 610–6: 10-Foot Single or Double Arm Construction



4/12/16 kV OH Branch Line Fusing

Approved by:

What's Changed? Added 2nd Insulators in Figure DC 610-6.

Effective Date:
10-30-2020

Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Maintain minimum climbing/working space clearances.
   A. Centerline of pole to fuseholder — 21 inches MIN 12/16 kV
   B. Face of pole to fuseholder — 14-1/2 inches MIN 12/16 kV
   C. Centerline of pole to fuseholder — 15 inches MIN 4 kV
   D. Face of pole to fuseholder — 8-1/2 inches MIN 4 kV
3. Lead wire, taps, jumpers, and so on must maintain a 6-inch minimum distance from crossarm surfaces and hardware.
4. Bonding and bonded hardware must maintain 1-1/2-inch clearance from unbonded hardware.
5. Clearance pins and insulators may be necessary for over or under arm taps.
6. Line conductors shall connect to the top/line side of the fuseholder. Load conductors shall connect to the bottom/load side of the fuseholder.
7. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
8. Clearance may be reduced to 4 feet for existing installations.
9. Surge Arresters shall be installed when covered conductors are used (see CC 130).

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DC 612 Spring Washer Hardware Connection Details

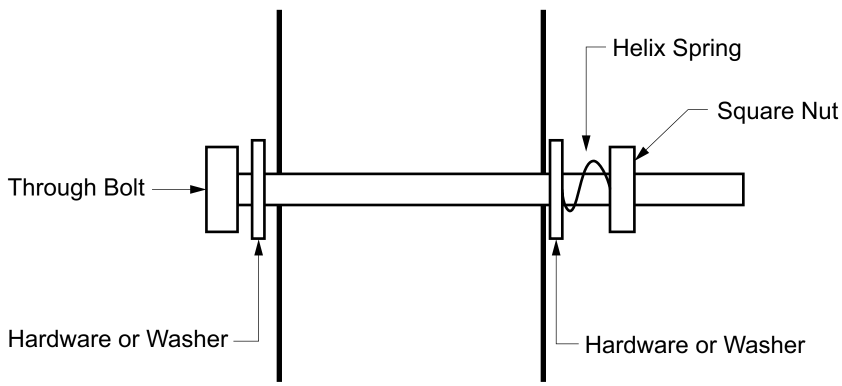
Scope DC 612.1 Typical Non-Tension Hardware

Spring washers are applied on hardware assemblies to reduce the likelihood of loose connections due to vibration, temperature, and/or shrinking of the wood over time. Loose connections may result in Radio Interference (RI) and Television Interference (TVI). Spring washers shall be installed on the nut-end of bolts.

Table DC 612–1: Spring Washer

Size	SAP
3/8"	10072344
1/2"	10072345
5/8"	10072346
3/4"	10072347

Figure DC 612–1: Cross Section of Hardware Assembly for Single Crossarm



Note(s):

1. Composite crossarms with arrester and fuse holder brackets will require a minimum 8-inch bolt to accommodate the dimensions of the spring washer, bond wire, and the crossarm L-brackets.

Figure DC 612–2: Spring Washer Hardware Assembly for Single Crossarm

Figure DC 612–3: Spring Washer Hardware Assembly for Flat Brace on Crossarm

Figure DC 612–4: Cross Section of Hardware Assembly for Double Crossarm

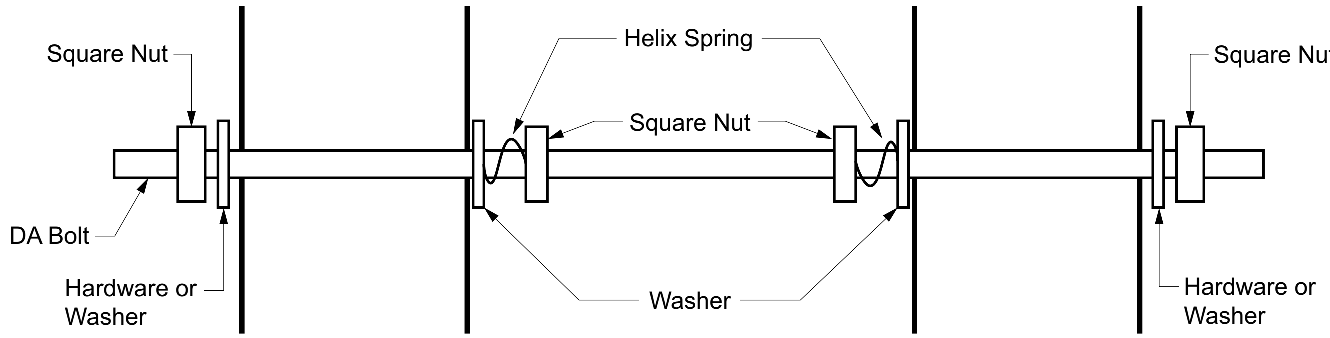


Figure DC 612–5: Spring Washer Hardware Assembly for Double Crossarm

Figure DC 612–6: Cross Section of Hardware Assembly for Poles

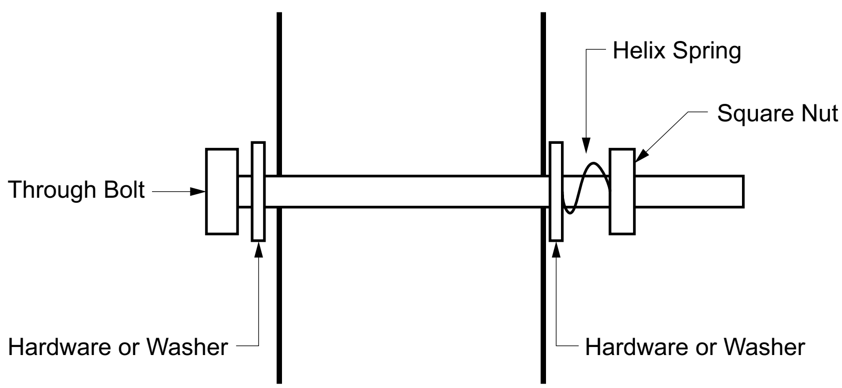


Figure DC 612–7: Spring Washer Hardware Assembly for Poles

Scope DC 612.2 Typical Tension Hardware

Figure DC 612–8: Typical Spring Washer Hardware Assembly for Double Crossarm and Bonding

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DC 615 Back Brace Installation Criteria

Scope DC 615.1 Typical Back Brace Installation Details

Figure DC 615–1: Standard Back Brace Typical Front View

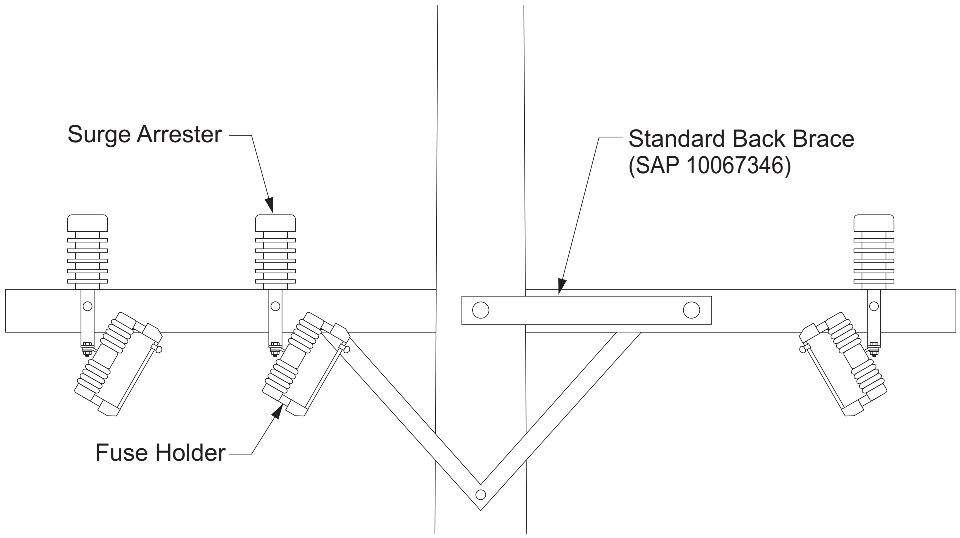
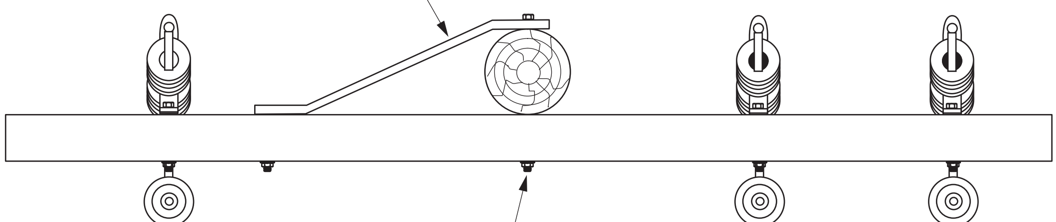


Figure DC 615–2: Standard Back Brace Typical Top View



Note(s):

1. Standard back brace shall be used for poles less than 10-inches in diameter.

Figure DC 615–3: Back Brace for Large Diameter Poles Typical Front View

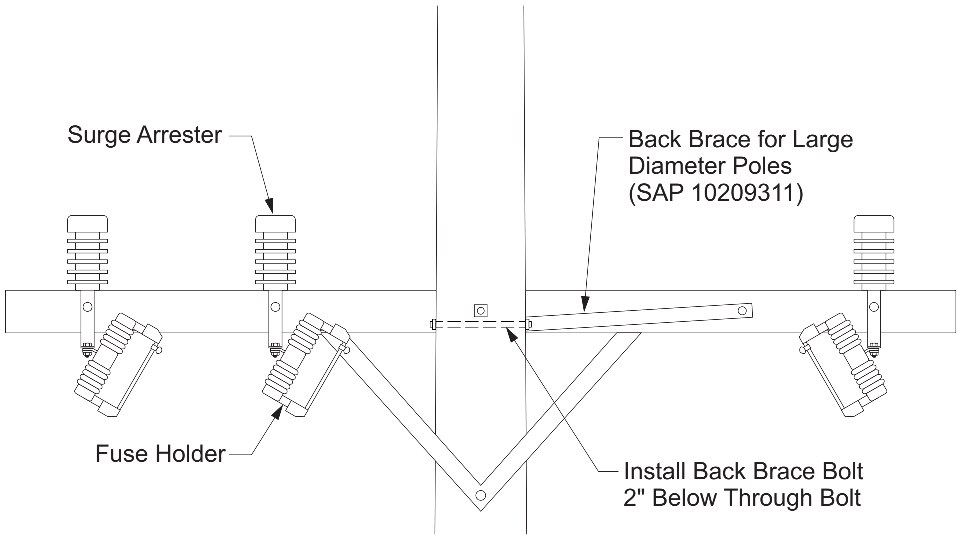
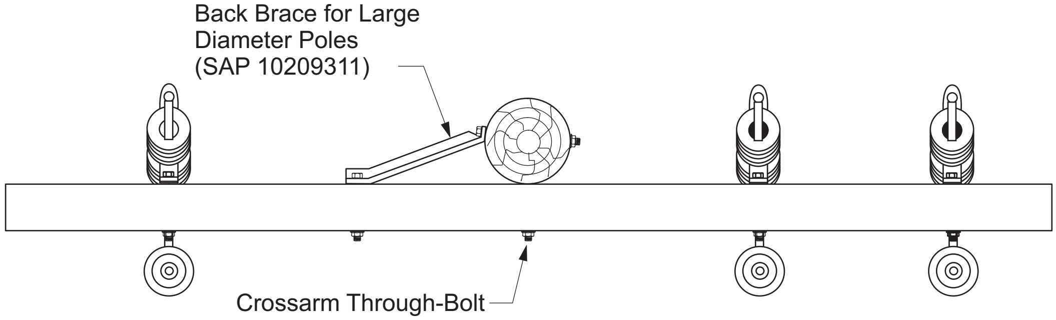


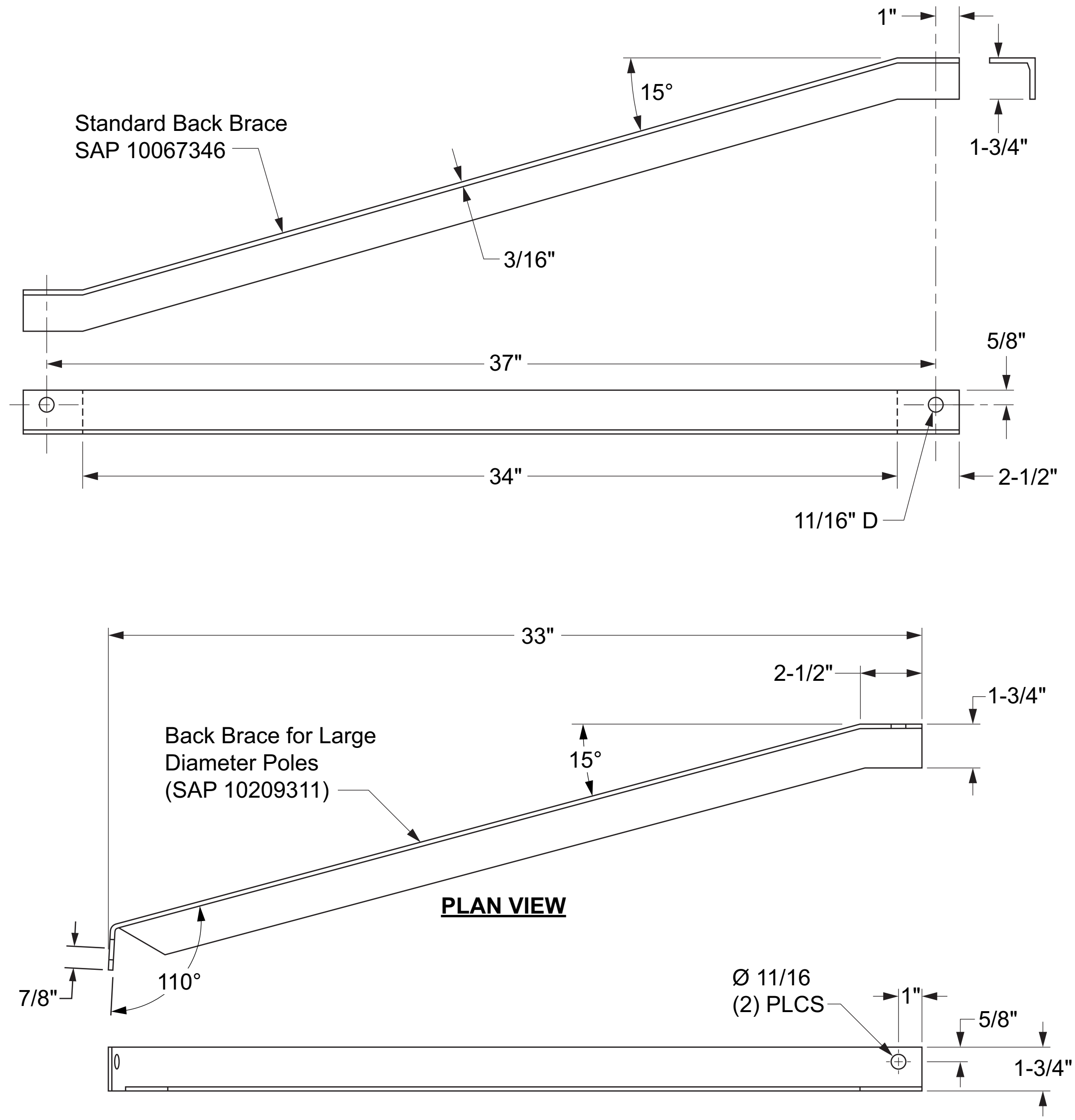
Figure DC 615–4: Back Brace for Large Diameter Poles Typical Top View



Note(s):

1. Back brace for large diameter poles shall be used on poles 10-inches in diameter and larger. It may also be used for retrofit installations on poles of any diameter.

Figure DC 615–5: Dimension Specifications of Back Braces



Note(s):

1. The back brace is applied to limit conductor movement by stabilizing a crossarm associated with operational equipment such as fuse holders and disconnect switches. The brace is also applied to provide support for rotational force associated with alley arm construction and larger UG primary riser applications.
2. The back brace is required for the following new installation applications:
   - Single (arm) Alley Arm installations.
   - 750 kcmil and larger pothead single crossarm installations.
   - Fuse holder crossarms that do not support line conductors.
   - Fuse holder crossarms that are not supported by a V-brace.

- Fuse holder crossarm associated with polemount transformer or switched capacitor banks that do not have support channels which connect to the crossarm.
- Fuse holder crossarm for fixed capacitor banks.
- When the crew foreman or troubleman deems necessary.
- Whenever detailed equipment specific standards list the back brace.

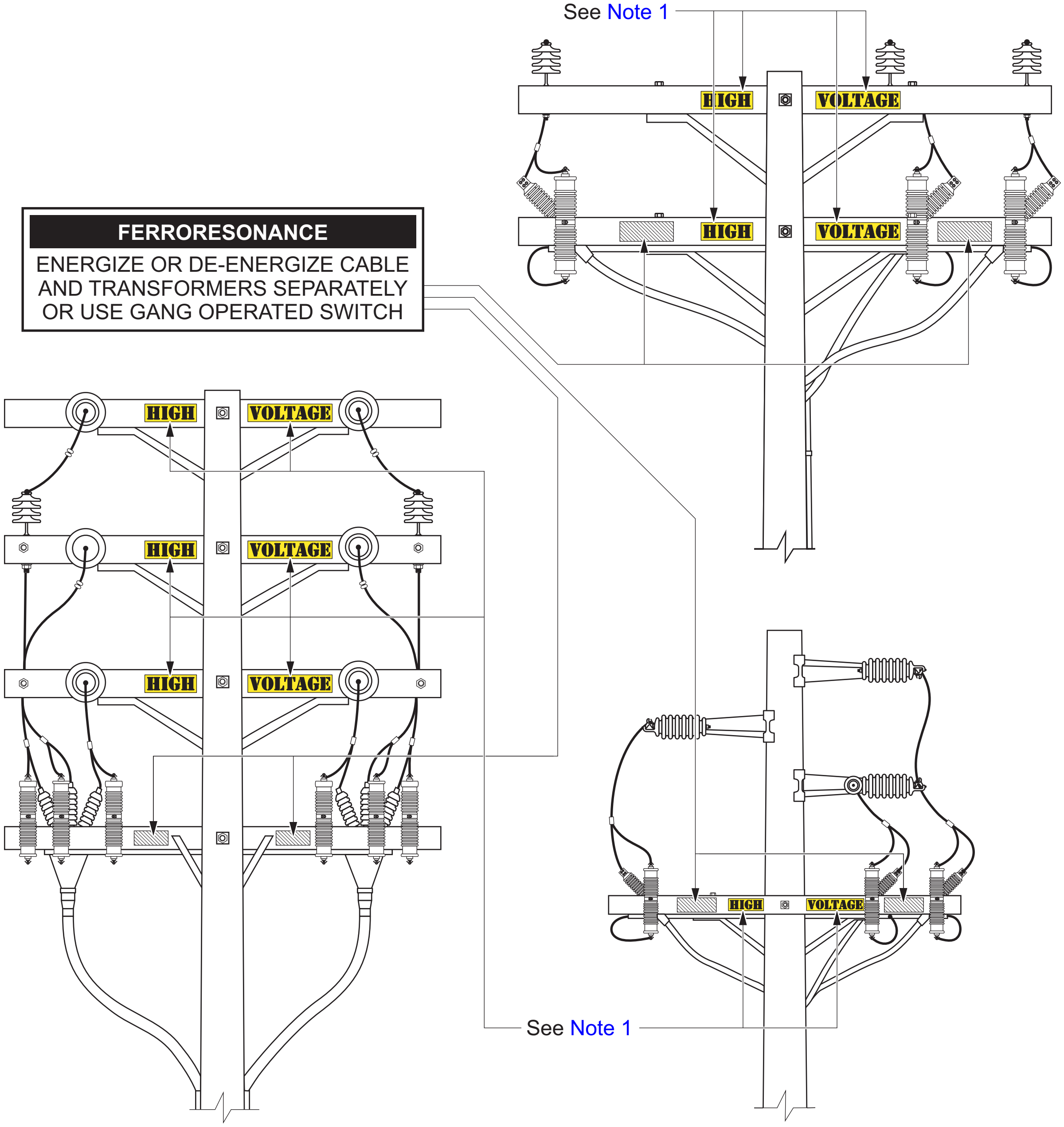
3. When performing work on a pole with existing conditions (such as the bulleted items in Note 2 above) covered by this standard, it is at the foreman's discretion to install a back brace, unless the work is directly on, and related to situations listed above.
4. See DC 612 for hardware details.
5. Back brace may be used to stabilize single line arms in high wind areas.

What's Changed? Added switched capacitor banks to bullet 5 of Note 2 to allow for use of back brace for fuse holder crossarms.

DC 620 Suggested Location of Ferroresonance Safety Instruction Signs

Scope DC 620.1 Suggested Location of Ferroresonance Safety Instruction Signs

Figure DC 620–1: Suggested Location of Ferroresonance Safety Instruction Signs



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. The ferroresonance signs shall be placed at the riser pole on both sides of the pothead arm (or the fuseholder arm where the pothead arm is not available) so that they will be seen by any one who attempts to energize or de-energize a potentially ferroresonant system on phase at a time.

Approved by:	Suggested Location of Ferroresonance Safety Instruction Signs	DC 620 Sheet 1 of 1
Effective Date: 04-27-2012	**What's Changed?** Figure DC 620-1, Note1 was updated to reference PO 120 for HIGH VOLTAGE sign requirements.	DOH

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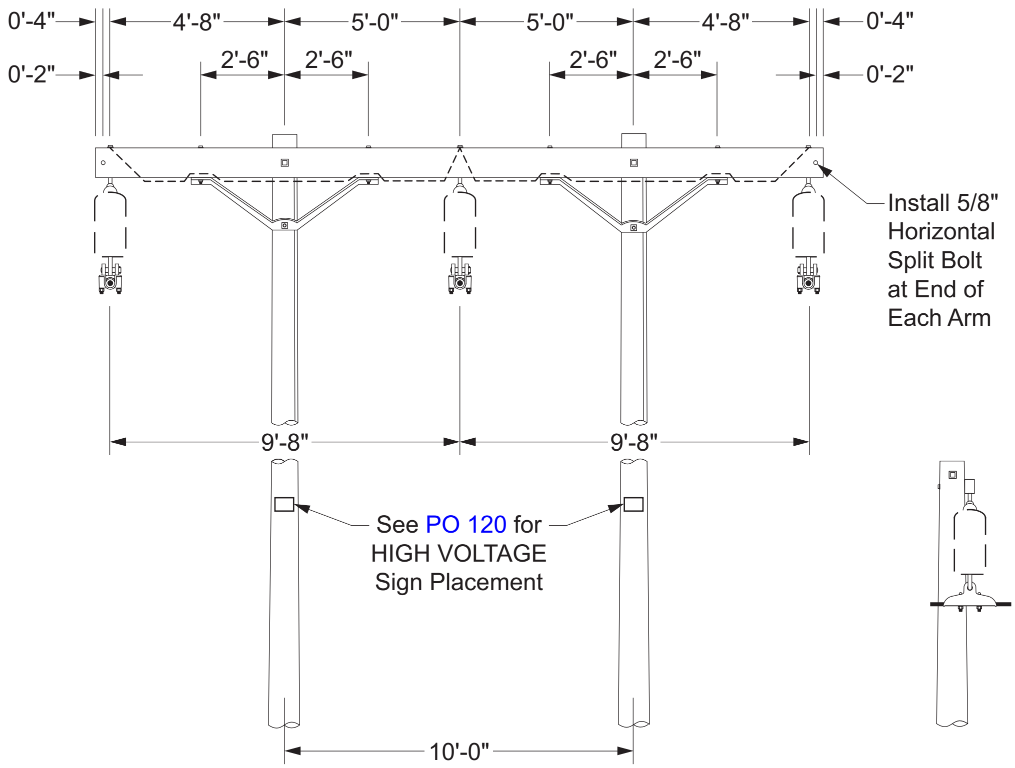
DC 630 H-Frame 3- and 4-Wire Construction (All Distribution Voltages)

Scope DC 630.1 H-Frame, Single Circuit, Single-Arm, Suspension, 3-Wire, 20-foot (6" × 6") Timbers

Figure DC 630–1: H-Frame, Single Circuit, Single-Arm, Suspension, 3-Wire, 20-foot Timbers (PREFERRED)

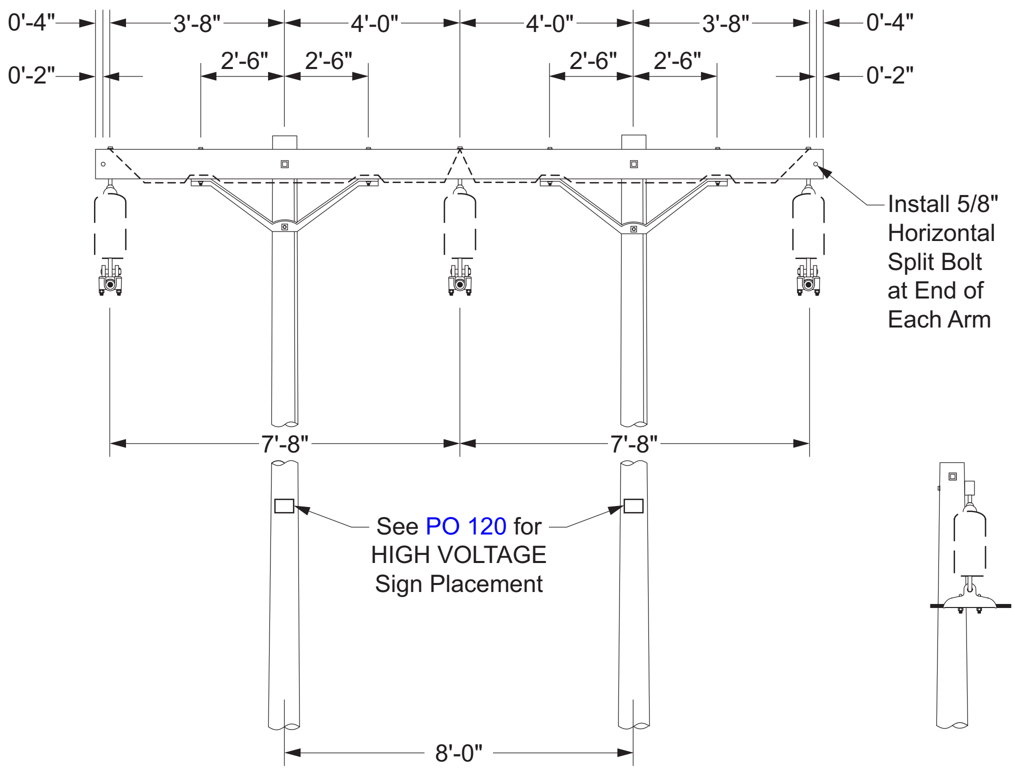


Note(s):

1. Consider H-Frame construction for spans exceeding 500 feet. Contact field engineering for assistance.
2. Allowable vertical load at each end of crossarm: 1,600 lb.
3. See DC 535 for Wildlife Protection standards.

Scope DC 630.2 H-Frame, Single Circuit, Single-Arm, Suspension, 3-Wire, 16-foot (3-1/2" × 5-1/2") Timbers

Figure DC 630–2: H-Frame, Single Circuit, Single-Arm, Suspension, 3-Wire, 16-foot Timbers (ALTERNATE)

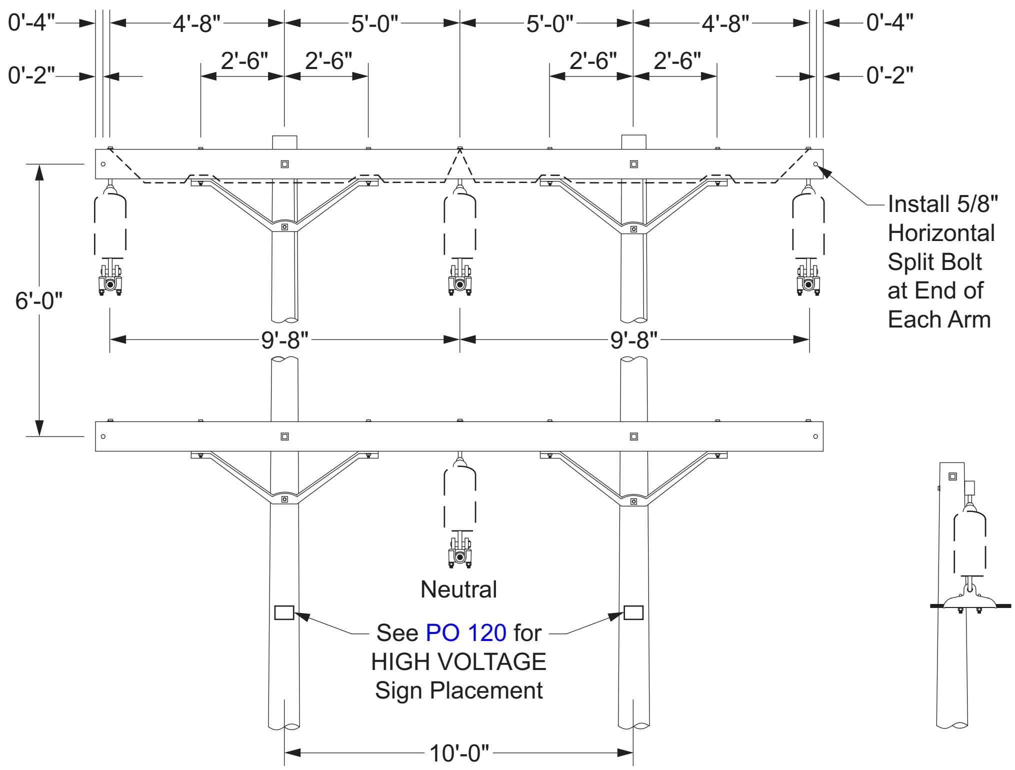


Note(s):

1. Consider H-Frame construction for spans exceeding 500 feet. Contact Field Engineering for assistance.
2. For allowable vertical load contact Field Engineering.
3. See DC 535 for Wildlife Protection standards.

Scope DC 630.3 H-Frame, Single Circuit, Single-Arm, Suspension, 4-Wire, 20-foot (6" × 6") Timbers

Figure DC 630–3: H-Frame, Single Circuit, Single-Arm, Suspension, 4-Wire, 20-foot Timbers (PREFERRED)

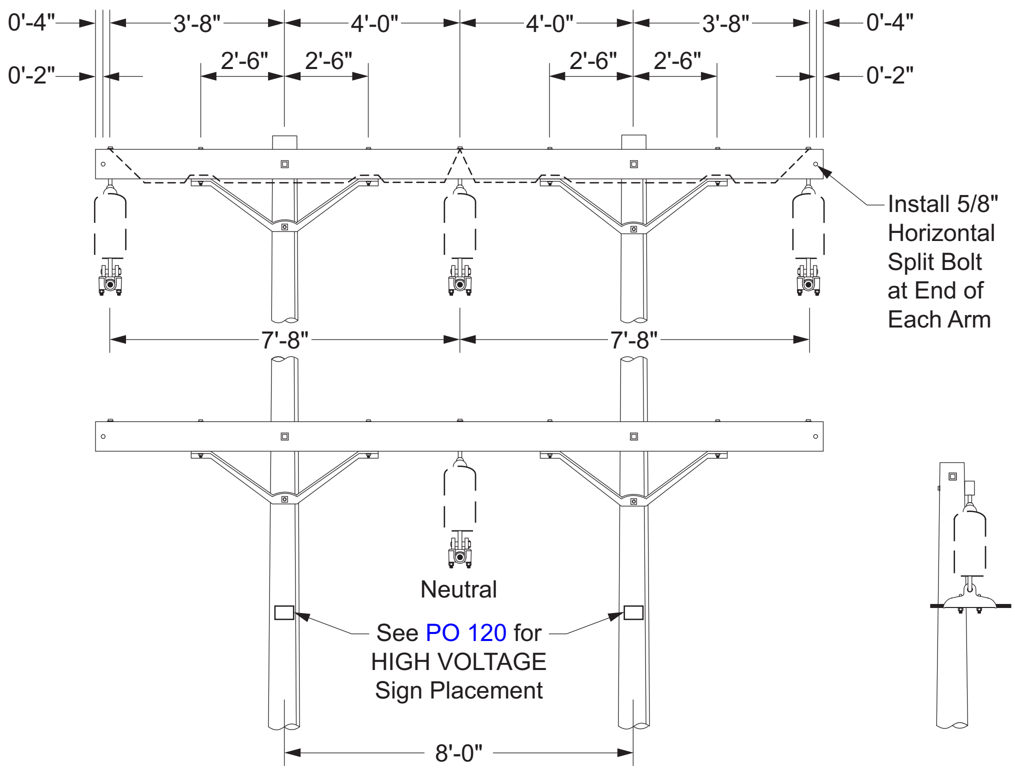


Note(s):

1. Consider H-Frame construction for spans exceeding 500 feet. Contact field engineering for assistance.
2. Allowable vertical load at each end of crossarm: 1,600 lb.
3. See DC 535 for Wildlife Protection standards.

Scope DC 630.4 H-Frame, Single Circuit, Single-Arm, Suspension, 4-Wire, 16-foot (3-1/2" × 3-1/2") Timbers

Figure DC 630–4: H-Frame, Single Circuit, Single-Arm, Suspension, 4-Wire, 16-foot Timbers (ALTERNATE)

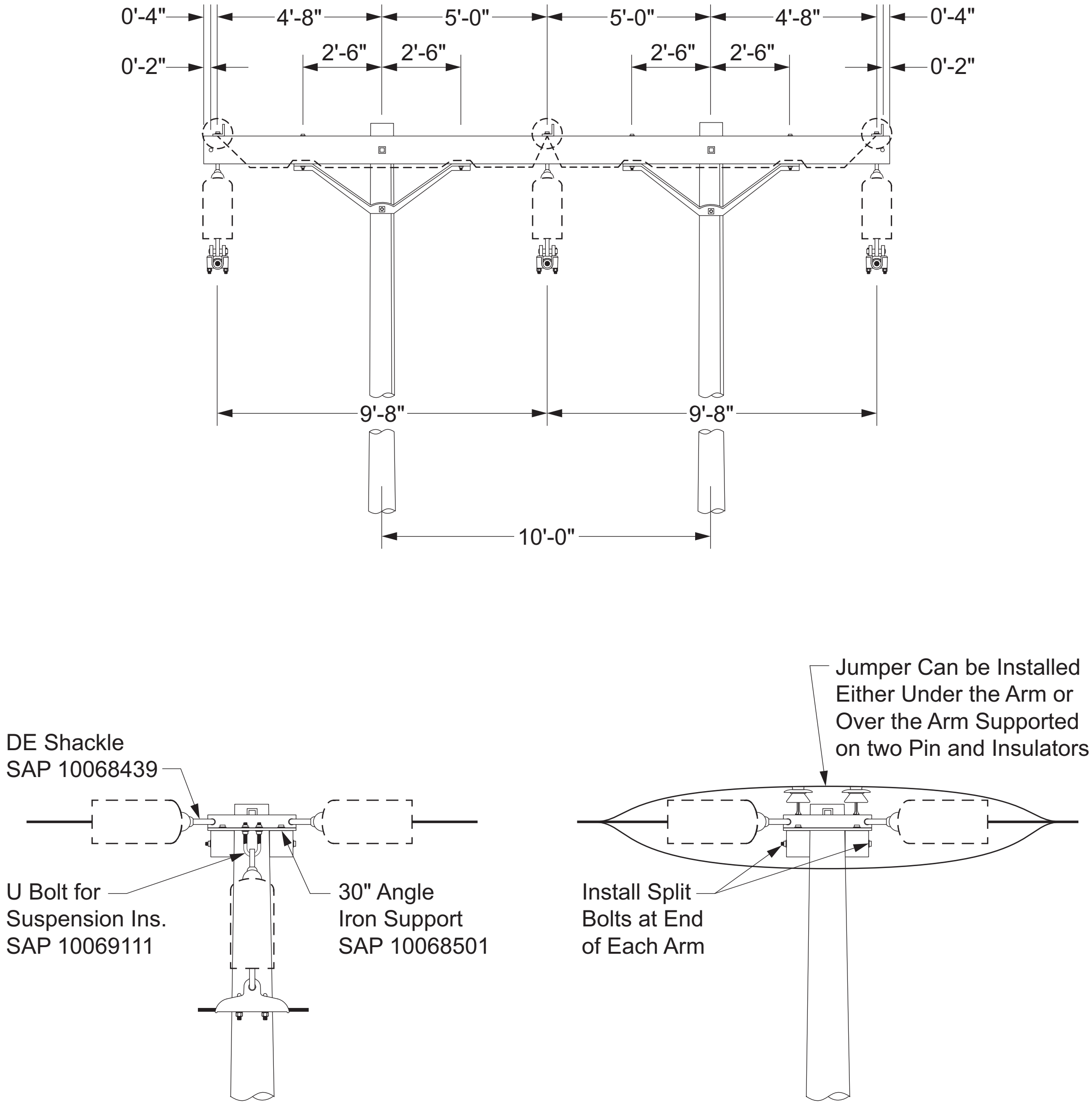


Note(s):

1. Consider H-Frame construction for spans exceeding 500 feet. Contact field engineering for assistance.
2. For allowable vertical load contact field engineering.
3. See DC 535 for Wildlife Protection standards.

Scope DC 630.5 H-Frame, Single Circuit, Double-Arm, Suspension or Dead-End, 3-Wire, 20-foot (6" × 6") Timbers

Figure DC 630–5: H-Frame, Single Circuit, Double-Arm, Suspension or Dead-End, 3-Wire, 20-foot (PREFERRED)

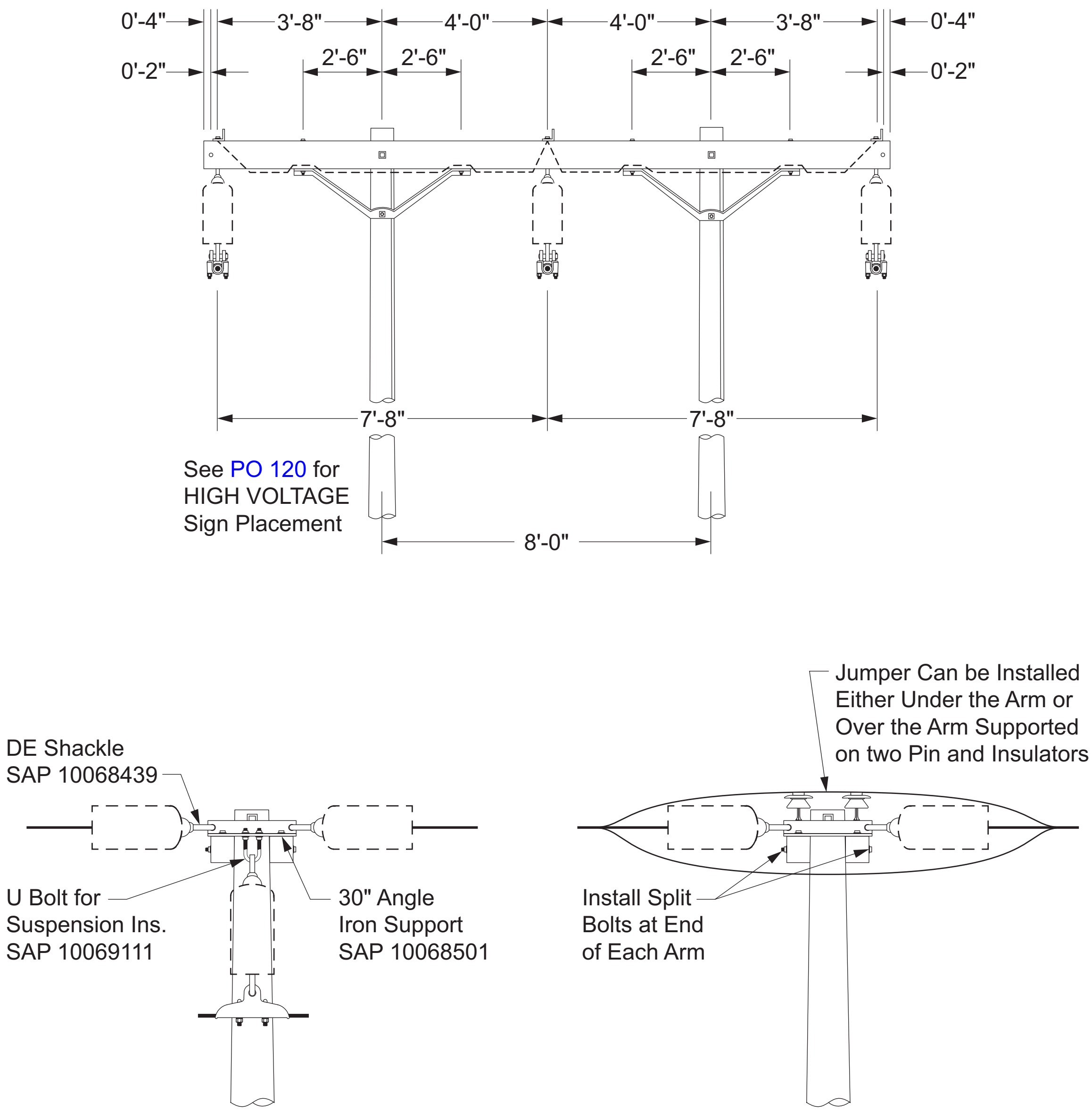


Note(s):

1. Consider H frame for spans exceeding 500 feet. Contact field engineering for assistance.
2. Allowable vertical load at each end of crossarm: 3,400 lb.
3. For combined vertical and dead-end load contact field engineering.
4. See DC 535 for Wildlife Protection standards.

Scope DC 630.6 H-Frame, Single Circuit, Double-Arm, Suspension or Dead-End, 3-Wire, 16-foot (3-1/2" × 5-1/2") Timbers

Figure DC 630–6: H-Frame, Single Circuit, Double-Arm, Suspension or Dead-End, 3-Wire, 16-foot (ALTERNATE)



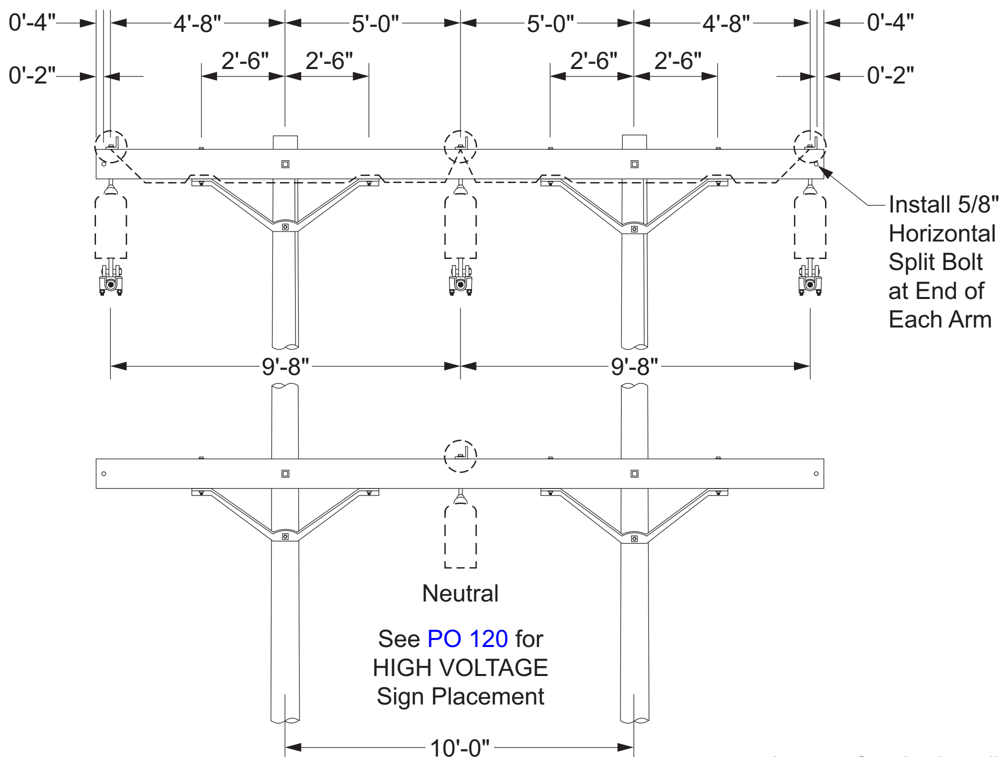
Note(s):

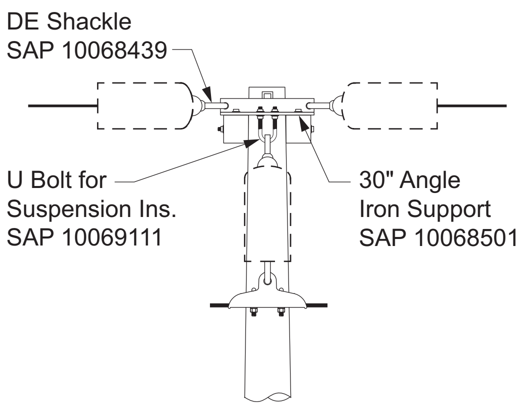
1. Consider H frame for spans exceeding 500 feet. Contact field engineering for assistance.
2. For combined vertical and dead-end load contact field engineering.
3. See DC 535 for Wildlife Protection standards.

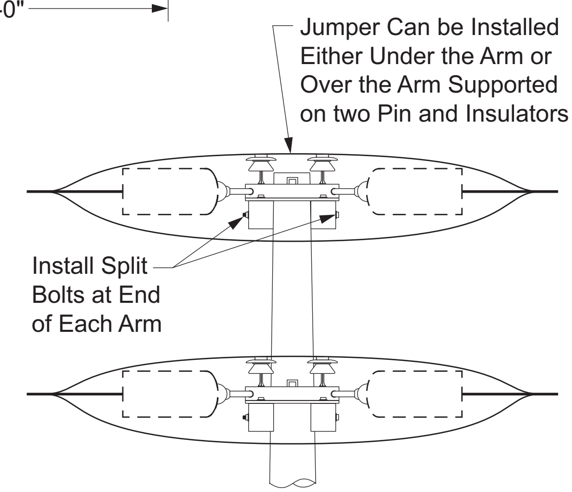
What's Changed? Added requirement for two pin and insulators when installing over the arm jumper loops.

Scope DC 630.7 H-Frame, Single Circuit, Double-Arm, Suspension or Dead-End, 4-Wire, 20-foot (6" × 6") Timbers

Figure DC 630–7: H-Frame, Single Circuit, Double-Arm, Suspension or Dead-End, 4-Wire 20-foot Timbers (PREFERRED)





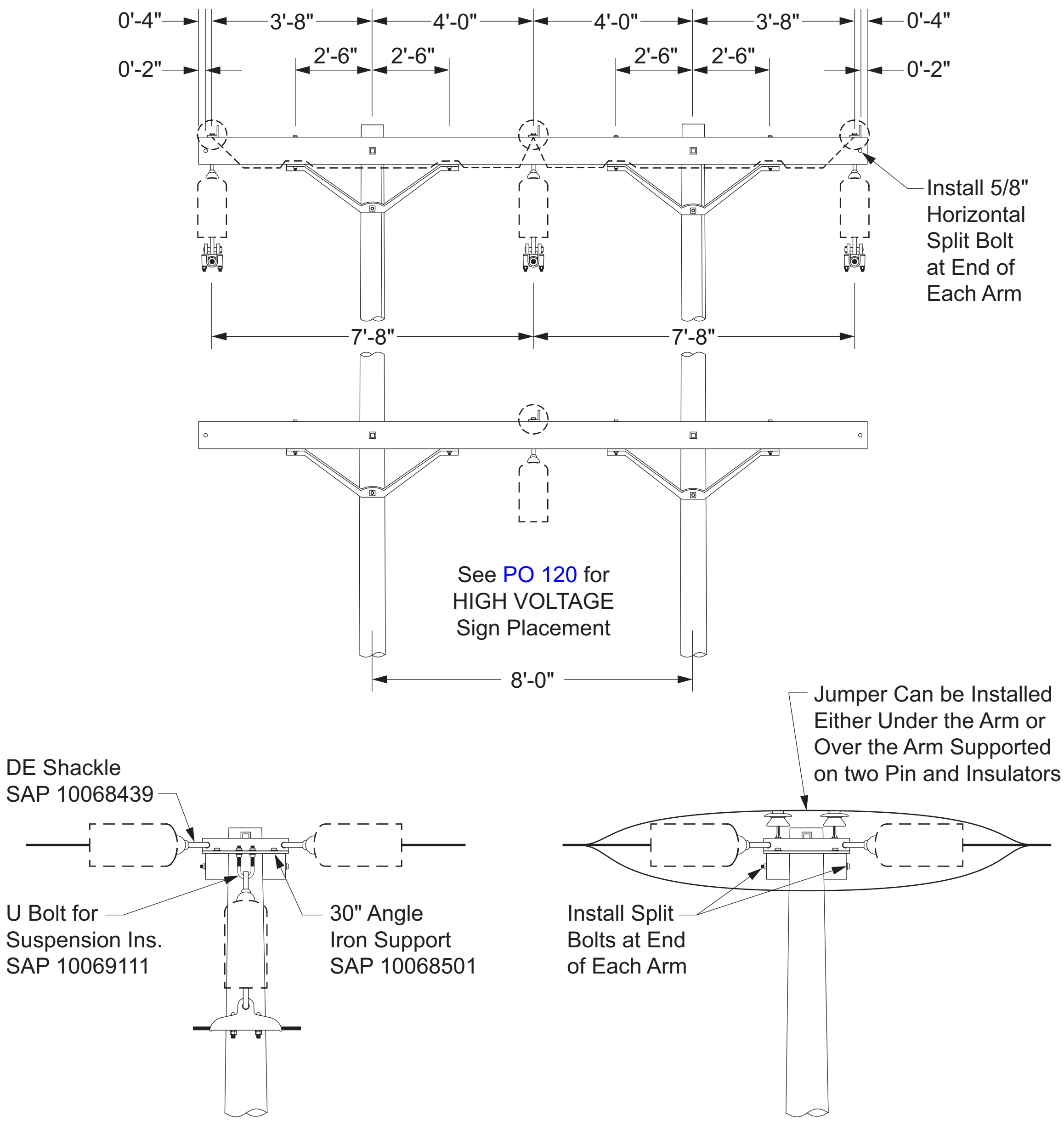


Note(s):

1. Consider H frame for spans exceeding 500 feet. Contact field engineering for assistance.
2. Allowable vertical load at each end of crossarm: 3,400 lb.
3. For combined vertical load dead-end load contact field engineering.
4. See DC 535 for Wildlife Protection standards.

Scope DC 630.8 **H-Frame, Single Circuit, Double-Arm, Suspension or Dead-End, 4-Wire, 16-foot (3-1/2" × 5-1/2") Timbers**

Figure DC 630–8: H-Frame, Single Circuit, Double-Arm, Suspension or Dead-End, 4-Wire, 16-foot Timbers (ALTERNATE)



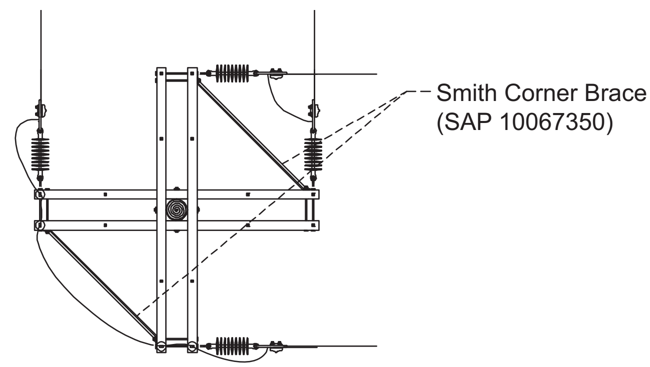
Note(s):

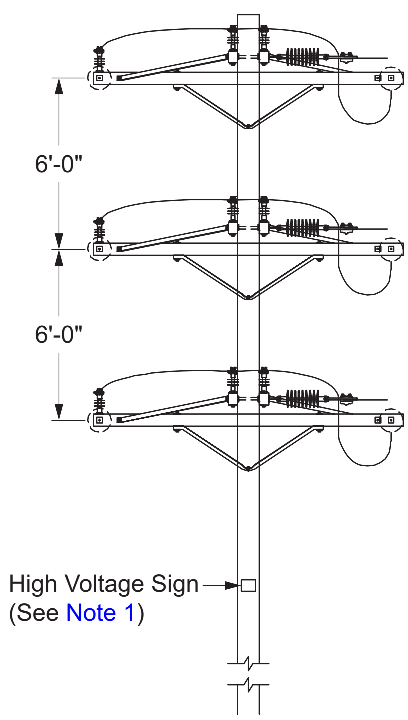
1. Consider H frame for spans exceeding 500 feet. Contact field engineering for assistance.
2. For allowable vertical and dead-end load contact field engineering.
3. See DC 535 for Wildlife Protection standards.

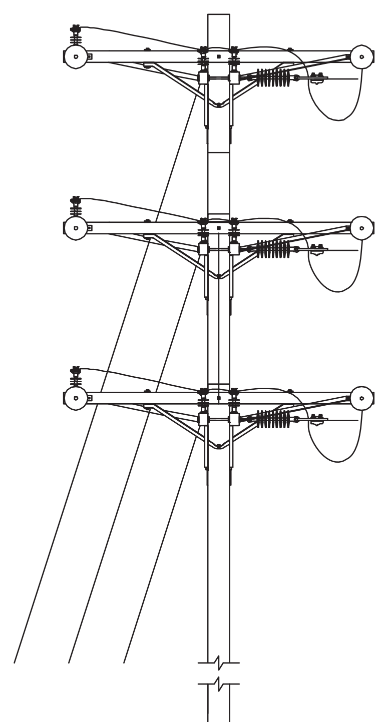
DC 635 Smith Corner 3- and 4-Wire Construction, Composite and Wood 10' Crossarm (All Distribution Voltages)

Scope DC 635.1 Wood Crossarm, Double Circuit, Post-Type Jumper Support Insulators, Smith Corner, 3-Wire

Figure DC 635–1: Wood Crossarm, Double Circuit, Post-Type Jumper Support Insulators, Smith Corner, 3-Wire





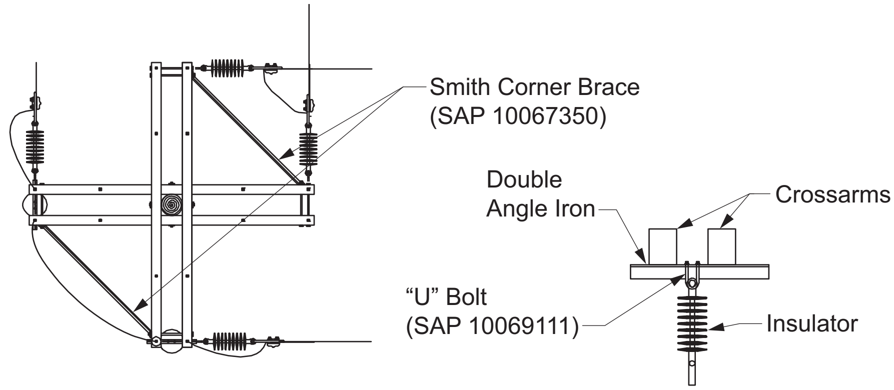


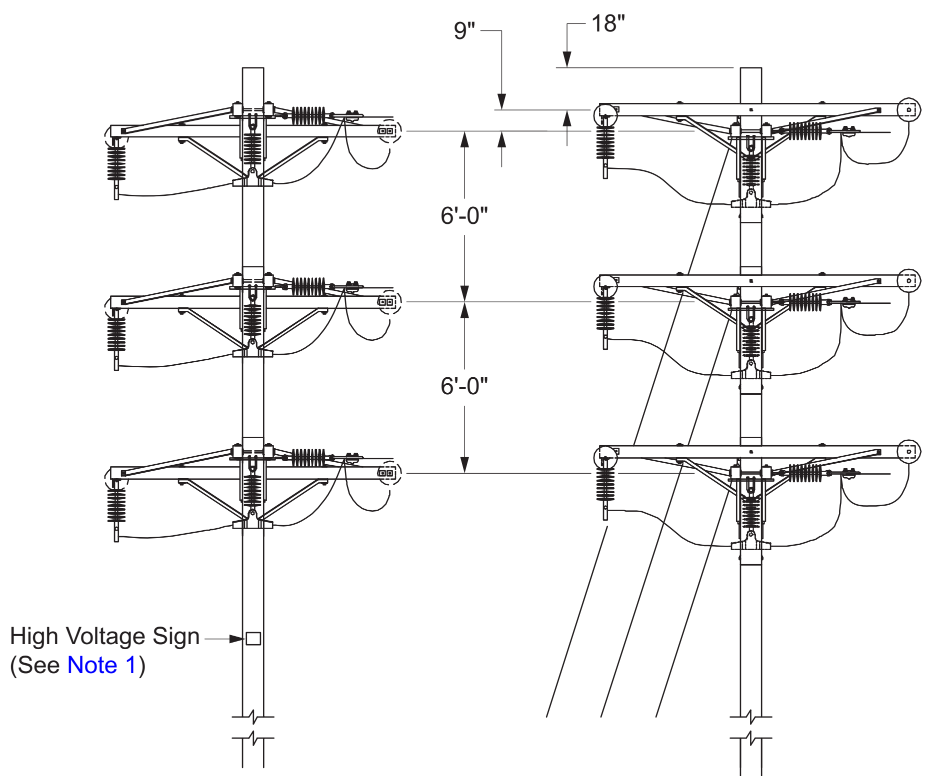
Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. See DC 535 for Wildlife Protection standards.
3. Post Insulators are shown but Pin Insulators are also acceptable.

Scope DC 635.2 Wood Crossarm, Double Circuit, Suspension Jumper Support Insulators, Smith Corner, 3-Wire

Figure DC 635–2: Wood Crossarm, Double Circuit, Suspension Jumper Support Insulators, Smith Corner, 3-Wire



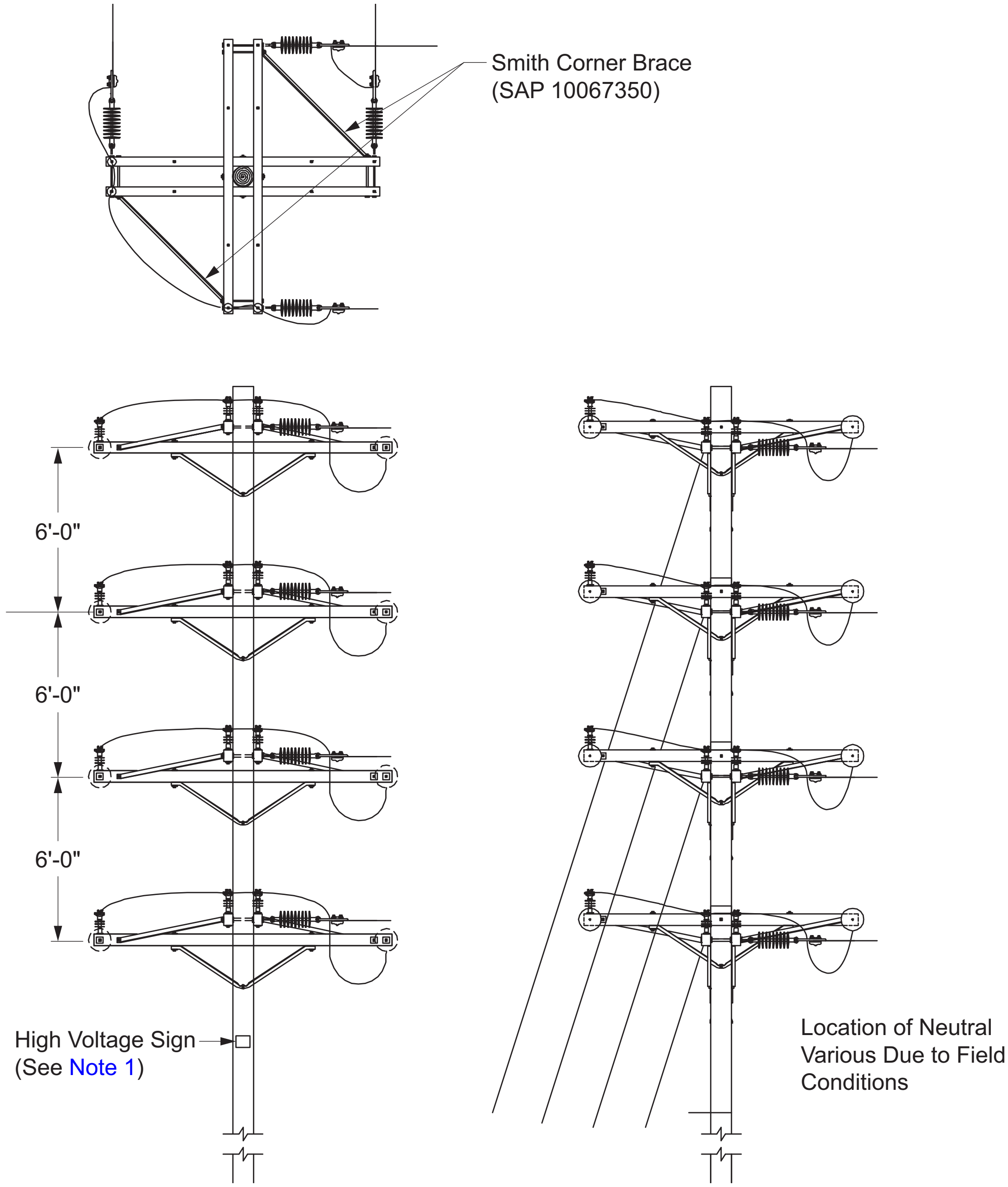


Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. See DC 535 for Wildlife Protection standards.

Scope DC 635.3 Wood Crossarm, Double Circuit, Post-Type Jumper Support Insulators, Smith Corner, 4-Wire

Figure DC 635–3: Wood Crossarm, Double Circuit, Post-Type Jumper Support Insulators, Smith Corner, 4-Wire

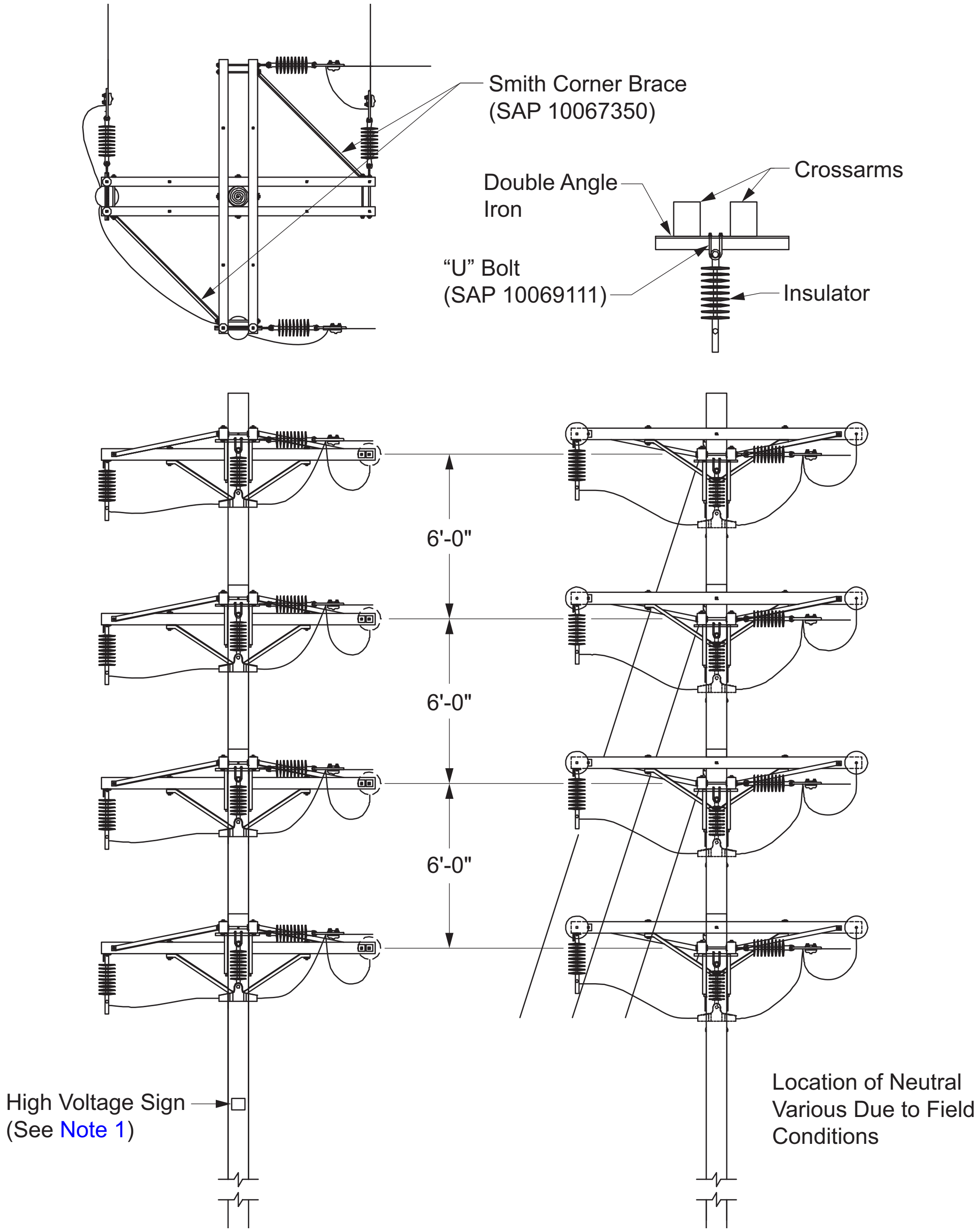


Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. See DC 535 for Wildlife Protection standards.
3. Post Insulators are shown but Pin Insulators are also acceptable.

Scope DC 635.4 Wood Crossarm, Double Circuit, Suspension Jumper Support Insulators, Smith Corner, 4-Wire

Figure DC 635–4: Wood Crossarm, Double Circuit, Suspension Jumper Support Insulators, Smith Corner, 4-Wire

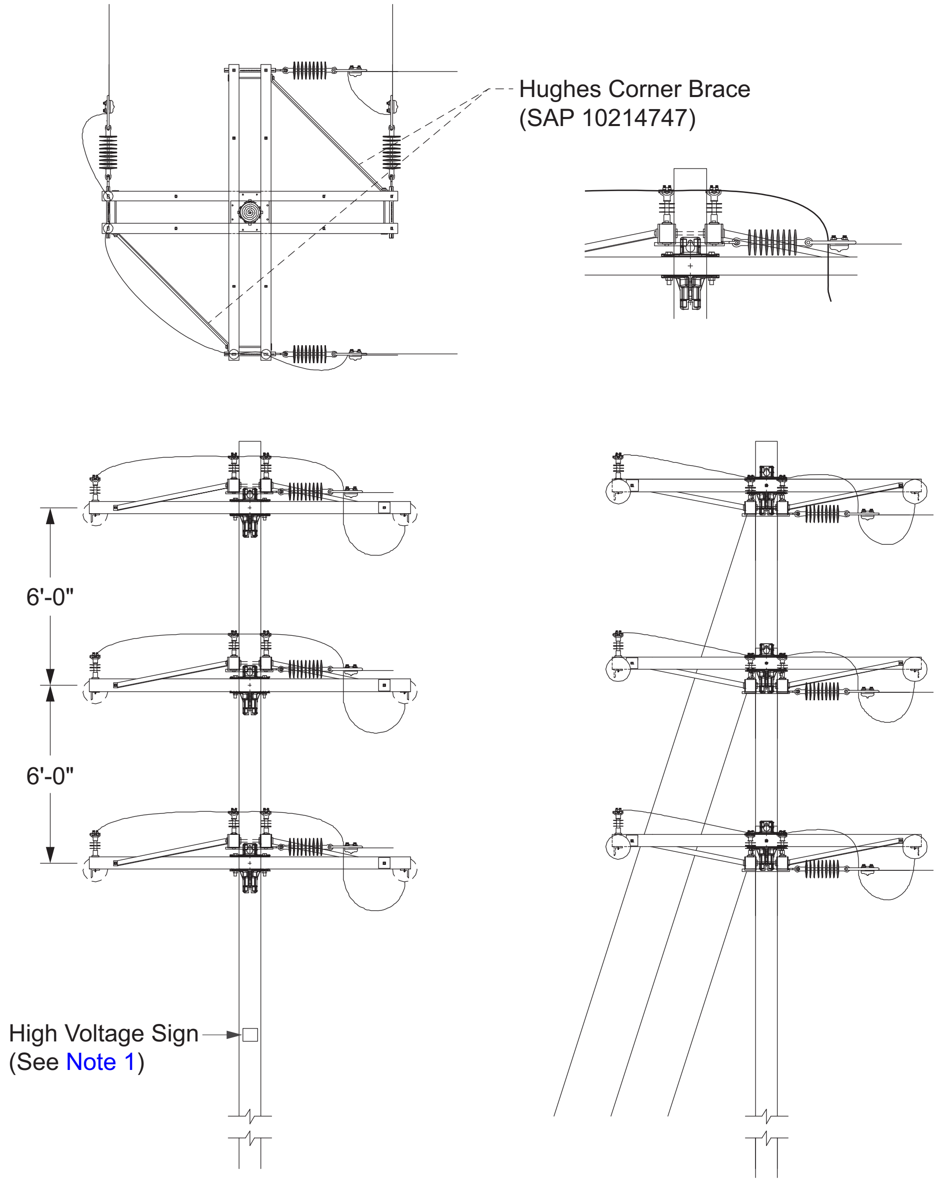


Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. See DC 535 for Wildlife Protection standards.

Scope DC 635.5 Composite Crossarm, Double Circuit, Post-Type Jumper Support Insulators, Hughes Corner, 3-Wire

Figure DC 635–5: Composite Crossarm, Double Circuit, Post-Type Jumper Support Insulators, Hughes Corner, 3-Wire

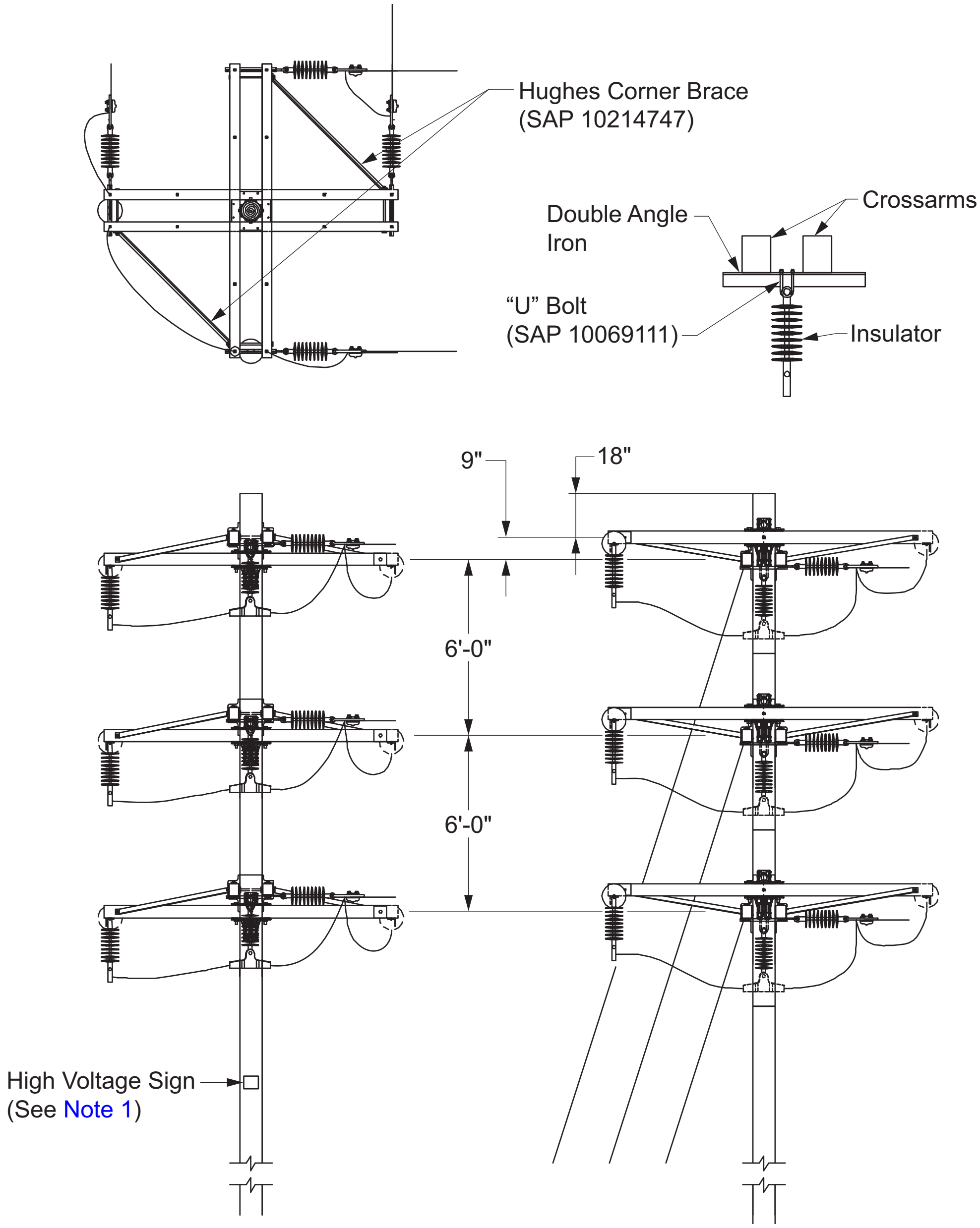


Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. See DC 535 for Wildlife Protection standards.
3. Post Insulators are shown but Pin Insulators are also acceptable.

Scope DC 635.6 Composite Crossarm, Double Circuit, Suspension Jumper Support Insulators, Hughes Corner, 4-Wire

Figure DC 635–6: Composite Crossarm, Double Circuit, Suspension Jumper Support Insulators, Hughes Corner, 4-Wire

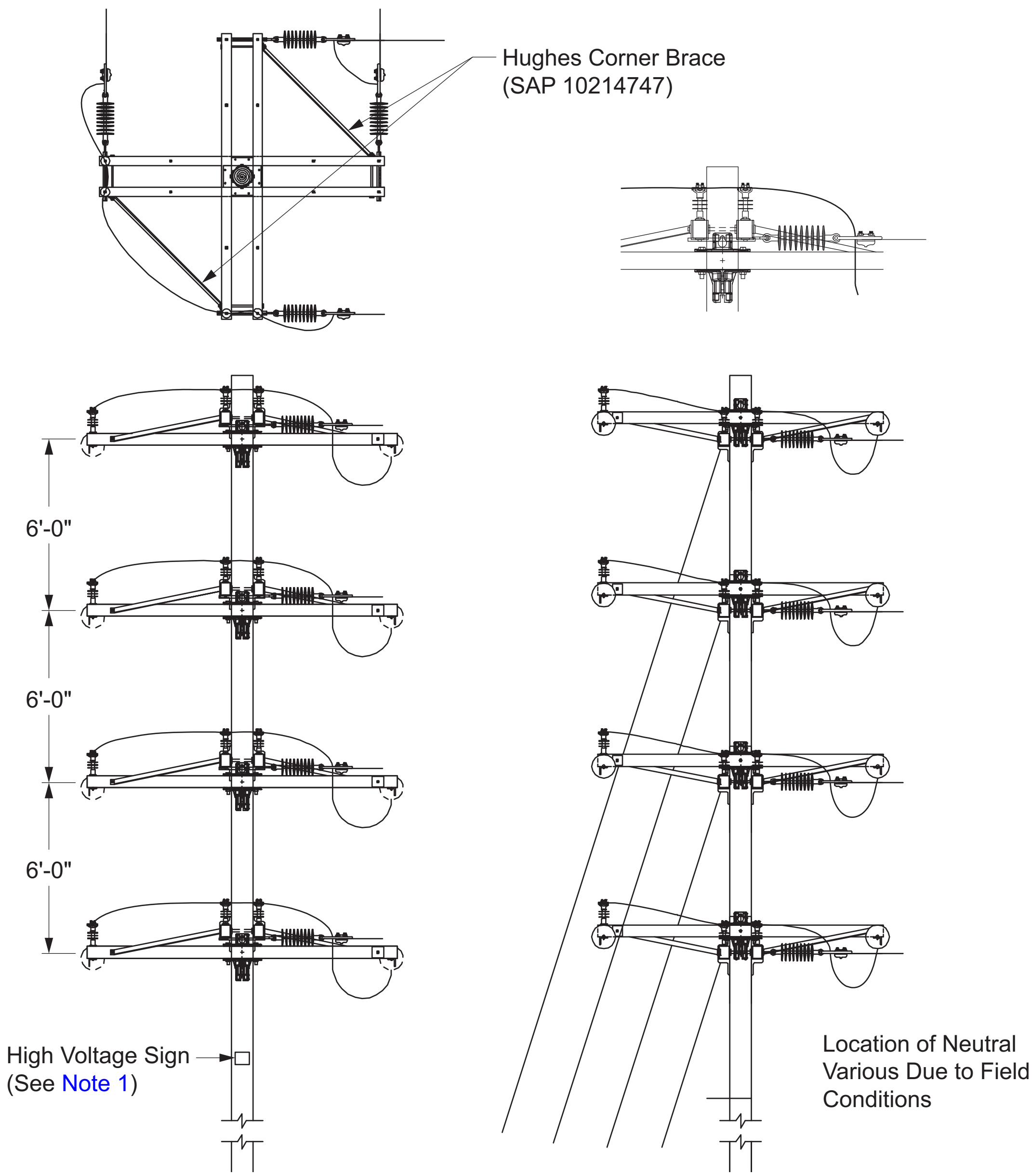


Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. See DC 535 for Wildlife Protection standards.

Scope DC 635.7 Composite Crossarm, Double Circuit, Post Type Suspension Jumper Support Insulators, Hughes Corner, 3-Wire

Figure DC 635–7: Composite Crossarm, Double Circuit Post Type Suspension Jumper Support Insulators, Hughes Corner, 3-Wire

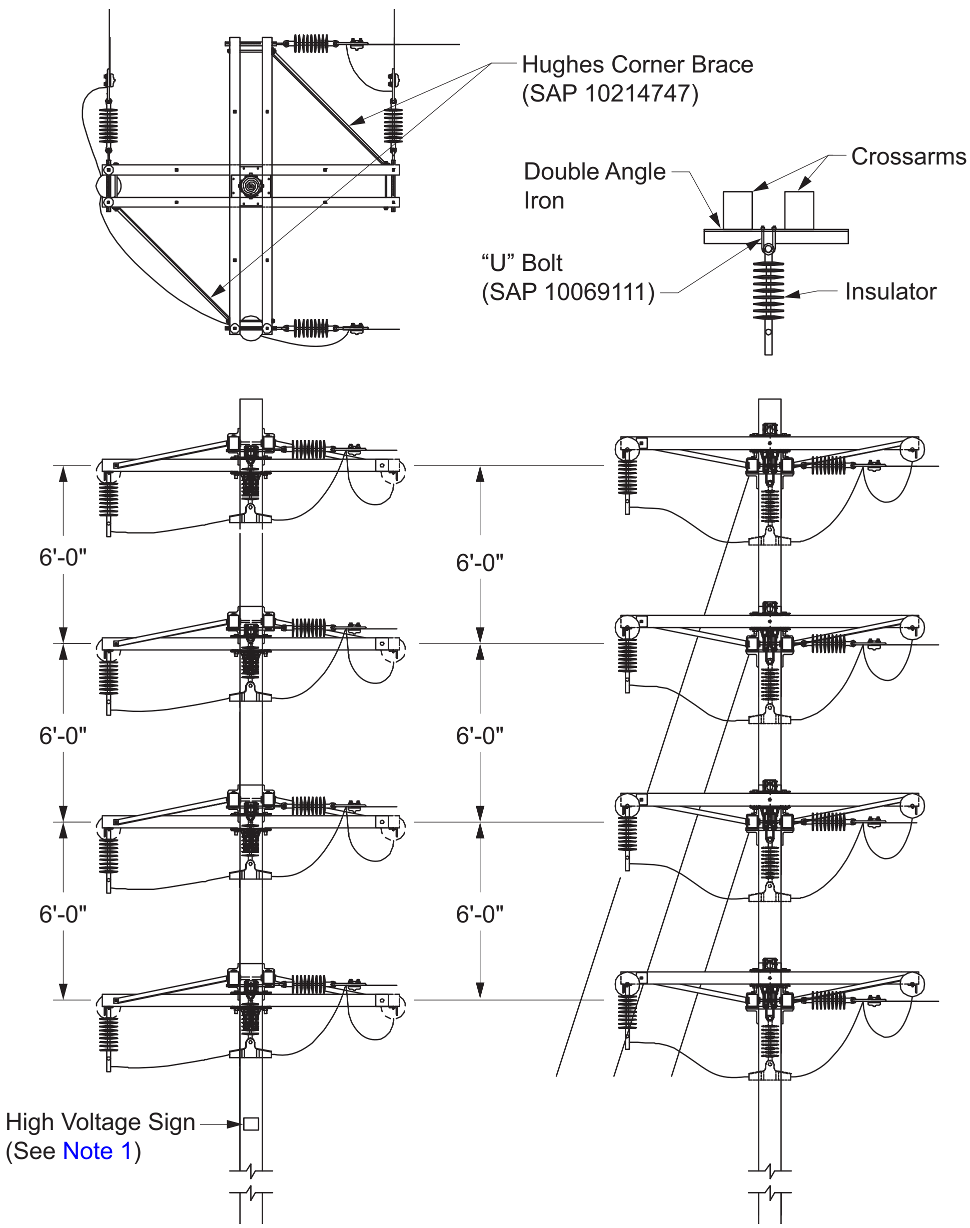


Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. See DC 535 for Wildlife Protection standards.
3. Post Insulators are shown but Pin Insulators are also acceptable.

Scope DC 635.8 Composite Crossarm, Double Circuit, Suspension Jumper Support Insulators, Smith Corner, 4-Wire

Figure DC 635–8: Composite Crossarm, Double Circuit, Suspension Jumper Support Insulators, Hughes Corner, 4-Wire



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. See DC 535 for Wildlife Protection standards.

DC 640 Overhead Platform Rack Structures

Scope DC 640.1 Overhead Platform Rack Structures (2-Pole and 3-Pole Design)

1.0 Structural Requirements

1.1 17'-4" Platform Rack (2-Pole Design)

The 17'-4" platform rack for 2-pole design can support an overall equipment weight up to a maximum of 10,000 pounds and shall be installed onto each pole with an end-mounting bracket connector. See Table DC 640–1 for 17'-4" platform rack selection details.

1.2 17'-4" Platform Rack (3-Pole Design)

The 17'-4" platform rack for 3-pole design can support up to a maximum of 15,000 pounds and shall be installed onto each end pole with an end-mounting bracket connector and will require an additional center mounting bracket for the connection to the middle pole. See Table DC 640–1 for 17'-4" platform rack selection details.

1.3 13'-6" Platform Rack (2-Pole and 3-Pole Design) — Retrofit Applications Only

The 13'-6" platform rack shall be installed for retrofit applications only. The installation and construction for all new overhead platform racks will be the same.

The retrofit applications are as follows:

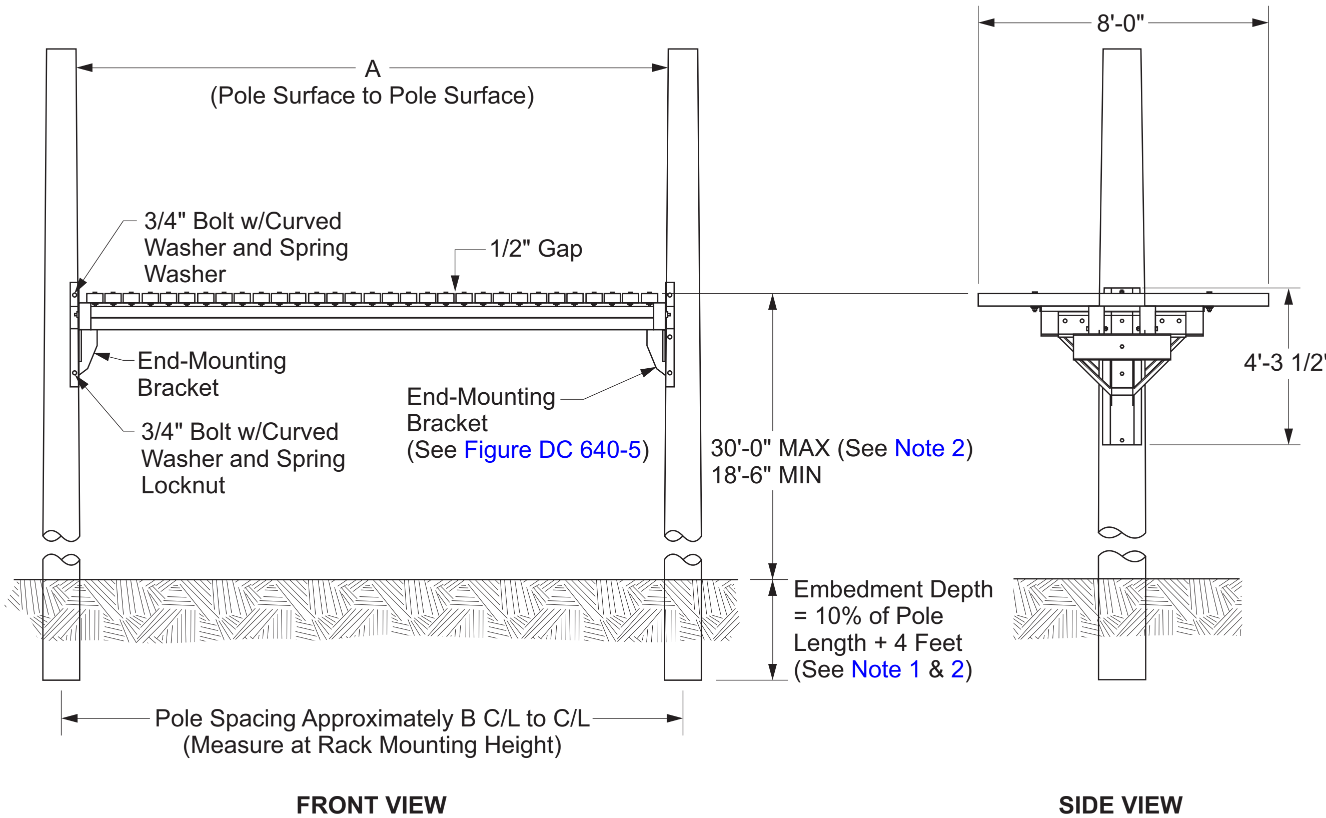
- Cable Tie Down Assembly per Scope DC 640.1, Section 1.2 (preferred method).
- Wood Brace Assembly per Scope DC 640.2, Section 1.3.

Table DC 640–1: Overhead Platform Rack for 2-Pole and 3-Pole Installations

Item	Description	SAP	Maximum Overall Equipment Weight
1	17'-4" Platform Rack - 2-Pole Design[a/] End-Mounting Bracket	10178672 10178677	Up to 10,000 Pounds (See Figure DC 640–1)
2	17'-4" Platform Rack - 3-Pole Design[b/] End-Mounting Bracket Center-Mounting Bracket	10178672 10178677 10178676	Up to 15,000 Pounds (See Figure DC 640–2)
3	13'-6" Platform Rack - 2-Pole Design[a/c/] End-Mounting Bracket	10182724 10182725	Up to 10,000 Pounds (See Figure DC 640–1)
4	13'-6" Platform Rack - 3-Pole Design[b/c/] End-Mounting Bracket Center-Mounting Bracket	10182724 10182725 10188676	Up to 15,000 Pounds (See Figure DC 640–2)

a/ 2-Pole 17'-4" platform rack requires two end-mounting brackets, one for each pole.
b/ 3-Pole 17'-4" platform rack requires a two end-mounting brackets and one (1) center-mounting bracket.
c/ 2-Pole and 3-Pole 13'-6" platform racks are for retrofit applications only and shall not be installed for new construction.

Figure DC 640–1: 17'-4" Platform Rack (2-Pole Design) - Maximum Weight (Up to 10,000 pounds)



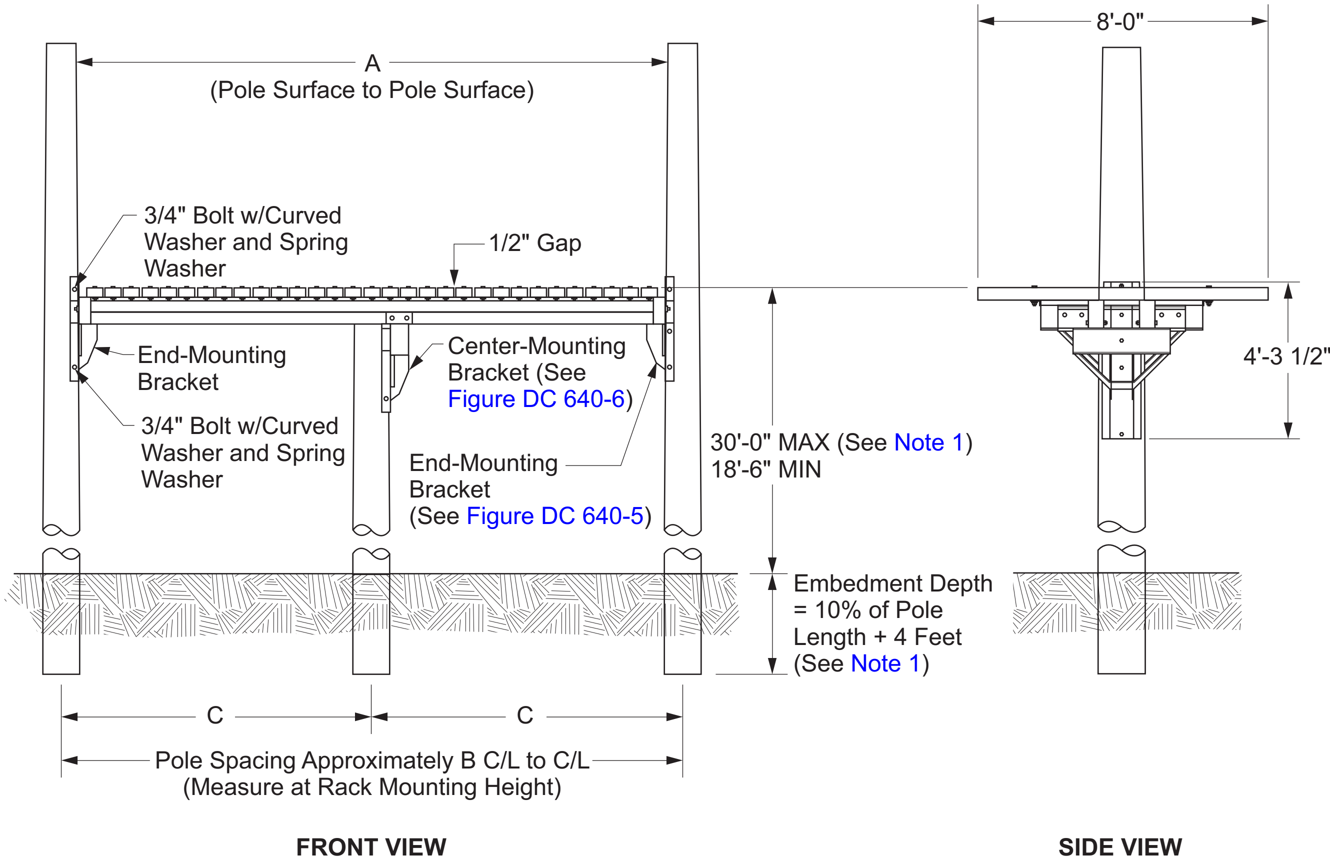
Note(s):

1. The pole embedment depth shall be 10 percent of the pole length plus an additional 4 feet. In no case shall the embedment depth be less than 8 feet minimum.
2. For communication under build, platform rack may be installed at a maximum height of 30 feet with a required pole embedment depth of 10 percent of the pole length plus an additional 4 feet. In no case shall the embedment depth be less than 10 feet minimum for communication under build.
3. See Figure DC 640–5 for End-Mounting Bracket bolt locations.

Table DC 640–2: Overhead Platform Rack Dimensions

Description	A	B
17'-4" Platform Rack	17'-4"	18'-9"
13'-6" Platform Rack	12'-1"	13'-6"

Figure DC 640–2: 17'-4" Platform Rack (3-Pole Design) – Maximum Weight (Up to 15,000 pounds)



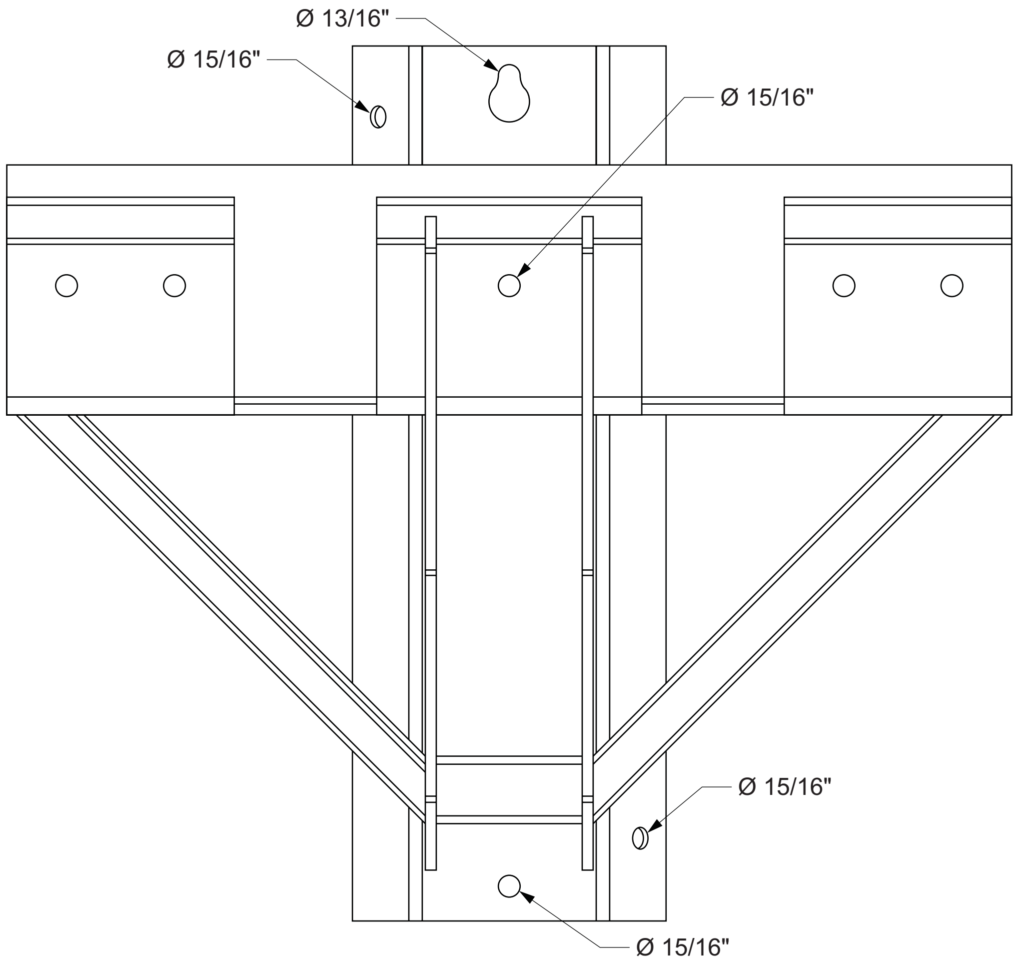
Note(s):

1. The pole embedment depth shall be 10 percent of the pole length plus an additional 4 feet. In no case shall the embedment depth be less than 10 feet minimum.
2. See Figure DC 640–5 for End-Mounting Bracket bolt locations. See Figure DC 640–6 for Center-Mounting Bracket bolt locations.

Table DC 640–3: Overhead Platform Rack Dimensions

Description	A	B	C
17'-4" Platform Rack	17'-4"	18'-9"	9'-4.5"
13'-6" Platform Rack	12'-1"	13'-6"	6'-9"

Figure DC 640–3: End-Mounting Bracket Bolt Locations

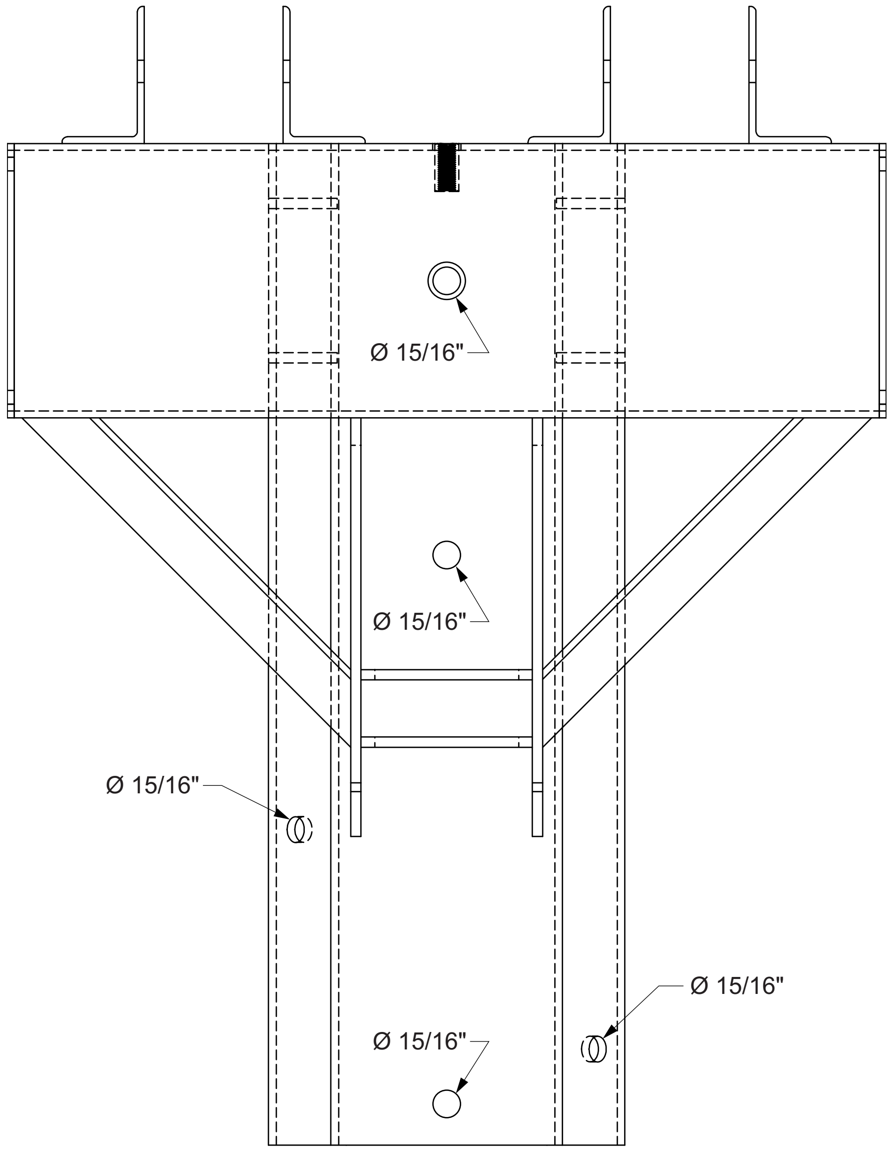


FRONT VIEW

Note(s):

1. Bracket shall be attached to pole using 3/4-inch bolts with a curved washer and spring washer in all holes with a callout.

Figure DC 640–4: Center-Mounting Bracket Bolt Locations



FRONT VIEW

Note(s):

1. Bracket shall be attached to pole using 3/4-inch bolts with a curved washer and spring washer in all holes with a callout.

Figure DC 640–5: End-Mounting Bracket Detail

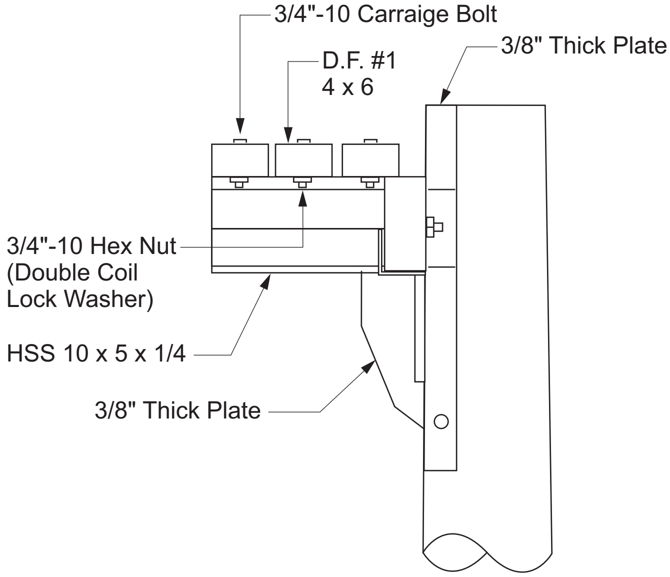
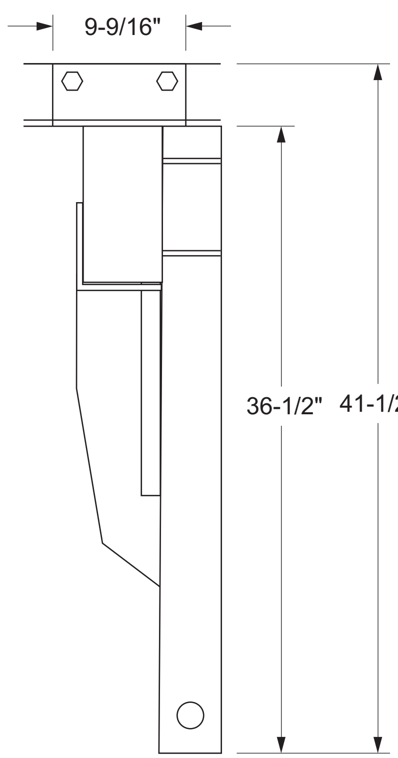


Figure DC 640–6: Center-Mounting Bracket Detail



Scope DC 640.2 Equipment Anchorage for Overhead Platform Racks

1.0 Equipment Anchorage for Overhead Platform Racks

Apparatus equipment placed onto overhead platform racks will require the installation of both the snubber seismic restraints and cable tie down assembly as shown in Sections 1.1 and 1.2, respectively.

1.1 Snubbers (Seismic Restraints)

Snubber seismic restraints are metal plates used to restrain equipment from excessive movement during a seismic event. Properly anchor apparatus equipment installed on the overhead platform rack at the base of each piece of equipment using four snubbers (one per quadrant). The three types of Snubbers available for installation are as follows:

A. Snubber Type I (Large-Round Based) — Install large round-based snubbers across a span of three planks and are in-line with front and back of equipment. Install a minimum of two 5/8-inch though bolts.

B. Snubber Type II (Small-Round Based) — Install small round-based snubbers on one plank and in-line with poles. Install a minimum of two 5/8-inch through-bolts.

C. Snubber Type III (Square Based) — Install square-based snubbers on all four corners of square-based equipment. Install a minimum of three 5/8-inch through-bolts.

Note: Apply strips of foam protective tape to cover the inside surface of each snubber to avoid metal to metal contact with the equipment.

See Figure DC 640–7 and Figure DC 640–8 for snubber types and proper platform placement.

Table DC 640–4: SAP Numbers for Snubber Materials

Item	Description	SAP
1	Type I Snubbers (Round-Base)	10178294
2	Type II Snubbers (Round-Base)	10178591
3	Type III Snubbers (Square-Base)	10179217

Figure DC 640–7: Snubbers Type I and Type II for Round-Based Equipment

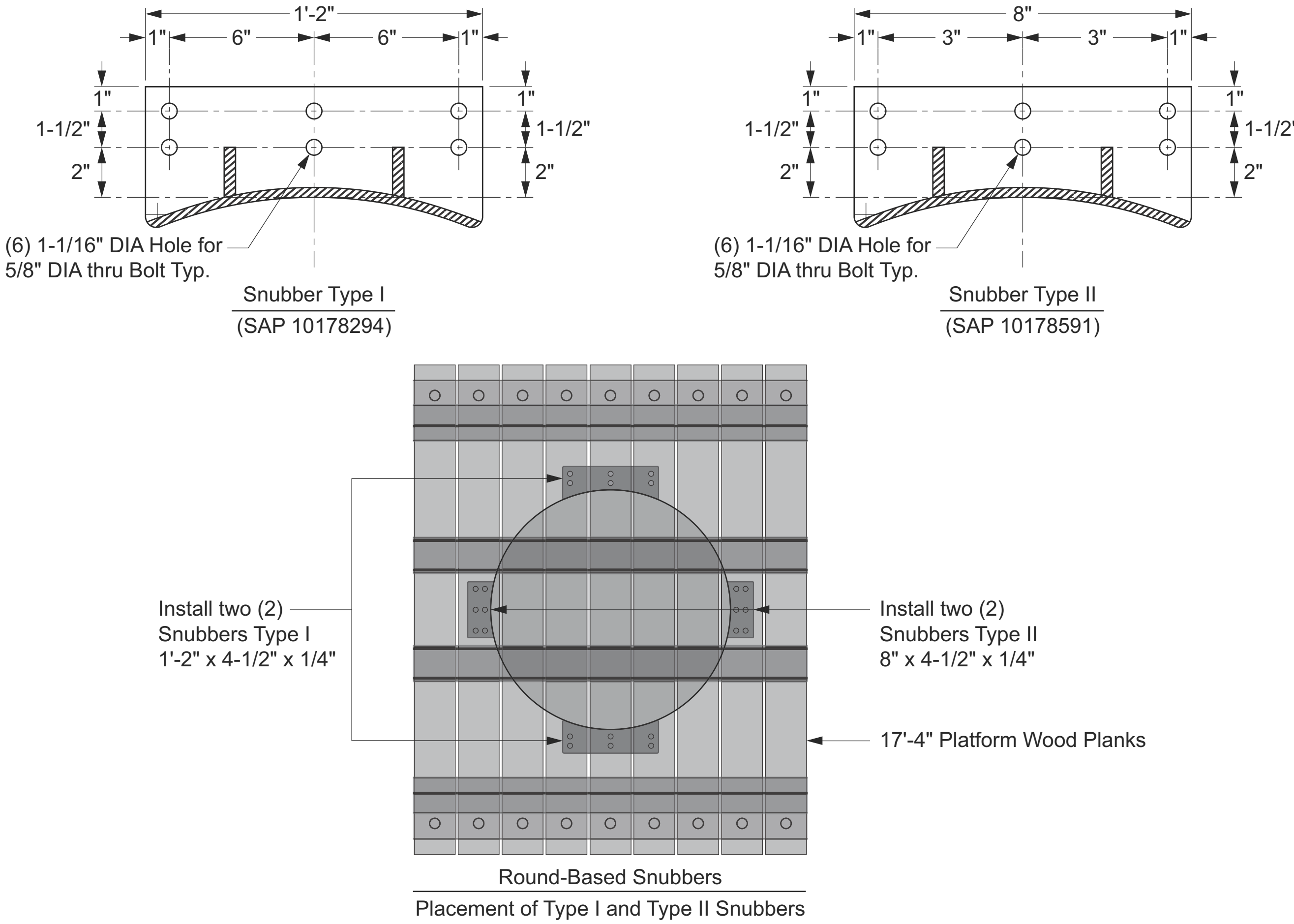
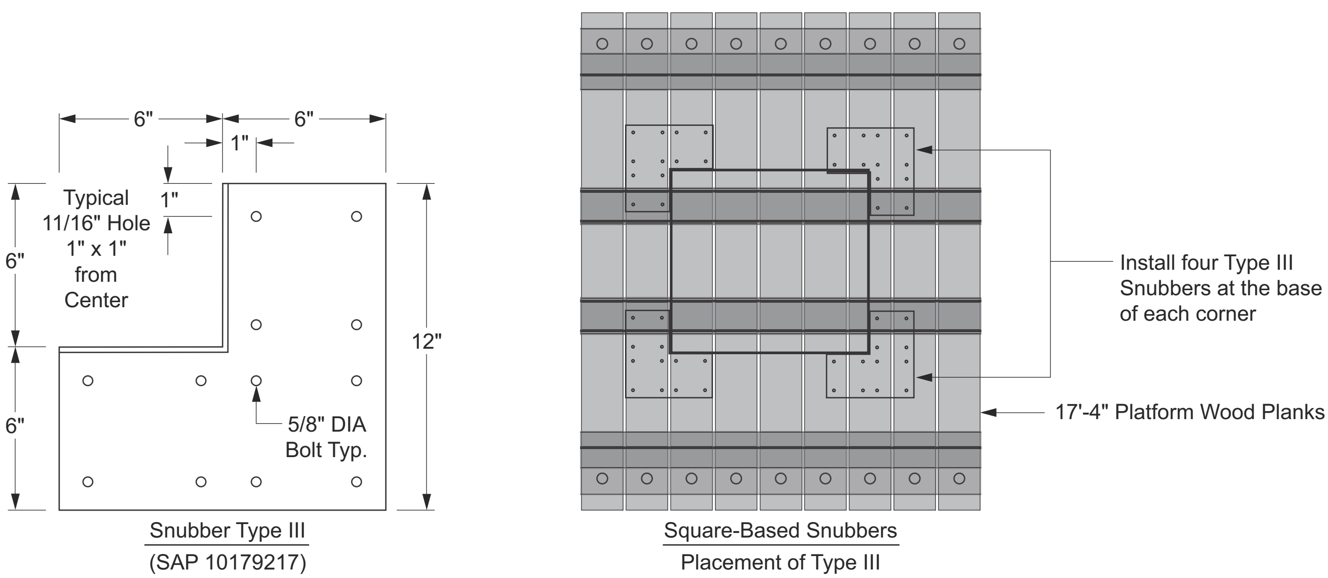


Figure DC 640–8: Snubbers Type III for Square-Based Equipment



Overhead Platform Rack Structures

Approved by:

What's Changed?

Effective Date: 08-25-2017

1.2 Cable Tie Down Assembly

Apparatus equipment placed onto the overhead platform rack will require the installation of two cable tie down assemblies to secure the equipment in place. Install the cable tie down assembly between the equipment's lifting lugs and the wood platform planks, as shown in Figure DC 640–9 for transformers larger than 167 kVA. For 167 kVA transformers and smaller see Figure DC 640–10. For details on the retrofit of the 13'-6" platform rack, see Table DC 640-6 and Figure DC 640-11.

Table DC 640–5: Equipment Cable Tie Down Assembly Materials

Item	Description	SAP
1	Cable Tie Down Assembly:	
	Clevis, Electrical Type, 18,000 LB Rating	10067656
	Thimbleye, 2" × 4" Size	10068524
	9/32" Guy Wire	10067958
	Dead End, 9/32" and 5/16" Stranded STL Guy Wire Conductor, Automatic Short Bail Kind	10067504
	Cable Hold-Down Roller Adapter[a/]	10183302

[a/] Transformer cable hold-down roller adapter will be required for anchoring 167 kVA or smaller transformers only (see Figure DC 640–10).

Figure DC 640–9: Installation of Cable Tie Down Assembly for Transformers Larger than 167 kVA

Cable Tie Down Assembly

Assembly Anchored to Lifting Lugs

Assembly Anchored to Platform Planks

Note(s):

1. Span guy fixture may be rotated to provide sufficient clearance between cooling fins.
2. Apply strip of protective foam tape (SAP 10178998) to cooling fin if sufficient clearance cannot be achieved.
3. For retrofit applications, use an additional 2" × 6" × 0'-6" Long Plank at the cable tie down anchor. See detail 1 of Figure DC 640-11.

Figure DC 640–10: Installation of Cable Tie Down Assembly for Transformers 167 kVA and Smaller

Cable Tie Down Assembly with Cable Hold-Down Roller Assembly

Cable Hold-Down Roller Adapter for 167 kVA Transformers and Smaller

Assembly Anchored to Platform Planks

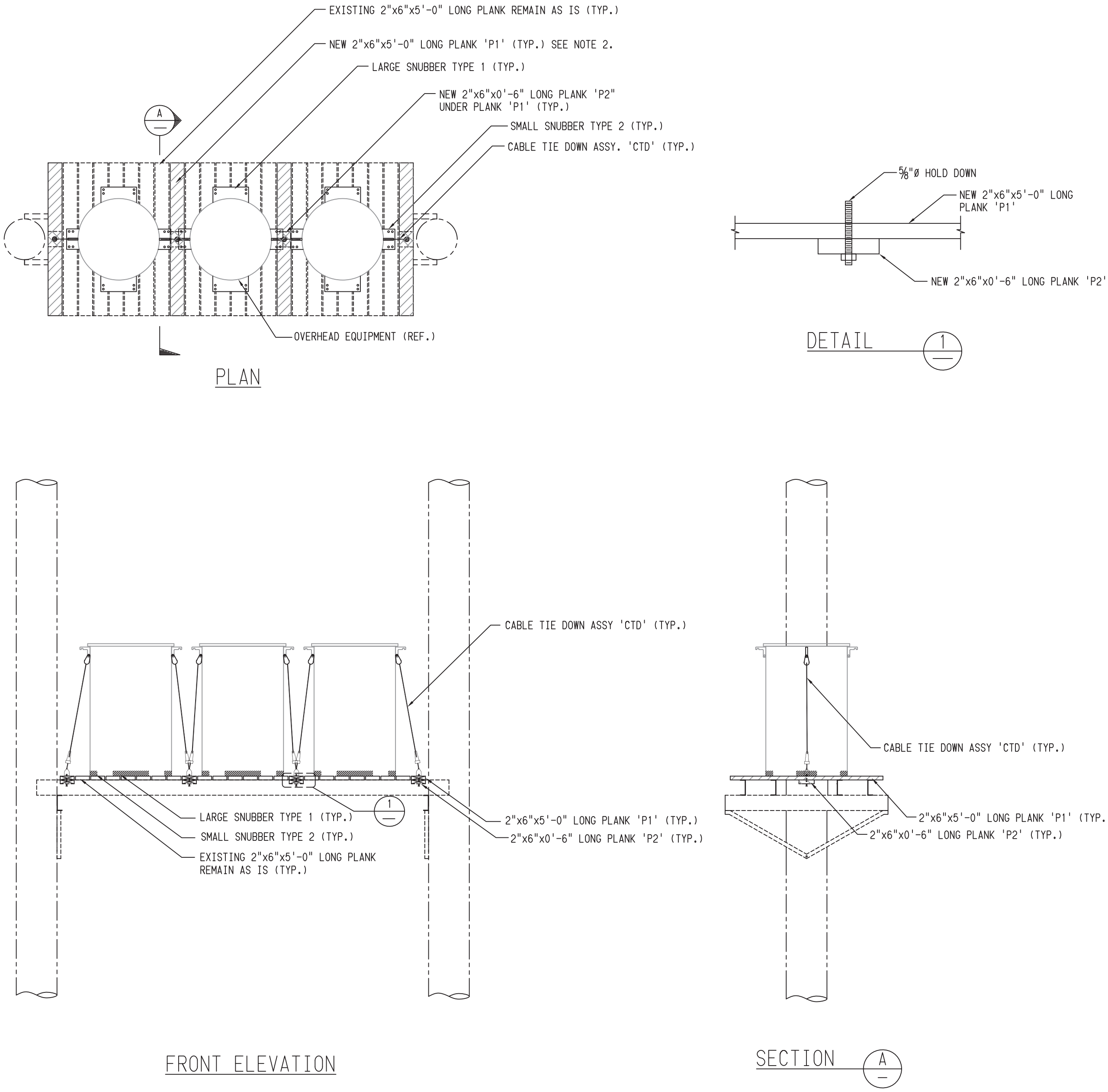
Note(s):

1. Span guy fixture may be rotated to provide sufficient clearance between cooling fins.
2. Apply strip of protective foam tape (SAP 10178998) to cooling fin if sufficient clearance cannot be achieved.
3. For retrofit applications, use an additional 2" × 6" × 0'-6" Long Plank at the cable tie down anchor. See detail 1 of Figure DC 640-11.

Table DC 640–6: Cable Tie Down Required Material

MATERIALS REQUIRED FOR ONE PLATFORM		
6	EA.	CABLE TIE DOWN ASSEMBLY 'CTD' SAP : 10067656 SAP : 10068524 SAP : 10067958 SAP : 10067504 SAP : 10183302
5	EA.	2"x6" PLANK SAP : 10060224
6	EA.	LARGE SNUBBER TYPE 1 SAP : 10178294
6	EA.	SMALL SNUBBER TYPE 2 SAP : 10178591

Figure DC 640–11: Cable Tie Down Assembly Details



Note(s):

1. Construction Site Representative shall verify location of lifting lugs to their respective cable tie down installation on the existing platform.
2. Replace existing plank and install plank “P1” and “P2” at the tie down anchor.

Approved by:

What’s Changed? Added Figure DC 640-11: Cable Tie Down Details and notes.

Effective Date:

08-25-2017

1.3 Wood Brace Assembly

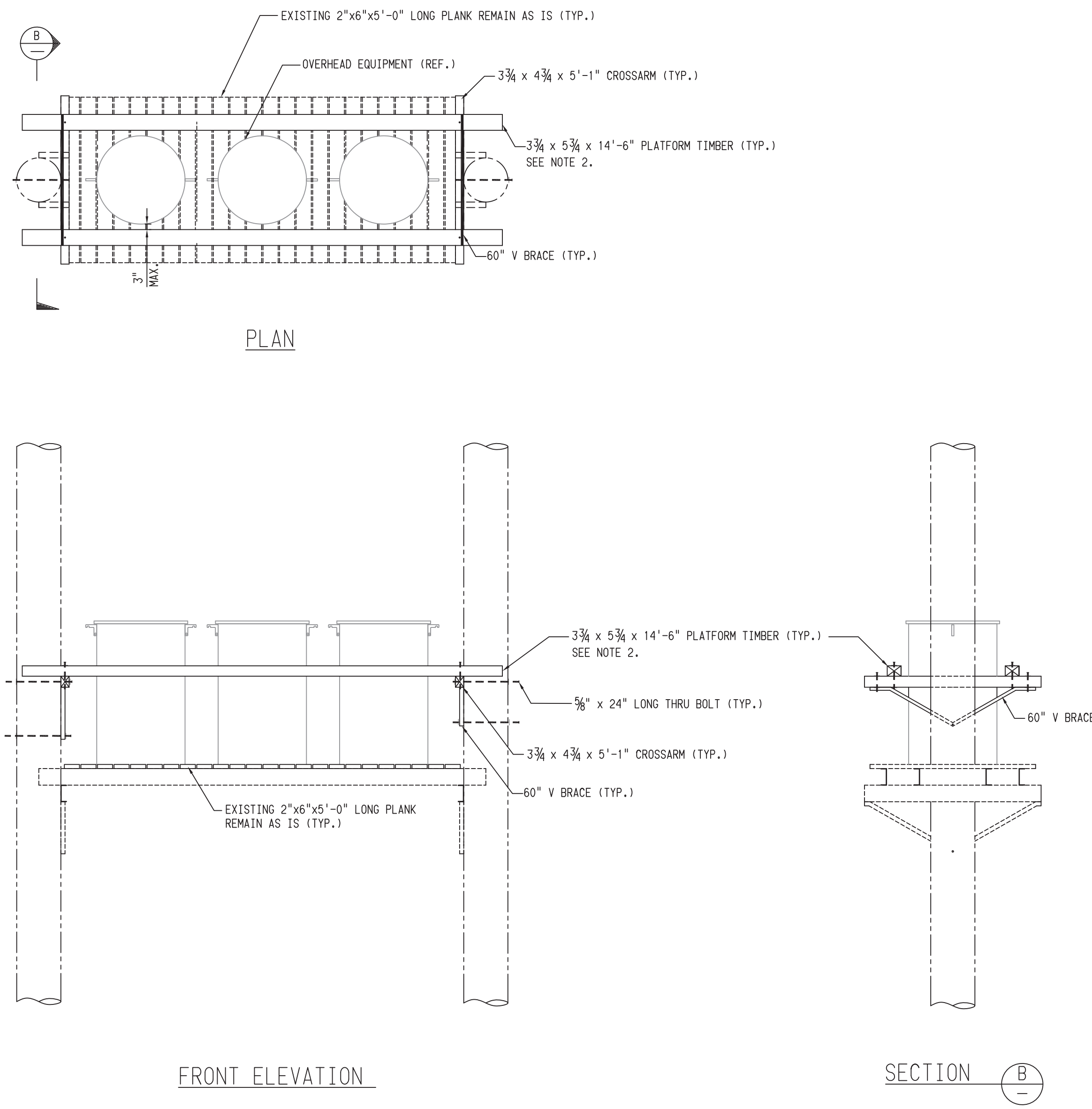
As a second option to the 13'-6" Retrofit Application, a wood brace assembly can be used to secure the apparatus equipment in place. This option can be used in place of the cable tie down method where space is restricted. For details on the wood brace assembly, see Figure DC 640-12.

Table DC 640–7: Wood Brace Assembly Required Materials

ATERIALS REQUIRED FOR ONE PLATFORM		
2	EA.	3¾ x 5¾ x 14'-6" PLATFORM TIMBER SAP : 10060277
2	EA.	3¾ x 4¾ x 5'-1" CROSSARM SAP : 10060281
4	EA.	⅝" Ø x 24" LONG THRU BOLT SAP : 10068969
8	EA.	⅝" Ø x 12" LONG THRU BOLT SAP : 10068963
2	EA.	60" V BRACE SAP : 10067347

What's Changed? Added Subsection 1.3 and Table DC 640-7: Wood Brace Assembly Required Materials.

Figure DC 640–12: Wood Brace Assembly Details



Note(s):

1. Holes shall not be more than 1/16" off longitudinal center.
2. Platform timbers shall be installed horizontally.

Overhead Platform Rack Structures

Approved by:

What's Changed? Added Figure DC 640-12: Wood Brace Assembly Details and notes.

Effective Date:

08-25-2017

DOH–GR: Grounding Bonds and Insulators

TABLE OF CONTENTS

STANDARD **TITLE**

GR 100 Grounding — General Requirements

Scope GR 100.1 Grounding Applications Involving Wood Poles

1.0 General Information

1.1 Ground wires are to be attached to the ground electrodes. Two standard 8-foot ground rods will meet the requirements of General Order (G.O.) 95.

1.2 Driven ground rods shall be installed 8 feet into the ground.

1.3 Ground conductors, running laterally under the ground, must be a minimum of 18 inches below finished grade. The tops of the ground rods must be 12 inches below grade.

1.4 Ground conductors and their connections shall be located to minimize breakage or mechanical disturbance.

1.5 Ground conductors are not to be less than #6 copper. See GR 106 for size requirements.

1.6 No fuse, switch, cutout, or other device shall be inserted in the ground conductor. No splices or connections except those made with a screw-clamp-type or compression connector.

1.7 Ground conductors must clear all equipment not intended to be grounded by not less than 1-1/2 inches. Equipment must be installed to maintain this clearance under all conditions.

2.0 Requirements for Application of Preferred Grounding Method Using Protected Ground Wire

2.1 Staples with protective pad shall be used on protected ground wire (PGW) with integral protective covering. Staples will be installed to hold the ground wire in place without damaging the protective covering.

2.2 The maximum distance between the staples on protected ground wire is 30 inches on poles and 18 inches on the crossarm.

2.3 Ground conductors attached to the underside of the arm will be covered with approved covering throughout their entire length. PGW meets this requirement without additional covering. See GR 107 for surge arrester grounds under the crossarm.

2.4 One vertical run of protected ground wire is allowed in the climbing space without the use of wood molding.

2.5 When in theft or vandalism areas, protected ground wire may be covered with 1-inch PVC or U-shaped molding to 8 feet above finished grade. Exposed connections shall be covered with a bolt cover or U-shaped molding.

3.0 Requirements for Application of Alternate Grounding Method Using Wood Molding over Bare Ground Wire

3.1 Nails shall not be driven into ground molding or PVC conduit. Straps or staples shall be used to hold molding or PVC conduit in place.

3.2 When bare ground conductor is used with wood molding on a pole or arm, 1-inch staples shall be used over the molding. The maximum distance between molding staples on poles is 36 inches. The maximum distance between molding staples on arms is 18 inches.

3.3 Only one wood-covered ground wire is permitted in the climbing space. In rack construction, grounds are not permitted in the climbing space per G.O. 95, Rule 54.9-F.

3.4 Bare ground conductors are to be covered with wood molding, or PVC conduit, throughout their entire length. The PVC conduit is not permitted in the climbing space per G.O. 95, Rule 22.2-A.

4.0 Secondary Circuits

4.1 All single-phase circuits not exceeding 250 V shall have the neutral point of the transformer grounded per G.O. 95, Rule 58.3-C1.

4.2 All three-phase circuits not exceeding 250 V shall have either a phase or neutral grounded per G.O. 95, Rule 58.3-C(1)(c).

4.3 Ground conductors shall be attached to main secondary lines. Connections to branch lines or to neutral conductor on service arms are not approved.

4.4 Except where permitted by G.O. 95, ground wire for transformers shall be located on the same pole as the transformer. In no case shall it exceed one span from the transformer pole.

4.5 Ground electrodes and conductors for grounding secondary circuits shall not be located on the same pole with surge arrester and primary neutral grounds whenever possible (see Paragraph 5.1, Sheet 3 and GR 110). Where this is not practical, grounding of these systems shall be separated by a distance of not less than 6 feet (see Paragraph 5.2, Sheet 3 and GR 110).

4.6 Where driven grounds are used to ground two or more pieces of equipment on the same pole, the sets of ground rods shall be bonded together below grade.

5.0 Surge Arresters

5.1 Surge arresters, when placed on a pole for the protection of apparatus or transformers, shall be located on the same pole as the apparatus or transformer. In this case, the secondary neutral ground shall be placed on an adjacent pole whenever possible.

5.2 Where secondary neutral grounds cannot be placed in accordance with Paragraph 5.1 above, place the secondary neutral ground on the same pole as the arrester ground. The surge arrester ground conductor is to be installed a minimum distance of 6 inches from all other ground conductors on the pole. In this situation, place two separate sets of ground rods (one set for the arresters, and one set for the secondary neutral) not less than 6 feet apart between the different sets. The set of ground rods for the surge arrester shall be the set closest to the pole.

5.3 Ground conductors for surge arresters shall be as short and as free of bends and angles as possible.

5.4 For RCS and AR installations with dedicated transformers, the surge arresters, secondary neutral, and any utility supply equipment cases shall be connected to a common ground. Refer to the equipment-specific installation standards for further details.

6.0 Bond Wires

6.1 Grounded guy wires are not to be used as the grounding medium for bond wires. Bond wire that is intended to be grounded shall have a separate ground installed. Grounded guys are to clear bond wires by not less than 1-3/4 inches.

7.0 Cases or Frames of Equipment

7.1 Where a metering installation employs current and potential transformers, the common point of the instrument transformer secondaries shall be grounded.

7.2 The cases, or hangers, of all transformers, including instrument transformers for meters, that are located less than 8 feet from the ground shall be grounded.

7.3 Pole- or-rack mounted cases of 33 kV transformers and all automatic reclosers shall be grounded. “Caution Case Grounded” signs shall be installed within the climbing space of the structure.

7.4 On 115 kV and 66 kV lines where an overhead ground wire is attached to the pole, the bonding system will be attached to the ground wire. This will create a completely grounded structure. If any of the subject poles are supported by grounded guys, the grounded guys will be attached to the bonding system. In cases where steel wishbone crossarms are used, the ground wire will be attached to the steel arms at the location on the lower arm provided for this purpose. Where distribution circuits of 12 kV, 16 kV, or 33 kV are attached, and it is necessary to ground the distribution circuit bond wire, a separate ground will be provided. This ground shall be separated from the transmission ground wire by one-quarter the circumference of the pole.

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GR 103 Grounding — Lightweight Steel Poles

Scope GR 103.1 Grounds and Attachments Made to Lightweight Steel Poles

Grounds, transformer attachments, and hardware attachments shall be made to LWS poles with a T-connector if a welded connector mount is available at the appropriate height. Otherwise the attachment shall be made with a through-bolt. (See Figure GR 103–2 [Sheet 2] through Figure GR 103–3 [Sheet 3]).

Figure GR 103–1: Installation of a T-Connector and a Ground Wire in a Welded Connector Mount

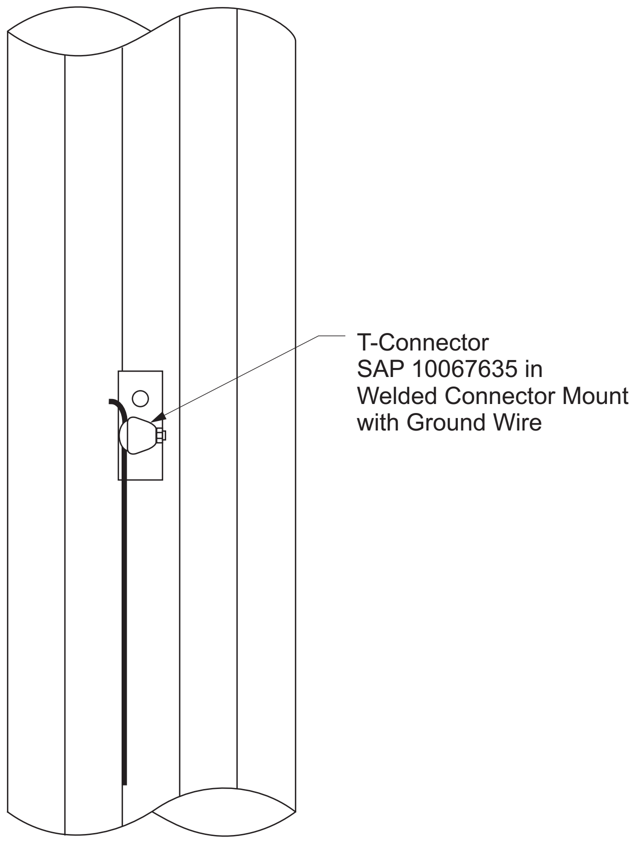
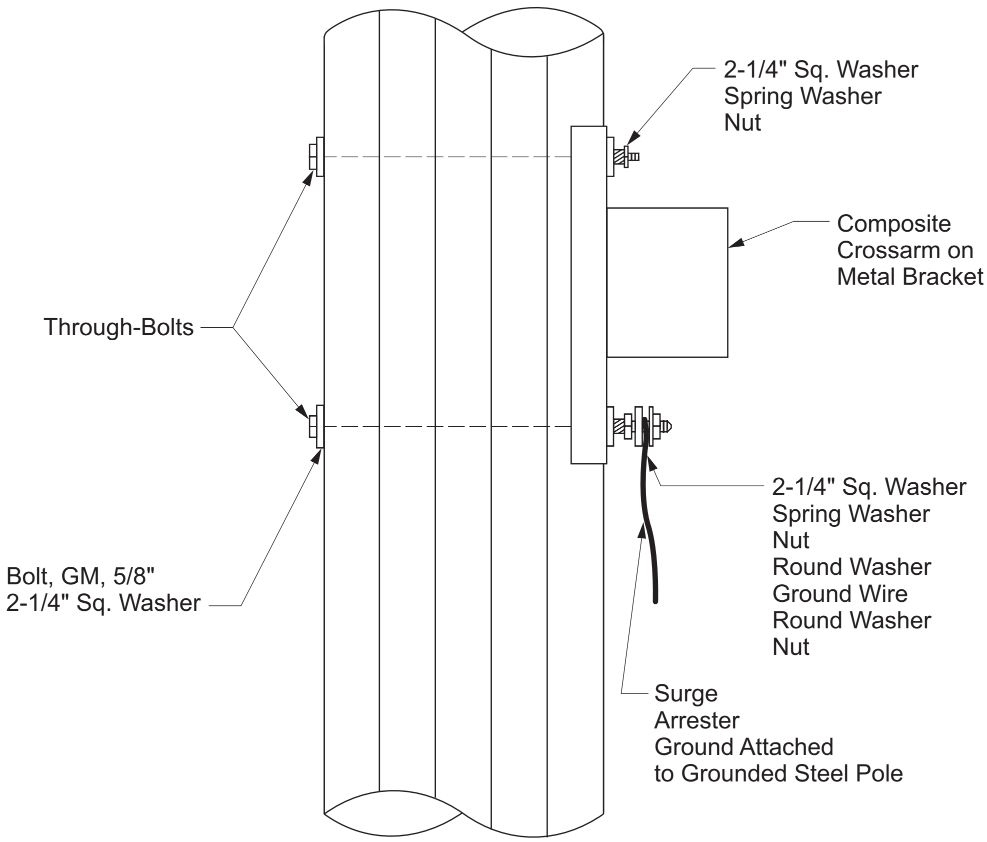


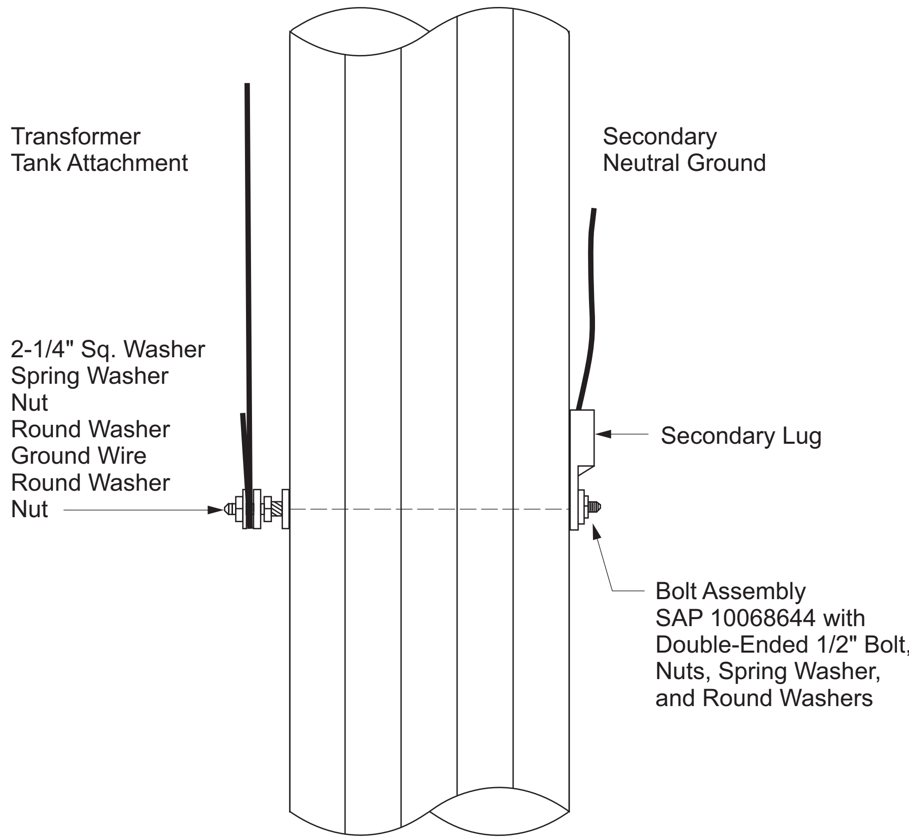
Figure GR 103–2: Installation of a Surge Arrester Ground Using a Crossarm Bracket Through-Bolt



Note(s):

1. Do not attach crossarm hardware bond wire to the grounded steel pole.

Figure GR 103–3: Installation of a Transformer Tank Attachment and Secondary Neutral Ground using the Same Through-Bolt



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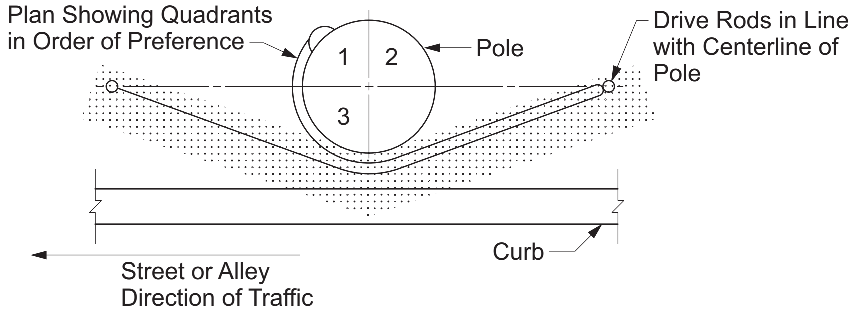
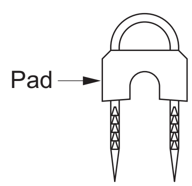
GR 105 Grounding — Wood Poles

Scope GR 105.1 Preferred Grounding Installation on Wood Poles Using Protected Ground Wire (PGW) with Integral Protective Covering

Figure GR 105–1: Preferred Grounding — Wood Poles, Part 1



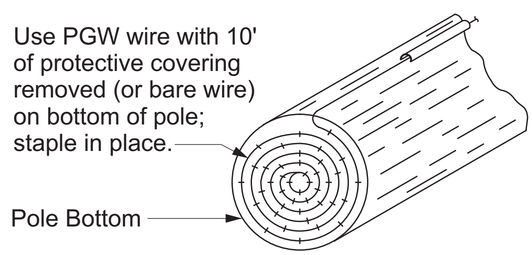


Approved Staple w/ Pad
For use on ground wire with protective cover.

Space staples every 30" MAX.

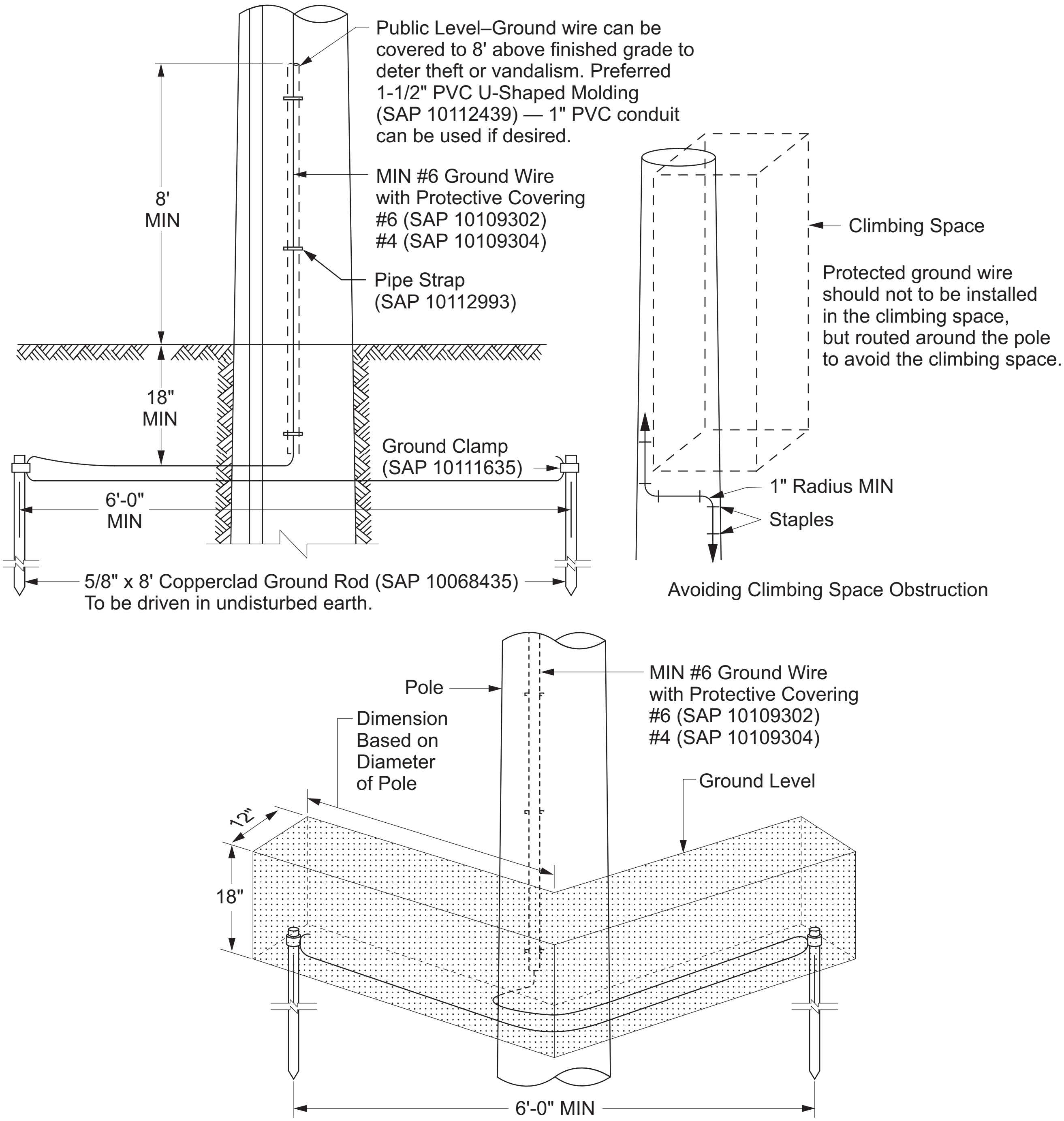
#6 (SAP 10069797) - Use 3/8" staple, pad color gray.
#4 (SAP 10069794) - Use 7/16" staple, pad color black.

NOTE: To avoid damage to the protective covering, do not over-drive staple.



Use in rocky soil where impossible to drive ground rods.

Figure GR 105–2: Preferred Grounding — Wood Poles, Part 2

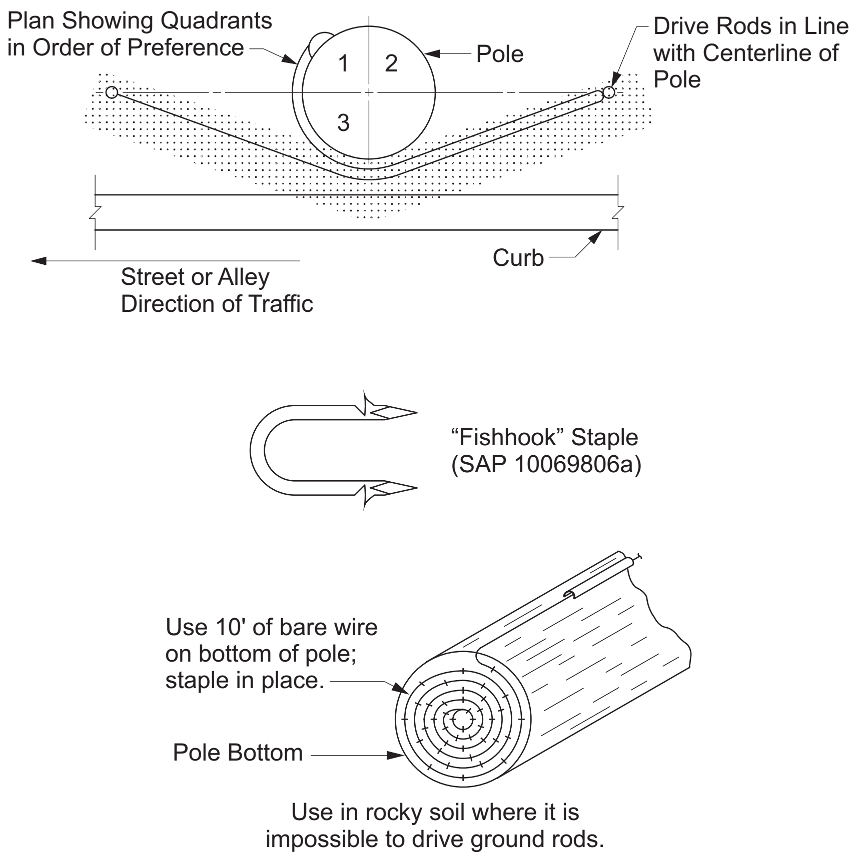


Note(s):

1. If installation in the climbing space cannot be avoided, the PGW may be used without wood molding.
2. Ground wires are not allowed in climbing space of rack construction.

Scope GR 105.2 Alternate Grounding Installation on Wood Poles Using Wood Molding and Bare Ground Wire

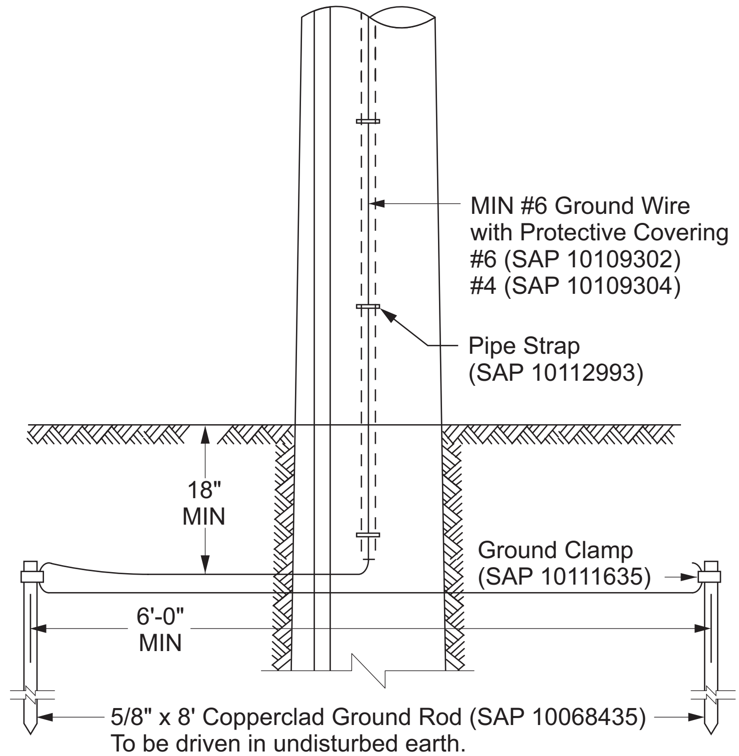
Figure GR 105–3: Alternate Grounding — Wood Poles, Part 1

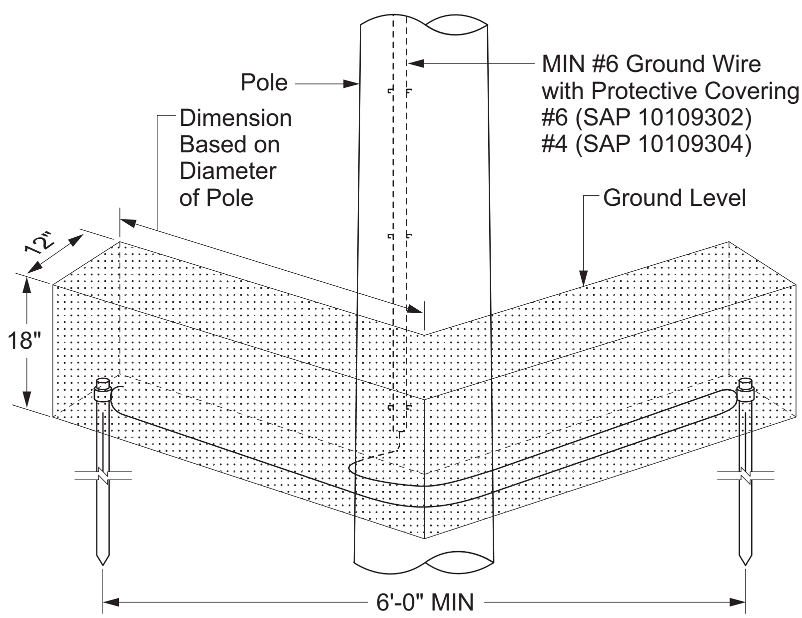


Note(s):

1. Use only where PGW cannot be used or on existing wood molding installations.

Figure GR 105–4: Alternate Grounding — Wood Poles, Part 2





GR 106 Transformer Ground Conductor Size Requirements

Scope GR 106.1 Transformer Ground Conductor Size Requirements

Table GR 106–1: Single Phase Transformers

kVa Size	Minimum Ground Wire Size
25–100	#6 PGW[a/]
167	#4 PGW

[a/] Protected Ground Wire

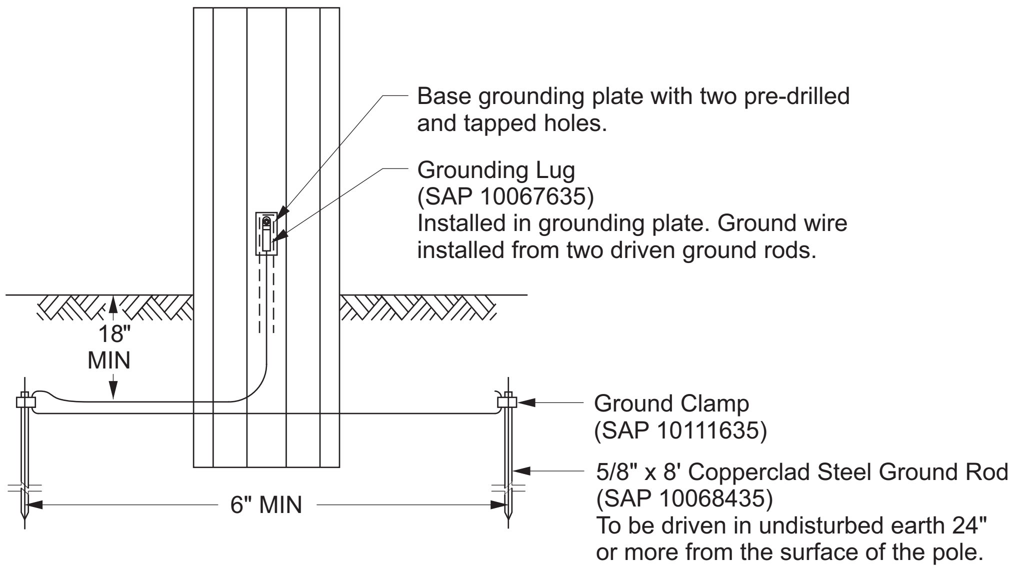
Table GR 106–2: Three Phase — Bank/Transformer

kVa Size	Minimum Ground Wire Size
75–300	#4 PGW
500–750	#2 BC[a/]
1,000–2,500	#2/0 BC
3,750	#4/0 BC

[a/] Bare Copper

Scope GR 106.2 Grounding of Subtransmission Light Duty Steel Poles

Figure GR 106–1: Installation of Ground Rods Installed at the Base of a Steel Pole with a Coated Base



Note(s):

1. Install PVC cover (SAP 10068606) over the portion of the ground connection above ground. Attach with steel straps and #10 sheet metal screws (SAP 10071490) installed in field-drilled holes in pole.
2. Ground wire will be #4 Cu.
3. See PO 100.3 for reasons for these special requirements.

GR 107 Method of Securing Surge Arrester Ground under the Crossarm

Scope GR 107.1 Method of Securing Surge Arrester Ground under the Crossarm

Figure GR 107–1: Method “A” Using Pipe Straps

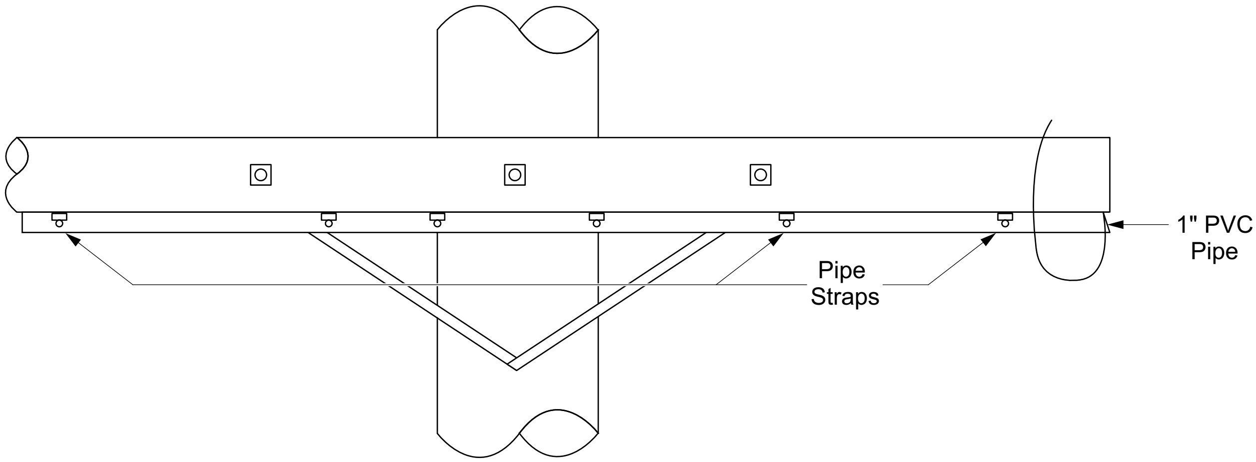
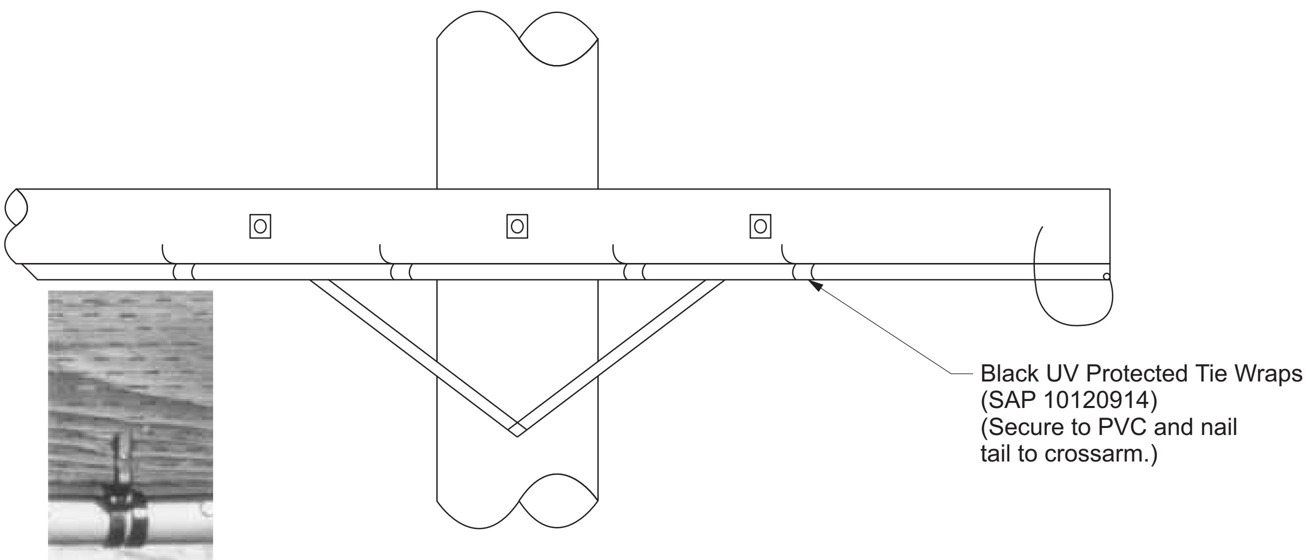


Figure GR 107–2: Method “B” Using Tie-wraps where Metal Clearance to Bond is Impaired



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GR 110 Establishing Neutral Grounds — 4-Wire System

Scope GR 110.1 Establishing Neutral Grounds — 4-Wire System

1.0 General Information

1. Primary neutral grounds shall be installed every 1,200 feet or less for 4 kV, 12/6.9 kV, and 16.4/9.4 kV 4-wire circuits. This spacing applies to the entire circuit including the feeder and all tap lines.
2. Each tap line, two spans or longer on 4 kV shall be ground at its outer ends.
3. Primary grounds shall not be located on the same pole with transformer secondary grounds whenever possible. The secondary neutral ground shall be placed on an adjacent pole.
4. Where secondary neutral grounds cannot be placed in accordance with Section 1.0, Paragraph 3, place the secondary neutral ground on the same pole as the primary neutral ground. In this situation, place two separate sets of ground rods (one set for the primary neutral and one set for the secondary neutral) not less than 6 feet apart between the different sets.
5. Contact Field Engineering for guidance on arrangement of grounds where the requirements of Section 1.0, Paragraph 3 and Section 1.0, Paragraph 4 cannot be met.

Figure GR 110–1: Establishing Neutral Grounds — 4-Wire System

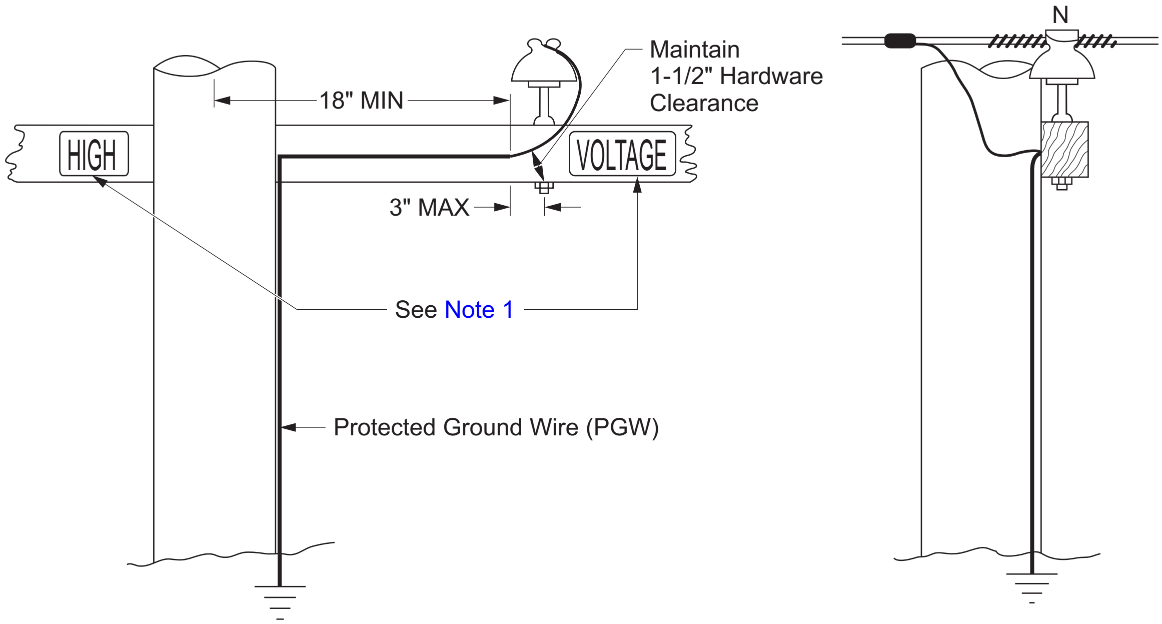


Figure GR 110–1.2: Preferred Method

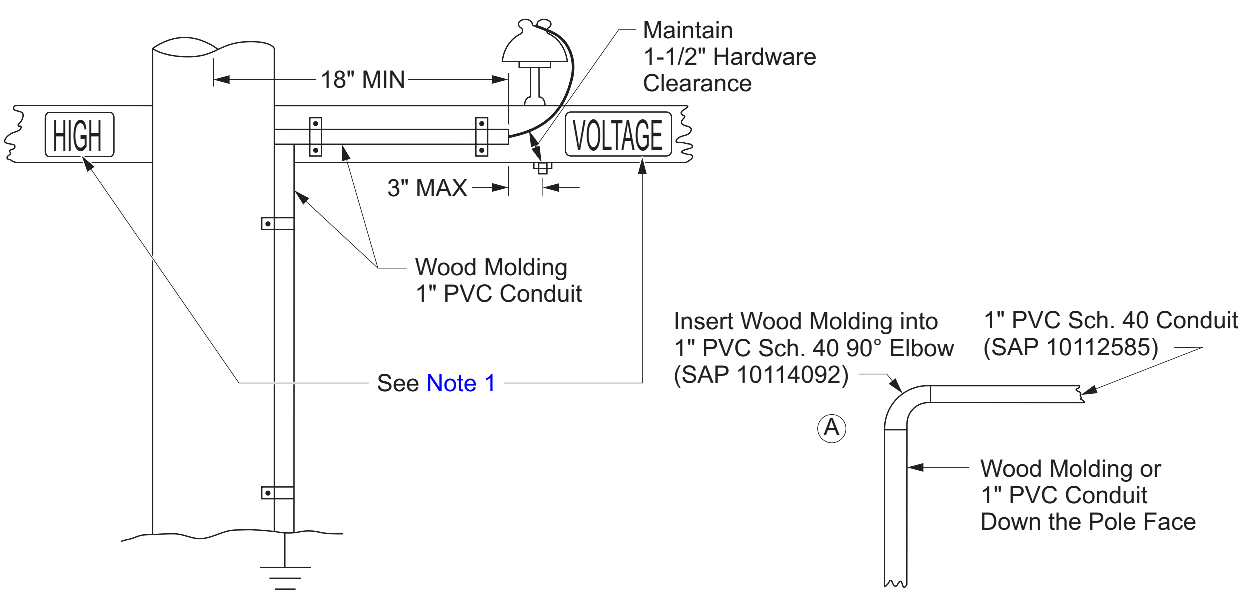


Figure GR 110–1.3: Alternate Method 1

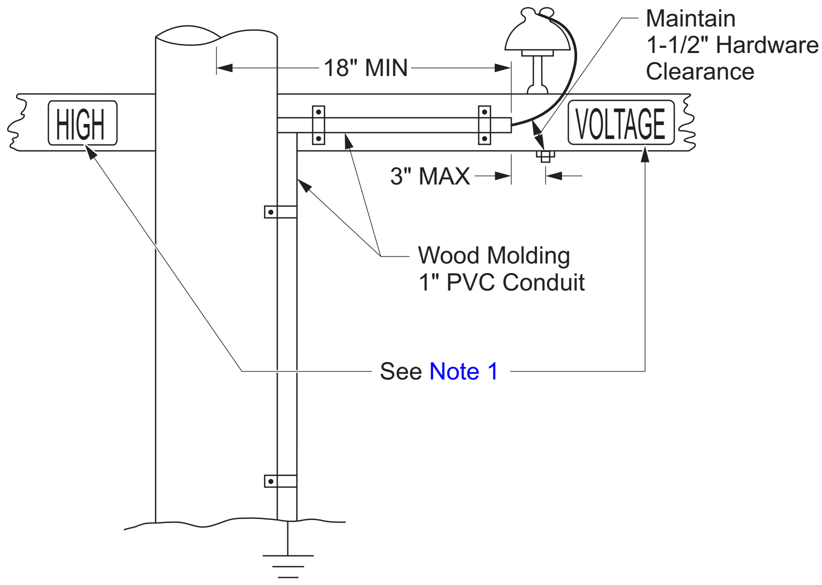


Figure GR 110–1.4 Alternate Method 2

Note(s):

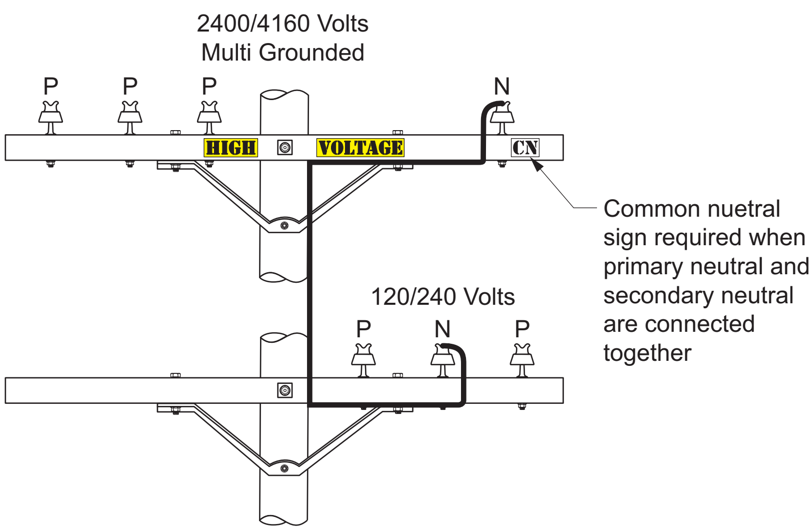
1. See PO 120 for HIGH VOLTAGE sign installation requirements.

Scope GR 110.2 4 kV Common Neutral System

The neutral conductor of a 4 kV primary circuit shall not be interconnected with the neutral conductor of a 0–750 Volts secondary circuit, except on existing “common-neutral” systems. No new “common-neutral” system shall be established without FE approval. Extension from existing “common-neutral” systems shall be reviewed by FE to determine “common-neutral” requirements. Where surge arresters are present with “common-neutral” construction, the surge arrester ground shall be separately grounded from the “common-neutral” ground.

A common neutral sign (SAP 10135292) on the crossarm at the primary neutral position facing the climbing space (see Figure GR 110–2) is required when both primary and secondary neutrals are connected together.

Figure GR 110–2: Common Neutral Sign



GR 111 Electrical Connection of Neutral Conductors to Lightweight Steel (LWS) Poles

Scope GR 111.1 Electrical Connection of Neutral Conductors to LWS Poles

1.0 Neutral to Pole Connections

1.1 Connect the neutral conductors of all primary and secondary circuits on subtransmission LWS poles to the grounded pole (with the exception of the neutral conductors of primary circuits with floating neutral protection). All neutral-to-pole connections will be made using conductor at least the same ampacity as the primary and/or secondary neutral conductor of the circuit. Connections to the primary neutral conductor will be made with two parallel groove connectors.

1.2 Primary neutral-to-pole connections shall be made to high-current grounding pads. The high-current grounding pad will be installed on the pole using through-bolts with spring washers. (See Figure GR 111–2 [Sheet 2].) Connections to the pad will be made with high-current rated lugs. The preferred pad location for grounding primary neutrals is above the neutral conductor.

Figure GR 111–1: Primary Neutral Connection to Steel Pole

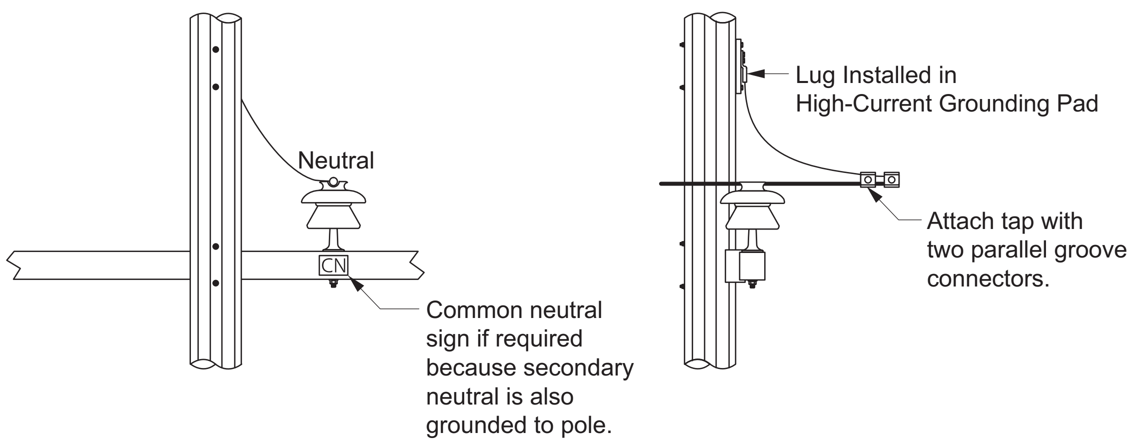


Figure GR 111–2: Primary Neutral Ground Pad Installation

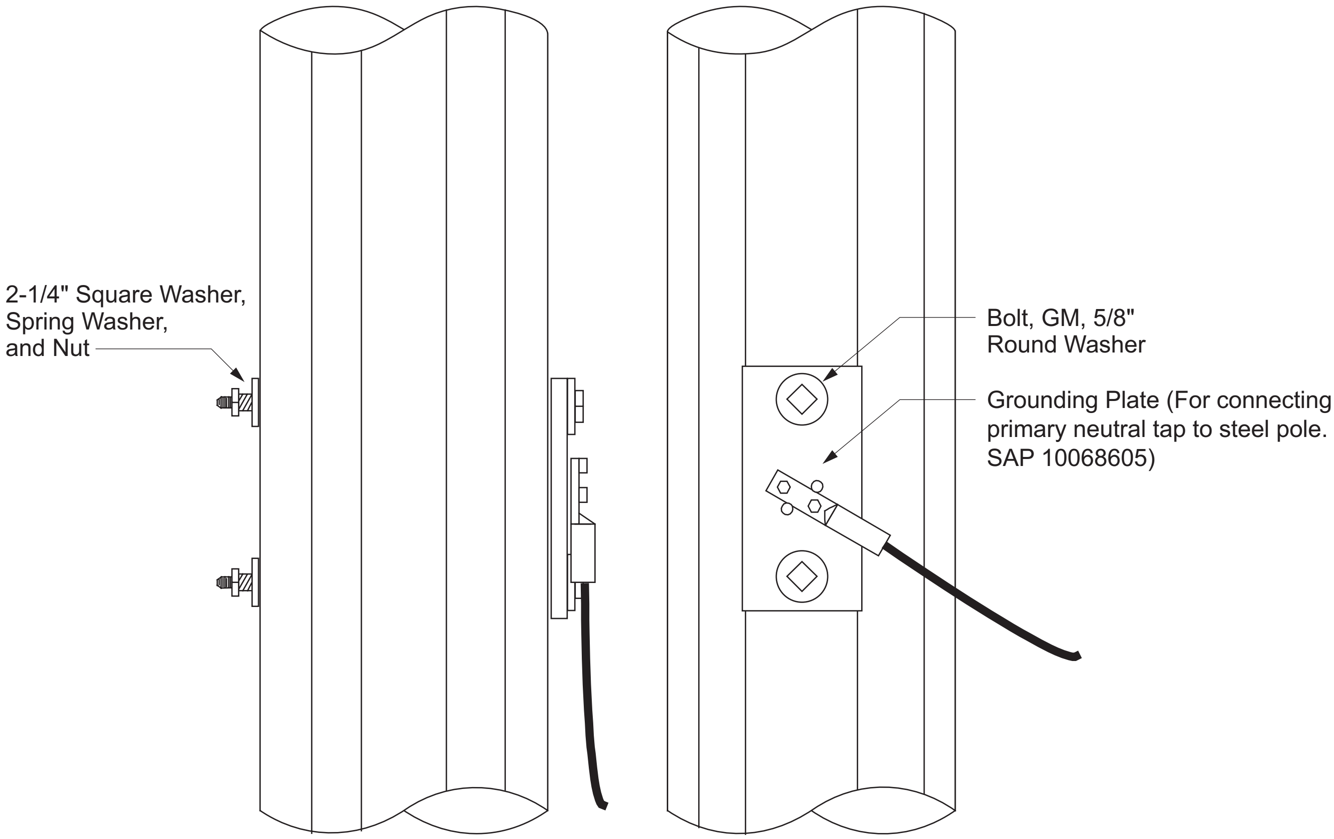


Table GR 111–1: Primary Neutral High-Current Ground Pad Installation

Neutral ACSR or Al	Lug	Parallel Groove Connector
#4	10112328	10112370
1/0	10112330	10112370
336 ACSR	10112310	10112368[a/]

[a/] For 336 ACSR, use two parallel groove connectors.

1.3 Secondary neutral-to-pole connections shall be made directly to the pole using secondary lugs attached to the pole with a single 1/2" GM through-bolt with spring and flat washers (see Figure GR 111–3 [Sheet 3]). Use the same conductor for tap and line. Connections to the neutral conductor will be made with parallel grove connectors.

Figure GR 111–3: Secondary Neutral-Pole Connection

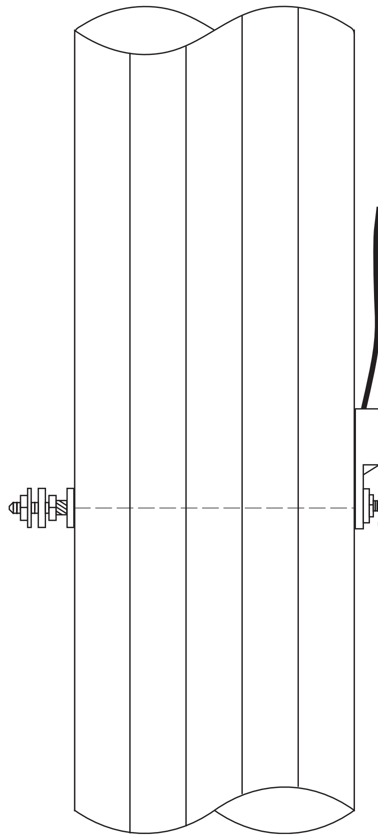


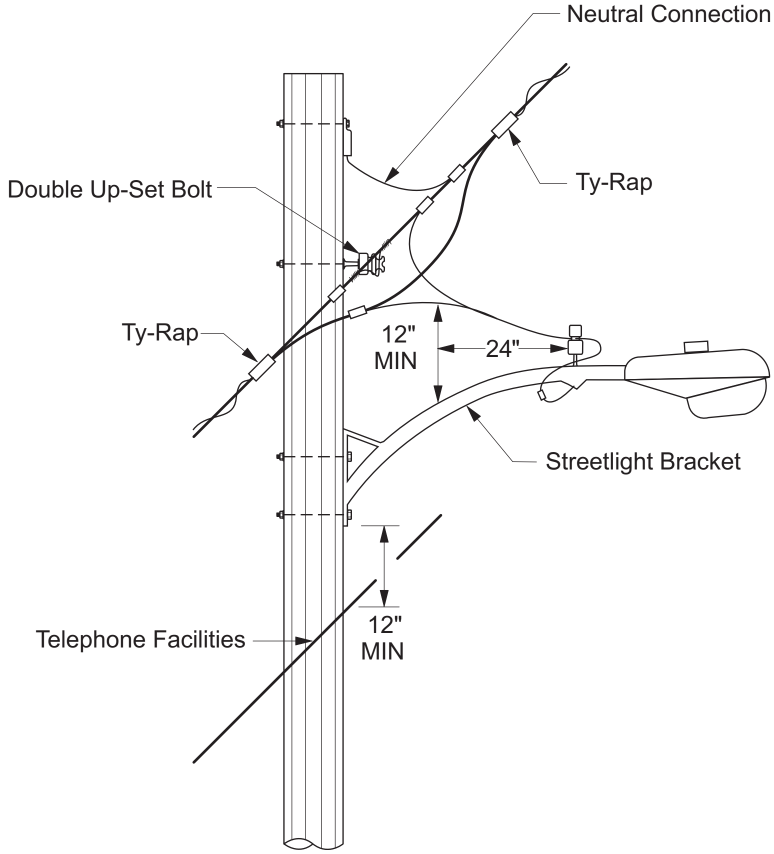
Table GR 111–2: Secondary Neutral Ground Installation

Neutral—Al	Lug	Parallel Groove Connector
#4	10112328	10112373
1/0	10112330	10112373
4/0	10112332	10112368
350	10112333	10112368

1.4 All neutral-to-pole connections shall be made outside of the climbing space.

1.5 A common neutral sign (SAP 10135292) on the crossarm at the primary neutral position facing the climbing space (see Figure GR 110–1 [Sheet 2]) is required when both primary and secondary neutrals are connected to the pole.

Figure GR 111–4: Streetlight Neutral Connection to Steel Pole



GR 120 Secondary Grounds on Transformers

Scope GR 120.1 Secondary Grounds on Transformers

Figure GR 120–1: One Transformer — Single-Phase Service Only

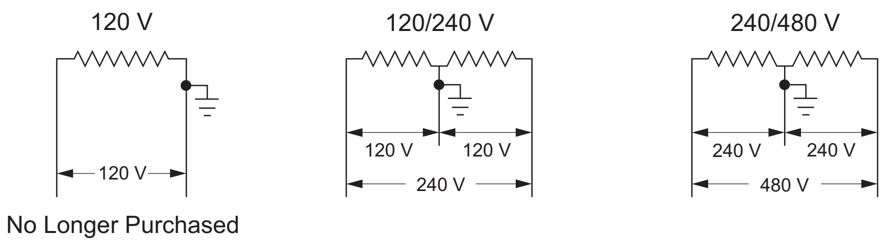
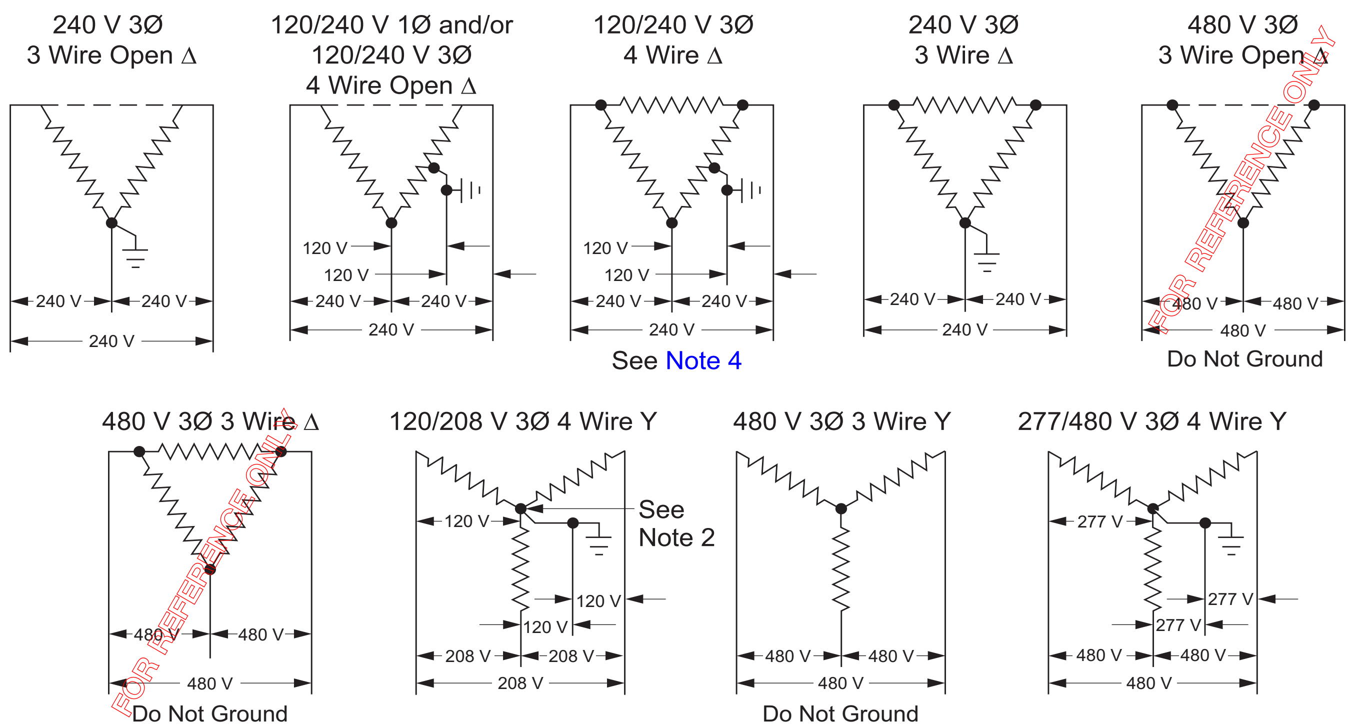


Figure GR 120–2: Bank of Two or Three Transformers — Single- and/or 3-Phase Services



Where light and power are served from separate transformers, each source shall have a separate ground connection.

Note(s):

1. Do not connect 3-phase, 3 wire services to 3-phase, 4 wire banks.
2. Use same size wire as phase wires for neutral interconnection on transformers.
3. On steel poles, all ground connections for transformers must be connected to the pole. Bond all transformers cases to the pole using #4 Cu conductor.
4. Before closing secondary delta leads, verify that the voltage across is less than 20 V. This connection between the leads must be made on the secondary rack.
5. 3-phase multi-conductor secondary and services can be constructed on a single roller where pole space is limited.

Figure GR 120–3: 120/240 V, 1Ø and/or 240 V, 3Ø, 4 Wire Open Delta
(2-1Ø Transformers With 120/240 V Secondary Windings)

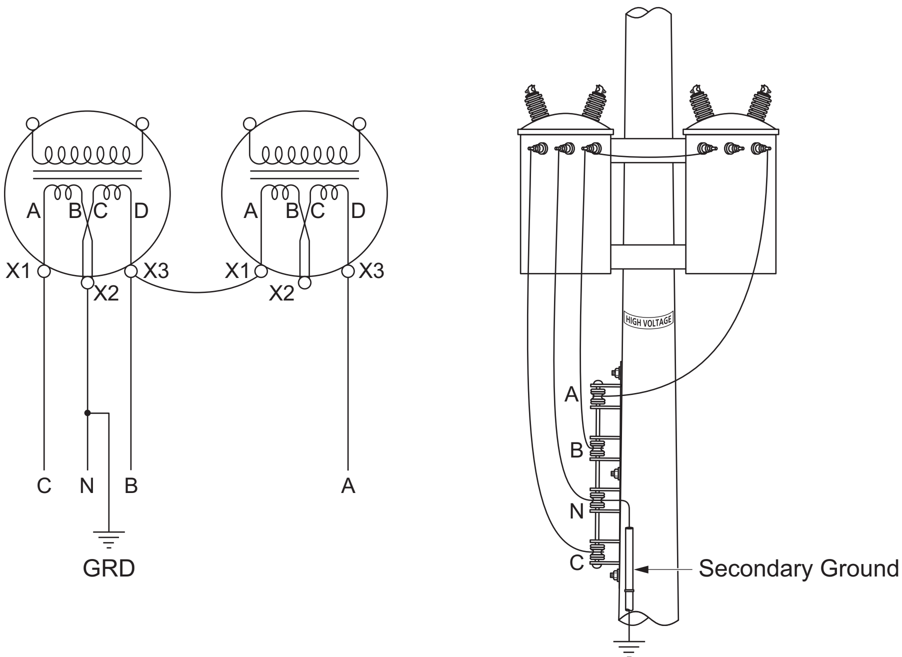
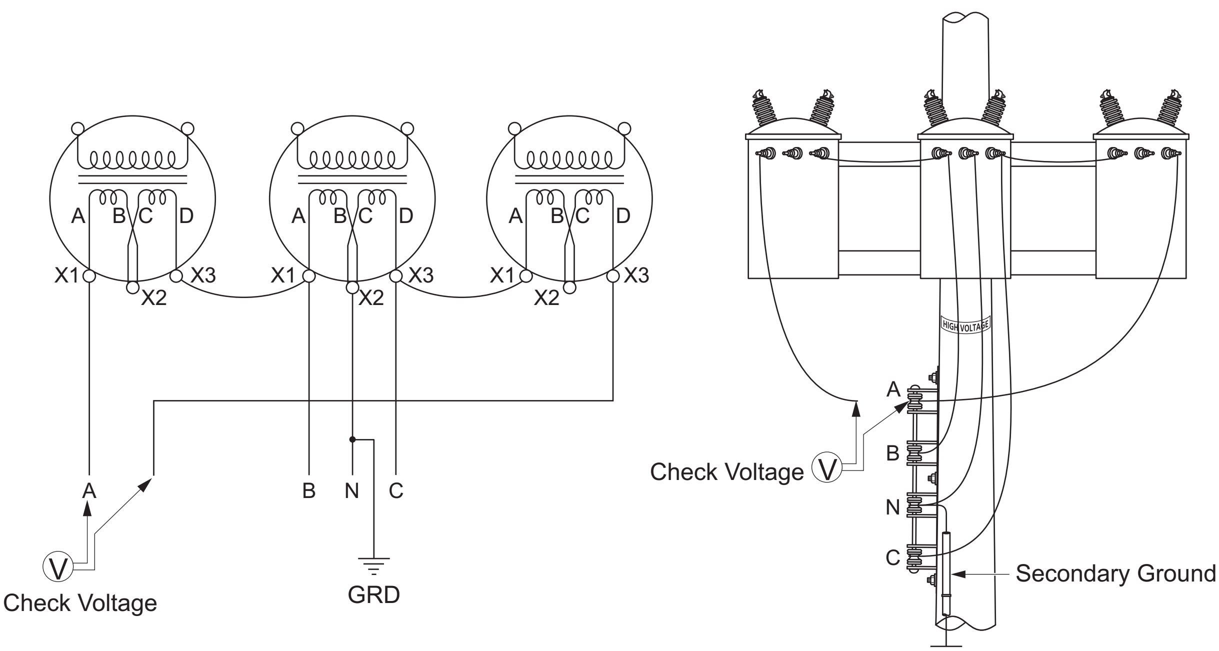
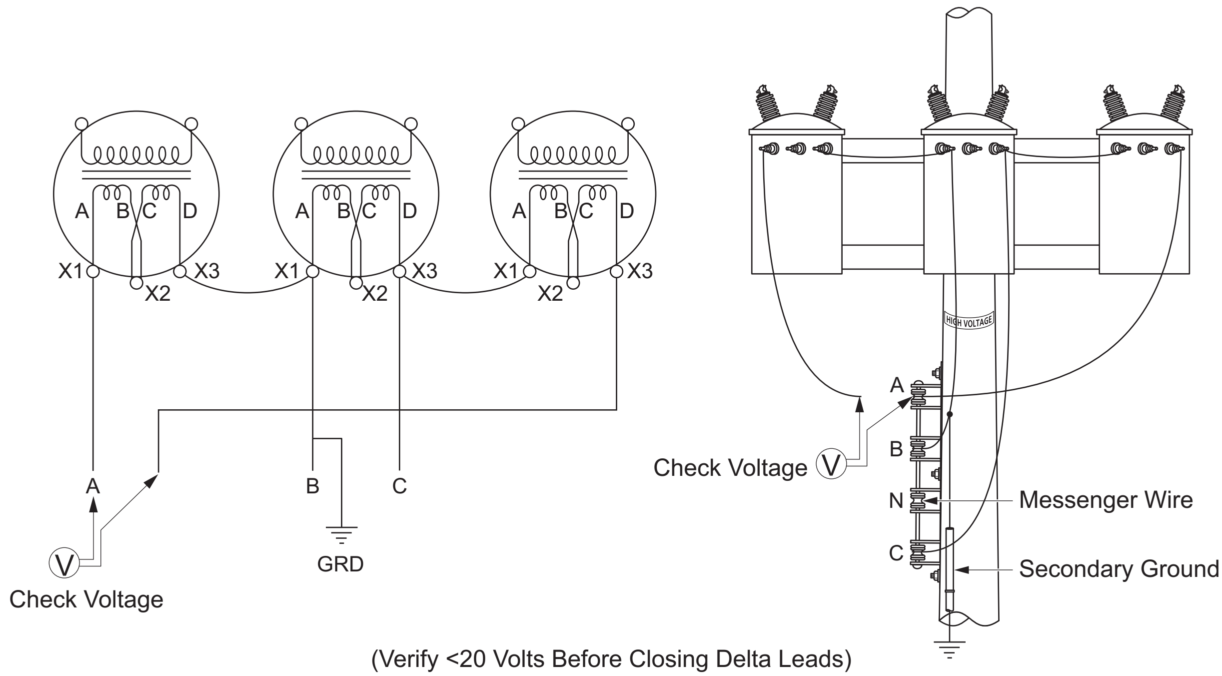


Figure GR 120–4: 120/240 V, 3Ø, 4 Wire Delta
(3-1Ø Transformers With 120/240 V Secondary Windings)



(Verify <20 Volts Before Closing Delta Leads)

Figure GR 120–5: 240 V, 3Ø, 3 Wire Delta, Corner Grounded
(3-1Ø Transformers With 120/240 V Secondary Windings)



(Verify <20 Volts Before Closing Delta Leads)

Figure GR 120–6: 480 V, 3Ø, 3 Wire Open Delta
(2-1Ø Transformers With 480 V Secondary Windings)

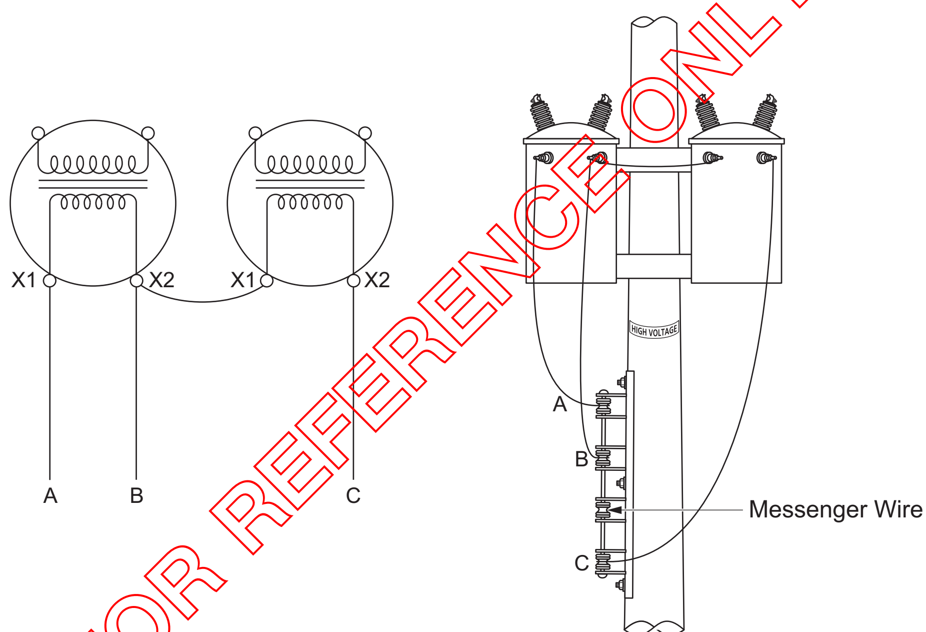


Figure GR 120–7: 480 V, 3Ø, 3 Wire Closed Delta
(3-1Ø Transformers With 240/480 V Secondary Windings)

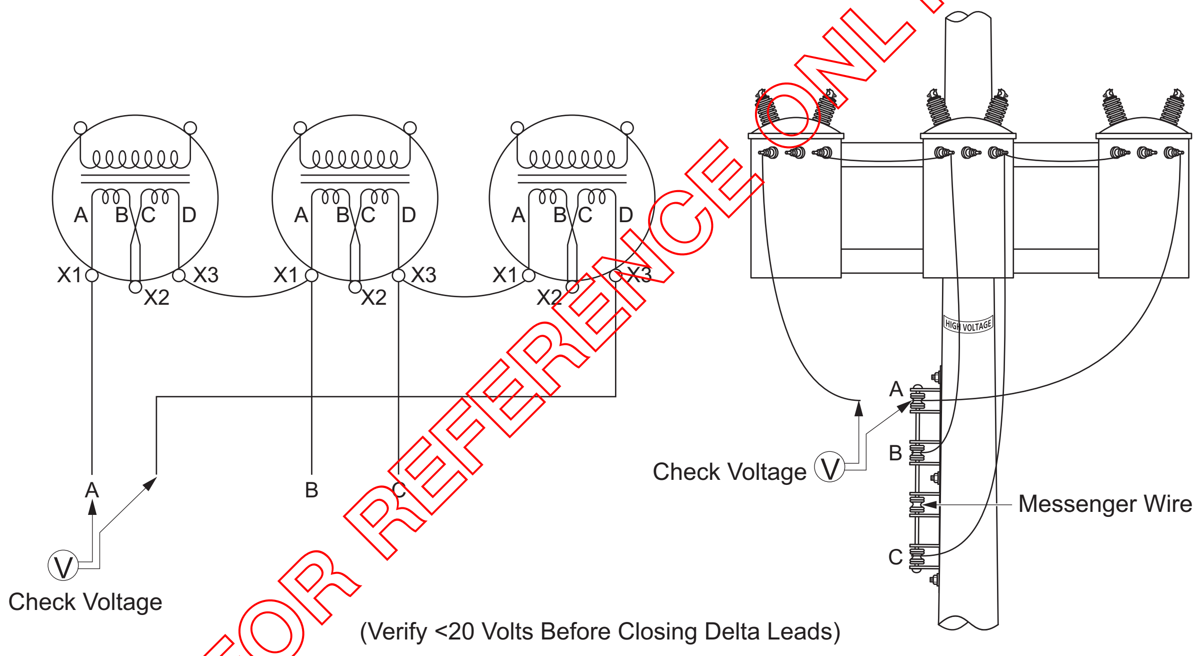
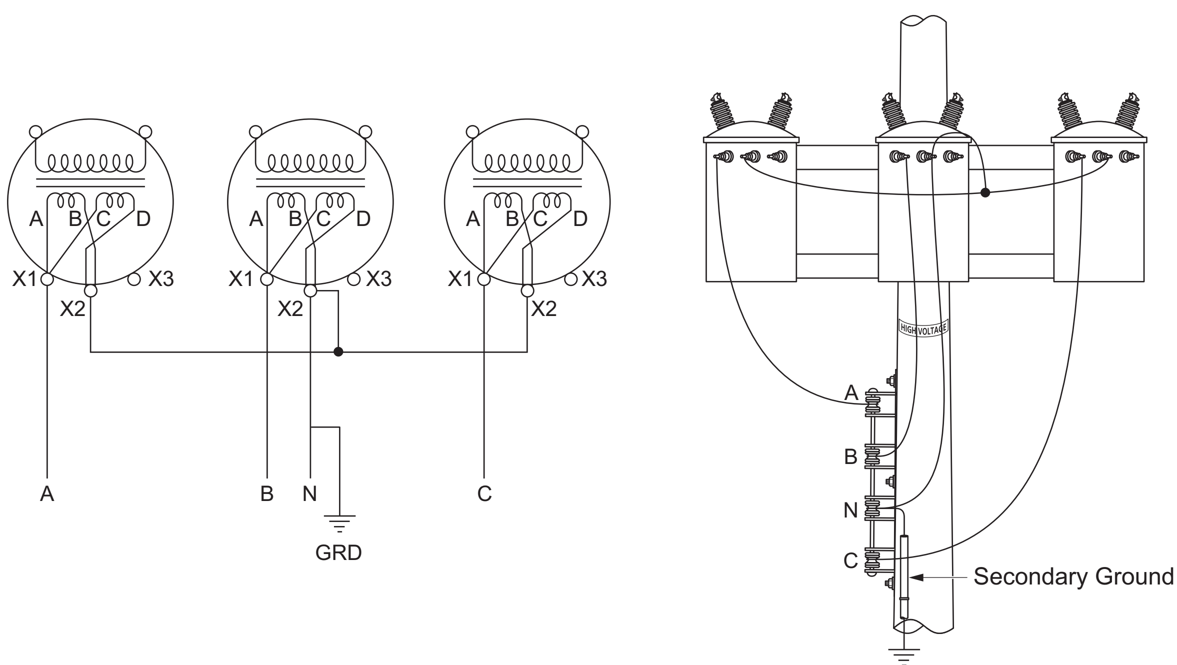


Figure GR 120–8: 120/208 V, 3Ø, 4 Wire Wye
(3-1Ø Transformers With 120/240 V Secondary Windings – Cutover to 120 V)



Secondary Grounds on Transformers

Approved by:

What's Changed?

Effective Date:
10-29-2021

Figure GR 120–9: 480 V, 3Ø, 3 Wire Secondary, Ungrounded-Wye
(3-1Ø Transformers With 277 V Secondary Windings)

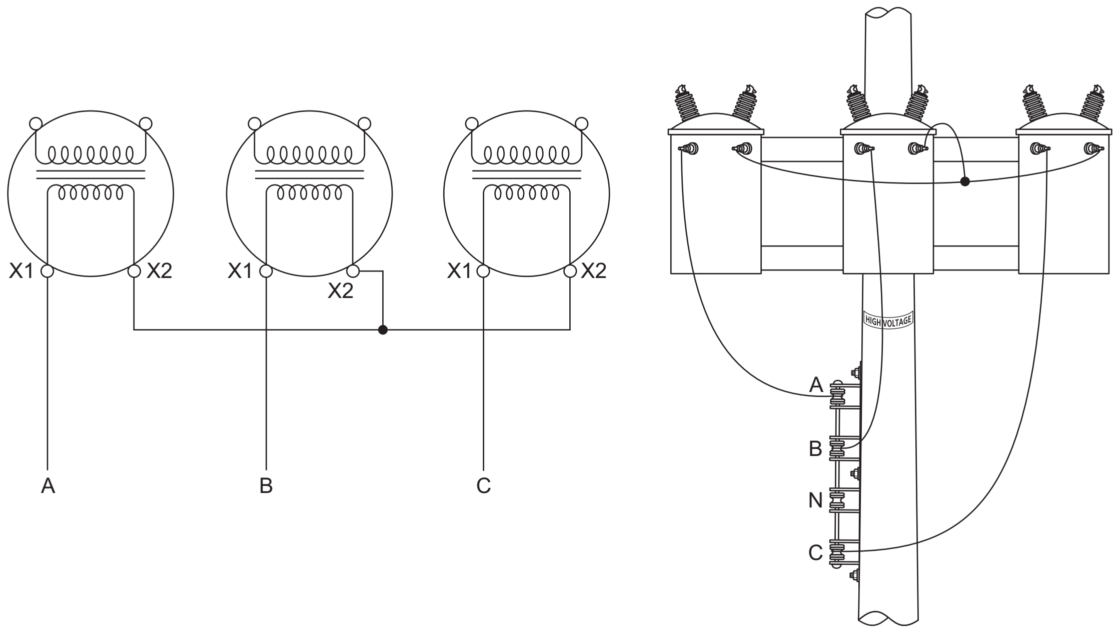
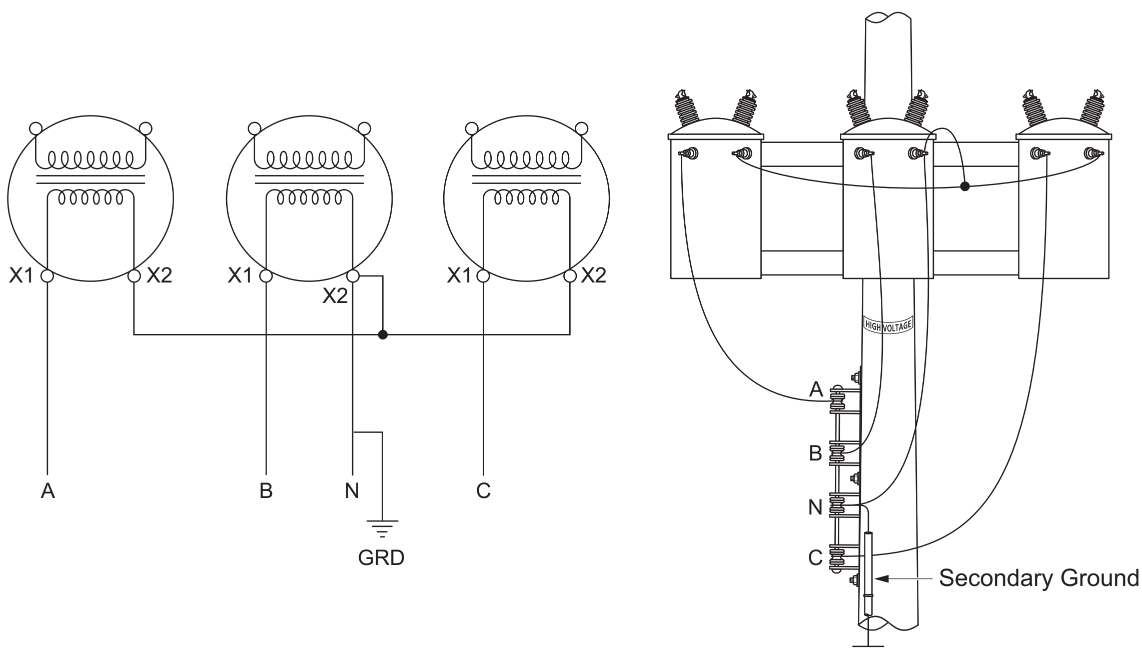


Figure GR 120–10: 277/480 V, 3Ø, 4 Wire Wye
(3-1Ø Transformers With 277 V Secondary Windings)



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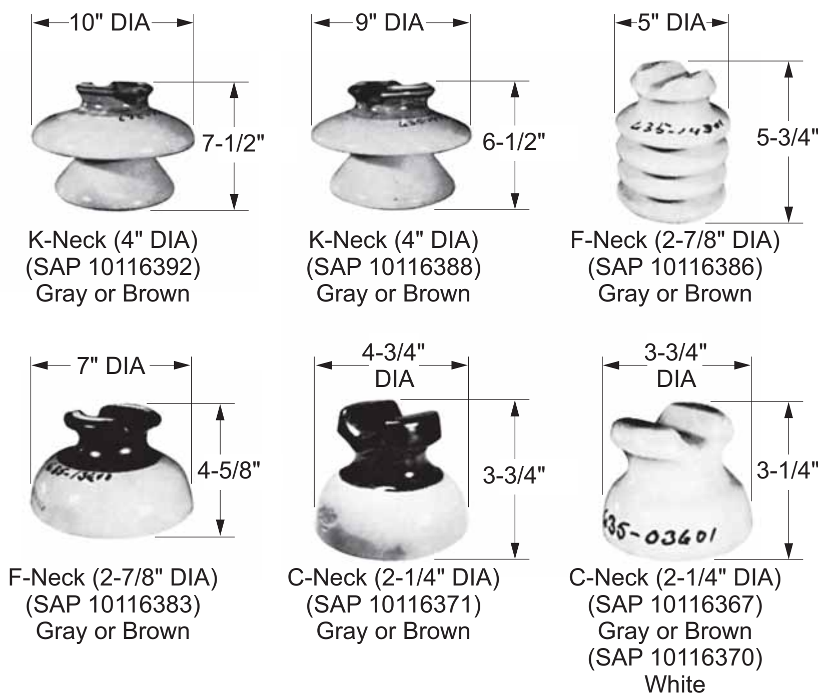
GR 200 Pin-Type Line Insulators

Scope GR 200.1 Porcelain Pin-Type Line Insulators

1.0 Application

Porcelain pin-type insulators are available for use as an alternative option after silicone post-type insulators have been considered. The porcelain pin-type insulators shall not be used in covered conductor systems.

Figure GR 200–1: Porcelain Pin-Type Insulators



Note(s):

1. For Porcelain Pin-Type Installation details see Scope GR 200.3, Section 1.0.
2. See GR 215, insulation area map.

Figure GR 200–2: Insulator Angle Pins (SAP 10068298 & 10068299)

Figure GR 200–3: Insulator Vertical Pins (SAP 10068303, 10068306, &10068281)

Table GR 200–1: Porcelain Pin-Type Insulators

Line Voltage (kV)	Insul. Area[a/]	Conductor	Nom. kV Rating	SAP	Insulator Pins	
					Vertical Pin SAP	Angle Pin SAP
33	B, C	Phase	45	10116390	10068306	10068299
16	A[b/], B, C	Phase	35	10116388	10068306	10068299
	A[b/], B, C	Neutral	23	10116383	10068303	10068298
12	A[b/]	Phase	35	10116388	10068306	10068299
	B, C	Phase	27	10116386	10068306	10068299
	A[b/], B, C	Neutral	23	10116383	10068303	10068298
	(Note)[c/]	Neutral	13	10116371	10068303	10068298
4 or less	(Note)[d/]	Phase	13	10116371	10068303	10068298
	A, B, C	Phase	7	10116367	10068303	10068298
	A, B, C	Neutral	7	10116370	10068303	10068298
St. Light (6.6 Amp)	A, B, C	—	13	10116371	10068303	10068298

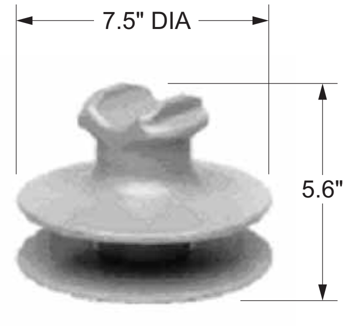
[a/] New units purchased will be gray; however, brown units may be supplied by the re-use of returned units.
[b/] For 25 kV, use 12 kV or 16 kV type A insulator.
[c/] With Region approval, SAP 10116383 may also be used on phase conductors in Northwestern and Eastern Regions, with SAP 10116371 then being used on the neutral conductor.
[d/] Use on 4 kV in extreme contamination areas along beach (with steel pin and spring washer).

Note(s):

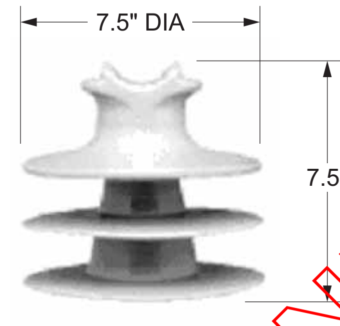
1. See DC 535 for Wildlife Protection standards.
2. Do not install upside down.
3. Not for use with covered conductor.
4. On 12 foot dead-end arm (4" × 6"), use 7-1/2 inch Long Shank Pin (SAP 10068281).
5. See Figure GR 200–2 and Figure GR 200–3 for photos of insulator vertical and angle pins.

Scope GR 200.2 Polymer Pin-Type Line Insulators — Tie Top

Figure GR 200–4: Polymer Pin Type Insulators — Tie Top



25 kV Class
(SAP 10116319)



35 kV Class
(SAP 10116354)

Note(s):

1. For Polymer Pin-Type Installation details see Scope GR 200.3, Section 2.0.

Table GR 200–2: Polymer Pin-Type Insulators — Tie Top

Line Voltage (kV)	Insul. Area	Nom. kV Rating	Pin-Type Insulators	Insulator Pins	
			SAP	Vertical Pin SAP	Angle Pin SAP
33	A, B, C	35	10116354	10068306	10068299
16	A, B, C	35	10116354	10068303	10068299
	Neutral	25[a/]	10116319	10068303	10068299
4 and 12	A, B, C	25	10116319	10068303	10068299
	Neutral	25[a/]	10116319	10068303	10068299

[a/] The same nominal kV rated insulator can be used on all conductors provided that the Neutral is identified with an "N" sign (SAP 10135124).

Note(s):

1. To be used with the Universal Conductor Clamp (see CO 510).
2. See DC 535 for Wildlife Protection standards.
3. Not to be used for installations where there is an upward vertical strain. Use Post Type insulators instead (see GR 205).
4. Do not install upside down.
5. 1-3/8 inch insulators can be used with a 1-inch pin and adapter (SAP 10068613).
6. Not for use with covered conductor.
7. On 12 foot dead-end arm (4" × 6"), use 7-1/2 inch Long Shank Pin (SAP 10068281).
8. See Figure GR 200–2 and Figure GR 200–3 for photos of insulator vertical and angle pins.

Scope GR 200.3 Polymer Pin-Type Line Insulators — Vice-Top, Aluminum Inserts

1.0 Application

Vice-top insulators with aluminum inserts are available for use as an alternative option after silicone post-type insulators have been considered. The aluminum insert vice-top insulators shall only be used with bare aluminum conductors in non-HFRA applications. These insulators shall not be used in covered conductor systems.

Figure GR 200–5: Polymer Pin-Type Insulators — Vice-Top, Aluminum Inserts (For Use with Aluminum Conductor)

25 kV Class (SAP 10181690)

35 kV Class (SAP 10181692)

Note(s):

1. For Polymer Pin-Type Installation details see Scope GR 200.6, Section 2.0.

Table GR 200–3: Polymer Pin-Type Insulators — Vice-Top, Aluminum Inserts

Line Voltage (kV)	Insul. Area[a/]	Nom. kV Rating	Pin-Type Insulators	Insulator Pins	
			SAP	Vertical Pin SAP	Angle Pin SAP
33	A, B, C	35	10181692	10068306	10068299
16	A, B, C	35	10181692	10068306	10068299
	Neutral	25[b/]	10181690	10068306	10068299
4 and 12	A, B, C	25	10181690	10068306	10068299
	Neutral	25[b/]	10181690	10068306	10068299

[a/] See GR 215 for insulating/contamination area map.
[b/] The same nominal kV rated insulator can be used on all conductors provided that the Neutral is identified with an “N” sign (SAP 10135124).

Note(s):

1. See DC 535 for Wildlife Protection standards.
2. Not to be used for installations where there is an upward vertical strain. Use Post Type insulators instead (see GR 205).
3. Do not install upside down.
4. 1-3/8 inch insulators can be used with a 1-inch pin and adapter (SAP 10068613).
5. Do not reuse nylon torque bolts; replace with SAP 10116757 for Hendrix, SAP 10210141 for Preformed Line Products.
6. On 12 foot dead-end arm (4" × 6"), use 7-1/2 inch Long Shank Pin (SAP 10068281).
7. See Figure GR 200–2 and Figure GR 200–3 for photos of insulator vertical and angle pins.

What’s Changed? Added Application, removed Note 1 and Note 7.

Scope GR 200.4 Polymer Pin-Type Line Insulators — Vice-Top, Bronze Inserts

1.0 Application

Vice-top polymer insulators with bronze inserts are shall be used for bare copper conductors. Silicone post-type insulators (trunnion type with applicable clamp) or porcelain pin-type insulators may be used as alternatives.

Figure GR 200–6: Polymer Pin-Type Insulators — Vice-Top, Bronze Inserts (For Use with Copper Conductor)

25 kV Class (SAP 10181691)

35 kV Class (SAP 10181693)

Note(s):

1. For Polymer Pin-Type Installation details see Scope GR 200.6, Section 2.0.

Table GR 200–4: Polymer Pin-Type Insulators — Vice-Top, Bronze Inserts

Line Voltage (kV)	Insul. Area[a/]	Nom. kV Rating	Pin-Type Insulators SAP	Insulator Pins Vertical Pin SAP	Insulator Pins Angle Pin SAP
33	A, B, C	35	10181693	10068306	10068299
16	A, B, C	35	10181693	10068306	10068299
	Neutral	25[b/]	10181691	10068306	10068299
4 and 12	A, B, C	25	10181691	10068306	10068299
	Neutral	25[b/]	10181691	10068306	10068299

[a/] See GR 215 for insulating/contamination area map.
[b/] The same nominal kV rated insulator can be used on all conductors provided that the Neutral is identified with an "N" sign (SAP 10135124).

Note(s):

1. See DC 535 for Wildlife Protection standards.
2. Not to be used for installations where there is an upward vertical strain. Use Post Type insulators instead (see GR 205).
3. Do not install upside down.
4. 1-3/8 inch insulators can be used with a 1-inch pin and adapter, SAP 10068613.
5. Do not reuse nylon torque bolts; replace with SAP 10116757 for Hendrix, SAP 10210141 for Preformed Line Products.
6. Not for use with covered conductor.
7. On 12 foot dead-end arm, (4" × 6"), use 7-1/2 inch Long Shank Pin (SAP 10068281).
8. See Figure GR 200–2 and Figure GR 200–3 for photos of insulator vertical and angle pins.

Scope GR 200.5 Polymer Pin-Type Line Insulators — Vice-Top, Nylon Inserts

1.0 Application

Vice-top insulators with nylon inserts shall only be used in covered conductor systems.

Figure GR 200–7: Polymer Pin-Type Insulators — Vice-Top, Nylon Inserts (For Use with Insulated or Covered Conductor ONLY)


25 kV Class
(SAP 10116334)


35 kV Class
(SAP 10116335)

Note(s):

1. For Polymer Pin-Type Installation details see Scope GR 200.6, Section 2.0.

Table GR 200–5: Polymer Pin-Type Insulators — Vice-Top, Nylon Inserts

Line Voltage (kV)	Insul. Area[a/]	Nom. kV Rating	Pin-Type Insulators	Insulator Pins	
			SAP	Vertical Pin SAP	Angle Pin SAP
33	A, B, C	35	10116335	10068306	10068299
16	A, B, C	35	10116335	10068306	10068299
	Neutral	25[b/]	10116334	10068306	10068299
4 and 12	A, B, C	25	10116334	10068306	10068299
	Neutral	25[b/]	10116334	10068306	10068299

[a/] See GR 215 for insulating/contamination area map.
[b/] The same nominal kV rated insulator can be used on all conductors provided that the Neutral is identified with an “N” sign (SAP 10135124). If the same insulator is used on all conductors (A, B,C, and Neutral), the “N” sign shall be used on every crossarm to identify the neutral.

Note(s):

1. See DC 535 for Wildlife Protection standards.
2. Not to be used for installations where there is an upward vertical strain. Use Post Type insulators instead (see GR 205).
3. Do not install upside down.
4. 1-3/8 inch insulators can be used with a 1-inch pin and adapter (SAP 10068613).
5. Do not reuse nylon torque bolts; replace with SAP 10116757 for Hendrix, SAP 10210141 for Preformed Line Products.
6. On 12 foot dead-end arm, (4" × 6"), use 7-1/2 inch Long Shank Pin (SAP 10068281).
7. See Figure GR 200–2 and Figure GR 200–3 for photos of insulator vertical and angle pins.

What’s Changed? Added Application and removed Note 1.

Scope GR 200.6 Pin-Type Insulator Installation Instructions

1.0 Porcelain Pin-Type Insulator Installation Instructions

1.1 Install insulator onto pin threads.

1.2 Rotate insulator clockwise until resistance is felt.

1.3 Now turn the insulator clockwise to align the top saddle or clamp-top with the conductor a maximum of 1/2 turn.

1.4 For Tie-top insulators:
- Place conductor in the saddle and tie securely.

1.5 For Clamp-top insulators:
- Place conductor in the clamp and tighten bolt.

Note(s):
1. Do not install upside down.

2.0 Polymer Pin-type Insulator Installation Instructions

2.1 Install insulator onto pin threads.

2.2 Rotate insulator clockwise 4 to 5-1/2 complete turns.

2.3 The insulator pin threads will make contact with the mastic in the insulator threads as it is tightened. It is normal for the insulator to rotate counter-clockwise when released due to the pressure created by the mastic in the threads.

2.4 Now turn the insulator clockwise to align the top saddle or clamp-top with the conductor a maximum of 1/2 turn.

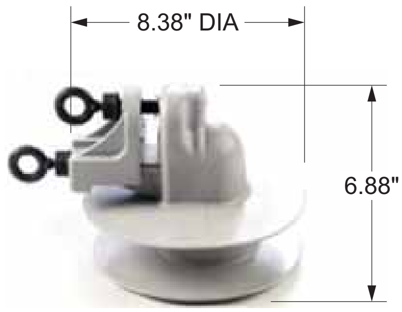
2.5 For Tie-Top insulators:
- Place conductor in the saddle and tie securely.

2.6 For Vice-Top insulators:
- Place conductor in the vise and tighten bottom bolt first.
- The torque bolts are designed to break when the required torque is achieved.
- DO NOT USE THE SIDE POSITION FOR ANY REASON.

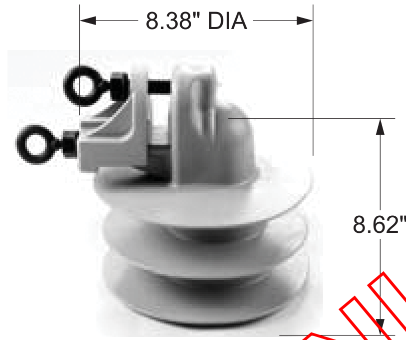
Note(s):
1. Do not tighten polymer pin-type insulators more the 6 complete turns.
2. Do not install upside down.

Scope GR 200.7 Polymer Pin Type Line Insulators — Clamp Top with Universal Inserts

Figure GR 200–8: Polymer Pin Type Insulators — Clamp Top with Universal Inserts



25 kV Class
(SAP 10204194)



35 kV Class
(SAP 10204196)

Note(s):

1. Clamp top insulators with universal inserts are approved for AL, CU and covered conductors.
2. For Polymer Pin-Type Installation details see Scope GR 200.6, Section 2.0.

Table GR 200–6: Polymer Pin Type Insulators — Clamp Top with Universal Inserts

Line Voltage (kV)	Insul. Area	Nom. kV Rating	Pin-Type Insulators	Insulator Pins	
			SAP	Vertical Pin SAP	Angle Pin SAP
33	A, B, C	35	10204196	10068306	10068299
16	A, B, C	35	10204196	10068306	10068299
	Neutral	25[a/]	10204194	10068306	10068299
4 and 12	A, B, C	25	10204194	10068306	10068299
	Neutral	25[a/]	10204194	10068306	10068299

[a/] The same nominal kV rated insulator can be used on all conductors provided that the Neutral is identified (SAP 10135124).

Note(s):

1. See DC 535 for Wildlife Protection standards.
2. Not to be used for installations where there is an upward vertical strain. Use Post Type insulators instead. See GR 205.
3. Do not install upside down.
4. 1-3/8 inch insulators can be used with a 1-inch pin and adapter (SAP 10068613).
5. Do not reuse nylon torque bolts; replace with SAP 10116757.

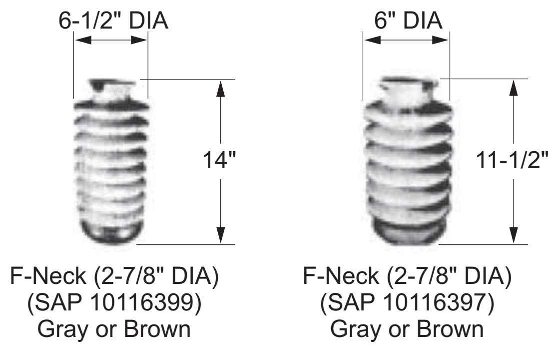
GR 205 Post-Type Line Insulators

Scope GR 205.1 Porcelain Post-Type Line Insulators — Tie-Top

1.0 Application

Porcelain post-type insulators may be used as an alternative after silicone post-type insulators have been considered for bare wire applications. These insulators shall not be used in covered conductor systems.

Figure GR 205–1: Porcelain Post-Type Insulators — Tie-Top



Note(s):

1. For Porcelain Post-Type installation details refer to Scope GR 205.5.
2. New units purchased will be gray; however, brown units may be supplied by the re-use of returned units.

Table GR 205–1: Porcelain Post-Type Insulators — Tie Top

Line Voltage (kV)	Insul. Area[a]	Conductor	Nom. kV Rating	SAP[b]	Insulator Studs[c] Short (1-3/4") SAP	Long (7-1/2" to 8") SAP	Extra Long (10") SAP
33	A	Phase	45	10116399[d]	10116404	10116398	10213439
	B, C	Phase	45	10116399	10116404	10116398	10213439
16	A, B, C	Phase	35	10116397	10116404	10116398	10213439
	A, B, C	Neutral	25[e]	10116326	10116404	10116398	10213439
12	A	Phase	35	10116397	10116404	10116398	10213439
	B, C	Phase	25	10116326	10116404	10116398	10213439
	A, B, C	Neutral	25[e]	10116326	10116404	10116398	10213439
4 or Less	A, B, C	Phase	15	Key 6 - See Polymer Table	—	—	—
	A, B, C	Neutral	15	Key 6 - See Polymer Table	—	—	—

a/ See GR 215, insulation area map.
b/ For angle construction, use angle base SAP 10068619.
c/ New gray horizontal clamp-top post insulators are automatically supplied with short studs.
d/ This insulator is recommended for use in insulation area “A” only when it is mounted horizontally (for example, wood upsweep arm).
e/ The same nominal kV rated insulator can be used on all conductors provided that the Neutral is identified (SAP 10135124).

Note(s):

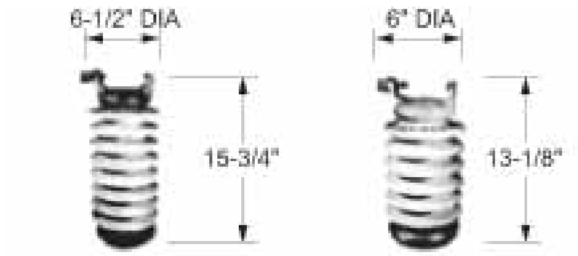
1. See CO 510 for clamp SAP numbers.
2. Not used with horizontal clamp-top post insulators.
3. See DC 535 for Wildlife Protection standards.
4. See Figure GR 200–4 and Figure GR 200–5 for photos of insulator studs and angle base.

Scope GR 205.2 Porcelain Post-Type Line Insulators — Trunnion-Top

1.0 Application

Porcelain post-type trunnion top insulators may be used as an alternative after silicone post-type insulators (universal clamp or trunnion top) have been considered for bare wire applications. These insulators shall not be used in covered conductor systems.

Figure GR 205–2: Porcelain Post-Type Insulators — Trunnion-Top



(SAP 10116425)
Gray or Brown

(SAP 10116424)
Gray or Brown

Note(s):

1. For Porcelain Post-Type installation details refer to Scope GR 205.5.
2. New units purchased will be gray; however, brown units may be supplied by the re-use of returned units.

Table GR 205–2: Porcelain Post-Type Insulators — Trunnion Top

Line Voltage (kV)	Insul. Area[a/]	Conductor	Nom. kV Rating	SAP[b/c/]	Insulator Studs[d/] Short (1-3/4") SAP	Long[e/] (7-1/2" to 8") SAP	Extra Long (10") SAP
33	A	Phase	46	10116425	10116404	10116398	10213439
	B, C	Phase	46	10116425	10116404	10116398	10213439
16	A, B, C	Phase	35	10116424	10116404	10116398	10213439
	A, B, C	Neutral	35[f/]	10116424	10116404	10116398	10213439
12	A	Phase	35	10116424	10116404	10116398	10213439
	B, C	Phase	35	10116424	10116404	10116398	10213439
	A, B, C	Neutral	35[f/]	10116424	10116404	10116398	10213439
4 or Less	A, B, C	Phase	15	Key 6 - See Polymer Table	—	—	—
	A, B, C	Neutral	15	Key 6 - See Polymer Table	—	—	—

a/ See GR 215, insulation area map.
b/ For angle construction, use angle base SAP 10068619.
c/ See CO 510 for clamp SAP numbers.
d/ New gray horizontal clamp-top post insulators are automatically supplied with short studs.
e/ Not used with horizontal clamp-top post insulators.
f/ The same nominal kV rated insulator can be used on all conductors provided that the Neutral is identified (SAP 10135124)

Note(s):

1. See DC 535 for Wildlife Protection standards.
2. See Figure GR 200–4 and Figure GR 200–5 for photos of insulator studs and angle base.

Scope GR 205.3 Polymer Post-Type Line Insulators — Clamp-Top

1.0 Application

Clamp-top post-type insulators shall be used for bare aluminum wire applications and are the preferred insulator in non-HFRA applications. These insulators shall not be used in covered conductor systems.

Figure GR 205–3: Polymer Post-Type Insulators — Clamp-Top

15 kV Class
(SAP 10116349)

28 kV Class
(SAP 10116350)

35 kV Class
(SAP 10116351)

46 kV Class
(SAP 10116352)

Note(s):

1. For Porcelain Post-Type installation details refer to Scope GR 205.5.

Table GR 205–3: Polymer Post-Type Insulators — Clamp-Top

Line Voltage (kV)	Insul. Area[a]	Nom. kV Rating	SAP	Insulator Studs		
				Short Stud SAP[b]	Long Stud SAP	Extra Long SAP
33	A, B, C	46	10116352	10116404	10116398	10213439
16	A	35	10116351	10116404	10116398	10213439
	B, C	28	10116350	10116404	10116398	10213439
	Neutral	28[c]	10116350	10116404	10116398	10213439
12 and Below	A	28	10116350	10116404	10116398	10213439
	B, C	15	10116349	10116404	10116398	10213439
	Neutral	15[c]	10116349	10116404	10116398	10213439

[a] See GR 215 for insulating/contamination area map.
[b] Short Insulator Stud and Angle Base (SAP 10068619) should be used for angle applications. Short insulator stud may also be used with the ridge-pin bracket (SAP 10067373) for ridge pin applications.
[c] The same nominal kV rated insulator can be used on all conductors provided that the Neutral is identified (SAP 10135124).

Note(s):

1. See DC 535 for Wildlife Protection standards.
2. Clamp Top insulators are rated for #4 through 653 ACSR, except SAP 10116352 which will accommodate up to 1192 kcmil.
3. Armor rod may be used for additional protection of conductors. It is not required.

Figure GR 205–4: Insulator Studs (SAP 10116404, SAP 10116398, and SAP 10213439)

Figure GR 205–5: Insulator Angle Base (SAP 10068619)

Scope GR 205.4 Polymer Post-Type Line Insulators — Trunnion-Top

1.0 Application

Trunnion-top post-type insulators are required to be used for bare wire applications when there is an upward vertical strain in the line. These insulators may also be used as alternatives to clamptop post-type insulators (see Scope GR 205.3). They shall not be used in covered conductor systems.

Figure GR 205–6: Polymer Post-Type Insulators — Trunnion-Top

15 kV Class (SAP 10116326) | 28 kV Class (SAP 10116327) | 35 kV Class (SAP 10116325) | 46 kV Class (SAP 10116331)

Note(s):

1. For Porcelain Post-Type installation details refer to Scope GR 205.5.

Table GR 205–4: Polymer Post-Type Insulators — Trunnion-Top

Line Voltage (kV)	Insul. Area[a]	Nom. kV Rating	SAP	Insulator Studs		
				Short Stud SAP[b]	Long Stud SAP	Extra Long SAP
33	A, B, C	46	10116331	10116404	10116398	10213439
16	A	35	10116325	10116404	10116398	10213439
	B, C	28	10116327	10116404	10116398	10213439
	Neutral	28[c]	10116327	10116404	10116398	10213439
12 and below	A	28	10116327	10116404	10116398	10213439
	B, C	15	10116326	10116404	10116398	10213439
	Neutral	15[c]	10116326	10116404	10116398	10213439

[a] See GR 215 for insulating/contamination area map.
[b] Short Insulator Stud and Angle Base (SAP 10068619) should be used for angle applications. Short insulator stud may also be used with the ridge-pin bracket (SAP 10067373) for ridge pin applications.
[c] The same nominal kV rated insulator can be used on all conductors provided that the Neutral is identified (SAP 10135124).

Note(s):

1. See DC 535 for Wildlife Protection standards.
2. Trunnion top insulators may be used on un-guyed spans.
3. See CO 510 for Trunnion Top Clamp SAP numbers.
4. Armor rod may be used for additional protection of conductors. It is not required.

Scope GR 205.5 Porcelain and Polymer Post-Type Insulator Installation Instructions

1.0 Porcelain and Polymer Post-Type Insulator Installation Instructions

1.1 Install insulator onto the appropriate stud
- Long and Extra Long Stud for Cross-Arm mounting.
- Short Stud for Angle Base or ridge-pin bracket mounting.

1.2 For Tie-top insulators:
- Place conductor in the saddle and tie securely.

1.3 For Trunnion-Top Insulators:
- Place clamp into trunnion and conductor into clamp and tighten.

1.4 For Clamp-top insulators:
- Place conductor in the clamp and tighten.

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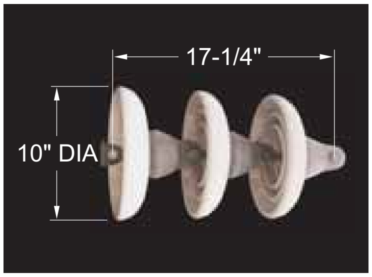
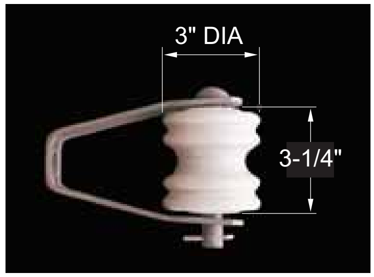
GR 210 Line Insulators — Dead-Ends

Scope GR 210.1 Typical Dead-end Type Insulators

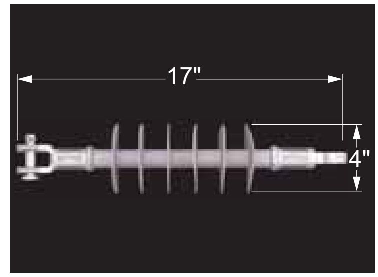
Figure GR 210–1: Dead-end Type Insulators



SAP 10116461 (Gray)
(3 Units)

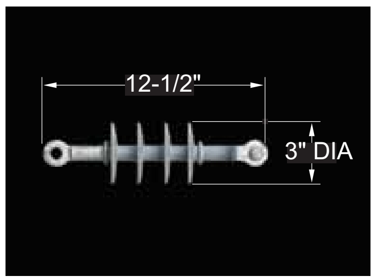


SAP 10116496 (Gray or Brown)
(See Note 1)

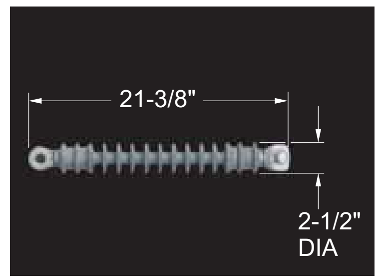


SAP 10116332 (Gray)
(See Note 2 and 3)

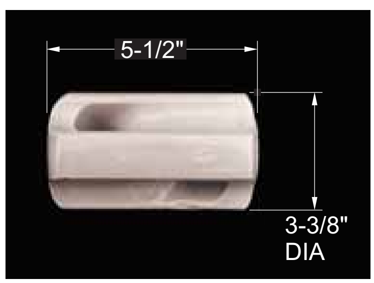
SAP 10116434 (Gray or Brown)
(See Note 1)



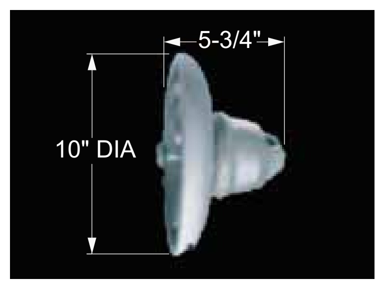
SAP 10116431 (Gray)
(See Note 2 and 4)



SAP 10116432
(See Note 2 and 3)



SAP 10116492 (Gray or Brown)
(See Note 1)



SAP 10116462 (Gray)
SAP 10116463 (Brown)
(See Note 1 and 5)

1. New units purchased will be gray; however, brown units may be supplied by the re-use of returned units.
2. Preferred dead-end insulator for general use. When installing these insulators in the vertical position, hang the insulator so the taper on the skirt is up. For contaminated area, use one size larger insulator.
3. The insulator as shown may not be identical. Check the voltage rating on the insulator to ensure proper usage.
4. May be used for a 12/16-kV neutral system.
5. For suspension construction only.

Table GR 210–1: Dead-end Type Insulators

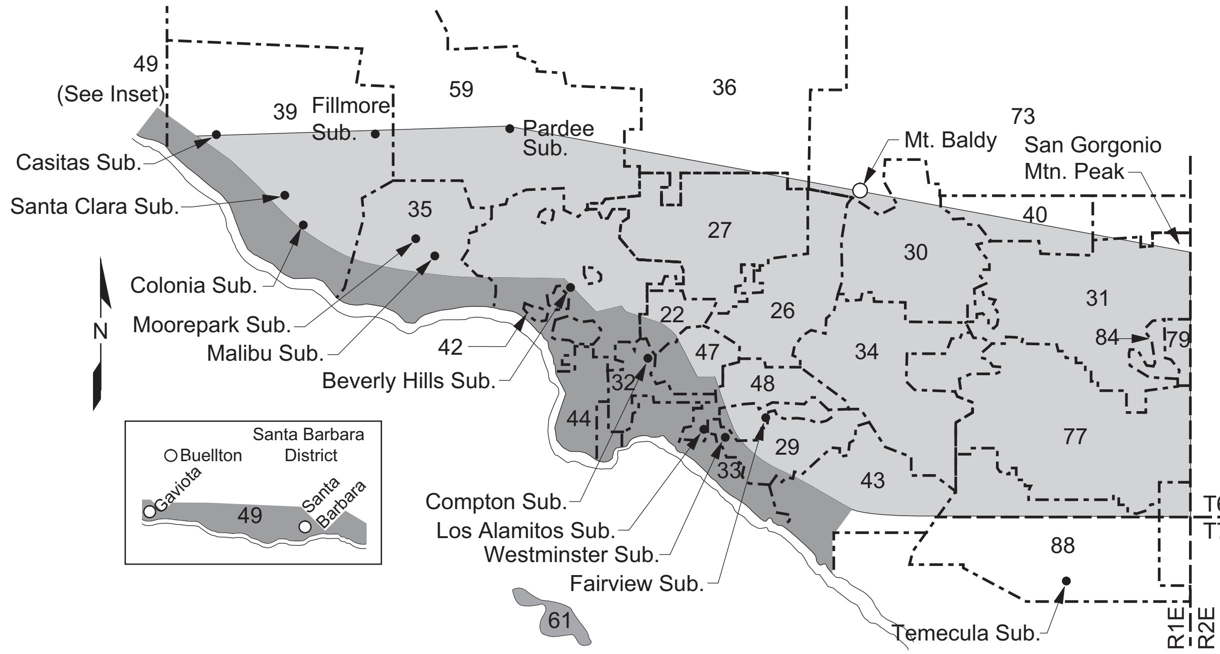
Line Voltage (kV)	Contamination Area[a]	Dead-end Type Insulators			
		Number of Units	SAP	Wet Flashover (kV)	Mechanical Strength (lb)
25 or 33	A, B, C A, B, C	1 3	10116432[b] 10116462[b]	130 130	15,000 20,000
16[b]	A, B, C A, B, C	1 3	10116332 10116434	110 80	15,000 10,000
12[b]	A, B, C A, B, C	1 2[c]	10116431 10116434	65 55	15,000 10,000
4 and 2.4	A, B, C	1	10116431	65	15,000
0.750 or Less	A, B, C	1	10116496	16	4,000
		1 (Neutral)	10116496	16	4,000
Streetlight (6.6A)	A, B, C	1	10116431	65	15,000
		1	10116492	18	20,000

[a] See GR 215, contamination area map.
[b] For gray bonded insulator, use SAP 10116462. If brown bonded insulator is required, use SAP 10116463.
[c] Three units are recommended in extreme contamination areas, such as in the immediate vicinity of cement plants or near the ocean.

GR 215 Contamination Area Map

Scope GR 215.1 Contamination Area Map

Figure GR 215–1: Contamination Area Map



Area "A" — High Contamination —	Heavy fog, salt spray, or cement plant and other heavy industrial contamination areas.	• Substations
Area "B" — Moderate Contamination —	Light to moderate fog, or moderate to heavy smog areas.	○ Cities
Area "C" — Light Contamination —	Dry (desert) or light smog areas.	- - - Service Center Boundaries

What's Changed? Figure GR 215-1 was updated to reflect the new facilities (Wildomar and Menifee Server Centers) located in the Desert Spring Region.

Table GR 215–1: Work Location (Planning Regions)

Northwest Regions			
Highland	**Metro West**	**North Coast**	**San Joaquin**
36 Antelope Valley	32 Dominguez Hills	35 Thousand Oaks	51 San Joaquin
52 Tehachapi	42 Santa Monica	39 Ventura	50 Shaver Lake
53 Kernville	44 South Bay	49 Santa Barbara	
72 Barstow	46 Long Beach	59 Valencia	
73 Victorville	47 Whittier		
87 Blythe	85 Bishop/Mammoth		
Southwest Regions			
Desert	**Metro East**	**Orange**	**San Jacinto**
30 Foothill	22 Montebello	29 Santa Ana	77 Menifee
31 Redlands	26 Covina	33 Huntington Beach	88 Wildomar
40 Arrowhead	27 Monrovia	43 Saddleback	
79 Palm Springs	34 Ontario	48 Fullerton	
84 29 Palms/Yucca Valley		61 Catalina	
		86 Ridgecrest	

Note(s):

1. For insulators, see GR Section.
2. For more accurate location of insulation area boundaries, see service center maps. This map, due to small scale used, is approximate only.
3. Districts not shown on map are considered to have light contamination.
4. Service center personnel should determine contamination boundaries from experience encountered. This also includes pockets of higher level contamination in an area.

What's Changed? Figure GR 215-1 was updated to reflect the new facilities (Wildomar and Menifee Server Centers) located in the Desert Spring Region.

GR 300 Bonding Requirements 12 kV to 115 kV

Scope GR 300.1 Requirements for Bonding of 12 kV to 115 kV Line Hardware

1. All 115 kV, 66 kV, 33 kV, 25 kV, 16 kV, and 12 kV circuits on wood and composite crossarms shall be bonded in all locations.
   a. Two 3-wire circuits of 12 kV or above using vertical construction on wood and composite crossarms shall be bonded separately in all locations.
   b. Two 4-wire circuits of 12 kV or above using vertical construction on wood and composite crossarms shall be bonded together except at Grade “A” crossing (G.O. 95, Rule 113.1).
2. Use #8 soft-drawn solid bare copper for new bonds. For wood crossarms, fasten with gun staples using bonding wire plastic insulators (SAP 10179472) or with hand-driven 1-1/2-inch fence staples with RTVI plastic insert (SAP 10070130). For composite crossarms, fasten with self-tapping screws (see PO 370) using bonding clips (SAP 10113253).
3. In all cases where gun staples are employed, use 1-1/2-inch galvanized gun staples (SAP 10070127). Uncovered bonds run on the surface of the pole. (Use #4 soft-drawn bare copper.)
4. Bond wire shall clear all unbonded hardware and metal signs by at least 1-1/2 inches. For wood crossarms, run bond wire on bottom surface of crossarm, raising it to back or face only to clear unbonded hardware, except unbonded crossarm bracket on composite crossarms. Use 1/2-inch Schedule 40 PVC (SAP 10112580) attached with 1/2-inch conduit strap (SAP 10112988) to clear crossarm bracket on composite crossarms (see Figure GR 300–1).
5. Bond wire shall be installed in one continuous piece where practical for each circuit bonded. This may be done by starting at one bolt, making a hairpin loop at the second bolt, and ending at the third bolt. Do not cross bond wire between washers. Splices are not desirable, but may be used provided they are made under suitable protective covering in accordance with Rule 22.2 of G.O. 95 when on surface of pole.
6. Use Protected Ground Wire (PGW) for bond wires that run on the surface of the pole. Where separate bond wires are run on the same pole, they shall be separated by a minimum of 6 inches measured on the surface of the pole. **Exception:** Do not cover bonds on steel arm construction.
7. When bonded insulators are used, the bond wire on the top insulator is 19 inches long. It shall be placed using three 5/8-inch washers and two square nuts. One full turn shall be made around the eye bolt or double-arm bolt before tightening nuts. The bond wire shall be attached to the suspension clamp with one #8 Stainless Steel Lock washer and a #8 32-7/16-inch-long machine screw with Phillips head.
8. Insulator-to-insulator bonds shall be folded down tightly against the insulator shank to prevent contact with porcelain.
9. A hairpin loop shall be formed at bond wire terminations to facilitate working on the bond with live-line tools on 115 kV, 66 kV, 33 kV, and 25 kV only.

Figure GR 300–1: 1/2" Schedule 40 PVC for Clearing Composite Crossarm Bracket

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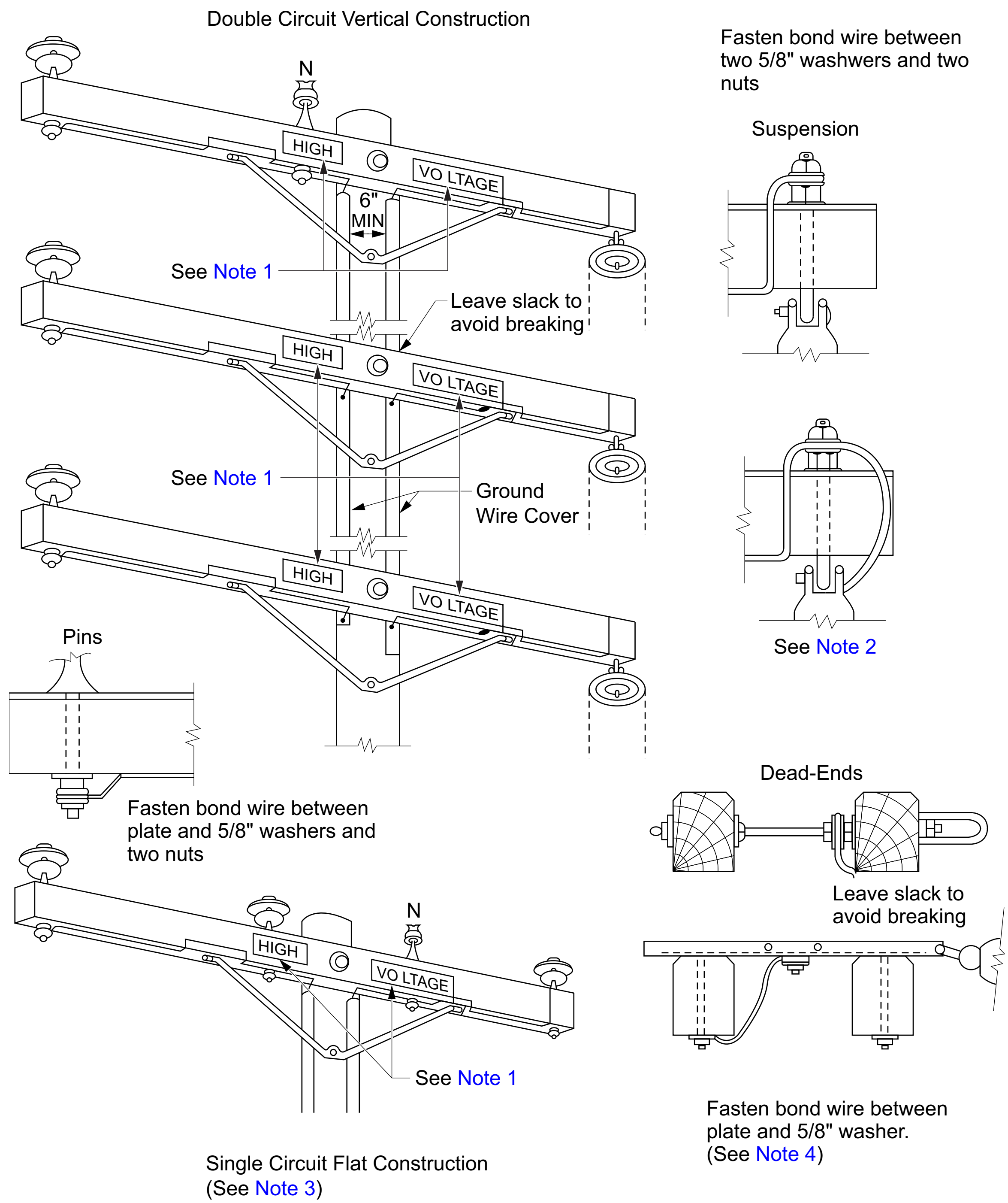
GR 305 Bonding Methods 12 kV to 66 kV

Scope GR 305.1 Bonding Methods 12 kV to 66 kV

Figure GR 305–1: Bonding Methods 12 kV to 66 kV



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. See bonding requirements, GR 300.
3. For notes, see GR 300.
4. See DC Section for bonding vertical circuits attached directly.

DOH–PO: Poles and Guying

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PO 100 Poles — General Information

Scope PO 100.1 Wood Poles

1.0 Pole Applications

1.1 Wood Poles

A. The following types of tree species can be used for wood poles on distribution lines:

1. Pacific Coast Douglas-Fir (Pseudotsuga menziesii)

2. Western Red Cedar (Thuja plicata)

Note: All new species shall be approved by SCE's Wood Products Specialist.

B. The following wood preservatives are approved to be used on distribution wood poles:

1. Pentachlorophenol (PCP) (common name *penta-in-oil*, light-to-dark brown color)

2. Ammonical Copper Zinc Arsenate (ACZA) (common name *Chemonite*, grayish/green color)

Note: All wood preservatives shall be approved by SCE's Wood Products Specialist.

C. The following are the areas of application where the above wood poles and preservatives can be used:

1. A1 and A2, with B1 or B2, can be used in urban and rural areas with residential, commercial, and industrial loads.

2. A1 with B2 shall be used in bucket-accessible, woodpecker-dense areas, or where existing Chemonite poles are being replaced. In these areas non-wood poles may be used.

D. Composite crossarms shall be used on wood poles.

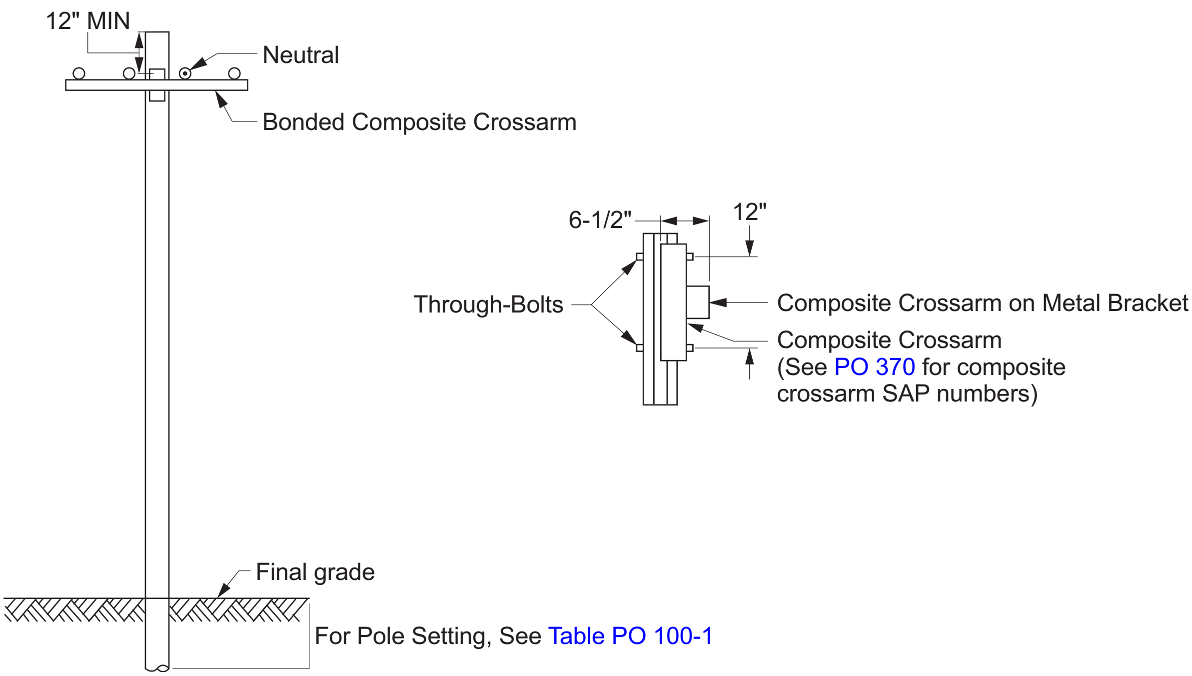
E. When installing a composite crossarm, the first hole for the bracket shall be placed 12 inches minimum from the top of the pole (see Figure PO 100–1).

Exception:

When placing the composite crossarm at 12 inches from the pole will create a G.O. 95 infraction and the pole is bucket accessible.

A Pole Loading calculation SHALL be performed, (refer to PLM, Section PLM-2), and if passes, the bracket may be placed in the hole 6 inches from the top of the pole opposite of the manufactured gain.

Figure PO 100–1: Wood Pole with 4-Wire Primary



Scope PO 100.2 Steel Poles

1.0 Subtransmission Engineered Tubular Steel Poles

Engineered Tubular Steel Poles (TSP) can be recognized by their provisions for poles steps—welded step bases, pull out steps or slip in pocket steps. All of the features of these poles and the attachments of all lines to each pole are individually engineered, and drawings are provided to crews working on the installation of each pole. Construction crews will attach lines to these poles as indicated in the drawings.

2.0 Subtransmission Lightweight Steel Poles

Lightweight Steel (LWS) poles can be easily recognized in the field by the pre-drilled holes in the sides of the pole for steps, and a maximum wall of less than one-quarter inch.

LWS poles require different methods for grounding, neutral connection, and transformer bonding than that of wood poles.

A. All overhead distribution primary and secondary neutrals on LWS poles (except primary floating neutrals) must be connected directly to the pole.

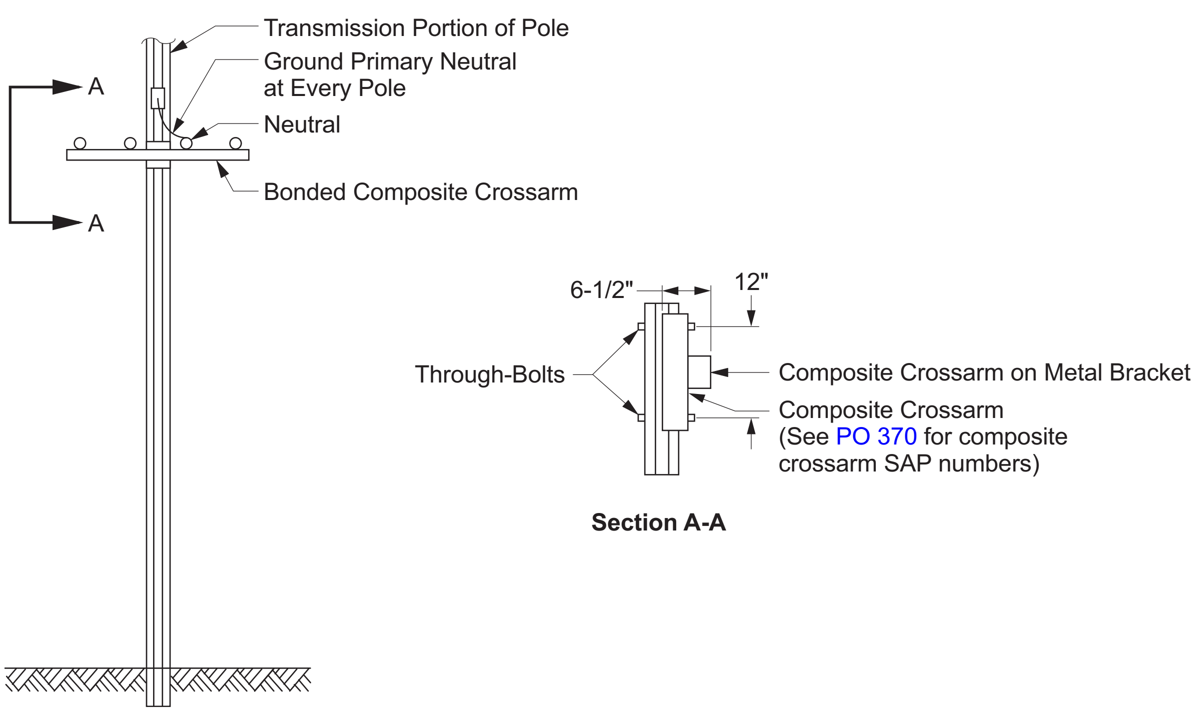
B. All distribution apparatus grounds will be attached to the pole. See Sections GR 100 and DAP AP 100 for these equipment grounds on subtransmission LWS poles.

C. When both a four-wire primary distribution system neutral and a secondary system neutral are connected to one of these poles, attach one common neutral sign (SAP 10135292) to the crossarm supporting the primary neutral; attach the sign at the steel structure, directly beneath the neutral support.

D. Risers will be installed on these poles as shown in the DUG Manual, Section CR 141.

E. Transformer cases will be bonded to the pole.

Figure PO 100–2: Steel Pole with 4-Wire Primary



F. Use predrilled holes in poles when possible, otherwise the poles may be field drilled. Use standard through-bolts for attachments.

G. Where existing wood pole practice requires lags, use through-bolts.

H. Ground surge arresters by running a ground wire from the arrester to the grounding plates at the distribution level of the pole or to a through-bolt ground as shown in DAP AP 431 and GR 106.

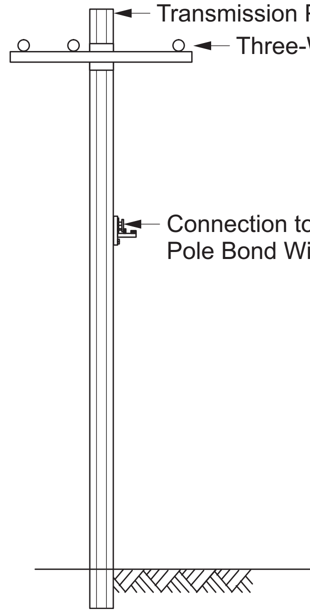
I. Use a composite crossarm with mounting bracket for distribution and/or communication facilities. Use bonding clips (SAP 10113253) to attach bond wire to composite crossarms. Do not attach crossarm hardware bond wire to the grounded steel pole. For composite crossarms see PO 370.

J. Do not install steel crossarms on LWS poles.

K. Do NOT install capacitor banks on steel poles.

L. All primary conductors must be attached to insulators using a universal conductor clamp. See CO 510 and CO 515 for SAP numbers. Tie-wire or grip-type conductor clamps are not acceptable.

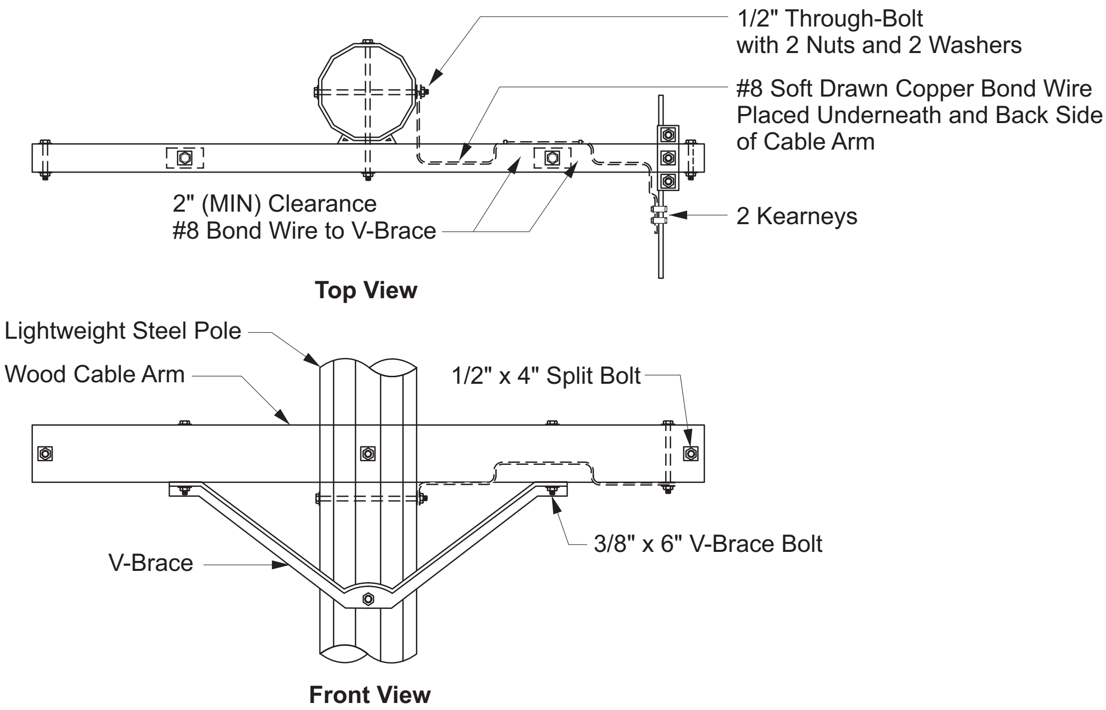
Figure PO 100–3: Steel Pole with Three-Wire Primary



M. Communication circuits on steel poles must not be connected to the pole-bond wire or any SCE conductors.

Communication circuits may be grounded to the steel pole, unless the situation shown in the Distribution Design Standards Manual (DDS), DDS-10 exists. Under this situation, communication circuits should not be grounded to the steel pole unless a breaker (for example, insulator) is installed in the communication messenger wire that connects the open span (for example, the span where the fault return conductor is not installed) to prevent the flow of distribution neutral currents. If it is desirable to install communication equipment messengers on the steel poles in this situation, the messengers must be installed on insulators.

Figure PO 100–4: Typical Communications Attachment



N. Install visibility strips (SAP 10068389) on LWS poles where required.

O. Refer to TO 801 and TO 802 of the Transmission Overhead Manual (TOH) for information on pole steps for steel poles.

P. Construction crews will attach lines and equipment to these poles using the same construction practices used on wood poles except as indicated in these construction and design standards: DAP AP 431; GR 106; GR 111; GR 120; PO 360; DDS 10, Paragraph 5.3 and Paragraph 5.5; DUG CR 141; and DUG CR 141.

Scope PO 100.3 Handling and Framing of Wood and Steel Poles

1.0 Pole Handling

1.1 Extreme care must be exercised in handling treated poles. When using sharp-pointed tools to set poles, care must be taken to minimize the number of laceration abrasions inflicted in the butt section. Poles must not be dropped upon or dragged over jagged rocks. Use nylon slings for handling steel poles.

1.2 When loading poles on dollies, the average pole weights tabulated in the DDS Manual, Section DDS-10 should be consulted to avoid overloading the pole dolly. The safe work practices section of the Accident Prevention Manual should be followed when loading and unloading poles of any type.

1.3 When handling steel poles, use nylon straps to tighten the poles down on the pole dolly. When using grabbers to set the pole, duct tape rags around the grabbers. Duct taping the rags will prevent the scraping of the pole finish. Use nylon slings for lifting poles into place.

2.0 Pole Framing

2.1 Wood Poles

A. When a factory gain is not present at the location of the wood crossarm installation, use a galvanized steel mechanical crossarm gain (SAP 10067936). This will ensure that the crossarm is mounted to the wood pole on a solid and level surface. For double or triple arms only one gain is required.

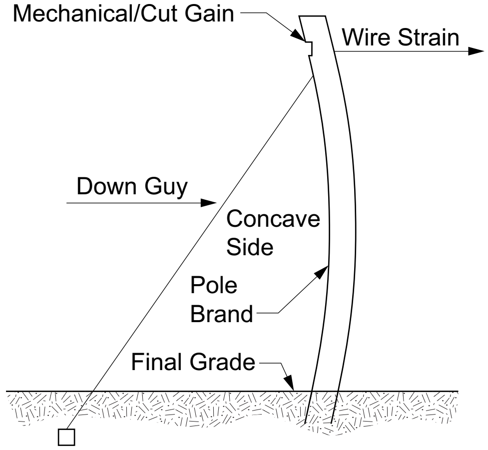
Note: The center of the top gain and through-bolt hole shall be a minimum of 6-1/2 inches from the top of the pole for new 40 foot poles and longer.

B. When installing the galvanized crossarm gain, set the gain square with the axis of the pole (of proper width) to securely fit the crossarm.

C. For New Pole Sets: Whenever possible, all single pole structures should be completely framed with crossarms and crossarm braces before setting.

D. On any pole having a curvature, set the gains on the concave surface so the curvature will be in the direction of the line when the pole is set, as shown in Figure PO 100–5 below:

Figure PO 100–5: Mechanical Gain Installation Example with Concave Surface



E. On dead-end arm(s) set the gain on the opposite side of the pole with the most strain.

Scope PO 100.4 Pole Steps on Distribution Wood Poles

1.0 Pole Stepping

The installation of pole steps on wood poles is not required.

1.1 New Wood Pole Installations

On sole use and joint use poles designed to support risers or equipment, steps may be installed at the discretion of the foreman in accordance with Section 2.0 and 3.0 below.

1.2 Pre-Existing and Replacement Wood Pole Installations

For poles with pre-existing equipment or risers, steps may be installed at the discretion of the foreman in accordance with Section 2.0 and 3.0 below.

2.0 Step Location

2.1 General

If installed, the lowest step shall be placed not less than 9 feet above the ground line or any easily climbable foreign structure. Above this point, the vertical distance between steps on the same side of the pole shall not exceed 36 inches. The vertical distance between steps on alternating sides of the pole shall not exceed 18 inches.

- When the diameter of the pole section is 12 inches or less, the steps shall be located 180 degrees apart. When the pole section is greater than 12 inches in diameter, the horizontal arc distance along the surface of the pole between step bases shall not exceed 18 inches (see Figure PO 110–4).
- Additional steps may be installed to permit movement over or around obstructions such as crossarms and distribution equipment.

2.2 Risers

If installed, steps shall be placed so that runs or cable risers do not interfere with the free use of the steps.

- The lowest step shall be installed per Subsection 2.1 above. The highest step shall be installed approximately 3 feet above the uppermost cable riser opening.

3.0 Step Installation and Utilization

3.1 Installation

Step 1. Drill a one-half inch diameter hole four inches deep in step location.

Step 2. Hammer the step in until the Depth Gage (see Figure PO 110–1) on the step touches the pole.

Step 3. Rotate the step a minimum of one clockwise turn to set the step into the wood, leaving the Foot Stop section of the step upright.

3.2 Utilization

Personnel should use caution when utilizing existing steps to ascend or descend poles. Over time steps can become loose for various reasons. Whenever practical, wood pole steps should be removed.

However, if steps are needed and the pole step condition is in question, tighten the step or remove and replace the step approximately two inches from the original hole along the horizontal plane.

Scope PO 100.5 Setting and Removing for Wood Poles

1.0 Pole Setting

1.1 The following table gives the minimum pole setting depth in firm soil and solid rock for wood and steel.

Table PO 100–1: Pole Settings

Overall Length of Pole (ft)	Guyed Curves and Corners Straight Lines[a/]	Non-Guyed Curves, Corners, Points of Extra Strain, and Service Poles Not Exceeding 30 Feet in Length	Solid Rock[a/]
25	4'-6"	5'-0"	3'-0"
30	5'-0"	5'-6"	3'-0"
35	5'-0"	6'-0"	3'-6"
40	5'-6"	6'-0"	3'-6"
45	6'-0"	6'-6"	4'-0"
50	6'-6"	7'-0"	4'-0"
55	7'-0"	7'-6"	4'-6"
60	7'-6"	8'-0"	4'-6"
65	8'-0"	8'-6"	5'-0"
70	8'-6"	9'-0"	5'-0"
75	9'-0"	9'-6"	5'-6"
80	9'-6"	10'-0"	6'-0"
85	10'-0"	10'-6"	6'-0"
90	10'-6"	11'-0"	6'-0"
95	10'-6"	11'-0"	6'-0"
100	10'-6"	11'-0"	6'-0"

[a/] G.O. 95, Rule 49.1

1.2 Horizontal clearance from face of curb to face of pole shall not be less than 18 inches. For new pole and pole replacements, if space permits or can be provided at no additional cost or low cost minor work, maintain a minimum clearance of 36 inches for pedestrian right-of-way access. Avoid pole placement in wheelchair ramp locations.

1.3 Maintain a four-foot clearance from the top of the slope of a commercial driveway and a two-foot clearance from the top of the slope of a residential driveway. Apply pole visibility strips per PO 120.

1.4 Five-foot clearance to be maintained from fire hydrant.

1.5 Firmly tamp the bottom of the hole or set pole on an anchor plate where necessary.

1.6 Dig all pole holes large enough to permit tamping backfill to full depth.

1.7 Set poles so that they stand as nearly vertical as possible and so that the crossarms are at right angles or parallel to the direction of the line. Poles intended to be set in a straight line shall be set so that no pole is more than 2 inches out of line with the others.

1.8 Poles at line terminals, angles, and at other points of abnormal stress shall be given a rake against the direction of the stress, equal to the width of the pole top. Set poles with required rake. Never bend a pole by pulling guy to achieve rake.

1.9 Backfill shall be thoroughly tamped throughout the backfill operation while pole is held in position. After the hole is completely filled and thoroughly tamped, earth shall be piled up and packed around the pole.

1.10 Pole -setting foam can be used as a backfill in rocky areas where there is not enough earth for backfill and compaction.

2.0 Pole Removing

2.1 After pole is removed, the pole holes must be completely backfilled and thoroughly tamped. The backfill shall be leveled to grade with no depression or mound allowed.

2.2 When pole is removed from paved area or area subject to pedestrian traffic, fill top 6 inches of the hole with asphalt patch or concrete.

Scope PO 100.6 Dimensions and Weights for Wood and Steel Poles

Table PO 100–2: Dimensions and Weights for Wood and Steel Poles

Pole Length (ft)	ANSI Size Class	Height Above Groundline (ft)	Groundline Circum. (in) Wood	Top Circum. (in) Wood	Weight (lb) Douglas Fir	Western Red Cedar	Steel
25	5[a/]	20.0	25.5	19	415	350	196
30	5[a/]	24.5	27.5	v	520	440	260
30	4[a/]	24.5	29.5	21	635	540	298
35	4[a/]	29.0	30.0	21	805	660	377
35	3						
35	2						
35	1						
40	H3	34.0	48.5	33	2,214	n/a	
40	H2	34.0	46.0	31	2,029	n/a	
40	H1	34.0	43.5	29	1,845	n/a	
40	1	34.0	41.0	27	1,545	1,320	0
40	2	34.0	38.5	25	1,310	1,145	800
40	3	34.0	36.0	23	1,165	970	531
40	4[a/]	34.0	33.5	21	1,025	875	452
40	5[a/]	34.0	31.0	19	895	705	388
45	H5	38.5	56.0	37	3,275	n/a	
45	H4	38.5	53.5	35	2,998	n/a	
45	H3	38.5	51.0	33	2,721	n/a	
45	H2	38.5	48.5	31	2,444	n/a	
45	H1	38.5	45.5	29	2,168	n/a	
45	1	38.5	43.0	27	1,930	1,585	970
45	2	38.5	40.5	25	1,560	1,365	800
45	3	38.5	37.5	23	1,410	1,145	629
45	4[a/]	38.5	35.0	21	1,225	1,010	531
45	5	38.5	32.5	19	1,075	880	474
50	H5	43.0	58.5	37	3,920	n/a	
50	H4	43.0	55.5	35	3,551	n/a	
50	H3	43.0	53.0	33	3,182	n/a	
50	H2	43.0	50.5	31	2,859	n/a	
50	H1	43.0	47.5	29	2,583	n/a	
50	1	43.0	45.0	27	2,225	1,760	1,184
50	2	43.0	42.0	25	1,870	1,585	1,039
50	3	43.0	39.0	23	1,625	1,365	893
50	4[a/]	43.0	36.5	21	1,420	1,230	637
55	H5	47.5	60.5	37	4,566	n/a	
55	H4	47.5	58.0	33	4,059	n/a	
55	H3	47.5	55.0	35	3,690	n/a	
55	H2	47.5	52.0	31	3,275	n/a	
55	H1	47.5	49.5	29	2,998	n/a	
55	1	47.5	46.0	27	2,480	2,025	1,243
55	2	47.5	43.0	25	2,130	1,760	1,270
55	3[a/]	47.5	40.0	23	1,845	1,540	1,045
60	H6	52.0	65.5	39	5,765	n/a	
60	H5	52.0	62.5	37	5,165	n/a	
60	H4	52.0	59.5	35	4,658	n/a	
60	H3	52.0	57.0	33	4,197	n/a	
60	H2	52.0	54.0	31	3,782	n/a	
60	H1	52.0	51.0	29	3,413	n/a	
60	1	52.0	48.0	27	2,845	2,290	1,530
60	2[a/]	52.0	45.0	25	2,480	1,935	1,379
65	H6	56.5	67.5	39	6,503	n/a	
65	H5	56.5	64.5	37	5,857	n/a	
65	H4	56.5	61.5	35	5,258	n/a	
65	H3	56.5	58.5	33	4,750	n/a	
65	H2	56.5	55.5	31	4,243	2,565	2,090
65	H1	56.5	52.5	29	3,828	2,430	1,950
65	1[a/]	56.5	49.5	27	3,330	2,815	1,760
65	2[a/]	56.5	46.5	25	2,810	2,200	1,560

Table PO 100–2: Dimensions and Weights for Wood and Steel Poles *(Continued)*

Pole Length (ft)	ANSI Size Class	Height Above Groundline (ft)	Groundline Circum. (in) Wood	Top Circum. (in) Wood	Weight (lb) Douglas Fir	Western Red Cedar	Steel
70	H6	61.0	69.0	39	7,287	n/a	
70	H5	61.0	66.5	37	6,549	n/a	
70	H4	61.0	63.5	35	5,903	n/a	
70	H3	61.0	60.5	33	5,258	n/a	
70	H2	61.0	57.0	31	4,796	3,550	2,290
70	H1	61.0	54.0	29	4,280	3,360	2,140
70	1[a/]	61.0	51.0	27	3,860	3,170	1,930
70	2[a/]	61.0	48.0	25	3,145	2,640	1,710
75	H6	65.5	71.0	39	7,840	n/a	
75	H5	65.5	68.0	37	7,287	n/a	
75	H4	65.5	65.0	35	6,549	n/a	
75	H3	65.5	62.0	33	5,903	n/a	
75	H2	65.5	59.0	31	5,250	4,140	2,520
75	H1	65.5	55.5	29	4,800	3,920	2,350
75	1[a/]	65.5	52.5	27	4,320	3,695	2,120
75	2[a/]	65.5	49.0	25	3,515	3,170	1,890
80	H6	70.0	72.5	39	8,855	n/a	
80	H5	70.0	69.5	37	7,979	n/a	
80	H4	70.0	66.5	35	7,195	n/a	
80	H3	70.0	63.5	33	6,503	n/a	
80	H2	70.0	60.0	31	5,850	4,930	2,730
80	H1	70.0	57.0	29	5,250	4,665	2,550
80	1[a/]	70.0	54.0	27	4,980	4,400	2,310
80	2[a/]	70.0	50.5	25	4,040	3,695	2,060
85	H6	74.5	74.5	39	9,731	n/a	
85	H5	74.5	71.5	37	8,763	n/a	
85	H4	74.5	68.0	35	7,887	n/a	
85	H3	74.5	65.0	33	7,102	n/a	
85	H2	74.5	61.5	31	6,400	5,425	2,950
85	H1	74.5	58.5	29	5,765	5,130	2,760
85	1[a/]	74.5	55.0	27	5,480	4,840	2,500
85	2[a/]	74.5	51.5	25	4,385	3,960	2,240
90	H6	79.0	76.0	39	10,608	n/a	
90	H5	79.0	73.0	37	9,547	n/a	
90	H4	79.0	69.5	35	8,624	n/a	
90	H3	79.0	66.5	33	7,748	n/a	
90	H2	79.0	62.0	31	6,960	6,510	3,180
90	H1	79.0	58.5	29	6,310	6,160	2,970
90	1[a/]	79.0	55.0	27	6,035	5,810	2,700
90	2[a/]	79.0	52.0	25	4,945	4,930	2,420
95	H6	84.0	77.5	39	11,530	n/a	
95	H5	84.0	74.5	37	10,377	n/a	
95	H4	84.0	71.0	35	9,362	n/a	
95	H3	84.0	67.5	33	8,440	n/a	
95	H2	84.0	64.5	31	7,610	7,560	3,420
95	H1	84.0	61.0	29	6,820	7,155	3,190
95	1[a/]	84.0	57.0	27	6,600	6,750	2,900
95	2[a/]	84.0	54.0	25	5,985	5,950	2,610
100	H6	89.0	79.0	39	12,000[a/]	n/a	
100	H5	89.0	76.0	37	10,600[a/]	n/a	
100	H4	89.0	72.5	35	9,800[a/]	n/a	
100	H3	89.0	69.0	33	9,200[a/]	n/a	
100	H2	89.0	65.5	31	8,600[a/]	8,400	3,670
100	H1	89.0	62.0	29	7,800[a/]	7,950	3,420
100	1[a/]	89.0	58.5	27	7,205	7,500	3,110
100	2[a/]	89.0	55.0	25	6,545	6,550	2,810

[a/] Numerals indicate size classes normally stocked by Edison. Other sizes are available on special order only.

PO 105 Temporary Cover for Pre-Dug Pole Holes

Scope PO 105.1 Temporary Cover for Pre-Dug Pole Holes

1.0 General Information

This procedure provides requirements for temporary pole hole cover to be used for pre-dug pole holes or for safely securing the pole hole until the pole is set (maximum of 10 days). The importance of covering the pole hole prior to setting a pole is paramount to safety, see APM Rule 206 Subsection B. This standard covers distribution class poles only.

After a pole hole is excavated, the resulting hole should be temporarily covered (no longer than 10 days) to prevent personnel, animals and objects from falling in. This method is deemed a suitable hole cover mentioned in SCE standards.

NOTE

Exception: Pole holes may remain covered more than 10 days in inclement weather.

2.0 Covering Temporary Pole Holes

After excavation of the pole hole and it is determined the pole will not be set immediately, but no more than 10 days.

STEP 1. Cover the opening at ground level with a:

- composite pole hole cover SAP 10184645 or
- minimum of 1-1/8 inch (actual minimum thickness 1.125 inch) thick 4' × 4' common hardwood plywood or
- a wood cable reel end with a minimum diameter of 4 feet.

STEP 2. Ensure the cover extends a minimum of 4 inches outside the diameter of the hole (where possible) upon solid surfaces and be covered to prevent small animals from crawling under the cover and falling into the hole. For questions or concerns regarding environmental requirements in specific areas or types of environmental risks, contact the Environmental Services Department by phone at (833) 723-2362 or via email at environmentalrequirements@sce.com.

STEP 3. Place spoils from the excavation on top of the temporary to prevent its movement and deter animals or the public from walking over or upon the covered excavation.

STEP 4. Place warning devices, including cones, caution tape, and/or barriers around the cover and spoils to warn the public of the existence of the excavation and to protect against injuries.

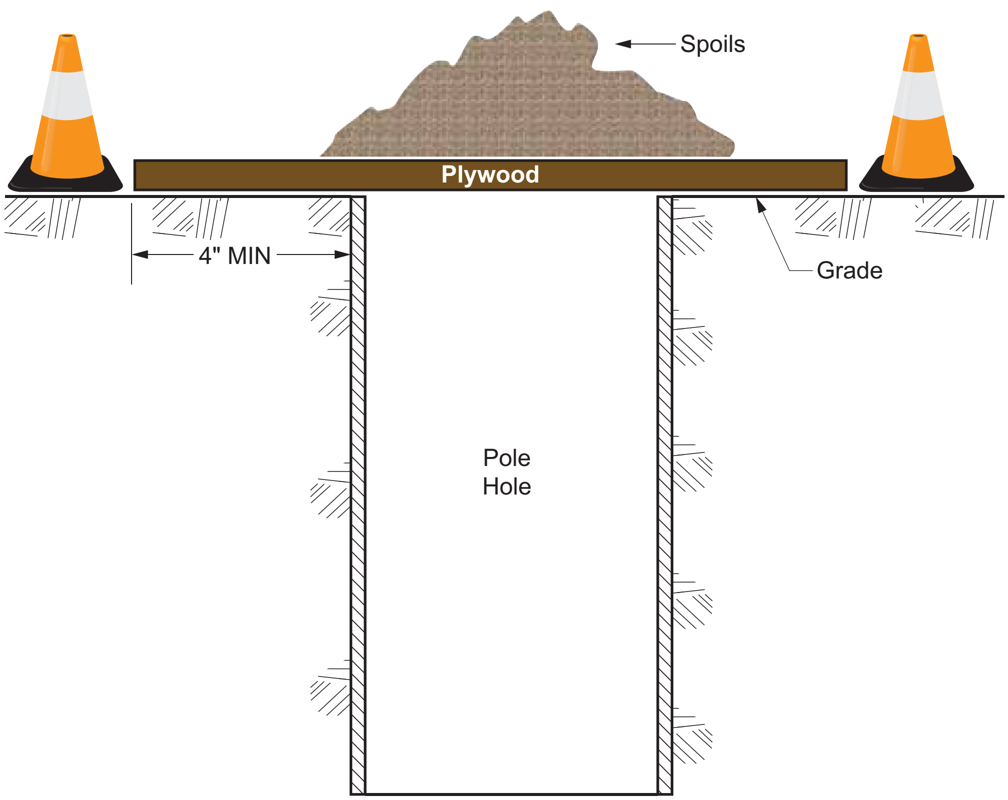
Figure 105–1: Suitable Pole Hole Covers

1-1/8-inch Plywood
Asphalt Not Required

40-inch Composite Pole-Hole Cover
SAP 10184645

Top/Bottom of
Wooden Cable Reel

Figure 105–2: Covered Pre-Dug Hole



Temporary Cover for Pre-Dug Pole Holes

Approved by:

What's Changed?

Effective Date:
10-30-2020

PO 110 Pole Steps on Subtransmission Wood Poles

Scope PO 110.1 Pole Steps on Subtransmission Wood Poles with Distribution Risers and/or Apparatus

1.0 Stepping

The installation of pole steps on wood poles supporting equipment is not required (see Scope PO 100.4).

2.0 Step Location

2.1 General

If installed, steps shall be placed so that runs, cable risers, or equipment do not interfere with the free use of the steps.

2.2 Equipment Poles

For sub-transmission poles with new or pre-existing equipment or apparatus energized at 600 V or greater, steps may be installed at the discretion of the foreman in accordance with Scope PO 100.4, Section 2.0 and 3.0; and Figure PO 110–1, PO 110–2, PO 110–3, and PO 110–4.

Figure PO 110–1: Pole Step Placement

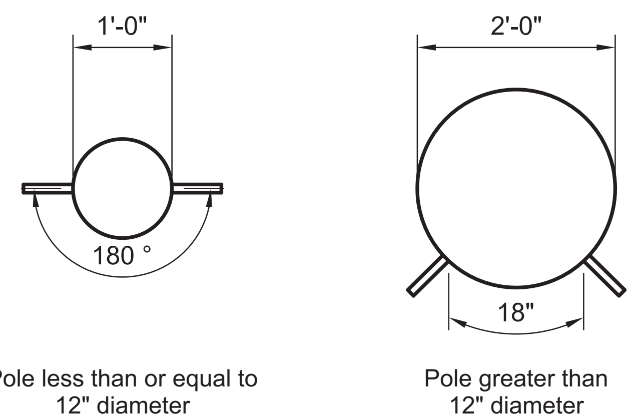


Figure PO 110–2: Pole Step (SAP 10068469)

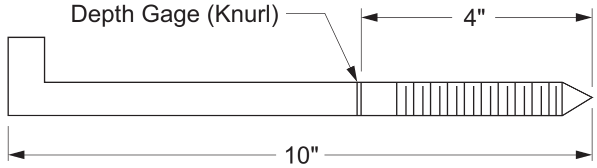


Figure PO 110–3: Pole Step Location — Example of a Climbing Space with Distribution Apparatus

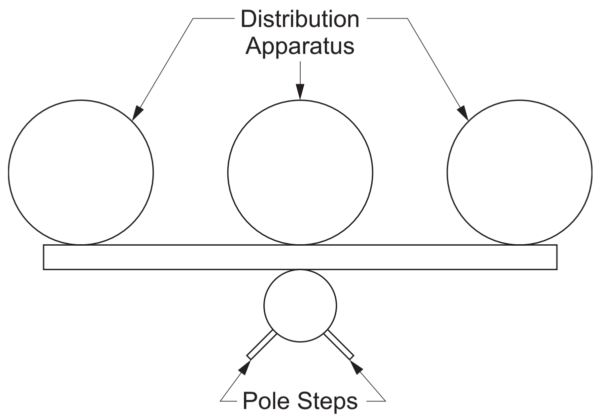
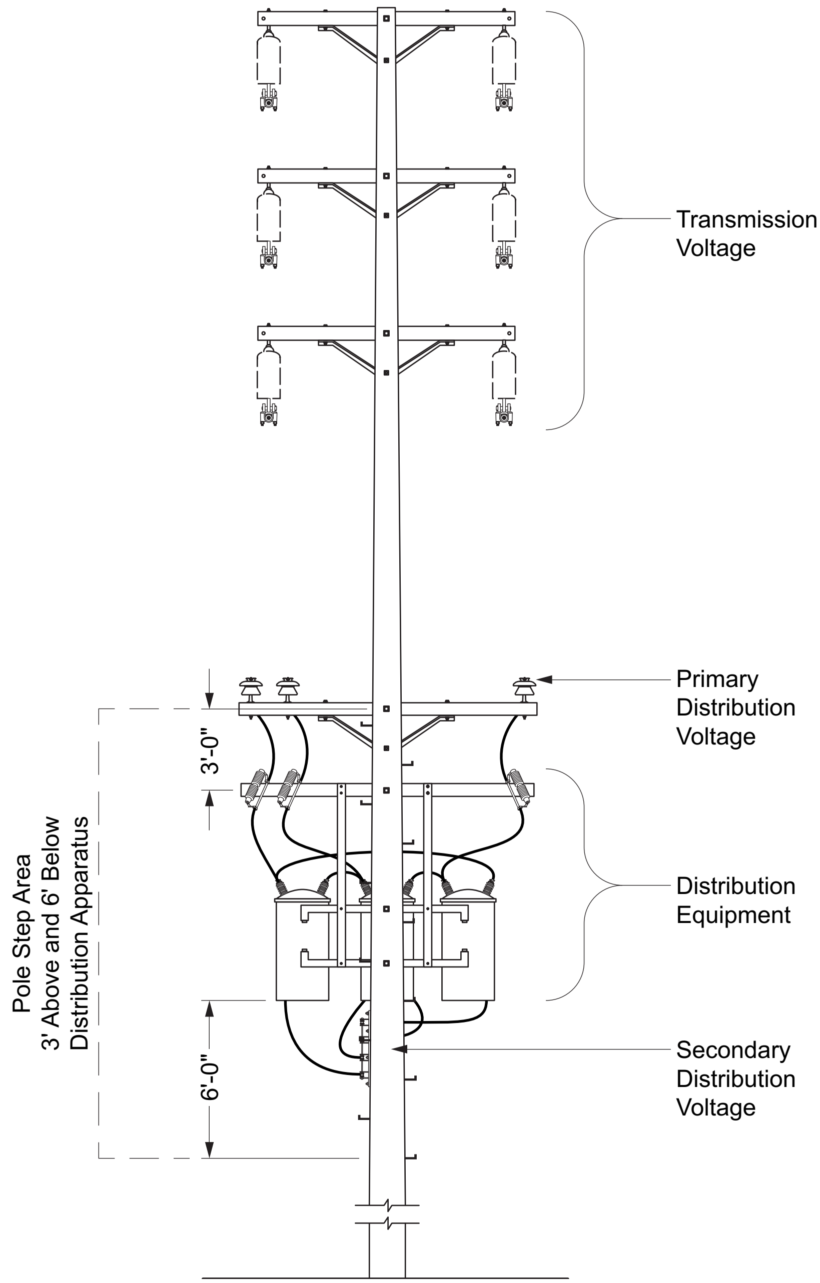


Figure PO 110–4: Pole Step Locations — Area of Step Installation with Distribution Apparatus (Typical)



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PO 112 Composite Poles

Scope PO 112.1 General Information

1.0 Pole Information

Refer to DDS-10 for design application of composite poles.

Presently, Edison receives composite poles from two different manufactures with two different manufacturing processes. The nature of these two manufacturing processes creates two different shapes. The Resin Systems (RS) composite poles are manufactured using a filament wound process that delivers a sectional, tapered pole that is larger in diameter at the bottom and smaller in diameter at the top. The Creative Pultrusion (CP) composite poles are manufactured using a pultruded process that delivers a single piece with a consistent diameter from top to bottom. In addition to the shape variation, pultruded poles by nature are single piece products as opposed to RS's sectional poles. SCE takes the approach to have composite poles designed to, at least, wood equivalent for both class and size. Therefore, even though the poles vary in shape, they provide the same design characteristics.

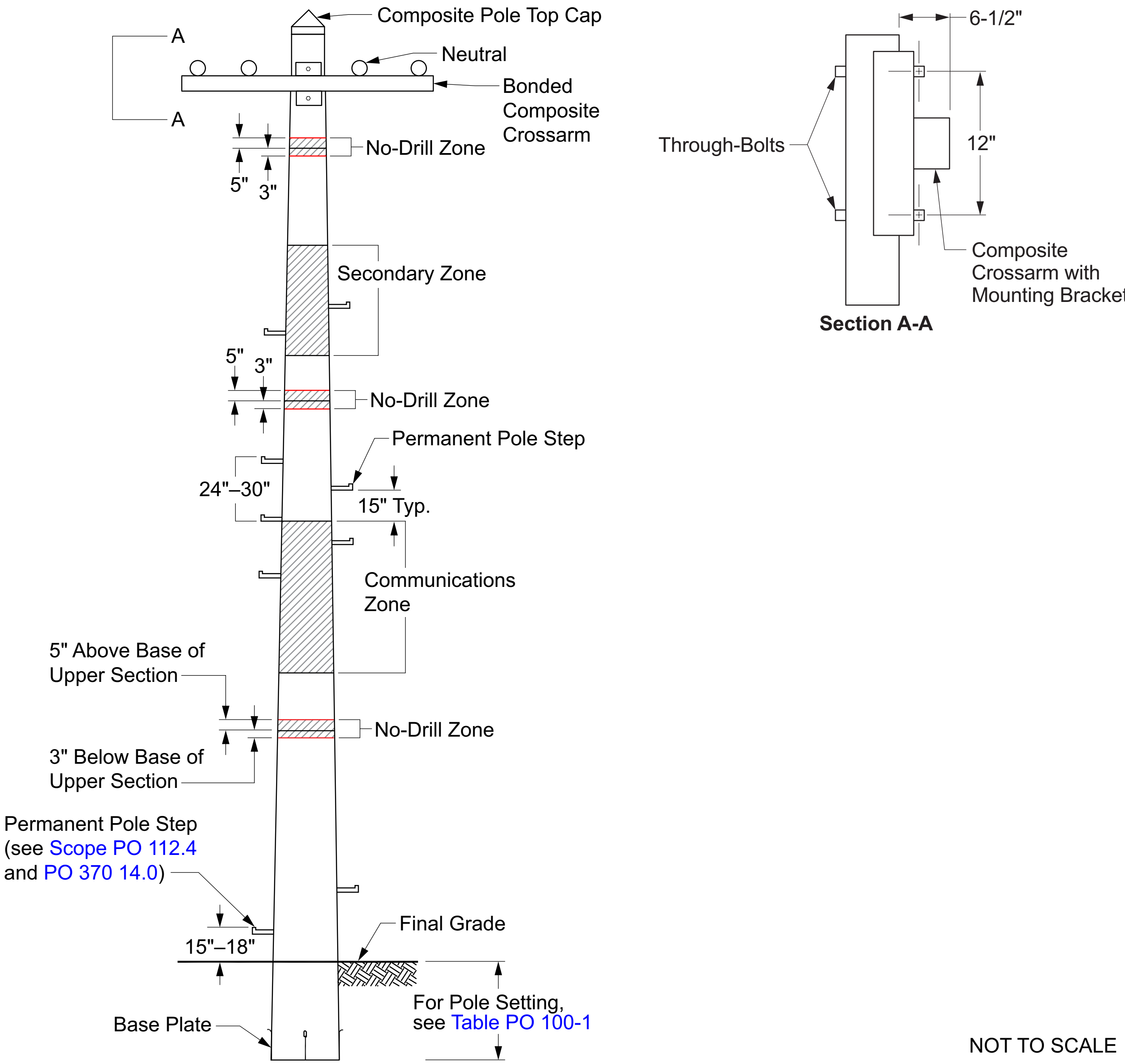
Sectional composite poles are round, tapered tubular structures that are connected by either a slip joint or compression fit (jacking required). The connections are then secured by the use of through-bolts or lag screws.

1.1 RS Sectional Composite Poles

The RS Poles are available in lengths from 35 feet to 75 feet. The standard color is brown. Contact Linear & Structural Strategies for details.

See Table PO 112–1 for dimensions and weights for the RS Poles and Table PO 112–2 for weights of the RS pole sections.

Figure PO 112–1: Typical RS Sectional Composite Pole



NOT TO SCALE

Note(s):

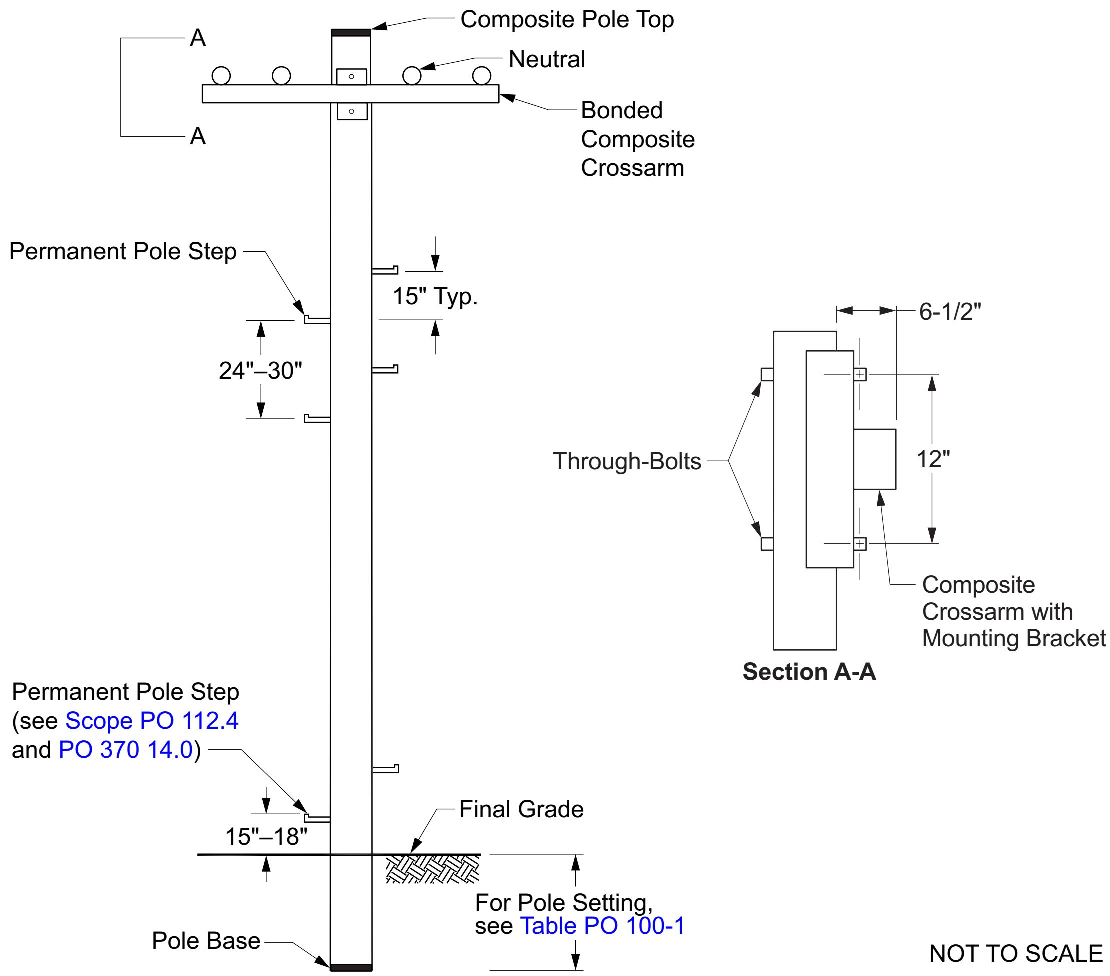
1. Use pole bands for attachments within no-drill zones (see PO 370 for pole band SAP numbers).
2. If needed to ascend and descend the pole during construction or maintenance, utilize permanent steps. After work is completed, remove permanent steps so that the remaining first step is located at least 9-feet above the ground line.

1.2 CP Continuous Composite Poles

The CP Poles are available in lengths from 35 feet to 80 feet. The standard color is brown. Contact Linear & Structural Strategies for details.

See Table PO 112–1 for dimensions and weights for the CP Poles.

Figure PO 112–2: Typical CP Continuous Composite Pole



Note(s):

1. If needed to ascend and descend the pole during construction or maintenance, utilize permanent steps. After work is completed, remove permanent steps so that the remaining first step is located at least 9-feet above the ground line.

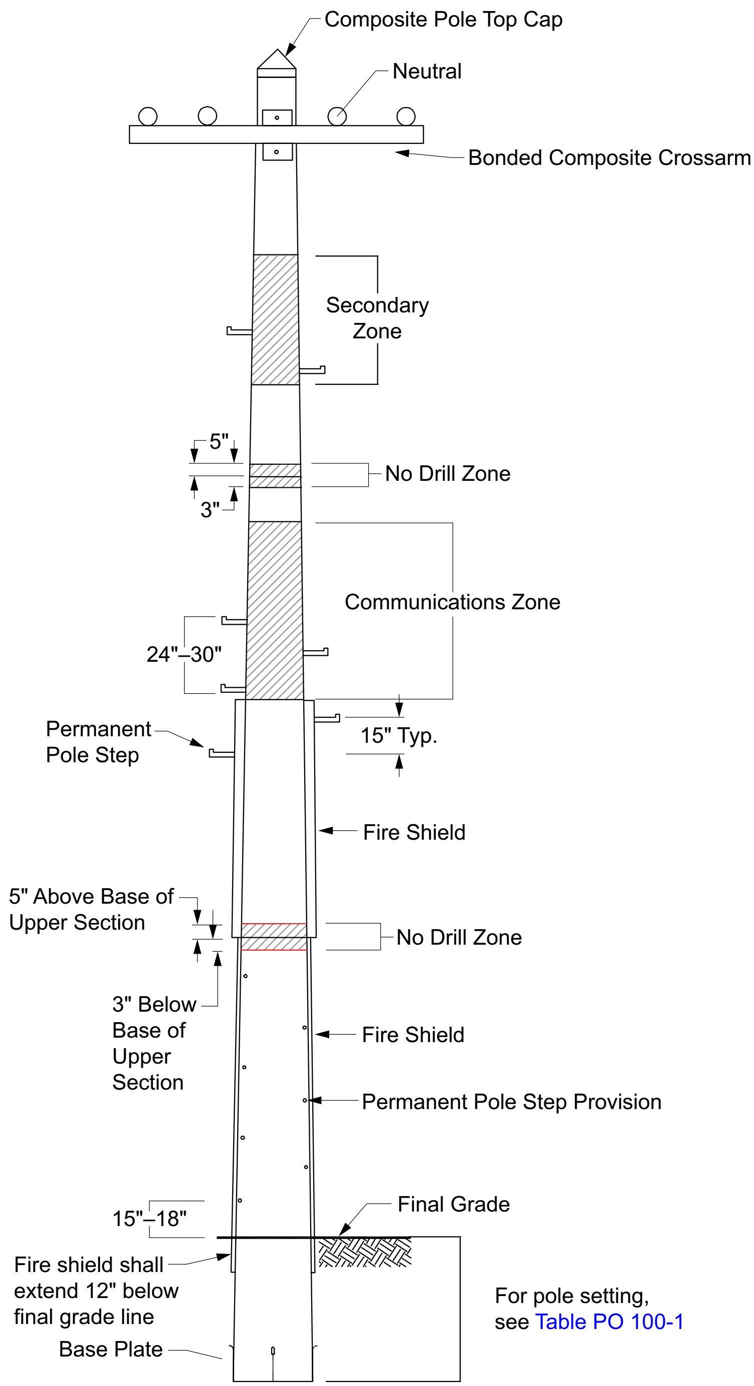
1.3 Composite Poles with Fire (or Protective) Shields

Composite poles with fire shield should only be utilized when there is mechanical setting means (that is, truck access or crane/helicopter set). Refer to DDS-10 for application requirements of the composite poles.

The fire shield composite poles are available in lengths 35 feet and 80 feet. They can be ordered as continuous (monopole), which comes fully pre-assembled, or as sectional, which come partially pre-assembled or fully pre-assembled. For a partially pre-assembled pole, the manufacturer will pre-assemble the bottom two sections with the fire shield. The remaining section(s) will be assembled in the field. See horizontal assembly of RS sectional composite poles in Scope PO 112.1 (Handling, Setting, and Framing) for details.

See Table PO 112–3 for dimensions, weights and SAP numbers for the fire shield composite poles.

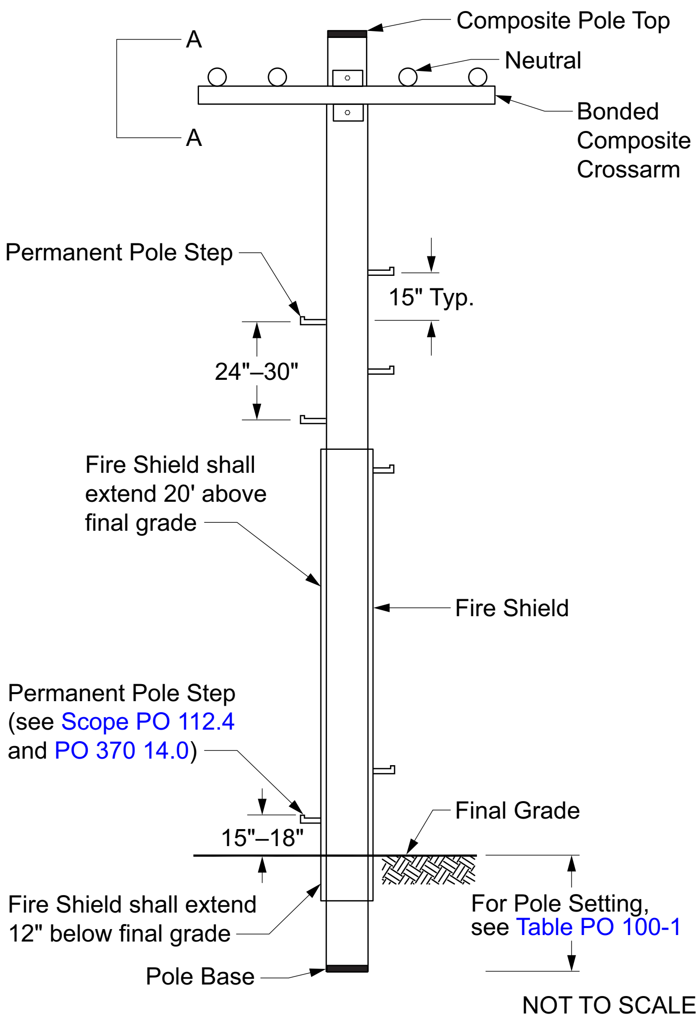
Figure PO 112–3: Typical RS Composite Pole with Fire Shield



Note(s):

1. Set the fire shield 12 inches below ground line.
2. If needed to ascend and descend the pole during construction or maintenance, utilize permanent steps. After work is completed, remove permanent steps so that the remaining first step is located at least 9 feet above the ground line.
3. Use pole bands for attachments within no-drill zones. See PO 370 for pole band SAP numbers.

Figure PO 112–4: Typical CP Composite Pole with Fire Shield



Note(s):

1. Set the fire shield 12 inches below ground line.
2. If needed to ascend and descend the pole during construction or maintenance, utilize permanent steps. After work is completed, remove permanent steps so that the remaining first step is located at least 9 feet above the ground line.

1.4 Dimension and Weights of Sectional Composite Poles

Table 112–1: Dimensions, Weights and SAP Numbers

Pole Length and Description	ANSI Size Class	Section Numbers	Height Above Ground-line	Manufacture	Ground-line Circumference (in)	Top Circumference (in)	Weight (lb)	SAP
35 ft Sectional Pole	1[a]	1, 2, 3	29	RS	43.5	29.3	850[b]	10209239
35 ft Continuous Pole	1[a], H1	—	29	CPI	37.7	37.7	585[b]	10214978
35 ft Continuous Pole	H2	—	29	CPI	50.3	50.3	799[b]	10214980
40 ft Sectional Pole	1[a]	2, 3, 4	34	RS	52.8	32.7	660[b]	10209233
40 ft Continuous Pole	1[a]	—	34	CPI	37.7	37.7	668[b]	10214982
40 ft Continuous Pole	H1, H2, H3, H4	—	34	CPI	50.3	50.3	912[b]	10214984
45 ft Sectional Pole[c]	1	1, 2, 3, 4	38.5	Intelli-Pole	46.5	30.8	850	10203242
45 ft Sectional Pole	1[a]	2, 3, 4	38.5	RS	52.4	28.9	660[b]	10209234
45 ft Continuous Pole	1[a]	—	38.5	CPI	37.7	37.7	750[b]	10214986
45 ft Continuous Pole	H1, H2, H3, H4	—	38.5	CPI	50.3	50.3	1,024[b]	10214987
50 ft Sectional Pole	1[a]	2, 3, 4, 5	43	RS	61.4	37.1	920[b]	10209235
50 ft Continuous Pole	1[a]	—	43	CPI	37.7	37.7	833[b]	10214988
50 ft Continuous Pole	H1, H2, H3	—	43	CPI	50.3	50.3	1,137[b]	10214989
55 ft Sectional Pole	1[a]	2, 3, 4, 5	47.5	RS	61	33.3	970[b]	10209236
55 ft Continuous Pole	1[a]	—	47.5	CPI	37.7	37.7	915[b]	10214991
55 ft Continuous Pole	1[a], H1, H2, H3	—	47.5	CPI	50.3	50.3	1,249[b]	10214993
60 ft Sectional Pole	1[a]	3, 4, 5/6	52	RS	72	38.7	1,350[b]	10209237
60 ft Continuous Pole	1[a]	—	52	CPI	37.7	37.7	998[b]	10214995
60 ft Continuous Pole	1[a], H1, H2, H3	—	52	CPI	50.3	50.3	1,362[b]	10214997
65 ft Sectional Pole	1[a]	3, 4, 5/6	56.5	RS	71.6	34.8	1,410[b]	10209238
65 ft Continuous Pole	1[a]	—	56.5	CPI	37.7	37.7	1,080[b]	10214999
65 ft Continuous Pole	1[a], H1, H2	—	56.5	CPI	50.3	50.3	1,474[b]	10215001
70 ft Continuous Pole	1[a]	—	61	CPI	37.7	37.7	1,080[b]	10214999
70 ft Continuous Pole	1[a], H1	—	61	CPI	50.3	50.3	1,474[b]	10215001
75 ft Continuous Pole	1[a]	—	65.5	CPI	37.7	37.7	1,246[b]	10215007
75 ft Continuous Pole	1[a], H1	—	65.5	CPI	50.3	50.3	1,699[b]	10215009
80 ft Continuous Pole	1[a]	—	70	CPI	37.7	37.7	1,328[b]	10215011
80 ft Continuous Pole	1[a], H1	—	70	CPI	50.3	50.3	1,812[b]	10215013

a/ Class 1 is the minimum class for composite poles. Use Class 1 composite poles when rebuilding existing wood poles with classes 5 through 1. SPIDACalc determines if a Class 1 composite pole meets the minimum required safety factors.

b/ Nominal weight + 10%. Refer to manufacturer ID tag for actual weight. See Table PO 112–2 for weight of individual RS pole sections.

c/ Not approved for new construction. See Table PO 112–2 for weight of individual Intelli-Pole sections.

= FOR REFERENCE ONLY

Note(s):

1. Contact Linear & Structural Strategies for questions pertaining to this table.
2. Lead time for composite pole ordering is 6–8 weeks.

Table 112–2: Weights for RS Pole Sections

Section Number	Section Length (ft)	Weight (lb)
1L	20.2	205
1	15.1	155
2	17.7	180
3	17.4	225
4	18.9	320
5	19.0	355
5/6	34.9	780
6/7	34.9	920
8/9	34.7	1,200
10/11	36.9	1,460

Note(s):

1. The smallest section number making up an RS pole is the top section. The largest section number making up an RS pole is the base section.

Table 112–3: Dimensions, Weights, and SAP Numbers for Fire Shield Composite Poles

Pole Length and Description	ANSI Size Class	Height Above Ground-line	Manufacture	Ground-line Circumference (in)	Top Circumference (in)	Weight (lb)	SAP
35 ft Continuous Pole with FR Shield	1[a/], H1	29	CPI	39.7	37.7	706[b/]	10214979
35 ft Continuous Pole with FR Shield	H2	29	CPI	52.2	50.3	962[b/]	10214981
40 ft Continuous Pole with FR Shield	1[a/]	34	CPI	39.7	37.7	788[b/]	10214983
40 ft Continuous Pole with FR Shield	H1, H2, H3, H4	34	CPI	52.2	50.3	1,074[b/]	10214985
45 ft Sectional Pole (Partially Pre-Assembled) with FR Shield	1[a/]	38.5	RS	52.4	28.9	660[c/ b/]	10210664
45 ft Sectional Pole (Partially Pre-Assembled) with Shield	H1	38.5	RS	61.8	38	1,006[c/ b/]	10212589
45 ft Continuous/Fully Pre-Assembled Pole with FR Shield	1[a/]	38.5	CPI	39.7	37.7	871[b/]	10210665
			RS	52.4	28.9	770[b/]	
45 ft Continuous/Fully Pre-Assembled Pole with FR Shield	H1, H2	38.5	CPI	52.2	50.3	1,187[b/]	10212590
			RS	73.2	47.1	1,218[b/]	
45 ft Continuous/Fully Pre-Assembled Pole with FR Shield	H3, H4	38.5	CPI	52.2	50.3	1,187[b/]	10212591
			RS	82.6	55.9	1,378[b/]	
50 ft Sectional (Partially Pre-Assembled) Pole with Shield	1[a/]	43	RS	61.4	37.1	1,158[c/ b/]	10210666
50 ft Continuous/Fully Pre-Assembled Pole with FR Shield	1[a/]	43	CPI	39.7	37.7	953[b/]	10210667
			RS	61.4	28.9	1,120[b/]	
50 ft Continuous Pole with FR Shield	H1, H2, H3	43	CPI	52.2	50.3	1,299[b/]	10214990
55 ft Sectional (Partially Pre-Assembled) Pole with Shield	1[a/]	47.5	RS	61	33.3	1,103[c/ b/]	10212455
55 ft Continuous Pole with FR Shield	1[a/]	47.5	CPI	39.7	37.7	1,036[b/]	10214992
55 ft Continuous Pole with FR Shield	1[a/], H1,H2,H3	47.5	CPI	52.2	50.3	1,412[b/]	10214994
60 ft Sectional (Partially Pre-Assembled) Pole with Shield	1[a/]	52	RS	72	38.7	1,470[c/ b/]	10212456
60 ft Continuous Pole with FR Shield	1[a/]	52	CPI	39.7	37.7	1,118[b/]	10214996
60 ft Continuous Pole with FR Shield	1[a/], H1,H2,H3	52	CPI	52.2	50.3	1,524[b/]	10214998
65 ft Sectional (Partially Pre-Assembled) Pole with Shield	1[a/]	56.5	RS	71.7	34.9	1,528[c/ b/]	10212457
65 ft Continuous Pole with FR Shield	1[a/]	56.5	CPI	39.7	37.7	1,201[b/]	10215000
65 ft Continuous Pole with FR Shield	1[a/], H1,H2	56.5	CPI	52.2	50.3	1,627[b/]	10215002
70 ft Sectional (Partially Pre-Assembled) Pole with Shield	1[a/]	61	RS	80.7	42.5	1,907[c/ b/]	10212458
70 ft Continuous Pole with FR Shield	1[a/]	61	CPI	39.7	37.7	1,283[b/]	10215004
70 ft Continuous Pole with FR Shield	1[a/], H1,H2	61	CPI	52.2	50.3	1,749[b/]	10215006
75 ft Sectional (Partially Pre-Assembled) Pole with Shield	1[a/]	65.5	RS	80.3	38.7	1,970[c/ b/]	10212459
75 ft Continuous Pole with FR Shield	1[a/]	65.5	CPI	39.7	37.7	1,366[b/]	10215008
75 ft Continuous Pole with FR Shield	1[a/], H1	65.5	CPI	52.2	50.3	1,862[b/]	10215010
80 ft Continuous Pole with FR Shield	1[a/]	70	CPI	39.7	37.7	1,449[b/]	10215012
80 ft Continuous Pole with FR Shield	1[a/], H1	70	CPI	52.2	50.3	1,974[b/]	10215014

a/ Class 1 is the minimum class for composite poles. Use Class 1 composite poles when rebuilding existing wood poles with classes 5 through 1. SPIDACalc determines if a Class 1 composite pole meets the minimum required safety factors.

b/ Nominal weight + 10%. Refer to manufacturer ID tag for actual weight.

c/ See Table PO 112–4 for weights of partially pre-assembled and individual pole sections for RS poles with fire shields.

Note(s):

1. Lead time for fire shield composite pole ordering is 6 to 8 weeks.
2. Contact Linear & Structural Strategies for questions pertaining to this table.

What's Changed? Updated Table PO 112-1 to FRO Intelli-Pole and add CP as an approved supplier of composite poles.

Table 112–4: Weights of Partially Pre-Assembled and Individual Pole Sections for Composite Poles with Fire Shields

Pole Length and Description	Pole Section	Section Length (ft)	Weight (lb)
45 ft Partially Pre-Assembled Pole with 18 ft Fire Shield, Class 1	Sections 2 and 3 (Bottom Two Sections) with Fire Shield	34	643
	Section 2 (Top Section)	14	147
45 ft Partially Pre-Assembled Pole with 18 ft Fire Shield, Class H1	Sections 4 and 5 (Bottom Two Sections) with Fire Shield	34.7	780
	Section 3 (Top Section)	17.4	226
50 ft Partially Pre-Assembled Pole with 25 ft Fire Shield, Class 1	Sections 4 and 5 (Bottom Two Sections) with Fire Shield	35	895
	Section 3	17.4	226
	Section 2 (Top Section)	3	37
55 ft Partially Pre-Assembled Pole with 25 ft Fire Shield, Class 1	Sections 4 and 5 (Bottom Two Sections) with Fire Shield	34.7	780
	Section 3	17.4	226
	Section 2 (Top Section)	8.1	27
60 ft Partially Pre-Assembled Pole with 25 ft Fire Shield, Class 1	Sections 4 and 5/6 (Bottom Two Sections) with Fire Shield	50.5	1,302
	Section 3 (Top Section)	12.3	168
65 ft Partially Pre-Assembled Pole with 25 ft Fire Shield, Class 1	Sections 4 and 5/6 (Bottom Two Sections) with Fire Shield	50.5	1,302
	Section 3 (Top Section)	17.3	226
70 ft Partially Pre-Assembled Pole with 25 ft Fire Shield, Class 1	Sections 5 and 6/7 (Bottom Two Sections) with Fire Shield	49.9	1,480
	Section 4	18.9	324
	Section 3 (Top Section)	7.3	103
75 ft Partially Pre-Assembled Pole with 25 ft Protective Shield, Class 1	Sections 5 and 6/7 (Bottom Two Sections) with Fire Shield	49.9	1,480
	Section 4	18.9	324
	Section 3 (Top Section)	12.3	166

Scope PO 112.2 Handling, Setting, and Framing

1.0 Pole Handling

1.1 Handling Composite Poles

Care must be exercised when handling composite poles:

- Avoid forceful impacts on the pole to preserve outer resin surface.
- Poles must not be dropped or dragged over jagged rocks. Avoid forceful impact with the ground or other hard objects.
- Use nylon slings for handling or moving composite poles or sections.
- Avoid using hardware with sharp edges or sharp corners in direct contact with the exterior of the pole.

RS Sectional poles can be left nested for transportation and assembled at the work location. Through-bolts or pole steps may be attached to transport sections to installation site. For sections whose weights exceed 200 pounds, use a pole dolly to transport sections to installation site.

Visually inspect the composite pole for any damage which may have occurred during handling. Such damage includes: signs of surface gouging, delamination, and cracks.
For any questions, contact Linear & Structural Strategies.

1.2 Poles on Dollies

When loading poles on dollies, the average pole weights tabulated in Table PO 112–1 should be consulted to avoid overloading the pole dolly. The safe work practices section of the Accident Prevention Manual should be followed when loading and unloading poles of any type.

Use nylon straps to secure the composite poles onto the pole dolly. When using grabbers to set the pole. Use caution to avoid squeezing.

2.0 Pole Setting

2.1 Composite Pole Depth

Set composite poles to the same depth required by wood poles (see Table PO PO 100–1).

2.2 Horizontal Clearance from Face of Curb

Horizontal clearance from face of curb to face of pole shall not be less than 18 inches. For new pole and pole replacements, if space permits or can be provided at no additional cost or low cost minor work, maintain a minimum clearance of 36 inches for pedestrian right-of-way access. Avoid pole placement in wheelchair ramp locations.

2.3 Clearance from Top of Slope

Maintain a four-foot clearance from the top of the slope of a commercial driveway and a two-foot clearance from the top of the slope of a residential driveway. Apply pole visibility strips per PO 120.

2.4 Clearance from Fire Hydrant

Five-foot clearance to be maintained from fire hydrant.

2.5 Tamping

Firmly tamp the bottom of the hole or set pole on an anchor plate where necessary.

Dig all pole holes large enough to permit tamping backfill to full depth.

2.6 Alignment

Set poles so that they stand as nearly vertical as possible and so that the crossarms are at right angles or parallel to the direction of the line. Poles intended to be set in a straight line shall be set so that no pole is more than 2 inches out of line with the others.

Poles at line terminals, angles, and at other points of abnormal stress shall be given a rake against the direction of the stress, equal to the width of the pole top. Set poles with required rake. Never bend a pole by pulling guy to achieve rake.

2.7 Backfill

Backfill shall be thoroughly tamped throughout the backfill operation while pole is held in position. After the hole is completely filled and thoroughly tamped, earth shall be piled up and packed around the pole.

2.8 Pole Setting Foam

Pole setting foam can be used as a backfill in rocky areas where there is not enough earth for backfill and compaction.

2.9 Caisson or Sono-Tube

Use of a caisson or sono-tube is required when setting composite poles utilizing a helicopter (see PO 143 for further details).

3.0 Pole Framing

3.1 Pole Framing General Criteria

Whenever possible, all single-pole structures shall be completely framed with crossarms, grounds, and steps before setting. Bore through-bolt holes for the required number of crossarms and apparatus (transformers, capacitor banks, automatic reclosers) before the pole is set.

Composite poles have factory provided pre-drilled hole for the primary crossarm bracket. The primary crossarm bracket is located 12 inches from the top of the pole.

3.2 Mounted Apparatus

Apparatus mounted to composite poles shall be secured with 3/4-inch through-bolts and 4" × 4" curved square washers to spread out load. Ensure that the radius of the curved washers and hardware matches the pole curvature. Install washers on both ends of through-bolts.

For riser installation on composite poles using double-sided Unistrut riser support, refer to DUG CR 110. Note that lag screw-type hardware is not approved for use on composite poles.

3.3 Field Drilling Additional Holes

Additional holes for pole steps, hardware, and equipment may be drilled in the field. Holes shall be drilled using a carbide drill bit (see PO 370). The holes must be no less than 6 hole diameters apart center to center and must be no less than 5 hole diameters from the edge of a section (see Table PO 112–1 for typical hole size spacing). Additional permanent working steps may be installed by drilling 1-inch diameter holes.

3.4 Hardware

Use through bolts with spring washers for all hardware attachments. Tighten through bolts to 35 ft-lbs maximum. This is equivalent to the spring washer fully compressed. **DO NOT** over-tighten.

Use 4" × 4" min curved square washers on round composite poles. Use 4" × 4" MIN flat square washers on octagonal poles. Install washers on both ends of through-bolts.

Ensure that the radius of the curved washers and hardware matches the pole curvature.

3.5 Unapproved Hardware

The following hardware are not approved for use on composite poles:

- Lag bolts or any lag screw-type hardware. (Lag bolts are only approved for RS pole joints).
- Hardware with teeth or cleats — Teeth and cleats are designed to bite into wood. A similar piece of hardware should exist with a smooth surface, such as those used for steel or concrete poles.
- Nails and Staples — Use self-drilling screws instead.
- Hardware with sharp edges or sharp corners in direct contact with the pole — Use curved backup washer or neoprene pad to spread out load.

3.6 No Drill Zones for Sectional Composite Poles

No Drill Zones for RS Poles

- No drill zone tags will be installed on the pole sections by the manufacturer.
- Do not drill within a no-drill zone. These areas typically extend from 3 inches below to 5 inches above the end of a joint overlap. See Figure PO 112–1 for no-drill zones on RS poles.
- Use pole bands for attachments within no-drill zones (see PO 370 for SAP numbers).

4.0 Pole Steps on Composite Poles

Composite poles have factory pre-drilled climbing step holes that are vertically spaced 15 inches to 18 inches (not to exceed 30 inches on the same side of the pole).

At locations where the pole diameter is 12 inches or less, the step holes are 180 degrees apart. Where the pole diameter is greater than 12 inches, the horizontal arc distance between the step holes are 120 degrees.

Installation of permanent steps is required on composite poles set in rear property line and/or areas where there is restricted vehicular access.

Temporary step plates shall be installed at the first seven steps above ground line of the Intelli-Pole® and RS sectional composite poles. Temporary step plates (SAP 10068609) and detachable steps (SAP 10068470) shall be installed using a 1-inch hole.

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Figure PO 112–5: Temporary Step Plates and Detachable Steps for the Intelli-Pole® and RS Poles (Not for use on the RS Poles with Protective Shields)

The first permanent step (SAP 10068660) shall not be less than 9 feet above grade or any easily climbable foreign structure from which one could reach or step. Permanent climbing steps shall be installed using a 1-inch hole.

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Figure PO 112–6: Permanent/Temporary Climbing Steps for Composite Poles

The composite poles will have the first seven step holes above ground line plugged using the manufacturer provided pole plugs. When performing work on the pole, the pole plugs will be removed and permanent steps will be used as climbing steps above ground line. When work is completed, remove the permanent steps and re-plug the pole holes using the manufacturer provided pole plugs.

Factory pre-drilled working step holes are provided on the secondary and communication levels. Field drilling for additional pole steps are allowed (see Subsection 3.3 for details).

Scope PO 112.3 Assembly and Removal

1.0 Construction

1.1 Distribution Equipment Installed on Composite Poles

Distribution equipment installed on composite poles will use the same construction practices as for equipment installed on wood poles — using composite crossarms and other wood pole construction practices — except for the following:

1. Use the predrilled holes for pole steps. Additional holes for pole steps, hardware, and equipment may be drilled in the field. The holes must be no less than 6 hole diameters apart center to center and must be no less than 5 hole diameters from the edge of a section (see Table PO 112–5 for typical hole size spacing). Use through-bolts for all other attachments such as transformers, capacitor banks, automatic reclosers, and other apparatus. For apparatus, see Subsection 3.2.
2. All holes shall be drilled using a carbide drill bit. Do not use standard wood bits.

Table 112–5: MIN Hole Spacing

Hole Size[a/] (in)	Required Spacing Between Holes (in)	Required Spacing from Section Edge (in)
11/16	4-1/8	3-7/16
13/16	4-7/8	4-1/16
1	6	5

[a/] Maximum 1-inch diameter. For diameters larger than 1-inch, contact Linear and Structural Strategies.

3. Where existing wood pole practice calls for nails or staples for ground attachments, use 2-inch #10 self-drilling screws (SAP 10071503) with protected ground wire.
4. Composite crossarms with attached mounting brackets (see PO 370 for SAP numbers) are used without V-braces. Use a carbide drill bit for boring mounting holes when required. Use bonding clips (SAP 10113253) to attach bond wire to composite crossarms. Use 1-inch #10 self-drilling screws (SAP 10072230) to attach bonding clips.
5. Do not install steel crossarms on composite poles.
6. Use unistrut riser support (SAP 10073393) and attach risers as described in the Distribution Underground Construction Standards (DUG), Section CR 110. Attach unistrut riser support to pole using a DA bolt, square nuts, spring washers, and 4-inch square curved washer.
7. Install pole-top caps and pole butt plates on composite poles using self-drilling screws.
8. Do not cut a gain on non-wood products.
9. A guying tee (SAP 10181650) attached using 3/4-inch through bolts and square or curved square washers shall be used for span or down guying on composite poles (see PO 370 for details).
10. Install plugs on all excess holes to prevent insects and small animals from possibly building a hive or nesting inside the pole (see PO 370 for pole hole plug SAP numbers).
11. Install visibility strips on composite poles where required (see PO 120 for application of visibility strips and PO 370 for the visibility strip SAP number).
12. Use 1-inch #10 self-drilling screws (SAP 10072230) to attach the pole number plate, pole markings such as height or year, neutral markings on crossarms, or apparatus identification onto composite poles.

1.2 Vertical Assembly of RS Round Sectional Tapered Poles Using a Pole Gin

RS sectional poles are shipped in nested bundles secured with a shipping bolt and have sections numbered 1 through 11 depending on the pole height. These bundles will be approximately 19 feet or 37 feet in length depending on pole height.

STEP 1. Remove the shipping bolt located at the large end of the nested bundle. This bolt holds all the sections together from a single point. Ensure that the nested section set is elevated to allow for removal of the bolt. Ensure that the shipping bolt is on the bottom of the nested sections to reduce section movement after the shipping bolt is removed and to avoid possible injury.

STEP 2. Un-nest the sections starting with the innermost (smallest) section first and layout on blocking for assembly. Lift up the base of the section during its removal from the nested bundle to minimize scratching along its length.

STEP 3. Insert four J-Bolts from the inside of the base section into pre-drilled base plate holes located at the bottom of the base section.

STEP 4. Place the base plate on the base of the pole section and align the base plate with the installed J-Bolts. Attach using provided washers and nuts.

STEP 5. Install temporary step plates and detachable steps (SAP 10068609 and SAP 10068470) and permanent steps (SAP 10068660) in manufacturer pre-drilled holes.

STEP 5.1. Turn nuts on pole step until they are no longer engaged on threads.

STEP 5.2. Insert the step into 1-inch pole step hole so that curved surface of step or step plate can be placed against the pole surface.

STEP 5.3. Rotate the pole step so that the stepping surface is facing upwards once pole is erected.

STEP 5.4. Hand tighten nut on pole step until snug.

STEP 5.5. Using a wrench, tighten an additional 1/2 to 3/4 of a turn.

STEP 6. Set and tamp the base section of pole, ensuring that it is plumb and that the step holes are in the proper orientation. Set base section to the same depth required by wood poles (see Table PO PO 100–1).

STEP 7. Attach approved pole gin to the base pole section.

STEP 8. Attach an appropriately sized sling around the pole section just above the stenciled center of gravity. The manufacturer will provide the top section cut to length, so the center of gravity will be determined in the field.. This sling will be used to raise the section.

STEP 9. Attach a tag line to the base of the section being raised and another tag line to the top of the section being raised.

STEP 10. Install two jacking bars and secure with a ratchet strap into the bottom two jacking bar holes of the section to be lifted.

STEP 11. Using a clevis, connect a 48 inch sling to each jacking bar. Connect another clevis into the free end of the sling. These will be used to connect hoists for the compression step.

STEP 12. Raise the section and place onto the section below (base section), ensuring that the alignment marks are properly aligned (see Figure PO 112–7).

STEP 13. In preparation for jacking the slip joint together, disconnect the tag line from the base of the section just raised.

STEP 14. Drill two 1-inch holes 2-feet above ground line so that they are in line with the pre-drilled jacking bar holes further up the pole.

STEP 15. Install two jacking bars into these new jacking bar holes and secure with a ratchet strap.

STEP 16. Connect two chain hoists between the lower jacking bars and the 48-inch slings connected to the upper jacking lugs, snug up and then ratchet hoists one at a time ensuring that the tension on both hoists is as equal as possible.

STEP 17. Continue ratcheting on the hoists, maintaining relatively equal tension on both sides, until the upper section no longer moves.

STEP 18. Remove the chain hoists.

STEP 19. Drill through the inner section at the base end of the slots in the outer (upper) section with an 11/16-inch drill bit using the pre-cut slots as a guide. Locate the drilled holes as close to the base-end of the slots as possible.

STEP 20. Insert a lag bolt through the holes drilled in STEP 19 (Page 16) and secure using round washer and square nuts supplied by the manufacturer.

STEP 21. Remove the upper jacking bars and ratchet strap.

STEP 22. Reposition the approved pole gin onto the section just installed as outlined in STEP 7 (Page 15), and repeat STEP 8 (Page 15)–STEP 13 (Page 15).

STEP 23. Install 12-foot slings to the 48-inch slings hanging from the lower jacking bars on the section just raised.

STEP 24. Install chain hoists between the 12-foot slings and the jacking bars just above the ground line on the base section, snug up and then ratchet the hoists ensuring that the tension on both hoists remains equal.

STEP 25. Repeat STEP 17 (Page 16)–STEP 21 (Page 16).

STEP 26. If another section is being installed, repeat STEP 22 (Page 16)–STEP 25 (Page 16).

STEP 27. Install the pole top cap to the top section using manufacturer provided self-drilling screws into manufacturer pre-drilled pilot holes and plug all holes as needed.

1.3 Horizontal Assembly of RS Round Sectional Tapered Poles

STEP 1. Remove the shipping bolt located at the large end of the nested bundle. This bolt holds all the sections together from a single point. Ensure that the nested section set is elevated to allow for removal of the bolt. Ensure that the shipping bolt is on the bottom of the nested sections to reduce section movement after the shipping bolt is removed and to avoid possible injury.

STEP 2. Un-nest the sections starting with the innermost (smallest) section first and layout on blocking for assembly. Lift up the base of the section during its removal from the nested bundle to minimize scratching along the length of the section.

STEP 3. Starting with the largest sections to be assembled, slide the base of the smaller section over the tip of the larger section by hand using the alignment marks as a guide (see Figure PO 112–7). Using the alignment marks ensures that the jacking holes and any pre-drilled holes are kept in alignment. Repeat for all other sections.

STEP 4. Beginning with the two largest sections, insert two jacking into the pre-drilled jacking holes. Pre-drilled jacking holes are located at 180 degrees to each other section. Ensure that the bars are fully inserted and flush with the pole wall and oriented in the direction of the come-along to prevent damage to the pole wall or jacking bar.

STEP 5. Wrap a jacking lug safety strap around the section at each jacking bar location. Ensure that the strap passes through the large hole in the jacking bar. Fasten the strap with the ratcheting device, the strap should be as snug as possible but not tight.

STEP 6. Ensure that the sections being assembled are aligned using the longitudinal section tip and base alignment marks, then attach come-alongs to the jacking bars on both sides of the pole.

STEP 7. Winch sections together using equal force on both sides. During this process ensure that the longitudinal alignment between the sections is maintained. When sections quit moving, use a rubber mallet on the butt of the smaller (upper) section to relieve any built up stress in the slip joint. The module will move when the stress is released. Continue jacking until the sections quit moving. Repeat until the module no longer moves when struck by the rubber mallet or dead blow hammer.

STEP 8. Remove the come-alongs and jacking bars, and plug the two jacking holes using hole plugs.

STEP 9. Drill through the inner sections at the base end of the slot in the outer (upper) section with an 11/16-inch drill bit using the pre-cut slots as a guide. Locate the drilled hole as close to the base-end of the slot as possible.

STEP 10. Insert a DA bolt through the holes drilled in STEP 19 (Page 16) and secure using 4-inch curved square washers and square nuts.

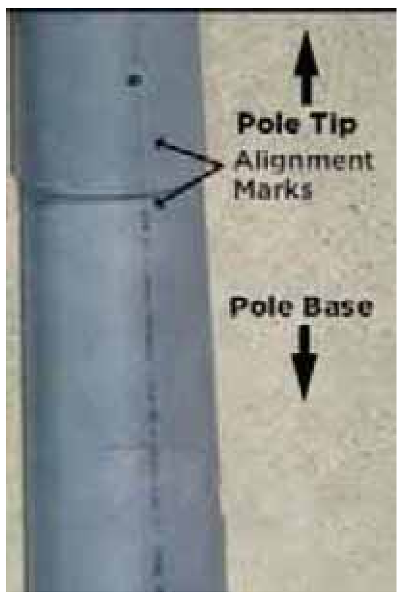
STEP 11. Repeat for STEP 4 (Page 15)–STEP 9 (Page 15) for all remaining sections.

STEP 12. Insert four J-Bolts from the inside of the base section into pre-drilled base plate holes located at the bottom of the base section.

STEP 13. Place the base plate on the base of the pole and align the base plate with the installed J-Bolts. Thread J-Bolts through the slots on the base plate and then attach the washers and nuts by hand. Tighten each nut with a socket or crescent wrench.

STEP 14. Install the pole top cap to the top section using manufacturer provided self-drilling screws.

Figure PO 112–7: Pole Marking Details



2.0 Removal

After pole is removed the pole holes must be completely backfilled and thoroughly tamped. The backfill shall be leveled to grade with no depression or mound allowed.

When pole is removed from paved area or area subject to pedestrian traffic, fill top 6 inches of the hole with asphalt patch or concrete.

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Scope PO 112.4 Composite Pole Reference

1.0 Overview

1.1 Octagonal Single-Piece Composite Poles

Octagonal single-piece composite poles manufactured by Creative Pultrusions, previously known as Powertrusion, are earlier generations of single piece composite poles previously used by SCE. The octagonal poles are non-tapered, and have a 10-inch outside diameter.

Figure PO 112–8: Octagonal Single-Piece Composite Poles

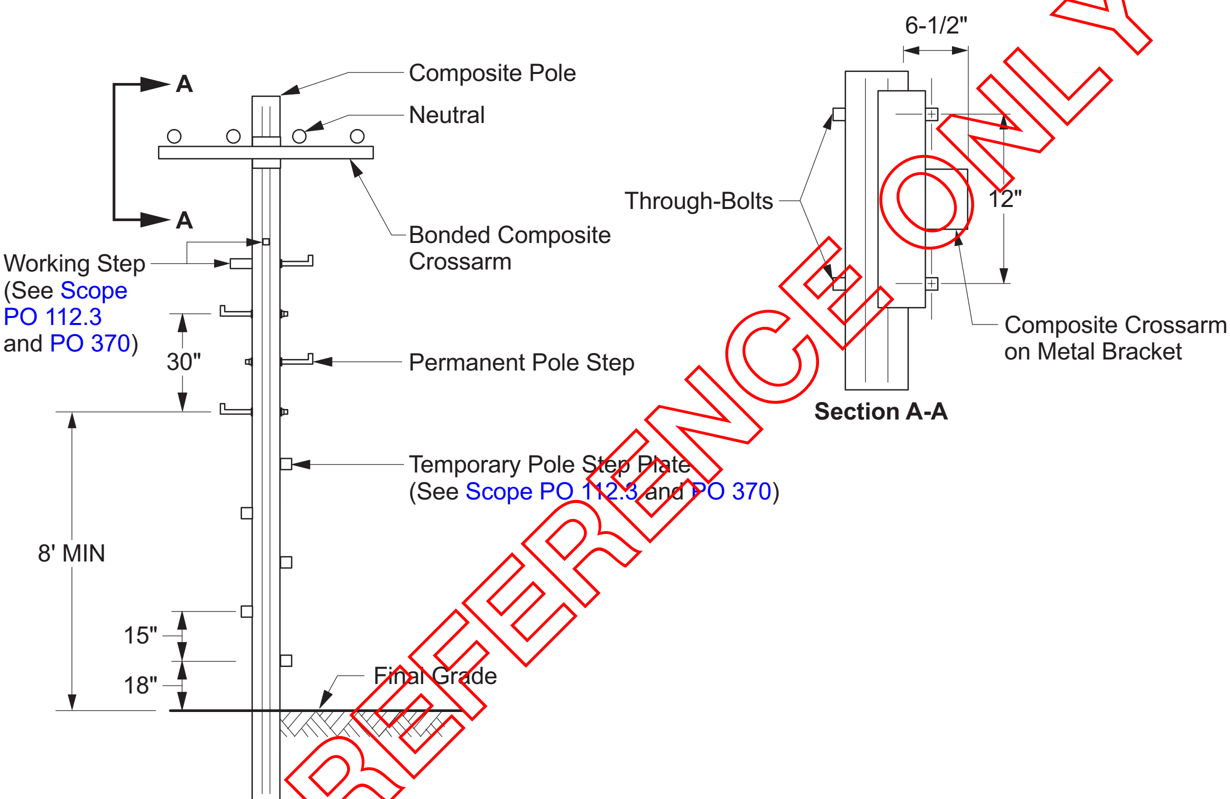
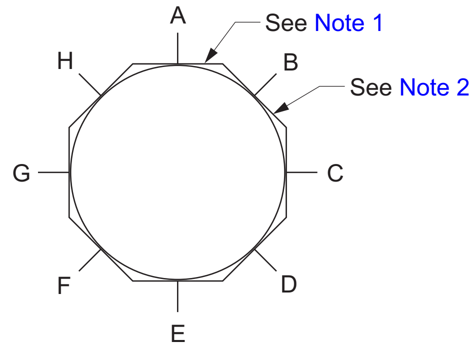


Figure PO 112–9: Octagonal Single-Piece Composite Pole (Top View)



Note(s):

1. The pole is oriented by the line arm holes drilled at the top of the pole (that is, A-to-E).
2. There are 4 seams on the octagonal pole. Equipment shall NOT be installed on a seamed face. Use non-seam faces A, C, E, and G to mount hardware and apparatus. The seamed faces (B, D, F, and H) are located 45 degrees to the non-seamed faces. Identification of the non-seamed faces can be done by referencing the location of the cross arm holes drilled at the top of the pole. These will be drilled through two non-seamed faces (A and E). The other non-seamed faces will be 90 degrees to those faces (C and G).
3. For attachments using 5/8-inch through-bolts, use 11/16-inch carbide drill bit (SAP 10134193). For attachments using 3/4-inch through-bolts, use 13/16-inch carbide drill bit (SAP 10145817).
4. For 3rd party attachments to octagonal composite poles, contact Distribution Apparatus & Standards Engineering for assistance.

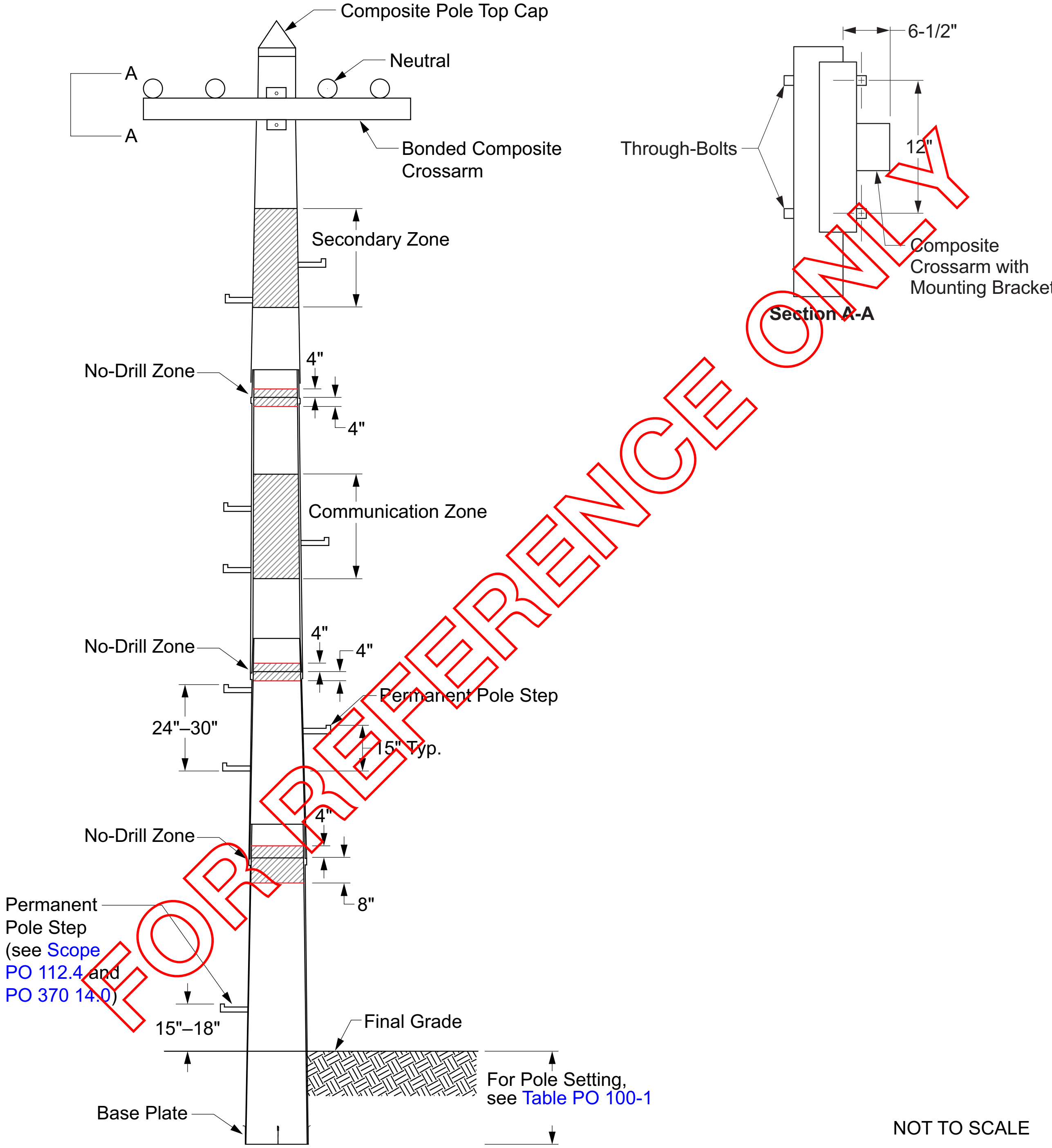
Scope PO 112.5 Intelli-Pole® Sectional Composite Pole

1.0 Intelli-Pole® Sectional Composite Poles

Intelli-Pole® is only available in a length of 45 feet. Transformer and equipment weights on the Intelli-Pole® are limited to 4,000 pounds.

See Table PO 112–1 for dimension and weights for the Intelli-Pole® and Table PO 112–2 for weights of the Intelli-Pole® sections

Figure PO 112–10: Typical Intelli-Pole® Round Sectional Tapered Composite Poles



Note(s):

1. See Subsection 3.6 for no-drill zone decal installations on the Intelli-Pole®.
2. Use pole bands for attachments within no-drill zones (see PO 370 for pole band SAP numbers).

Table 112–6: Weights for Intelli-Pole® Sections

Section Number	Section Length (ft)	Weight (lb)
1 (Top Section)	12.5	140
2	12.5	150
3	12.5	275
4 (Bottom Section)	12.5	285

No Drill Zones for Intelli-Pole

- Do not drill within a no drill zone. For the bottom section, this area typically extends from 4 inches above to 8 inches below the end of the joint overlap. For all other sections, this area typically extends from 4 inches above to 4 inches below the end of the joint overlaps (see Figure 1.0).
- Apply a no-drill zone decal with arrows up (SAP 10204661) at the bottom of each no-drill zone. Apply a no-drill zone decal with arrows down (SAP 10204660) at the top of each no-drill zone.

1.1 Assembly of Intelli-Pole® Round Sectional Tapered Poles

STEP 15. Sectional tapered poles have four sections numbered 1 through 4. Remove the nested sections. Two sections are nested together as shown in Figure PO 112–11. Sections must be removed as shown in Figure PO 112–12.

STEP 16. Install temporary step plates and detachable steps (SAP 10068609 and SAP 10068470) and permanent steps (SAP 10068660) in manufacturer predrilled holes before assembly.

STEP 16.1. Turn nuts on pole step until they are no longer engaged on threads.

STEP 16.2. Insert the step into 1-inch pole step hole so that curved surface of step or step plate can be placed against the pole surface.

STEP 16.3. Rotate the pole step so that the stepping surface is facing upwards once pole is erected.

STEP 16.4. Hand tighten nut on pole step until snug.

STEP 16.5. Using a wrench, tighten an additional 1/2 to 3/4 of a turn.

STEP 16.6. For temporary steps, break off installation handle.

STEP 17. Install the pole bottom plate to section 4 and the pole top cap to section 1 using manufacturer provided self-drilling screws into manufacturer pre-drilled holes.

STEP 18. Attach properly rated and approved equipment lifting gin to the top of the existing wood pole.

STEP 19. Attach a handling rope to the joint bolt inside of the base section (section 4), wrapping the exposed rope with cloth to prevent cutting with the edges of the pole section.

STEP 20. Section 4 (pole butt) is placed in the same pole hole depth as wood poles (see Table PO PO 100–1). Ensure that the pole is level by using a bubble level to plumb the base section. Place the level on top of the machined joint area.

STEP 21. Orient the base section (section 4) so that the step holes and holes for securing the two sections together are in the proper orientation.

What's Changed? Updated Table PO 112-6 to FRO Intelli-Pole. Marked assembly instructions for Intelli-Pole as "For Reference Only".

NOTE Crossarm mounting holes are in line with joint through-bolt holes.

STEP 22. Tamp using similar methods as wood poles while avoiding impact to the pole section.

STEP 23. If section 4 (pole butt) will be left unattended, install safety cap (SAP 10207279).

STEP 24. Attach a through-bolt to the top of section 3 and tie a nylon sling to it. Tie rags around the nylon sling to prevent cutting the sling with the edges of the pole sections.

STEP 25. Lift the section and align holes using the orange index alignment marks stenciled on each section, ensuring that the step holes and the holes for securing the two sections together are in the proper orientation.

STEP 26. Slide section 3 onto base section 4 until it rests against the machined lower flange.

STEP 27. Use the two manufacturer provided box bolts to secure joint between sections 3 and 4.

STEP 28. Lift and assemble each of the remaining sections, following STEP 22 (Page 23) through STEP 25 (Page 23) above, by aligning marks and securing sections in place using through-bolt hardware.

STEP 28.1. Use manufacturer provided 5/8-inch galvanized bolt.

STEP 28.2. Use manufacturer provided 5/8-inch curved washers and nuts.

STEP 28.3. Finger tighten nuts, and then tighten 1/2 turn with a wrench.

STEP 28.4. Place back-up 5/8-inch nut and snug with wrench.

Figure PO 112–11: Nested Intelli-Pole® Sectional Composite Poles (End-view)

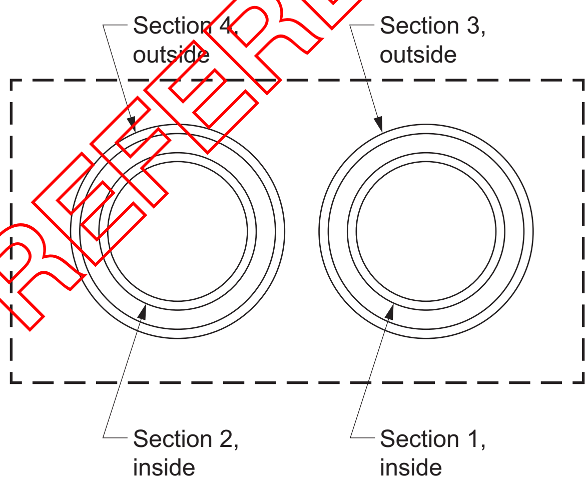


Figure PO 112–12: Nested Intelli-Pole® Sectional Composite Poles (Top-view)

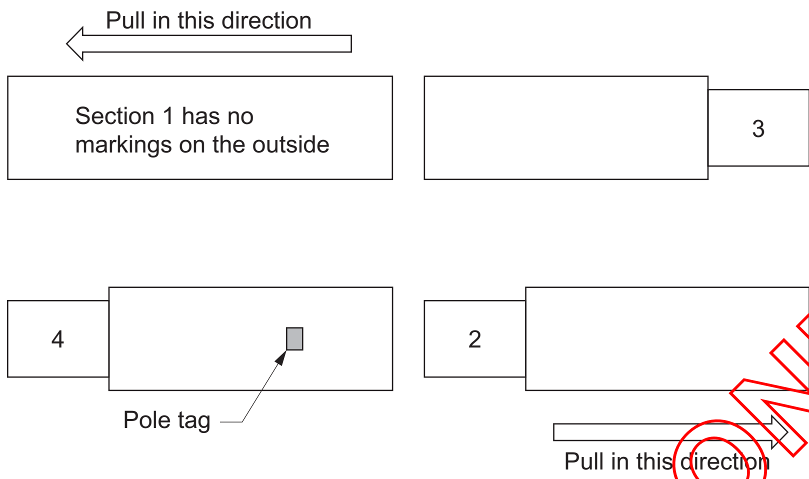


Figure PO 112–13: Slip Joint Assembly of Intelli-Pole® Sectional Composite Pole

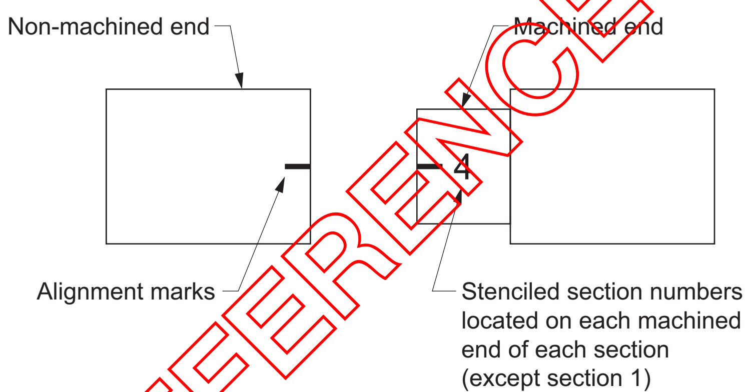
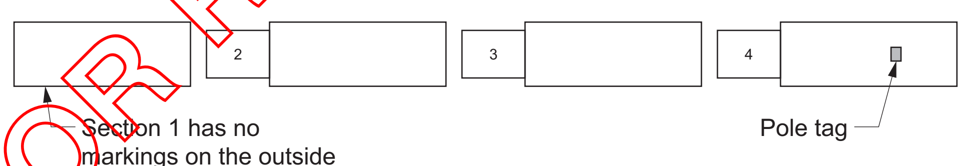


Figure PO 112–14: Intelli-Pole® Sectional Composite Pole Assembly Sequence and Numbering



Note(s):

1. Stenciled section 4 is the base.

PO 114P Hybrid Poles — Pilot

Scope PO 114P.1 General Information

1.0 Hybrid Pole Applications

Distribution Hybrid poles are two piece structures consisting of Light Weight Tubular Steel (LWS) at the base; and a composite (fiber-reinforced polymer) pole section on the top. The pole segments are tapered and bolt together at a flange-type joint. Hybrid poles are set in the same manner as wood poles. The LWS base segment of the pole is finished with a natural weather steel surface whereby over time the LWS color will resemble brown.

1.1 Restricted Application

A. Hybrid Poles shall be used for Edison only (E-All) installations only during the pilot period. No electrical equipment (transformers, capacitors, and so forth) connected to the primary or secondary shall be installed during the pilot installation period.

Hybrid poles are to be installed on tangent primary 3 wire circuit poles only during the pilot period.

B. Hybrid Distribution poles are not to be placed in areas subject to constant below ground moisture and coastal environments subjected to marine weather influence. As a general rule, Hybrid poles should not be placed within 1 mile from the coast line.

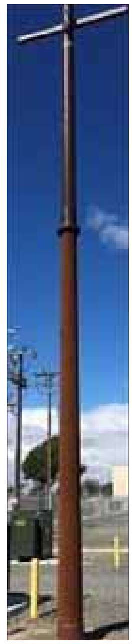
1.2 Fault Return Conductor (FRC)

Hybrid poles are not required to have a fault return conductor (FRC) installed from the pole location to the substation-grounding grid. Installation of poles on 3 wire circuits without FRC is allowed for pilot.

PILOT

NOTE For additional information, contact Linear & Structural Strategies or Protection Engineering.

Figure PO 114P–1: Assembled Hybrid Pole (Steel Bottom, Top Composite)



1.3 Hybrid Pole Color/Material Finish

The Distribution Hybrid Pole comprises a base carbon steel section and a top composite (FRP) section.

A. Base section — Natural weathering steel. The steel section is engineered to provide a natural rust finish that overtime provides a protective layer when exposed to the outdoor elements. As the finish matures (1–2 years; wet and dry cycles) the steel color closely resembles a brownish tint.

B. Top section — Composite (FRP). The composite section is manufactured to provide a color finish that will resemble a finished natural weathering steel base. The manufactured color finish is a brownish tint.

1.4 Hybrid Pole Length, Class and Weight

Table PO 114P–1: Pole Length, Class, Dimensions and Weight

Pole Length	Steel/FRP Length (ft)	Class	Weight[a/]	Base O.D (in)	Tip O.D (in)
45	28/17	H1	1353	15.9	8.3
50	28/22	H1	1569	16.7	8.5

[a/] Total weight of assembled single pole.

Figure PO 114P–2: Hybrid Pole Sections with Flanges

Scope PO 114P.2 Handling and Framing

1.0 Pole Handling

Hybrid Poles are shipped as a two-piece tapered round pole product and it is recommended to be assembled in the field due ease of transport. However, Hybrid poles may be assembled in pre-fab and transported in a similar manner to other composite poles. Hybrid poles are a bolt together "Flange" style design incorporating a permanent flange base plate attached to the steel and composite sections (see Figure PO 114P–3). The 45 foot and 50 foot pole pieces are not interchangeable due to specific bolt up flange designs. The 45 foot pole is engineered for using a 4 bolt flange and the 50 foot pole uses a 6 bolt assembly pattern.

- When loading assembled poles on dollies or sections on vehicles, the pole weights indicated in Table PO 114P–1 should be consulted for total weight calculations.
- Each hybrid pole comes with its set of assembly hardware (bolts, washers, nuts) The 45 foot hybrid pole kit contains 4 sets of hardware, 50 foot pole contains 6 sets.
- Hybrid pole assembly hardware is tighten till snug; then 1/4 turn. Bolts shall be installed with the threads facing up and the nuts on top of flange assembly.
- When handling Hybrid poles, see PO 112 for additional information.

Figure PO 114P–3: Hybrid Pole Assembly Flange

PILOT

2.0 Hybrid Pole Framing

Whenever possible, all single-pole structures shall be completely framed with crossarms and braces before setting. Bore through-bolt holes for the required number of crossarms before the pole is set.

- Hybrid poles are pre-drilled for top primary crossarm and primary level working steps. Climbing steps holes for both steel and composite sections are also pre-drilled for the entire pole. Steel section steps are a laser cut "knock-out" type hole usable by bending the hole cut-out inward.
- Composite crossarms and associated mounting brace shall be used on all Hybrid poles.

- Additional holes for hardware may be drilled in the field. Holes shall be drilled using a carbide drill bit on the composite section and a carbide “step drill” or “hole saw” on the steel section of the pole. The holes must be no less than 6 bolt diameters apart center to center (see Table 112–2 for typical hole size spacing).
- Crossarms and attachments mounted to hybrid poles will be secured with through-bolts and 3-inch round washers and lock washers.

2.1 Steel Base Section

- Hardware attachments to the steel section should use through-bolts similar to wood or composite poles.
- Small diameter risers and U-Groove moldings are attached using a self-tapping sheet metal screw. A 1/4 inch pilot hole must be drilled prior to installing the self-tapping screw.
- Earth grounding conductor will connect via grounding lugs provided at base and top section of LWS section. (see grounding hybrid pole for details).

2.2 Composite Pole Section

Hardware attachments for the hybrid pole are similar to composite pole attachment methods. See PO 112 Section 3.0 for reference.

2.3 Drilling Holes on Steel Poles with Cordless Battery Powered Drills

☐ Do not use general purpose drill bits.
☐ Only use carbide drill bits.
☐ The following drill bits are approved for use on steel pole sections.
☐ Carbide hole saw bits (SAP TBD).
☐ Carbide high speed metal drill bits for pilot holes.
☐ Holes should be drilled at least 6 hole diameters apart.

Figure PO 114P–4: Carbide Hole Saw Bit

Scope PO 114P.3 Assembly

Hybrid poles are assembled by bolting the two pole sections (LWS & Composite) together to create one hybrid pole. The pole sections bolt together at the Flange joints provided at the top of the steel section and the bottom of the composite section. The 45 foot H1, hybrid poles utilize the sections with 4 bolt holes located in the flange. The 50 foot H1 hybrid poles utilize the sections with 6 bolt holes located in the flange. See assembly flange Figure PO 112–3. To orient the poles for proper alignment during assembly, align the manufactures nameplates on both pole sections and bolt the pole together at the flanges with manufacturer's supplied hardware. Tighten hardware (bolt, nut, and washer) by using a criss-cross pattern until the lock washer is flattened and the hardware is tight.

1.0 Pole Marking

STEP 1. Use #10 sheet metal screws, 1 inch (SAP 10071501) to attach the pole number plate and any additional signage or markings on hybrid poles.

STEP 2. Follow all required pole markings as shown in PO 120.

2.0 Hybrid Pole Setting

STEP 1. Set hybrid poles to the same depth required by wood poles (see Table PO 100–1).

STEP 1.1 Final hole depth must compensate for placement of 1 foot of rock gravel placed at bottom of pole hole.

STEP 2. Maintain a four-foot clearance to be maintained from the top of the slope of a commercial driveway and a two-foot clearance from the top of the slope of a residential driveway. Apply pole visibility strips per PO 120.

Five-foot clearance to be maintained from fire hydrants.

STEP 3. Firmly tamp the bottom of the hole or set pole on an anchor plate where necessary.

- Dig all pole holes large enough to permit tamping backfill to full depth.

STEP 4. Place 1 foot of rock gravel at base of pole hole for water seepage.

STEP 5. Set poles so that they stand as nearly vertical as possible and so that the crossarms are at right angles or parallel to the direction of the line. Poles intended to be set in a straight line shall be set so that no pole is more than 2 inches out of line with the others.

STEP 6. Backfill shall be thoroughly tamped throughout the backfill operation while pole is held in position. After the hole is completely filled and thoroughly tamped, earth shall be piled up and packed around the pole.

- Pole-setting foam can be used as a backfill in rocky areas where there is not enough earth for backfill and compaction.

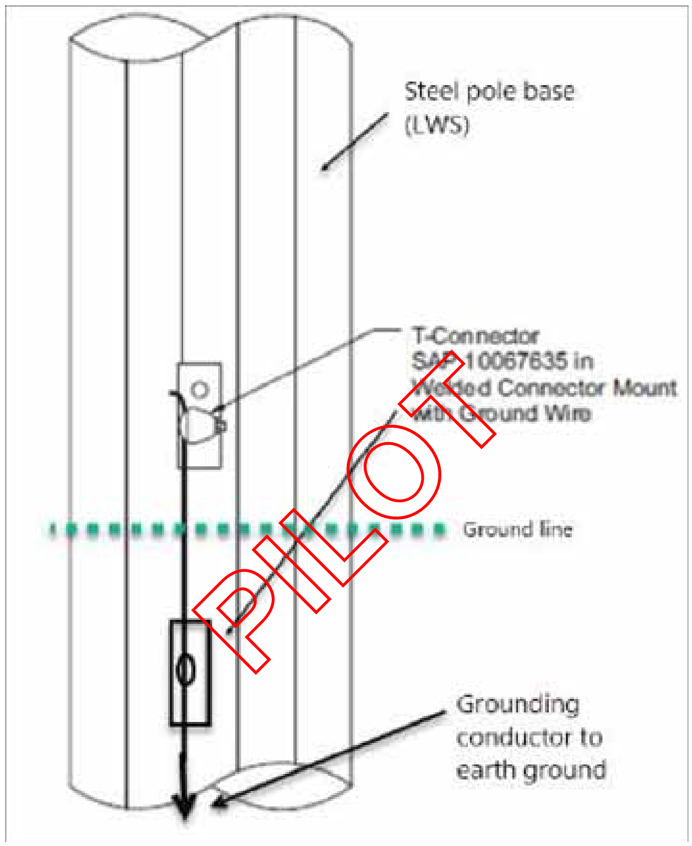
3.0 Pole Stepping

Hybrid poles for use in pilot will be non-stepped and vehicle (bucket) access only.

4.0 Grounding of Hybrid Pole

Hybrid poles are provided with two grounding nuts at the base of the steel pole; one above the ground line and one below the ground line. Hybrid pole steel sections must be attached to earth ground utilizing the two grounding nuts at the base of the pole. Once the pole is backfilled, the lower grounding nut will be permanently below the ground line level. The top grounding nut will be above ground once ground conductor installation is complete.

Figure PO 114P–5: Grounding of Hybrid Pole



Hybrid poles installed during pilot will have the steel base effectively grounded.

5.0 Nameplates

Hybrid pole factory nameplates are permanently mounted on both the steel section and the steel flange of the composite section. The nameplate located on the steel section is welded to the pole at 10 feet above the base of the section.

Nameplates located on the steel sections and the composite sections are used for pole alignment when assembling hybrid pole sections together to form entire pole.

Nameplates contain the following information:

- Manufacture of Pole
- Assembled pole length and class
- Weight of individual pole section
- Date of manufacturer
- Manufacturer's shop order number

Figure PO 114P–6: Nameplate

6.0 Removal

After hybrid pole is removed, the pole holes must be completely backfilled and thoroughly tamped. The backfill shall be leveled to grade with no depression or mound allowed.

Hybrid poles may be disassembled after removal for transportation if required.

PO 115 Temporary Attachment of Pole Sections with Third-Party Facilities to Composite Poles

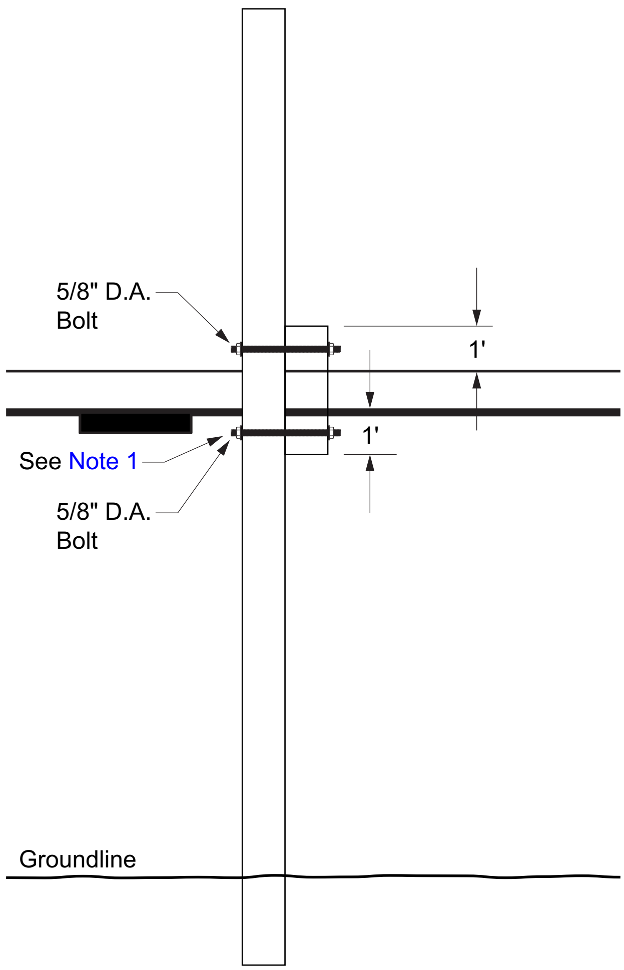
Scope PO 115.1 Temporary Attachment of Wood Pole Sections with Third-Party Facilities to Composite Poles

1.0 Method of Attaching Pole Sections with Third Party Facilities

1.1 Wood Poles within 5-inches of Composite Pole

When the wood pole with attached third-party facilities is within 5 inches of the replacement composite pole, attach to composite pole as shown in Figure PO 115–1 or Figure PO 115–2. These methods may not be used for poles which have third-party risers attached.

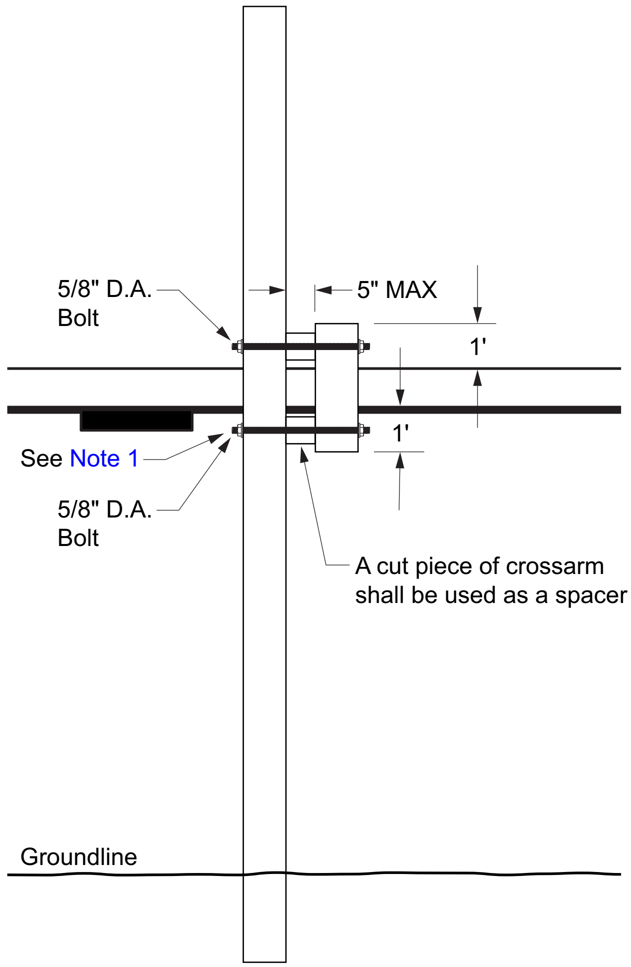
Figure PO 115–1: Wood Pole within 5 Inches of Composite Pole (No Spacers)



Note(s):

1. Use curved square washers on composite pole. Use square washers on wood pole section.
2. Back all square and curved square washers with a spring washer and square nut.

Figure PO 115–2: Wood Pole within 5 Inches of Composite Pole (Using Spacers)



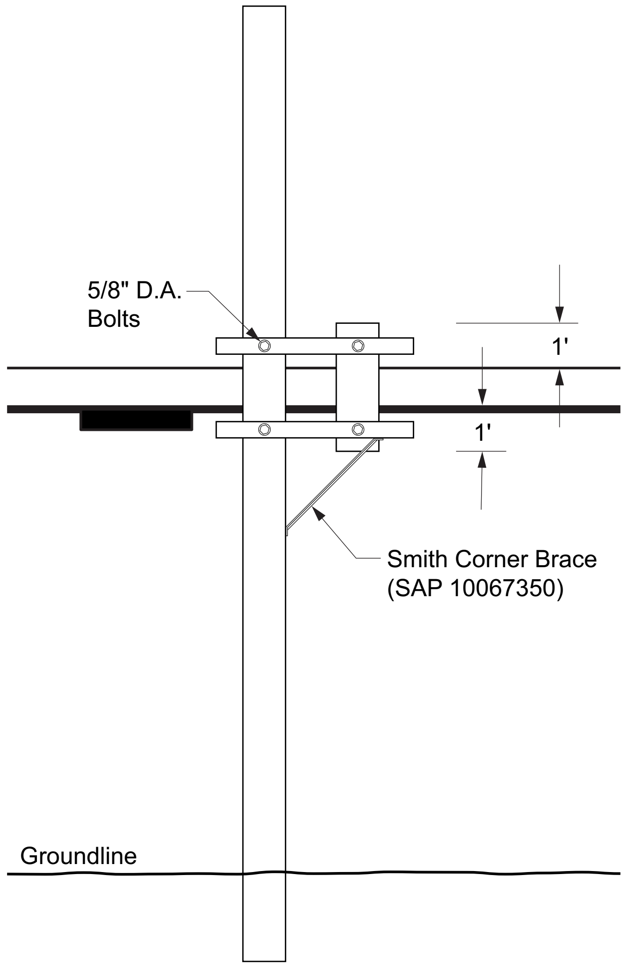
Note(s):

1. Use curved square washers on composite pole. Use square washers on wood pole section.
2. Back all square and curved square washers with a spring washer and square nut.

1.2 Wood Poles Farther than 5 Inches from Composite Pole

When the wood pole with attached third-party facilities is farther than 5 inches from replacement composite pole, attach to composite pole as shown in Figure PO 115–3. This method may not be used for poles which have third-party risers attached.

Figure PO 115–3: Wood Pole Farther than 5 Inches from Composite Pole



Note(s):

1. Use curved square washers on composite pole. Use square washers on wood pole section and crossarm sections.
2. Back all square and curved square washers with a spring washer and square nut.

2.0 Removal

When removing temporarily attached pole sections from composite poles, use appropriate diameter pole hole plugs to plug any holes on the composite pole (see PO 370).

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PO 120 Pole Numbering, Marking, and HIGH VOLTAGE Signs

Scope PO 120.1 Typical Pole Numbering

1.0 Pole Numbering

1.1 As the preferred method, all poles, including service poles and guy stubs, should be labeled with metal pole number plates (SAP 10135278) with 7/8-inch yellow and black numbers/letters. Plates shall be fastened between 8 feet and 12 feet above the ground. Table PO 120–1 shows SAP numbers for 7/8-inch non-reflective numbers/letters.

1.2 For poles located in High Fire Risk Areas (HFRA), metal pole number plates (SAP 10135278) and 7/8-inch non-reflective numbers/letters shall be installed near the pole top/primary cross arm during new pole installations, pole replacements, or maintenance activities at the primary voltage level. See Table PO 120–1 for SAP numbers for 7/8-inch non-reflective Numbers/Letters.

1.3 As an alternative, plastic pole number plates and one-inch reflective letters/numbers may be used in non-HFRA when metal pole number plates are not available. When plastic pole number plates are used for new pole number applications, the existing metal pole number plate must be destroyed to avoid duplicate pole number installation in the field.

- Plastic Pole Plate: SAP 10135347
- Table PO 120–2 shows SAP numbers for 1-inch reflective Numbers/Letters.

1.4 Poles on streets or alleys should be numbered such that the number plates are visible from the street or alley side. Poles on rear property lines should have the pole number plate installed facing the side toward the street to which the location reference is made. Pole numbers should be in sequence where practical.

1.5 Pole-marking plates shall include a letter or an initial to designate the original ownership of the pole. When the original owner sells the pole or relinquishes his equity, in the case of jointly owned poles, the new owner shall assume ownership and renumber the pole.

1.6 In extreme temperature areas, specific pole numbers can be duplicated on metal plates. Contact Procurement to order specific metal plates.

Table PO 120–1: SAP Numbers for 7/8-inch Non-Reflective Numbers/Letters

Number/Letter	SAP	Number/Letter	SAP
0	10132310	I	10132328
1	10132311	J	10132329
2	10132312	K	10132330
3	10132313	L	10132331
4	10132314	M	10132332
5	10132315	N	10132333
6	10132316	O	10132334
7	10132317	P	10132335
8	10132318	Q	10132336
9	10132319	R	10132337
A	10132320	S	10132338
B	10132321	T	10132339
C	10132322	U	10132340
D	10132323	V	10132341
E	10132324	W	10132342
F	10132325	X	10132343
G	10132326	Y	10132344
H	10132327	Z	10132345

Note(s):

1. 7/8-inch non-reflective number/letters shall be used with metal pole plates (SAP 10135278).

Table PO 120–2: SAP Numbers for 1-inch Reflective Numbers/Letters

Number/Letter	SAP	Number/Letter	SAP
A	10132275	S	10132293
B	10132276	T	10132294
C	10132277	U	10132295
D	10132278	V	10132296
E	10132279	W	10132297
F	10132280	X	10132298
G	10132281	Y	10132299
H	10132282	Z	10132300
I	10132283	0[a/]	10132289
J	10132284	1	10132301
K	10132285	2	10132302
L	10132286	3	10132303
M	10132287	4	10132304
N	10132288	5	10132305
O	10132289	6	10132306
P	10132290	7	10132307
Q	10132291	8	10132308
R	10132292	9	10132309

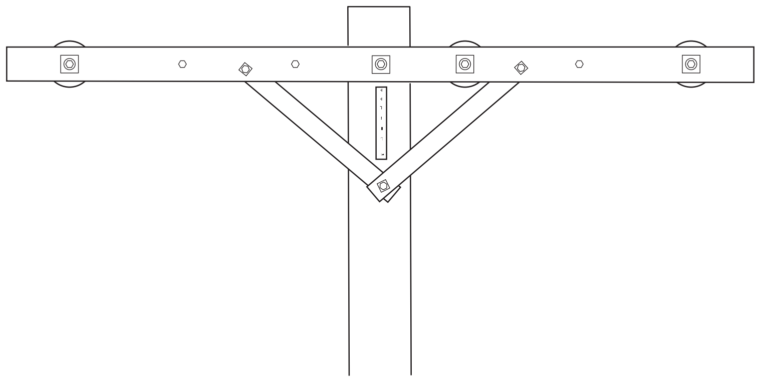
[a/] Letter "O" is the same as number "0" and thus has the same SAP number.

Note(s):

1. 1-inch reflective number/letters shall be used with plastic pole plates (SAP 10135347).

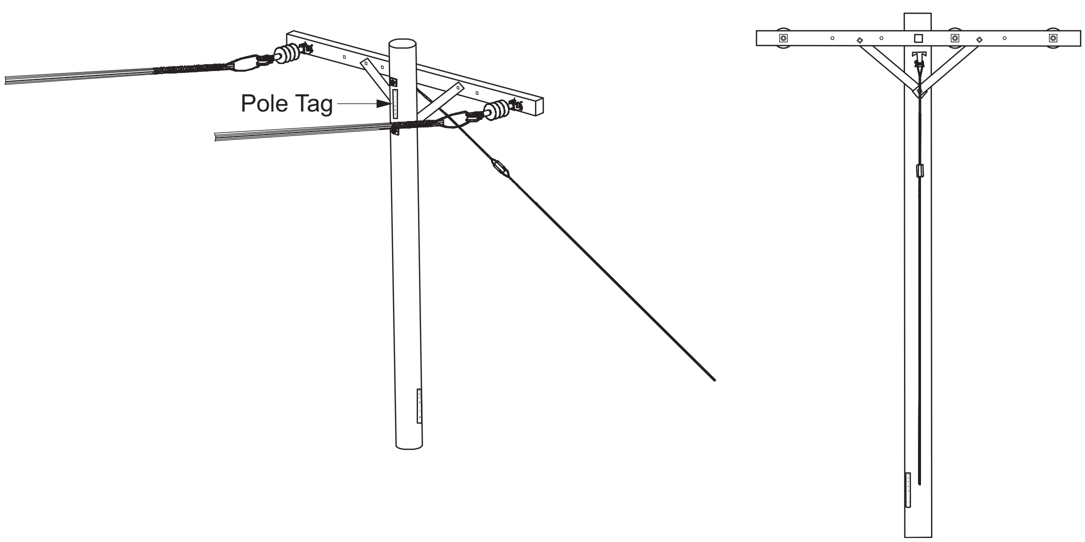
A. The preferred location of the pole tag shall be located as close to the inside vertex of the V-brace as possible (see Figure PO 120–1). For composite cross arms, place pole tag within 15 inches of the bottom of the pole mounting bracket, on the same pole face as the bracket.

Figure PO 120–1: Preferred Location of HFRA Pole Tag



B. For cases where the area inside the V-brace is not feasible due to equipment or hardware, the rear of the pole should be considered. If this is not achievable, then the pole tag should be placed under equipment or cross arm hardware within 3 feet from the pole top and in-line with primary conductors (see Figure PO 120–2).

Figure PO 120–2: Pole Top Pole Tag Installation Example



Note(s):

1. Pole tag shall be installed in line with conductors.

Scope PO 120.2 Pole Marking Using Brands, Metal Bands, Visibility Strips and High Voltage Signs

1.0 Pole Marking

1.1 *Brands or Monograms (for use in setting depth)* — Pole suppliers' branded monograms or discs are placed so the bottom of the brand is 10 feet from the butt (plus or minus two inches) for 25- through 60-foot poles. SCE Poles 65 feet and greater, treated after January 1, 2013 will have the brand installed at 14 feet (plus or minus two inches) from the butt. Poles 65 feet and greater, treated prior to January 1, 2013 will have the brands installed at 13 feet (plus or minus two inches) from the butt.

1.2 *Placing of Metal Bands on Edison Poles* — The Los Angeles County Forester and Fire Warden have been permitted to place a metal band on Edison-owned poles to readily identify the location of fire hydrants.

Note: ***Permission has been granted to all counties in our service territory with the understanding that there is no responsibility on our part for the maintenance of such strips or for the transferring of them from old to new poles.***

1.3 Pole-marking nails with recessed figures shall be located on the pole as follows:

A. Pole-Height Nail — Locate just below and to the left of center of pole-marking plate (SAP number varies by height).

B. Year-Set Nail — Locate just below and to the right of center of pole-marking plate (SAP 10135267).

C. Year-Treated and Depth-of-Setting Nail — Driven when secondhand pole is retreated. Located 13 feet from butt of pole.

D. Secondhand Nail — Driven when pole is treated and located 12 inches below year-treated nail. If a pole is reset without being returned for treatment, this nail should be driven 2 inches below and between height-and-date nail when the pole is reset.

E. For composite poles, remove nail from marker and replace with #10 self-tapping screw (SAP 10071501).

2.0 Pole-Marking Using Visibility Strips

2.1 General Information

A. Visibility Strips meeting the requirements for Class L (CA) type markers, as described in Chapter 3 of California's Manual on Uniform Traffic Control Devices (MUTCD) will be installed on all poles located on state highways and for the conditions described below.

B. A "set" of visibility strips consists of three separate 2-inch by 12-inch horizontal rectangles with Federal yellow reflective material on one side (see Figure PO 120–3)

Table PO 120–3: Visibility Strip Installation

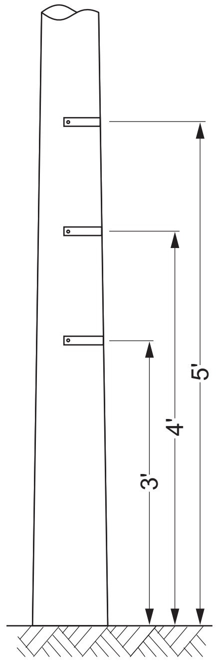
Type of Pole	Description	Quantity	Size	SAP
Wood	Visibility Strip	1	2" × 12"	10068488
	Nail	2	1-3/4"	10069984
Composite	Visibility Strip	1	2" × 12"	10068488
	Self-drilling Screw	2	#10 × 1"	10072230
Light Weight Steel	Visibility Strip Decal	1	2" × 12"	10068376

C. Visibility strips will be installed at heights of 3 feet, 4 feet, and 5 feet as measured vertically from the lowest point of level ground at the base of the pole to the bottom edge of the visibility strip respectively (see Figure PO 120–3)

D. Where two sets of visibility strips are installed, two individual strips shall be placed so that the end of one strip overlaps the other by at least 1 inch and affixed to the pole so the resulting combined length of reflective material at each vertical level is approximately 23 inches.

E. Where wood or PVC molding is covering un-insulated ground wire, visibility strips will be installed or re-arranged so that the visibility strip extends over the molding so that it does not contact the ground wire.

Figure PO 120–3: Methods of Marking Poles for Visibility



2.2 General Requirements

A. *Poles on Curves, with or without Curbs, Visible to Traffic in Two Directions* — Install at least two sets of visibility strips so the reflective material is visible to traffic in both directions through the curve (see Figure PO 120–4)

B. *Poles on Curves, with or without Curbs, Visible to Traffic in One Direction* — Install one set of visibility strips facing approaching traffic (see Figure PO 120–5)

C. *Poles on Offset One-Way Intersections, with or without Curbs* — Install one set of visibility strips facing the center of the intersection (see Figure PO 120–6)

D. *Poles on Offset Two-Way Intersections, with or without Curbs* — Install at least two sets of visibility strips facing the center of the intersection (see Figure PO 120–7)

E. *Poles Located within 12 Feet of Roadways, Outside of the Paved Shoulder* — Install one set of visibility strips in the direction of approaching traffic (see Figure PO 120–8)

F. *Poles Located in Alleys* — Install two sets of visibility strips facing center of alley of approaching traffic, taking into account narrow driveways and intersections (see Figure PO 120–9)

G. *Poles Located in Industrial, Commercial and Public Parking Lots* — Install at least two sets of visibility strips, taking into account existing barriers, parking structures, and blind spots (see Figure PO 120–10)

H. *Poles Located near Residential Driveways* — Install one set of visibility strips, taking into account narrow approach angles, location of carports, garages or parking structures and potential for back-in contacts (see Figure PO 120–11)

I. *Poles Located on Private Agricultural, Dairy, or Farmland Property* — Install two sets of visibility strips on poles not protected by barriers that are adjacent to houses, barns, or farmland buildings subject to traffic such as heavy equipment, commercial vehicles, agricultural machinery, tractors, trailers, and combines (see Figure PO 120–12)

Figure PO 120–4: Poles on Curves, with or without Curbs, Visible to Traffic in Two Directions

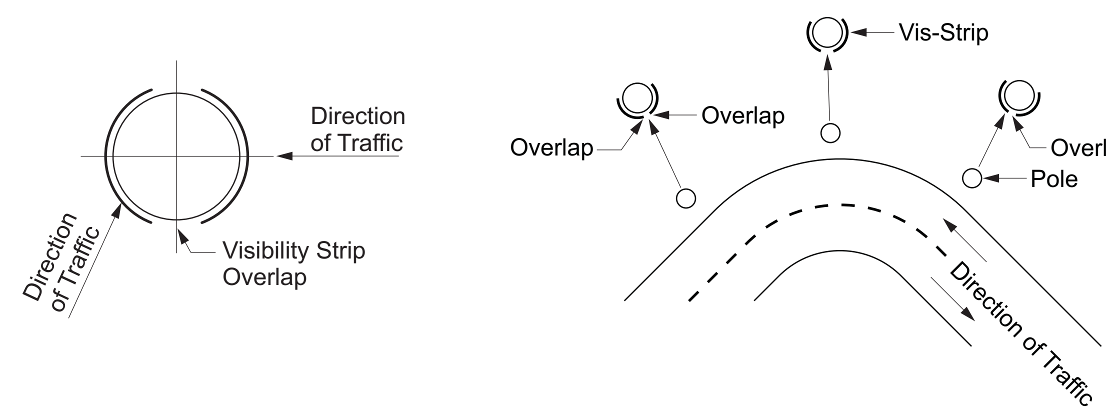


Figure PO 120–5: Poles on Curves, with or without Curbs, Visible to Traffic in One Direction

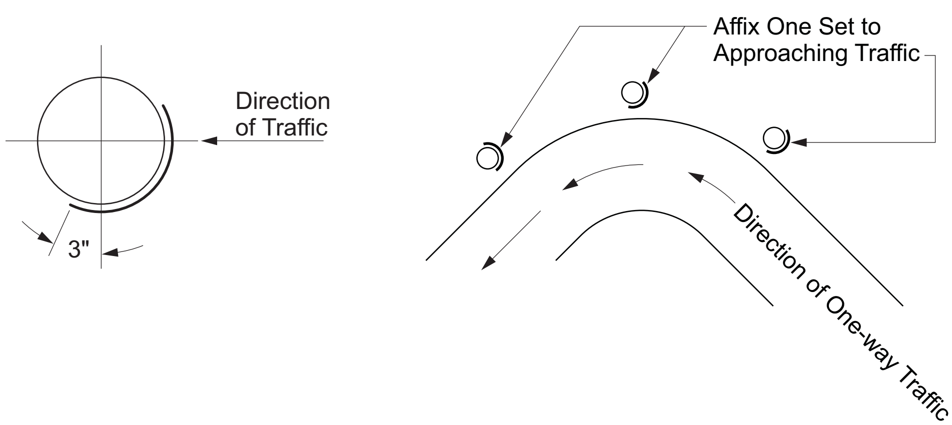


Figure PO 120–6: Poles on Offset One-Way Intersections, with or without Curbs

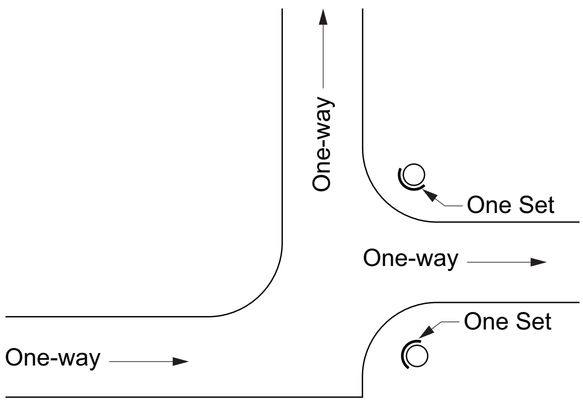


Figure PO 120–7: Poles on Offset Two-Way Intersections, with or without Curbs

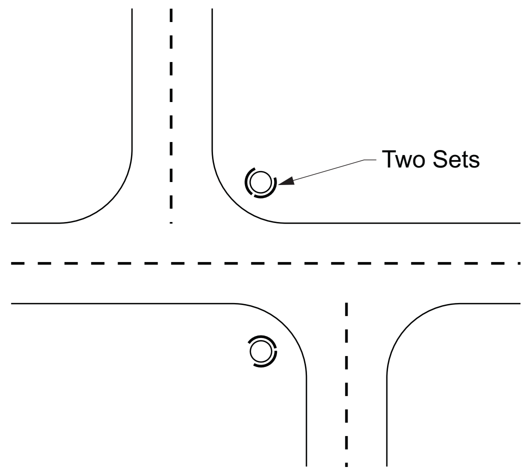


Figure PO 120–8: Poles Located within 12 Feet of Roadways, Outside of the Paved Shoulder/Curb

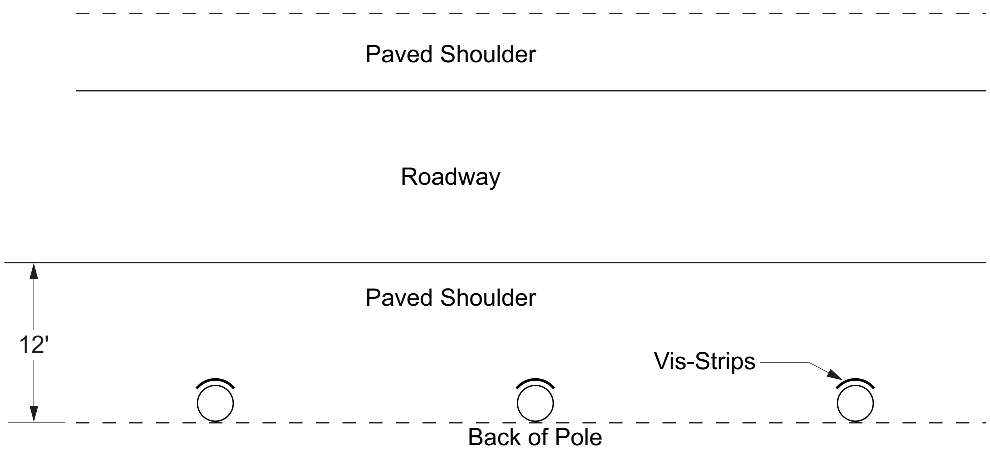


Figure PO 120–9: Poles Located in Alleys

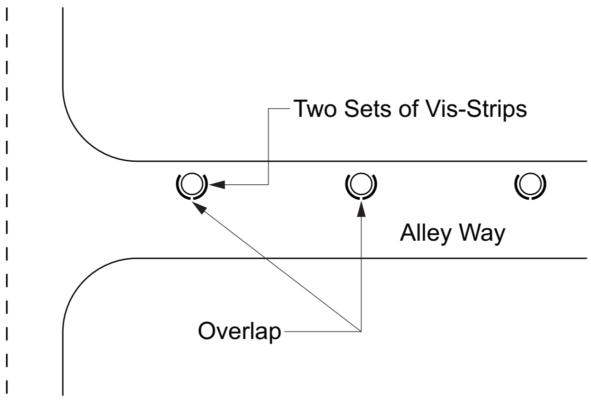


Figure PO 120–10: Poles Located in Industrial, Commercial and Public Parking Lots

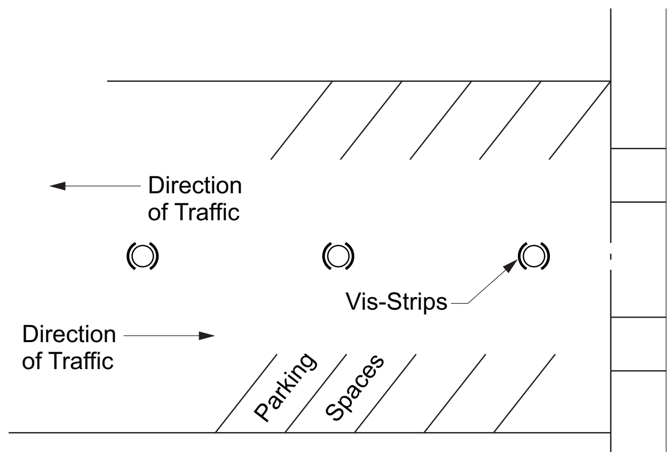


Figure PO 120–11: Poles Located near Residential Driveways

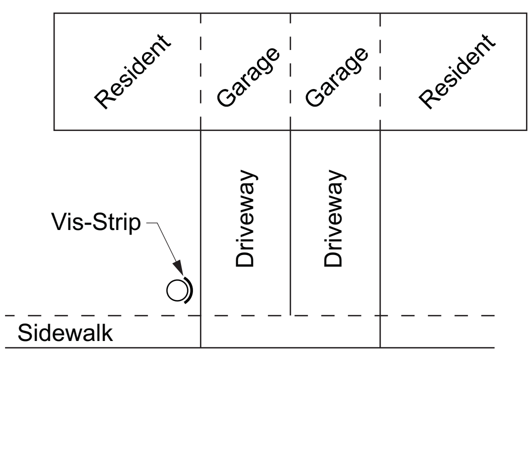
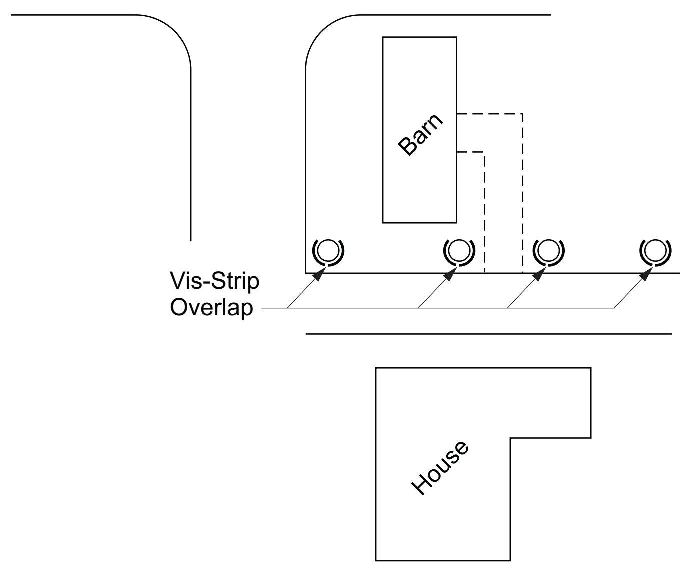


Figure PO 120–12: Poles Located on Private Agricultural, Dairy, or Farmland Property



3.0 Pole-Marking Using High Voltage Signs — General Information

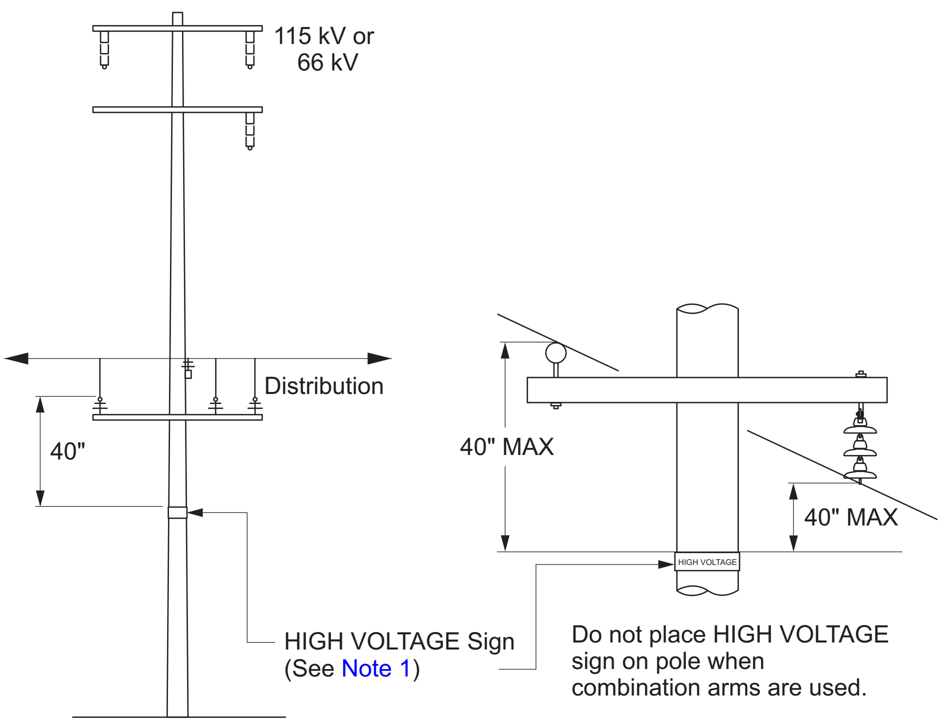
Poles or crossarms shall be marked with approved HIGH VOLTAGE signs. Wherever possible, HIGH VOLTAGE signs shall be placed on the pole at the lowest level of line conductors energized in excess of 750 V, which indicates that all circuits above that level are HIGH VOLTAGE. No additional HIGH VOLTAGE signs are necessary.

As an alternate method to marking poles, HIGH VOLTAGE signs shall be placed on all crossarms supporting line conductors energized in excess of 750 V.

3.1 Wood, fiberglass, and steel poles with crossarm(s) supporting the lowest level of the line conductors energized in excess of 750 V:

A. Wood Poles — The standard location for marking wood poles with HIGH VOLTAGE signs is on the pole. Use the plastic HIGH VOLTAGE sign (SAP 10135280) with engraved black letters on yellow background and galvanized nails. HIGH VOLTAGE signs are to be placed in order to approximately encircle the pole so that the top of the sign is located no more than 40 inches below the lowest level of the line conductors energized in excess of 750 V.

Figure PO 120–13: Standard HIGH VOLTAGE Sign Installation (Wood Poles)



Note(s):

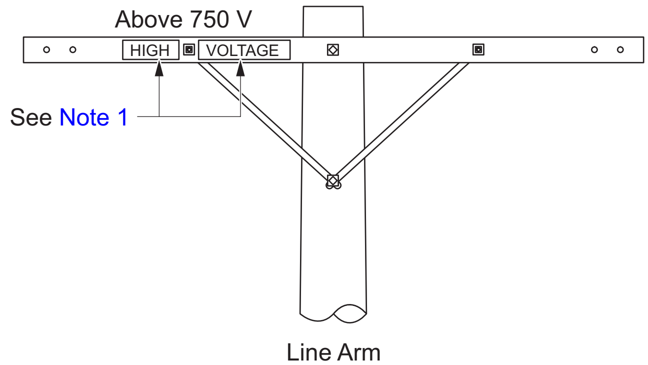
1. For new construction, HIGH VOLTAGE signs can be installed on poles or crossarms. When replacing deteriorated HIGH VOLTAGE signs, consider installing on the pole so encroachment on energized equipment is not required.

3.2 Fiberglass and Steel Poles — The standard location for marking fiberglass and steel poles is on the pole. Use the HIGH VOLTAGE sign (SAP 10135407) with yellow letters on black background with adhesive material. Wipe the pole surface with a clean rag before applying. HIGH VOLTAGE signs approximately encircle the pole so that the top of the sign is located no more than 40 inches below the lowest level of the line conductor energized in excess of 750 V.

Figure PO 120–14: Standard HIGH VOLTAGE Sign Installation (Fiberglass and Steel Pole)

A. As an alternate to marking poles with HIGH VOLTAGE signs, signs shall be placed on both faces of all crossarms supporting line conductors energized in excess of 750 V. Double arms need only be signed on the outer two faces. Use the plastic HIGH VOLTAGE sign and galvanized nails; do not staple signs to the crossarm.

Figure PO 120–15: Alternate HIGH VOLTAGE Sign Installation on Crossarm

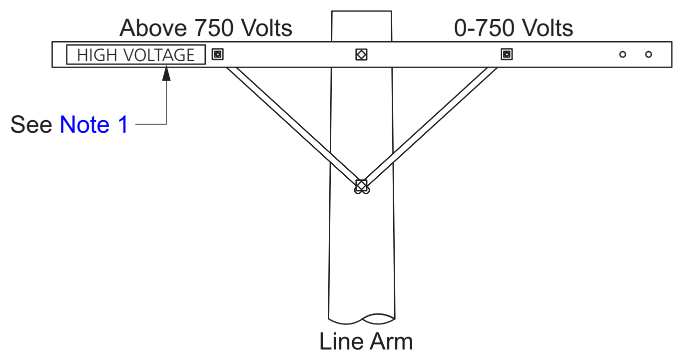


Note(s):

1. For new construction, High Signs can be installed on poles or arms. When replacing deteriorated High Signs, consider installing on pole so encroachment on energized equipment is not required.

3.3 Crossarms supporting conductors energized in excess of 750 V and conductors of 750 V or less (combination arms) shall have signs placed on both faces of the crossarm side supporting line conductors of 750–7500 V. Double arms need only be signed on the outer two faces. When placing HIGH VOLTAGE signs on crossarms, all crossarms supporting line conductors energized in excess of 750 V shall be marked with HIGH VOLTAGE signs.

Figure PO 120–16: HIGH VOLTAGE Sign Installation on Combination Arm



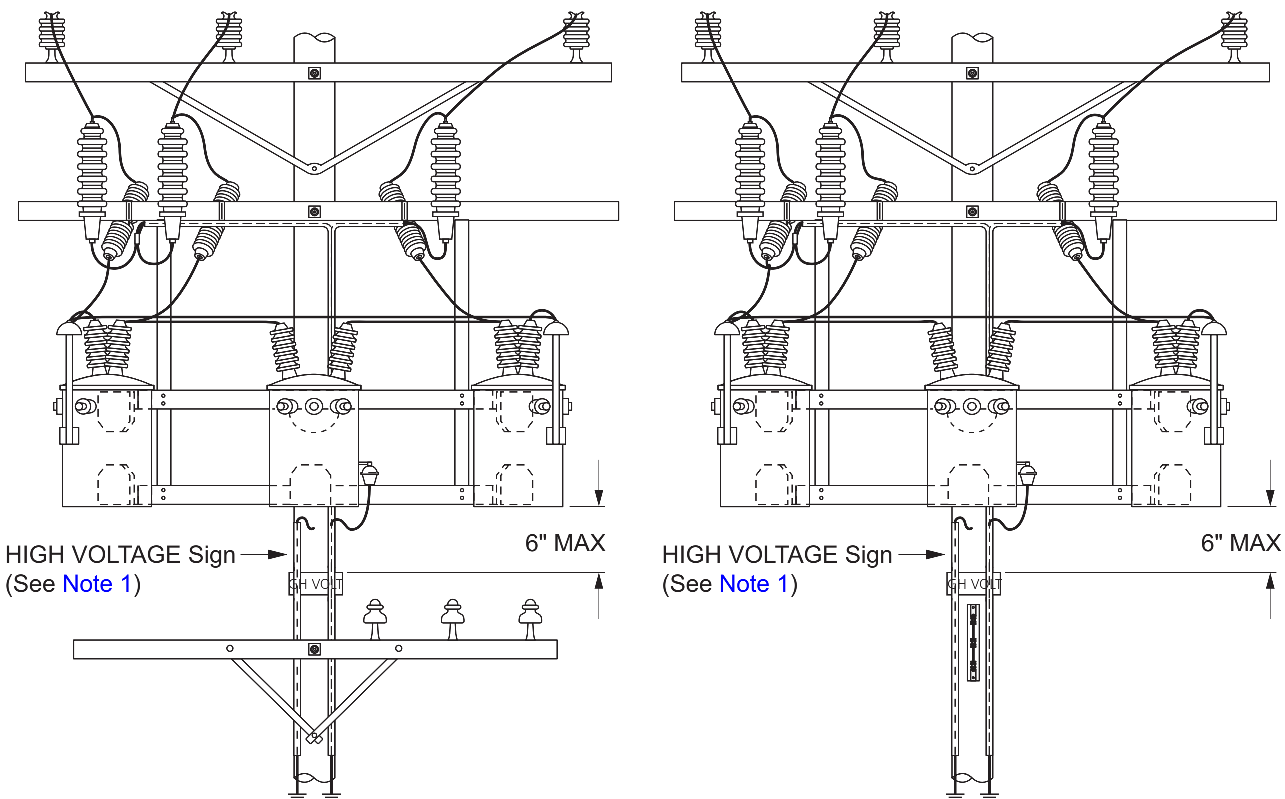
Note(s):

1. For new construction, High Signs can be installed on poles or arms. When replacing deteriorated High Signs, consider installing on pole so encroachment on energized equipment is not required.

3.4 Crossarms supporting equipment (for example, transformers, cutouts, regulators, air switches, and capacitors) located below the lowest level of line conductors energized in excess of 750 V:

A. The standard location for marking poles with HIGH VOLTAGE signs is on the pole. HIGH VOLTAGE signs are to be placed in order to approximately encircle the pole, so that the top of the sign is located no more than 6 inches below the equipment and above supply line conductors energized at 0–750 V and all communication line conductors.

Figure PO 120–17: Standard HIGH VOLTAGE Sign Installation Below Equipment



Note(s):

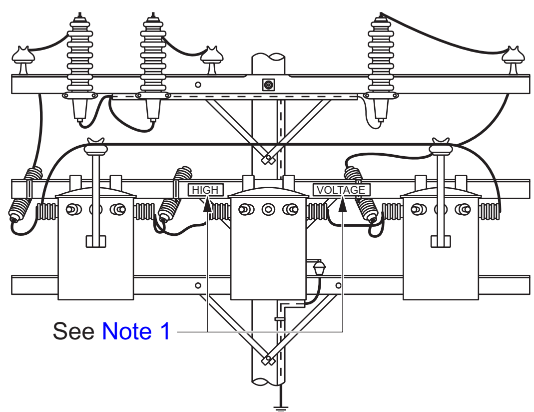
1. For new construction, High Signs can be installed on poles or arms. When replacing deteriorated High Signs, consider installing on pole so encroachment on energized equipment is not required.

B. As an alternate to marking poles with HIGH VOLTAGE signs, arms supporting equipment energized in excess of 750 V and arms supporting line conductors energized in excess of 750 V shall be marked with HIGH VOLTAGE signs. Signs shall be placed on both faces of the crossarm. Double arms need only be signed on the outer two faces. Arms supporting equipment shall be placed as follows:

1. Hanger arms within 30 inches of the line arm need not be signed. Hanger arms more than 30 inches from the line arm and supporting one transformer, regulator, and so forth, must be signed on both faces. Hanger arms more than 30 inches from the line arm and supporting two or more transformers, regulators, and so forth, need only be signed on the face toward the climbing space.

2. Fuseholder and cutout arms require signs only when they are more than 30 inches below a signed line or hanger arm, and require signs on the face toward the climbing space only. Surge arrester arms require HIGH VOLTAGE signs on both sides of the arm.

Figure PO 120–18: Alternate HIGH VOLTAGE Sign on Hanger Arm



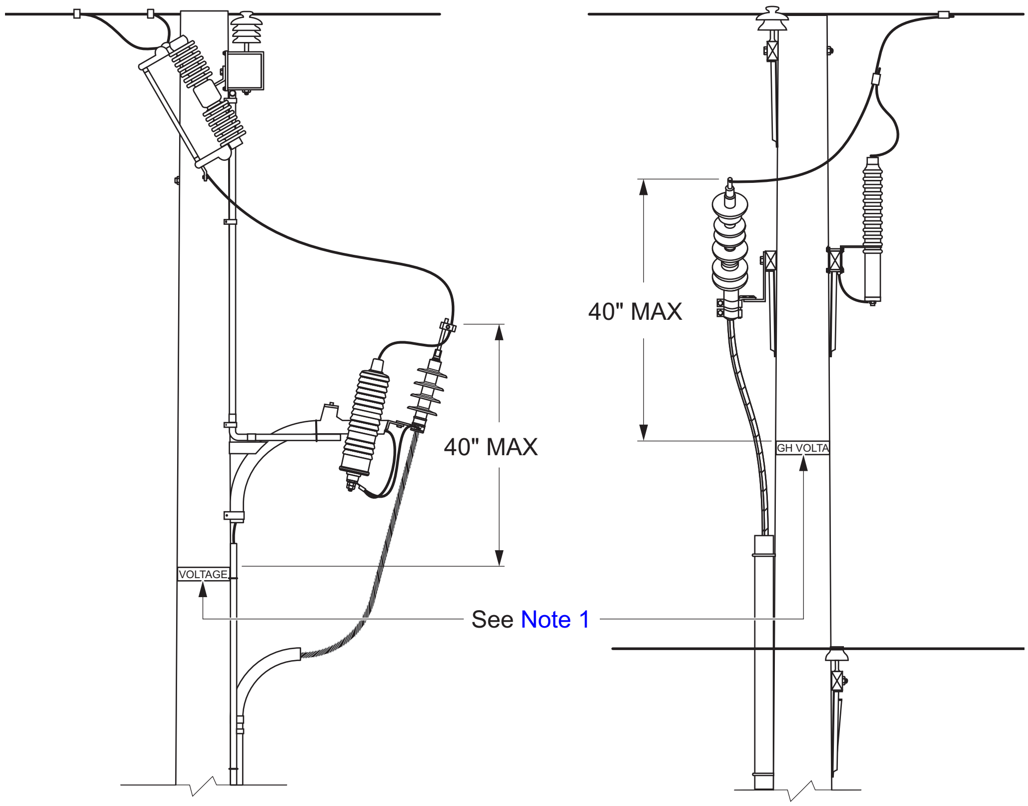
Note(s):

1. For new construction, High Signs can be installed on poles or arms. When replacing deteriorated High Signs, consider installing on pole so encroachment on energized equipment is not required.

3.5 Risers energized in excess of 750 V:

Poles that support risers shall be marked with a HIGH VOLTAGE sign(s) on the pole so that it approximately encircles the pole. The top of the sign shall be located 40 inches below the energized pothead terminal.

Figure PO 120–19: HIGH VOLTAGE Sign Installation on Riser Poles



Note(s):

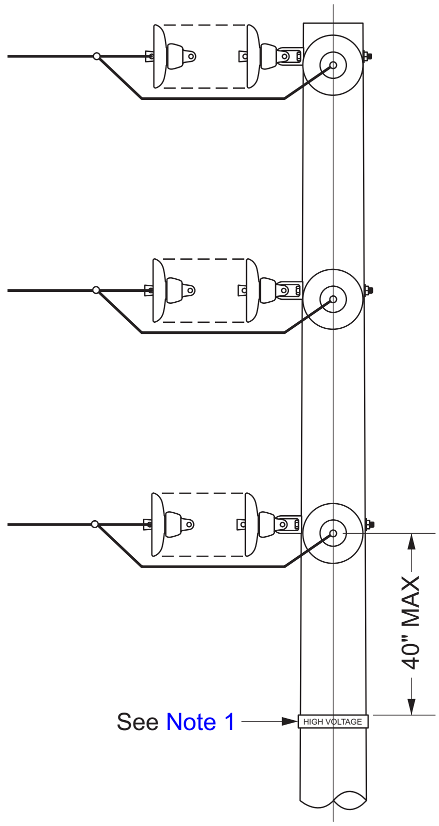
1. For new construction, High Signs can be installed on poles or arms. When replacing deteriorated High Signs, consider installing on pole so encroachment on energized equipment is not required.

3.6 Wood, fiberglass, and steel poles supporting conductors of more than 750 V that are attached directly to the pole in vertical configuration:

A. Wood Poles — The standard location for marking wood poles with HIGH VOLTAGE signs is on the pole. Use the plastic HIGH VOLTAGE sign (SAP 10135280) with engraved black letters on yellow background and galvanized nails. HIGH VOLTAGE signs must approximately encircle the pole so that the top of the sign is located no more than 40 inches below the lowest level of the line conductors energized in excess of 750 V.

Fiberglass and Steel Poles — The standard location for marking fiberglass and steel poles is on the pole. Use the HIGH VOLTAGE sign (SAP 10135407) with yellow letters on black background with adhesive material. Wipe the pole surface with a clean rag before applying. HIGH VOLTAGE sign(s) must approximately encircle the pole so that the top of the sign is located no more than 40 inches below the lowest level of the line conductor energized in excess of 750 V.

Figure PO 120–20: HIGH VOLTAGE Sign Installation for Wood, Fiberglass, and Steel Pole Vertical Configuration

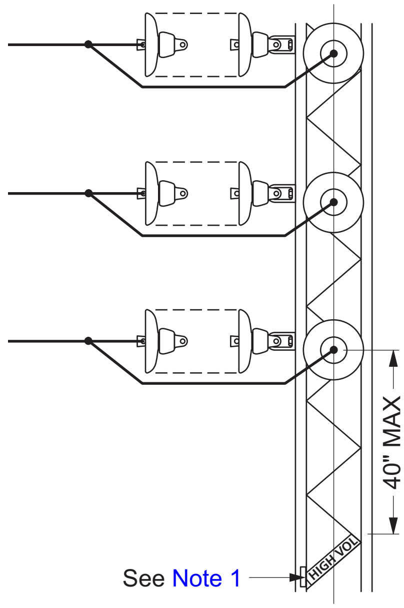


Note(s):

1. For new construction, High Signs can be installed on poles or arms. When replacing deteriorated High Signs, consider installing on pole so encroachment on energized equipment is not required.

B. Place HIGH VOLTAGE signs on lattice poles on the opposite side of the pole. Signs shall be located no more than 40 inches below the lowest level of the line conductor energized in excess of 750 V. Fasten signs with galvanized plumbers tape and #8-32 × 3/4-inch roundhead machine screws.

Figure PO 120–21: HIGH VOLTAGE Sign Installation for Steel (Lattice) Poles Vertical Configuration



Lattice Pole

Note(s):

1. For new construction, High Signs can be installed on poles or arms. When replacing deteriorated High Signs, consider installing on pole so encroachment on energized equipment is not required.
2. For complete HIGH VOLTAGE sign marking requirements, refer to General Order (G.O.) 95, Rules 51.6-A.

3.7 When correcting deteriorated sign conditions, the standard installation is to install the replacement HIGH VOLTAGE sign(s) (SAP 10135280) on the pole with the top of the sign being no more than 40 inches below the lowest level of the line conductors energized in excess of 750 V.

Deteriorated signs above the level of the lowest line conductor energized in excess of 750 V shall be removed when work permits. Refer to Distribution Operations and Maintenance Policies and Procedures (DOM) Manual, Section IM-2, for removal of deteriorated HIGH VOLTAGE signs.

An alternative for the replacement of HIGH VOLTAGE signs is to use HIGH VOLTAGE crossarm wrap-around signs with Velcro® fastening strips (SAP 10135304). These signs are installed on the crossarm from the public level using a telescoping hot stick with hi-clamp attachment (SAP 10147972).

When replacing deteriorated HIGH VOLTAGE signs by attaching them to crossarms, all crossarms supporting conductors energized to 750 V or greater must be labeled with HIGH VOLTAGE signs.

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PO 121 Phasing Identification Labeling

Scope PO 121.1 Pole Labeling

1.0 General Information

1.1 All overhead circuits shall be identified with phase labeling on the pole utilizing the Phase Identification (ID) tool.

1.2 Phase identification may be performed during opportunities such as:

- Construction involving primary conductor
- New pole sets
- Primary arm change outs
- Stringing primary wire
- New transformers

1.3 Examples where phase identification and labeling is especially valuable include:

- Main line break off poles with tap lines
- Tap lines themselves
- In proximity of OH switches
- Previously unmarked sections of main lines
- Corner poles
- Primary riser poles

2.0 Material

Stainless steel color-coated A, B, C letters are the approved method for phase labeling. Each letter will have their individual colors.

3-inch Stainless Steel Color-Coated Letters	SAP
A (Red)	10175405
B (White)	10175315
C (Blue)	10175314

3.0 Application

3.1 Pole Labeling

Poles shall be labeled with color coated ABC’s that are applied to the pole to coincide with the appropriate conductor and phase. Nails shall be used to apply phase labeling letters to wood poles, and self-tapping screws shall be used for composite poles. When possible, attach the ABC’s to the oncoming traffic side of the pole to be easily viewed while driving by pole. ABC’s should be installed at 5–6 feet. AGL to mitigate damage from 3rd parties.

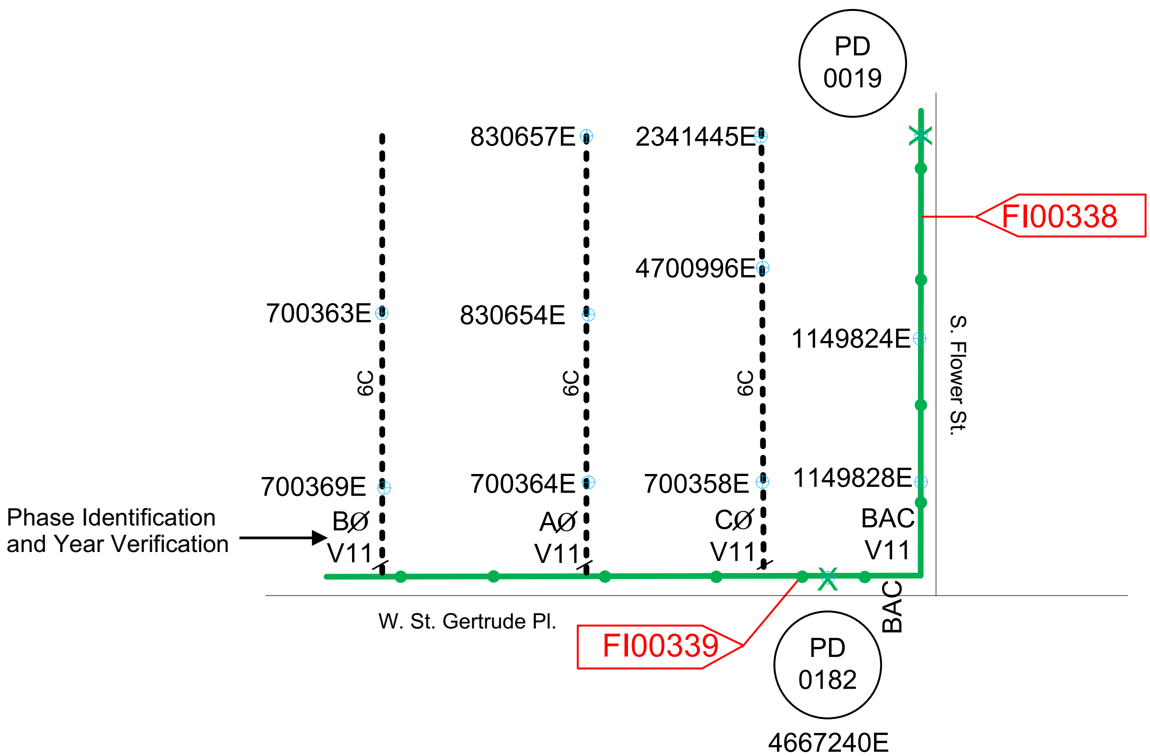
Figure PO 121–1: Pole Labeling

CAUTION **Whenever a pole needs to be replaced, whether it is planned, or emergency, the labels SHALL only be replaced after the Phase ID tool has been used.**

3.2 Phase Identification for Circuit Mapping

Mark circuit maps "VYY" where "V" indicates the phasing was verified using the phase ID tool, and "YY" is the year it was verified. See example in Figure 121.2 below where V11 designates phases verified in 2011.

Figure PO 121–2: Phase ID and Year Verification for Circuit Maps



PO 130 Pole-Key and Block Support

Scope PO 130.1 Pole-Key and Block Support

1.0 Application

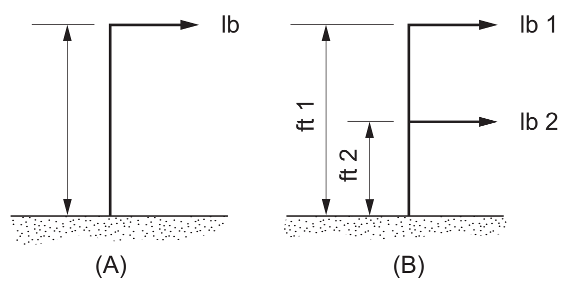
1.1 The pole key is recommended for keying wood poles used in street lighting, or as a pole reinforcement in soft soils where the load is unbalanced.

1.2 Breast blocks and pole keys shall not be used where the slack span configuration resisting moments tabulated below are exceeded.

1.3 For angle limitations apply the resultant pull of conductors at various deviation angles.

1.4 For usable pole strengths in grade A or grade B construction, refer to pole size, strength, and weight.

Figure PO 130–1: Equations



(A) ft X lb = ft - lb
(B) $(ft_1 \times lb_1) + (ft_2 \times lb_2) = ft - lb$

Table PO 130–1: Resisting Moment Applications

Type of Soil		Resisting Moment[a/] (ft/lb)
Class	**Description**	
3	Shale, Broken Red Rock, Hardpan, Compact Clay-Gravel Mixtures	55,125
4	Gravel, Compact Gravel and Sand, Claypan	47,500
5	Medium-Firm Clay, Loose Sand and Gravel, Compact Coarse Sand	36,750
6	Soft Plastic Clay, Loose Coarse Sand, Clayey Silt, Compact Fine Sand	28,875

[a/] Resisting moment is due to combined effects of adding pole key and breast block support elements and a standard pole embedment of 10 percent of pole length + 2 feet.

Note(s):

1. For a unguyed reduced tension span, the corresponding pole's new imposed ground line moments shall be demonstrated to be adequately resisted without the use of a breast block-pole key configuration.

2.0 Installation Instructions

2.1 Screw a 3/4-inch anchor rod into base of pole-key.

2.2 Drop the pole-key into hole, at base of pole, on opposite side of the applied strain. See Figure PO DOH–2.1.

2.3 Expand pole-key with tamping bar into solid earth. See Figure PO 130–2.2.

2.4 The pole-key must be fully expanded to insure a maximum bearing surface.

2.5 When the pole-key is fully expanded, see Figure PO 130–2.3, the anchor rod is removed and the hole filled and tamped.

Figure PO 130–2: Methods of Self-Sustaining Pole with Breast Block and Pole-Key

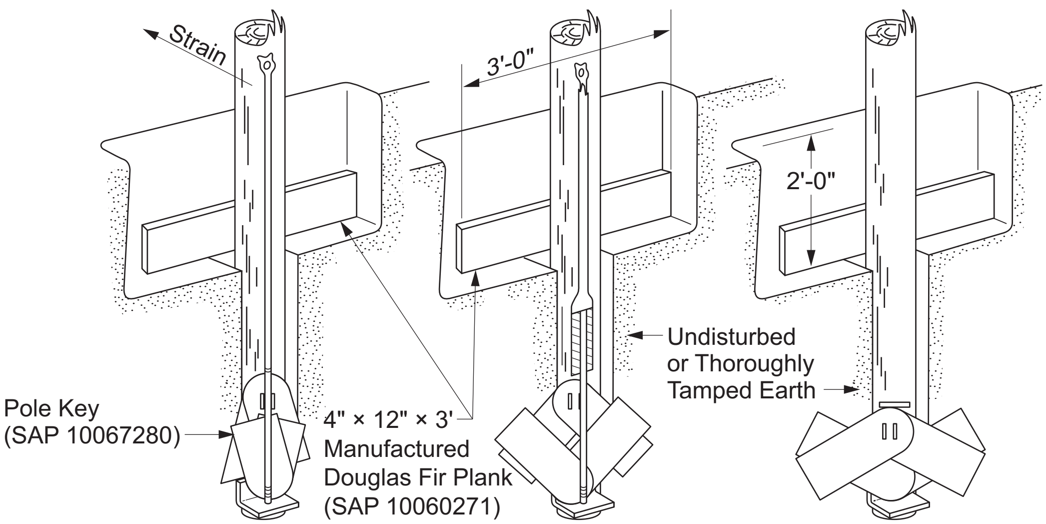


Figure PO DOH–2.1 **Figure PO 130–2.2** **Figure PO 130–2.3**

Pole-Key and Block Support

What's Changed? Section 2.6 and Figure PO 130-2.3 have been updated for clarity.

Approved by: ajf

Effective Date: 01-25-2019

PO 140 Pole, Temporary Wood Stubbing/Straightening

Scope PO 140.1 Pole, Temporary Wood Stubbing/Straightening

1.0 Temporary Wood Stubbing

For emergency repairs, wood poles may be stubbed temporarily (no more than one year) using a similarly sized wood pole stub, see Table PO 140–1.

Poles which are rotted, or damaged near the ground level, and in otherwise good condition may be stubbed temporarily, except in the following conditions:

1.1 Wood Stubs Not Permitted

A. Poles used in crossings or conflicts where Grade A construction is required.

B. Poles used where Grade B construction is required for Class C lines crossing railroads (G.O. 95).

C. Poles supporting equipment in excess of 500 pounds.

D. Angle, dead-end, or poles subject to abnormal stress.

1.2 Wood Stubs Permitted (Not Preferred)

A. Poles supporting three or more power circuits.

B. Poles located on major highways or residential streets where stubbing would be unsightly.

NOTE Steel stubs are not approved for use as temporary pole supports. Steel stubs are utilized as a long-term pole repair method and installed by contractors per SCE Material Specification No. 457, refer to PO 147.

2.0 Temporary Wood Stub Setting

2.1 Confirm selection of wood stub with responsible supervisor or planner.

2.2 Do not set wood stub on climbing side (high side). See Figure PO 140–1.

2.3 Set wood stubs in ground to the same depth as required for the specific length of pole being reinforced.

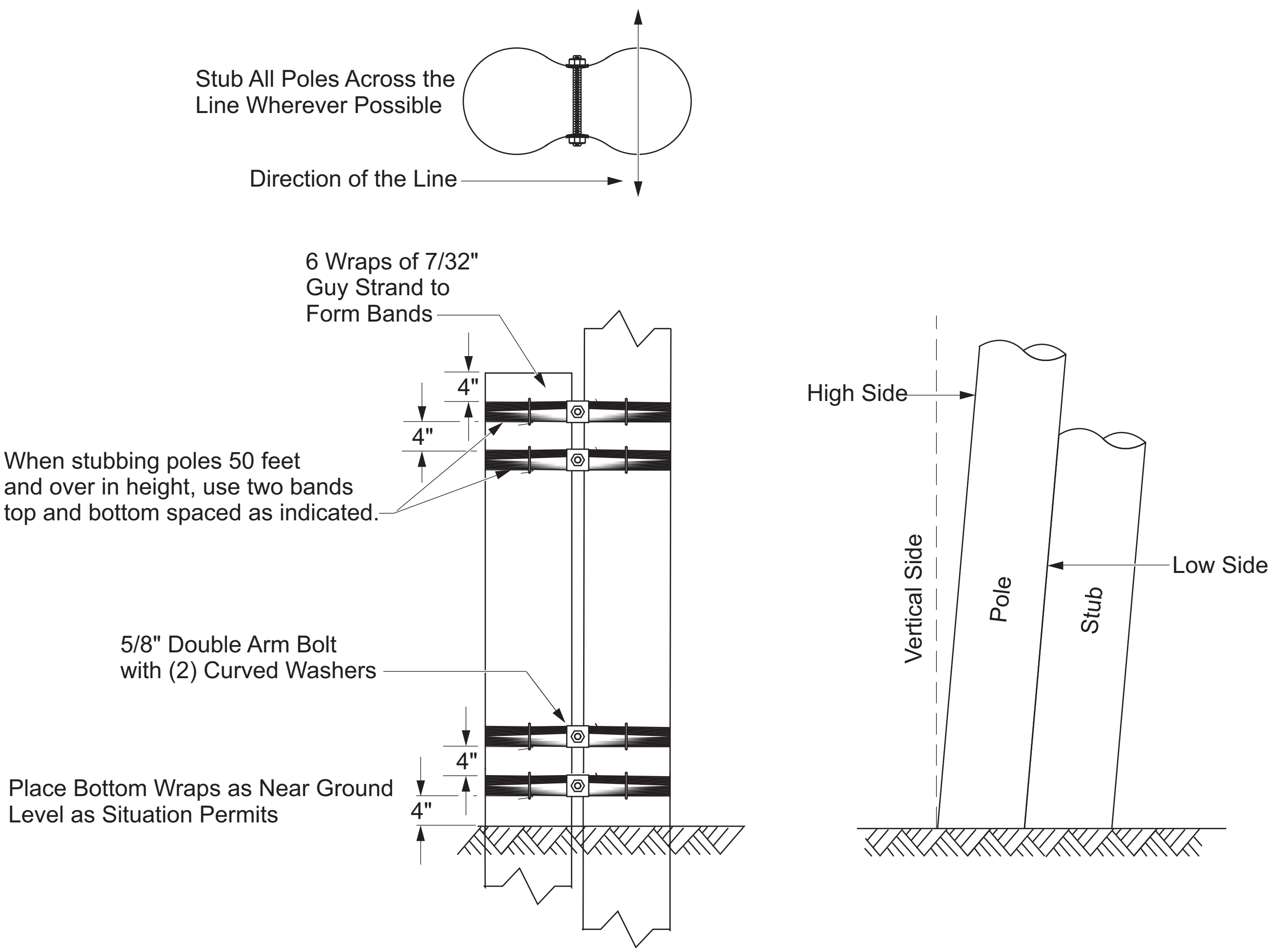
2.4 Use wood stub lengths as tabulated below:

Table PO 140–1: Wood Stub Lengths

Pole Length (ft)	Stub Length (ft)
25 to 30	10
35 to 50	12
50 and Over	15

3.0 Method of Temporary Wood Stubbing

Figure PO 140–1: Method of Temporary Wood Stubbing



Note(s):

1. Temporary wood stubs are not to be secured to the deteriorated pole using bolts. Only the guy wire banding method shall be used to secure the wood stub to the pole.
2. Set wood stub in ground to at least the same depth as required for the specific length of pole being reinforced.

Scope PO 140.2 Use of Pole Set-Urethane Foam for Pole Reinforcement

1.0 Directions

1.1 Pour compounds “A” and “B” together into container box.

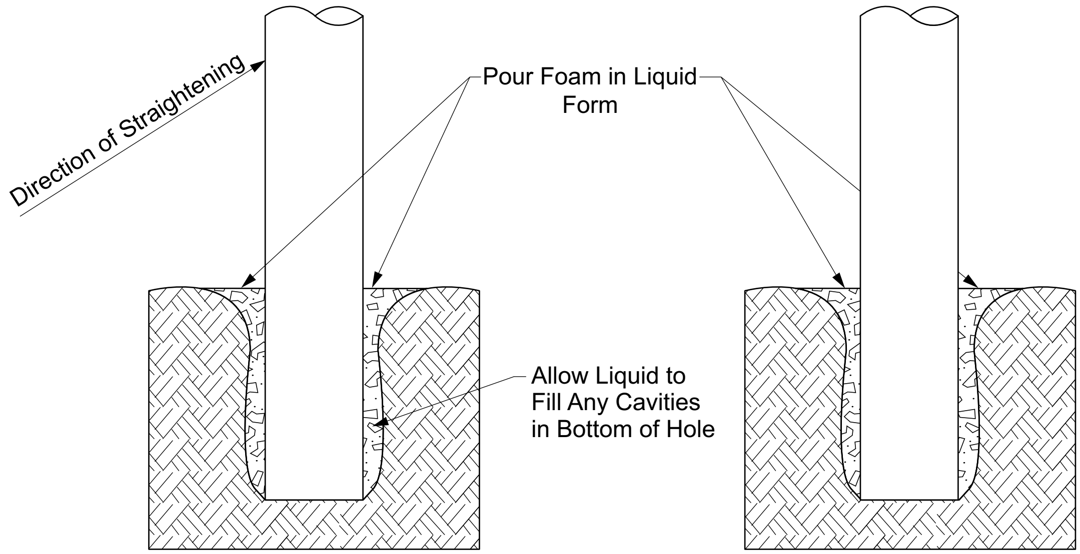
1.2 Immediately mix liquids together for 30 seconds by using impeller and rod furnished in kit with electric drill. (Take care not to hit sides of box with impeller.)

1.3 Pour chemical into hole while still in liquid state. Wait approximately 10 minutes for foam to set up before adding more compound.

Figure PO 140–2: Urethane Foam Kit

SAP 10061289 (One Gallon Kit)

Figure PO 140–3: Use of Pole Set-Urethane Foam for Pole Reinforcement



Pole Straightening

For use in unstable or loose ground, one or two gallons of foam will usually be sufficient.

Pole Setting in Unstable or Loose Soils

Use where imported soil is reqired in muddy or loose ground. Two to three gallons of foam are required.

Note(s):

3. Do not use urethane foam where normal backfill soil is available.

PO 141P Star Pole Anchor

Scope PO 141P.1 Star Pole Anchor

1.0 Star Pole Anchor

Star pole anchors utilize large conical wedge anchors to secure poles to solid rock. In order to support a pole to its full bending strength large forces must be passed to the anchors. Therefore they should only be used when anchored to solid massive rock of sufficient strength and extent to carry that load. Rock condition shall be equivalent to solid concrete in terms of digging effort. The rock shall not be heavily fractured or relatively easy to fracture or fragment with normal excavation equipment. It shall not be installed on buried boulders unless it is ascertained that the rock extends at least 6 feet in any direction from the pole.

Planner shall probe within a 6 foot radius of the proposed pole location with a probe SAP 10175771 to determine soil depth and proper rock mass. If the planner cannot determine this with a simple probe, a planner pre-check for civil to pothole the area and report findings shall be conducted prior to design.

Figure PO 141P–1: Star Pole Anchor

1.1 Pole and Anchor Selection

Pole selection and preparation depend on whether the rock surface is exposed or buried.

A. The pole butt may be set directly on exposed rock when it is unlikely the pole butt will be covered by soil during its service life. In this case the planner should make the pole selection accounting for this. The planner should perform the pole loading per the PLM with the full length of the pole above the ground line.

B. When a pole is set on rock surfaces below soil or gravel and it projects from this permeable material the butt shall be cut to allow the through-bored section of the pole to be at ground line. New Douglas-Fir poles come with a through-boring pattern of small holes which extend from two feet above to four feet below the ground line based on normal pole setting depths per Table PO 100–1. Through boring allows the chemical insecticide/fungicide to penetrate the full cross section of the pole eliminating heart wood decay in that zone.

   The through-bored zone of the pole shall remain at ground line for poles set in soil. The portion cut from the pole butt shall equal the normal setting depth (from the table) less the soil depth over the rock surface.

   Example:

   A 45 foot pole has a normal setting depth of 6'-6". If the rock surface is 2'-3" below the ground surface, then the amount to cut from the butt end of the pole would be 4'-3".

   Pole loading these poles should assume normal setting depth of the pole. Pole load per the PLM.

   The new butt after cutting should be field treated with Tenino Copper (SAP 10210604). Tenino Copper does not require any special permit to be held by those applying it.

C. Star Pole Anchor comes in two types: SPA-2 intended for use with distribution poles up to 55 feet set on exposed rock or 65 feet for poles that will be set in buried rock per B. above; SPA-3 has longer and larger diameter anchors and is intended for use with transmission class poles and recommended for any pole with a design ground line circumference over 52 inches.

D. These anchor devices are suitable for poles with a design ground line circumference not to exceed 60 inches. Design ground line circumference is the GLC on the planner SPIDA report, not the measured actual GLC. Actual measured GLC will often exceed the design GLC and this is acceptable.

E. Design selection of anchors will be an estimate and will be determined by looking up the design GLC from the Planner's Pole Loading Report, adding 1-inch and using the resulting value in Table PO 141P–1 to determine the number of SPA-2 or SPA-3 anchor units required. SPA-3 shall be used if the design GLC is determined to be greater than 53.5 inches. Quantity of anchors used in the field will be adjusted based on the measured GLC.

F. The measured GLC of the prepared pole will be used to determine final quantity of anchors in the field.

1.2 Drilling for Star Pole Anchor Installation

STEP 1. Clear area of any clay or gravel until the rock surface is exposed.

STEP 2. Verify slope of the rock under the pole, must be less than 3 inches. Maximum gap between butt of the pole to the rock shall not exceed 3 inches.

STEP 3. Use drilling template provided by manufacturer. Drilled holes shall be:

STEP 3.1 For Spa-2 anchors drill holes two inches in diameter and 24 inches deep;

STEP 3.2 For Spa-3 anchors drill holes 3-inches in diameter and 29-inches deep.

When saddles are attached to the through-bore section of the pole an attempt should be made to orient the template relative to the line direction, so that the lag screws in the saddles will not be parallel to the through boring hole pattern.

1.3 Pole and Anchor Assembly

STEP 1. Clean drilled holes out thoroughly with high pressure air. Insert anchor into drilled holes.

STEP 2. Hold pole vertically in place for anchor assembly.

STEP 3. Assemble and tighten all threaded rods in the saddles of the anchors. Two per anchor for Spa-2 and 3 per anchor for Spa-3.

STEP 4. Screw and tighten all steel bolts with flared cone, 300 ft-lb torque required.

STEP 5. Drill 1/4-inch pilot holes in the pole for lag bolts using the holes in the anchor bands as a guide. Screw and tighten all lag bolts in the holes, 40 ft-lb torque required.

STEP 6. Fill all anchor bolt holes with non-shrink grout (Five Star Grout or SikaGrout 212 are acceptable).

STEP 7. In the case where the anchor is set below shallow soil overburden, the hole shall be backfilled with structural concrete per UGS GI 020.

Table PO 141P–1: Star Anchor Type and Quantity Selection based on GLC

Pole Dia. at GL (inches)	Groundline Circumference (inches)	SPA 2			SPA 3	
		3 leg	4 leg	5 leg	4 leg	5 leg
8	25.1	3	—	—	—	—
8.5	26.7	3	—	—	—	—
9	28.3	3	—	—	—	—
9.5	29.8	3	—	—	—	—
10	31.4	3	—	—	—	—
10.5	33.0	3	—	—	—	—
11	34.6	—	4	—	—	—
11.5	36.1	—	4	—	—	—
12	37.7	—	4	—	—	—
12.5	39.3	—	4	—	—	—
13	40.8	—	4	—	—	—
13.5	42.4	—	4	—	—	—
14	44.0	—	—	5	—	—
14.5	45.6	—	—	5	—	—
15	47.1	—	—	5	—	—
15.5	48.7	—	—	5	—	—
16	50.3	—	—	5	4	—
16.5	51.8	—	—	5	4	—
17	53.4	—	—	5	4	—
17.5	55.0	—	—	5	4	—
18	56.5	—	—	5	4	—
18.5	58.1	—	—	—	—	5
19	59.7	—	—	—	—	5
21	66.0	—	—	—	—	5

PILOT

Note(s):

1. Verify and adjust as needed the quantity of anchors based on field measured GL.

PO 142 Pole Push Brace

Scope PO 142.1 Method of Installing a Push Brace

A pole push brace is not approved for use on new construction. For replacement of existing pole push brace, contact Distribution Structural Engineering for guidance

Push brace shall be used when conventional guying is not adequate or feasible for wood poles. Pole load calculation and intrusive inspection is required prior to installation.

Table PO 142–1: Pole Set Depth

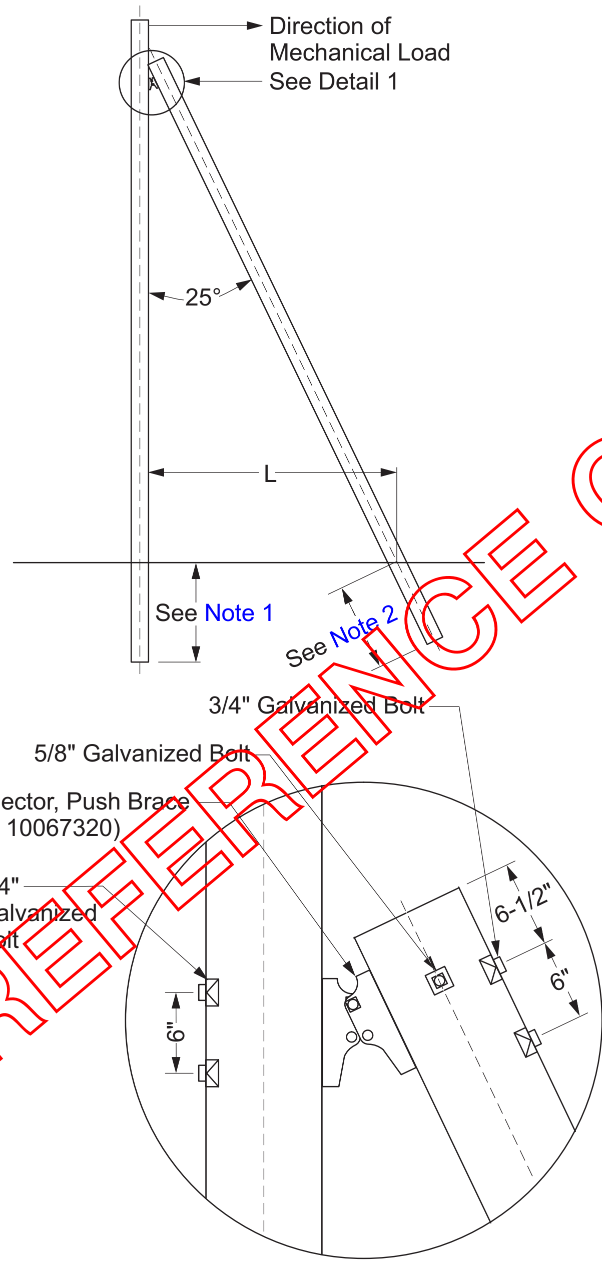
Length of Pole Overall (ft)	Brace Length (ft)	L (ft)	Brace Pole Depth
35	35	12	5'–0"
40	40	14	5'–0"
45	45	15	5'–6"
50	50	17	5'–6"

Table PO 142–2: Allowable Horizontal Tension (lb)

Brace Length (ft)	Pole Class	Soil Condition		
		Soft[a]	Medium[b]	Hard[c]
35	1	940	1,520	2,080
	2	900	1,400	1,920
	3	800	1,280	1,760
	4	700	1,165	1,600
	5	660	1,050	1,440
40	1	1,000	1,620	2,230
	2	930	1,495	2,060
	3	860	1,370	1,890
	4	790	1,260	1,730
	5	720	1,150	1,570
45	1	1,070	1,720	2,380
	2	985	1,585	2,185
	3	900	1,450	1,990
	4	830	1,335	1,830
	5	760	1,220	1,670
50	1	1,130	1,830	2,530
	2	1,040	1,680	2,320
	3	950	1,530	2,110
	4	880	1,410	1,930
	5	810	1,290	1,750

[a] Sands, Sandy Clay, Silty Sand, Clay, Clayey Sand, Silty Clay, Clayey Silt, Clayey Gravel, Silty Gravel
[b] Sandy Gravel, Gravel, Sedimentary and Foliated Rock
[c] Massive Crystalline Bedrock

Figure PO 142–1: Push Brace



Note(s):

1. Line Pole Depth (LPD)—See PO 100.
2. Brace Pole Depth (BPD)

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PO 143 Caisson Installation

Scope PO 143.1 Caisson and Sono Tube General Information

1.0 Caisson Installation — Typical

1.1 General

Diameters for caissons are 30 and 36 inches.

Caissons are not coded in the material and tool catalog.

The depth of the caisson shall be stamped on the caisson above ground level. The stamp shall be on the uphill side of the caisson. In cases where scour is expected, the maximum scour allowed shall be stamped as well.

Soil Conditions

- Use caissons in unstable soil conditions such as river bottoms, shifting sands, and so forth, when setting poles with helicopters. Refer to DOM MO-4 Helicopter Pole Setting.
- The length of the caisson and the depth of installation are dependent on its use, location and surrounding soil conditions.
- Whenever caissons are to be installed in river bottoms or suspected flood areas, contact Transmission Engineering.

Sono Tubes

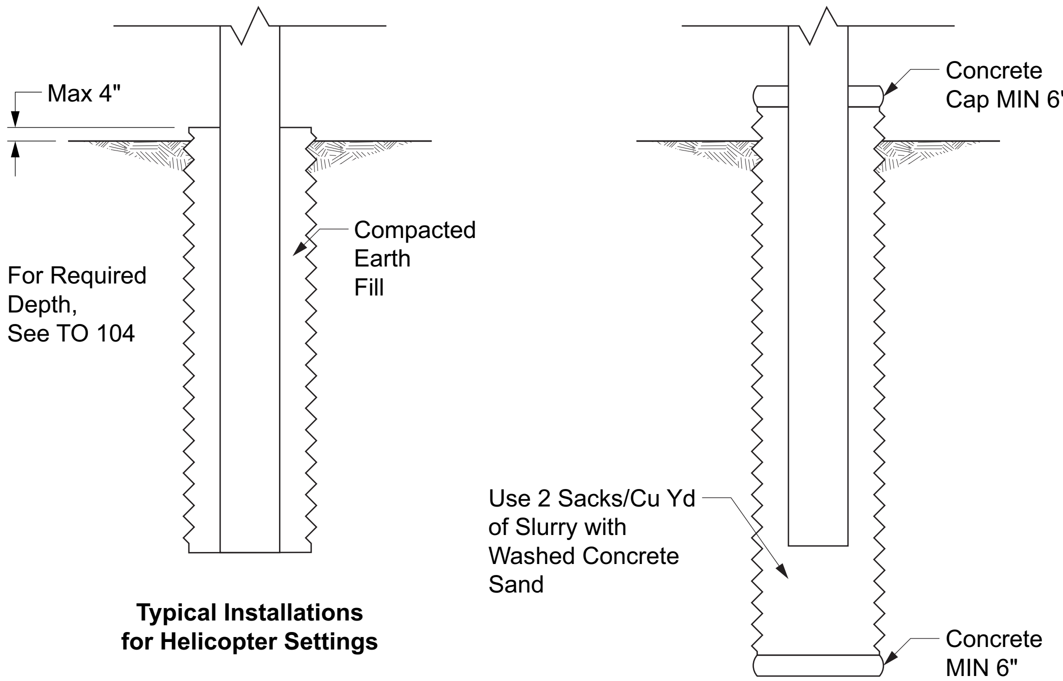
- Use Sono tubes in stable soil when setting poles with helicopters. Refer to DOM MO-4 Helicopter Pole Setting.

  Caissons and Sono Tubes will be sized according to pole diameters. The Caisson or Sono Tube will give approximate 6 inches around the pole for backfill. Sono Tubes may be cut to proper length. Contractor or civil crew digging the hole shall provide and install Caisson or Sono Tube.

1.2 Grounding

Caissons shall not be used as a ground. Temporary ground rods shall be outside the caisson. Ground rods shall be 24 inches or more from caissons. Caissons should not be bonded to temporary grounds if present.

Figure PO 143–1: Caisson Installation — Typical



Typical Installations for Helicopter Settings

Typical River Bottom Installation

Note 1: Caissons must be installed at existing grades when being installed in USDA forest service locations.

Note 2: For river bottom installations, contact Engineering for Caisson and pole setting depths and for maximum scour permitted.

2.0 Caisson Installation — Typical Ditch Installation

2.1 General

Caissons can also be used when poles are to be installed in or near drainage ditches. Drainage ditches shall be protected from erosion at the pole locations. If the ditch has a history of deep erosion, contact Transmission Engineering for the caisson design.

The length of the caisson shall be 15 feet or 20 feet depending on the slope of the ditch. The depth of the caisson shall be stamped on the caisson above ground level. The stamp shall be on the uphill side of the caisson.

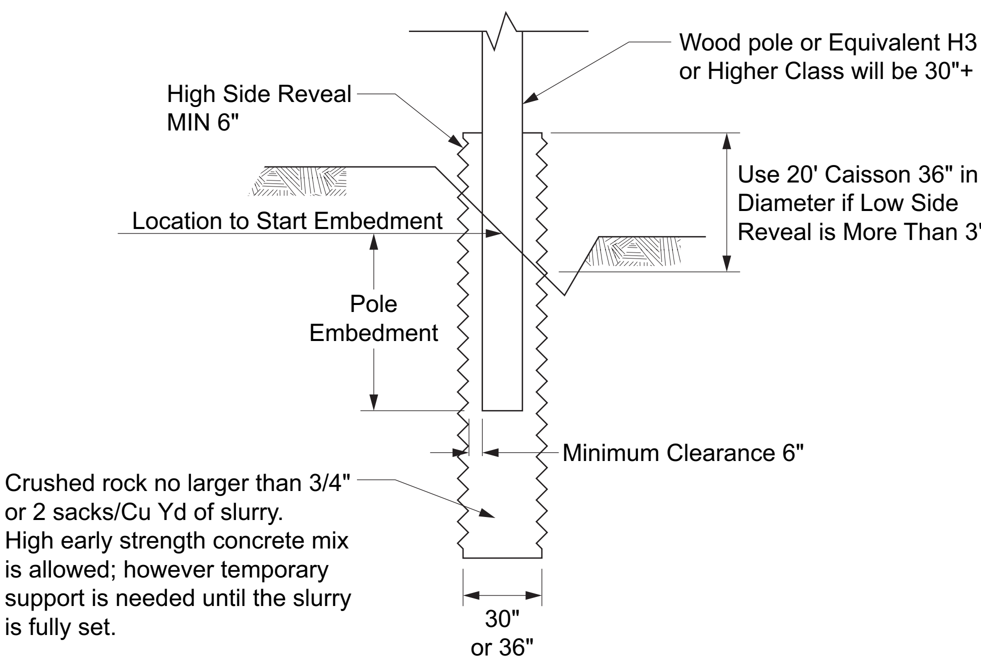
The caisson high side reveal shall be greater than 6 inches and the top of the caisson shall be higher than the highest expected water level in the ditch. If a high side reveal of more than 18 inches is required, contact Transmission Engineering.

Use 12 gauge steel or higher. Use a 20 foot caisson when the terrain is such that the projection on the downhill side of the caisson exceeds 3 feet.

Do not re-use existing caissons.

Fill with crushed rock (no pea gravel) no larger than 3/4 inch (Class 2 base, all-natural products only) or use two sack slurry for heavier loaded poles.

Figure PO 143–2: Caisson Installation — Ditch Installation



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PO 145 Modular Pole Butt Replacement for Damaged Poles, Pole Relocation

Scope PO 145.1 Modular Pole Butts

Figure PO 145–1: Modular Pole Butts

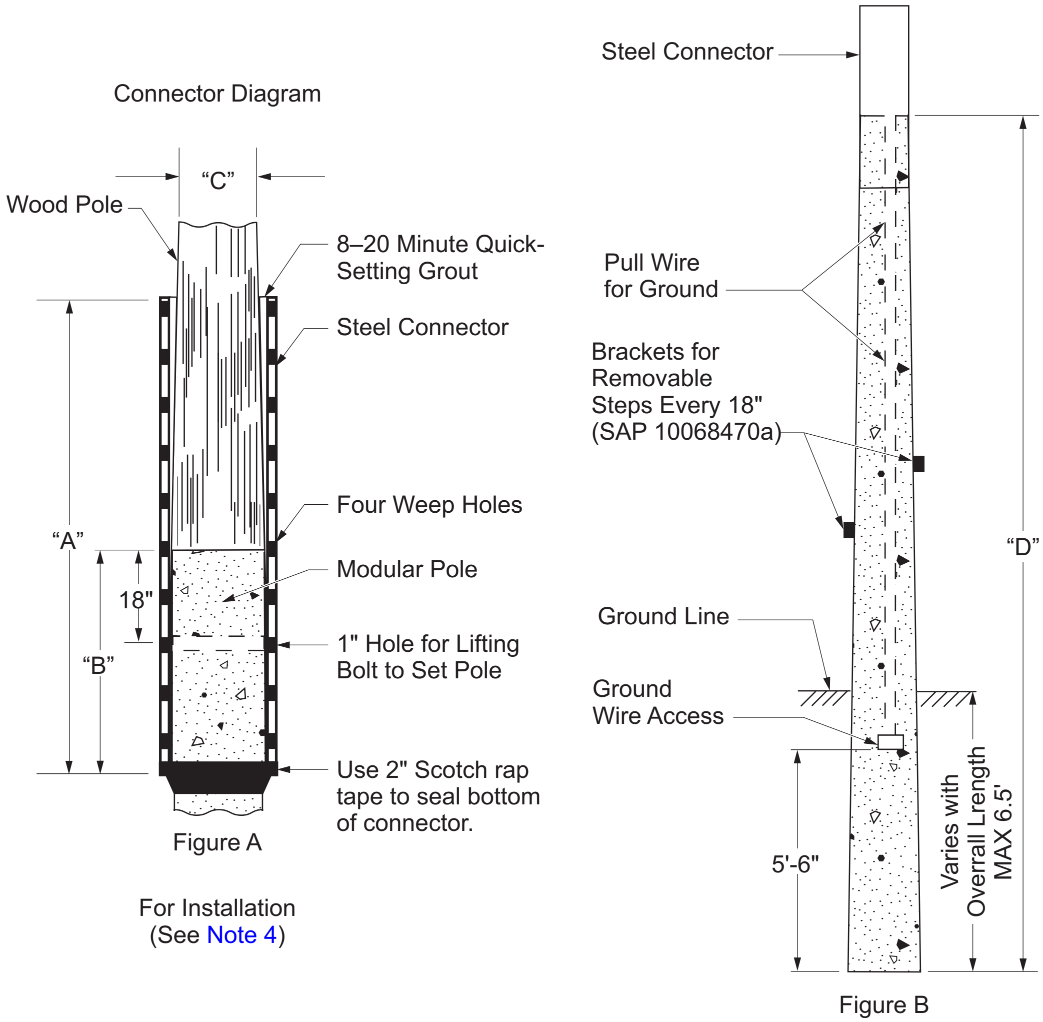


Table PO 145–1: Modular Pole Butts

Mod. Size (ft)	SAP	A (in)	B (in)	C (in)	D (ft)	MAX Pole Diameter (in)	Weight (lb)
9	10060282	60	30	15-3/4	9	14-3/4	1,860
14	10060284	60	30	15-3/4	14	14-3/4	2,860
18	10060283	40	15	12	18	11	2,200

Note(s):

1. These poles are for replacement of maximum 55-foot Class 3 pole.
2. Only 14-foot and 18-foot modulars have pull wire for ground wire. Cover ground wire with wood molding inside steel connector to the bottom of the wood pole.
3. Use double arm bolt in 1-inch hole provided for lifting pole upright.
4. See PO 145.2.

Scope PO 145.2 Step-By-Step Procedure for Installing Mod-Pole

1.0 Lateral Transfer Method

1.1 Set concrete module into old pole hole location or adjacent to pole to be repaired.

1.2 Cut wood pole at desired height or at the same height as the top of the concrete module.

1.3 Slip connector sleeve slightly above the new bottom of the wood pole and secure it with lag.

1.4 Center wood pole above concrete module and lower connector sleeve to correct location for splicing. See Fig. "A" Figure PO 145–1.

1.5 Lower rubber splicing band or use 2-inch tape (SAP 10116916) between the module and the connector to form a seal for pouring grout.

1.6 Secure wood wedges in sleeve to center the wood pole. Install plastic plugs in weep-holes and then pour grout mixture until connector is filled.

1.7 Three bags of grout are furnished with the kit. If the space between the pole and the connector is more than one inch, peagravel should be mixed with the grout.

1.8 Remove plugs from weep-holes when the grout is hardened and clean the holes to the pole surface with a lag.

1.9 Attach one-inch yellow Scotch reflective tape (SAP 10065793) to the butt for visibility strips where necessary. The modpole is drilled for pole no. attachments.

Note(s):

1. Separate Grout Kit (66 lb) with wedges, plugs, tape, and mixing sticks can be ordered under SAP 10067050.
2. Additional grout (only), 22 lb bag, can be ordered under SAP 10067049.

Scope PO 145.3 Grout and Pea Gravel Requirements for Modular Pole Butts

To determine the amount of grout and pea gravel required for a given wood pole diameter, refer to the table below.

Wood Pole Diameter (in)		9-ft or 14-ft Module		18-ft Module	
	Circ. (in)	Grout (lb)[a/]	Pea Gravel (lb)	Grout (lb)[a/]	Pea Gravel (lb)
8	25	—[b/]	—[b/]	66 (3 bags)	42
8-1/2	26.5	—[b/]	—[b/]	66	34
9	28	—[b/]	—[b/]	66	26
9-1/2	30	—[b/]	—[b/]	66	18
10	31.4	88 (4 bags)	120	66	10
10-1/2	33	88	103	65	0
11	34.5	88	92	52	0
11-1/2	36	88	80	40	0
12	37.5	88	66	—	—
12-1/2	39	88	54	—	—
13	40.5	88	40	—	—
13-1/2	42.5	88	25	—	—
14	44	88	10	—	—
14-1/2	45.5	81	0	—	—
15	47	62	0	—	—

[a/] 9 and 14 foot modules are supplied with 88 lb of grout. 18 foot modules are supplied with 66 lb of grout.
[b/] It is not recommended that the 9 or 14 foot module be used with small diameter poles (8 through 9-1/2–inch diameter.)

PO 147 Reinforcement and Replacement of Deteriorated Poles

Scope PO 147.1 Ground Line Reinforcement of Wood Poles

1.0 Reinforcement/Restoration

1.1 Reinforcement of wood poles as a long term repair may be used in some instances instead of pole replacement. Acceptable methods are steel channel reinforcement (steel stubbing) by contract service and “Mod Pole” butt replacement per PO 145. Temporary wood pole “stubbing” per PO 140 cannot be used as a long term reinforcement but only for temporary support.

1.2 Contract services for wood pole inspection and reinforcement should be coordinated through the Steel Stub Program Manager. In all cases of pole reinforcement, the total installed cost of pole replacement or steel channel support should be considered first. It may be more economical to replace a pole or use the less expensive support than to use the “Mod Pole”.

1.3 Of all the above methods of support, the “Mod Pole” is the most expensive and should be used selectively on emergency “car-hit-pole” jobs where above-ground damage has occurred, where additional pole height is needed or other conditions where the mod pole is economically advantageous.

1.4 Limitations for contract steel channel reinforcement may be found in SCE Material Specifications MS 454 and MS 457.

2.0 Fiberglass Wrap Restoration

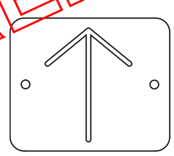
2.1 “Repol” reinforcement shall not be used under the following conditions:

A. In Grade A or B railroad crossings.

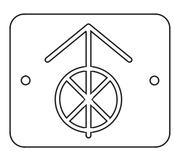
B. Poles with any wood decay more than 96 inches above ground.

C. Poles that can be replaced more cost effectively (Contact Timber Products engineer for contract costs).

Figure PO 147–1: Deteriorated Pole Signs Required by the DOM Manual



Stub or Repol



Replace or Repol

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PO 148 New Wood Pole with FR Wrap

Scope PO 148.1 Wood Pole with FR Wrap — New Installation

1.0 General Information

NOTE FR Wrap is previously known as Protective Barrier.

1.1 FR Wrap Description

The Fire Resistant (FR) Wrap is an intumescent (swelling up when heated) grid made of 23 gauge galvanized steel coated with a durable intumescent polymer. It is designed to protect the pole by expanding at temperatures greater than 300°F and creating a barrier that protects and shields the wooden structure from radiant heat and fire.

1.2 Climbing Poles with FR Wrap

Prior to climbing a pole with the FR Wrap installed on it, check to make sure the wrap is securely attached to the pole. Gaffs can easily penetrate through the 23 gauge wrap and make good contact with the wooden pole behind. When climbing, be attentive to the partially obstructive pole behind the wrap for climbing hazards (ex. Checks).

NOTE Watch for flared out metal from existing gaff marks in pole around the exposed wood. If encountered, press and/or hammer it back into the pole.

If accessing the pole after a fire and the FR Wrap has been activated, remove the activated portion(s) of the wrap on the pole you will be climbing.

1.3 Minimum Installation Clearance requirements Around FR Wrap

- A minimum 8-foot clearance between the top of the FR Wrap and exposed energized parts greater than 750 V.
- A minimum 8-foot clearance between the top of the FR Wrap and energized equipment (greater than 750 V), tanks, bracket, and crossarms.
- Attachments for OH secondary cables, such as rollers, crossarms, through bolts shall be connected 8 feet above the top of the FR Wrap.
- Cables operated at 750 V and less shall be protected in conduit when extending past the FR Wrap or within 8 feet of the top portion.
- Control cabinets for automation may be installed directly to the FR Wrap.

If installing a new pole with wrap and the clearance are not meet, remove the portion of the FR Wrap that falls within this zone. Secure the top of wrap every 4–6 inches with a 1-3/4", 11 gauge galvanized roofing nail (SAP 10069984).

1.4 Attaching Assets Through and Over FR Wrap

The FR Wrap can be cut, manipulated, adjusted or have a section removed in order to install equipment or assets to the pole.

- Tin snips, shears, or a sharp blade can be used to cut or remove a section of the wrap in order to sufficiently install the necessary equipment or assets.
- Care must be taken to ensure the gap between the FR Wrap and the equipment is no longer than 1/2-inch.
- Effective attachment of assets will include minimizing the surface area of exposed wood so it does not impede the survivability of the pole and the performance of the FR Wrap in the event of a fire.
- Ensure the FR Wrap edge is tightly fastened to the pole if a cut is required to remove a small portion of the wrap in order to install equipment. Use 11 gauge galvanized roofing nail (SAP 10069984) to tighten any loose edging of the FR Wrap.

2.0 Application for New Wood Poles

The FR Wrap is intended for use on wooden utility poles in SCE's High Fire Risk Areas (HFRA). Poles shall be delivered from pole manufacture with wrap installed. The FR Wrap will be positioned to start at 2 feet 10-inches below ground line and extend up to a height of approximately 20 feet above ground line. New wood poles should be pole load the same way a new wood pole without a FR Wrap would be loaded.

Figure PO 148–1: Typical FR Wrap Wood Utility Pole

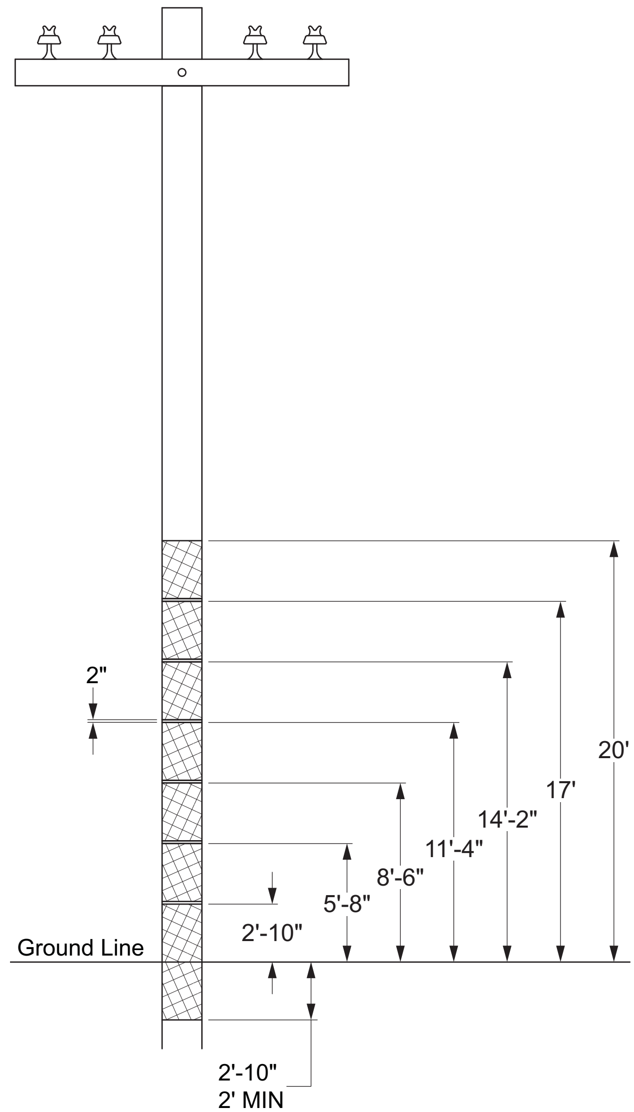

Table 148–1: Dimensions, Weights, and SAP # for Wood Poles with FR Wrap

Pole Length (ft)	ANSI Size Class	Height Above Groundline (ft)	Minimum Groundline Circum. (in) with Wrap	Top Circum (in) Wood	Weights (lb)			SAP
					Douglas Fir	FR Wrap	Douglas Fir with FR Wrap	
25	5	20	26.5	19	415	29	444	10212466
30	5	24.5	28.5	19	520	31	551	10212467
35	5	29	30	19	640	32	672	10212468
35	4	29	33.5	21	805	36	841	10212469
35	3	29	36	23	860	39	899	10212470
35	2	29	38.5	25	1,000	41	1,041	10212471
35	1	29	41.5	27	1,165	44	1,209	10212472
40	5	34	32	19	895	34	929	10212473
40	4	34	34.5	21	1,025	37	1,062	10212474
40	3	34	37	23	1,165	40	1,205	10212475
40	2	34	39.5	25	1,310	42	1,352	10212476
40	1	34	42	27	1,545	45	1,590	10212477
40	H1	34	44.5	29	1,845	48	1,893	10212478
40	H2	34	47	31	2,029	50	2,079	10212479
40	H3	34	49.5	33	2,214	53	2,267	10212480
40	H4	34	52	35	2,390	55	2,445	10212481
45	4	38.5	36	21	1,225	39	1,264	10212483
45	3	38.5	38.5	23	1,410	41	1,451	10212484
45	2	38.5	41.5	25	1,560	44	1,604	10212485
45	1	38.5	44	27	1,930	47	1,977	10212486
45	H1	38.5	46.5	29	2,168	50	2,218	10212487
45	H2	38.5	49.5	31	2,444	53	2,497	10212488
45	H3	38.5	52	33	2,721	55	2,776	10212489
45	H4	38.5	54.5	35	2,998	58	3,056	10212490
45	H5	38.5	57	37	3,275	61	3,336	10212491
50	4	43	37.5	21	1,420	40	1,460	10212492
50	3	43	40	23	1,625	43	1,668	10212493
50	2	43	43	25	1,870	46	1,916	10212494
50	1	43	46	27	2,225	49	2,274	10212495
50	H1	43	48.5	29	2,583	52	2,635	10212496
50	H2	43	51.5	31	2,859	55	2,914	10212497
50	H3	43	54	33	3,182	58	3,240	10212498
50	H4	43	56.5	35	3,551	60	3,611	10212499
50	H5	43	59.5	37	3,920	63	3,983	10212500
55	3	47.5	41	23	1,845	44	1,889	10212501
55	2	47.5	44	25	2,130	47	2,177	10212502
55	1	47.5	47	27	2,480	50	2,530	10212503
55	H1	47.5	50.5	29	2,998	54	3,052	10212504
55	H2	47.5	53	31	3,275	56	3,331	10212505
55	H3	47.5	56	33	3,690	60	3,750	10212506
55	H4	47.5	59	35	4,059	63	4,122	10212507
55	H5	47.5	61.5	37	4,566	65	4,631	10212508

Table 148–1: Dimensions, Weights, and SAP # for Wood Poles with FR Wrap *(Continued)*

Pole Length (ft)	ANSI Size Class	Height Above Groundline (ft)	Minimum Groundline Circum. (in) with Wrap	Top Circum (in) Wood	Weights (lb) Douglas Fir	Weights (lb) FR Wrap	Weights (lb) Douglas Fir with FR Wrap	SAP
60	2	52	46	25	2,480	50	2,530	10213297
60	1	52	49	27	2,845	53	2,898	10213298
60	H1	52	52	29	3,413	56	3,469	10213299
60	H2	52	55	31	2,782	59	2,841	10213300
60	H3	52	58	33	4,197	62	4,259	10213301
60	H4	52	60.5	35	4,658	65	4,723	10213302
60	H5	52	63.5	37	5,165	68	5,233	10213303
60	H6	52	66.5	39	5,765	71	5,836	10213304
65	2	56.5	47.5	25	2,810	51	2,861	10213305
65	1	56.5	50.5	27	3,330	54	3,384	10213306
65	H1	56.5	53.5	29	3,828	58	3,886	10213307
65	H2	56.5	56.5	31	4,243	61	4,304	10213308
65	H3	56.5	59.5	33	4,750	64	4,814	10213309
65	H4	56.5	62.5	35	5,258	67	5,325	10213310
65	H5	56.5	65.5	37	5,857	70	5,927	10213311
65	H6	56.5	68.5	39	6,503	73	6,576	10213312
70	2	61	49	25	3,145	53	3,198	10213313
70	1	61	52	27	3,860	56	3,916	10213314
70	H1	61	55	29	4,280	59	4,339	10213315
70	H2	61	58	31	4,796	62	4,858	10213316
70	H3	61	61.5	33	5,258	66	5,324	10213317
70	H4	61	64.5	35	5,903	69	5,972	10213318
70	H5	61	67.5	37	6,549	72	6,621	10213319
70	H6	61	70	39	7,287	75	7,362	10213320
75	2	65.5	50	25	3,515	54	3,569	10213321
75	1	65.5	53.5	27	4,320	58	4,378	10213322
75	H1	65.5	56.5	29	4,800	61	4,861	10213323
75	H2	65.5	60	31	5,250	64	5,314	10213324
75	H3	65.5	63	33	5,903	67	5,970	10213325
75	H4	65.5	66	35	6,549	71	6,620	10213326
75	H5	65.5	69	37	7,287	74	7,361	10213327
75	H6	65.5	72	39	7,840	77	7,917	10213328

3.0 Handling and Framing Poles with FR Wrap

3.1 Handling Poles with FR Wrap

A. Care must be exercised when handling treated poles with FR Wrap pre-installed by manufacture.

- Avoid forceful impacts on the pole to preserve protective wrap.
- Poles must not be dropped or dragged over jagged rocks.
- When using sharp-pointed tools to set poles, care must be taken to minimize the number of laceration abrasions inflicted in the butt section.
- Use only nylon slings for lifting poles with FR Wrap.

B. When loading poles on dollies, the average pole weight tabulated in Table should be consulted to avoid overloading the dolly. The safe work practices section of the Accident Prevention Manual should be followed when loading and unloading poles of any type.

3.2 Framing Wood Poles with FR Wrap

Frame wood poles with FR Wrap with the same requirements as a standard wood pole (see Scope PO 100.3)

3.3 Grounding Installation Over the FR Wrap

Grounding installation on wood poles with FR Wrap shall use Protected Ground Wire (PGW) with Integral Protective Covering (see Scope GR 105.1) installed on the exterior side of the FR Wrap.

4.0 Inspecting and Patching Poles with FR Wrap

4.1 Inspecting Poles with FR Wrap

A. For New pole Sets, the FR Wrap shall be completely assessed for damage from top to bottom, 360-degrees before setting. Damage to look for includes:

- ☐ Tears
- ☐ Cuts
- ☐ Penetrations greater than 1-inch in diameter
- ☐ Loosened sections
- ☐ Scraped sections (intumescent polymer missing)
- ☐ Dislodged or loosened staples

4.2 Patching the FR Wrap

A. Poles received with FR Wrap installed from manufacture will have a patch kit attached to the top of the new pole.

1. Four 6" × 6" FR Wrap patches.

B. Patches will be installed over the identified damaged areas with eight (8) 1-3/4", 11 gauge galvanized roofing nails (SAP 10069984).

5.0 Setting Wood Poles with FR Wrap Installed

5.1 Setting Poles with FR Wrap

Set Poles with FR Wrap to the same setting depth required by wood poles (see Table PO 100–1).

6.0 Maintenance, Removal, and Disposal of the FR Wrap

6.1 Maintenance

Once pole is in-service with FR Wrap, minimal maintenance will be required. The wrap is a durable intumescent polymer which is inert in the environmental conditions. Periodic inspections shall be performed to ensure that the FR Wrap stays securely attached without physical damage.

After a fire has hit the pole and the FR Wrap, an inspection of the wrap shall be performed. The inspection is to assess the condition of the intumescent polymer to see if it has been activated (swelled-up creating the barrier). If the FR Wrap has been activated, it should be replaced from 2-feet above the highest activated portion to 1-foot below ground line.

6.2 Removal of the FR Wrap

The FR Wrap can be removed by cutting and/or pulling the wrap from the pole through the staples. If re-applying with new FR Wrap, the staples shall be removed or hammered into the pole flush.

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PO 150 Pole Top Extensions

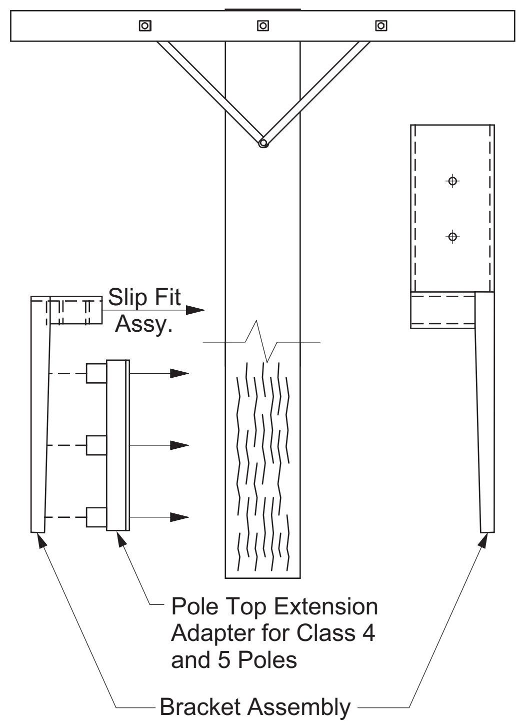
Scope PO 150.1 Applications for Pole Top Extensions

1.0 Wood 5-Foot, 6-Foot, and 7-Foot Extensions

The wood pole top extension is composed of a galvanized bracket with a square block extension. This extension comes in three sizes (5-, 6-, and 7-foot lengths). If the existing pole top is a Class 4 or Class 5 (21- or 19-inch circumference), an adapter kit must be used. The following table lists the SAP numbers:

Figure PO 150–1: Wood 5-Foot, 6-Foot, and 7-Foot Extensions

Extension Size	SAP
7 ft	10067761
6 ft	10067762
5 ft	10067763
Adapter Kit	10068586



Note(s):

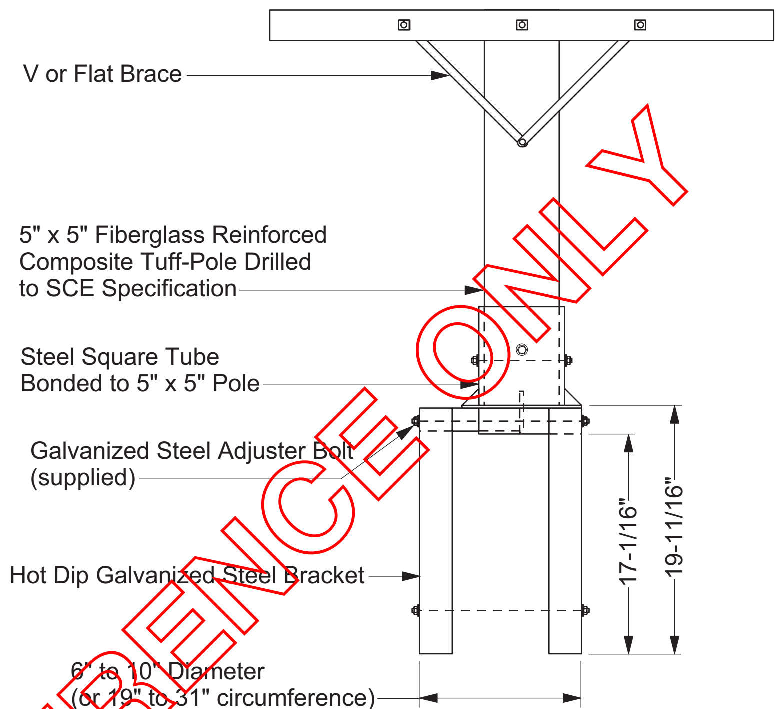
1. Install back brace (SAP 10067346) on fuseholder crossarms attached to pole top extensions.
2. SCE equipment is not approved to be installed on a wood PTX. Fiberglass PTXs are no longer approved for use. Refer to DDS-10, Section 5.2 D for information on PTXs and what can be installed on a wood PTX.

2.0 Fiberglass Extensions

The fiberglass pole top extension should be used when only 5-foot extension or less is necessary. Do not dead-end on the fiberglass pole top extension.

Figure PO 150–2: Fiberglass 5-Foot Extensions Only

Extension Size	SAP Number
5 foot	10067737



3.0 Metallic Extensions

3.1 There are two types of pole top extensions currently being used:

A. On poles with wire sizes #2 copper and 1/0 aluminum conductor, steel reinforced (ACSR) or smaller, use the flat brace as shown on Figure PO 150–3.1.

B. On poles with wire sizes larger than #2 copper and 1/0 ACSR, use the angle brace as shown on Figure PO 150–3.2.

3.2 These two types of pole top extensions shall only be used in the Distribution System when the cost of replacing the pole is not warranted.

3.3 The old type of pole top extension shall not be used in the Distribution System when:

A. Unbalanced strain requires the use of a guy wire.

B. Transformers are to be used.

C. Grade A Construction is to be used.

D. Alley arms are to be used.

Figure PO 150–3: Old Pole Top Extensions

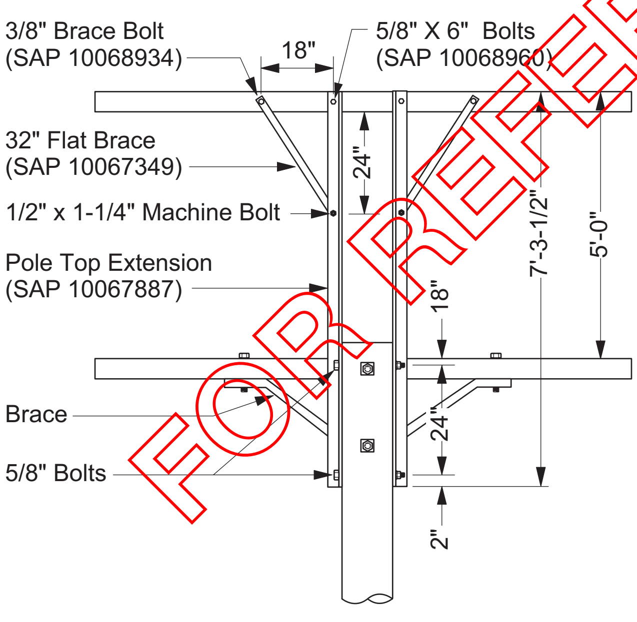


Figure PO 150–3.1

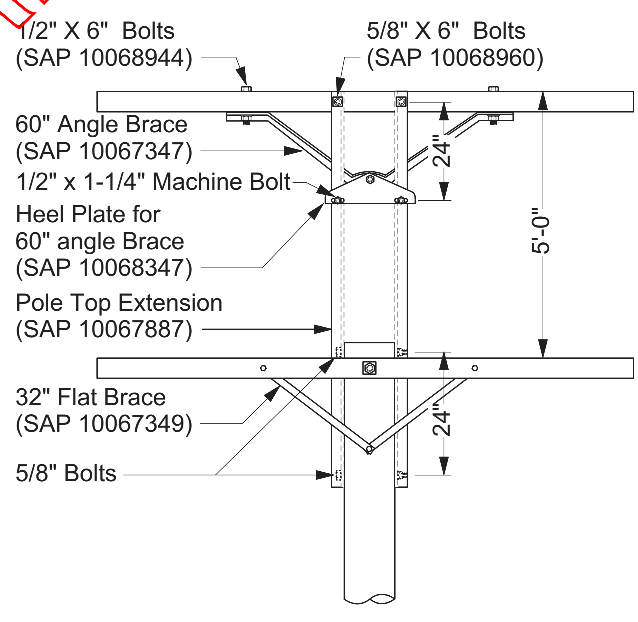


Figure PO 150–3.2

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PO 200 Grade “A” and Limited Access Highway Crossing — General Requirements

Scope PO 200.1 General Information

GRADE “A” CROSSING

A Grade “A” crossing, as defined by G.O. 95—Strength Requirements—is required where Class “H” circuits cross conflicting class “C” circuits, or where Class “H” and/or “L” circuits cross major railways. Refer to G.O. 95, Rule 20.6-D, Page II-7 for definition of classes.

LIMITED ACCESS HIGHWAY

Applies to freeways (including on-ramps and off-ramps) and other major highways with two lanes or more in opposing direction.

1.0 Insulators

For all conductor sizes, excessive angles, or natural dead-ends, use dead-end insulators.

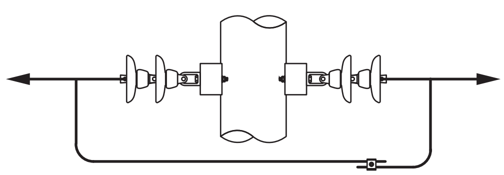
2.0 Splices

Consent agreements have been obtained between the Company and Pacific Telephone and Telegraph Co., and General Telephone Co. to install splices in Class “H” and “L” circuits at major Class “C” circuit crossings. However, they should be avoided when practical. Splices are prohibited in major railway crossings. Splices are undesirable in minor railway and minor Class “C” circuit crossings. See CO Section for approved splices.

3.0 Taps

Taps shall be made in the jumper loop between dead-end insulators.

Figure PO 200–1: Typical Configurations for Grade “A” Crossing Poles

	Type	Maximum Size Conductor
	Double Dead End Arm	All Class “H” and/or “L” Distribution Conductors

Scope PO 200.2 Grade “A” Crossing General Requirements

4.0 Span Lengths

Tabulated below are maximum span lengths for major crossings for various conductor sizes under light and heavy loading conditions:

Table PO 200–1: Span Lengths

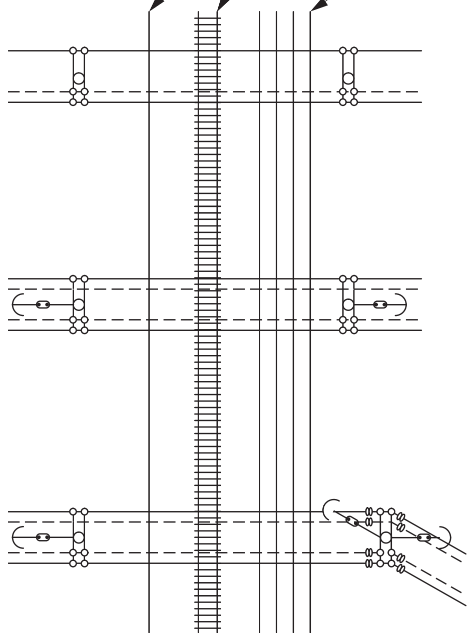
Conductor Size		Straddle Span Length (ft)	
Copper	**ACSR**	**Light Loading**	**Heavy Loading**
No. 6	No. 4[a/]	300	150
No. 4	No. 2	Normal Span Length of Line	Normal Span Length of Line
and Larger			

[a/] Not approved for use on new construction.

5.0 Guying

Guying requirements for major crossings are outlined in Cases I through III below. They apply to all conductors in light and heavy loading areas strung according to sag tables in the CO Section.

Figure PO 200–2: Guying



Case I:

Three wires maximum of No. 6 or 4 Cu, or No. 4 ACSR (only for existing construction).
Straight line construction. No anchor guy, head guy, or span guy required.

Case II:

Two or more wires of sizes greater than Case I on one or more double crossarms.
Straight-line construction. Anchor guys or head guys required.

Case III:

Two or more wires of sizes greater than Case I on one or more double crossarms. Angle in line.
Anchor guys or head guys required. In addition, for angles less than 45 degrees, bisector guys required.

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PO 300 Guying — General Information

Scope PO 300.1 Guying — General Information

1.0 Guying Requirements for Distribution and Transmission Lines

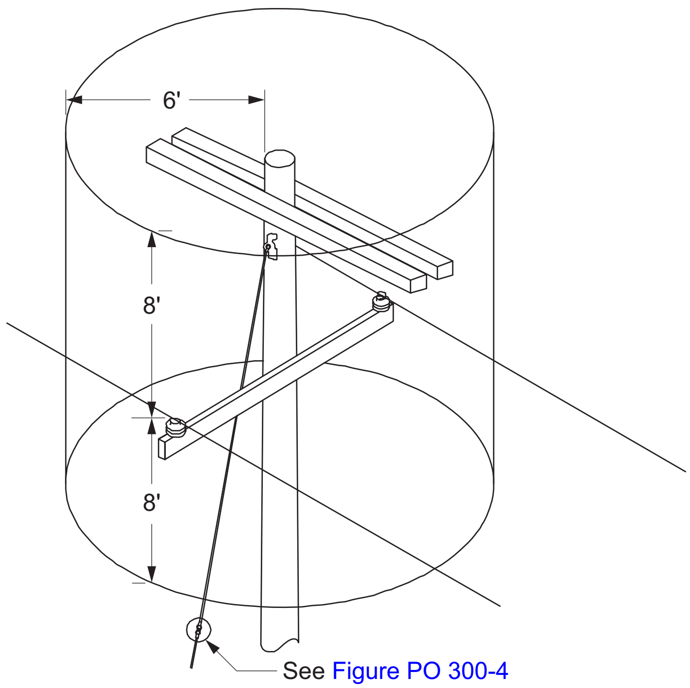
1.1 When the mechanical loads to be imposed upon the poles are greater than can be safely supported by the poles, use guys to provide additional strength. This applies particularly to angles and dead-ends when the conductor stresses are sufficiently unbalanced to make guying necessary.

1.2 No guys shall be attached to trees or other private property (except in special cases when permission to do so must be obtained in writing from the owner).

1.3 Guys attached to anchors must be protected with standard guards. Where more than one guy is attached to an anchor rod, only the outermost guy must be protected (see PO 350).

1.4 Use fiberglass guy strain insulators in all guys attached to poles in order to meet G.O. 95 guying isolation and zone of proximity requirements (see Figure PO 300–1). When using fiberglass guy strain insulators (FGSI), porcelain guy strain insulators are not required (see Section 3.0 (Sheet 3) for additional requirements).

Figure PO 300–1: Fiberglass Guy Strain Insulator — Zone of Proximity



NOTE Some applications such as sidewalk horizontal braces, wizzars, rear-property lines, or where steep grade changes do not allow for the safe installation of the fiberglass guy strain insulator to adhere to the requirements in Subsection 3.2. If so, porcelain guy strain insulators shall be used based on existing standards.

1.5 All guys shall be attached to poles with special hardware designed for this purpose. Preformed guy grips will be used to make up guy heads at the anchor end of guys, over rollers for fiberglass guy strain insulators, and over porcelain guy strain insulators.

1.6 When two or more guy wires are installed in close proximity to each other, the attachment of one guy shall not overlap that of another, but each shall be entirely independent of the other and at least 12 inches apart at the point of attachment to the pole.

1.7 Guys should be installed and adjusted before the conductors are strung so that the pole or crossarm will stand in its proper position when the entire unbalanced stress is taken by the guy.

1.8 The point of attachment of the guy to the pole should be as near the level of the crossarms supporting the conductors as is practical to avoid undue bending stresses in the pole. Wherever possible down guy leads (distance from pole to eye of anchor rod) should be equal to or greater than the height of the guy attachment above ground. If it is impractical to install a satisfactory anchor guy at the dead-end pole, the stress may be carried by means of a span guy to an adjacent pole that can be properly guyed.

2.0 Guy Wires

2.1 For guy wires, anchors, and guying components SAP numbers, see Table PO 315–1).

2.2 A corrosion-resistant Bezinal guy wire is available for use in coastal areas (within 1 mile of the ocean) and other locations where standard galvanized steel guy wire has been susceptible to severe corrosion damage.

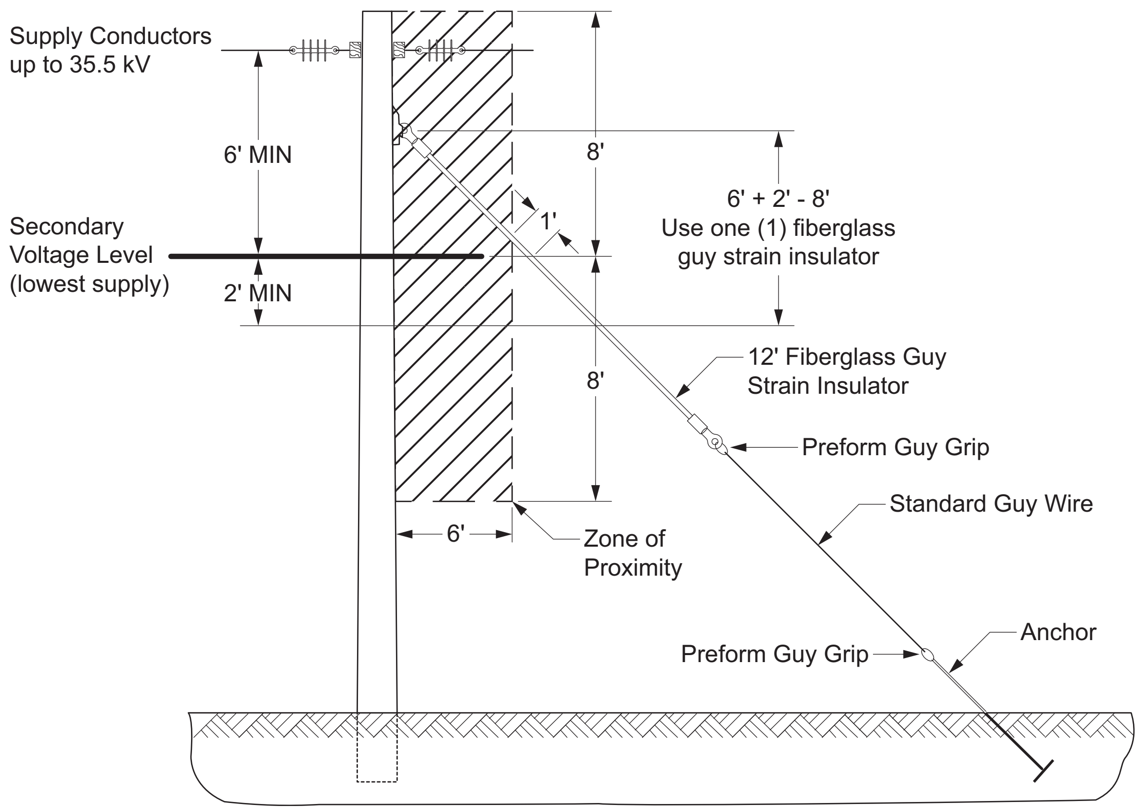
3.0 Fiberglass Guy Strain Insulator

3.1 The fiberglass guy strain insulator (SAP 10212605) shall be used in conjunction with standard guy wires and anchors for 33 kV applications and below. For additional components, see Table PO 315–1.

3.2 For new guy installations, guy remediation, and/or pole replacements that require guying in High-Fire Risk Areas (HFRAs), the fiberglass guy strain rod shall be used. Total length of fiberglass guy strain insulators shall meet the following requirements as measured from the connection point on the pole to the end of the fiberglass on the final fiberglass guy strain insulator. These requirements apply to both down guy and span guy installations:

- At least 1 foot of the fiberglass section shall extend beyond the zone of proximity to ensure alignment with insulation requirements per G.O. 95.
- Total length of fiberglass guy strain insulator shall be a minimum of 2 feet greater than the distance between the guy attachment point and the lowest supply conductor attachment (see Figure PO 300–2). For other guying examples, see PO 340.

Figure PO 300–2: Example for Determination of Fiberglass Guy Strain Insulator Length



3.3 The remaining distance of the guying installation shall use standard guy wire applicable to the strength requirements of the installation.

3.4 Two or more fiberglass guy strain insulators can be linked together utilizing a chain link (SAP 10068258).

Figure PO 300–3: Two Fiberglass Guy Strain Insulators Linked

Link together with Chain link SAP 10068258

3.5 Fiberglass guy strain rods can be installed to wood, composite, or lightweight steel poles using the guying tee (SAP 10181650). If composite arms are being utilized, the guy strain rod can be installed directly to the composite arm mounting bracket.

- When the fiberglass guy strain insulator is attached directly to the guying tee or composite cross arm bracket, the fiberglass guy strain insulator is limited to a 5 degree deviation angle from the point of attachment (see Figure PO 300–4).

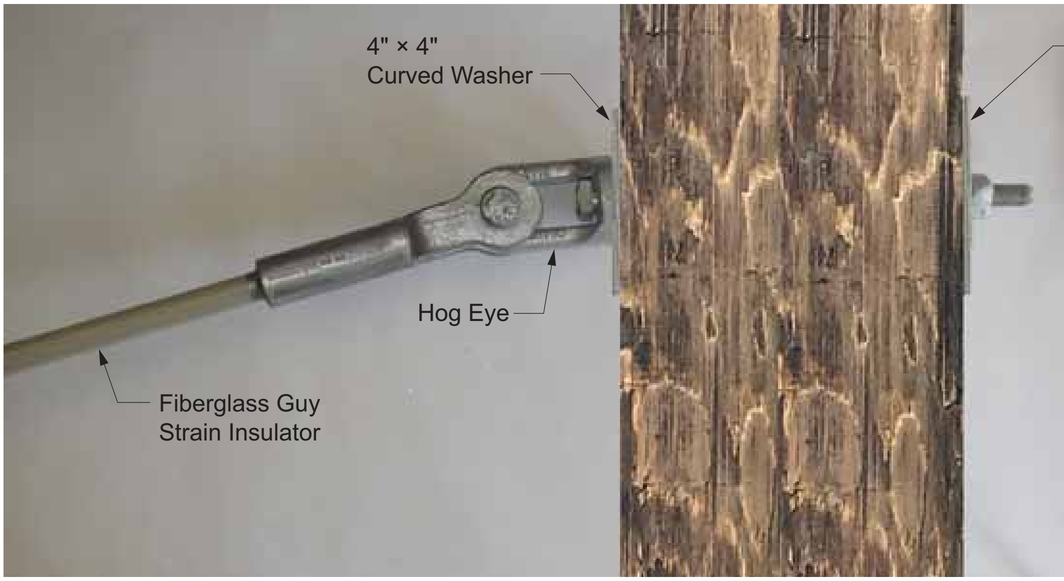
Figure PO 300–4: Angle Deviation of Fiberglass Guy Strain Insulator

Figure PO 300–4.4: Composite Arm Dead-end Bracket

Figure PO 300–4.5: Guying Tee

5.6 Span guys utilizing the fiberglass guy strain insulator shall be installed per the details in Figure PO 300–5. The span guy deviation angle shall be limited to 20 degrees (above or below) measured from horizontal. If the incline/decline angle exceeds 20 degrees, then the guying tee shall be used.

Figure PO 300–5: Span Guy Using Fiberglass Guy Strain Insulator (Preferred)



5.7 All other guying requirements described in Section 1.0 (Sheet 1) shall apply.

Scope PO 300.2 Anchors for Guys

1.0 Screw Anchors

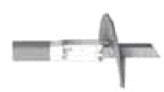
Heavy-Duty Power-Installed Screw Anchors (PISA) are the PREFERRED type of anchoring due to their minimal ground disturbance, speed of installation, and effectiveness in many types of soil. Truck access is needed to install screw anchors as identified in PO 310. Plate anchors will continue to be used in extremely loose soils and in inaccessible areas. See Section 2.0 for plate anchors requirement.

PISAs shall only be used with 1" × 7' anchor rod (SAP 10185605) attached to appropriate screw as listed below. PISAs shall only be driven into the ground by acceptable method such that the bottom of the eye of the anchor rod shall extend a minimum of 4 inches and a maximum of 18 inches above finish grade for new installation, measured along the rod. For specific PISA installation method and requirements, see PO 310. If an extension is required, a 1" × 3-1/2' anchor extension (SAP 10067299) is available for use only with a PISA 1" × 7' anchor rod. PISA rods shall NOT attach to cross plates and deadened eye with cross plate assembly.

Table PO 300–1: Rod

Size	SAP	Remark
1" × 7'	10185605	See Figure PO 310-2 PISA ID Tag.

Table PO 300–2: Screw Anchors

Size	SAP	Remark
Single 8" Helix	10200593	
Double 8" Helix	10200272	
Double 10" Helix	10200180	

What's Changed? Added a new section clarifying the installation requirements for screw anchors and Tables PO 300-1 and PO 300-2.

2.0 Plate Anchors

A sheet steel cross plate shall be buried in the ground to a depth such that the bottom of the eye of the anchor rod shall extend a minimum of 4 inches and a maximum of 18 inches above finished grade for new installation, measured along the rod. A digger-derrick/line truck with appropriate auger size shall be used to excavate the soil. For a 17" × 17" cross plate, utilize 20-inch diameter auger size and for 23" × 23" cross plate, use 24-inch diameter auger size. A trench/slot is cut so that the rod will be in alignment with the guys. The face of the plate shall be at right angles to the direction of the guy, and shall bear against undisturbed soil. Anchor holes shall be backfilled in the same manner as the holes for line poles. When a backhoe is used to dig holes for anchors, each anchor shall be limited to a working load of 11,500 pounds. Cross plate anchors shall not be used with 7-foot screw anchor rods. Cross plate anchors shall only be used in conjunction with the appropriate anchor rods, listed below. Cross plate anchors shall not have any other equipment connected directly to them other than approved anchor rods. Expanding rock anchors, DA bolts, dead-end eyes, and so forth. shall not be connected to the cross plate.

2.1 Only approved anchor rods listed in this standard are allowed for use. The anchor rods shall be attached directly to the appropriately sized cross plate anchors listed below and identified in Table PO 310–1.

2.2 For multiple anchor installations, it is necessary for the plate anchors to be properly spaced to prevent failure. It is recommended that there be a minimum of 6 feet of spacing between the plate anchors. If the recommended spacing can't be obtained, then the following criteria shall be used.

Cross plate anchors shall have separations of:

- 4 feet for installations up to 10,000 lb
- 5 feet for installations up to 15,000 lb
- 6 feet for installations up to 18,000 lb
- 7 feet for installations greater than 18,000 lb

Table PO 300–3: Rod

Size	SAP	Remark
3/4" × 8'	10185600	Stainless steel anchor rod shall only be used with concrete anchor. 
1" × 10'	10185604	
1" × 10' (Stainless Steel)	10067254	
1-1/4" × 10'	10210269	

Table PO 300–4: Plate Anchors

Size	SAP	Remark
17" × 17" Cross Plate	10067304	
23" × 23" Cross Plate	10210268	

Table PO 300–5: Concrete Anchor

Size	SAP	Remark
Concrete Anchor Plate	10067304	

3.0 Rock Anchor

Rock anchors should be used when anchoring to solid rock. See PO 340 for guidance on criteria and requirements for rock anchor and anchor extensions.

4.0 Anchor Extensions

Anchor rod extensions are designed to extend a properly installed existing 1-inch or 1-1/4"-inch diameter anchor rod, including rock anchors. These anchor extensions are ONLY allowed for use when the eye of a properly installed triple eye anchor is below grade to allow for the guy attachments to be made above ground. Anchor extensions shall NOT be used in place of anchor rods and must be installed in the eye of the anchor rod. No modifications of anchor rod extensions are allowed. The attachment bolt that comes with the anchor extension shall not be replaced with other hardware to fit double eye or thimble eye anchor rods. Only one anchor extension is permitted per anchor rod, do not daisy chain anchor rod extensions.

4.1 For existing installations, the following applies:

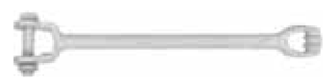
- The appropriate length anchor extension should be selected to allow guy attachments to be made as close to 4 inches minimum through 36 inches maximum above grade.
- Where the entire eye is above grade and no additional guy is to be installed, no action is needed.

- When the work requires additional guy or replacing an existing guy, anchor extension may be used provided existing anchor is properly installed.
- Where entire eye is below ground, anchor extension may be used provided existing anchor is properly installed.

4.2 For new installations, the following applies:

- The bottom of the eye shall be 4 inches minimum to 18 inches maximum above grade.

Table PO 300–6: Anchor Rod Extensions

Size	SAP	Remark
1-1/4" × 2'	10212770	
1-1/4" × 3'	10067266	
1-1/4" × 6'	10067298	
1" × 3-1/2' (for use with PISA rods only)	10067299	

5.0 Joint Anchors

Anchor and rod installations for joint use with other utilities shall be made as specified under “Anchors for Guys,” and as may be agreed upon under joint pole routine.

6.0 Anchors, Removal or Abandonment

When an anchor location is abandoned, the rod and plate shall be removed if in a hazardous or potentially dangerous location.

Otherwise, cut the rods off at least 12 inches below the ground line and abandon the remaining anchor. Screw anchor rods may be either unscrewed or cut off. Under no conditions should the rod be bent over or left exposed.

To avoid risk of liability, it is important that all personnel be instructed to follow these requirements.

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PO 310 Power-Installed Screw Anchors

Scope PO 310.1 Heavy-Duty Power-Installed Screw Anchors (PISA)

The standard for anchoring is “Heavy-Duty Power Installed Screw Anchors.” These anchors have 1-1/2-inch hubs compared to the old type screw anchor with 1-3/8-inch hubs. The 1-1/2-inch hub anchor will withstand considerably more installation torque and can, therefore, be used in more areas of the company (see Table PO 315–1). Plate anchors will continue to be used in extremely loose soil, inaccessible areas, or rock bed areas (see Table PO 315–1).

1.0 Tooling

A digger-derrick/line truck equipped with a heavy-duty PISA wrench (SAP 10148222 or SAP 10148223, and SAP 10148225), and a new drive end assembly (SAP 10148716) (used for 1-1/2-inch hub anchors). Torque indicator (SAP 10144863) shall be used for installing the new heavy-duty anchors for predicting the anchor performance (see Table PO 310–1).

2.0 Torque Indicator Operating Instructions

STEP 1. Install the torque indicator between the appropriate flanged kelly bar adapter and the locking dog assembly (see Figure PO 310–1).

STEP 2. Install indicator so that the plate with built-in nut assembly will be toward the kelly bar.

STEP 3. Check freedom of unit by rotating bottom plate with respect to top plate.

STEP 4. The edge of each plate has an indented mark accented with a painted line. Rotate plate to bring these index marks into alignment with each other. These marks must be aligned before each loading for proper operation (see Figure PO 310–1).

STEP 5. Determine the minimum torque value needed for anchor installation. See examples for calculating holding strength Scope PO 310.2.

STEP 6. Load the unit with 14 pins.

NOTE

DO NOT install more pins exceeding torque value of anchor or equipment driving anchor than is necessary. Fourteen pins maximum for 7,000 lb anchor (1-1/2-inch hub).

STEP 7. Install anchor(s) so that the rod is in alignment with the guys.

STEP 8. Drive anchor into the soil until Wrench Locking Dog Assembly is 14 inches above grade, measured along the rod.

STEP 9. Remove the appropriate number of pins that is equal 18,000 lb holding capacity based on the number and diameter of the helices (single or double helix) (see Table PO 310–1).

STEP 10. Drive anchor one more turn, if pins shear, proceed to Section 2.0, Step 17, if pins do not shear, proceed to Section 2.0, Step 11.

STEP 11. Remove the appropriate number of pins that equal 15,000 lb holding Capacity based on the number and diameter of the helices (single or double helix) (see Table PO 310–1).

STEP 12. Drive anchor one more turn, if pins shear, proceed to Section 2.0, Step 17, if pins do not shear, proceed to Section 2.0, Step 13.

STEP 13. Remove the appropriate number of pins that equal 10,000 lb holding capacity based on the number and diameter of the helices (single or double helix) (see Table PO 310–1).

STEP 14. Drive anchor one more turn, if pins shear, proceed to Section 2.0, Step 17, if pins do not shear, proceed to Section 2.0, Step 15.

STEP 15. Remove the appropriate number of pins that equal 5,000 lb holding capacity based on the number and diameter of the helices (single or double helix) (see Table PO 310–1).

STEP 16. Drive anchor one more turn, if pins shear, proceed to Section 2.0, Step 17, if pins do not shear, proper torque was not achieved. Install an additional anchor, that is, screw or cross plate. See Table PO 310–1 Note 4 for anchor spacing.

STEP 17. Bottom of the eye of the rod shall be 4 inches minimum and 18 inches maximum above finished grade measured along rod.

STEP 18. Withdraw Kelly bar adapter, Torque indicator and Drive end assembly.

STEP 19. Break off a tab of PISA ID Tag so that the appropriate anchor holding strength determined in Section 2.0, Step 11, Step 13, Step 15, and Step 17 will be visible when ID Tag is placed on threaded end of exposed rod. Screw anchor triple eye onto exposed rod.

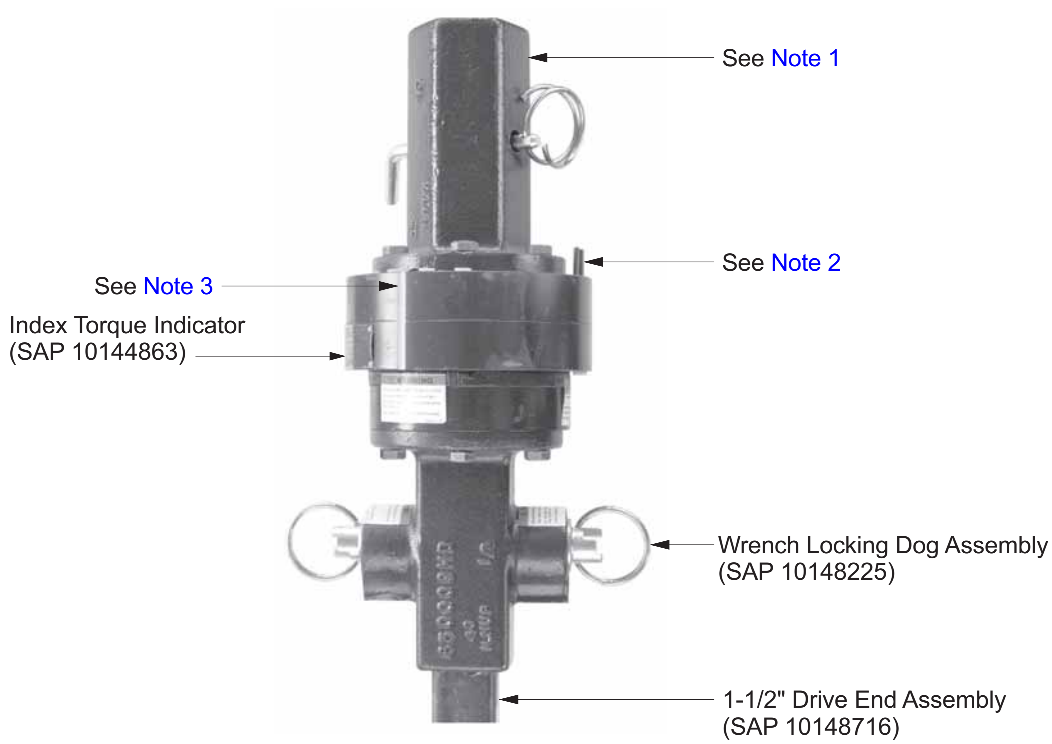
Note(s):

1. Kelly bar adapter 2" hex shaft (SAP 10148222) 2-5/8" hex shaft (SAP 10148223) (see Section 2.0, Step 1.)
2. Loading pins (SAP 10148739) (see Section 2.0, Step 6.)
3. Index marks on torque indicator (see Section 2.0, Step 4.)

3.0 Loading Pins

Each individual pin has a shearing value of 500 foot-pounds. As the chart below indicates, a predetermined amount of pins sheared will predict the holding strength of the anchor. Pins may be ordered by boxes of 1,800 (SAP 10148739).

Figure PO 310–1: Power Installed Screw Anchors



What's Changed? Step 17: clarified bottom of the eye of the rod shall be 4 inches minimum above finished grade.

Table PO 310–1: Installing Torque Versus Holding Strengths

Type of Anchors	Torque (in Minimum Pins Sheared)			Rod and Eye		Anchor Assembly Load Rating (lb)		Guideline for Guys[a]
Power Installed Screw Anchors (PISA)	8-Inch Single	8-Inch Double	10-Inch Double	Size	SAP	At Failure	Allowabl New (S.F. = 2)	
1-3/8" or 1-1/2" Anchor Hub	3	2	2	1" × 7" Triple Eye	10185605	10,000	5,000	1-9/32"
	7	5	4			20,000	10,000	2-9/32", or 1-3/8", or 1-7/16"
1-1/2" Anchor Hub Only	9	8	7			30,000	15,000	3-9/32", or 1-9/32" & 1-3/8", or 1-9/32" & 1-7/16"
	12	10	9			36,000	18,000	2-3/8", or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32"
4" Granite Anchors	—	4-Inch Single	4-Inch Double					
	—	9	—	1" × 7" Triple Eye	10185605	20,000	10,000	2-9/32", or 1-3/8", or 1-7/16"
	—	10	—			30,000	15,000	3-9/32", or 1-9/32" & 1-3/8", or 1-9/32" & 1-7/16"
	—	12	12			36,000	18,000	2-3/8", or 1-3/8" & & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32"
Cross-Plate Anchors	Anchor Rod and Plate			Rod SAP	Anchor SAP			
	Key 10			—	17" Cross Plate[b] 10067304	16,000	8,000	1-3/8"
	3/4" × 8' Double Eye			10185600		23,000	11,500	2-9/32" or 1-3/8" or 1-7/16"
	1" × 10' Triple Eye			10185604		36,000	18,000	2-3/8", or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32"
	1-1/4" × 10' Triple Eye			10210269	23" Cross Plate 10210268	58,000	29,000	2-7/16" or 3-3/8" or 2-3/8" and 1-9/32"
Expanding Rock	3/4" × 15" Triple Eye			—	Expanding Rock Anchor 10200271	23,000	11,500	2-9/32' or 1-3/8" or 1-7/16"

a/ Where a backhoe is used to dig holes for plate anchor, each anchor shall be limited to a working load of 11,500 lb.

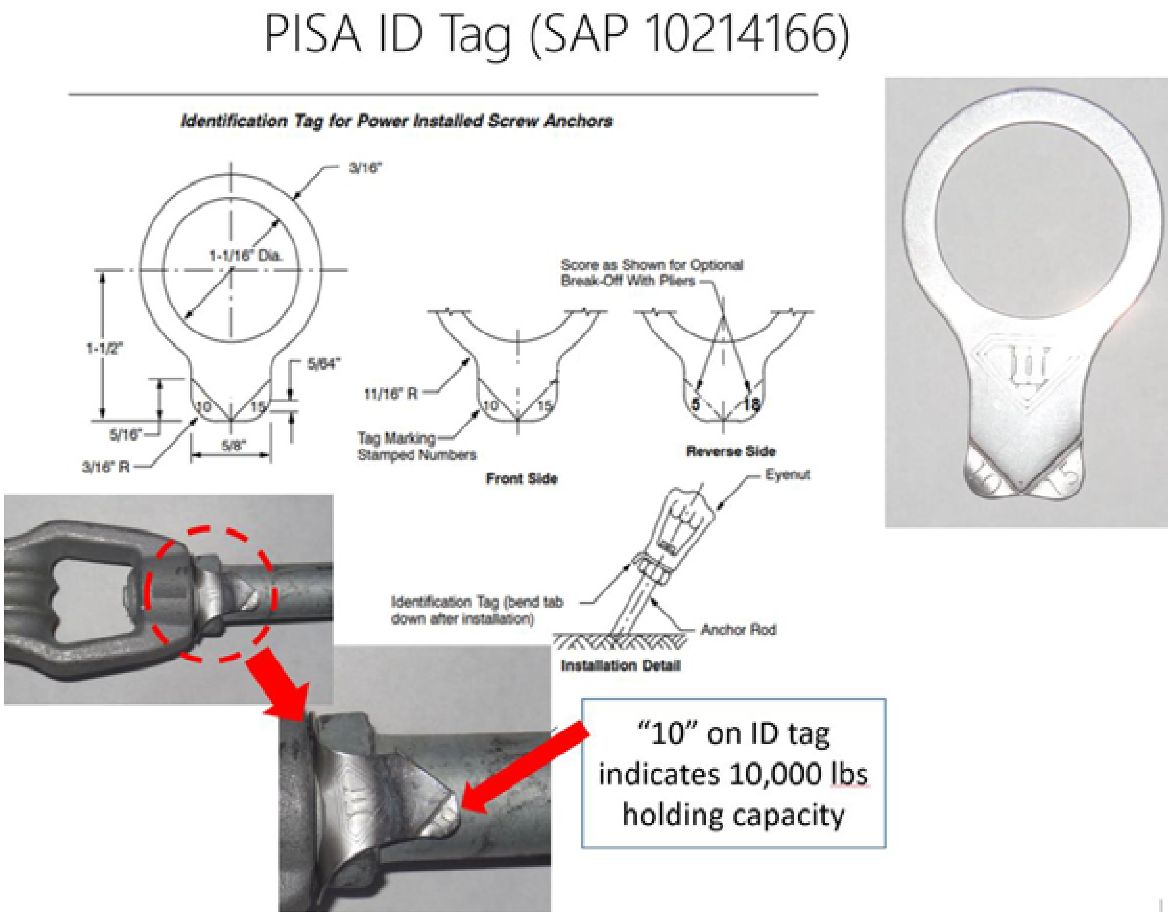
b/ In corrosion areas use: 1-inch copper-clad anchor rod — SAP 10067254, 3/4-inch copper-anchor rod — SAP 10067255, Concrete anchor plate — SAP 10067305

Note(s):

1. The torque indicator enables anchors to be installed to a predetermined torque value which gives a positive indication of the holding strength of the anchor in any type of soil. The torque indicator will prevent excessive torque on the anchor during installation, thus preventing fracture and loss of the anchor.
2. Anchors shall have the same safety factor requirements as the guys they support (2.0 for new).
3. PISA anchors shall be installed with a minimum spacing of 4 times the largest helix. For example, two-8 inch anchors, the minimum spacing between the two shall be 32 inches.
4. It is recommended that there be a minimum of 6 feet of spacing between the plate anchors. If the recommended spacing cannot be obtained, then the following criteria shall be used:
   — 4 feet for installations up to 10,000 lb new
   — 5 feet for installations up to 15,000 lb new
   — 6 feet for installations greater than 15,000 lb new
5. See Table PO 320–8 for placement of anchor plate relative to anchor eye rod.
6. For multiple backhoe installations, trenches should be perpendicular to guy wire.
7. Guy recommendations are guidelines to insure that the anchor can support the full strength capability of the guys. Where limitations exist for anchor placement, the anchor may be loaded to its maximum table capability based on the evaluated maximum guy loads from the pole loading report.
8. Minimum size guy strand for anchor guys is 9/32".
9. 5/16" and 7/16" high-strength guy strand may be substituted for 9/32" and 3/8" EHS guy strand, respectively.
10. An anchor shall have allowable working strength equal to or greater than the working strength of a guy or guys attached to it. See PO 320 for the working tensions for guys, as shown for overhead guys in a level tension.

4.0 Installation of Holding Strength Identification Tag

Figure PO 310–2: PISA ID Tag



Scope PO 310.2 Holding Strength Calculations for PISA Anchors

The necessary holding strength shall be determined by the number and size of down guys to be attached to the anchor.

Example:

1. One 3/8-inch and one 9/32-inch E.H.S. guys are to be attached to an anchor. What holding strength should the anchor have?

   Ans. See PO 320 — The total conductor pull at a level angle is the rated guy strength with a safety factor of 2 (working tension), so that 1-3/8-inch E.H.S. guy has a working tension of 7,700 lb, and 1-9/32-inch guy has a working tension of 4,475 lb. The total holding strength for the anchor should be the sum of the rated working tensions of both guys, or 7,000 lb + 4,475 lb = 12,175 lb. A screw anchor installed with a holding strength above 12,175 lb should be used (see Table PO 310–1).

2. One 3/8-inch and two 9/32-inch E.H.S. guys are to be installed on an anchor. (The maximum amount allowed on a triple eye rod per PO 320.) What holding strength should the anchor have?

   Ans. Per PO 320, the full rated working tension for guys with a safety factor of two is found under level angle. 1-3/8-inch E.H.S. = 7,700 lb and two 9/32-inch E.H.S. — 4,475 lb × 2 = 8,950 lb. The total pull will be 7,700 lb + 8,950 lb = 16,650 lb.

In accordance with Table PO 310–1, an anchor with a holding strength above 16,650 lb should be used. Therefore, a single 8-inch PISA should shear 12 loading pins, a double 8-inch PISA should shear 10 loading pins, or a double 10-inch PISA should shear 9 loading pins upon installation.

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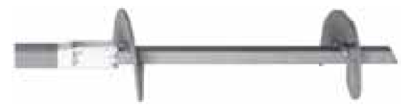
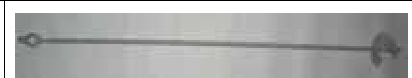
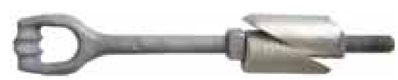
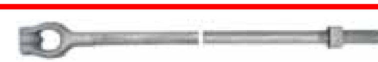
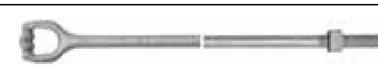
PO 315 Anchor and Guying Components

Scope PO 315.1 Anchor and Guying Components

Table PO 315–1: Anchors and Guying Components

SAP	Description	
10200593	Pisa Anchor, Single 8" Helix	
10067289	Pisa Anchor, Double 4" Helix	
10200272	Pisa Anchor, Double 8" Helix	
10200180	Pisa Anchor, Double 10" Helix	
10067293	Anchor Rod, Single 4" Helix, Hand Installed, 5'6" × 3/4", Thimble Eye, Galvanized Steel*. * For temporary/emergency application ONLY, max. of 12 months. Maximum 2,000 lb working load limit.	
10200271	Expanding Rock Anchor, 15" × 3/4" dia. Triple Eye, 1-3/4" to 2-3/8" Expanded, Galvanized Steel Expanded, Galvanized Steel	
10200179	Expanding Pole Key Anchor, 7" to 27-1/4" Expanded, Steel	
10067304	Cross Plate, Anchor, 20", Steel, is used with 5/8", 3/4", or 1" Rod	
10210268	Cross Plate, Anchor, 24", Steel, is used with 1-1/4" Rod	
10067305	Concrete Anchor Plate, 20" round, is used with Stainless Steel Anchor Rod SAP 10067254	
10067296	Rod, Anchor, 6' × 5/8", Thimble Eye, Galvanized Steel	
10185600	Rod, Anchor, Twin Eye, 8' × 3/4", Twin Eye, Galvanized Steel	
10185605	Rod, Anchor, 7' × 1", Triple Eye, Galvanized Steel, for use with PISA anchor	
10185604	Rod, Anchor, 10' × 1" Triple Eye Rod, Galvanized Steel	
10210269	Rod, Anchor, 10' × 1-1/4", Triple Eye, Galvanized Steel	
10067254	Rod, Anchor, 10' × 1", Triple Eye, Stainless Steel, is used with Concrete Anchor Plate (SAP 10067305)	
10212770	Anchor Extension, 1-1/4" × 2', 40,000 lb, is used when existing anchor is covered with soil due to grade change and does not meet the 4" to 36" distance in PO 310 and PO 350.	
10067266	Anchor Extension, 1-1/4" × 3'	
10067298	Anchor Extension, 1-1/4" × 6'	

What's Changed? Table PO 315-1: Added and updated Anchor Extension info. 6' × 5/8" Thimble Eye Anchor Rod changed to reference only. 7' × 1" Triple Eye Anchor Rod to be used with PISA anchor.

Table PO 315–1: Anchors and Guying Components *(Continued)*

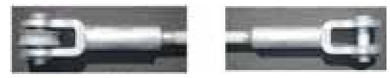
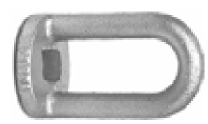
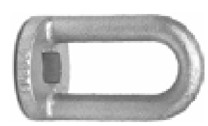
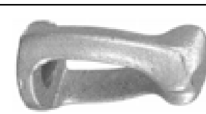
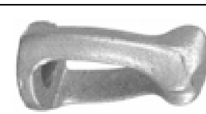
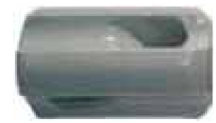
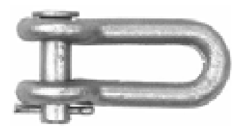
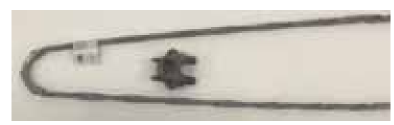
SAP	Description	
10067299	Pisa Anchor Extension, 1" × 3-1/2'	
10212605	Guy Strain Insulator, 30,000 lb, also known as a Fishstick, 12' fiberglass rod, silicone coated, clevis w/1roller, is used with guy wires.	
10212978	Roller Pin Cotter Key, to be used with Guy Strain Insulator (SAP 10212605)	
10068439	Shackle, 30,000 lb, w/bolt, nut, and cotter, is used on the structure end of insulator strings. All dead-ends on tubular steel poles will utilize this shackle.	
10068240	Guy Hook, 20,050 lb, also known as a Bear Claw, is used to attach a guy wire to a pole.	
10181650	Guying Attachment, 35,000 lb, also known as a Guying Tee, is used to make attachments at the pole. The stem mounting hole can be used to attach guy rod insulators and preformed type guy grips attach directly through the seat on the pole side of the guy attachment.	
10067854	Dead-End Eye, 12,400 lb, also known as a Hog eye, is used on a 5/8" bolt to provide an eye in which to place insulators or other items needing to be dead-ended.	
10067856	Dead-End Eye, 18,300 lb, also known as a Hog eye, is used on a 3/4" bolt to provide an eye in which to place insulators or other items needing to be dead-ended.	
10069678	Nut, eye type, oval, 5/8" diameter, galv stl material. Oval eye nut used for dead-ending with suspension or strain insulators.	
10068524	Thimble Eye, 12,400 lb, also known as a Span Guy eye, is installed on a 5/8" bolt to provide a thimble for dead-ending guys.	
10068525	Thimble Eye, 18,300 lb, also known as a Span Guy eye, is installed on a 3/4" bolt to provide a thimble for dead-ending guys.	

Table PO 315–1: Anchors and Guying Components *(Continued)*

SAP	Description	
10067656	Clevis Thimble, 18,300 lb, also known as a Heart, is used to dead-end conductors for which other dead-ending devices are not available. It is generally used in connection with a pre-formed dead-end.	
10116492	Guy Strain Insulator, 20,000 lb is used to break and insulate a guy wire from ground.	
10068452	Chain Shackle, 30,000 lb, w/pin and cotter, is used on the insulator end where dead-ended on a double-arm bracket.	
10067957	7/32" Preformed Dead-End Guy Grip (Green)	
10067958	9/32" Preformed Dead-End Guy Grip (Blue)	
10067961	7/16" Preformed Dead-End Guy Grip (Green)	
10067959	3/8" Preformed Dead-End Guy Grip (Orange)	
10067845	3/8" Preformed Dead-End Guy Grip (Orange)[a/]	
10212698	5/16" Preformed Dead-End Shunt Guy Grip (Green)	
10212697	9/32" Preformed Dead-End Shunt Guy Grip (Blue)	
10212658	7/16" Preformed Dead-End Shunt Guy Grip (Green)	
10212657	3/8" Preformed Dead-End Shunt Guy Grip (Orange)	
10110468	7/32" Guy Wire, E.H.S	
10110471	9/32" Guy Wire, E.H.S	
10110475	7/16" Guy Wire, E.H.S.	
10110473	3/8" Guy Wire, E.H.S.	

[a/] For High Corrosion Coastal Areas (within 1 mile of the ocean).

Table PO 315–2: Guying Components — Automatic Dead-Ends

Wire Size	Short Bail SAP	Long Bail SAP
5/16" or 9/32" E.H.S.	10067504	10211779
7/16" E.H.S.	10067507	10184970
3/8" E.H.S.	10067506	10067405

Table PO 315–3: Guying Components — Automatic Dead-Ends (Fits Over Guy Strain Insulator)

Wire Size	SAP
3/8" E.H.S.	10067689
7/16" E.H.S.	10204169

= For Reference Only

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PO 320 Determination of Anchor/Guy Size

Scope PO 320.1 Instructions for Use of Guy Requirement Tables

Example No. 1 — Minimum Anchor Guy Lead

Given three 653.9 kcmil ACSR conductors in light loading sagged at 2,847 lb in vertical configuration and supported by a 90 foot pole set 9 feet in the ground. Find the minimum lead (distance from pole to anchor) required when two 3/8-inch anchor guys are to support the line in Grade A Construction.

a. From Table PO 320–1 determine that each guy will support one half of the total conductor pull. Multiply 2,847 lb by three and divide by two. Answer: 4,270 lb.

b. Find in Table PO 320–6 under 3/8-inch guy, a conductor pull safe for one guy that exceeds 4,200 lb. Answer: 4,425 lb. Now read down and see 35 degree angle guy makes with pole.

c. Find in Table PO 320–3 the value under the height (guy to ground) of 80 feet. Read across that line to the 35 degree column (angle guy to pole) and see 56 feet.

d. This 56 feet is the minimum lead required for the top guy. If the lower guy is attached at 68 feet on the pole, find in Table PO 320–3 that the minimum lead required for a second anchor is 49 feet.

Example No. 2 — Anchor Guy

Given 4/0 aluminum triplex secondary at dead-end, to be anchor guyed with the guy attached to the pole 30 feet above the ground (height), and anchor rod where it enters the ground placed 30 feet from the back of the pole (lead). Find the size of guy required. Spans are 150 feet in Urban Area.

a. Find in Table PO 320–2 the tension for 4/0 aluminum triplex conductor light loading. Answer: 2,470 lb.

b. Next find in Table PO 320–3 the guy angle most nearly corresponding to a height of 30 feet and a lead of 30 feet. Answer: 45 degrees.

c. Then find in Table PO 320–6 the required size for guy to hold conductor tension of (a), 2,470 lb at a guy angle of (b), 45 degrees using the next larger figure above 2,470 lb. In this case the next larger figure in the column for a 45 degree angle is 2,830. Result: Use one 5/16- or 9/32-inch guy.

Example No. 3 — Side Anchor Guy

Given three 336.4 kcmil ACSR distribution conductors in light loading with a deviation angle of 30 degrees in the line. Find the size of guy to hold the angle pole with a height of 45 feet and a lead of 21 feet.

a. Find in Table PO 320–4 the resultant side pull for three 336.4 kcmil ACSR conductors at a deviation angle of 30 degrees. Answer: 3 × 1,182 = 3,546 lb.

b. Next, find in Table PO 320–3 the guy angle most nearly corresponding to a height of 45 feet and a lead of 21 feet. Answer: 25 degrees.

c. For a Grade A Construction, find in Table PO 320–6 the required size of guy for resultant pull of (a), 3,546 lb and a guy angle of (b); 25 degrees, using the next larger figure above 3,546 lb. In this case the next larger figure in the 25 degree column is 1,895 + 3,260 lb. Result: Use on 9/32-inch guy and one 3/8-inch guy.

Example No. 4 — Anchor Guy

Given three 2/0 bare copper distribution conductors at dead-end in light loading area, to be anchor guyed with the guy attached to the pole 45 feet above the ground (height), and anchor rod eye placed 50 feet from the back of the pole (lead). Find the size of guy required.

a. Find in Table PO 320–1 the tension for one 2/0 bare copper conductor (1,482 lb). Multiply this tension by 3. Answer: 4,446 lb.

b. Next find in Table PO 320–3 the guy angle most nearly corresponding to a height of 45 feet and a lead of 50 feet. Answer: 50 degrees.

c. Then find in Table PO 320–7 the required size of guy for conductor tension of (a) 4,446 lb at a guy angle of (b), 50 degrees, using the next larger figure above 5,900 lb. In this case the next larger figure in the column for a 50 degree angle is 4,570. Result: Use one 3/8-inch guy.

Example No. 5 — Overhead Guy

Given three No. 2 bare copper conductors at dead-end on one end of a crossarm. Find the size of arm guy to hold the total load.

a. Find in Table PO 320–1 the tension for one No. 2 bare copper conductor. Multiply this tension by three. Answer: 2,283 lb.

b. Next find in Table PO 320–6, under the column headed "Overhead Guys", the required size of guy for a conductor tension of (a) 2,283 lb, using the next larger figure above 2,283 lb. In this case the next larger figure in the column for level guys is 2,400 lb. Result: Use one 7/32-inch guy.

Scope PO 320.2 Conductor Dead-End Tensions for the Determination of Anchor/Guy Size

Tension Table for bare ACSR, copper triplex, aluminum multiplex, bare and weather resistant copper conductors at California Light and Heavy Loading conditions.

Multiply tensions in column (3) by number of conductors dead-ended.

Table PO 320–1: Conductor Dead-End Tensions for the Determination of Anchor/Guy Size

Type of Conductor	Wire Size AWG		Wire Tension at Dead-End (lb)	
	Size	Strands	Light	Heavy
ACSR	#4[a/]	6/1	520	604
	#2	6/1	675	761
	1/0	6/1	1,242	1,415
	2/0	6/1	1,543	1,768
	3/0	6/1	1,914	2,204
	4/0	6/1	2,402	2,780
	336.4	18/1	2,284	2,768
	336.4	30/7	3,260	3,260
	653.9	18/3	2,847	3,200
Aluminum Duplex	#4	6/1	592	604
	#6	6/1	385	386
Aluminum Triplex	#6	6/1	386	382
	#4	6/1	576	604
	#2	6/1	580	761
	1/0	6/1	1,309	1,415
	4/0	6/1	2,469	2,781
Aluminum Quadruplex	#4	6/1	575	604
	1/0	6/1	1,313	1,415
	4/0	6/1	2,474	2,771
AAC	1/0	7	567	662
	4/0	7	1,075	1,312
	336.4	19	1,533	1,994
	477	19	1,939	2,498
	636	37	2,591	3,130
	1033.5	37	4,545	5,477
Copper	#6	1	320	
	#4	1	484	
	#4	7	484	
	#2	7	761	
	1/0	19	1,415	
	2/0	7	1,482	
	3/0	1	1,680	
	4/0	19	2,288	
Weather Resistant Copper	#6	7	375	
	#4	1	484	
	#2	7	830	
	2/0	7	1,590	
	4/0	7	2,455	
Copper Triplex	#6	7	320	640
	#4	7	484	970
	#2	7	761	1,015

[a/] Not approved for use on new construction.

All dead-end tensions on tubular steel poles will be calculated separately by the Transmission Engineering office or Division Engineering office, whichever applies.

These are guying tensions only. For conductor sags, see CO Section.

Note(s):

1. Values based on 200' final span wire.
2. The Table lists the dead-end tension of conductors for California light and heavy-loading conditions. The dead-end tension must be multiplied by the number of conductors to determine the total dead-end tension for guying. Conduction tension may vary depending on span length and wind-loading conditions. The tensions presented were determined with the use of G.O. 95 requirements for light and heavy loading.

Table PO 320–2: Conductor Dead-End Tensions for the Determination of Anchor/Guy Size

Type of Conductor Solid or Stranded	Wire Size AWG	Wire Tension at Dead End (lb)
ACSR	#4[a/] 1/0 336.4 kcmil 653.9 kcmil	604 1,415 2,846 3,267
Copper Triplex	#4 #2	484 761
Aluminum Triplex or Quadruplex	1/0 4/0	1,415 2,780
Weather Resistant Copper	#6 #4 #2 2/0 4/0	375 540 830 1,590 2,455
Bare Copper	#6 #4 #2 2/0 4/0	320 484 761 1,482 2,288

[a/] Not approved for use on new construction.

Table PO 320–3: Determination of Deviation Angles and the Angle Between Guy and Pole

Height to Ground (ft)	Lead (Pole to Anchor) (ft)															
90	5	8	11	14	17	21	24	33	42	52	63	76	90	107	129	156
85	4	7	10	13	17	20	23	31	40	49	60	71	85	101	121	147
80	4	7	10	13	16	18	21	29	37	46	56	67	80	95	114	139
75	4	7	9	12	15	17	20	27	35	43	53	63	75	89	107	130
70	4	6	9	11	14	16	19	25	33	40	49	59	70	83	100	121
65	3	6	8	10	13	15	17	24	30	38	46	55	65	77	93	113
60	3	5	7	10	12	14	16	22	28	35	42	50	60	72	86	104
55	3	5	7	9	11	13	15	20	26	32	39	46	55	66	79	95
50	3	4	6	8	10	12	13	18	23	29	35	42	50	60	71	87
45	2	4	6	7	9	10	12	16	21	26	32	38	45	54	64	78
40	2	3	5	6	8	9	11	15	19	23	28	34	40	48	57	69
35	2	3	4	6	7	8	9	13	16	20	25	29	35	42	50	61
30	2	3	4	5	6	7	8	11	14	17	21	25	30	36	43	52
25	1	2	3	4	5	6	7	9	12	14	18	21	25	30	36	43
20	1	2	2	3	4	5	5	7	9	12	14	17	20	24	29	35
Angle (Guy-to Pole)	3	5	7	9	11	13	15	20	25	30	35	40	45	50	55	60

Note(s):

1. To determine the deviation angle see explanatory drawing of guy tables PO 320.2.

Table PO 320–4: Light Loading Conductor Tension Side Guys[a/]

Conductor Type		Strands	5	10	15	20	25	30	35	40	45	50	55	60
			Deviation Angles (Degrees)											
			Tension (lb)											
ACSR	# 4[b/]	6/1	45	91	136	181	225	269	313	356	398	440	480	520
	#2	6/1	59	118	176	234	292	349	406	462	517	571	623	675
	1/0	6/1	108	216	324	431	538	643	747	850	951	1050	1147	1242
	2/0	6/1	135	269	403	536	668	799	928	1055	1181	1304	1425	1543
	3/0	6/1	167	334	500	665	829	991	1151	1309	1465	1618	1768	1914
	4/0	6/1	210	419	627	834	1040	1243	1445	1643	1838	2030	2218	2402
	336.4	18/1	199	398	596	793	989	1182	1374	1562	1748	1931	2109	2284
	336.4	30/7	284	568	851	1132	1411	1688	1961	2230	2495	2755	3011	3260
	653.9	18/3	248	496	743	989	1232	1474	1712	1947	2179	2406	2629	2847
Aluminum Duplex	#4	6/1	51	101	152	202	252	301	349	397	445	491	537	581
	#6	6/1	34	67	101	134	167	199	232	263	295	325	356	385
Aluminum Triplex[c/]	#6	6/1	34	67	101	134	167	200	232	264	295	326	356	386
	#4	6/1	50	100	150	200	249	298	346	394	441	487	532	576
	#2	6/1	63	126	188	250	312	373	434	493	552	609	666	721
	1/0	6/1	114	228	342	455	567	678	787	895	1002	1106	1209	1309
	4/0	6/1	215	431	645	858	1069	1279	1485	1690	1890	2088	2281	2470
Aluminum Quadruplex[c/]	#4	6/1	50	100	150	200	249	298	346	393	440	486	531	575
	1/0	6/1	115	229	343	456	568	680	790	898	1005	1110	1213	1313
	4/0	6/1	216	431	646	860	1071	1281	1488	1693	1894	2092	2286	2475
AAC	1/0	7	49	99	148	197	245	294	341	388	434	479	524	567
	4/0	7	94	187	281	373	465	556	647	735	823	909	993	1075
	336.4	19	134	267	400	532	664	794	922	1049	1173	1296	1416	1533
	477	19	169	338	506	673	839	1004	1166	1326	1484	1639	1791	1939
	636	37	226	452	676	900	1122	1341	1558	1772	1983	2190	2393	2591
	1033.5	37	397	792	1186	1578	1967	2353	2733	3109	3479	3842	4197	4545
Copper	#6	1	28	56	84	111	139	166	192	219	245	270	296	320
	#4	1	42	84	126	168	210	251	291	331	370	409	447	484
	#4	7	42	84	126	168	210	251	291	331	370	409	447	484
	#2	7	66	133	199	264	329	394	458	521	582	643	703	761
	1/0	19	123	247	369	491	613	732	851	968	1083	1196	1307	1415
	2/0	7	129	258	387	515	642	767	891	1014	1134	1253	1369	1482
	3/0	1	147	293	439	583	727	870	1010	1149	1286	1420	1551	1680
	4/0	19	199	397	595	792	987	1180	1371	1560	1745	1927	2106	2280
Weather Resistant Copper	#6	7	33	65	98	130	162	194	226	257	287	317	346	375
	#4	1	42	84	126	168	210	251	291	331	370	409	447	484
	#2	7	72	145	217	288	359	430	499	568	635	702	767	830
	2/0	7	139	277	415	552	688	823	956	1088	1217	1344	1468	1590
	4/0	7	214	428	641	853	1063	1271	1476	1679	1879	2075	2267	2455
Copper Triplex	#6	7	28	56	84	111	139	166	192	219	245	270	296	320
	#4	7	42	84	126	168	210	251	291	331	370	409	447	484
	#2	7	66	133	199	264	329	394	458	521	582	643	703	761
Aerial Bundled Cable	350	3/C	436	872	1305	1736	2164	2588	3007	3420	3827	4226	4617	5000
	1/0	3/C	364	726	1088	1447	1804	2157	2506	2850	3189	3522	3848	4167
	1/0	2/C	267	533	798	1062	1324	1583	1839	2092	2340	2585	2824	3058
	1/0	1/C	166	332	497	661	823	985	1144	1301	1456	1608	1756	1902

[a/] The deviation angle of the line is the angle formed by the continuation of the line in one direction and the line running in the new direction (refer to G.O. 95).
[b/] Not approved for new construction.
[c/] Tensions for triplex and quadruplex are the total for the neutral plus the covered aluminum conductors.

Note(s):

1. Resultant pull of one conductor at various angles[b/] for bare ACSR aluminum triplex and quadruplex, and bare triplex and weather-resistant copper conductors strung in light or heavy loading areas. Multiply values in table by number of conductors to get resultant pull.
2. The above values are obtained by multiplying the dead-end tension for one conductor by two times the sine of one-half of the deviation angle of the line.

Table PO 320–5: Heavy Loading Conductor Tension for Side Guys[a/]

Conductor Type		Strands	Deviation Angles (Degrees)											
			5	10	15	20	25	30	35	40	45	50	55	60
			Tension (lb)											
ACSR	# 4[b/]	6/1	53	105	158	210	261	313	363	413	462	511	558	604
	#2	6/1	66	133	199	264	329	394	458	521	582	643	703	761
	1/0	6/1	123	247	369	491	613	732	851	968	1083	1196	1307	1415
	2/0	6/1	154	308	462	614	765	915	1063	1209	1353	1494	1633	1768
	3/0	6/1	192	384	575	765	954	1141	1326	1508	1687	1863	2035	2204
	4/0	6/1	243	485	726	965	1203	1439	1672	1902	2128	2350	2567	2780
	336.4	18/1	241	482	723	961	1198	1433	1665	1893	2119	2340	2556	2768
	336.4	30/7	284	568	851	1132	1411	1688	1961	2230	2495	2755	3011	3260
	653.9	18/3	279	558	835	1111	1385	1656	1925	2189	2449	2705	2955	3200
Aluminum Duplex	#4	6/1	53	105	158	210	261	313	363	413	462	511	558	604
	#6	6/1	34	67	101	134	167	200	232	264	295	326	356	386
Aluminum Triplex[c/]	#6	6/1	33	67	100	133	165	198	230	261	292	323	353	382
	#4	6/1	53	105	158	210	261	313	363	413	462	511	558	604
	#2	6/1	66	133	199	264	329	394	458	521	582	643	703	761
	1/0	6/1	123	247	369	491	613	732	851	968	1083	1196	1307	1415
	4/0	6/1	243	485	726	965	1203	1439	1672	1902	2128	2350	2567	2780
Aluminum Quadruplex[c/]	#4	6/1	53	105	158	210	261	313	363	413	462	511	558	604
	1/0	6/1	123	247	369	491	613	732	851	968	1083	1196	1307	1415
	4/0	6/1	243	485	726	965	1203	1439	1672	1902	2128	2350	2567	2780
AAC	1/0	7	58	115	173	230	287	343	398	453	507	560	611	662
	4/0	7	114	229	343	456	568	679	789	897	1004	1109	1212	1312
	336.4	19	174	348	521	693	863	1032	1199	1364	1526	1685	1841	1994
	477	19	218	435	652	868	1081	1293	1502	1709	1912	2111	2307	2498
	636	37	273	546	817	1087	1355	1620	1882	2141	2396	2646	2891	3130
	1033.5	37	478	955	1430	1902	2371	2835	3294	3746	4192	4629	5058	5477
Copper	#6	1	28	56	84	111	139	166	192	219	245	270	296	320
	#4	1	42	84	126	168	210	251	291	331	370	409	447	484
	#4	7	42	84	126	168	210	251	291	331	370	409	447	484
	#2	7	66	133	199	264	329	394	458	521	582	643	703	761
	1/0	19	123	247	369	491	613	732	851	968	1083	1196	1307	1415
	2/0	7	129	258	387	515	642	767	891	1014	1134	1253	1369	1482
	3/0	1	147	293	439	583	727	870	1010	1149	1286	1420	1551	1680
	4/0	19	199	397	595	792	987	1180	1371	1560	1745	1927	2106	2280
Weather Resistant Copper	#6	7	33	65	98	130	162	194	226	257	287	317	346	375
	#4	1	42	84	126	168	210	251	291	331	370	409	447	484
	#2	7	72	145	217	288	359	430	499	568	635	702	767	830
	2/0	7	139	277	415	552	688	823	956	1088	1217	1344	1468	1590
	4/0	7	214	428	641	853	1063	1271	1476	1679	1879	2075	2267	2455
Copper Triplex	#6	7	56	112	167	222	277	331	385	438	490	541	591	640
	#4	7	85	169	253	337	420	502	583	664	742	820	896	970
	#2	7	89	177	265	353	439	525	610	694	777	858	937	1015
Aerial Bundled Cable	350	3/C	436	872	1305	1736	2164	2588	3007	3420	3827	4226	4617	5000
	1/0	3/C	364	726	1088	1447	1804	2157	2506	2850	3189	3522	3848	4167
	1/0	2/C	267	533	798	1062	1324	1583	1839	2092	2340	2585	2824	3058
	1/0	1/C	166	332	497	661	823	985	1144	1301	1456	1608	1756	1902

[a/] The deviation angle of the line is the angle formed by the continuation of the line in one direction and the line running in the new direction (refer to G.O. 95).
[b/] Not approved for new construction.
[c/] Tensions for triplex and quadruplex are the total for the neutral plus the covered aluminum conductors.

Table PO 320–6: Total Conductor Pulls Safe for One Guy at Various Guy Angles[a/]

For steel anchor guys and overhead guys in all urban areas and in rural areas where Grade "A" construction is required by G.O. 95, Rule No. 42, Safety Factor = 2.

Size of Guy	Anchor Guys										Overhead Guys
1/4	—	—	—	—	—	—	—	—	—	—	2,375
7/32[b/]	—	—	—	—	—	—	—	—	—	—	2,400
5/16	1,035	1,370	1,690	2,000	2,295	2,570	2,830	3,065	3,275	3,465	4,000
9/32[b/]	1,160	1,530	1,895	2,235	2,570	2,880	3,170	3,430	3,670	3,885	4,475
3/8[b/]	1,995	2,630	3,260	3,850	4,425	4,950	5,450	5,900	6,310	6,675	7,700
7/16	1,895	2,480	3,065	3,625	4,160	4,660	5,125	5,555	5,940	6,280	7,250
7/16[b/]	2,590	3,420	4,230	5,000	5,735	6,430	7,070	7,660	8,190	8,660	10,000
Angle (Guy to Pole)	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	Level[c/]

Table PO 320–7: Total Conductor Pulls Safe for One Guy at Various Guy Angles[a/]

For alumoweld guys in all "A" and "B" copper corrosion (beach) areas where Grade "A" construction is required by G.O. 95, Rule No. 42, Safety Factor = 2.

Size of Guy	Anchor Guys										Overhead Guys
6M	776	1,026	1,268	1,500	1,721	1,928	2,121	2,298	2,457	1,498	8,000
10M	1,294	1,710	2,113	2,500	2,868	3,213	3,535	3,830	4,095	4,330	5,000
16M	2,070	2,736	3,380	4,000	4,588	5,142	5,656	6,128	6,553	6,928	8,000
Angle (Guy to Pole)	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	Level[c/]

[a/] Ultimate conductor tension divided by safety factor (from Table 24, G.O. 95).
[b/] Standard extra high strength steel guy strand sizes.
[c/] Rated guy strength with G.O. 95 safety factor for anchor holding strength information. Safe pulls for 1/4, 5/16, and 7/16 high strength steel guy strand are listed as a reference for existing and reusable guys. 3/4-inch hardware shall be used with 3/8 inch guy strand and larger.

Note(s):

1. 7/16 down guys shall be attached with pole guying tee (SAP 10181650)

Figure PO 320–1: Length of Guy Wire

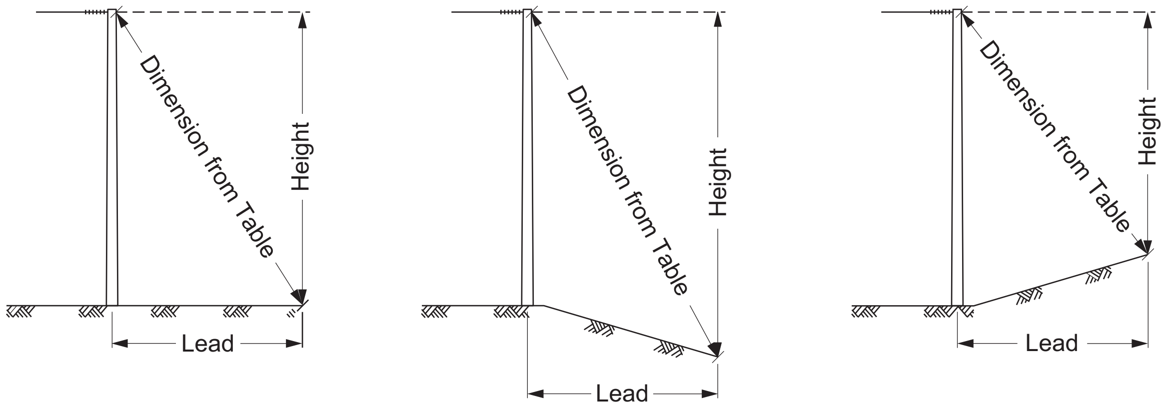
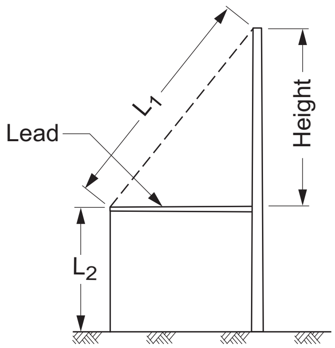


Table PO 320–8: Length of Guy Wire

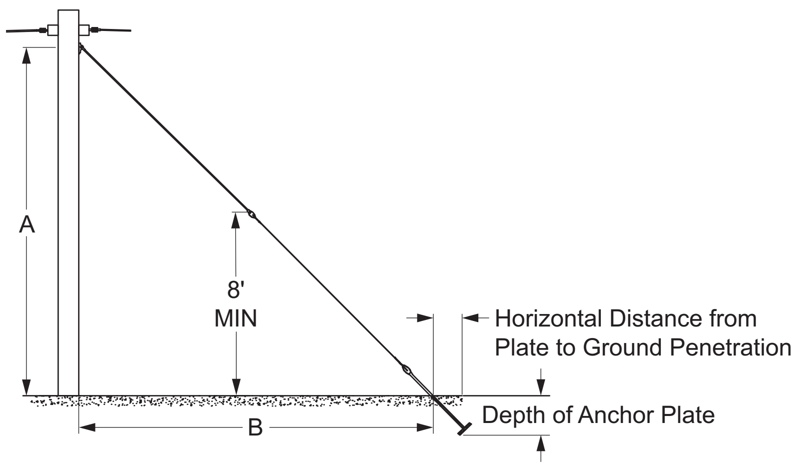
Height (ft)	Lead (ft)																
	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
10	14	18	23	27	32	37	42	46	51	56	61	66	71	76	81	86	92
15	18	21	25	30	34	39	42	48	53	58	62	67	72	77	82	87	92
20	23	25	28	33	36	41	45	50	54	59	64	68	73	78	83	88	93
25	27	30	33	36	40	43	48	52	57	60	66	71	75	79	84	89	94
30	32	34	36	40	43	47	50	55	59	63	68	72	77	81	86	90	96
35	37	39	41	44	47	50	55	58	62	66	71	75	79	83	88	92	98
40	42	43	45	48	50	54	57	61	65	69	73	77	81	85	90	94	100
45	46	48	51	53	55	58	62	64	69	72	76	80	84	88	92	96	102
50	51	53	54	56	59	61	65	68	71	75	79	82	87	90	95	98	104
55	56	58	59	61	64	66	70	72	76	78	83	86	90	93	97	102	106
60	61	62	64	65	68	70	73	75	79	81	85	89	93	96	100	105	109
65	66	67	68	71	73	75	78	80	83	86	90	93	97	98	103	107	112
70	71	72	73	74	77	78	81	83	87	89	93	97	99	103	107	110	115
75	76	77	78	79	81	83	85	88	90	93	96	98	103	106	110	114	118
80	81	82	83	84	86	88	90	92	95	97	100	103	107	110	114	117	121
85	86	87	88	89	90	92	94	96	98	102	105	107	110	114	117	120	124
90	92	92	93	94	96	98	100	102	104	106	109	112	115	118	121	124	128

Figure PO 320–2: Sidewalk Anchor



To calculate sidewalk anchor lengths, use L2 (height of sidewalk horizontal brace) plus L1 (length of guy based on ten foot lead column).

Figure PO 320–3: Placement of Anchor Plate Relative to Anchor Eye Rod Detail



Note(s):

1. Assumes 12 inches from ground level along rod to rod eye.
2. See Table PO 320–3 to determine guy to pole angle.

Table PO 320–9: Placement of Anchor Plate Relative to Anchor Rod Eye

	Horizontal Distance from Plate to Ground Penetration (ft)	Depth of Anchor Plate (ft)	Horizontal Distance from Plate to Ground Penetration (ft)	Depth of Anchor Plate (ft)
Angle guy to pole (degrees)	**8' Rod**		**10' Rod**	
15	2	7	2.5	9
20	2.5	7	3	9
25	3	7	4	9
30	3.5	7	4.5	8
35	4	6.5	5	8
40	4.5	6	5.5	7.5
45	5	5.5	6.5	7
50	5.5	5.5	7	6.5
55	6	5	7.5	6
60	6	4.5	8	5.5

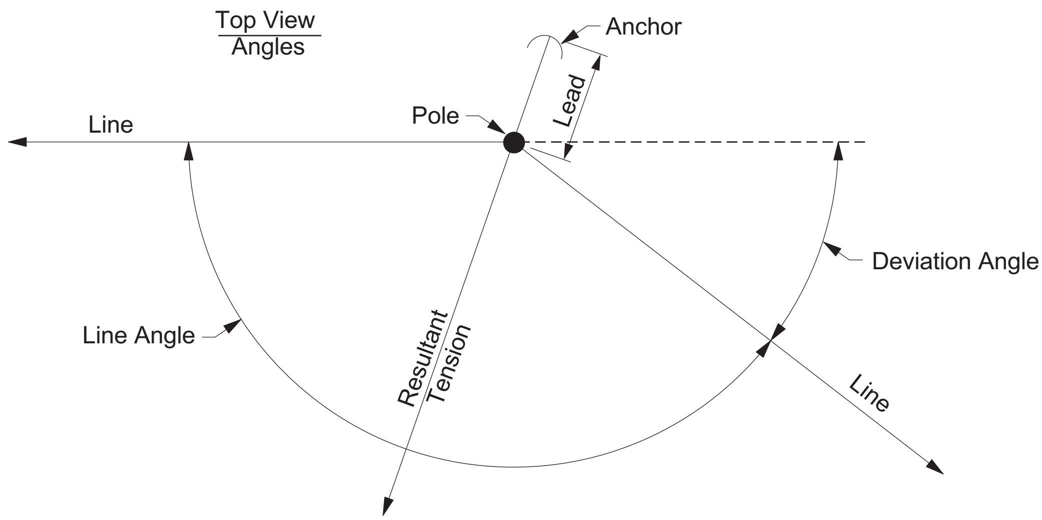
PO 330 Determination of Anchor Deviation Angle

Scope PO 330.1 Determination of Anchor Deviation Angle

1.0 Determination of Deviation Angle

To determine the deviation angle, use Table II as follows: Measure any convenient distance from 20 to 60 feet as a continuation of the line in one direction. This distance will correspond to “Height” in Table PO 320–3 (Sheet 5). Next measure the distance at right angles to this extension until the line in the new direction is encountered. This will correspond to “Lead” in Table PO 320–3 (Sheet 5).

Figure PO 330–1: Determination of Deviation Angle



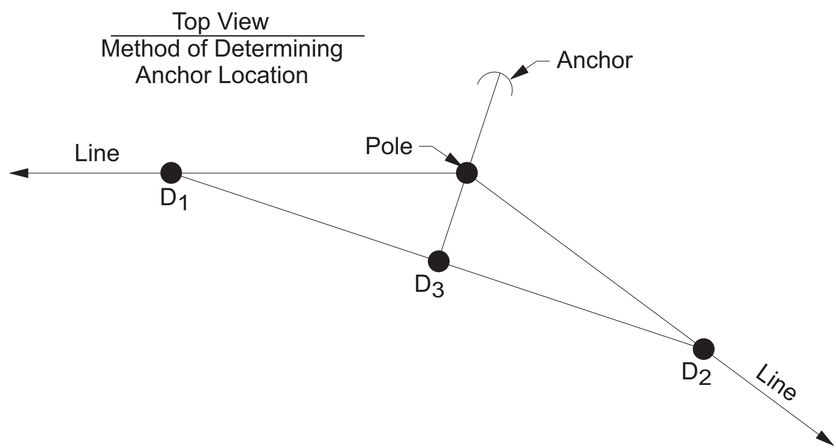
2.0 Determination of Side Anchor Location

2.1 Measure an equal distance of 20 to 60 feet from angle pole towards the two adjacent poles to D_1 and D_2. ($D_1 = D_2$)

2.2 Measure the straight line from D_1 to D_2 and mark one half this distance D_3. $\left(D_3 = \frac{1/2}{D_1D_2}\right)$

2.3 Anchor should be placed on the line that passes through D_3 and center-line of angle pole.

Figure PO 330–2: Determination of Side Anchor Location



PO 340 Types of Guying

Scope PO 340.1 Types of Guying

Figure PO 340–1: Overhead Guy across Streets and Roadways

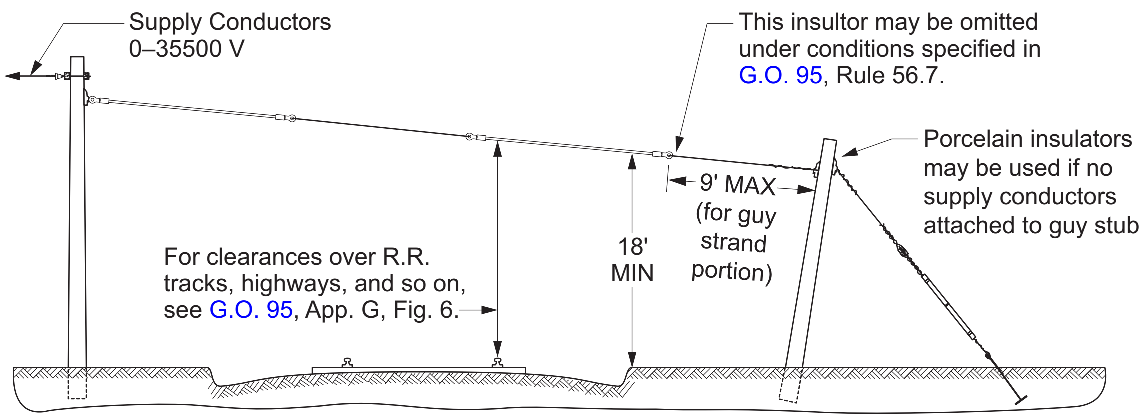
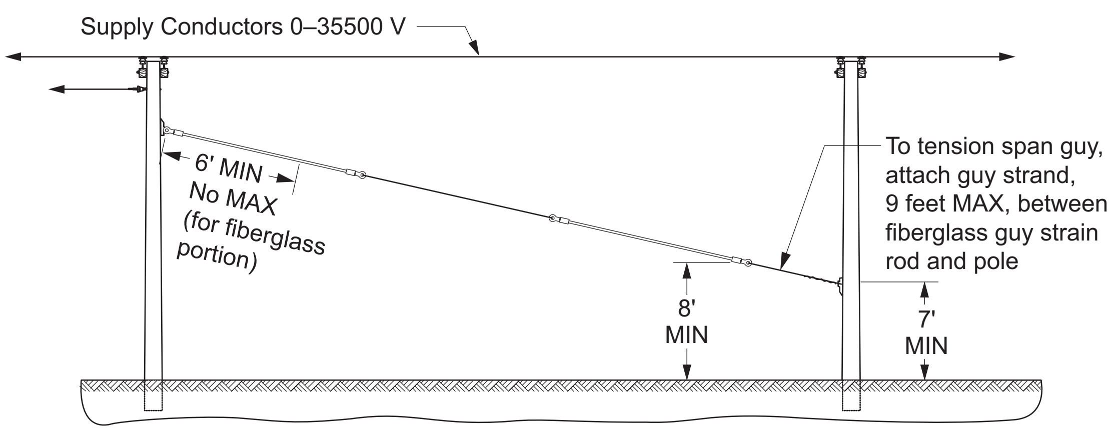


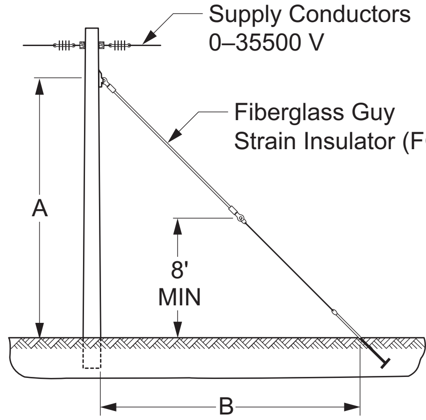
Figure PO 340–2: Overhead Span Guy Parallel to Streets and Roadways



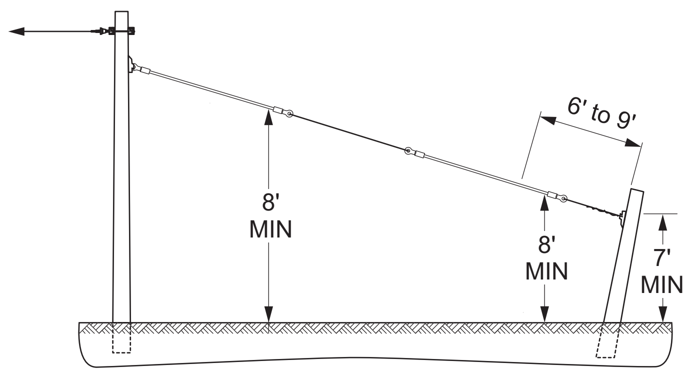
NOTE

If guy strain insulator is installed in lieu of Fiberglass Guy Strain Insulator (FGSI) due to length requirements, it shall be installed a minimum of 6 feet and a maximum of 9 feet away from the face of the pole to meet G.O. 95 Zone of Proximity requirements.

Figure PO 340–3: Anchor Guy and Overhead Guy Parallel to Streets and Roadways



Distance “B” should equal “A” approx. Where possible, “B” should not be less than one half of “A”.



Overhead Guy
Parallel to Streets and Roadways

Note(s):

1. No insulators are required in guys for metal poles or structures permanently grounded, except as required by G.O. 95, Rule 56.6E. When two guys are installed, they shall be at least 12 inches apart (See Note 2 (Sheet 5)).
2. Guying shall maintain a minimum safety factor required for grade of construction.

Figure PO 340–4: Types of Guying

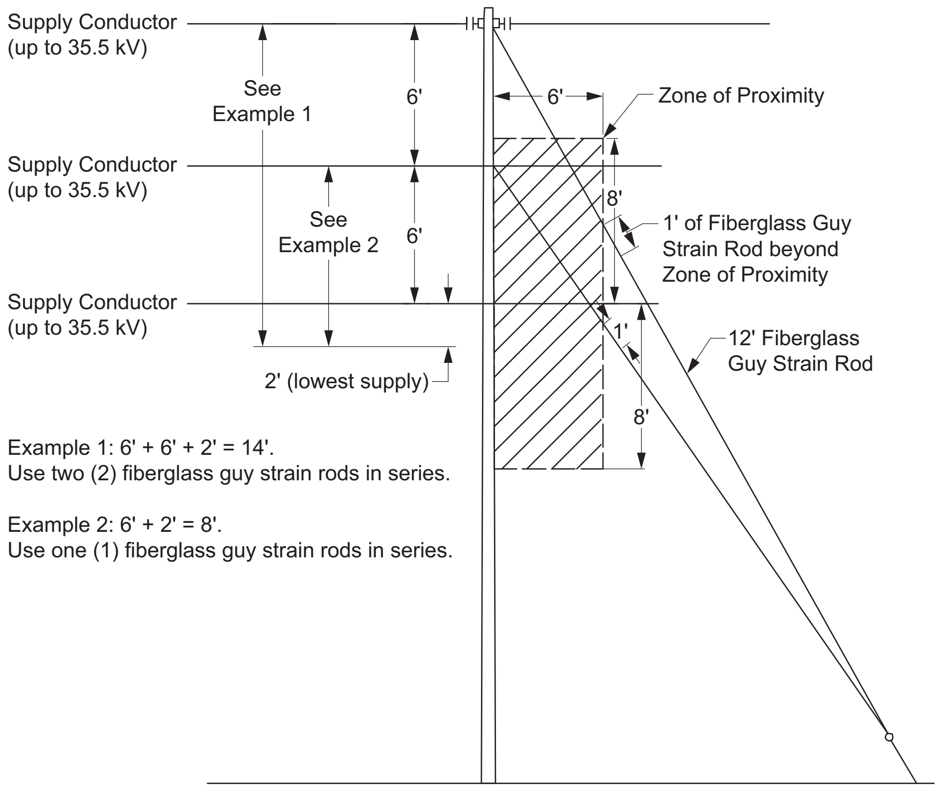


Figure PO 340–4.1

Figure PO 340–4: Types of Guying *(cont'd)*

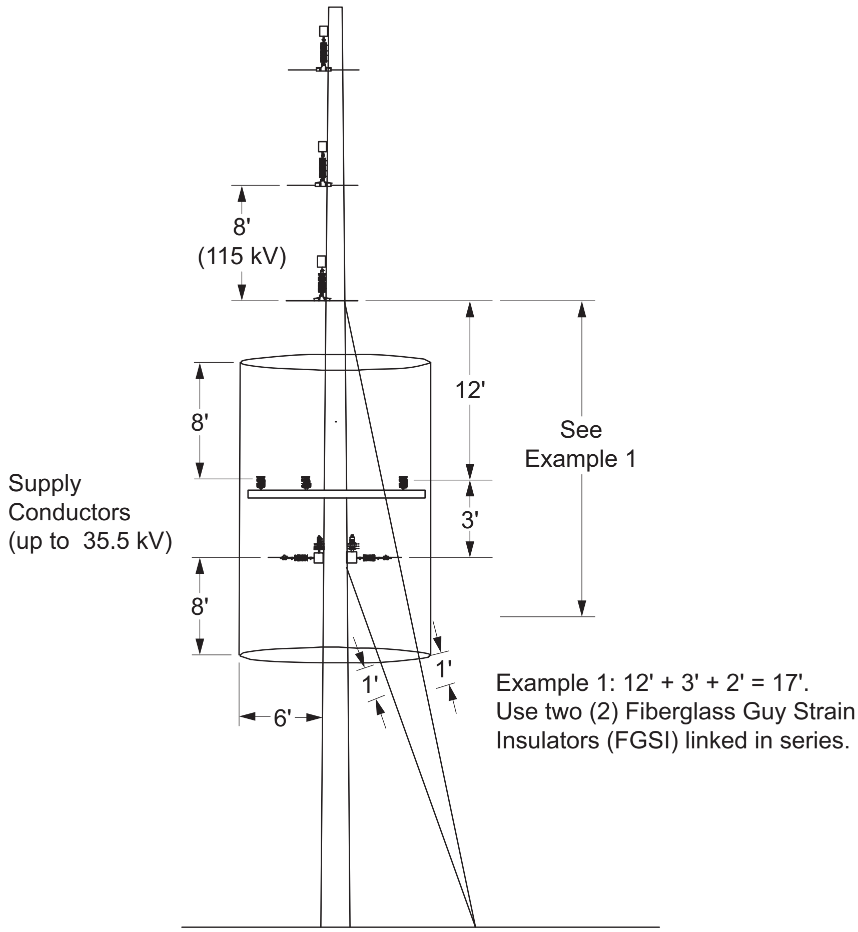
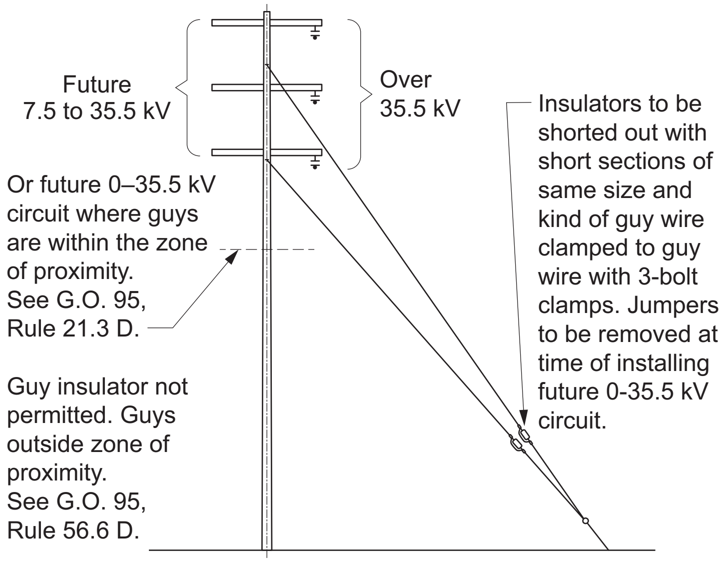


Figure PO 340–4.2

Figure PO 340–4: Types of Guying *(cont'd)*



This applies similiarly to other anchor or span guys in any direction.

Figure PO 340–4.3

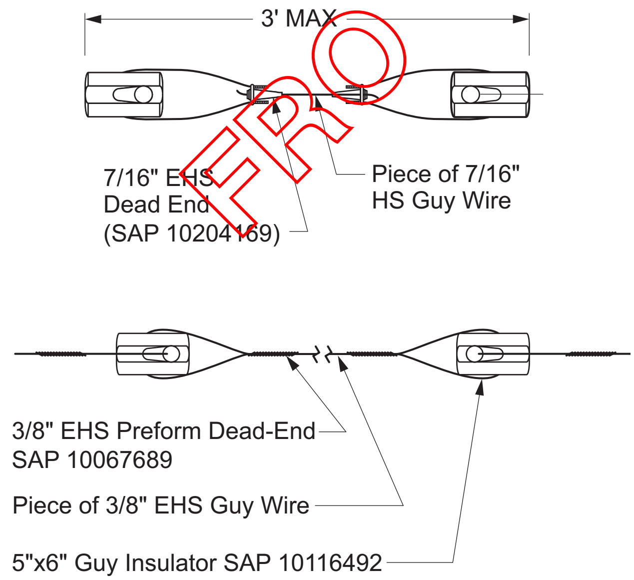


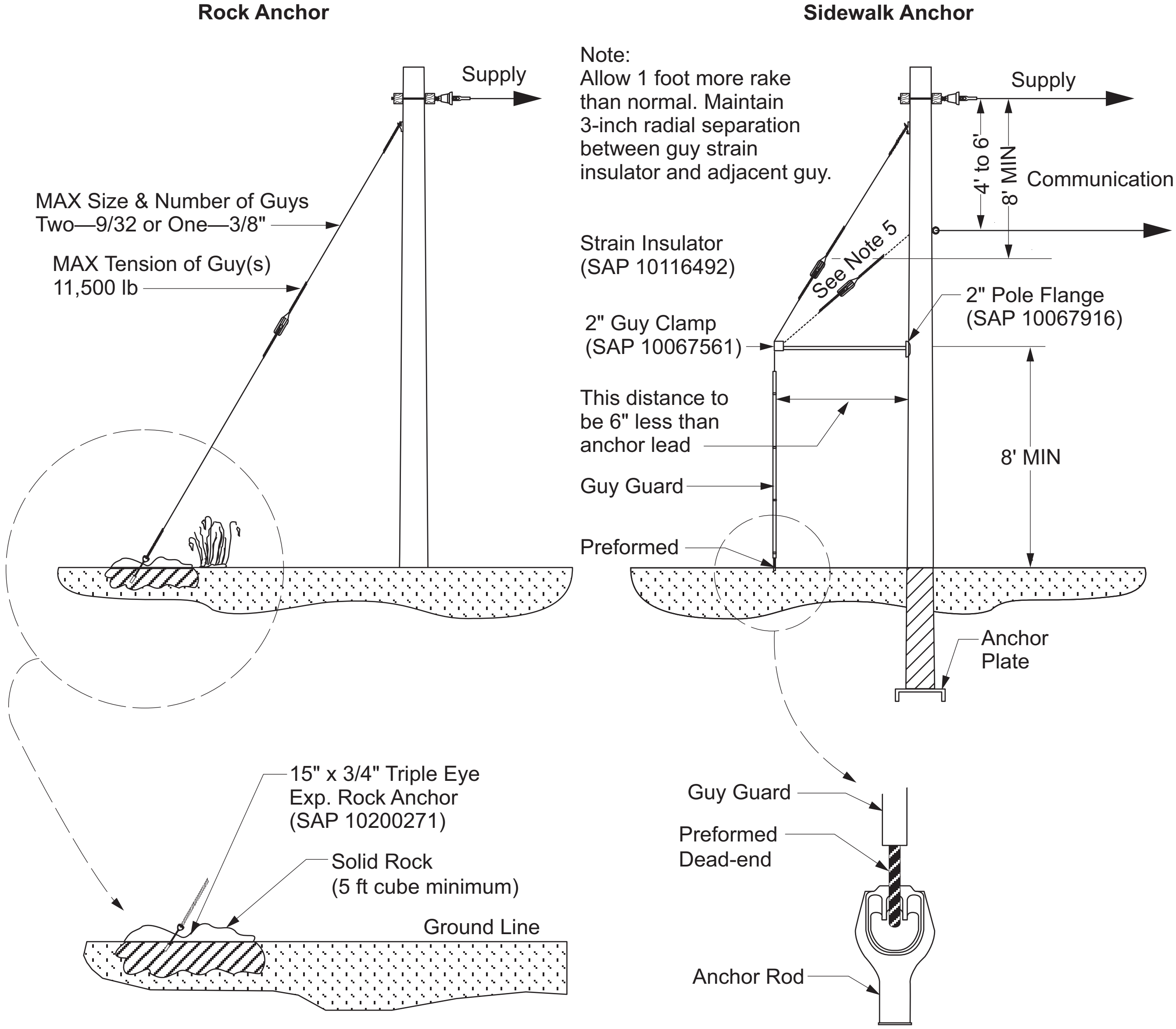
Figure PO 340–4.4

Note(s):

1. If dimension "X" is less than 8 feet, a second insulator located at a minimum of 8 feet vertically above ground is required.
2. One guy insulator required on circuits from 0 to 22.5 kV. Two insulators in series required from 22.5 kV to 35.5 kV, G.O. 95, Rules 56.8 and 86.8.
3. If FGSI does not meet installation requirements per PO 300, utilize double FGSI configuration as detailed in Figure PO 340–4.2.

Scope PO 340.2 Typical Installation of Rock Anchor Guying and Sidewalk Anchor Guying

Figure PO 340–5: Rock Anchor and Sidewalk Anchor

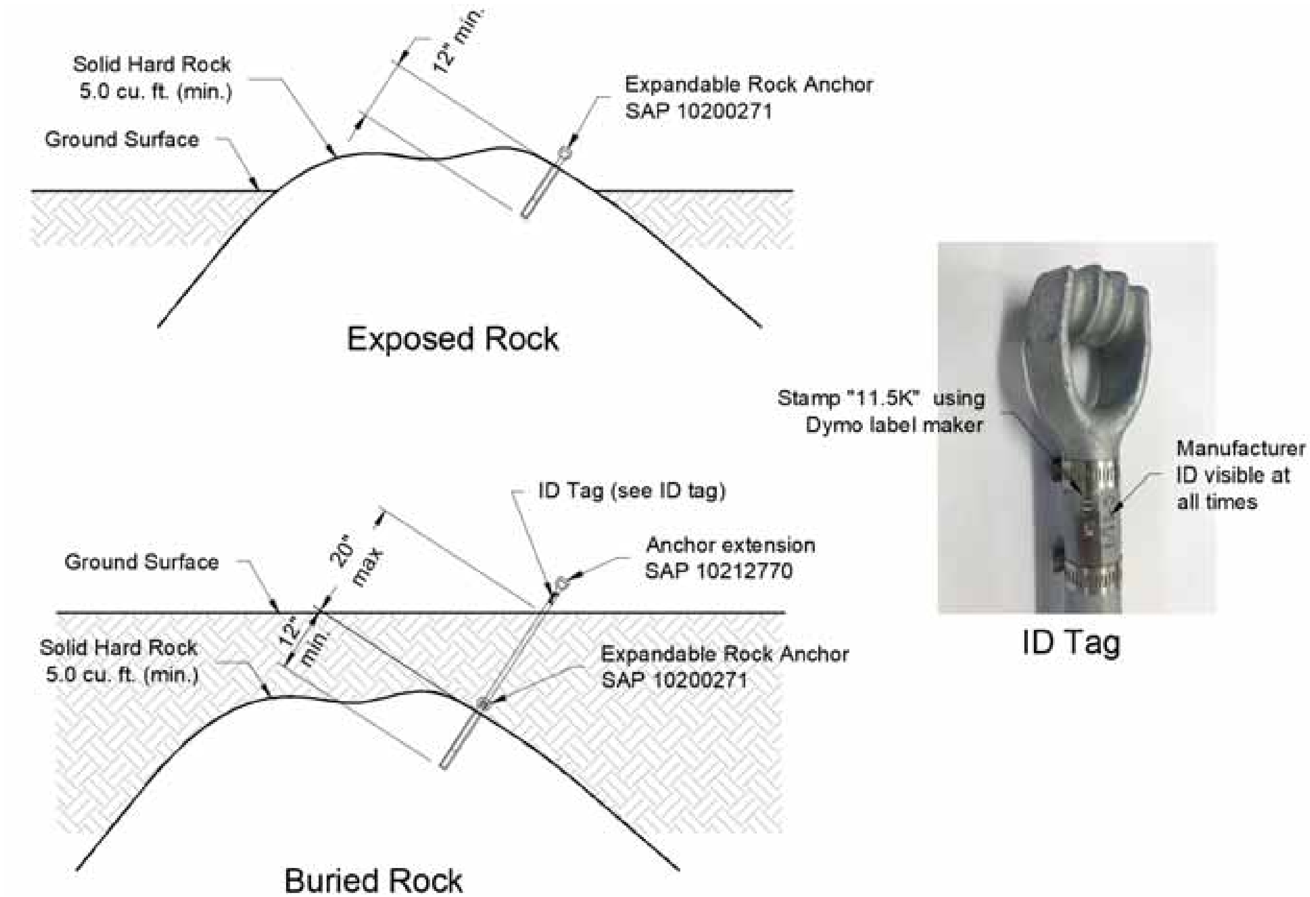


Note(s):

1. Rock anchors should only be installed in solid hard rock. Hard rock requires a minimum of 5 cu. ft. of solid mass that can either be partially exposed or buried to a maximum of 20 inches below ground. Never in decomposed or crumbly rock.
2. Drill a 1-7/8 inches diameter hole into the solid hard rock to a minimum depth of 12 inches. Clean the hole and place the rock anchor.
3. Expand the anchor wedge by inserting an 18 inches minimum lever into the eye and rotate the rod until cinched tight.
4. Place Non-Shrink Grout SAP 10066522 around the rod after cinching.
5. Maximum of two guys per sidewalk anchor.

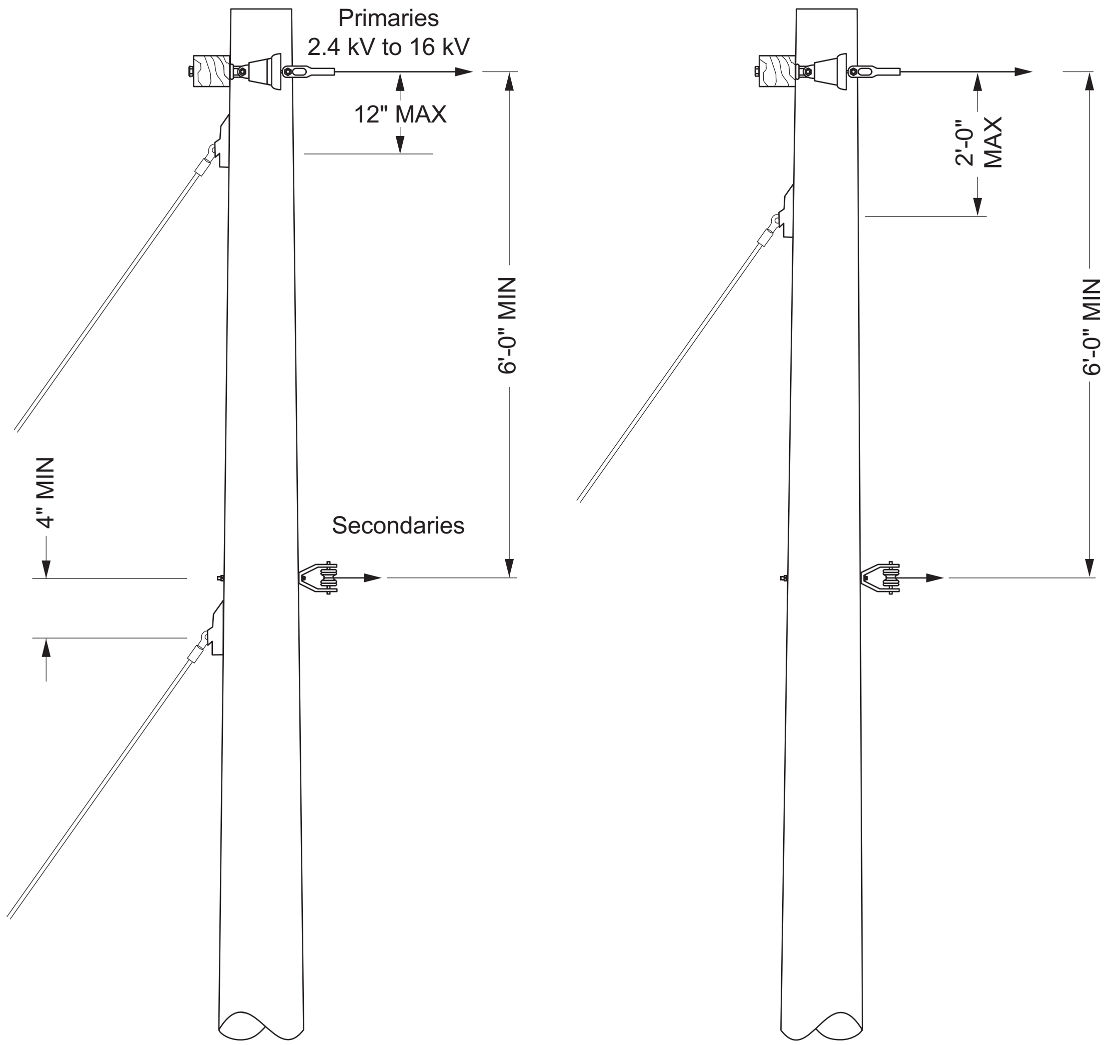
6. Rock anchor shall be installed in the same direction as the guy wires.
7. The bottom of the eye of the rock anchor shall be 4 inches above the rock, measured along the rod.
8. For new installations, if solid hard rock is found 20 inches below ground and meet the 5 cubic feet minimum volume requirement, anchor extension with identification tag can be installed (see Figure PO 340–6).

Figure PO 340–6: Rock Anchor Extension and ID Tagging



Scope PO 340.3 Typical Guying for Grades A and B Construction

Figure PO 340–7: Typical Guying for Grades A and B Construction



Grade A Construction **Grade B Construction Only**

Note(s):

1. Guying shall take into consideration the maximum bending moment that may be applied to a pole (due to pole loading and conductor strain) for a given wind area without exceeding the safety factor for the specified grade of construction.
2. Refer to Chapter PLM-2 of the Pole Loading Manual (PLM) for safety factors of new and in-service Grade A or Grade B construction.
3. Down guys shall not contact crossarms or hardware.

Scope PO 340.4 Maximum Conductor Tension for Guy Wires — Grade B Construction

Table PO 340–1: Maximum Conductor Tension for Guy Wires — Grade B Construction

Maximum Safe Conductor Tension (lb) for One Guy Wire [a/]			
Angle of (Guy-to-Pole) (Degrees)	**Guy Size**		
	9/32"	**3/8" (EHS)**	**7/16" (EHS)**
3	234	403	544
5	390	671	906
7	545	938	1,267
9	700	1,205	1,627
11	854	1,469	1,984
13	1,007	1,732	2,339
15	1,158	1,993	2,692
20	1,531	2,634	3,557
25	1,891	3,254	4,395
30	2,238	3,850	5,200
35	2,567	4,417	5,965
40	2,876	4,949	6,685
45	3,164	5,445	7,354
50	3,428	5,899	7,967
55	3,666	6,307	8,519
60	3,875	6,668	9,007
Level (Overhead Guy)	4475	7,700	10,400

[a/] Ultimate conductor tension divided by safety factor (from Table 24, G.O. 95). The 1/4", 5/16", and 7/16" entries are listed for reference only. The Maximum number of guys for a sidewalk anchor is two.

EXAMPLE:

A single 3/8" guy wire installed at a 40 degree angle, between the pole and guy, is capable of supporting a conductor tension of 4,949 pounds in Grade B construction.

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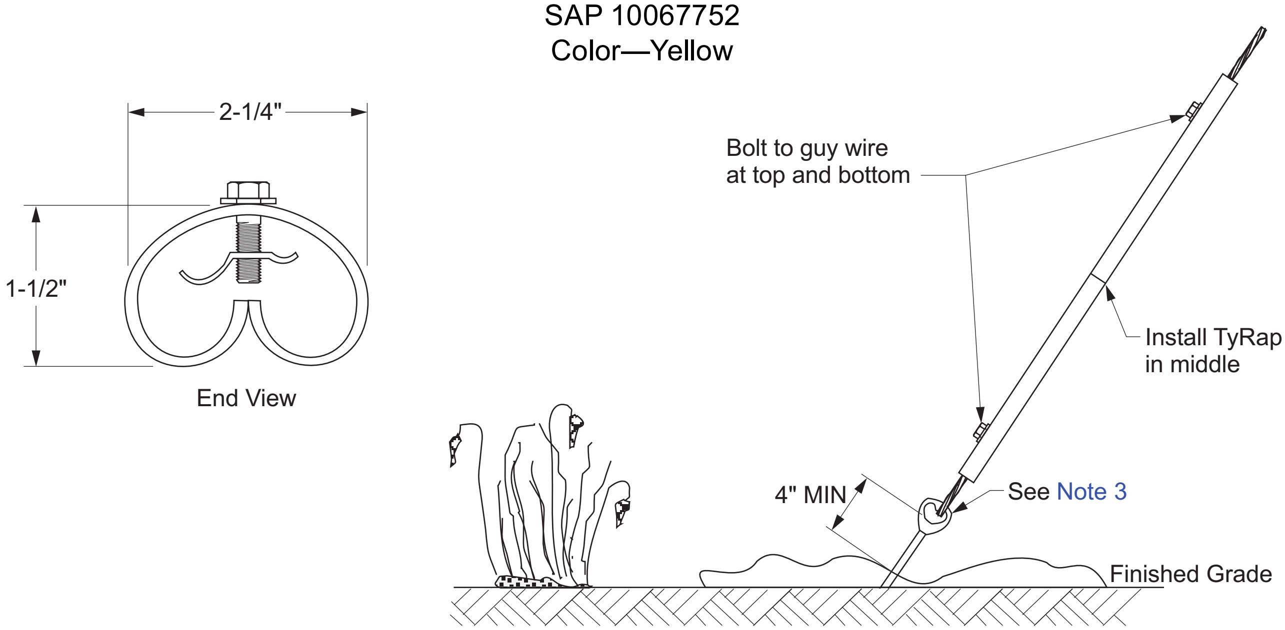
PO 350 Guy Guards

Scope PO 350.1 Approved Guy Guards, Application, and Installation Information

Figure PO 350–1: Plastic "Snapper" Guy Guard

SAP 10067752
Color—Yellow

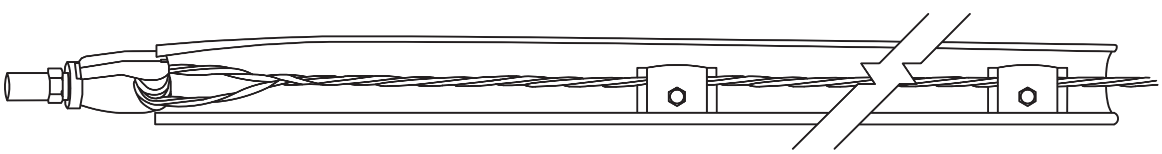


Application

1. All new and rebuild construction.
2. Use at the Foreman's discretion.

Figure PO 350–2: Half Round Plastic Guy Guard

SAP 10067972
Color—Gray

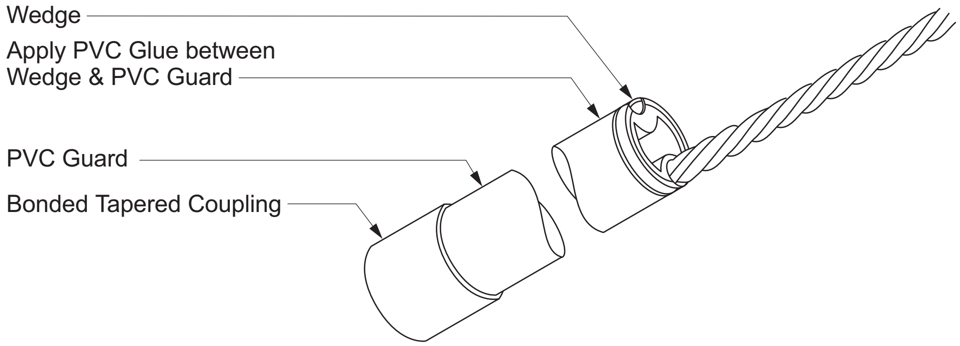


Application

1. New sidewalk anchor guys and replacement of damaged Guy Guards.
2. Use at the Foreman's discretion.
3. Bottom of the eye of the rod shall be a minimum of 4 inches and a maximum of 18 inches above finished grade measured along the rod.

Figure PO 350–3: Tubular PVC Guy Guard

SAP 10067970—Assembly includes Guard and Wedge (Alternate)
Color—Gray



Application

On all new and rebuild construction it is necessary to place the guard on the guy wire prior to tensioning.

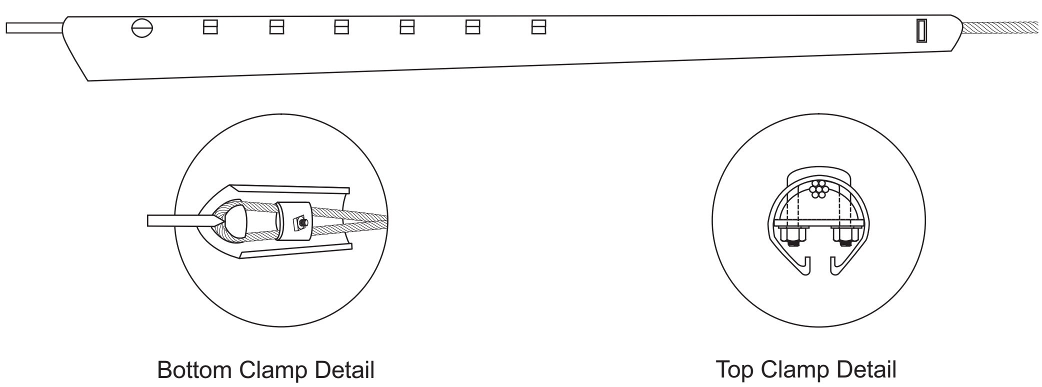
Install PVC wedge after guard is in place.

Note(s):

1. A parallel groove connector shall be installed above the wedge where a preformed dead-end is used at the bottom of the guy.
2. One-inch sch 40 PVC may be substituted for the tubular PVC guard. A parallel groove connector shall be installed on the guy above the end of PVC conduit.

Figure PO 350–4: Half Round Steel Guy Guard

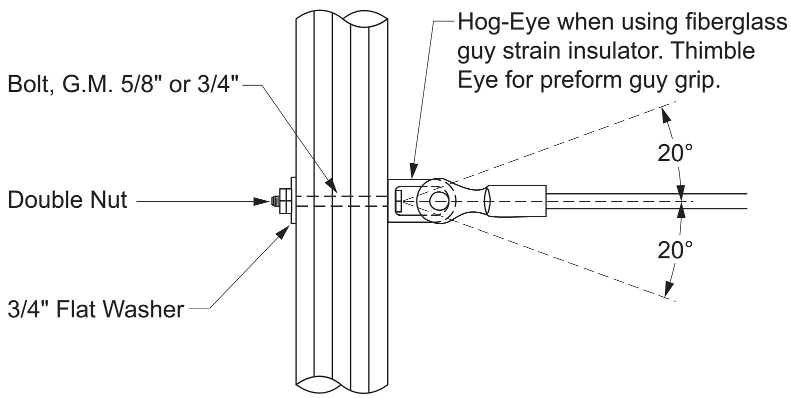
SAP 10067971



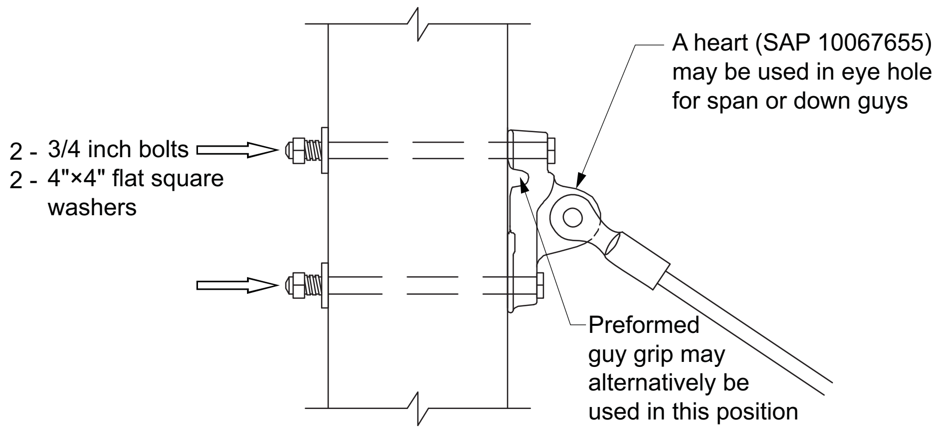
PO 360 Guying Subtransmission Lightweight Steel Poles

Scope PO 360.1 Installation of Guy Hardware on Lightweight Steel Poles

Figure PO 360–1: Installation of Guy Hardware on Lightweight Steel Poles



Span Guy



Guying Tee Detail
(SAP 10181650)

Note(s):

1. Anchor guys on LWS poles are installed without insulators.
2. Span guys between LWS poles are installed without insulators.
3. Follow the guying criteria for wood poles, including poles with communication and third party attachments, except as shown in these figures.

PO 370 Composite Pole Hardware

Scope PO 370.1 Composite Pole Hardware

1.0 Composite Crossarms

1.1 Composite crossarms (see Figure PO 370–1) are available in sizes ranging from 5 feet to 20 feet for either heavy tangent and dead-end types for use on composite poles (see Table PO 370–1).

Composite crossarms shall be used on composite poles.

Figure PO 370–1: Heavy Duty Crossarms

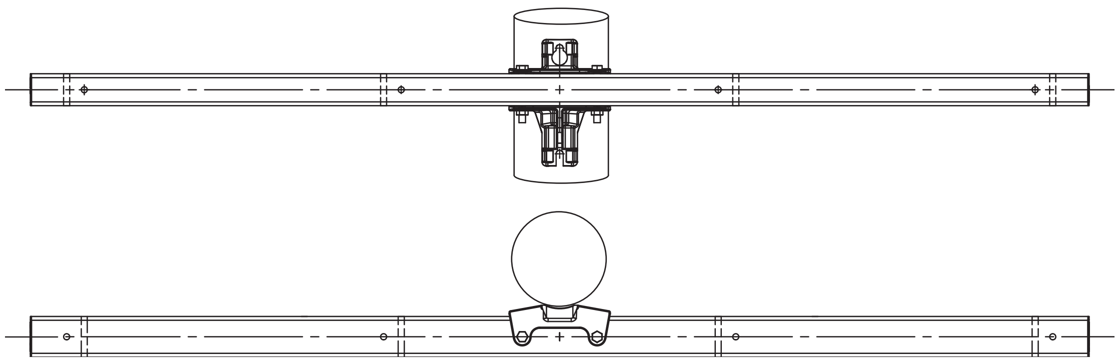


Table PO 370–1: Heavy Duty Crossarm SAP Numbers

Type	Size (ft)	SAP
Tangent	5	10211425
Tangent	8	10060793
Tangent	10	10060794
Tangent	12	10060795
Tangent	20	10208033
Dead-End	8	10060796
Dead-End	10	10060797
Dead-End	12	10060798
Dead-End	20	10208513
Tangent Alley Arm	10	10211423
Tangent Alley Arm	12	10211424

Note(s):

1. For installation, application or, assembly details, see PO 112.
2. 5 foot, 8 foot, and 10 foot composite crossarms dimensions are 3-5/8" × 4-5/8".
3. 12 foot and 20 foot composite crossarms dimensions are 4" × 6".
4. Composite crossarms include mounting assembly bracket. 3/4" bolts shall be used on mounting assembly bracket. V-braces and back braces are not required, except on 5 foot crossarms.
5. Field drilling on the centroid axis of the crossarm face is permissible using a carbide drill bit. Drilled holes shall be 2 inches MIN apart (center-to-center), 4 inches MIN from end of arm, and 15 inches MIN from center of arm except holes for vertical braces on capacitor banks and transformers.

6. Install 4" × 4" flat square washer (SAP 10071859) with spring washer on hardware bolts. Tighten nut until spring washer just fully compresses. Do not over tighten. Fuse holder, pot head, and lightning arresters do not require 4" × 4" washers on the “L” bracket side. Steel straight pins and angle pins only require 4" × 4" washers on the underside of the composite arm.
7. Tighten bolts to 35 ft-lbs maximum. This is equivalent to the spring washer fully compressed. **DO NOT** overtighten.

1.2 Crossarm Mounting Bracket with Guy Attachment Holes

Figure PO 370–2: Composite Crossarm Mounting Bracket with Guy Attachment Holes

Guy Attachment Holes Working Load Capacity 10,000 lb either hole. Only 1 guy allowed. (See PO 300, Scope PO 300 1.6)

2.0 Riser Support

Figure PO 370–3: Riser Support

Table PO 370–2: Riser Support

Table Note: Attach risers as described in PO 112, and refer to the Distribution Underground Construction Standards (DUG) Section CR 110.

Size	SAP
24" Extended	10073393

3.0 Pole Hole Plug

3.1 Pole hole plugs shall be installed in open composite pole holes per Table PO 370–4 to prevent bugs and moisture intrusion. Only use High Temperature plugs in Bulletin 322 and/or High Fire Risk Areas (HFRA).

Table PO 370–3: Plastic Pole Hole Plug

Plug Size (in)	SAP
5/8	10068598
3/4	10068599
7/8	10068601
1	10068602
1-1/2	10068603

= For Reference Only

Table PO 370–4: High Temperature Pole Hole Plug

Plug Size (in)	SAP
11/16	10211092
13/16 – 7/8	10211093
1	10211094
1-1/8 – 1-1/4	10211095

4.0 Insulated Clamp for Ground Wire

For use on composite poles, use (2) #10 × 2" self-drilling screws (SAP 10071503).

Figure PO 370–4: Insulated Clamp and (2) Self-drilling Screws

Table PO 370–5: Insulated Clamp and (2) Self-drilling Screws

Description	Quantity	Size	SAP
Insulated Clamp (Grey)	1	#4-PGW	10209485
Insulated Clamp (Black)	1	#6-PGW	10209484
Self-drilling Screw	2	#10 × 2"	10071503

5.0 Bonding Clip

Figure PO 370–5: Bonding Clip

Table PO 370–6: Bonding Clip

Description	Quantity	Size	SAP
Bonding Clip	1	1/8"	10113253
Self-drilling Screw	1	#10 × 1"	10072230

6.0 Thimble Eyelet

Figure PO 370–6: Thimble Eyelet

Table PO 370–7: Thimble Eyelet

Type	Application	Size	SAP
Standard	Span Guys	5/8"	10068524
		3/4"	10068525

7.0 Pole-Top Cap

Pole-top caps (see Figure PO 370–7) come in various sizes and fit directly on top of the pole module. Pole caps for octagon poles are available in 10 inches.

Figure PO 370–7: Pole Top and Base Section Cap for 45-Foot Round Composite Sectional Poles

Cone Type (Top Section)

Flat Type
(Top Section for Use with Ridge Pin)
(Bottom Section — Temporary)

Table PO 370–8: Pole Top and Base Section Cap for 45-Foot Round Composite Sectional Poles

Pole Manufacturer	Description	Cap Size	SAP
Highland	Base Section Temporary Cap	14" Flat Type	10207279
	Top Section Cap	9.5" Cone Type	10207280
	Top Section Cap	9.5" Flat Type (for use with ridge pin)	10207281
RS	Base Section Temporary Cap	14" Flat Type	10207279
	Top Section Cap	10" Cone Type	10207282
	Top Section Cap	10" Flat Type (for use with ridge pin)	10207283

Note(s):

1. Top and Base Covers are included with RS poles.

8.0 Spring Washer

Hardware for composite poles shall be tightened until the spring washer has been compressed to where the springs just touch.

Figure PO 370–8: Spring Washer

Table PO 370–9: Spring Washer

Size	SAP
3/8"	10072344
1/2"	10072345
5/8"	10072346
3/4"	10072347

9.0 Composite Pole Guying Tee

The composite pole guying tee shall be used when attaching all down guys, regardless of size, directly to composite and LWS poles. Pole guying tee shall be used when attaching 7/16th inch down guys directly to wood, composite, and LWS poles. See PO 320 (Sheet 8, Note 1). Two 3/4-inch through bolts shall be used to attach the tee to the pole. Must be used in conjunction with 4-inch curved square washers.

Figure PO 370–9: Composite Pole Guying Tee

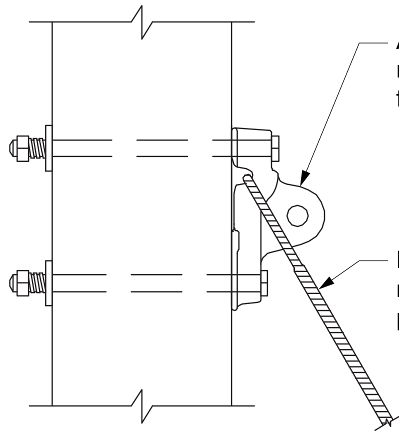



Table PO 370–10: Composite Pole Guying Tee

Maximum Working Load (lb)	SAP
10,400	10181650

10.0 Pole Plate for Sidewalk Guy

The sidewalk guy pole plate (SAP 10211422), shall be used on composite poles. Mount pole plate to pole with a 5/8 inch through bolt and spring washer. A 3 inch curved washer shall be used on the opposite side of the pole (see Figure PO 370–14 for details).

Figure PO 370–10: Pole Plate

11.0 Thimble Eye Bolt

Straight thimble eye bolts are to be used for span guys.

Figure PO 370–11: Thimble Eye Bolt, Straight Type

Table PO 370–11: Thimble Eye Bolt, Straight Type

Size	SAP	Strength (lb)
5/8" × 10"	10068513	13,550
5/8" × 12"	10068514	13,550
5/8" × 14"	10068512	13,550
5/8" × 16"	10068516	13,550
3/4" × 12"	10068520	20,050
3/4" × 14"	10068647	20,050

12.0 Pole Band

Figure PO 370–12: Stainless Steel Pole Band

Table PO 370–12: Stainless Steel Pole Band

Size (in)	SAP
1-1/4	10209449

13.0 Flat Square Washer

Figure PO 370–13: Flat Square Washer

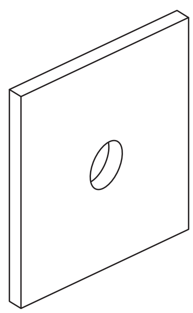


Table PO 370–13: Flat Square Washer

Size	Bolt Hole	SAP
4" × 4" × 1/4"	13/16"	10071859

14.0 Curved Square Washer

Figure PO 370–14: Curved Square Washer

Table PO 370–14: Curved Square Washer

Size	Bolt Hole	SAP
3" × 3" × 1/4"	5/8"	10071941
3" × 3" × 1/4"	3/4"	10071853
4" × 4" × 1/4"	3/4"	10071863
4" × 4" × 1/4"	7/8"	10071946

15.0 Permanent/Temporary Climbing Step

Figure PO 370–15: Permanent/Temporary Climbing Steps

Table PO 370–15: Permanent/Temporary Climbing Steps

Table Note: For installation, application or, assembly details, see PO 112.

Pole	SAP
Round	10068660

16.0 Temporary Pole Step Plate

Figure PO 370–16: Temporary Pole Step Mounting Assembly

Table PO 370–16: Temporary Pole Step Mounting Assembly

Table Note: For installation, application or, assembly details see PO 112.

Pole	Washer	SAP
Round	Curved	10068609

17.0 Detachable Temporary Pole Step

Figure PO 370–17: Detachable Temporary Pole Step

Table PO 370–17: Detachable Temporary Pole Step

Table Note: For installation, application or, assembly details, see PO 112.

Size	SAP
5-1/2"	10068470

= FOR REFERENCE ONLY

18.0 Mast Arm

Figure PO 370–18: Mast Arms

Table PO 370–18: Mast Arm

Size	SAP
30"	10118514
6'	10118515
16'	10200181

19.0 Insulator Pin

Figure PO 370–19: Insulator Pin

Table PO 370–19: Insulator Pin

Pin Length (in)	Shank Length (in)	SAP	Application
7	8-1/2	10068281	12' Tangent Only
7	7 to 7-1/2	10068306	8'/10' Tangent 8'/10'/12' Dead-end
7	1-3/4	10068309	Angle or Ridge Pin

NOTE

Install 4" × 4" flat square washer (SAP 10071859) on the underside of composite arms with straight steel pins and angle pins.

20.0 Insulator Studs

Table PO 370–20: Insulator Studs

Size	SAP
5/8" DIA × 10" L	10213439
5/8" DIA × 7-1/2" L	10116398
3/4" DIA × 1-3/4" L	10116404

Figure PO 370–20: Insulator Studs

21.0 Ridge Pin Bracket

Figure PO 370–21: Ridge Pin Bracket

Table PO 370–21: Ridge Pin Bracket

Size	SAP
Universal	10067373

22.0 Protected Ground Wire

Figure PO 370–22: Protected Ground Wire

Table PO 370–22: Protected Ground Wire

Size	SAP
4 AWG	10109304
6 AWG	10109302

23.0 No Drill Zone Decal for Intelli-Pole

Figure PO 370–23: No Drill Zone Decal

Table PO 370–23: No Drill Zone Decal

Type	SAP
Arrow Up	10204661
Arrow Down	10204660

Note(s):

1. For RS Composite Poles, No Drill Zone Tag is already installed.

24.0 Visibility Strip

Figure PO 370–24: Visibility Strip

Table PO 370–24: Visibility Strip

Description	Quantity	Size	SAP
Visibility Strip	1	2" × 12"	10068488
Self-drilling Screw	2	#10 × 1"	10072230

DOH–PR: Protection (Fusing)

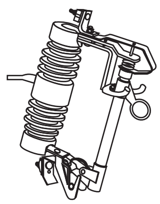
Table of Contents

Standard **Title**

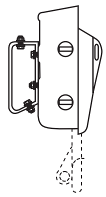
PR 100 Fusing Practices — General

Scope PR 100.1 Overhead Distribution Transformer Fusing Practices — 4–33 kV

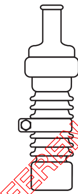
Figure PR 100–1: Overhead Distribution Transformer Fusing Practices — 4–33 kV



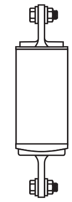
15 kV Open Cutout
See DOH, Table PR 107-1
(See Note 5, 8, and 11)



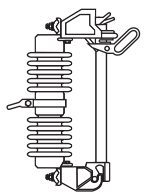
4.8 kV Enclosed Cutout
See DOH, Table PR 107-1
(See Note 5 and 9)



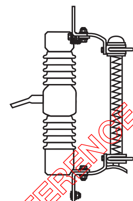
4.8 kV Bay-O-Net Cutout
(Key 06)



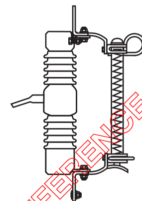
8.3 kV CLD
See DOH, PR-126
(See Note 4)



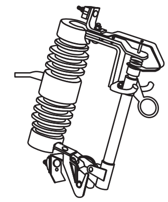
14.4 kV SMU-20
See DOH, Table PR 107-3
(See Note 2 and 5)



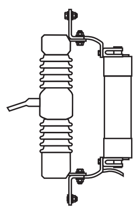
14.4 kV Liquid Fuse (#1)
(KEY 06)



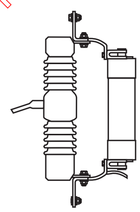
14.4 kV Liquid Fuse
(KEY 06)



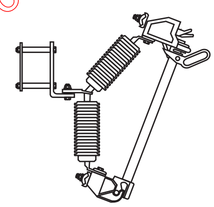
27 kV Open Cutout
for use on 12/16/25 kV
See DOH, Table PR 107-1
(See Note 5 and 11)



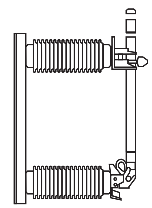
20.5 kV LR Fuse (Kearney)
for use on 12/16/25 kV
(KEY 06)
(See Note 6)



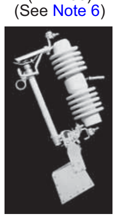
23 kV LRB Fuse (Bussman)
for use on 12/16/25 kV
See DOH, PR 127
(Formerly FDSH)
(See Note 6)



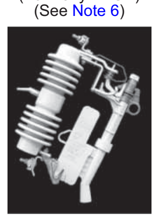
34.5 kV SMU 20
See DOH, Table PR 107-7
(See Note 3, 5, and 14)



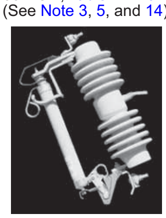
34.5 kV SMD 1A
See DOH, Table PR 107-8
(See Note 5)



27 kV Cutout with ECD
See DOH, Table PR 107-1
(See Note 10)



15 kV Fault Tamer ® Fuse
for use on 12/16/25 kV only
See DOH, Table PR 107-4
and PR 128
(See Note 5 and 12)

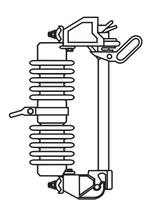


15 kV ELF Fuse
6 A to 50 A
See DOH, Table PR 107-5
(See Note 13)

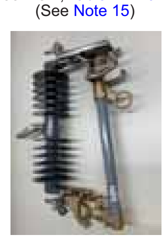
8 kV ELF Fuse
6 A to 80 A
See DOH, Table PR 107-2
(See Note 15)

17 kV X-Limiter Fuse
10 A to 100 A
See DOH, Table PR 107-6
(See Note 14)

34.5 kV Fault Tamer ® Fuse
See DOH, Table PR 107-9
and PR 128
(See Note 5)



25 kV SMU-20
See DOH, Table PR 107-3
and Table PR 107-7
(See Note 5)



Stainless Steel Polymer
27 kV Open Cutout
for use on 12/16/25 kV
See PR 129
(See Note 18)

Table PR 100–1: Fuse Applications by Voltage

Fuse Applications by Voltage (1)			
2.4/4.16/4.8 kV	**7/12/16 kV**	**14.4 /25 kV**	**33 kV**
15 kV Open Cutout (5)(8) Enclosed Cutout (5) Bay-O-Net Cutout (Key 6) 8 kV ELF (15) 14.4 kV SMU-20 (5)(16)	27 kV Open Cutout (11)(5)(18) Fault Tamer (12)(5) 15 kV ELF (13) 14.4 kV SMU-20 (2)(5) X-Limiter (14) ELF-LR(6) CLDs (4) Liquid Fuse (Key 6)(7)	27 kV Open Cutout (5)(11)(18) Fault Timer (12)(5) 15 kV ELF (13) Cutout with ECD (10) 14.4 kV SMU-20 (2)(5) 25 kV SMU-20 (5) X-Limiter (14) Liquid Fuse (Key 6)(7)	34.5 kV SMU-20 up to 500 MVA Duty (3)(5) SMD-1A over 500 MVA Duty (5) 34.5 kV Fault Tamer® (5) (17)

1.0 Fuse Applications in High Fire Risk Areas

Firebreak clearing around poles is not required for poles with all exempt equipment and material (see DC 605). Exempt fuses include liquid, SMU-20, CLD, LR, FDSH, Fault Tamer, X-Limiter ELF, and ECD cutout designs. Non-exempt fuses include links and SMD-1A designs.

Note(s):

1. Fuse sizes for each type of installation are shown in the fuse tables (PR Section).
2. Use SMD-20 fuseholders with 150 kV BIL on 7 kV and 12 kV circuits in contamination areas “A” and “B” per Insulation Area Map (GR Section) and on all 16 kV and 25 kV circuits.
3. Use fuse adapter (SAP 10107599) when using newer type SMU-20 fuses on old 34.5 SMD-20 fuseholder, SAP 10107515 — Key 6.
4. See PR 126 for CLD application.
5. Do not leave fuse hanging in the holder in an open position. Moisture may enter through the exhaust end and damage the fuse.
6. See PR 127 for ELF-LR fuse application.
7. Liquid fuses and fuseholders have been discontinued by the manufacturer. The ELF-LR fuses can be used directly in Size 1 liquid fuseholders.
8. 4.16 kV through 14.4 kV rated, but limited to use on 4 kV and 4.8 kV systems.
9. For use on 4 kV or 4.8 kV on congested poles (limited vertical space).
10. The cutout with ECD (Emission Control Device) is identical to a 27 kV open cutout, except a device (ECD) is attached to contain all expulsion particles during a fuse operation.
11. Restricted to non-High Fire Risk Areas (HFRA) where the available fault current does not exceed 7,500 A (sym).
12. Includes open cutout mounting. For 12 kV, 16 kV, and 25 kV systems where the available fault current is above 7,500 A (sym) (see PR 128).
13. The 15 kV ELF is a current-limiting fuse which mounts in a 27 kV open-style cutout mounting. This fuse is designed for the 12 kV, 16 kV, and 25 kV 1Ø (14.4 kV) overhead systems, and is available with the cutout mounting or as individual fuses for retrofitting in existing 27 kV open cutout mountings.
14. The X-Limiter is a current-limiting fuse designed specifically for use in a SMD-20 mounting (SAP 10107506).
15. The 8 kV ELF is a current-limiting fuse which mounts in a 15 kV open-style cutout fuseholders. The fuse is intended for fusing application in the 4 kV systems.
16. For use in HFRA in the 2.4/4.16/4.8 kV systems where current-limitation is not required, and in 4.16 kV branch line fusing.
17. The 34.5 kV Fault Tamer® has been discontinued by the manufacturer. Replacement fuse cartridges (see PR 107) are still available from manufacturer for existing installations.
18. The Stainless Steel Polymer 27 kV Universal cutout, is available for use in coastal environments (within 1 mile of the ocean). This cutout is for use on 12 kV, 16 kV, and 25 kV (single-phase, 14.4 kV line-to-ground) overhead systems (SAP 10215071).

PR 105 Full Load Line Currents

Scope PR 105.1 Full Load Line Currents

Table PR 105–1: Transformer Full Load Line Current in Amperes for 3Ø Banks (Three 1Ø Transformers in Bank or One 3Ø Transformer)

kVA 1Ø Rating	Rated Line Voltage 1Ø										
	120	240	277	480	2,400	4,160	4,800	7,200	12,000	16,500	34,400
	Line Current In Amperes										
1-1/2	13	6	5	3	0.6	0.4	0.3	0.2	0.1	0.1	0.04
3	25	13	11	6	1	0.7	0.6	0:4	0.3	0.2	0.09
5	42	21	18	10	2	1	1.0	0.7	0.4	0.3	0.15
7-1/2	63	31	27	16	3	2	1.6	1	0.6	0.5	0.22
10	83	42	36	21	4	3	2.1	1.5	0.8	0.6	0.29
15	125	63	54	31	6	4	3.1	2	1	1	0.44
25	208	104	90	52	10	6	5.2	3	2	2	0.73
37-1/2	313	156	135	78	16	9	7.8	5	3	2.5	1.1
50	417	208	180	104	21	12	10	7	4	3	1.5
75	625	313	270	156	31	18	16	10	6	5	2.2
100	833	417	360	208	42	24	21	14	8	6	2.9
150	1250	625	540	313	63	36	31	21	13	9	4.4
167	1392	696	600	348	70	40	35	23	14	10	4.9
200	1667	833	720	417	83	48	42	28	17	12	5.8
250	2083	1042	900	521	104	60	52	35	21	15	7.3
333	2775	1388	1200	694	139	80	69	46	28	20	9.7
500	4167	2083	1800	1042	208	120	104	69	42	30	14
750	—	3120	2700	1563	313	180	156	104	63	46	22
833	—	3480	3000	1740	350	200	174	115	70	50	24
1000	—	4170	3600	2083	417	240	208	139	83	61	29
1250	—	5210	4500	2615	520	300	261	175	105	75	36
1500	—	6250	5400	3125	625	361	313	208	125	90	44
1667	—	6960	6000	3480	700	400	348	230	140	100	49
2000	—	8340	7200	4167	833	481	417	278	167	120	58

Table PR 105–2: Transformer Full Load Line Current in Amperes for 3Ø Banks (Three 1Ø Transformers in Bank or One 3Ø Transformer)

kVA 3Ø Rating	Rated Line to Line Voltage 3Ø									
	208	240	480	2,400	4,160	4,800	7,200	12,000	16,500	34,400
	Line Current In Amperes									
10	28	24	12	2	1	1.2	0.8	0.5	0.4	0.2
15	42	36	18	4	2	1.8	1	0.7	0.5	0.3
25	69	60	30	6	3	3.0	2	1	0.8	0.4
30	84	72	36	7	4	3.6	2.5	1.5	1	0.5
37-1/2	104	90	45	9	5	4.5	3	2	1.3	0.6
45	125	108	54	11	6	5.4	3.5	2.25	1.5	0.7
50	139	120	60	12	7	6.0	4	3	2	0.8
75	208	180	90	18	10	9.0	6	4	3	1.3
100	278	241	120	24	14	12	8	5	4	1.7
112-1/2	312	271	135	27	16	14	9	6	4.5	1.9
150	416	361	180	36	21	18	12	7	5	2.5
200	555	481	241	48	28	24	16	10	7	3.4
225	625	541	271	54	31	27	18	11	8	3.8
300	833	723	361	72	42	36	24	14	11	5.1
500	1388	1203	601	120	69	60	40	24	18	8.5
750	2082	1804	902	180	104	91	60	36	26	13
1000	2776	2406	1203	241	139	120	80	48	35	17
1500	4164	3609	1804	361	208	180	120	72	52	25
2250	—	5419	2709	540	312	271	181	108	81	38
2500	—	6021	3010	602	347	301	200	120	87	42
3000	—	—	3609	722	416	361	241	144	105	51
3750	—	—	—	940	520	452	301	180	131	64
4500	—	—	—	1080	624	541	361	217	157	76
5000	—	—	—	1203	694	601	401	241	175	85
6000	—	—	—	1450	837	1722	481	280	210	108

PR 107 SAP Numbers for OH Fuses and Fuseholders

Scope PR 107.1 2.4 kV through 25 kV

Table PR 107–1: Fuse Links

Amp Size	SAP	Amp Size	SAP
2	10108888	25	10108895
3	10108889	30	10108896
5	10108890	40	10108897
7	10108891	50	10108898
10	10108892	65	10108900
15	10108893	80	10108901
20	10108894	100	10108902
Compatible Fuseholders			
27 kV Universal Cutout (Complete Assembly, includes fuse tube)			10107404
27 kV Universal Cutout with ECD			10107430
15 kV Universal Cutout (Complete Assembly, includes fuse tube)			10107393
Enclosed Cutout			10107572

Note(s):

1. Fuse links are used on all system voltages from 2.4 kV up to 25 kV.
2. The 27 kV universal cutout is used in the 12 kV, 16 kV, and 25 kV systems.
3. The 15 kV universal cutout and the enclosed (or box) cutout are used in the 2.4 kV, 4 kV, and 7.2 kV systems.
4. The 27 kV universal cutout with Emission Control Device (ECD) can be used on all system voltages from 2.4 kV up to 25 kV in High Fire Risk Areas (HFRA).
5. The 27 kV and 15 kV universal cutout, and the 27 kV universal cutout with ECD, can be used to break loads using the loadbuster tool.
6. The enclosed cutout cannot break loads and should only be opened when the circuit is de-energized, or when all secondary load has been disconnected from the transformer. It is used in congested pole assemblies with limited vertical clearance.
7. A Current-Limiting Device or CLD (K-Mate) can be applied in series with the fuse cutout in applications where current-limitation is desired. See PR 126.
8. The 15 kV Universal Cutout (SAP 10107393) may be used on a 12 kV circuit if the fault duty is less than 6.25 kA, **and** the circuit is located in a light contaminated area (GR 215, Area C). Note that only fuse links and the 8 kV ELF fuse can be used in the 15 kV cutouts. The 15 kV ELF and fault tamer fuses that are typically used on 12 kV and 16 kV circuits are compatible only with the 27 kV cutout.

Table PR 107–2: ELF Fuse — 8 kV Rating

Amp Size	SAP	Amp Size	SAP
6	10108433	30	10108393
8	10108384	40	10108394
12	10108387	50	10108400
18	10108389	65	10108430
20	10108390	80	10108431
25	10108391	—	—
Compatible Fuseholder			
15 kV Universal Cutout (assembly without fuse tube)			10107450

Note(s):

1. The 8 kV ELF fuse is used primarily in the 2.4 kV, 2.4/4.16 kV, and 4.8 kV systems.
2. The 8 kV ELF fuse can be used in HFRA.
3. The 50 A, 65 A, and 80 A ELF fuses are of double-barreled configuration.
4. The 15 kV universal cutout for the ELF fuse can be used to break loads using the loadbuster tool.
5. The 8 kV ELF fuse is a full-range current-limiting type fuse that can be used in HFRA and in applications where current limitation is desired.

Table PR 107–3: SMU-20 Fuse — 14.4 kV Rating

Amp Size	SAP	Amp Size	SAP
3K	10108795	15E	10108800
6K	10108796	20E	10108801
8K	10108797	25E	10108802
10K	10108798	30E	10108807
12K	10108799	40E	10108808
15K	10108620	50E	10108813
20K	10108621	65E	10108814
25K	10108623	80E	10108815
30K	10108624	100E	10108816
40K	10108439	125E	10108817
50K	10108440	150E	10108818
—	—	175E	10108804
—	—	200E	10108803
Compatible Fuseholders			
SMD-20 (125 kV BIL)			10107507
SMD-20 (150 kV BIL)			10107506

Note(s):

1. The 14.4 kV SMU-20 is used on all system voltages 16 kV and below, and in 14.4 kV installations in the 25 kV system.
2. The 14.4 kV SMU-20 can be used in HFRA for all system voltages 16 kV and below, and in 14.4 kV installations in the 25 kV system.
3. The E-Rated SMU-20 is a slow (time-current characteristic) fuse.
4. The 150 kV BIL SMD-20 fuseholder is used in contaminated areas A and B per insulation area map GR 215.
5. The SMD-20 fuseholder can be used to break loads using the loadbuster tool.

Table PR 107–4: Fault Tamer Fuse Cartridge — 15 kV Rating

Amp Size	SAP	Amp Size	SAP
3	10108481	10	10108449
5	10108483	15	10108485
7	10108484	20	10108450
Compatible Fuseholder[a/b/]			
27 kV Universal Cutout			10107451

[a/] Use SAP 10107405 for complete assembly including fuseholder (less cartridge).
[b/] Use SAP 10108640 for Fault Tamer fuse (less cartridge and fuse-holder).

Note(s):

1. The 15 kV fault tamer fuse is used only in the 12 kV, 16 kV, and 14.4/25 kV systems.
2. The fault tamer can be used in HFRA.
3. The 27 kV universal cutout for the fault tamer can be used to break loads using the loadbuster tool.
4. See PR 128 for additional information on the fault tamer.
5. The fault tamer fuse is a full-range current-limiting type fuse that can be used in HFRA and in applications where current limitation is desired.

Table PR 107–5: ELF Fuse — 15 kV Rating

Amp Size	SAP	Amp Size	SAP
6	10108464	25	10108468
8	10108465	30	10108469
12	10108466	40	10108470
18	10108473	50	10108471
20	10108467	—	—
Compatible Fuseholder			
27 kV Universal Cutout (assembly without fuse tube)			10107451

Note(s):

1. The 15 kV ELF fuse is used only in the 12 kV, 16 kV, and 14.4/25 kV systems.
2. The 15 kV ELF fuse can be used in HFRA.
3. The 30 A, 40 A, and 50 A ELF fuses are of double-barreled configuration.
4. The 27 kV universal cutout for the ELF fuse can be used to break loads using the loadbuster tool.
5. The 15 kV ELF fuse is a full-range current-limiting type fuse that can be used in HFRA and in applications where current limitation is desired.

Table PR 107–6: X-Limiter Fuse — 15 kV Rating

Amp Size	SAP	Amp Size	SAP
10	10108477	40	10108478
12	10108486	50	10108491
18	10108487	65	10108493
20	10108488	80	10108474
25	10108489	100	10108463
30	10108490	—	—
Compatible Fuseholders			
SMD-20 (125 kV BIL)			10107507
SMD-20 (150 kV BIL)			10107506

Note(s):

1. The X-Limiter is only used in the 12 kV, 16 kV, and 14.4/25 kV systems.
2. The X-Limiter can be used in HFRA.
3. The 65-A, 80-A, and 100-A X-Limiter fuses are of double-barreled configuration.
4. The 150 kV BIL SMD-20 fuseholder is used in contaminated areas A and B per insulation area map GR 215.
5. The SMD-20 fuseholder can be used to break loads using the loadbuster tool.
6. The X-Limiter fuse is a full-range current-limiting type fuse that can be used in HFRA and in applications where current limitation is desired.

Table PR 107–7: SMU-20 Fusing — 25 kV Rating

Amp Size	SAP	Amp Size	SAP
6K	10182305	15E	10182307
8K	10108707	25E	10182308
12K	10182306	40E	10182310
Compatible Fuseholders			
25 kV SMD-20 (150 kV BIL)			10107361

Note(s):

1. The 25 kV SMU-20 is approved for HFRA.

Table PR 107–8: SMU-20 Fuse — 34.5 kV Rating

Amp Size	SAP	Amp Size	SAP
3K	10108825	25E	10108832
6K	10108826	30E	10108833
8K	10108827	40E	10108834
10K	10108828	50E	10108835
12K	10108829	65E	10108836
15E	10108830	80E	10108837
20E	10108831	100E	10108839
Compatible Fuse Holder			
34.5 kV SMD-20			10107516

Note(s):

1. The 34.5 SMU-20 is used in the 35 kV system.
2. 34.5 kV SMD-20 can be used to break loads using the 33 kV loadbuster tool.
3. To use the 33 kV SMD-20 fuseholder with the older design (SAP 10107515 — Key 6), use fuse adapter SAP 10107599.
4. The 34.5 kV SMU-20 is approved for HFRA.

Table PR 107–9: SMD-1A Fuse — 34.5 kV Rating

Amp Size	SAP	Amp Size	SAP
3E	10108764	25E	10108784
5E	10108765	30E	10108785
7E	10108766	40E	10108786
10E	10108767	50E	10108787
13E	10108768	65E	10108788
15E	10108782	80E	10108789
20E	10108783	100E	10108790
Compatible Fuse Holder			
34.5 kV SMD-1A			10107518

Note(s):

1. The 34.5 kV SMD-1A fuse is used only in the 33 kV system.
2. 34.5 kV SMD-1A cannot break loads and should only be opened when the circuit is de-energized or when all secondary load has been disconnected from the transformer.
3. SMD-1A requires two crossarms for mounting.
4. The 34.5 kV SMD-1A fuse is not be used in HFRA.

Table PR 107–10: 34.5 kV Fault Tamer Fuse Cartridge

Amp Size	SAP	Amp Size	SAP
3	10108481	10	10108449
5	10108483	15	10108485
7	10108484	—	—
Compatible Fuse Holder [a/] [b/]			
38 kV Fuse Cutout			10107406

[a/] Use SAP 10107401 for complete assembly including fuseholder (less cartridge).
[b/] Use SAP 10159141 for 34.5 kV Fault Tamer fuse (less cartridge and fuseholder).

Note(s):

1. The 34.5 kV Fault Tamer is used only in the 33 kV system (see PR 128).
2. 34.5 kV Fault Tamer can be used in HFRA.
3. The 38 kV Fuse Cutout can be used to break loads using the 33 kV loadbuster tool.
4. The 34.5 kV Fault Tamer is no longer manufactured. Existing stock may be used to depletion. The Fuse cartridges listed above are still available from the manufacturer, for replacement purposes in existing installations.

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PR 108 Fuse Application Guides

Scope PR 108.1 4 kV through 16 kV Applications

Table PR 108–1: Fuse Application Guide for 4 kV Overhead Branch Lines

Branch Fuse (SMU-20/Link) (See Note 4)	MAX Load on Branch			Largest Transformer on Branch (See Note 1)			MIN Ground Relay MIN Trip (Amps) (See Note 3)
	MAX Load Current (Amps)	Connected Load Total kVA (See Note 2)		Transformer Equipment Fuse Size (SMU/Link)	1Ø 2.4 kV Transf. (kVA)	3Ø Transf. (kVA)	
		1Ø Branch (2.4 kV)	3Ø Branch				
15E/15	11	25	75	10K/10	10	30	30
25E/25	17	40	120	10K/15	15	45	60
40E/40	32	75	225	25E/25	25	75	120

Note(s):

1. Application of branch line fusing requires Field Engineering approval.
2. The largest transformer on the branch is determined by the maximum equipment fuse that will coordinate with the branch fuse. However, high-duty faults (within one-half mile of the substation) occurring at the equipment bushings may still interrupt both the equipment fuse and the branch fuse.
3. For three-phase branch lines, the total kVA includes both single-phase and three-phase transformation, and assumes that the single-phase loads are balanced for all three phases.
4. Branch fuses installed within one mile of the substation may not coordinate with the substation ground relay Instantaneous Trip (IT) settings, where applicable.
5. See Table PR 107–1 for fuse link SAP numbers. See Table PR 107–3 for SMU-20 SAP numbers.

EXAMPLE:

Using Table PR 108–1, consider the following scenario and determine what action, if any, is required:

- Existing 4 kV branch-line fuse = 15E
- Existing connected load = 25 kVA single-phase
- Additional load to be connected = two 10 kVA single-phase transformers

What action is required?

ANSWER:

Due to 4 kVA connected load on radial, 40E branch-line fuse is required.

Table PR 108–2: Fuse Application Guide for 12 kV Overhead Branch Lines

Branch Fuse (SMU-20 Slow) (See Note 3)	MAX Load on Branch			Largest Transformer on Branch (See Note 1)			MIN Ground Relay MIN Trip (Amps)
	MAX Load Current (Amps)	Connected Load Total kVA (See Note 2)		Transformer Equipment Fuse Size (SMU/Link)	1Ø 12 kV Transf. (kVA)	3Ø Transf. (kVA)	
		1Ø Branch	3Ø Branch				
15E	11	130	225	10K/10	50	75	30
25E	17	200	360	10K/10	50	75	60
40E	32	380	690	25E/15	100	225	100
50E	40	480	860	30E/30	100	225	120
80E	62	740	1400	50E/50	250	500	180

Note(s):

1. Application of branch line fusing requires Field Engineering approval.
2. The largest transformer on the branch is determined by the maximum equipment fuse that will coordinate with the branch fuse. However, high-duty faults (above 2500 A) occurring at the equipment bushings may still interrupt both the equipment fuse and the branch fuse.
3. For three-phase branch lines, the total kVA includes both single-phase and three-phase transformation, and assumes that the single-phase loads are balanced for all three phases.
4. See Table PR 107–3 for SMU-20 SAP numbers.

EXAMPLE:

Using Table PR 108–2, consider the following scenario and determine what action, if any, is required:

- Existing 12 kV branch-line fuse = 25E
- Existing connected load = 100 kVA single-phase
- Additional load to be connected = one 75 kVA single-phase transformers

What action is required?

ANSWER:

40E branch-line fuse is required due to the addition of a 75 kVA transformer. The largest single-phase transformer allowed with a 25E fuse is only 50 kVA.

Table PR 108–3: Fuse Application Guide for 16 kV Overhead Branch Lines

Branch Fuse (SMU-20 Slow) (See Note 3)	MAX Load on Branch			Largest Transformer on Branch (See Note 1)			MIN Ground Relay MIN Trip (Amps)
	MAX Load Current (Amps)	Connected Load Total kVA (See Note 2)		Transformer Equipment Fuse Size (SMU/Link)	1Ø 16 kV Transf. (kVA)	3Ø Transf. (kVA)	
		1Ø Branch	3Ø Branch				
15E	11	175	300	10K/10	75	112.5	30
25E	17	270	470	10K/10	75	112.5	60
40E	32	510	880	25E/15	167	300	100
50E	40	640	1,110	30E/30	167	300	120
80E	62	990	1,700	50E/50	333	500	180

Note(s):

1. Application of branch line fusing requires Field Engineering approval.
2. The largest transformer on the branch is determined by the maximum equipment fuse that will coordinate with the branch fuse. However, high-duty faults (above 2500 A) occurring at the equipment bushings may still interrupt both the equipment fuse and the branch fuse.
3. For three-phase branch lines, the total kVA includes both single-phase and three-phase transformation, and assumes that the single-phase loads are balanced for all three phases.
4. See Table PR 107–3 for SMU-20 SAP numbers.

Table PR 108–4: Fuse Application Guide for 14.4/25 kV Overhead Branch Lines with 14.4 kV SMU-20 Fuses

14.4 kV Branch Fuse (14.4 kV SMU-20) (see Note 4)	MAX Load on Branch			Largest Transformer on Branch			MIN Ground Relay MIN Trip (Amps)
	MAX Load Current (Amps)	Connected Load Total kVA		Transformer Equipment Fuse Size (SMU-20/Link)	1Ø Transf. (kVA)	3Ø Transf. (kVA)	
		1Ø Branch	3Ø Branch				
15E	11	160	275	8A ELF 10K/10 Fault Tamer	50 50 N/A	150 150 N/A	30
25E	17	240	420	12A ELF 12K/15 Fault Tamer 15A	75 75 75	225 225 225	60
40E	32	460	800	18A ELF 15E/20 Fault Tamer 15A	100 100 100	300 300 300	80
50E	40	575	1000	25A ELF 25E/25 Fault Tamer 15A	167 167 100	500 500 300	105
65E	45	650	1120	30A ELF 40E/40 Fault Tamer 15A	167 167 100	500 500 300	135
80E	62	890	1500	40A ELF 50E/50 Fault Tamer 15A	167 167 100	167 167 100	180

Note(s):

1. Application of branch line fusing requires Field Engineering approval.
2. The largest transformer on the branch is determined by the maximum equipment fuse that will coordinate with the branch fuse. However, high-duty faults (above 2500 A) occurring at the equipment bushings may still interrupt both the equipment fuse and the branch fuse.
3. For three-phase branch lines, the total kVA includes both single-phase and three-phase transformation, and assumes that the single-phase loads are balanced for all three-phases.
4. See PR 107 for SMU-20 SAP numbers.

Table PR 108–5: Fuse Application Guide for 33 kV Overhead Branch Lines with 34.5 kV SMU-20 Fuses

33 kV Branch Fuse (34.5 kV SMU-20) (see Note 4)	MAX Load on Branch			Largest Transformer on Branch			MIN Ground Relay MIN Trip (Amps)
	MAX Load Current (Amps)	Connected Load Total kVA		Transformer Equipment Fuse Size (SMU-20)	1Ø Branch Transf. (kVA)	3Ø Transf. (kVA)	
		1Ø Branch	3Ø Branch				
10K	6	200	350	6K	50	75	18
15E	11	360	625	10K	100	150	30
25E	17	560	975	10K	100	150	60
40E	32	1050	1500	25E	333	500	80
50E	40	1320	1500	30E	333	750	105
65E	45	1500	1500	40E	333	1000	135

Note(s):

1. Application of Branch Line Fusing requires Field Engineering approval.
2. The largest transformer on the branch is determined by the maximum equipment fuse that will coordinate with the branch fuse. However, high-duty faults (above 2500 A) occurring at the equipment bushings may still interrupt both the equipment fuse and the branch fuse.
3. For three-phase branch lines, the total kVA includes both single-phase and three-phase transformation, and assumes that the single-phase loads are balanced for all three-phases.
4. Branch fuses installed within one mile of the substation may not coordinate with the substation ground relay instantaneous trip (IT) settings, where applicable.
5. See PR 107 for SMU-20 SAP numbers.

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PR 110 Transformer Fusing Practices — 2.4 kV 3-Wire

Scope PR 110.1 Fuse Tables — 2.4 kV — Conventional Transformers

Table PR 110–1: 2.4 kV 1-Phase

kVA Size[a/]	Fuse Link	8 kV ELF[b/]
5	5	6
10	10	12
15	15	18
25	25	25
37-1/2	40	40
50	50	50
75	65	65
100	100	80
167	—	—

[a/] 2.4 kV transformer connected line-to-line

[b/] The ELF Fuse is a full-range, current-limiting type fuse that can be used in High Fire Risk Areas (HFRA) and in applications where current-limitation is desired.

Figure PR 110–1: 2.4 kV 1-Phase Wiring Connection

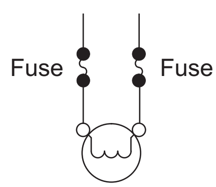
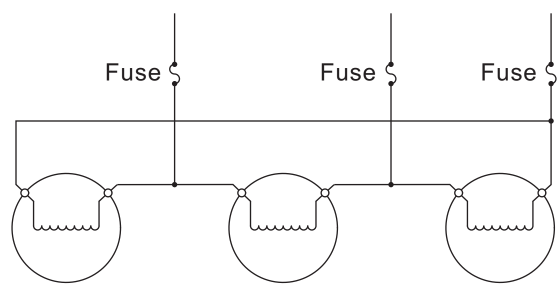


Table PR 110–2: 2.4 kV 3-Phase Delta

kVA Size	Fuse Link	8 kV ELF[a/]
15 or 3x5	10	8
30 or 3x10	20	18
45 or 3x15	25	25
75 or 3x25	40	40
112-1/2 or 3x37-1/2	65	65
150 or 3x50	80	80
225 or 3x75	100	—
300 or 3x100	—	—

[a/] The ELF Fuse is a full-range, current-limiting type fuse that can be used in HFRA and in applications where current-limitation is desired.

Figure PR 110–2: 3-Phase Delta Wiring Connection



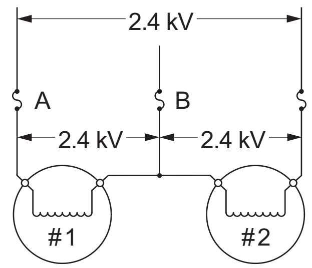
Note(s):

1. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.
2. Do not use Type CP, CSP, or FI Transformer in any closed delta bank.

Table PR 110–3: 2.4 kV Open Delta Bank

kVA Size		Fuse Link		8 kV ELF Fuse	
#1	#2	Fuse A	Fuse B or C	Fuse A	Fuse B or C
5	5	5	5	6	6
5	10	5	10	6	12
5	15	5	15	6	18
5	25	5	25	6	25
5	37.5	5	40	6	40
5	50	5	50	6	50
5	75	5	65	6	65
5	100	5	80	6	80
10	10	10	10	12	12
10	15	10	15	12	18
10	25	10	25	12	25
10	37.5	10	40	12	40
10	50	10	50	12	50
10	75	10	65	12	65
10	100	10	80	12	80
15	15	15	15	18	18
15	25	15	25	18	25
15	37.5	15	40	18	40
15	50	15	50	18	50
15	75	15	65	18	65
15	100	15	80	18	80
25	25	25	25	25	25
25	37.5	25	40	25	40
25	50	25	50	25	50
25	75	25	65	25	65
25	100	25	80	25	80
37.5	37.5	40	40	40	40
37.5	50	40	50	40	50
37.5	75	40	65	40	65
37.5	100	40	80	40	80
50	50	50	50	50	50
50	75	50	65	50	65
50	100	50	80	50	80
75	75	65	65	65	65
75	100	65	80	65	80
100	100	80	80	80	80

Figure PR 110–3: 2.4 kV Open Delta Bank Wiring Connection



Note(s):

1. The ELF fuse is a full-range, current-limiting type fuse that can be used in HFRA and in applications where current-limitation is desired.
2. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.

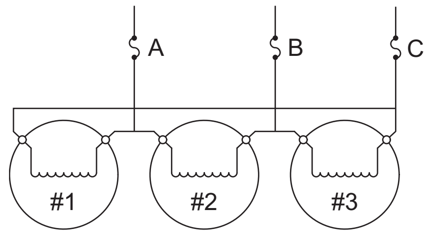
Table PR 110–4: 2.4 kV Delta Bank Having Unequal Transformer Units to Serve Combination 1-Phase and 3-Phase Loads

kVA Size		Fuse Link		8 kV ELF Fuse[1]	
#1 or #3	**#2**	**Fuse A or B**	**Fuse C**	**Fuse A or B**	**Fuse C**
5	10	15	10	12	8
5	15	20	10	18	8
10	15	25	20	20	18
10	25	30	20	30	18
15	25	40	25	40	25
15	37.5	50	25	50	25
25	37.5	50	40	50	40
25	50	65	40	65	40
37.5	50	65	65	65	65
37.5	75	80	65	80	65
50	75	100	80	—	—
50	100	100	80	—	—

Note(s):

1. The ELF fuse is a full-range, current-limiting type fuse that can be used in HFRA and in applications where current-limitation is desired.
2. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.
3. Do not use type CP, CSP, or FI transformer in any closed delta bank.

Figure PR 110–4: 2.4 kV Delta Bank Having Unequal Transformer Units Wiring Connection



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PR 112 Transformer Fusing Practices — 2.4/4.16 kV 4-Wire

Scope PR 112.1 Fuse Tables — 2.4/4.16 kV — 4-Wire Grounded or Isolated Neutral

Table PR 112–1: 2.4 and 4.16 kV 1-Phase

kVA Size[a]	2.4 kV		4.16 kV	
	Fuse Link	8 kV ELF[b]	Fuse Link	8 kV ELF[b]
5	5	6	3	6
10	10	12	5	6
15	15	18	10	8
25	25	25	15	18
37.5	40	40	20	20
50	50	50	25	25
75	65	65	40	40
100	100	80	50	50
167	—	—	80	80

[a] 2.4 kV transformers are connected line-to-neutral. 4.16 kV transformers are connected line-to-line.
[b] The ELF Fuse is a full-range current-limiting type fuse that can be used in High Fire Risk Areas (HFRA) and in applications where current-limitation is desired.

Table PR 112–2: 2.4/4.16 kV 3-Phase Wye

kVA Size	Fuse Link	8 kV ELF[a]
15 or 3x5	5	6
30 or 3x10	10	12
45 or 3x15	15	18
75 or 3x25	25	25
112.5 or 3x37.5	40	40
150 or 3x50	50	50
225 or 3x75	65	65
300 or 3x100	100	80
500 or 3x167	—	—

[a] The ELF Fuse is a full-range, current-limiting type fuse that can be used in HFRA and in applications where current-limitation is desired.

Note(s):

1. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.
2. For Wye banks with transformers of unequal sizes, fuse each phase as shown in the 2.4 kV 1-phase table for that particular transformer alone.

Figure PR 112–1: Connection Diagrams for Installing Transformers on Grounded Neutral Systems

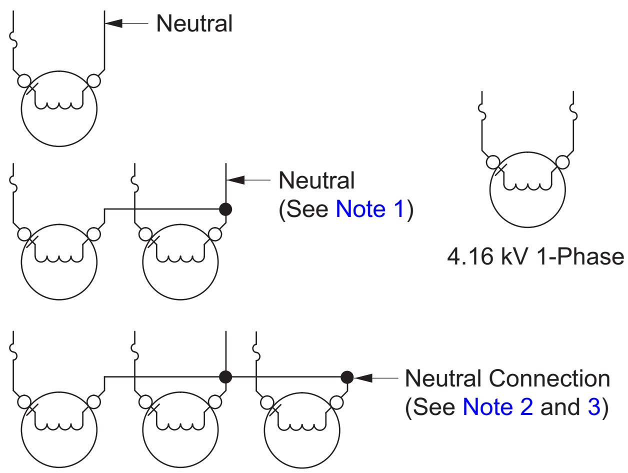
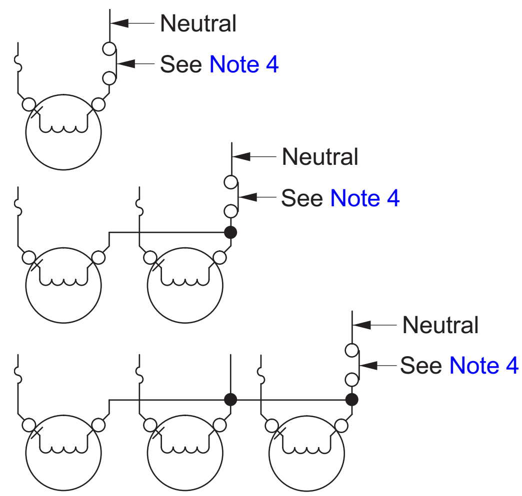


Figure PR 112–2: Connection Diagram for Isolated Neutral 4-Wire Systems



Note(s):

1. Open Wye banks (2 transformers) shall be connected to the system neutral.
2. Closed Wye-delta banks (3 transformers) shall **not** be connected to the system neutral.
3. Wye-Wye banks (3 transformers) shall be connected to the system neutral.
4. Cutout (SAP 10107450) with solid blade (SAP 10107394).

PR 114 Transformer Fusing Practices — 4.8 kV 3-Wire

Scope PR 114.1 Fuse Tables — 4.8 kV — Conventional Transformers

Table PR 114–1: 4.8 kV 1-Phase

kVA Size	Fuse Link	8 kV ELF[a/]
5	3	6
10	7	6
15	10	8
25	15	18
37.5	20	20
50	25	25
75	40	40
100	50	50
167	80	80
250	—	—

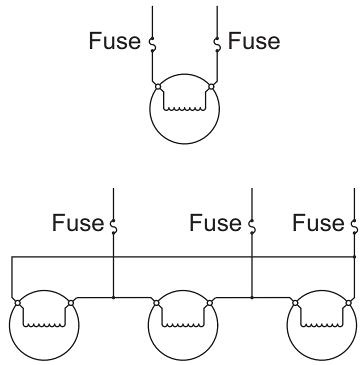
[a/] The ELF fuse is a full-range current-limiting type fuse that can be used in High Fire Risk Areas (HFRA) and in applications where current-limitation is desired.

Table PR 114–2: 4.8 kV 3-Phase Delta

kVA Size	Fuse Link	8 kV ELF[a/]
15 or 3x5	5	6
30 or 3x10	10	12
45 or 3x15	15	18
75or 3x25	25	25
112.5 or 3x37.5	40	40
150 or 3x50	50	50
225 or 3x75	65	65
300 or 3x100	80	80

[a/] The ELF fuse is a full-range, current-limiting type fuse that can be used in HFRA and in applications where current-limitation is desired.

Figure PR 114–1: 4.8 kV 1-Phase Wiring Connection and 4.8 kV 3-Phase Wiring Connection



Note(s):

1. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.
2. Do not use Type CP, CSP, or FI Transformer in any closed delta bank.

Table PR 114–3: 4.8 kV Open Delta Bank

kVA Size		Fuse Link		8 kV ELF[a/]	
#1	#2	Fuse A	Fuse B or C	Fuse A	Fuse B or C
5	5	3	3	6	6
5	10	3	7	6	8
5	15	3	10	6	12
5	25	3	15	6	18
5	37.5	3	20	6	20
5	50	3	25	6	25
5	75	3	40	6	40
5	100	3	50	6	50
5	167	3	80	6	80
10	10	7	7	8	8
10	15	7	10	8	12
10	25	7	15	8	18
10	37.5	7	20	8	20
10	50	7	25	8	25
10	75	7	40	8	40
10	100	7	50	8	50
10	167	7	80	8	80
15	15	10	10	12	12
15	25	10	15	12	18
15	37.5	10	20	12	20
15	50	10	25	12	25
15	75	10	40	12	40
15	100	10	50	12	50
15	167	10	80	12	80
25	25	15	15	18	18
25	37.5	15	20	18	20
25	50	15	25	18	25
25	75	15	40	18	40
25	100	15	50	18	50
25	167	15	80	18	80
37.5	37.5	20	20	20	20
37.5	50	20	25	20	25
37.5	75	20	40	20	40
37.5	100	20	50	20	50
37.5	167	20	80	20	80
50	50	25	25	25	25
50	75	25	40	25	40
50	100	25	50	25	50
50	167	25	80	25	80
75	75	40	40	40	40

Table PR 114–3: 4.8 kV Open Delta Bank *(Continued)*

kVA Size		Fuse Link		8 kV ELF[a/]	
#1	#2	Fuse A	Fuse B or C	Fuse A	Fuse B or C
75	100	40	50	40	50
75	167	40	80	40	80
100	100	50	50	50	50
100	167	50	80	50	80
167	167	80	80	80	80

[a/] The ELF Fuse is a full-range, current-limiting type fuse that can be used in HFRA and in applications where current-limitation is desired.

Note(s):

1. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.

Figure PR 114–2: 4.8 kV Open Delta Wiring Connection

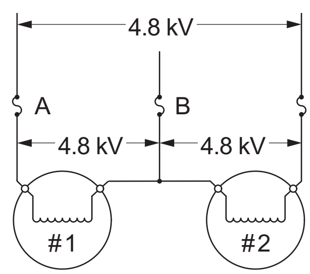


Table PR 114–4: 4.8 kV Delta Bank having Unequal Transformer Units to Serve Combination 1- and 3-Phase Loads

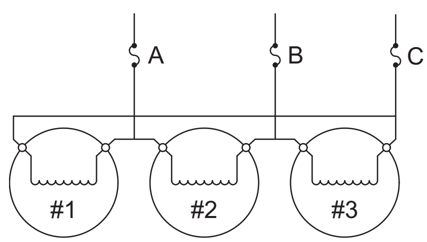
kVA Size		Fuse Link		8 kV ELF[a/]	
#1 or #3	#2	Fuse A or B	Fuse C	Fuse A or B	Fuse C
5	10	10	5	8	6
5	15	10	5	12	6
10	15	10	10	12	8
10	25	15	10	18	8
15	25	20	15	20	18
15	37.5	25	15	25	18
25	37.5	30	25	30	25
25	50	40	25	40	25
37.5	50	40	40	40	40
37.5	75	50	40	50	40
50	75	50	50	50	50
50	100	65	50	65	50
75	100	80	65	80	65
75	167	100	65	—	—
100	167	100	80	—	—

[a/] The ELF fuse is a full-range, current-limiting type fuse that can be used in HFRA and in applications where current-limitation is desired.

Note(s):

1. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.
2. Do not use Type CP, CSP, or FI Transformer in any closed delta bank.

Figure PR 114–3: 4.8 kV Delta Bank Having Unequal Transformer Units Wiring Connection



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PR 115 Transformer Fusing Practices — 6.9/9.4 kV Single-Phase

Scope PR 115.1 Fuse Tables — 6.9/9.4 kV Single-Phase Underground Transformer Served from Overhead Circuit

Table PR 115–1: 6.9 kV 1-Phase

kVA	Fuse Link	SMU-20	15 kV ELF	Fault Tamer
25	10	8K	8	10
50	20	20E	18	20
75	25	25E	25	—
100	30	30E	30	—
167	50	50E	50	—
250	80	80E	—	—

Table PR 115–2: 9.4 kV 1-Phase

kVA	Fuse Link	SMU-20	15 kV ELF	Fault Tamer
25	7	8K	8	7
50	15	15E	12	15
75	20	20E	18	20
100	25	25E	25	—
167	40	40E	40	—
250	65	65E	—	—

Note(s):

1. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.
2. The ELF fuse is a full-range current-limiting type fuse that can be used in applications where current limitation is desired.
3. The SMU-20 and the ELF fuse can be used in High Fire Risk Areas (HFRA).

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PR 116 Transformer Fusing Practices — 7.2 kV 3-Wire

Scope PR 116.1 Fuse Tables — 7.2 kV — Conventional Transformers

Table PR 116–1: 7.2 kV 1-Phase

kVA Size	Fuse Link	SMU-20	8 kV ELF[a/]
5	3	3K	6
10	5	6K	6
15	7	6K	6
25	10	10K	8
37.5	15	12K	12
50	20	20E	18
75	25	25E	25
100	30	30E	30
167	50	50E	50
250	80	80E	80

[a/] The ELF fuse is a full-range current-limiting type fuse.

Table PR 116–2: 7.2 kV 3-Phase Delta

kVA Size	Fuse Link	SMU-20	8 kV ELF[a/]
15 or 3x5	5	6K	6
30 or 3x10	7	6K	8
45 or 3x15	10	10K	12
75or 3x25	15	15E	18
112.5 or 3x37.5	20	20E	20
150 or 3x50	25	25E	25
225 or 3x75	40	40E	40
300 or 3x100	50	50E	50
500 or 3x167	80	80E	80

[a/] The ELF fuse is a full-range, current-limiting type fuse.

Note(s):

1. SMU-20 and ELF fuses can be used in High Fire Risk Areas (HFRA).
2. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.
3. Do not use type CP, CSP, or FI transformer in any closed delta bank.

Figure PR 116–1: 7.2 kV 1-Phase Wiring Connection and 7.2 kV 3-Phase Delta Wiring Connection

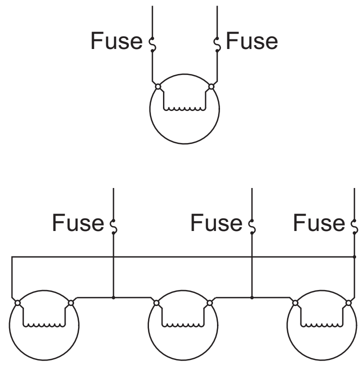


Table PR 116–3: 7.2 kV Open Delta Bank

Transformer Size - kVA		Fuse Link		SMU-20		8 kV ELF[a/]	
#1	**#2**	**Fuse A**	**Fuse B or C**	**Fuse A**	**Fuse B or C**	**Fuse A**	**Fuse B or C**
5	5	3	3	3K	3K	6	6
5	10	3	3	3K	6K	6	6
5	15	3	5	3K	6K	6	6
5	25	3	10	3K	8K	6	8
5	37.5	3	15	3K	12K	6	12
5	50	3	20	3K	15K	6	18
5	75	3	25	3K	25K	6	25
5	100	3	30	3K	30K	6	30
5	167	3	50	3K	50K	6	50
10	10	3	3	6K	6K	6	6
10	15	3	5	6K	6K	6	6
10	25	3	10	6K	8K	6	8
10	37.5	3	15	6K	12K	6	12
10	50	3	20	6K	15K	6	18
10	75	3	25	6K	25K	6	25
10	100	3	30	6K	30K	6	30
10	167	3	50	6K	50K	6	50
15	15	5	5	6K	6K	6	6
15	25	5	10	6K	8K	6	8
15	37.5	5	15	6K	12K	6	12
15	50	5	20	6K	15K	6	18
15	75	5	25	6K	25K	6	25
15	100	5	30	6K	30K	6	30
15	167	5	50	6K	50K	6	50
25	25	10	10	8K	8K	8	8
25	37.5	10	15	8K	12K	8	12
25	50	10	20	8K	15K	8	18
25	75	10	25	8K	25K	8	25
25	100	10	30	8K	30K	8	30
25	167	10	50	8K	50K	8	50
37.5	37.5	15	15	12K	12K	12	12
37.5	50	15	20	12K	15K	12	18
37.5	75	15	25	12K	25K	12	25
37.5	100	15	30	12K	30K	12	30
37.5	167	15	50	12K	50K	12	50
50	50	20	20	15E	15E	18	18
50	75	20	25	15E	25E	18	25
50	100	20	30	15E	30E	18	30
50	167	20	50	15E	50E	18	50
75	75	25	25	25E	25E	25	25
75	100	25	30	25E	30E	25	30
75	167	25	50	25E	50E	25	50
100	100	30	30	30E	30E	30	30
100	167	30	50	30E	50E	30	50
167	167	50	50	50E	50E	50	50

[a/] The ELF Fuse is a full-range, current-limiting type fuse.

Note(s):

1. SMU-20 and ELF fuses can be used in HFRA.
2. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.

Figure PR 116–2: 7.2 kV Open Delta Bank Wiring Connection

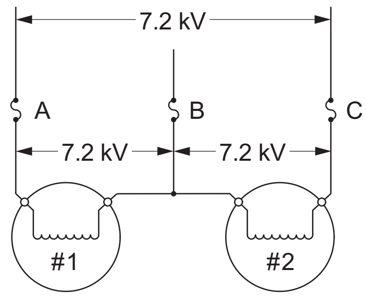


Table PR 116–4: 7.2 kV Delta Bank Having Unequal Transformer Units to Serve Combination 1- and 3-Phase Loads

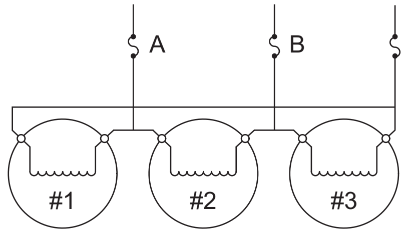
Transformer Size—kVA		Fuse Link		SMU-20		8 kV ELF[a/]	
#1 or #3	#2	Fuse A or B	Fuse C	Fuse A or B	Fuse C	Fuse A or B	Fuse C
5	10	5	5	6K	6K	6	6
5	15	7	5	6K	6K	6	6
10	15	7	7	8K	8K	8	8
10	25	10	7	12K	8K	12	8
15	25	10	10	12K	10K	12	12
15	37.5	15	10	15K	10K	18	12
25	37.5	20	15	20E	15E	20	18
25	50	25	15	25E	15E	25	18
37.5	50	25	20	25E	20E	25	25
37.5	75	30	20	30E	20E	30	25
50	75	40	30	40E	30E	40	30
50	100	50	30	50E	30E	40	30
75	100	50	40	50E	40E	50	40
75	167	65	40	65E	40E	65	40
100	167	80	50	65E	50E	65	50

[a/] The ELF fuse is a full-range, current-limiting type fuse.

Note(s):

1. SMU-20 and ELF fuses can be used in HFRA.
2. See Section PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.
3. Do not use type CP, CSP, or FI transformer in any closed delta bank.

Figure PR 116–3: 7.2 kV Delta Bank Having Unequal Transformer Units Wiring Connection



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PR 118 Transformer Fusing Practices — 12 kV

Scope PR 118.1 Fuse Tables — 12 kV — Conventional Transformers

Table PR 118–1: 12 kV 1-Phase

kVA Size	Fuse Link	Fault Tamer	SMU-20	15 kV ELF	X-Limiter
5	3	3	3K	6	10
10	3	3	3K	6	10
15	3	3	3K	6	10
25	5	5	6K	6	10
37.5	7	7	8K	8	10
50	10	10	10K	12	12
75	15	15	15E	18	18
100	20	20	20E	20	20
167	30	—	30E	30	30
250	50	—	50E	50	50
333	65	—	65E	—	65
500	80	—	80E	—	80

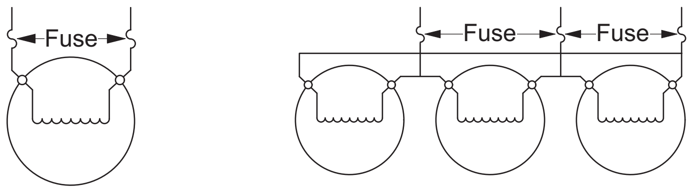
Table PR 118–2: 12 kV 3-Phase

kVA Size	Fuse Link	Fault Tamer	SMU-20	15 kV ELF	X-Limiter
15 or 3x5	3	3	3K	6	10
30 or 3x10	3	3	3K	6	10
45 or 3x15	5	5	6K	6	10
75 or 3x25	10	10	8K	8	10
112.5 or 3x37.5	15	15	15E	12	12
150 or 3x50	20	20	20E	18	18
225 or 3x75	25	—	25E	25	25
300 or 3x100	30	—	30E	30	30
500 or 3x167	50	—	50E	50	65
750 or 3x250	80	—	80E	—	80
1000 or 3x333	100	—	100E	—	100
1500 or 3x500	—	—	—	—	—

Note(s):

1. ELF and X-Limiter fuses are full-range, current-limiting type fuses.
2. SMU-20, Fault Tamer, ELF, and X-Limiter fuses can be used in High Fire Risk Areas (HFRA).
3. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.
4. Do not use Type CP, CSP, or FI Transformer in any closed delta bank.

Figure PR 118–1: 12 kV 1-Phase Wiring Connection and 12 kV 3-Phase Wiring Connection



What's Changed? Updated "High Fire Hazard Area" to "High Fire Risk Areas".

Table PR 118–3: 12 kV Open Delta Bank

kVA Size		Fuse Link/Fault Tamer[a/]		SMU-20		15 kV ELF	
#1	#2	Fuse A	Fuse B or C	Fuse A	Fuse B or C	Fuse A	Fuse B or C
5	5	3	3	3K	3K	6	6
5	10	3	3	3K	3K	6	6
5	15	3	3	3K	3K	6	6
5	25	3	5	3K	6K	6	6
5	37.5	3	7	3K	8K	6	8
5	50	3	10	3K	10K	6	12
5	75	3	15	3K	15K	6	18
5	100	3	20	3K	20K	6	20
5	167	3	30	3K	30K	6	30
10	10	3	3	3K	3K	6	6
10	15	3	3	3K	3K	6	6
10	25	3	5	3K	6K	6	6
10	37.5	3	7	3K	8K	6	8
10	50	3	10	3K	10K	6	12
10	75	3	15	3K	15K	6	18
10	100	3	20	3K	20K	6	20
10	167	3	30	3K	30K	6	30
15	15	3	3	3K	3K	6	6
15	25	3	5	3K	6K	6	6
15	37.5	3	7	3K	8K	6	8
15	50	3	10	3K	10K	6	12
15	75	3	15	3K	15K	6	18
15	100	3	20	3K	20K	6	20
15	167	3	30	3K	30K	6	30
25	25	5	5	6K	6K	6	6
25	37.5	5	7	6K	8K	6	8
25	50	5	10	6K	10K	6	12
25	75	5	15	6K	15K	6	18
25	100	5	20	6K	20K	6	20

Table PR 118–3: 12 kV Open Delta Bank *(Continued)*

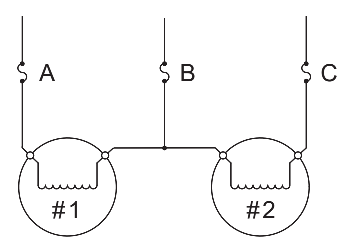
kVA Size		Fuse Link/Fault Tamer[a/]		SMU-20		15 kV ELF	
#1	#2	Fuse A	Fuse B or C	Fuse A	Fuse B or C	Fuse A	Fuse B or C
25	167	5	30	6K	30K	6	30
37.5	37.5	7	7	8K	8K	8	8
37.5	50	7	10	8K	10K	8	12
37.5	75	7	15	8K	15K	8	18
37.5	100	7	20	8K	20K	8	20
37.5	167	7	30	8K	30K	8	30
50	50	10	10	10K	10K	12	12
50	75	10	15	10K	15K	12	18
50	100	10	20	10K	20K	12	20
50	167	10	30	10K	30K	12	30
75	75	15	15	15E	15E	18	18
75	100	15	20	15E	20E	18	20
75	167	15	30	15E	30E	18	30
100	100	20	20	20E	20E	20	20
100	167	20	30	20E	30E	20	30
167	167	30	30	30E	30E	30	30

[a/] Fault tamer fuse link is limited to 20 A size. Do not use fault tamer if any of the transformers in a bank are larger than 100 kVA.

Note(s):

1. The ELF fuse is a full-range, current-limiting type fuse.
2. SMU-20, ELF, and fault tamer fuses can be used in HFRA.
3. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.

Figure PR 118–2: 12 kV Open Delta Bank Wiring Connection



What's Changed? Updated "High Fire Hazard Area" to "High Fire Risk Areas".

Table PR 118–4: 12 kV Delta Bank Having Unequal Transformer Units to Serve Combination Single- and Three-Phase Loads

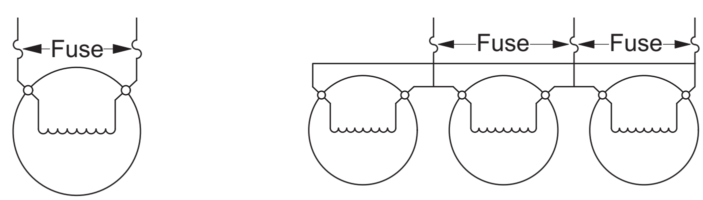
kVA Size		Fuse Link/Fault Tamer[a/]		SMU-20		15 kV ELF	
#1 or #3	#2	Fuse A or B	Fuse C	Fuse A or B	Fuse C	Fuse A or B	Fuse C
5	10	3	3	3K	3K	6	6
5	15	5	3	6K	3K	6	6
10	15	5	5	6K	6K	6	6
10	25	7	5	6K	6K	6	6
15	25	7	5	8K	6K	8	6
15	37.5	10	5	10K	6K	12	6
25	37.5	10	10	10K	8K	12	8
25	50	15	10	15K	8K	12	8
37.5	50	15	15	15K	12K	18	12
37.5	75	20	15	20K	12K	20	12
50	75	20	20	20E	15E	20	18
50	100	25	20	25E	15E	25	18
75	100	30	25	30E	25E	30	25
75	167	40	25	40E	25E	40	25
100	167	40	30	40E	30E	40	30

[a/] Fault tamer fuse link is limited to 20 A size. Do not use fault tamer if any of the transformers in a bank are larger than 100 kVA.

Note(s):

1. The ELF fuse is a full-range, current-limiting type fuse.
2. SMU-20, ELF, and fault tamer fuses can be used in HFRA.
3. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.
4. Do not use type CP, CSP, or FI transformer in any closed delta bank.

Figure PR 118–3: 12 kV Delta Bank Having Unequal Transformer Units Wiring Connection



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PR 120 Transformer Fusing Practices — 16 kV

Scope PR 120.1 Fuse Tables — 16 kV — Conventional Transformers

Table PR 120–1: 16 kV Single-Phase

kVA Size	Fuse Link	Fault Tamer	SMU-20	15 kV ELF	X-Limiter
5	3	3	3K	6	10
10	3	3	3K	6	10
15	3	3	3K	6	10
25	5	5	6K	6	10
37.5	5	5	6K	6	10
50	7	7	8K	8	10
75	10	10	10K	12	12
100	15	15	15E	18	18
167	25	20	25E	25	25
250	40	—	40E	40	40
333	50	—	50E	50	50
500	65	—	65E	—	65

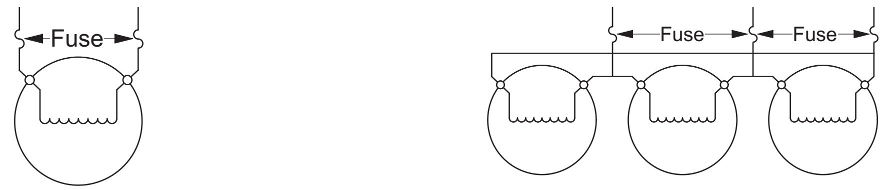
Table PR 120–2: 16 kV Three-Phase

kVA Size	Fuse Link	Fault Tamer	SMU-20	15 kV ELF	X-Limiter
15 or 3x5	3	3	3K	6	10
30 or 3x10	3	3	3K	6	10
45 or 3x15	5	5	6K	6	10
75 or 3x25	7	7	8K	8	10
112.5 or 3x37.5	10	10	10K	8	10
150 or 3x50	15	15	12K	12	12
225 or 3x75	20	20	20E	18	18
300 or 3x100	25	—	25E	25	25
500 or 3x167	40	—	40E	40	40
750 or 3x250	65	—	65E	—	65
1000 or 3x333	80	—	80E	—	80
1500 or 3x500	100	—	100E	—	100

Note(s):

1. ELF and X-Limiter fuses are full-range, current-limiting type fuses.
2. SMU-20, fault tamer, ELF and X-Limiter fuses can be used in High Fire Risk Areas (HFRA).
3. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.
4. Do not use type CP, CSP, or FI transformer in any closed delta bank.

Figure PR 120–1: 16 kV 1-Phase Wiring Connection and 16 kV 3-Phase Wiring Connection



What's Changed? Updated "High Fire Hazard Area" to "High Fire Risk Areas".

Table PR 120–3: 16 kV Open Delta Bank

kVA Size		Fuse Link/Fault Tamer[a/]		SMU-20		15 kV ELF	
#1	#2	Fuse A	Fuse B or C	Fuse A	Fuse B or C	Fuse A	Fuse B or C
5	5	3	3	3K	3K	6	6
5	10	3	3	3K	3K	6	6
5	15	3	3	3K	3K	6	6
5	25	3	5	3K	6K	6	6
5	37.5	3	5	3K	6K	6	6
5	50	3	7	3K	8K	6	8
5	75	3	10	3K	10K	6	12
5	100	3	15	3K	15K	6	18
5	167	3	25	3K	25K	6	25
10	10	3	3	3K	3K	6	6
10	15	3	3	3K	3K	6	6
10	25	3	5	3K	6K	6	6
10	37.5	3	5	3K	6K	6	6
10	50	3	7	3K	8K	6	8
10	75	3	10	3K	10K	6	12
10	100	3	15	3K	15K	6	18
10	167	3	25	3K	25K	6	25
15	15	3	3	3K	3K	6	6
15	25	3	5	3K	6K	6	6
15	37.5	3	5	3K	6K	6	6
15	50	3	7	3K	8K	6	8
15	75	3	10	3K	10K	6	12
15	100	3	15	3K	15K	6	18
15	167	3	25	3K	25K	6	25
25	25	5	5	6K	6K	6	6
25	37.5	5	5	6K	6K	6	6
25	50	5	7	6K	8K	6	8
25	75	5	10	6K	10K	6	12
25	100	5	15	6K	15K	6	18
25	167	5	25	6K	25K	6	25

Table PR 120–3: 16 kV Open Delta Bank *(Continued)*

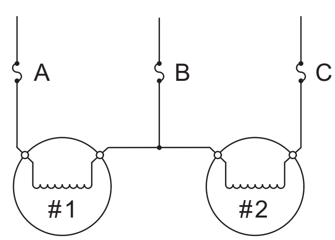
kVA Size		Fuse Link/Fault Tamer[a/]		SMU-20		15 kV ELF	
#1	**#2**	**Fuse A**	**Fuse B or C**	**Fuse A**	**Fuse B or C**	**Fuse A**	**Fuse B or C**
37.5	37.5	5	5	6K	6K	6	6
37.5	50	5	7	6K	8K	6	8
37.5	75	5	10	6K	10K	6	12
37.5	100	5	15	6K	15K	6	18
37.5	167	5	25	6K	25K	6	25
50	50	7	7	8K	8K	8	8
50	75	7	10	8K	10K	8	12
50	100	7	15	8K	15K	8	18
50	167	7	25	8K	25K	8	25
75	75	10	10	10K	10K	12	12
75	100	10	15	10K	15K	12	18
75	167	10	25	10K	25K	12	25
100	100	15	15	15E	15E	18	18
100	167	15	25	15E	25E	18	25
167	167	25	25	25E	25E	25	25

[a/] Fault tamer fuse link is limited to 20 A size. Do not use fault tamer if any of the transformers in a bank are larger than 100 kVA.

Note(s):

1. The ELF fuse is a full-range, current-limiting type fuse.
2. SMU-20, ELF, and fault tamer fuses can be used in HFRA.
3. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.

Figure PR 120–2: 16 kV Open Delta Bank Wiring Connection



What's Changed? Updated "High Fire Hazard Area" to "High Fire Risk Areas".

Table PR 120–4: 16 kV Delta Bank Having Three Unequal Units to Serve Combination Single- and Three-Phase Loads

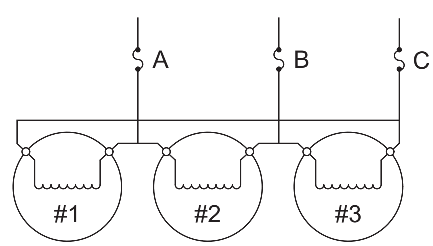
KVA Size		Fuse Link/Fault Tamer[a]		SMU-20		15 kV ELF	
#1 or #3	#2	Fuse A or B	Fuse C	Fuse A or B	Fuse C	Fuse A or B	Fuse C
5	10	3	3	3K	3K	6	6
5	15	3	3	3K	3K	6	6
10	15	3	3	3K	3K	6	6
10	25	5	3	6K	3K	6	6
15	25	5	5	6K	6K	6	6
15	37.5	7	5	8K	6K	8	6
25	37.5	7	7	8K	8K	8	6
25	50	10	7	10K	8K	12	6
37.5	50	10	10	12K	10K	12	8
37.5	75	15	10	15K	10K	18	8
50	75	15	15	15K	12K	18	12
50	100	20	15	20K	12K	20	12
75	100	20	20	20E	20E	20	18
75	167	30	20	30E	20E	30	18
100	167	30	25	30E	25E	30	25

[a] Fault tamer fuse link is limited to 20 A size. Do not use fault tamer if any of the transformers in a bank are larger than 100 kVA.

Note(s):

1. The ELF fuse is a full-range, current-limiting type fuse.
2. SMU-20, ELF, and fault tamer fuses can be used in HFRA.
3. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.
4. Do not use Type CP, CSP, or F1 Transformer in any closed delta bank.

Figure PR 120–3: 16 kV Delta Bank Having Three Unequal Units Wiring Connection



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PR 122 Transformer Fusing Practices — 14.4/25 kV 4-Wire

Scope PR 122.1 Fuse Tables — 14.4/25 kV — 4-Wire Grounded Neutral

Table PR 122–1: 14.4 kV 1-Phase

kVA Size	Fuse Link	SMU-20	15 kV ELF	X-Limiter	15 kV Fault Tamer
5	3	3K	6	10	3
10	3	3K	6	10	3
15	3	3K	6	10	3
25	5	6K	6	10	5
37.5	7	6K	6	10	7
50	10	8K	8	10	10
75	15	12K	12	12	15
100	20	15E	18	18	15
167	25	25E	25	25	N/A

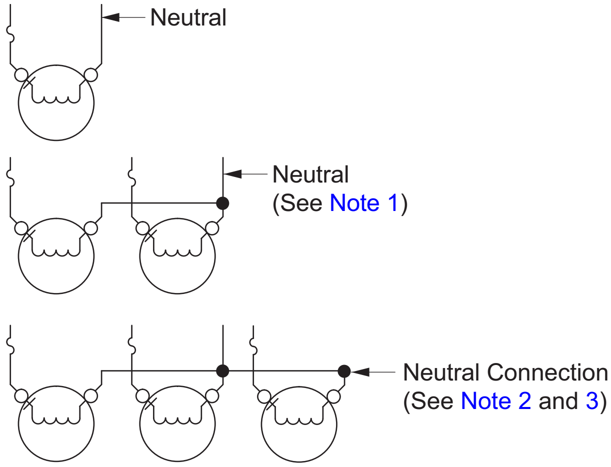
Table PR 122–2: 14.4/25 kV 3-Phase (See Note 5)

kVA Size	SMU-20	15 kV ELF	X-Limiter	15 kV Fault Tamer	Fuse Link	25 kV SMU-20
15 or 3x5	3K	6	10	3	3	N/A
30 or 3x10	3K	6	10	3	3	N/A
45 or 3x15	3K	6	10	3	3	N/A
75 or 3x25	6K	6	10	5	5	6K
112.5 or 3x37.5	6K	6	10	7	7	N/A
150 or 3x50	8K	8	10	10	10	8K
225 or 3x75	12K	12	12	15	15	12K
300 or 3x100	15E	18	18	15	20	15E
500 or 3x167	25E	25	25	N/A	25	25E
750 or 3-250	N/A	N/A	N/A	N/A	40	40E

Note(s):

1. ELF and X-Limiter fuses are full-range, current-limiting type fuses.
2. SMU-20, ELF, Fault Tamer and X-Limiter fuses can be used in High Fire Risk Areas (HFRA).
3. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.
4. For wye banks with transformers of unequal sizes, fuse each phase as shown in Table PR 122–1 (Sheet 1) for that particular transformer alone.
5. For wye to delta or delta to wye banks, only phase-to-phase rated fuses must be used. Use fuse links or the 25 kV SMU-20.
6. Use for 25 kV pad mounted three-phase transformer fusing.

Figure PR 122–1: Connection Diagrams for Installing Transformers on Grounded Neutral Systems



Note(s):

1. Open wye banks (2 transformers) shall be connected to the system neutral.
2. Closed wye-delta banks (3 transformers) shall **not** be connected to the system neutral.
3. Wye-wye banks (3 transformers) shall be connected to the system neutral.

PR 124 Fuse Tables — 2.4 kV and 12 kV — Constant Current Transformers

Scope PR 124.1 Fuse Tables — 2.4 kV and 12 kV — Constant Current Transformers (Overhead and Underground)

Table PR 124–1: Fuse Tables for 2.4 kV and 12 kV Constant Current Transformers

Size of Transformer (kVA)	Overhead Fuse Rating[a/]			Underground Fuse Ratings	
	2.4 kV	12 kV		2.4 kV	12 kV
	Fuse Link	Fuse Link	SMU 20	8 kV CLF	15 kV CLF
10	15	5	6K	18	6
15	25	5	6K	25	6
20	40	5	6K	40	6
25	40	10	10K	40	12
30	50	10	10K	2—25	12

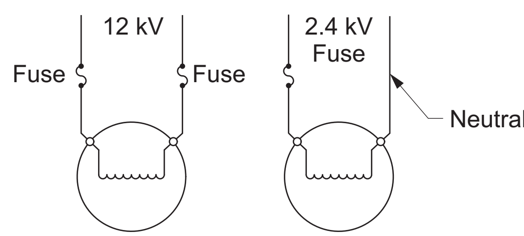
[a/] See PR 107 for the corresponding SAP numbers for overhead fuses and fuseholders.

Table PR 124–2: Underground CLF Ratings

Underground CLF Rating[a/]		
kV Rating	Amp Size	SAP
8	18	10108849
8	25	10108850
8	40	10108851
15	6	10108852
15	12	10108854

[a/] Underground fuses are full-range, current-limiting type fuses.

Figure PR 124–1: 2.4 kV and 12 kV Constant Current Transformers (Overhead and Underground) Wiring Connections



Note(s):

1. For underground fusing application, use the table above. Use 8 kV Current-Limiting Fuse (CLF) with 2W1P BURD Switch (SAP 10106366) for 2.4 kV RO transformers. Use 15 kV CLF with 2W2P BURD Switch (SAP 10106365) for 12 kV RO transformers. Refer to DUG PD 400 for switch information.

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PR 126 Fusing Practices — Current-Limiting Device (CLD) Application

Scope PR 126.1 Fusing Practices — CLD Application

Figure PR 126–1: CLD Mounted on Transformer Bushing

Typical CLD with Bird Guard (SAP 10067973)

Figure PR 126–2: CLD Mounted on Universal Cutout

Top Mounted

Bottom Mounted

1.0 Application Guidelines

1.1 Use CLD’s on Control Transformers (≤ 1 kVA) associated with Switch Capacitor Banks, Automated Recloser (AR’s) and Remote Control Switches (RCS’s).

	CLD Rating	SAP
4 kV PT	8.3 kV, 12 k Amps	10159437
12 kV/16 kV/25 kV PT	15.5 kV, 12 k Amps	10159438
33 kV PT	23 kV, 12 k Amps	10159439

1.2 CLD’s are used in high fault duty area exceeding fault interrupting capabilities of standard cutouts. The CLD has higher fault duty interruption ratings and will perform satisfactorily in high fault duty areas. The CLD is installed in series with the universal fuse cutout. Figure PR 126–3 (Sheet 4)

Table PR 126–1: Universal Fuse Cutout in the 4 kV OH System

8.3 kV CLD Amp Size	CLD SAP	MAX Fuse Link Size (Std. Speed)
12 k	10159437	20 Amps
25 k	10169161	30 Amps
40 k	10169160	50 Amps
65 k	10169159	60 Amps
80 k	10169158	85 Amps

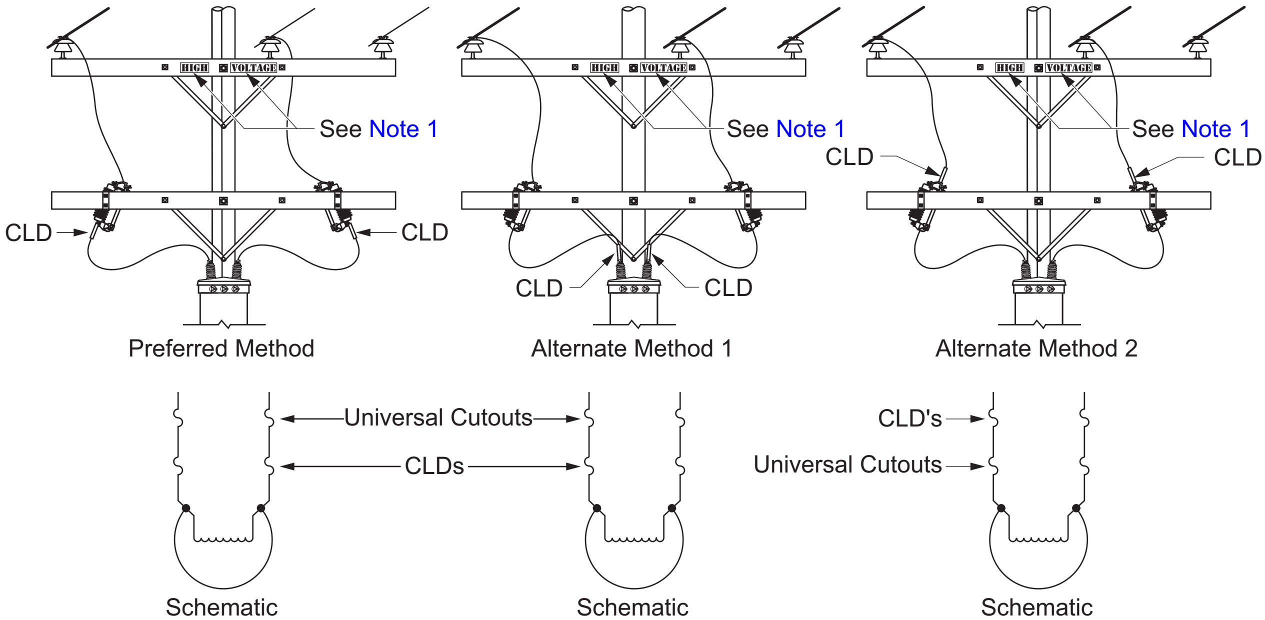
Table PR 126–2: Universal Fuse Cutout in the 12 kV and 16 kV OH Systems

15.5 kV CLD Amp Size	CLD SAP	MAX Fuse Link Size (Std. Speed)
12 k	10159438	20 Amps
25 k	10169150	30 Amps
40 k	10169146	50 Amps
65 k	10169140	60 Amps
80 k	10169139	85 Amps
100 k	10169162	85 Amps

Note(s):

1. Application of CLD's in the 4 kV Cutout increases the fault interrupting rating from 6.25 kA up to 40 kA (Fuse-CLD Combination).
2. Application of CLD's in the 12/16 kV Cutout increases the interrupting rating from 7.5 kA to 40 kA (Fuse-CLD Combination).
3. On all new installations, install a wildlife guard (SAP 10067973 or SAP 10067758).
4. When Re-fusing, if CLD tests indicate continuity, CLD may be re-used.
5. Universal adapters are provided with each new CLD. Installations may be on the top or on the bottom of the fuseholders, or on transformer bushings with vertical or horizontal lead connections. Mount CLD's in the vertical or near-vertical position to avoid contamination problems. See below (Figure PR 126–3 [Sheet 4]).
6. Install the CLD's shown in the Table PR 126–1 (Sheet 2) and Table PR 126–2 (Sheet 3) in series with universal cutouts (See Figure PR 126–3 [Sheet 4]) in order to increase the fault current interrupting capability of existing universal fuse cutouts, when the fault duty at the location of the cutout has exceeded the cutout's fault current interrupting rating.

Figure PR 126–3: Conventional Transformers with Universal Cutouts



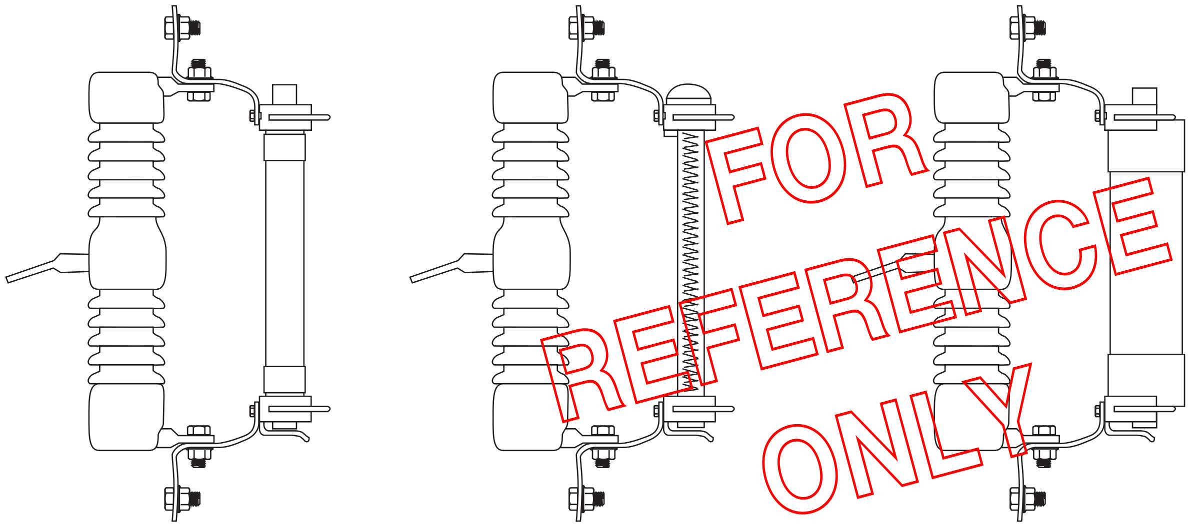
Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.

PR 127 Liquid Replacement Fuse Applications

Scope PR 127.1 Liquid Replacement Fuses

Figure PR 127–1: Typical Liquid Replacement Fuses



Cooper "ELF-LR" Fuse
6 Amp SAP 10108636
12 Amp SAP 10108637

Liquid Fuse

Kearny “LR” Fuse
6 Amp SAP 10108437
15 Amp SAP 10108438

Bussman "LRB" Fuse
(Formerly FDSH)
6 Amp SAP 10108480
15 Amp SAP 10108479

1.0 Application Guidelines

The Cooper Power ELF-LR fuse is designed for use in Size 1 liquid fuseholder as a direct replacement for the liquid fuse used on overhead transformers. Its full-range, current-limiting design provides a non-expulsion operation. This fuse is not approved for use on capacitor banks.

Suggested applications include:

1.1 In all areas where replacement of Size 1 liquid fuses is required.

1.2 With 12 kV and 16 kV single-phase or three-phase transformers, or 25 kV single-phase (14.4 kV) transformers.

Note(s):

1. The Kearney type “LR” and Bussman “LRB” are no longer available.
2. When liquid fuses are replaced with either LR, LRB, or ELF-LR fuses, all fuses in the bank should be replaced. Do not “mix” different types of fuses in the same bank, as their time-current characteristics are different and may not coordinate.
3. Replacement of the liquid fuses with LR, LRB, or ELF-LR fuse is a “hot stick” operation, requiring the use of a fuse grabber tool (SAP 10147869).

Recommended Size 1 liquid replacement fuse size applications are tabulated below for various transformer kVA applications.

Table PR 127–1: Single-Phase Conventional Transformers

Transformer (kVA)	12 kV		16 kV		14.4 kV/24.9 kV	
	ELF-LR	LR/LRB	ELF-LR	LR/LRB	ELF-LR	LR/LRB
3	6	6	6	6	–	—
5	6	6	6	6	6	6
10	6	6	6	6	6	6
15	6	6	6	6	6	6
25	6	6	6	6	6	6
37.5	12	15	6	6	6	6
50	12	15	12	15	12	15E
75	—	15	12	15	12	15
100	—	—	—	15	—	15

Table PR 127–2: Three-Phase Conventional Transformers

Transformer (kVA)	12 kV		16 kV	
	ELF-LR	LR/LRB	ELF-LR	LR/LRB
9 kVA 3Ø or three 3 kVA 1Ø	6	6	6	6
15 kVA 3Ø or three 5 kVA 1Ø	6	6	6	6
30 kVA 3Ø or three 10 kVA 1Ø	6	6	6	6
45 kVA 3Ø or three 15 kVA 1Ø	6	15	6	6
75 kVA 3Ø or three 25 kVA 1Ø	12	15	6	15
112.5 kVA 3Ø or three 37.5 kVA 1Ø	12	15	12	15
150 kVA 3Ø or three 50 kVA 1Ø	—	—	—	15

= For Reference Only

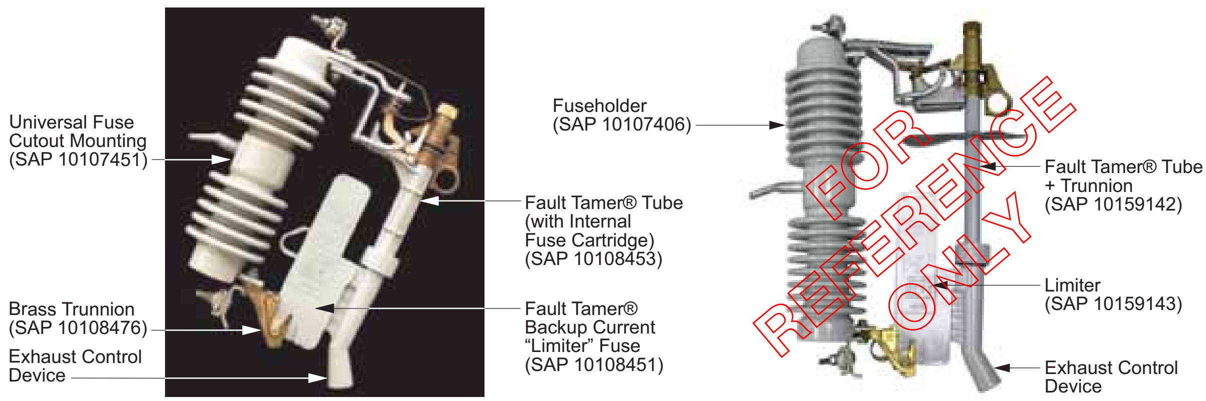
Note(s):

1. Consult Field Engineering for other transformer-fusing applications not found in tables.

PR 128 Fusing Practices — Fault Tamer® Application

Scope PR 128.1 Fault Tamer® Fuse

Figure PR 128–1: 15 kV and 34.5 kV Fault Tamer® Fuse



15 kV Fault Tamer® Fuse
(SAP 10107405)
Complete Assembly, Including Mounting, Limiter, Trunnion, and Fuse Tube (Less Fuse Cartridge)

34.5 kV Fault Tamer® Fuse
(SAP 10107401)
Complete Assembly, Including Mounting, Limiter, Trunnion, and Fuse Tube (Less Fuse Cartridge)

1.0 Description

The Fault Tamer® is a combination fuse cartridge and partial-range current-limiting fuse in an assembly which mounts in a standard universal fuse cutout mounting.

The fuse cartridge will operate for both low and high current faults (similar to a cutout link). A partial-range current-limiting fuse called the “Limiter” will operate only after a high-current fault such as a high-side transformer or external phase-to-phase fault. Operation of the “Limiter” fuse is determined by a continuity check (similar to a CLD) and is also field replaceable. The exhaust control device prevents the expulsion of particles during fuse operation. The Fault Tamer® fuse is provided as a complete assembly, which includes the mounting, fuse tube, brass trunnion, and limiter. The fuse cartridge must be ordered separately and is available in sizes, 3 through 20 A for 15 kV Fault Limiter and 3 through 15 A for 34.5 kV Fault Limiter. The 34.5 kV Fault Tamer® is no longer manufactured. Existing stock may be used to depletion. Fuse cartridges are still available from the manufacturer, for replacement purposes in existing 34.5 kV Fault Tamer® installations.

2.0 Application

The Fault Tamer® may be installed:

2.1 On 12 kV, 16 kV, 25 kV, and 33 kV overhead distribution circuits.

2.2 As a replacement for size one liquid fuses or SMU-20 fuses for load requirements up to 20 A. (Note: The Fault Tamer® mounts in a standard universal fuse cutout mounting and cannot be installed in a liquid or SMD-20 mounting.)

2.3 Recommended 15 kV Fault Tamer® fuse cartridge size replacement to existing Liquid Fuses are tabulated below.

2.4 For 15 kV Fault Tamer® ordering information (see Table PR 107–4).
For 34.5 kV Fault Tamer® ordering information (see Table PR 107–10).

Table PR 128–1: 15 kV Fault Tamer® Cartridge Replacement to #1 Liquid Fuses

Liquid Fuse	Fault Tamer® Cartridge	SAP
2E	3	10108481
5E	5	10108483
7E	7	10108484
10E	10	10108449
13E	15	10108485
15E	15	10108485
—	20	10108450

3.0 Operation

3.1 The Loadbuster tool shall be used when operating the fault tamer under load. It is important to align the Loadbuster with the fuse in order not to open the fuse inadvertently.

3.2 Do not leave the Fault Tamer® in the open position for extended periods of time. Moisture may damage the fuse tube.

3.3 The fuse grabber should be used when closing a Fault Tamer® to ensure positive control.

3.4 Continuity tests should be made on all Fault Tamer® fuses prior to installation. One probe of the tester on the trunnion and one probe on the upper ferrule.

3.5 **Caution:** When the Fault Tamer® operates, it can become hot enough to cause burns. Allow adequate time to cool down, or wear gloves before attempting to test or replace the fuse link in the fuse tube or the “limiter” fuse.

Scope PR 128.2 Fault Cartridge/Limiter Installation

Figure PR 128–2: 15 kV Fault Cartridge/Limiter Installation

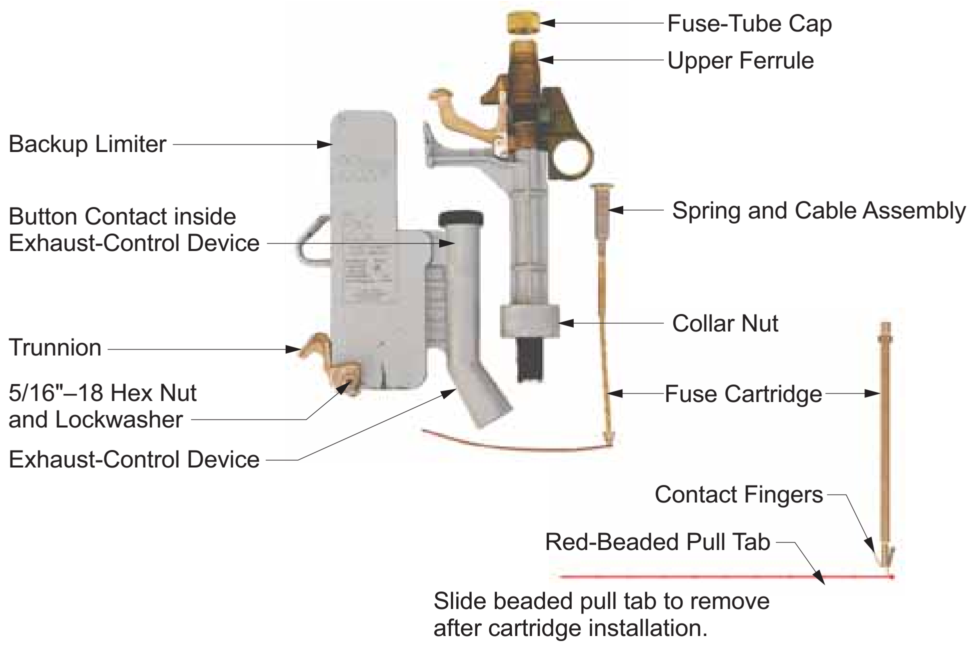
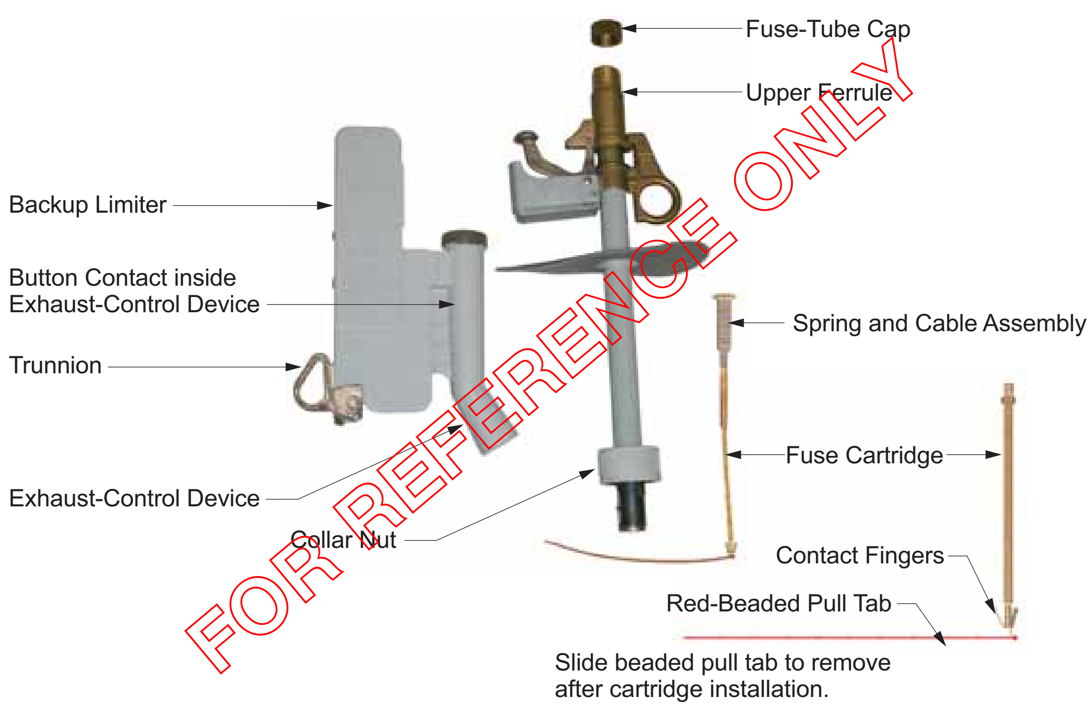


Figure PR 128–3: 34.5 kV Fault Cartridge/Limiter Installation



1.0 Installation of Fuse Cartridge

1.1 Unscrew the collar nut and separate the fuse-tube from the backup limiter.

1.2 Remove the fuse-tube cap, spring, and cable assembly.

1.3 Screw a fuse cartridge into the lower end of the spring and cable assembly and hand-tighten until the thread bottoms.

1.4 Remove any debris from the fuse-tube bore.

1.5 Insert the end of the red-beaded pull tab into the fuse-tube along with the spring and cable assembly.

1.6 Screw the fuse-tube cap onto the fuse-tube and tighten with pliers.

1.7 Carefully pull the red-beaded pull tab through the fuse-tube until the contact fingers are exposed. Relax the spring tension to allow the contact fingers to seat.

1.8 Remove the red-beaded pull tab.

1.9 Remove any debris from the exhaust control device.

1.10 Insert the keyed fuse-tube into the exhaust control device, aligning with the notches and hand-tighten the collar nut.

2.0 Replacement of Backup Limiter

2.1 Unscrew the collar nut and remove the fuse-tube from the exhaust-control device and backup limiter.

2.2 Determine if the backup limiter has operated by checking continuity. Touch one lead of the continuity tester to the trunnion and the other to the button contact inside the exhaust-control devise.

2.3 If it is determined the backup limiter has operated, remove the trunnion and install it on a replacement backup limiter using the lock washer and 5/16 inch–18 hex nut. Do not over-tighten.

2.4 Remove any debris from the exhaust-control device prior to installing the backup limiter onto the fuse-tube.[1/]

[1/] Do not reinstall a Fault Tamer® Fuse Limiter with a backup limiter that has operated.

PR 129 Fusing Practices — Stainless Steel Cutouts and Fuseholders

Scope PR 129.1 Stainless Steel 27 kV Universal Cutouts

Figure PR 129–1: Stainless Steel Polymer Cutout

Stainless Steel Polymer 27 kV Universal Cutout for use on 12 kV, 16 kV, and 25 kV (14.4 kV line-ground) (SAP 10215071)
Complete Assembly, Including Fuse Tube (Less Fuse Link)

1.0 Description

SAP 10215071 is a Stainless Steel, Polymer 27 kV Universal Cutout, for use on 12 kV, 16 kV, and 25 kV (14.4 kV line-ground) systems. This Cutout is intended for use in coastal environments (within 1 mile of the ocean).

Use SAP 10184094 Wildlife Cover with this polymer cutout.

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PR 130 Fuse Tables 33 kV, 480 V Secondaries or Less — 1Ø and 3Ø

Scope PR 130.1 Overhead Fuse Ratings for 33 kV Transformer Installations with 480 V Secondaries or Less — 1Ø and 3Ø

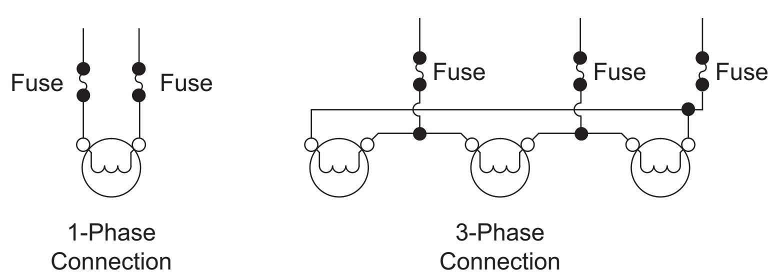
Table PR 130–1: Overhead Fuse Ratings for 33 kV Transformer Installations with 480 V Secondaries or Less — 1Ø and 3Ø

Single-Phase Transformers				Three-Phase Transformers			
Individual Transformer Size (kVA)	33 kV SMU-20 Fuse Size	SMD 1A Fuse Size	34.5 kV Fault Tamer	Individual Transformer Size (kVA)	33 kV SMU-20 Fuse Size	SMD 1A Fuse Size	34.5 kV Fault Tamer
25	3K	3E	3	75 or 3-25	6K	5E	5
50	6K	5E	5	150 or 3-50	8K	7E	7
75	8K	7E	7	225 or 3-75	12K	13E	10
100	10K	10E	10	300 or 3-100	15E	15E	15
167	12K	13E	15	500 or 3-167	20E	20E	—
250	20E	20E	—	750 or 3-250	30E	30E	—
333	25E	25E	—	1,000 or 3-333	40E	40E	—

Note(s):

1. See PR 107 for the corresponding SAP numbers for fuses and compatible fuse holders.
2. Fuse sizes for transformers with secondary voltages above 480 V should be coordinated through your distribution engineer.
3. Use SMU-20 for fault duties of 10,000 A or less.
4. Use SMD-1A for fault duties above 10,000 A but less than 17,500 A.
5. Use 34.5 kV Fault Tamer where current-limitation is desired.

Figure PR 130–1: Standard Fusing Equipment for 33 kV Transformer Installations



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PR 132 Fuse Tables 33 kV, 480 V Secondaries or Less — Open Delta

Scope PR 132.1 Overhead Fuse Ratings for 33 kV Open Delta Transformer Installations with 480 V Secondaries or Less

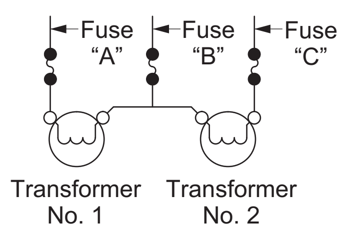
Table PR 132–1: Overhead Fuse Ratings for 33 kV Open Delta Transformer Installations with 480 V Secondaries or Less

Transformer		SMU-20		SMD-1A	
1	2	Fuse "A"	Fuse "B" or "C"	Fuse "A"	Fuse "B" or "C"
25	25	3K	3K	3E	3E
25	50	3K	6K	3E	5E
25	75	3K	8K	3E	7E
25	100	3K	10K	3E	10E
25	167	3K	12K	3E	13E
50	50	6K	6K	5E	5E
50	75	6K	8K	5E	7E
50	100	6K	10K	5E	10E
50	167	6K	12K	5E	13E
75	75	8K	8K	7K	7E
75	100	8K	10K	7K	10E
75	167	8K	12K	7K	13E
100	100	10K	10K	10K	10E
100	167	10K	12K	10K	13E
167	167	12K	12K	13K	13E

Note(s):

1. See PR 107 for the corresponding SAP numbers for fuses and compatible fuseholders.
2. Fuse sizes for transformers with secondary voltages above 480 V should be coordinated through your distribution engineer.
3. Use SMU-20 for fault duties of 500 MVA or less.
4. Use SMD-1A for fault duties above 500 MVA.

Figure PR 132–1: Standard Fusing Equipment for 33 kV Transformer Installations



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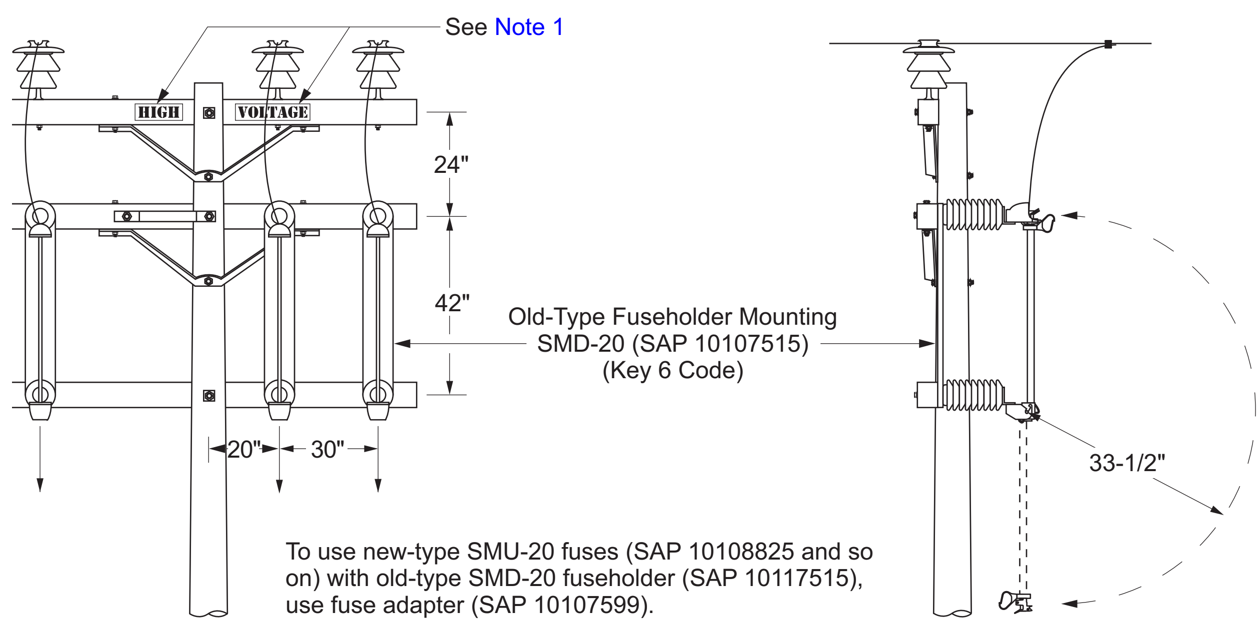
PR 134 Installation of 33 kV Fuse

Scope PR 134.1 Installation of 33 kV SMD-20 and SMD-1A

Figure PR 134–1: Old-Type SMD-20



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.

Figure PR 134–2: 33 kV SMD-20

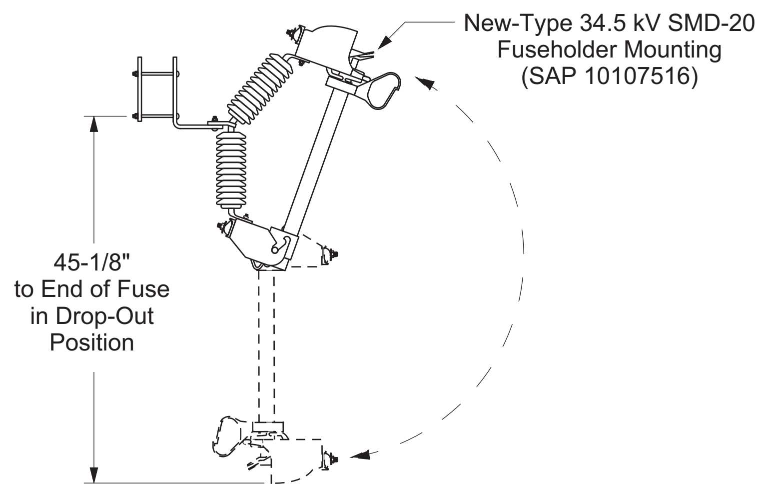


Figure PR 134–3: SMD-1A

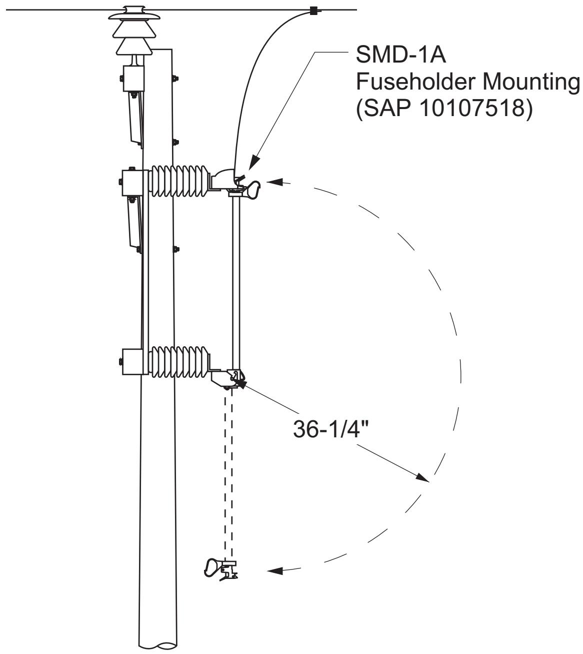
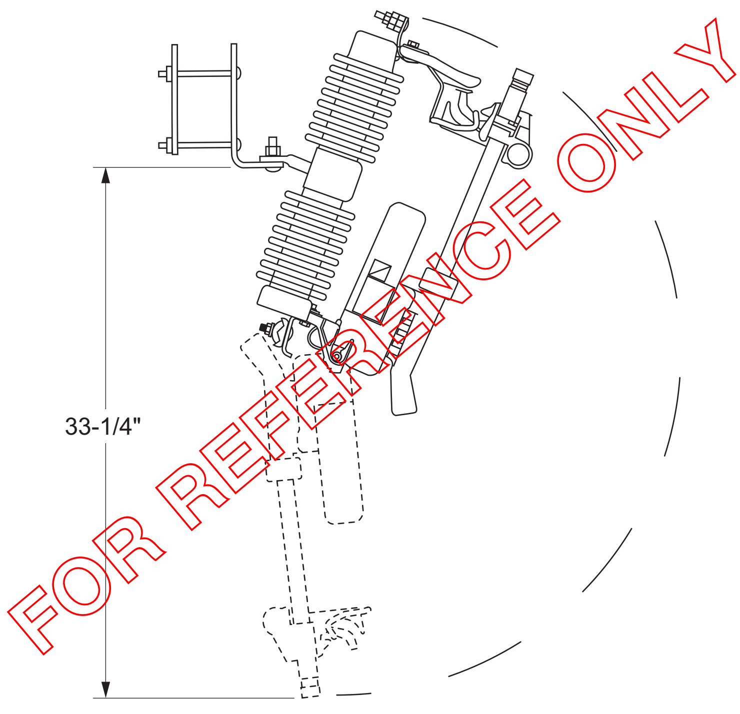


Figure PR 134–4: 34.5 kV Fault Tamer



Installation of 33 kV Fuse

Approved by:

What's Changed? Figure 134-4 made FOR REFERENCE ONLY.

Effective Date:
07-31-2015

PR 140 Capacitor Fusing Table

Scope PR 140.1 Capacitor Fusing Table

Table PR 140–1: Capacitor Fusing Table

Fuse Rating (SMU-20)						
kVAR	**2.4 kV**	**4.16 kV**	**4.8 kV**	**12 kV**	**16 kV**	**25 kV**
150	40E	25E	20E	10K	6K	—
300	80E	50E	40E	15E	12K	8K
450	—	65E	—	25E	—	—
600	—	80E	80E	30E	25E	15E
900	—	—	—	50E	40E	25E
1200	—	—	—	65E	50E	30E
1800	—	—	—	80E	65E	—

Note(s):

1. See PR 107 for the corresponding SAP numbers for fuses and compatible fuse holders.

Table PR 140–2: Fuse Link Sizes

kVAR	2.4 kV	4 kV	4.8 kV	12 kV	16 kV
150	40	25	20	10	5
300	80	50	40	15	15
600	—	80	80	30	25
900	—	—	—	50	40
1200	—	—	—	65	50
1800	—	—	—	—	—

= For Reference Only

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DOH–SC: Spacer Cable

TABLE OF CONTENTS

PILOT

STANDARD	**TITLE**

SC 100P Spacer Cable

Scope SC 100P.1 Spacer Cable General

1.0 General

Spacer Cable systems utilize a diamond shaped spacer to support Covered Conductor (CC) from a high strength messenger wire. The messenger serves as the support member of the system, providing mechanical protection from foreign objects falling onto the line (For messenger data see SC 120P; For Conductor Data, see CC 110).

The available covered conductor for use with spacer systems is Aluminum Conductor Steel-Reinforced (ACSR) or Hard Drawn Copper (HDCU). Copper covered conductor is strictly used for coastal applications (within 1 mile of the ocean) to provide corrosion resistance.

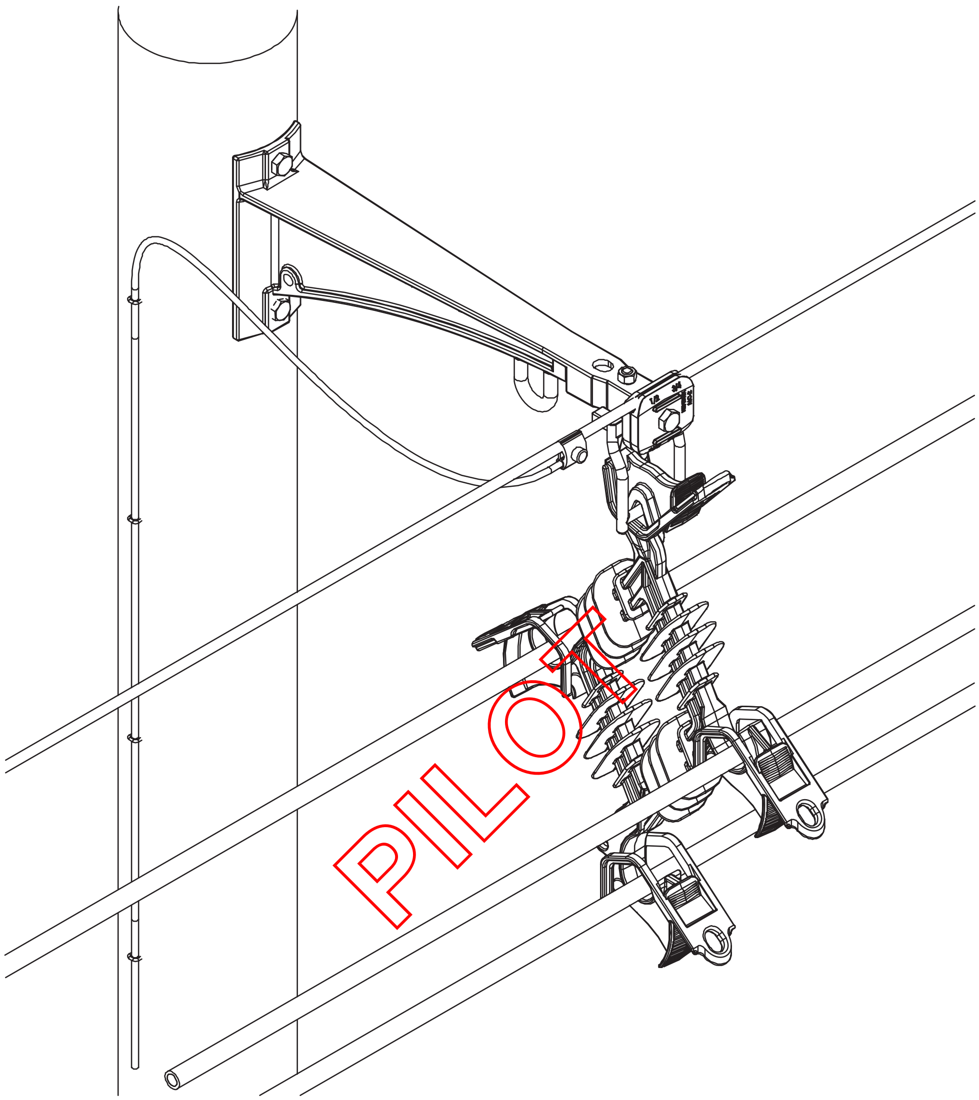
Covered conductor shall be treated and worked on the same as bare conductor. Spacer cable systems are not exempt from the tree trimming requirements set forth for bare wire and open-arm covered conductor construction (See the Vegetation Operations Manual).

Spacer cable installations are the preferred construction in the following situations:

- Areas of high vegetation
- Heavily treed areas where tree and branch removal is limited.
- Areas where proper horizontal line clearances cannot be maintained using other construction alternatives.
- Areas where multiple primary feeders on the same pole line are required.
- Areas where right-of-way space is limited.

NOTE Spacer Cable Systems shall not be installed on 4-Wire systems (Wye configuration). Spacer Cable is **ONLY** for use with Covered Conductor (see CC 110).

Figure SC 100P–1: Spacer Cable 3 Wire



SC 110P Spacer Cable Equipment

Scope SC 110P.1 Spacers

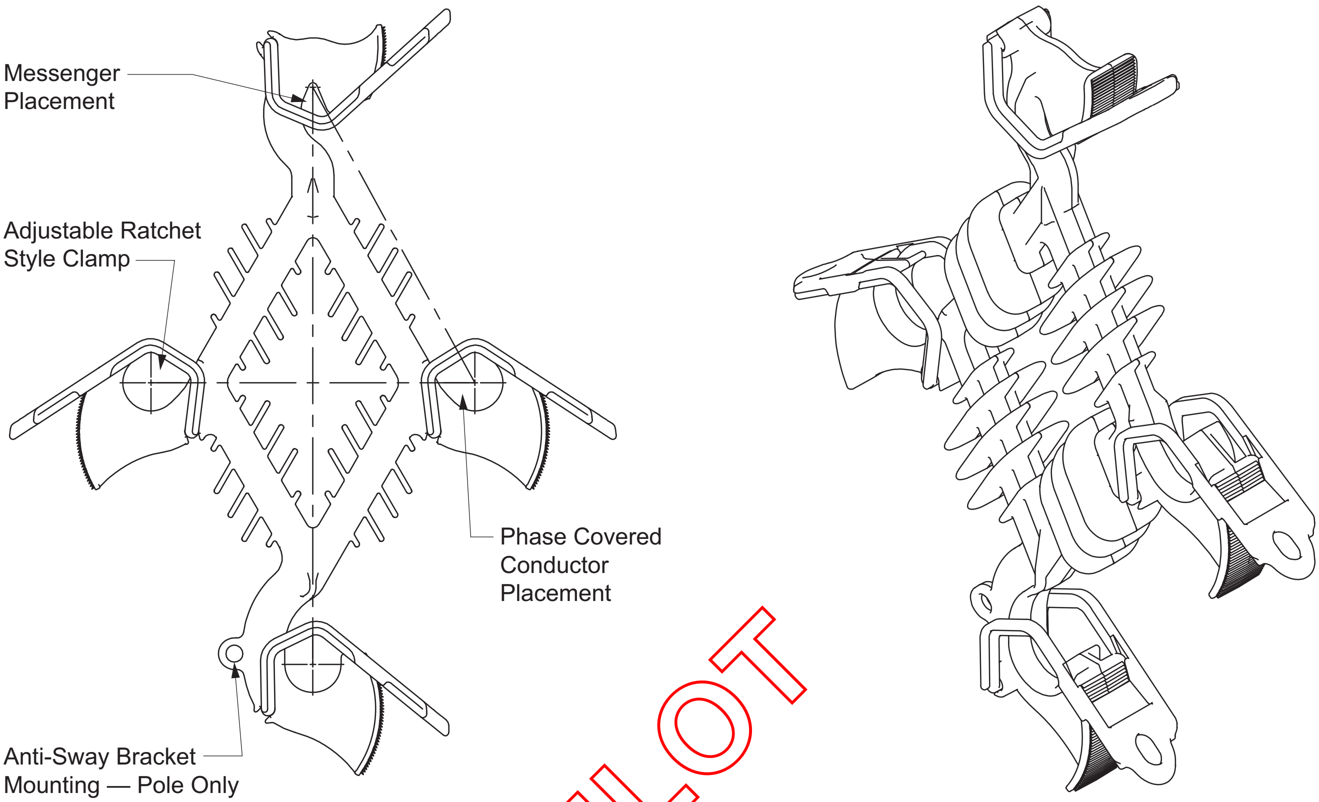
High density polyethylene (HDPE) spacers are suspended from the messenger wire, providing support and spacing for the phase conductors. Two spacers, providing 12-inch and 18-inch phase spacings, are approved for use on spacer cable distribution systems up to 16 kV (see Table SC 110P–1). Spacer can either be bolted or clamped to the messenger wire at intervals or 25–30 feet or to the tangent brackets when at the pole (see SC 140P).

Table SC 110P–1: Spacer Offerings

SAP	Phase Spacing (in)	Bolted Messenger Clamp	Weight (lb)	MAX Voltage Class (kV)
10212670	12	No	3.85	35
10212632	18	No	5.37	35
10212633	12	Yes	4	35
—	18	Yes	5.5	35

The phase conductors are secured to the spacer with a ratchet style clamp. High wind areas or circuits with elevation changes 15 degrees and greater shall use the spacer offering a bolted messenger connection (see Figure SC 110P–1). The spacer with the bolted messenger connection prevents the displacement of the spacer along the messenger. The 12-inch brackets are to be used in areas where environmental pollution is not of concern. Areas with heavy environmental pollution (such as coastal or industrial regions) shall utilize the 18-inch bracket. Coastal regions are defined as areas within 1 mile of the ocean.

Figure SC 110P–1: Spacer Description

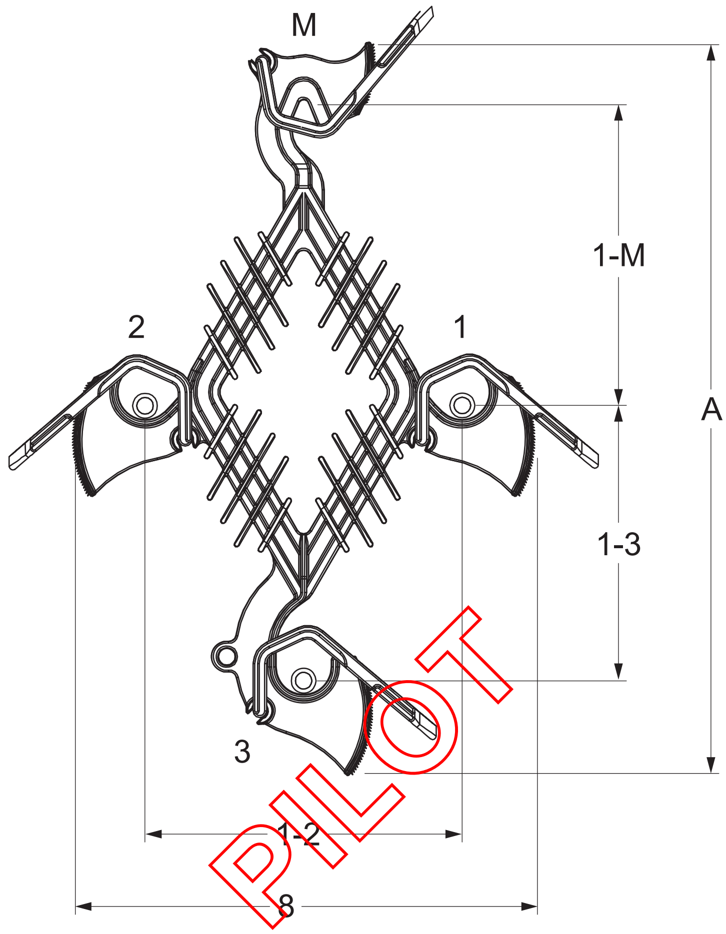


NOTE Bolted messenger clamp spacers shall be used in areas with potential for high winds or elevation changes of 15 degrees or more.

Table SC 110P–2: Spacer Dimensions

Spacer Size (in)	A (in)	B (in)	1-M (in)	1-2 (in)	1-3 (in)
12	29	20.5	12	11.5	11.5
18	39.25	27.125	18	18	18

Figure SC 110P–2: Spacer Dimensions

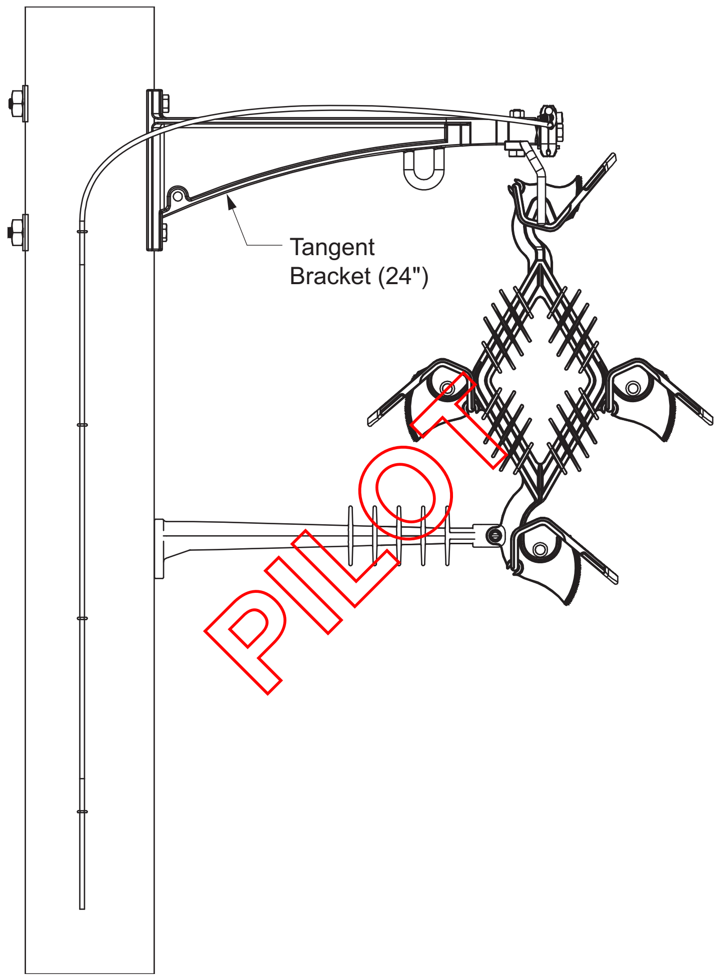


Scope SC 110P.2 Tangent Bracket and Anti-Sway Bracket

1.0 Tangent Bracket

The tangent bracket (SAP 10212667) is designed for messenger support on tangent non-equipment poles with a maximum line angle of 6 degrees. The tangent bracket provides the spacer an offset distance of 24-inches from the pole.

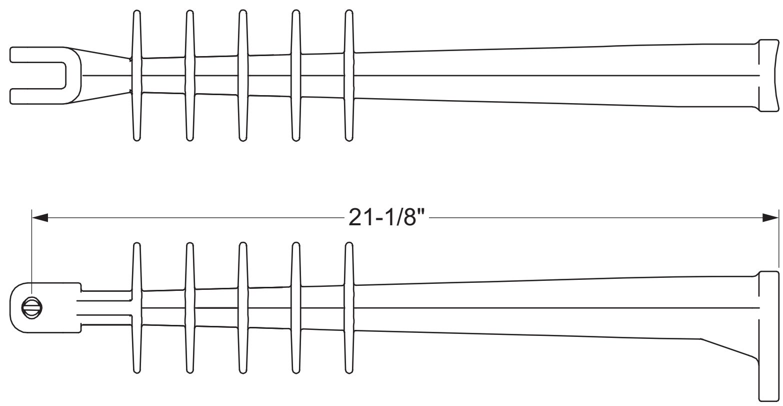
Figure SC 110P–3: 24-inch Tangent Bracket



2.0 Anti-Sway Bracket

The 24-inch anti-sway brackets (SAP 10212669) are designed for spacer support at tangent poles and shall be used at all poles that use the 24-inch Bracket Arm.

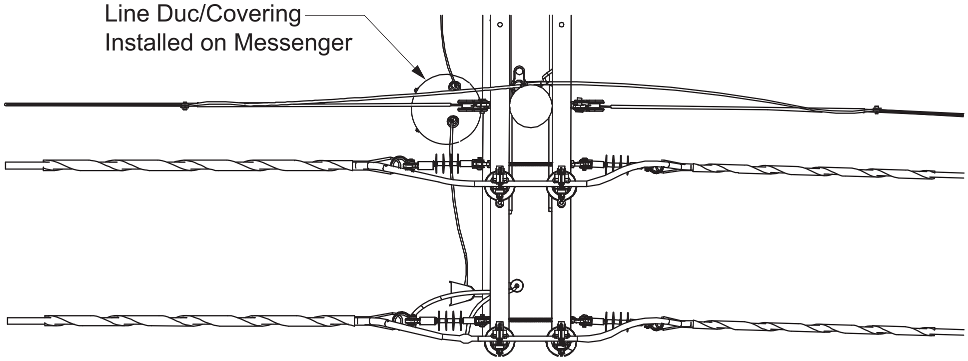
Figure SC 110P–4: Anti-Sway Bracket



Scope SC 110P.3 Messenger Cover (Exposed connection)

In areas where the conductor has been stripped, for example, as a result of the application of splice or tap, a messenger cover shall be applied. The messenger cover does not eliminate the need to properly cover/protect the covered conductor; for more information, see CC 170. The messenger cover shall be 8 feet long and where possible centered off the tap or splice connection.

Figure SC 110P–5: Spacer Cable Equipment Pole With Messenger Covering



Note(s):

1. Wildlife covers on deadends are not shown to show greater detail. See CC 150 for covered conductor wildlife protection.
2. See PO 120 for High Voltage sign installation requirements.
3. See CC 150 for cover conductor insulator requirements.
4. See AC 120 for clearances.
5. See CC 130.1 for covered conductor surge arrester requirements.
6. See CC 170 for covered conductor splicing requirements.

PILOT

Scope SC 110P.4 Materials List

Table SC 110P–3: Materials List

Part	SAP
Tangent Bracket	10212667
Anti-Sway Bracket	10212669
Non-Bolted 12" Spacer	10212670
Non-Bolted 18" Spacer	10212632
Bolted 12" Spacer	10212633
Bolted 18" Spacer	—
7°–90° Conering Plate	10212634
1/0 CC ACSR Coated Preformed Grip	10212672
336 CC ACSR Coated Preformed Grip	10212673

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SC 120P Messenger Wire

Scope SC 120P.1 General

The messenger wire is the mechanical support member of the spacer system. The messenger shall not be used as a system neutral or any other current carrying member. The messenger must be grounded in accordance with SC 130P.

Table SC 120P–1: Messenger Data

Messenger Size (in)	Stranding (AWG)	Messenger Diameter (in)	Weight (lb/1,000 ft)	Breaking Strength (lb)
3/8	7-#8	0.385	262	15,930
1/2	7-#6	0.486	416	22,730

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SC 130P Grounding

Scope SC 130P.1 Grounding General Work Practices

1.0 Application

The messenger shall be grounded intervals not exceeding 500 feet. If possible, the preferred construction practice is to ground every other pole to aid in preventing lightning flashover resulting in conductor burn down. Thus, the basic pole top is shielded and grounded.

The basic impulse level (BIL) is determined primarily by two factors: (1) inches of insulating material between conductors, and (2) conductor cover thickness.

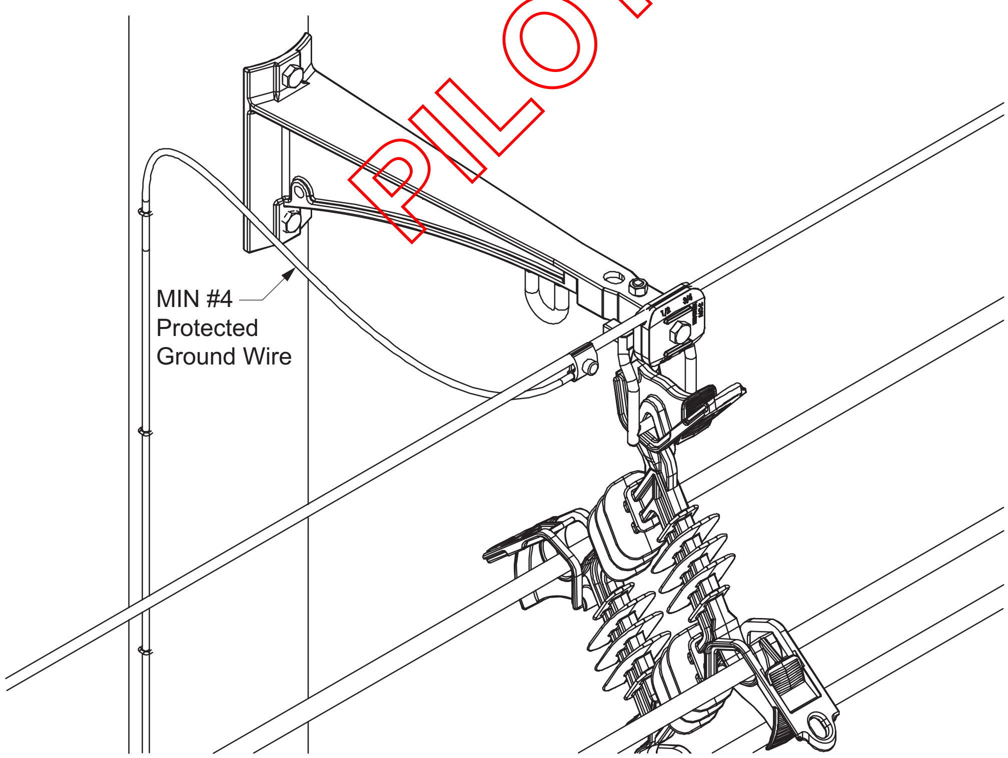
Table SC 130P–1: Covered Conductor BIL

Nominal Voltage	Withstand Voltage
17 kV	TBD
35 kV	TBD

2.0 Messenger Grounding

The supporting messenger should be grounded at both ends of each run and intermediate points not in excess of 500 feet. The messenger shall not be grounded through the support bracket.

Figure SC 130P–1: Spacer Grounding Configuration

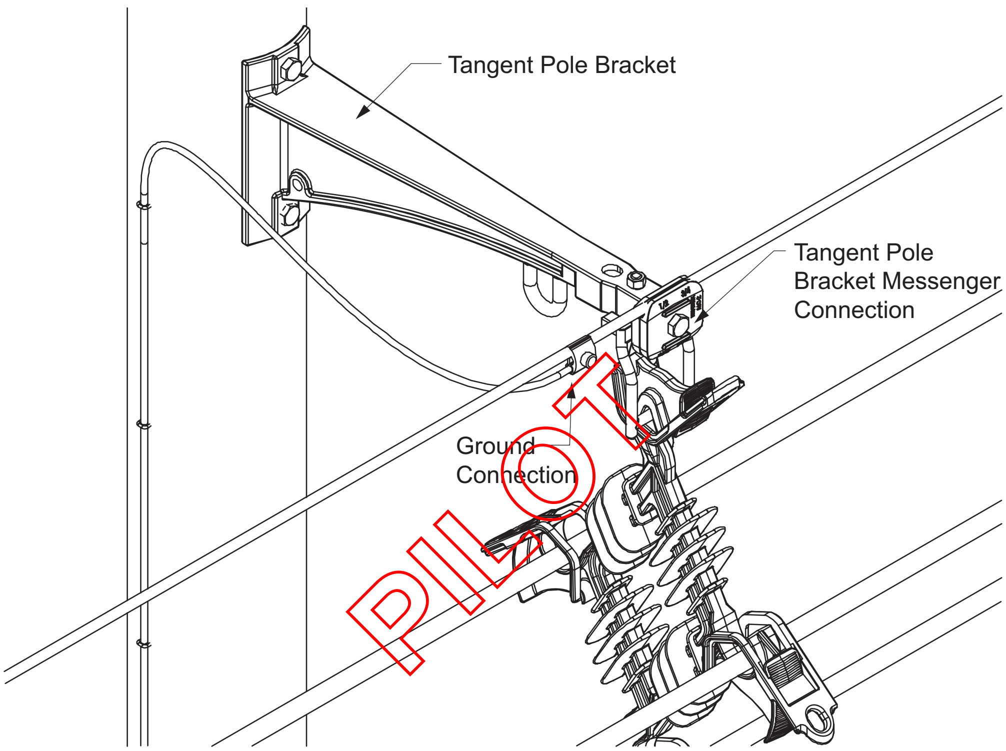


Note(s):
1. See AC 120 for clearances.
2. Do not install common grounds. Separate primary, secondary, lightning arrester and equipment grounds.
3. Spacer Cable Messenger will be electrically connected together. The messenger shall be electrically continuous throughout the circuit. At cable dead ends, a jumper wire of equivalent size must be used to ensure the messenger wire is electrically continuous.

3.0 Tangent Bracket Grounding

All messenger and phase conductor supporting brackets shall be bonded to the pole equipment grounding conductor as shown in individual drawings in this Standard. Adequate grounding of the tangent pole bracket is achieved through the connection of the equipment grounding conductor to the messenger. Proper torque must be ensured between the tangent pole bracket messenger connector and the messenger wire.

Figure SC 130P–2: Spacer Grounding Configuration Details



All other brackets, such as capacitor racks, recloser racks, and transformer mounts shall be grounded in accordance with the relative sections in Distribution Apparatus Construction Standards (DAP).

SC 131P Sagging and Clearances

Scope SC 131P.1 Sag Chart and Clearances for 1/0 ACSR SC Light Loading

Table SC 131P–1: 7#8 Alumoweld 1/0 ACSR CC G.O. 95 Light

Span (ft)	Initial Messenger Sag before 3 x 1/0 ACSR CC 35 kV Installation (ft)			Initial Sag after 3x 1/0 ACSR CC 35kV Installation (ft)			Final Sag (ft)
	50°F	70°F	90°F	50°F	70°F	90°F	130°F
100	0'-2"	0'-2"	0'-2"	0'-9"	0'-9"	0'-10"	1'-3"
120	0'-2"	0'-3"	0'-3"	1'-0"	1'-1"	1'-2"	1'-8"
140	0'-3"	0'-3"	0'-4"	1'-5"	1'-6"	1'-7"	2'-2"
160	0'-4"	0'-5"	0'-5"	1'-10"	1'-11"	2'-1"	2'-8"
180	0'-6"	0'-6"	0'-7"	2'-3"	2'-5"	2'-7"	3'-3"
200	0'-7"	0'-8"	0'-9"	2'-10"	3'-0"	3'-2"	3'-11"
220	0'-9"	0'-11"	1'-0"	3'-5"	3'-7"	3'-9"	4'-7"
240	1'-0"	1'-2"	1'-5"	4'-1"	4'-3"	4'-5"	5'-4"
260	1'-4"	1'-7"	1'-10"	4'-9"	5'-0"	5'-2"	6'-2"
280	1'-10"	2'-1"	2'-5"	5'-6"	5'-9"	6'-0"	7'-0"
300	2'-5"	2'-9"	3'-2"	6'-4"	6'-7"	6'-10"	7'-11"
320	3'-1"	3'-6"	4'-0"	7'-3"	7'-6"	7'-9"	8'-10"
340	4'-0"	4'-5"	4'-11"	8'-2"	8'-5"	8'-8"	9'-10"
360	4'-11"	5'-5"	5'-11"	9'-2"	9'-5"	9'-8"	10'-11"
380	6'-0"	6'-6"	7'-0"	10'-3"	10'-6"	10'-9"	12'-0"
400	7'-2"	7'-8"	8'-1"	11'-4"	11'-8"	11'-11"	13'-3"
420	8'-4"	8'-10"	9'-4"	12'-6"	12'-10"	13'-1"	14'-6"
440	9'-7"	10'-1"	10'-7"	13'-9"	14'-1"	14'-4"	15'-10"
460	10'-11"	11'-5"	11'-10"	15'-1"	15'-4"	15'-8"	17'-2"
480	12'-4"	12'-9"	13'-3"	16'-5"	16'-9"	17'-0"	18'-7"

Note(s):

1. Spans less than 500 feet will use the 7-#8 messenger size. Spans equal to or greater than 500 feet will use the 7-#6 messenger and require engineering approval.

Table SC 131P–2: 7#6 Alumoweld 1/0 ACSR CC G.O. 95 Light

Span (ft)	Initial Messenger Sag before 3 x 1/0 ACSR CC 35 kV Installation (ft)			Initial Sag after 3x 1/0 ACSR CC 35 kV Installation (ft)			Final Sag (ft)
	50°F	70°F	90°F	50°F	70°F	90°F	130°F
500	9'-2"	9'-9"	11'-4"	13'-6"	13'-10"	14'-2"	15'-9"
520	10'-3"	10'-10"	12'-6"	14'-7"	14'-11"	15'-4"	16'-11"
540	11'-5"	12'-0"	13'-7"	15'-9"	16'-1"	16'-6"	18'-1"
560	12'-7"	13'-2"	14'-10"	16'-11"	17'-4"	17'-8"	19'-4"
580	13'-10"	14'-5"	16'-1"	18'-2"	18'-7"	18'-11"	20'-8"
600	15'-2"	15'-9"	17'-4"	19'-6"	19'-10"	20'-3"	22'-0"
620	16'-6"	17'-1"	18'-8"	20'-9"	21'-2"	21'-7"	23'-4"
640	17'-11"	18'-5"	20'-1"	22'-2"	22'-7"	23'-0"	24'-9"
660	19'-4"	19'-11"	21'-6"	23'-7"	24'-0"	24'-5"	26'-3"
680	20'-10"	21'-4"	22'-11"	25'-1"	25'-6"	25'-11"	27'-9"
700	22'-4"	22'-10"	24'-6"	26'-7"	27'-0"	27'-5"	29'-4"
720	23'-11"	24'-5"	26'-0"	28'-2"	28'-7"	29'-0"	30'-11"
740	25'-6"	26'-0"	27'-7"	29'-9"	30'-2"	30'-7"	32'-7"
760	27'-2"	27'-8"	29'-3"	31'-5"	31'-10"	32'-3"	34'-3"
780	28'-10"	29'-5"	31'-0"	33'-1"	33'-6"	33'-11"	36'-0"
800	30'-7"	31'-2"	32'-9"	34'-10"	35'-3"	35'-8"	37'-9"
820	32'-5"	32'-11"	34'-6"	36'-7"	37'-0"	37'-6"	39'-7"
840	34'-3"	34'-9"	36'-4"	38'-5"	38'-10"	39'-4"	41'-6"
860	36'-1"	36'-8"	38'-2"	40'-4"	40'-9"	41'-2"	43'-5"
880	38'-0"	38'-7"	40'-1"	42'-3"	42'-8"	43'-1"	45'-4"
900	40'-0"	40'-6"	42'-1"	44'-2"	44'-8"	45'-1"	47'-4"
920	42'-0"	42'-7"	44'-1"	46'-2"	46'-8"	47'-1"	49'-5"
940	44'-1"	44'-7"	46'-2"	48'-3"	48'-9"	49'-2"	51'-6"
960	46'-2"	46'-9"	48'-3"	50'-4"	50'-10"	51'-3"	53'-8"
980	48'-4"	48'-11"	50'-5"	52'-6"	53'-0"	53'-5"	55'-10"
1000	50'-7"	51'-1"	52'-8"	54'-9"	55'-2"	55'-8"	58'-1"

Note(s):

1. Spans less than 500 feet will use the 7-#8 messenger size. Spans equal to or greater than 500 feet will use the 7-#6 messenger and require engineering approval.

Scope SC 131P.2 Sag Chart and Clearances for 1/0 ACSR SC Heavy Loading

Table SC 131P–3: 7#8 Alumoweld 1/0 ACSR CC G.O. 95 Heavy

Span (ft)	Initial Messenger Sag before 3 x 1/0 ACSR CC 35 kV Installation (ft)			Initial Sag after 3x 1/0 ACSR CC 35 kV Installation (ft)			Final Sag (ft)
	50°F	70°F	90°F	50°F	70°F	90°F	130°F
100	0'-2"	0'-2"	0'-2"	0'-9"	0'-9"	0'-10"	1'-3"
120	0'-2"	0'-3"	0'-3"	1'-0"	1'-1"	1'-2"	1'-8"
140	0'-3"	0'-3"	0'-4"	1'-5"	1'-6"	1'-7"	2'-2"
160	0'-4"	0'-5"	0'-5"	1'-10"	1'-11"	2'-1"	2'-8"
180	0'-6"	0'-6"	0'-7"	2'-3"	2'-5"	2'-7"	3'-3"
200	0'-7"	0'-8"	0'-9"	2'-10"	3'-0"	3'-2"	3'-11"
220	0'-9"	0'-11"	1'-0"	3'-5"	3'-7"	3'-9"	4'-7"
240	1'-0"	1'-2"	1'-5"	4'-1"	4'-3"	4'-5"	5'-4"
260	1'-4"	1'-7"	1'-10"	4'-9"	5'-0"	5'-2"	6'-2"
280	1'-10"	2'-1"	2'-5"	5'-6"	5'-9"	6'-0"	7'-0"
300	2'-6"	2'-11"	3'-4"	6'-5"	6'-7"	6'-10"	7'-11"
320	4'-1"	4'-6"	4'-11"	7'-8"	7'-11"	8'-2"	9'-3"
340	5'-10"	6'-3"	6'-8"	9'-1"	9'-4"	9'-7"	10'-8"
360	7'-8"	8'-1"	8'-5"	10'-8"	10'-11"	11'-2"	12'-3"
380	9'-7"	9'-11"	10'-3"	12'-4"	12'-7"	12'-10"	13'-11"
400	11'-6"	11'-10"	12'-2"	14'-1"	14'-4"	14'-7"	15'-8"
420	13'-6"	13'-10"	14'-2"	15'-11"	16'-2"	16'-5"	17'-6"
440	15'-7"	15'-11"	16'-3"	17'-10"	18'-2"	18'-5"	19'-5"
460	17'-9"	18'-0"	18'-4"	19'-11"	20'-2"	20'-5"	21'-6"
480	19'-11"	20'-3"	20'-7"	22'-1"	22'-4"	22'-7"	23'-8"

Note(s):

1. Spans less than 500 feet will use the 7-#8 messenger size. Spans equal to or greater than 500 feet will use the 7-#6 messenger and require engineering approval.

Table SC 131P–4: 7#6 Alumoweld 1/0 ACSR CC G.O. 95 Heavy

Span (ft)	Initial Messenger Sag before 3 x 1/0 ACSR CC 35 kV Installation (ft)			Initial Sag after 3x 1/0 ACSR CC 35 kV Installation (ft)			Final Sag (ft)
	50°F	70°F	90°F	50°F	70°F	90°F	130°F
500	9'-2"	9'-9"	11'-4"	13'-6"	13'-10"	14'-2"	15'-9"
520	10'-3"	10'-10"	12'-6"	14'-7"	14'-11"	15'-4"	16'-11"
540	11'-5"	12'-0"	13'-7"	15'-9"	16'-1"	16'-6"	18'-1"
560	13'-2"	13'-8"	15'-3"	17'-3"	17'-8"	18'-0"	19'-8"
580	15'-0"	15'-6"	17'-1"	18'-11"	19'-4"	19'-9"	21'-4"
600	16'-11"	17'-5"	18'-11"	20'-8"	21'-1"	21'-6"	23'-1"
620	18'-10"	19'-4"	20'-10"	22'-6"	22'-11"	23'-3"	24'-11"
640	20'-10"	21'-4"	22'-9"	24'-5"	24'-9"	25'-2"	26'-9"
660	22'-11"	23'-5"	24'-10"	26'-4"	26'-9"	27'-1"	28'-9"
680	25'-0"	25'-6"	26'-10"	28'-4"	28'-9"	29'-1"	30'-9"
700	27'-2"	27'-7"	29'-0"	30'-5"	30'-9"	31'-2"	32'-9"
720	29'-4"	29'-10"	31'-2"	32'-6"	32'-11"	33'-3"	34'-11"
740	31'-7"	32'-1"	33'-5"	34'-9"	35'-1"	35'-6"	37'-1"
760	33'-11"	34'-4"	35'-8"	37'-0"	37'-4"	37'-9"	39'-4"
780	36'-4"	36'-9"	38'-0"	39'-3"	39'-8"	40'-1"	41'-8"
800	38'-9"	39'-2"	40'-5"	41'-8"	42'-1"	42'-5"	44'-0"
820	41'-3"	41'-8"	42'-11"	44'-1"	44'-6"	44'-11"	46'-6"
840	43'-9"	44'-2"	45'-6"	46'-8"	47'-0"	47'-5"	49'-0"
860	46'-4"	46'-10"	48'-1"	49'-2"	49'-7"	50'-0"	51'-7"
880	49'-0"	49'-6"	50'-9"	51'-10"	52'-3"	52'-7"	54'-2"
900	51'-9"	52'-2"	53'-5"	54'-6"	54'-11"	55'-4"	56'-11"
920	54'-7"	55'-0"	56'-3"	57'-4"	57'-8"	58'-1"	59'-8"
940	57'-5"	57'-10"	59'-1"	60'-2"	60'-6"	60'-11"	62'-6"
960	60'-4"	60'-9"	62'-0"	63'-1"	63'-5"	63'-10"	65'-5"
980	63'-4"	63'-9"	65'-0"	66'-0"	66'-5"	66'-9"	68'-4"
1000	66'-5"	66'-10"	68'-0"	69'-1"	69'-5"	69'-10"	71'-5"

Note(s):

1. Spans less than 500 feet will use the 7-#8 messenger size. Spans equal to or greater than 500 feet will use the 7-#6 messenger and require engineering approval.

Scope SC 131P.3 Sag Chart and Clearances for 336 ACSR SC Light Loading

Table SC 131P–5: 7#8 Alumoweld 336 ACSR CC G.O. 95 Light

Span (ft)	Initial Messenger Sag before 3 x 336 ACSR 35 kV CC Installation (ft)			Initial Sag after 3x 336 ACSR CC 35 kV Installation (ft)			Final Sag (ft)
	50°F	70°F	90°F	50°F	70°F	90°F	130°F
100	0'-2"	0'-2"	0'-3"	1'-2"	1'-2"	1'-3"	1'-8"
120	0'-3"	0'-3"	0'-5"	1'-7"	1'-8"	1'-9"	2'-3"
140	0'-4"	0'-5"	0'-8"	2'-2"	2'-3"	2'-5"	2'-11"
160	0'-6"	0'-7"	1'-1"	2'-10"	3'-0"	3'-1"	3'-8"
180	0'-10"	1'-0"	1'-9"	3'-7"	3'-9"	3'-11"	4'-6"
200	1'-5"	1'-8"	2'-8"	4'-5"	4'-7"	4'-9"	5'-5"
220	2'-3"	2'-7"	3'-7"	5'-5"	5'-7"	5'-9"	6'-5"
240	3'-4"	3'-8"	4'-8"	6'-5"	6'-7"	6'-9"	7'-6"
260	4'-6"	4'-11"	5'-10"	7'-7"	7'-9"	7'-11"	8'-9"
280	5'-10"	6'-2"	7'-1"	8'-9"	8'-11"	9'-2"	10'-0"
300	7'-2"	7'-6"	8'-4"	10'-1"	10'-3"	10'-5"	11'-4"
320	8'-8"	8'-11"	9'-9"	11'-6"	11'-8"	11'-10"	12'-9"
340	10'-2"	10'-6"	11'-3"	13'-0"	13'-2"	13'-4"	14'-3"
360	11'-9"	12'-1"	12'-11"	14'-7"	14'-9"	14'-11"	15'-11"
380	13'-6"	13'-9"	14'-7"	16'-3"	16'-5"	16'-8"	17'-7"
400	15'-3"	15'-7"	16'-4"	18'-0"	18'-3"	18'-5"	19'-4"
420	17'-2"	17'-5"	18'-3"	19'-10"	20'-1"	20'-3"	21'-3"
440	19'-2"	19'-5"	20'-2"	21'-10"	22'-0"	22'-3"	23'-3"
460	21'-3"	21'-6"	22'-3"	23'-11"	24'-1"	24'-4"	25'-4"
480	23'-5"	23'-8"	24'-5"	26'-0"	26'-3"	26'-6"	27'-6"

Note(s):

1. Spans less than 500 feet will use the 7-#8 messenger size. Spans equal to or greater than 500 feet will use the 7-#6 messenger and require engineering approval.

Table SC 131P–6: 7#6 Alumoweld 336 ACSR CC G.O. 95 Light

Span (ft)	Initial Messenger Sag before 3 x 336 ACSR 35 kV CC Installation (ft)			Initial Sag after 3x 336 ACSR CC 35 kV Installation (ft)			Final Sag (ft)
	50°F	70°F	90°F	50°F	70°F	90°F	130°F
500	17'-7"	18'-0"	19'-1"	20'-9"	21'-0"	21'-3"	22'-6"
520	19'-4"	19'-8"	20'-9"	22'-5"	22'-9"	23'-0"	24'-3"
540	21'-2"	21'-6"	22'-7"	24'-3"	24'-6"	24'-9"	26'-0"
560	23'-0"	23'-4"	24'-5"	26'-1"	26'-4"	26'-8"	27'-11"
580	24'-11"	25'-3"	26'-4"	28'-0"	28'-3"	28'-7"	29'-10"
600	26'-11"	27'-3"	28'-4"	30'-0"	30'-3"	30'-7"	31'-10"
620	29'-0"	29'-4"	30'-5"	32'-0"	32'-4"	32'-7"	33'-11"
640	31'-2"	31'-6"	32'-6"	34'-2"	34'-6"	34'-9"	36'-1"
660	33'-4"	33'-8"	34'-9"	36'-4"	36'-8"	37'-0"	38'-3"
680	35'-7"	36'-0"	37'-0"	38'-8"	38'-11"	39'-3"	40'-7"
700	38'-0"	38'-4"	39'-4"	41'-0"	41'-3"	41'-7"	42'-11"
720	40'-5"	40'-9"	41'-9"	43'-5"	43'-8"	44'-0"	45'-4"
740	42'-11"	43'-3"	44'-3"	45'-11"	46'-2"	46'-6"	47'-10"
760	45'-5"	45'-9"	46'-10"	48'-5"	48'-9"	49'-1"	50'-5"
780	48'-1"	48'-5"	49'-5"	51'-1"	51'-5"	51'-8"	53'-1"
800	50'-10"	51'-2"	52'-2"	53'-9"	54'-1"	54'-5"	55'-9"
820	53'-7"	53'-11"	54'-11"	56'-7"	56'-10"	57'-2"	58'-7"
840	56'-5"	56'-9"	57'-9"	59'-5"	59'-9"	60'-0"	61'-5"
860	59'-4"	59'-9"	60'-9"	62'-4"	62'-8"	63'-0"	64'-4"
880	62'-5"	62'-9"	63'-9"	65'-4"	65'-8"	66'-0"	67'-4"
900	65'-6"	65'-10"	66'-10"	68'-5"	68'-9"	69'-1"	70'-5"
920	68'-8"	69'-0"	70'-0"	71'-7"	71'-11"	72'-3"	73'-7"
940	71'-10"	72'-2"	73'-2"	74'-10"	75'-2"	75'-5"	76'-10"
960	75'-2"	75'-6"	76'-6"	78'-2"	78'-5"	78'-9"	80'-2"
980	78'-7"	78'-11"	79'-11"	81'-6"	81'-10"	82'-2"	83'-7"
1000	82'-0"	82'-4"	83'-4"	85'-0"	85'-4"	85'-7"	87'-0"

Note(s):

1. Spans less than 500 feet will use the 7-#8 messenger size. Spans equal to or greater than 500 feet will use the 7-#6 messenger and require engineering approval.

Scope SC 131P.4 Sag Chart and Clearances for 336 ACSR SC Heavy Loading

Table SC 131P–7: 7#8 Alumoweld 336 ACSR CC G.O. 95 Heavy

Span (ft)	Initial Messenger Sag before 3 x 336 ACSR 35 kV CC Installation (ft)			Initial Sag after 3x 336 ACSR CC 35 kV Installation (ft)			Final Sag (ft)
	50°F	70°F	90°F	50°F	70°F	90°F	130°F
100	0'-2"	0'-2"	0'-3"	1'-2"	1'-2"	1'-3"	1'-8"
120	0'-3"	0'-3"	0'-5"	1'-7"	1'-8"	1'-9"	2'-3"
140	0'-4"	0'-5"	0'-8"	2'-2"	2'-3"	2'-5"	2'-11"
160	0'-6"	0'-7"	1'-1"	2'-10"	3'-0"	3'-1"	3'-8"
180	0'-10"	1'-0"	1'-9"	3'-7"	3'-9"	3'-11"	4'-6"
200	1'-5"	1'-8"	2'-8"	4'-5"	4'-7"	4'-9"	5'-5"
220	2'-3"	2'-7"	3'-7"	5'-5"	5'-7"	5'-9"	6'-5"
240	3'-4"	3'-8"	4'-8"	6'-5"	6'-7"	6'-9"	7'-6"
260	4'-6"	4'-11"	5'-10"	7'-7"	7'-9"	7'-11"	8'-9"
280	5'-10"	6'-2"	7'-1"	8'-9"	8'-11"	9'-2"	10'-0"
300	7'-2"	7'-6"	8'-4"	10'-1"	10'-3"	10'-5"	11'-4"
320	8'-11"	9'-3"	9'-6"	11'-7"	11'-10"	12'-0"	12'-11"
340	10'-11"	11'-2"	11'-6"	13'-5"	13'-8"	13'-10"	14'-9"
360	13'-0"	13'-3"	13'-6"	15'-5"	15'-7"	15'-10"	16'-8"
380	15'-3"	15'-6"	15'-9"	17'-6"	17'-8"	17'-11"	18'-9"
400	17'-6"	17'-9"	18'-0"	19'-8"	19'-11"	20'-1"	21'-0"
420	19'-11"	20'-2"	20'-4"	22'-0"	22'-3"	22'-5"	23'-4"
440	22'-5"	22'-8"	22'-10"	24'-6"	24'-8"	24'-11"	25'-9"
460	25'-0"	25'-3"	25'-6"	27'-1"	27'-3"	27'-6"	28'-4"
480	27'-9"	28'-0"	28'-3"	29'-9"	30'-0"	30'-2"	31'-0"

Note(s):

1. Spans less than 500 feet will use the 7-#8 messenger size. Spans equal to or greater than 500 feet will use the 7-#6 messenger and require engineering approval.

Table SC 131P–8: 7#6 Alumoweld 336 ACSR CC G.O. 95 Heavy

Span (ft)	Initial Messenger Sag before 3 x 336 ACSR 35 kV CC Installation (ft)			Initial Sag after 3x 336 ACSR CC 35 kV Installation (ft)			Final Sag (ft)
	50°F	70°F	90°F	50°F	70°F	90°F	130°F
500	19'-3"	19'-7"	19'-11"	22'-0"	22'-3"	22'-6"	23'-8"
520	21'-5"	21'-9"	22'-1"	24'-0"	24'-4"	24'-7"	25'-9"
540	23'-8"	24'-0"	24'-3"	26'-2"	26'-6"	26'-9"	27'-11"
560	25'-11"	26'-3"	26'-7"	28'-5"	28'-9"	29'-0"	30'-2"
580	28'-4"	28'-7"	28'-11"	30'-9"	31'-1"	31'-4"	32'-6"
600	30'-9"	31'-1"	31'-5"	33'-2"	33'-6"	33'-9"	34'-11"
620	33'-4"	33'-7"	33'-11"	35'-8"	36'-0"	36'-3"	37'-5"
640	35'-11"	36'-3"	36'-7"	38'-4"	38'-7"	38'-10"	40'-0"
660	38'-8"	38'-11"	39'-3"	41'-0"	41'-3"	41'-6"	42'-8"
680	41'-5"	41'-9"	42'-1"	43'-9"	44'-0"	44'-4"	45'-6"
700	44'-4"	44'-8"	44'-11"	46'-8"	46'-11"	47'-2"	48'-4"
720	47'-4"	47'-7"	47'-11"	49'-7"	49'-10"	50'-2"	51'-3"
740	50'-5"	50'-8"	51'-0"	52'-8"	52'-11"	53'-2"	54'-4"
760	53'-6"	53'-10"	54'-2"	55'-9"	56'-1"	56'-4"	57'-6"
780	56'-9"	57'-1"	57'-4"	59'-0"	59'-3"	59'-7"	60'-8"
800	60'-2"	60'-5"	60'-9"	62'-4"	62'-7"	62'-11"	64'-0"
820	63'-7"	63'-10"	64'-2"	65'-9"	66'-0"	66'-4"	67'-5"
840	67'-1"	67'-5"	67'-8"	69'-3"	69'-6"	69'-10"	71'-0"
860	70'-9"	71'-0"	71'-3"	72'-11"	73'-2"	73'-5"	74'-7"
880	74'-5"	74'-9"	75'-0"	76'-7"	76'-10"	77'-2"	78'-3"
900	78'-3"	78'-6"	78'-10"	80'-5"	80'-8"	80'-11"	82'-1"
920	82'-2"	82'-5"	82'-9"	84'-4"	84'-7"	84'-10"	86'-0"
940	86'-2"	86'-6"	86'-9"	88'-4"	88'-7"	88'-10"	90'-0"
960	90'-4"	90'-7"	90'-10"	92'-5"	92'-8"	93'-0"	94'-1"
980	94'-6"	94'-9"	95'-1"	96'-7"	96'-11"	97'-2"	98'-4"
1000	98'-10"	99'-1"	99'-5"	100'-11"	101'-3"	101'-6"	102'-7"

Note(s):

1. Spans less than 500 feet will use the 7-#8 messenger size. Spans equal to or greater than 500 feet will use the 7-#6 messenger and require engineering approval.

Scope SC 131P.5 Sag Chart and Clearances for 635 ACSR SC Light Loading

Table SC 131P–9: 7#8 Alumoweld 653 ACSR CC G.O. 95 Light

Span (ft)	Initial Messenger Sag before 3 x 653 ACSR CC 35 kV Installation (ft)			Initial Sag after 3x 653 ACSR CC 35 kV Installation (ft)			Final Sag (ft)
	50°F	70°F	90°F	50°F	70°F	90°F	130°F
100	0'-3"	0'-3"	0'-5"	1'-8"	1'-9"	1'-9"	2'-2"
120	0'-5"	0'-6"	0'-11"	2'-4"	2'-5"	2'-6"	3'-0"
140	0'-10"	1'-1"	1'-10"	3'-2"	3'-4"	3'-5"	3'-11"
160	1'-10"	2'-1"	2'-10"	4'-2"	4'-3"	4'-5"	4'-11"
180	3'-1"	3'-4"	4'-0"	5'-3"	5'-5"	5'-6"	6'-1"
200	4'-5"	4'-8"	5'-3"	6'-6"	6'-8"	6'-10"	7'-5"
220	5'-11"	6'-1"	6'-8"	7'-11"	8'-1"	8'-2"	8'-10"
240	7'-5"	7'-8"	8'-3"	9'-5"	9'-7"	9'-9"	10'-4"
260	9'-2"	9'-4"	9'-11"	11'-1"	11'-3"	11'-5"	12'-0"
280	10'-11"	11'-2"	11'-8"	12'-11"	13'-0"	13'-2"	13'-10"
300	12'-11"	13'-1"	13'-8"	14'-10"	15'-0"	15'-1"	15'-9"
320	15'-0"	15'-2"	15'-9"	16'-11"	17'-0"	17'-2"	17'-10"
340	17'-3"	17'-5"	17'-11"	19'-1"	19'-3"	19'-5"	20'-1"
360	19'-7"	19'-9"	20'-3"	21'-5"	21'-7"	21'-9"	22'-5"
380	22'-1"	22'-3"	22'-9"	23'-11"	24'-1"	24'-3"	24'-11"
400	24'-9"	24'-11"	25'-5"	26'-7"	26'-9"	26'-11"	27'-7"
420	27'-6"	27'-8"	28'-2"	29'-4"	29'-6"	29'-8"	30'-5"
440	30'-5"	30'-7"	31'-2"	32'-3"	32'-5"	32'-7"	33'-4"
460	33'-6"	33'-8"	34'-3"	35'-4"	35'-6"	35'-8"	36'-5"
480	36'-9"	36'-11"	37'-5"	38'-7"	38'-9"	38'-11"	39'-8"

Note(s):

1. Spans less than 500 feet will use the 7-#8 messenger size. Spans equal to or greater than 500 feet will use the 7-#6 messenger and require engineering approval.

Table SC 131P–10: 7#6 Alumoweld 653 ACSR CC G.O. 95 Light

Span (ft)	Initial Messenger Sag before 3 x 653 ACSR CC 35 kV Installation (ft)			Initial Sag after 3x 653 ACSR CC 35 kV Installation (ft)			Final Sag (ft)
	50°F	70°F	90°F	50°F	70°F	90°F	130°F
500	27'-10"	28'-1"	28'-10"	30'-1"	30'-3"	30'-6"	31'-5"
520	30'-4"	30'-7"	31'-4"	32'-7"	32'-9"	33'-0"	33'-11"
540	32'-11"	33'-2"	33'-11"	35'-2"	35'-4"	35'-7"	36'-6"
560	35'-8"	35'-11"	36'-7"	37'-10"	38'-1"	38'-3"	39'-3"
580	38'-6"	38'-9"	39'-5"	40'-8"	40'-11"	41'-1"	42'-1"
600	41'-5"	41'-8"	42'-4"	43'-7"	43'-10"	44'-0"	45'-0"
620	44'-5"	44'-8"	45'-4"	46'-7"	46'-10"	47'-1"	48'-0"
640	47'-7"	47'-10"	48'-6"	49'-9"	50'-0"	50'-2"	51'-2"
660	50'-10"	51'-1"	51'-9"	53'-0"	53'-3"	53'-5"	54'-5"
680	54'-2"	54'-5"	55'-1"	56'-4"	56'-7"	56'-10"	57'-9"
700	57'-8"	57'-11"	58'-7"	59'-10"	60'-1"	60'-3"	61'-3"
720	61'-3"	61'-6"	62'-2"	63'-5"	63'-8"	63'-10"	64'-10"
740	64'-11"	65'-2"	65'-10"	67'-1"	67'-4"	67'-7"	68'-6"
760	68'-9"	69'-0"	69'-8"	70'-11"	71'-2"	71'-4"	72'-4"
780	72'-8"	72'-11"	73'-7"	74'-10"	75'-1"	75'-4"	76'-3"
800	76'-9"	77'-0"	77'-8"	78'-11"	79'-2"	79'-4"	80'-4"
820	80'-11"	81'-2"	81'-10"	83'-1"	83'-4"	83'-6"	84'-6"
840	85'-3"	85'-5"	86'-2"	87'-4"	87'-7"	87'-10"	88'-10"
860	89'-8"	89'-10"	90'-7"	91'-9"	92'-0"	92'-3"	93'-3"
880	94'-2"	94'-5"	95'-1"	96'-4"	96'-7"	96'-9"	97'-9"
900	98'-10"	99'-1"	99'-9"	101'-0"	101'-3"	101'-5"	102'-5"
920	103'-8"	103'-10"	104'-7"	105'-9"	106'-0"	106'-3"	107'-3"
940	108'-7"	108'-10"	109'-6"	110'-9"	110'-11"	111'-2"	112'-2"
960	113'-8"	113'-10"	114'-7"	115'-9"	116'-0"	116'-3"	117'-3"
980	118'-10"	119'-1"	119'-9"	121'-0"	121'-2"	121'-5"	122'-5"
1000	124'-2"	124'-5"	125'-1"	126'-4"	126'-6"	126'-9"	127'-9"

Note(s):

1. Spans less than 500 feet will use the 7-#8 messenger size. Spans equal to or greater than 500 feet will use the 7-#6 messenger and require engineering approval.

Scope SC 131P.6 Sag Chart and Clearances for 653 ACSR SC Heavy Loading

Table SC 131P–11: 7#8 Alumoweld 653 ACSR CC G.O. 95 Heavy

Span (ft)	Initial Messenger Sag before 3 x 653 ACSR CC 35 kV Installation (ft)			Initial Sag after 3x 653 ACSR CC 35 kV Installation (ft)			Final Sag (ft)
	50°F	70°F	90°F	50°F	70°F	90°F	130°F
100	0'-3"	0'-3"	0'-5"	1'-8"	1'-9"	1'-9"	2'-2"
120	0'-5"	0'-6"	0'-11"	2'-4"	2'-5"	2'-6"	3'-0"
140	0'-10"	1'-1"	1'-10"	3'-2"	3'-4"	3'-5"	3'-11"
160	1'-10"	2'-1"	2'-10"	4'-2"	4'-3"	4'-5"	4'-11"
180	3'-1"	3'-4"	4'-0"	5'-3"	5'-5"	5'-6"	6'-1"
200	4'-5"	4'-8"	5'-3"	6'-6"	6'-8"	6'-10"	7'-5"
220	5'-11"	6'-1"	6'-8"	7'-11"	8'-1"	8'-2"	8'-10"
240	7'-5"	7'-8"	8'-3"	9'-5"	9'-7"	9'-9"	10'-4"
260	9'-2"	9'-4"	9'-11"	11'-1"	11'-3"	11'-5"	12'-0"
280	10'-11"	11'-2"	11'-8"	12'-11"	13'-0"	13'-2"	13'-10"
300	12'-11"	13'-1"	13'-8"	14'-10"	15'-0"	15'-1"	15'-9"
320	15'-0"	15'-2"	15'-9"	16'-11"	17'-0"	17'-2"	17'-10"
340	17'-3"	17'-5"	17'-11"	19'-1"	19'-3"	19'-5"	20'-1"
360	19'-7"	19'-9"	20'-3"	21'-5"	21'-7"	21'-9"	22'-5"
380	21'-0"	21'-2"	21'-4"	23'-0"	23'-1"	23'-3"	24'-0"
400	23'-9"	23'-11"	24'-1"	25'-8"	25'-10"	26'-0"	26'-9"
420	26'-8"	26'-10"	27'-0"	28'-7"	28'-9"	28'-11"	29'-8"
440	29'-9"	29'-11"	30'-1"	31'-8"	31'-10"	32'-0"	32'-8"
460	33'-0"	33'-2"	33'-4"	34'-10"	35'-0"	35'-2"	35'-11"
480	36'-5"	36'-7"	36'-9"	38'-3"	38'-5"	38'-6"	39'-3"

Note(s):

1. Spans less than 500 feet will use the 7-#8 messenger size. Spans equal to or greater than 500 feet will use the 7-#6 messenger and require engineering approval.

Table SC 131P–12: 7#6 Alumoweld 653 ACSR CC G.O. 95 Heavy

Span (ft)	Initial Messenger Sag before 3 x 653 ACSR CC 35 kV Installation (ft)			Initial Sag after 3x 653 ACSR CC 35 kV Installation (ft)			Final Sag (ft)
	50°F	70°F	90°F	50°F	70°F	90°F	130°F
500	26'-1"	26'-4"	26'-8"	28'-6"	28'-9"	29'-0"	30'-0"
520	28'-9"	29'-0"	29'-3"	31'-1"	31'-4"	31'-6"	32'-6"
540	31'-5"	31'-8"	31'-11"	33'-9"	34'-0"	34'-2"	35'-2"
560	34'-2"	34'-5"	34'-8"	36'-6"	36'-9"	37'-0"	38'-0"
580	37'-1"	37'-4"	37'-7"	39'-5"	39'-8"	39'-10"	40'-10"
600	40'-2"	40'-4"	40'-7"	42'-5"	42'-8"	42'-10"	43'-10"
620	43'-3"	43'-6"	43'-9"	45'-6"	45'-9"	45'-11"	46'-11"
640	46'-6"	46'-9"	47'-0"	48'-9"	48'-11"	49'-2"	50'-2"
660	49'-10"	50'-1"	50'-4"	52'-1"	52'-3"	52'-6"	53'-6"
680	53'-4"	53'-6"	53'-9"	55'-6"	55'-9"	55'-11"	56'-11"
700	56'-11"	57'-1"	57'-4"	59'-1"	59'-3"	59'-6"	60'-6"
720	60'-7"	60'-10"	61'-0"	62'-9"	63'-0"	63'-2"	64'-2"
740	64'-5"	64'-7"	64'-10"	66'-7"	66'-9"	67'-0"	68'-0"
760	68'-4"	68'-7"	68'-9"	70'-6"	70'-8"	70'-11"	71'-11"
780	72'-4"	72'-7"	72'-10"	74'-6"	74'-9"	75'-0"	75'-11"
800	76'-6"	76'-9"	77'-0"	78'-8"	78'-11"	79'-1"	80'-1"
820	80'-10"	81'-1"	81'-4"	83'-0"	83'-2"	83'-5"	84'-5"
840	85'-3"	85'-6"	85'-9"	87'-5"	87'-7"	87'-10"	88'-10"
860	89'-10"	90'-1"	90'-3"	91'-11"	92'-2"	92'-5"	93'-4"
880	94'-6"	94'-9"	95'-0"	96'-7"	96'-10"	97'-1"	98'-0"
900	99'-4"	99'-6"	99'-9"	101'-5"	101'-8"	101'-10"	102'-10"
920	104'-3"	104'-6"	104'-9"	106'-4"	106'-7"	106'-10"	107'-9"
940	109'-4"	109'-7"	109'-10"	111'-5"	111'-8"	111'-11"	112'-10"
960	114'-7"	114'-10"	115'-0"	116'-8"	116'-11"	117'-1"	118'-1"
980	119'-11"	120'-2"	120'-5"	122'-0"	122'-3"	122'-6"	123'-5"
1000	125'-5"	125'-8"	125'-11"	127'-6"	127'-9"	128'-0"	129'-0"

Note(s):

1. Spans less than 500 feet will use the 7-#8 messenger size. Spans equal to or greater than 500 feet will use the 7-#6 messenger and require engineering approval.

Scope SC 131P.7 Conductor Sagging

Concluding the tensioning of the messenger wire and while the conductors are in the stringing block. The conductors shall be sagged in accordance with the Sag Gauge tool when using a Roll by Stringing Block (see SC 210P). When both the stringing block and stringing gauge are not used, refer to the measurement guide for alternative methods. Instruction for both procedures, shall be referenced in the self-directed job aid Technology Integration.

Figure SC 131P–1: Hendrix Sag Gauge

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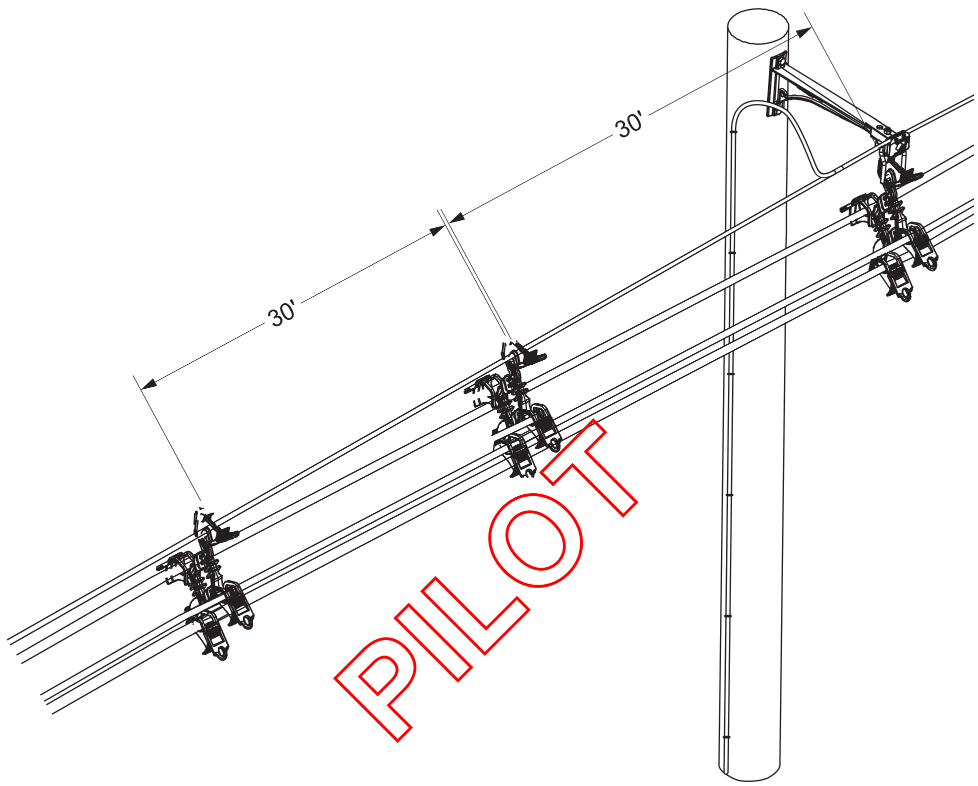
SC 140P Spacer Installation Intervals

Scope SC 140P.1 General

Spacers shall be evenly spaced at intervals of 25–30 feet. This applies to both the 12 inch and 18 inch spacer (bolted and non-bolted) and is not dependent on the angle of the span (see SC 110P).

Figure SC 140P–1: Spacer Cable Spacing Intervals



NOTE

All spacer ratcheting connections shall be ensured for tightness once proper sagging of the messenger and conductor are performed.

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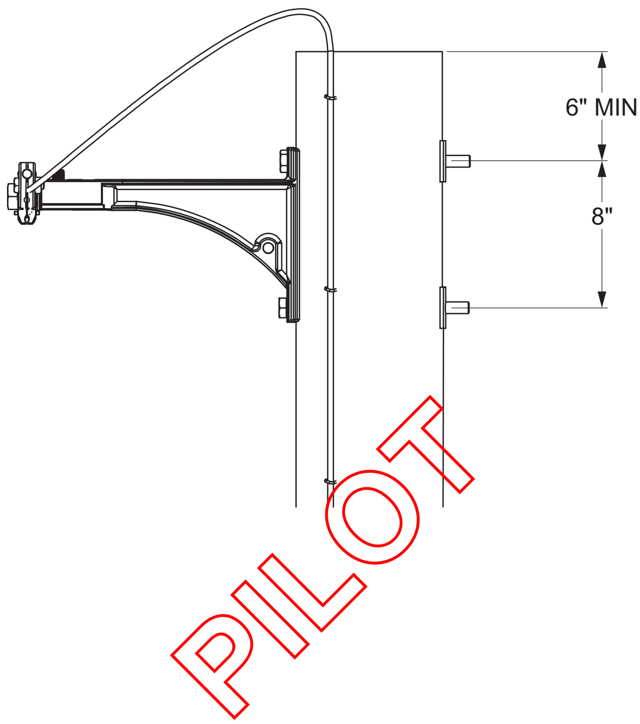
SC 141P Tangent Bracket Construction

Scope SC 141P.1 General

1.0 Tangent Bracket Open-Crossarm Construction

See Figure SC 141P–1 for the minimum installation dimensions for the tangent bracket.

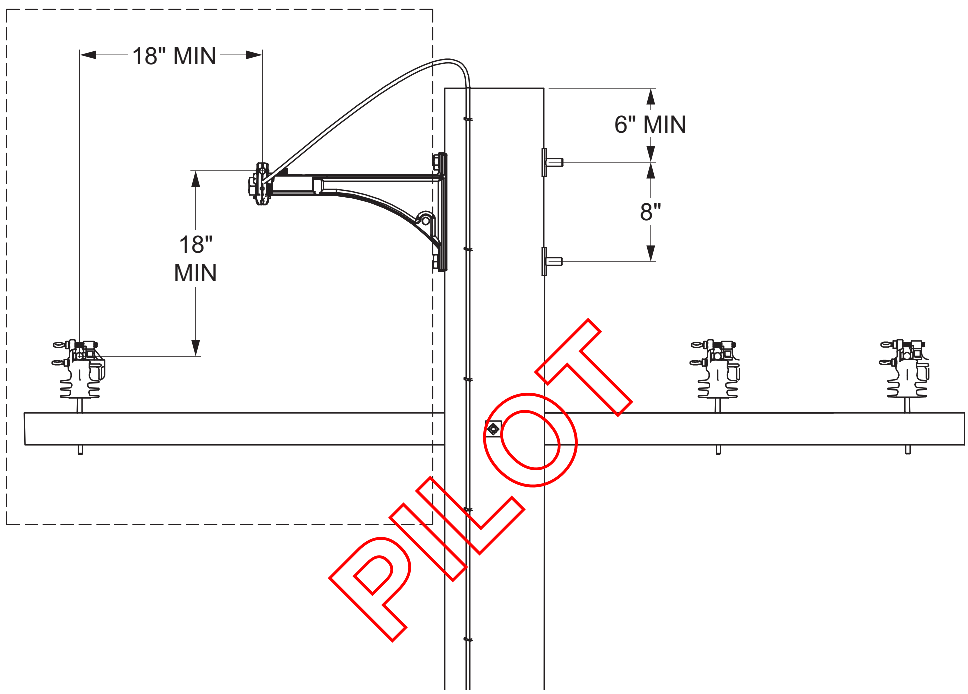
Figure SC 141P–1: Tangent Bracket Minimum Installation Dimensions



2.0 Tangent Bracket Open-Crossarm Construction

For equipment poles, with line angles no greater than 6 degrees, the tangent bracket may be used to avoid dead-ending the messenger wire. The orientation of the bracket must be such that the messenger is in line with the preceding span and shall be installed no closer than 6 inches from the top of the pole. The orientation of the tangent bracket will dictate the location of the insulators. The side of the crossarm sharing the same side as the tangent bracket shall only have a single insulator in order to maintain the appropriate radial clearances from the messenger wire.

Figure SC 141P–2: Tangent Open Crossarm Construction



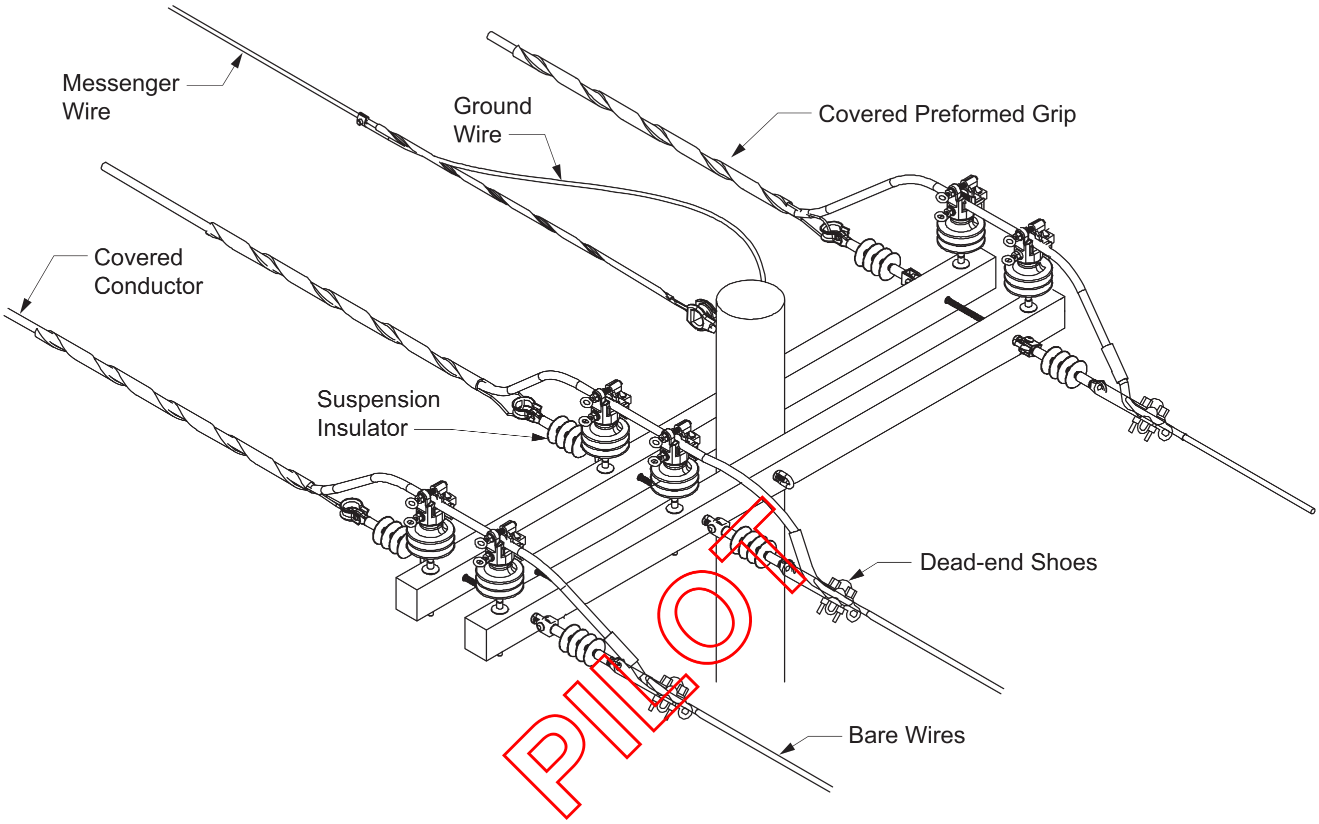
Note(s):

1. Wildlife covers on dead-ends are not shown to show greater detail. See CC 150 for covered conductor wildlife protection.
2. See PO 120 for High Voltage sign installation requirements.
3. See CC 150 for cover conductor insulator requirements.
4. See AC 120 for clearances.
5. See CC 130.1 for covered conductor surge arrester requirements.
6. See CC 170 for covered conductor splicing requirements.
7. See SC 150P for messenger deadening requirements.
8. Equipment poles must use a double composite crossarm dead-end construction.

SC 150P Dead-ending

Scope SC 150P.1 Bare Conductor to Spacer Cable

Figure SC 150P–1: Transition from Bare Conductor to Spacer Cable



Note(s):

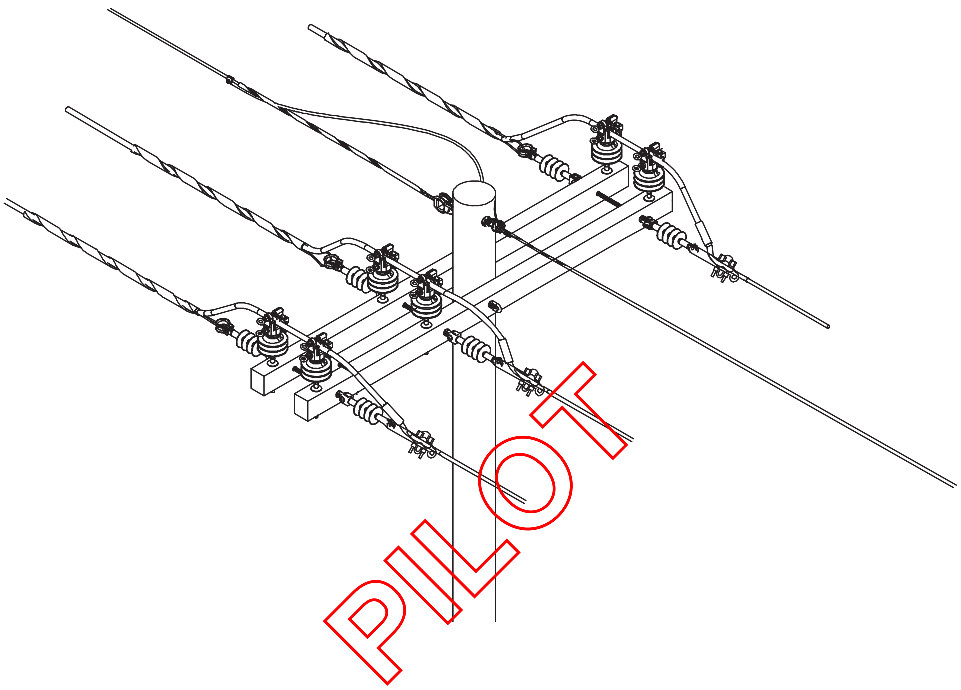
1. Wildlife covers on dead-ends are not shown to show greater detail. See CC 150 for covered conductor wildlife protection.
2. See PO 120 for High Voltage sign installation requirements.
3. See CC 150 for cover conductor insulator requirements.
4. See AC 120 for clearances.
5. See CC 130.1 for covered conductor surge arrester requirements.
6. See CC 170 for covered conductor splicing requirements.
7. The messenger must be dead-ended if the ratio of either the fore span or back span exceeds a 2:1 ratio.

Scope SC 150P.2 Covered Conductor to Cover Conductor Deadending

The messenger shall be dead-ended in the following scenarios:

- Equipment poles in which the line angle is in excess of 6 degrees.
- To avoid splicing the messenger.
- If the ratio of either the fore span or back span exceeds a 2:1 ratio.

Figure SC 150P–2: Spacer Cable Open Cross Arm Construction



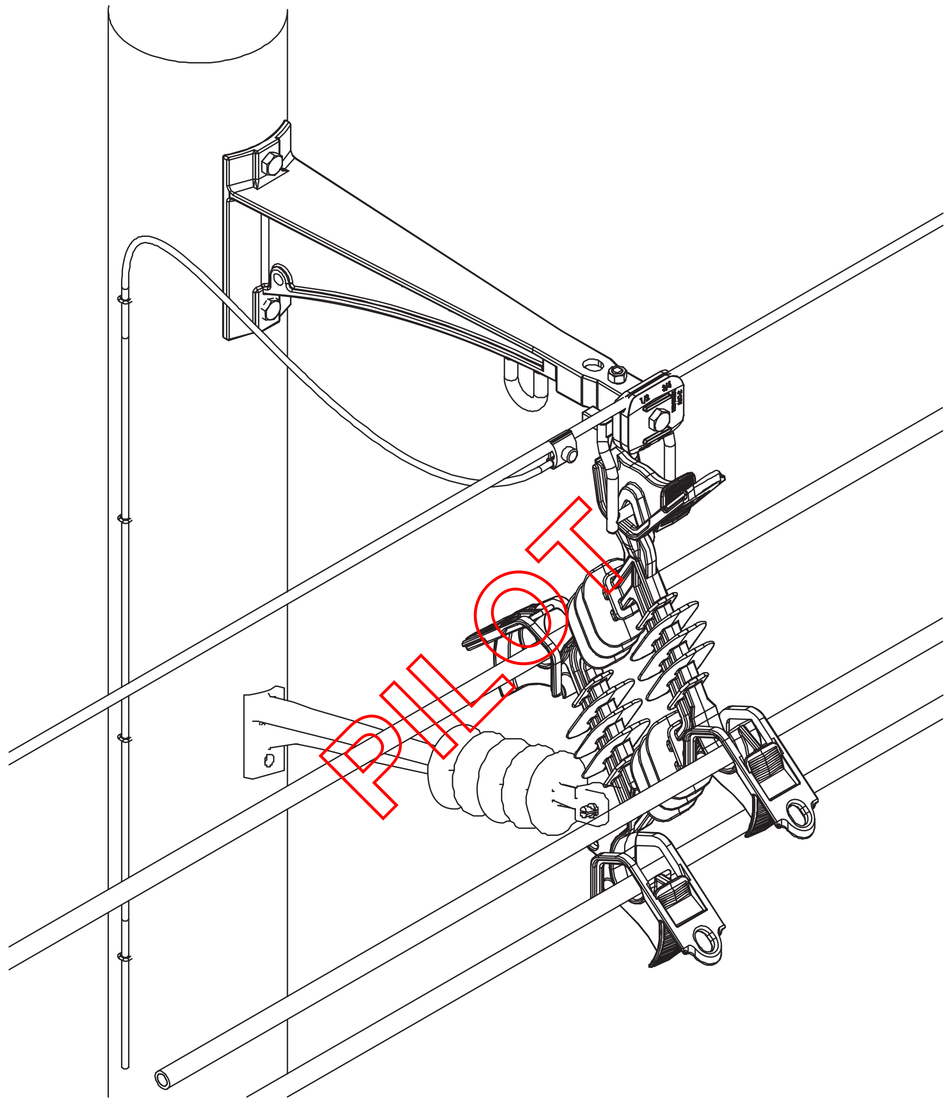
Note(s):

1. Wildlife covers on dead-ends are not shown to show greater detail. See CC 150 for covered conductor wildlife protection.
2. See PO 120 for High Voltage sign installation requirements.
3. See CC 150 for cover conductor insulator requirements.
4. See AC 120 for clearances.
5. See CC 130.1 for covered conductor surge arrester requirements.
6. See CC 170 for covered conductor splicing requirements.

SC 160P Tangent Non-Equipment Poles 0°–6°

Scope SC 160P.1 General

Figure SC 160P–1: Spacer Cable Tangent Non-Equipment Construction



Note(s):

1. See PO 120 for High Voltage sign installation requirements.
2. See AC 120 for clearances.
3. See CC 130.1 for covered conductor surge arrester requirements.
4. See CC 170 for covered conductor splicing requirements.

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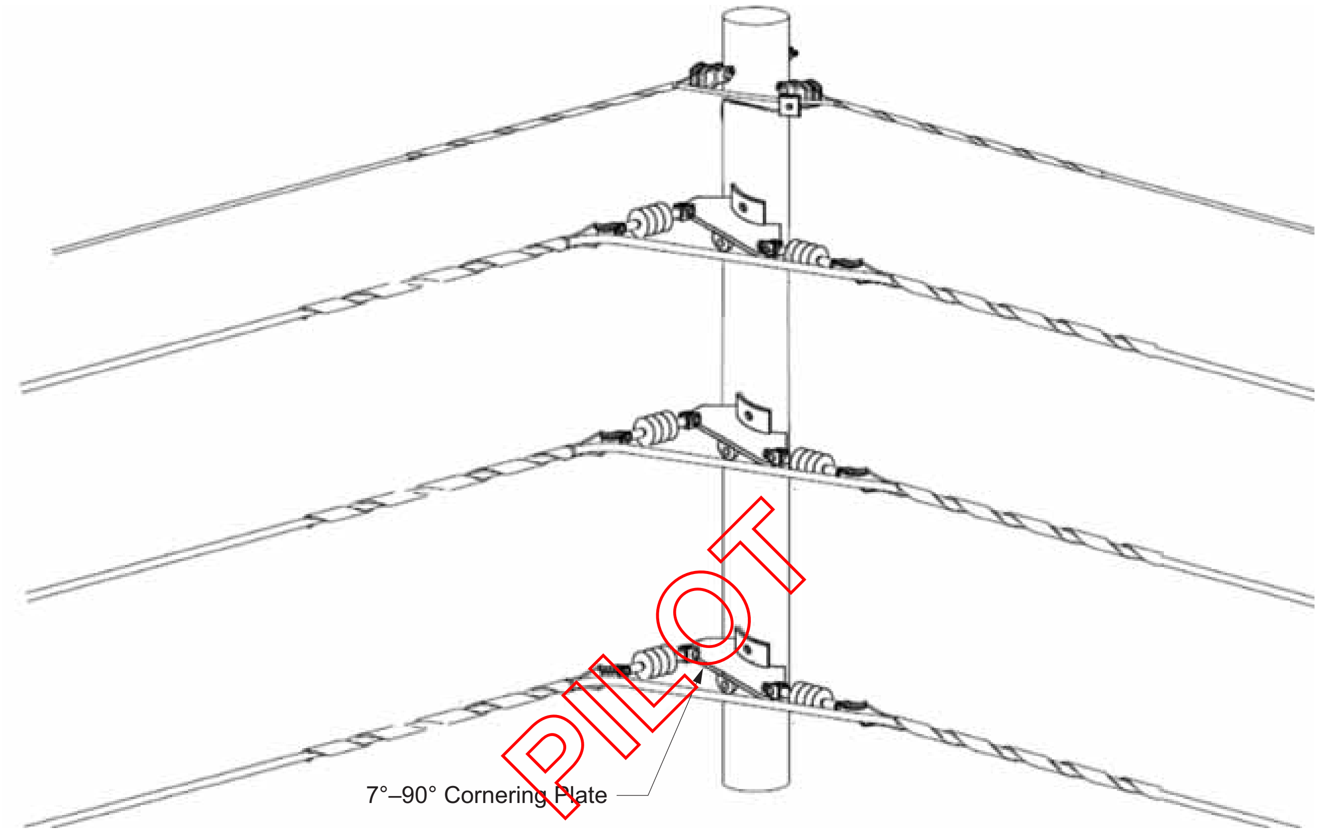
SC 170P Angled Non-Equipment Poles 7°–90°

Scope SC 170P.1 General

Figure SC 170P–1: Spacer Cable Non-Equipment Angled Construction (7°–90°)



Note(s):

1. See PO 120 for High Voltage sign installation requirements.
2. See CC 150 for cover conductor insulator requirements.
3. See AC 120 for clearances.
4. See CC 130.1 for covered conductor surge arrester requirements.
5. See CC 170 for covered conductor splicing requirements.
6. Line angles greater than 90 degrees will require dead-ending.

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SC 180P Connection to 1Ø Transformer

Scope SC 180P.1 General

Transformer connections shall utilized an open crossarm construction in order to maintain climbing space. The covered conductor shall be stripped only on the side of the transformer to reduce the number of open points.

Figure SC 180P–1: 12/16 kV Spacer Cable Connected to 1Ø Transformer Bank Dead-end Shoes (Top View)

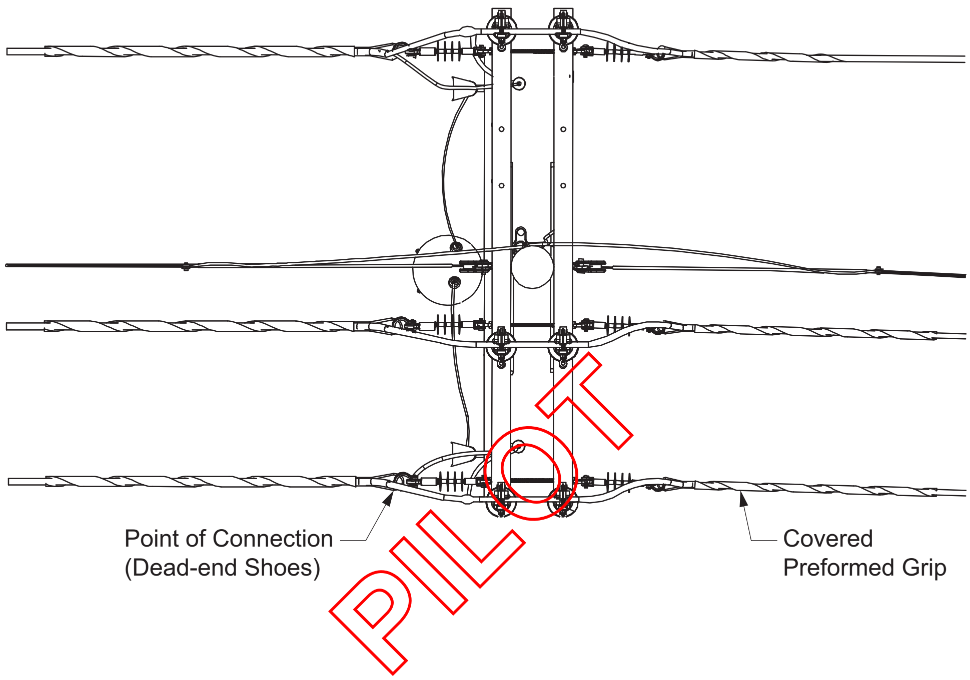
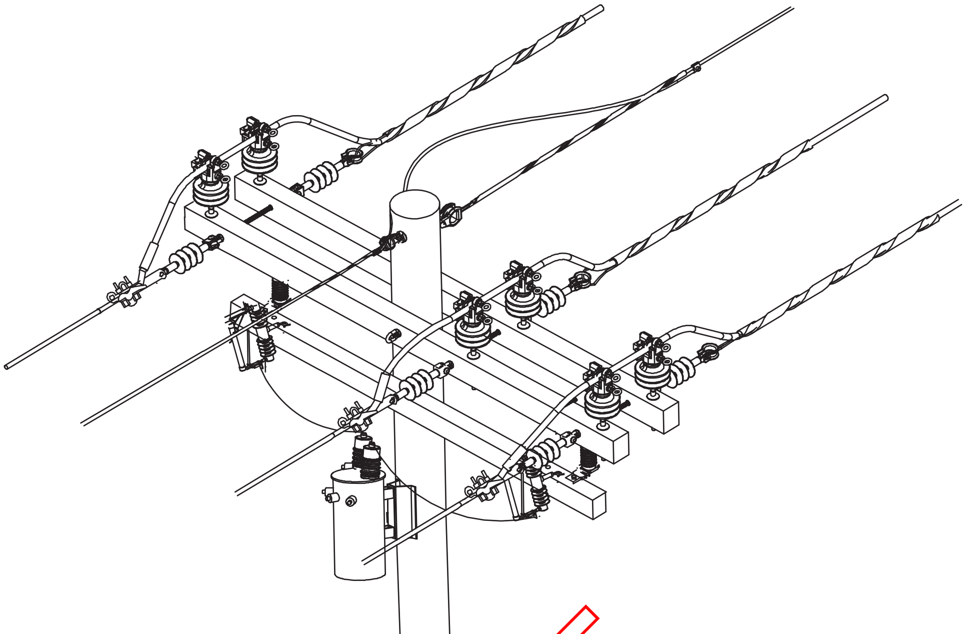


Figure SC 180P–2: 12/16 kV Spacer Cable 1Ø Transformer Construction (Isometric View)



PILOT

Note(s):

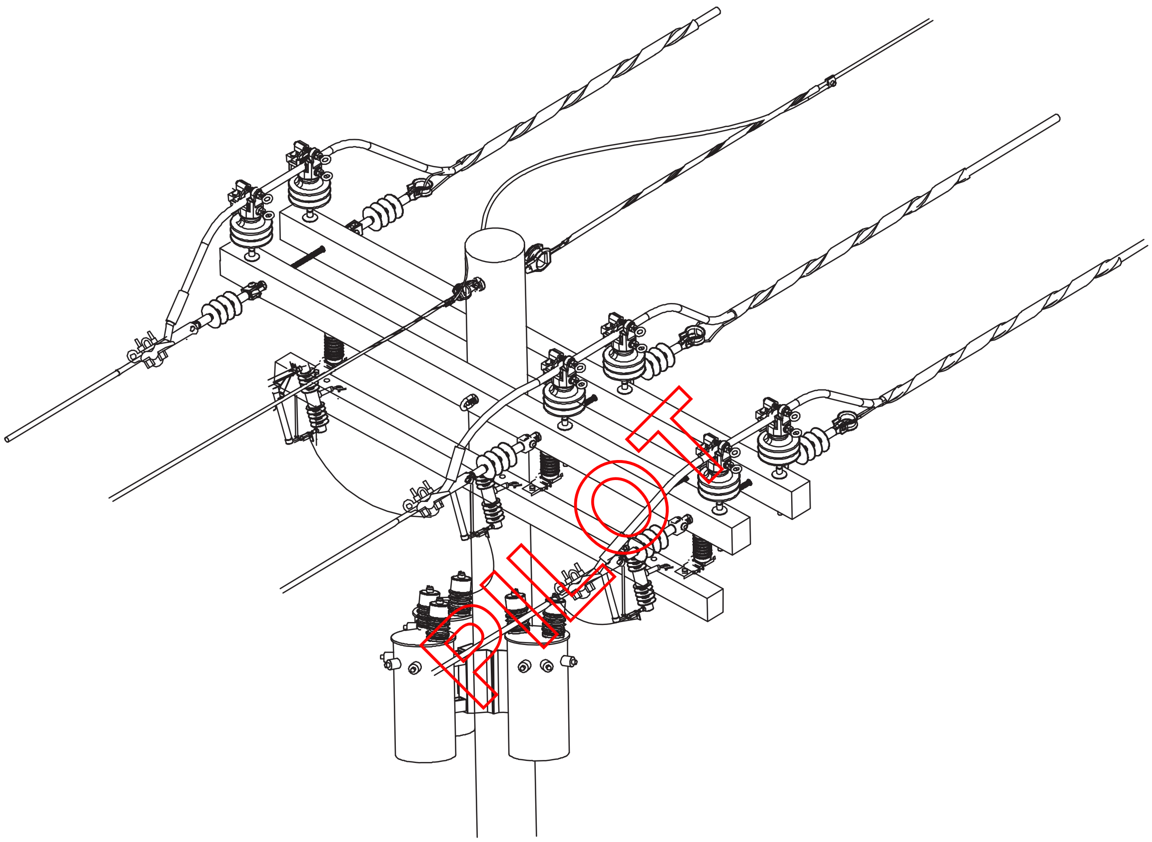
1. See PO 120 for High Voltage sign installation requirements.
2. See CC 150 for cover conductor insulator requirements.
3. See AC 120 for clearances.
4. See CC 130.1 for covered conductor surge arrester requirements.
5. See CC 170 for covered conductor splicing requirements.
6. Line angles greater than 90 degrees will require dead-ending.
7. See SC 141P for tangent bracket requirements.

SC 190P Connection to 3Ø Transformer

Scope SC 190P.1 General

Transformer connections shall utilized an open crossarm construction in order to maintain climbing space. The covered conductor shall be stripped only on the side of the transformer to reduce the number of open points.

Figure SC 190P–1: 12/16 kV Spacer Cable Connected to 3-1Ø Transformer Bank (Isometric View)



Note(s):

1. See PO 120 for High Voltage sign installation requirements.
2. See CC 150 for cover conductor insulator requirements.
3. See AC 120 for clearances.
4. See CC 130.1 for covered conductor surge arrester requirements.
5. See CC 170 for covered conductor splicing requirements.
6. Line angles greater than 90 degrees will require dead-ending.
7. See SC 141P for tangent bracket requirements.

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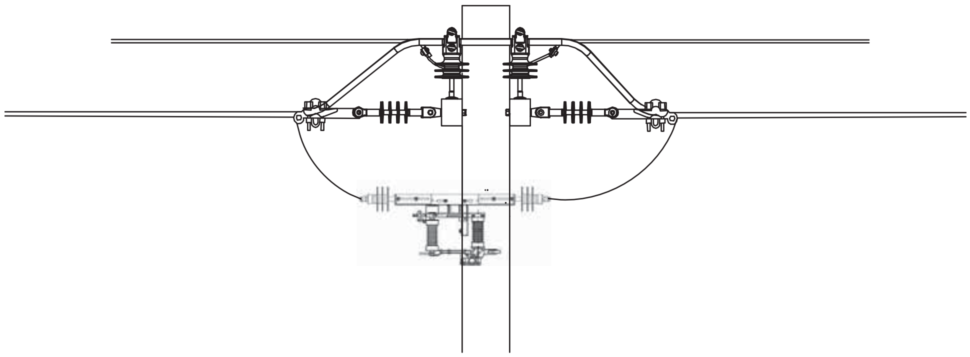
SC 200P Connection to Omni-Rupter Switch

Scope SC 200P.1 General

Switches used with the spacer cable system shall utilize below line arm construction utilizing the Hughes adapter.

Figure SC 200P–1: Spacer Cable Overhead Switch Construction



Note(s):

1. See PO 120 for High Voltage sign installation requirements.
2. See CC 150 for cover conductor insulator requirements.
3. See AC 120 for clearances.
4. See CC 130.1 for covered conductor surge arrester requirements.
5. See CC 170 for covered conductor splicing requirements.
6. Line angles greater than 90 degrees will require dead-ending.
7. See SC 141P for tangent bracket requirements.

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SC 210P Spacer Cable Installation Equipment

Scope SC 210P.1 General

1.0 Roll-By Stringing Block (PBR-3)

The Roll By Stringing Block is utilized in pulling 2 or 3 wire circuits. Utilized every 25–30 feet in combination to the placement of the 12 inch or 18 inch spacer.

Figure SC 210P–1: Roll-By Stringing Block

2.0 Messenger Trolley

Messenger Trolley is the lead pulling mechanism with the function of pulling the PBR-3 block/blocks with conductors attached.

Figure SC 210P–2: Messenger Trolley

NOTE

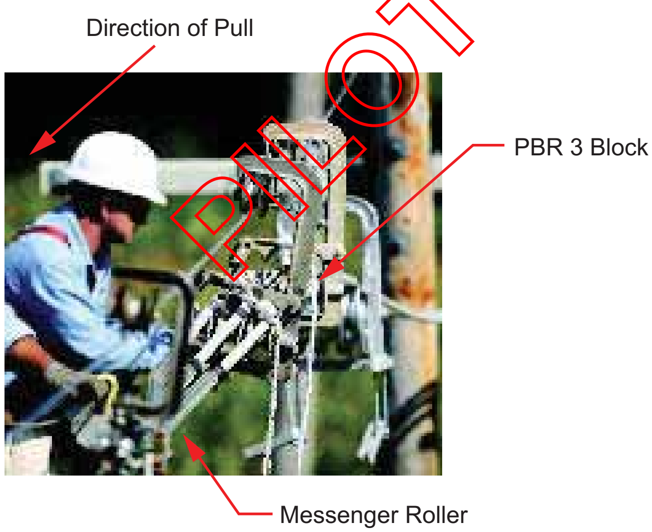
The messenger trolley is bi-directional, it is imperative that the “C” shape of the bracket is facing the pole.

3.0 Underarm Messenger Clamp

The Underarm Messenger Clamp may be required in instances when changing sides of the pole.

Figure SC 210P–3: Underarm Messenger Clamp

Figure SC 210P–4: Reference of PBR 3 Block in Combination with the Messenger Roller



DOH–SL: Street Lighting

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SL 100 Definitions — Street-Lighting Terms

Scope SL 100.1 Definitions — Street-Lighting Terms

1.0 Ballast

A small transformer designed to provide the necessary voltage to start and operate a vapor ARC lamp and to limit the current in the lamp. One type of ballast is required for operation on a series circuit. A different type is used on a multiple circuit. The capacity of a ballast must match the wattage of the lamp it serves.

2.0 Bracket

A short, curved piece of pipe used to attach a luminaire to a pole or electrolier. There are two standard lengths, 4-feet and 6-feet long for use on steel and concrete electroliers. On wood poles, a 6-foot bracket is used for street lighting and a 30-inch bracket is used for area lighting.

3.0 Bracket Adapter

An end fitting with cable entrance in lower side for use on 1-1/4 inch diameter brackets and mast arms.

4.0 Cascading

Using a street-lighting circuit to control another street-lighting circuit. When a 6.6 A series circuit or a controlled 120 V multiple street-lighting circuit is used to energize a switch or relay to turn the lights of another circuit on and off, it is called cascading.

5.0 C.I.F.

Cut-in-Flat. This term is used by Edison to indicate non-metered or flat rate service.

6.0 Constant-Current Transformer

A transformer that automatically maintains a constant current in its secondary circuit under varying conditions of load when supplied from a constant potential source. These transformers are commonly referred to as ROs by Edison personnel. They are sometimes referred to as constant-current regulators.

7.0 Duplex-Drop Wire

Two-wire cable used for the service drop to a streetlight. It consists of two conductors, #8 AWG, stranded aluminum or medium hard-drawn copper, insulated and laid parallel in a cable. The insulation is rated at 600 V and the cable is so constructed that the two conductors can be readily separated.

8.0 EEI-NEMA

Edison Electric Institute-National Electric Manufacturers Association. This is the combination of two organizations. Committees are appointed, consisting of members of both organizations to develop various standards for the manufacturing of electrical products. The members of both organizations vote on the recommended specifications. If the recommendations become Standards, they are then used as guides by both electric companies and manufacturers in specifying and manufacturing electrical products.

9.0 Electrolier

The nomenclature given to streetlight poles. Streetlight poles are structures that contain the necessary internal channels and openings for wiring and external attachments for brackets and luminaires. Our standards include three types of electroliers; steel, concrete, and composite. The steel electroliers are normally supplied by overhead wires and the concrete and composite electroliers are normally served by underground conductors.

10.0 Film Cutout

A small disc used in a series street-lighting circuit and inserted between the prongs of a series socket. It is in effect a voltage fuse, which blows and completes the series circuit when current flow through the lamp is interrupted.

11.0 Globe

A non-refracting cover which attaches to the luminaire to complete the enclosure for the lamp. The globe protects the lamp and reflector from dirt and moisture. We used diffusing globes on all of our standard luminaires for incandescent lamps.

12.0 IES

Illuminating Engineering Society (IES). An organization which provides a forum for all matters concerning illumination. It recommends certain lighting practices and publishes the *IES Lighting Handbook* which is termed *The Standard Lighting Guide*.

13.0 I - Individual

A term used by Edison to indicate either a mercury vapor or an incandescent luminaire for use on a 6.6 A series circuit.

14.0 IL

A small current transformer formerly used in series circuits to insulate the lamp from the high voltage of the main circuit. This transformer has also been used to operate incandescent lamps designed for 15 A or 20 A from a 6.6 A circuit. Transformers of this type are obsolete.

15.0 IM - Individual Multiple

A term used by Edison to indicate either a mercury vapor or incandescent luminaire for use on a 120 V multiple streetlight circuit. This unit does not contain a receptacle for a photoelectric controller. These units have been replaced in usage by type IMC.

16.0 IMC - Individual Multiple Controlled

A term used by Edison to indicate either a mercury vapor or incandescent luminaire for use on 120 volt multiple secondaries. This unit contains a receptacle for a photoelectric controller.

17.0 Lamp

The light source employed. We use incandescent, mercury vapor, high-pressure sodium vapor, low pressure sodium vapor, and metal halide vapor lamps as light sources.

18.0 Light Center

The distance (in inches) from the center of the light source to outer end of the base contact. This is from the center of the filament in an incandescent lamp and from the center of the arc in a mercury vapor lamp.

19.0 Lumen

The unit quantity of light output. It is the basis for our street-lighting rate schedules. Changes are based on the lumen rating of the lamps.

All street lamps, series and multiple, are rated in lumens. Mercury vapor lamps are sometimes referred to by their wattage rating as well as their lumen rating. This is done because the ballasts used with them are rated in watts.

Luminaires are also classified by the lumen rating of the lamps they are designed to operate.

20.0 Luminaire

An illumination device which contains a light source. Our present standard units are side mounted enclosed luminaires. Previous standards also included top mounted and open bottom units.

21.0 Mast Arm

A long attachment to a pole for supporting the luminaire. Standard lengths are: 30 inches, 4 feet, 6 feet and 8 feet.

22.0 Mounting Height

The vertical distance between the roadway surface and the center of the light source. This is the technical definition. Our usage of the term designates the height above the street surface at which a streetlight luminaire is suspended when supported by a wood pole, or poles. When supported by an ornamental electrolier, it is the distance above the ground level at the base of the electrolier.

For top mounted luminaires, this distance is measured to the center of the head of the luminaire.

For side mounted luminaires, it is measured to a horizontal line through the center of the slipfitter in the side of the head.

23.0 Multiple

A constant voltage circuit used for street lighting. Also, a term used to identify equipment designed for use on such a circuit. All units are wired in parallel and operated at the same voltage, normally 120 V.

24.0 Photocontroller

A small device containing a light-sensitive cell and a switch which turns the lights on when light decreases to a predetermined level, and turns them off in the morning when the light increases to a certain level.

25.0 Protective Device

A receptacle for holding a film cutout and to be connected across the secondary of an SL transformer. It is used to prevent flashover of sockets, wiring insulation breakdown and excessive loading of constant-current transformer that might result from open-circuit operation.

26.0 RCOC

A switch or relay manufactured by the South Bend Current Controller Company and used to control street-lighting circuits. RCOC means Remote Control of Outdoor Circuits. These are magnetic switches, closed when the operating coil is energized and opened by gravity, when the coil is de-energized. Some have coils operated at 6.6 A and others have coils operated at 120 V.

27.0 Receptacle

A device used in series luminaires for receiving the series socket. It is made of porcelain or similar insulating material, has two terminals for connections from the series circuit and two spring contacts, between which the series socket is inserted. When the series socket is withdrawn, the two contacts spring together to complete the series circuit.

28.0 Refractor

A transparent band, bowl, or globe designed to control the direction of the light rays emerging from a luminaire by means of refracting prisms.

29.0 RO

The designation given by the General Electric Company to their oil-cooled, outdoor, constant-current transformers used for supplying series street-lighting circuits. The term, RO, is commonly used by Edison personnel to designate all makes of constant-current street-lighting transformers.

30.0 Series

A type of electrical circuit used in street lighting. Also, a term used to identify equipment designed for use on such a circuit. The same current (6.6 A) passes through all luminaires in the circuit. The voltage of the circuit varies, depending on the load. This type of circuit is not economical to install because of the very high cost of the constant current transformer.

31.0 Service Point

The location where energy is delivered to a customer-owned street-lighting system. This is usually a metal box, owned and installed by the customer on an Edison wood pole or an underground fed pedestal. The customer is required to provide a disconnecting device in this box or pedestal to isolate his system in case of trouble or for maintenance work.

32.0 Silhouette

The effect produced when an object is seen as a dark outline against a brighter background. This condition occurs in street lighting when the dominant light source is beyond the object viewed. A major part of our seeing at night by street lighting is through silhouette vision; where the light from a more or less distant lamp reflected from beyond the object by the pavement surface makes the background appear brighter than the object itself. While silhouette lighting does not reveal color and detail of an object, it does indicate closely its position, size, motion and outline so that the object can usually be readily identified. It is this phenomenon that makes it possible to see effectively with low intensity street and highway lighting.

33.0 SL

A small transformer used to insulate a portion of a series circuit from the high voltage of the main circuit. They are usually 6.6 A to 6.6 A. We recommend their use when supplying a small customer-owned underground circuit from a long, high voltage, overhead series circuit.

Note: These transformers are no longer manufactured.

34.0 Slipfitter

That part of a luminaire which supports it on the end of a bracket or mast arm. All of our standard luminaires have 2-inch slipfitters and may be used on all of our standard electroliers.

35.0 Socket

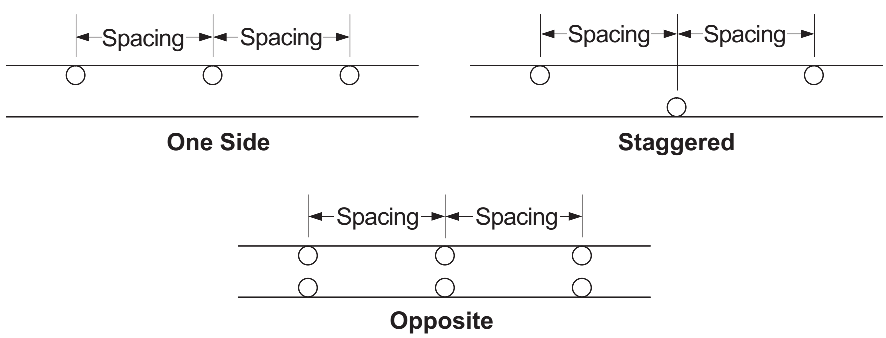
That part of a street-lighting luminaire where the final electrical contacts are made to the lamp. Multiple sockets are large size, or mogul (1-1/2-inch diameter), for all 120 V lamps except the 1,000 lumen. They are fixed in position.

Series sockets are always mogul in size. They have two spring prongs that make contact when plugged into the series receptacle. The film cutout is placed between the two prongs.

36.0 Spacing

The distance along the centerline of the street between streetlights.

Figure SL 100–1: Streetlight Spacing



37.0 USASI (Formerly ASA)

United States of America Standards Institute. This organization publishes standards which are the consensus of those substantially concerned with the manufacturer and use of electrical equipment (among many products). If USASI standards are available for a particular product, we normally use them in preference to any others.

38.0 Visibility

The ability to be seen or to facilitate seeing: The distinctness with which objects may be observed. Atmospheric conditions, intensity of light on the object, color of the object and contrast of object against its field are determining factors in visibility.

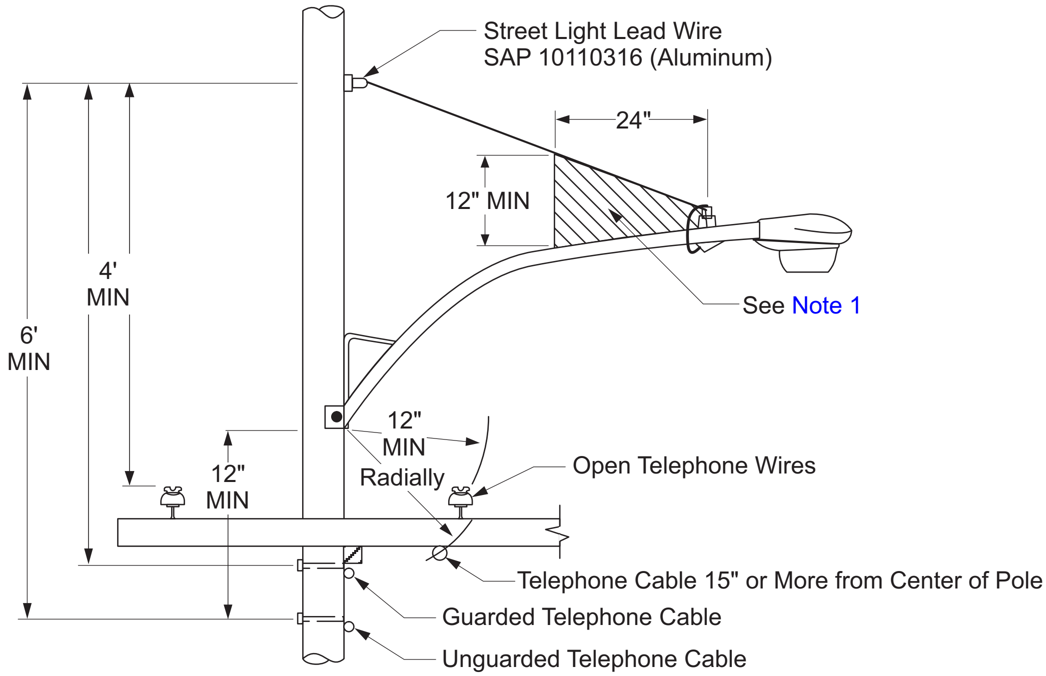
39.0 Dual Raceway

A pair of enclosed conduits that form physical pathways for electrical wiring. Raceways protect wires and cables from heat, corrosion, humidity, water, and other threats.

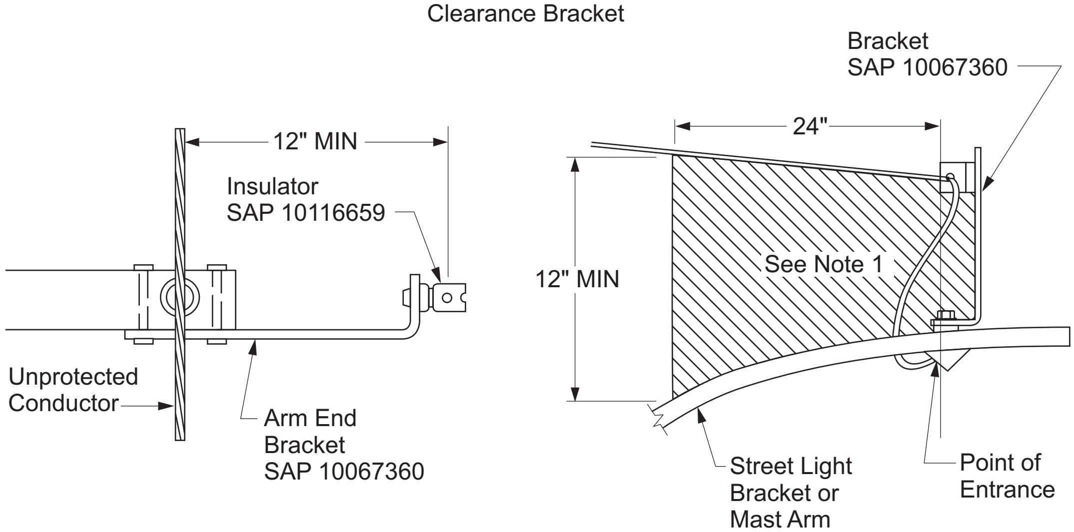
SL 105 Clearances Required by G.O. 95 Rules

Scope SL 105.1 Minimum Streetlight Clearances Required by G.O. 95 Rules

Figure SL 105–1: Minimum Streetlight Clearances Required by G.O. 95 Rules



Clearance Bracket



Note(s):

1. Streetlight lead wires shall be 12 inches minimum radially from streetlight hardware except in the shaded area.
2. #8 2-conductor cable is also supplied with copper conductor. SAP 10109555 Copper should be used only in copper designated areas.

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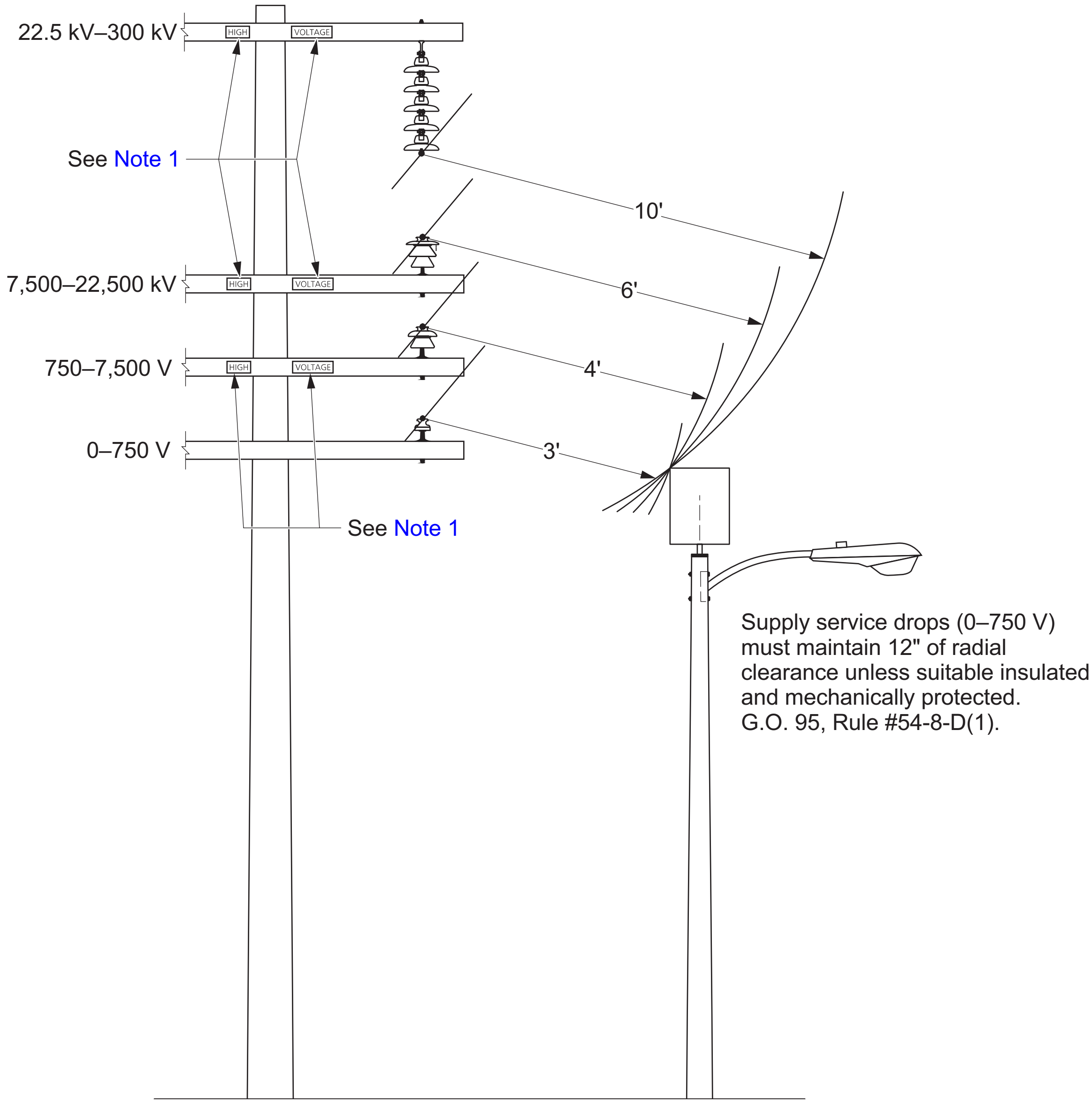
SL 106 Clearances to Electroliers

Scope SL 106.1 Clearances to Electroliers

Figure SL 106–1: Clearances to Electroliers



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Radial clearances required for various voltage conductors are the same at poles as mid-spans.

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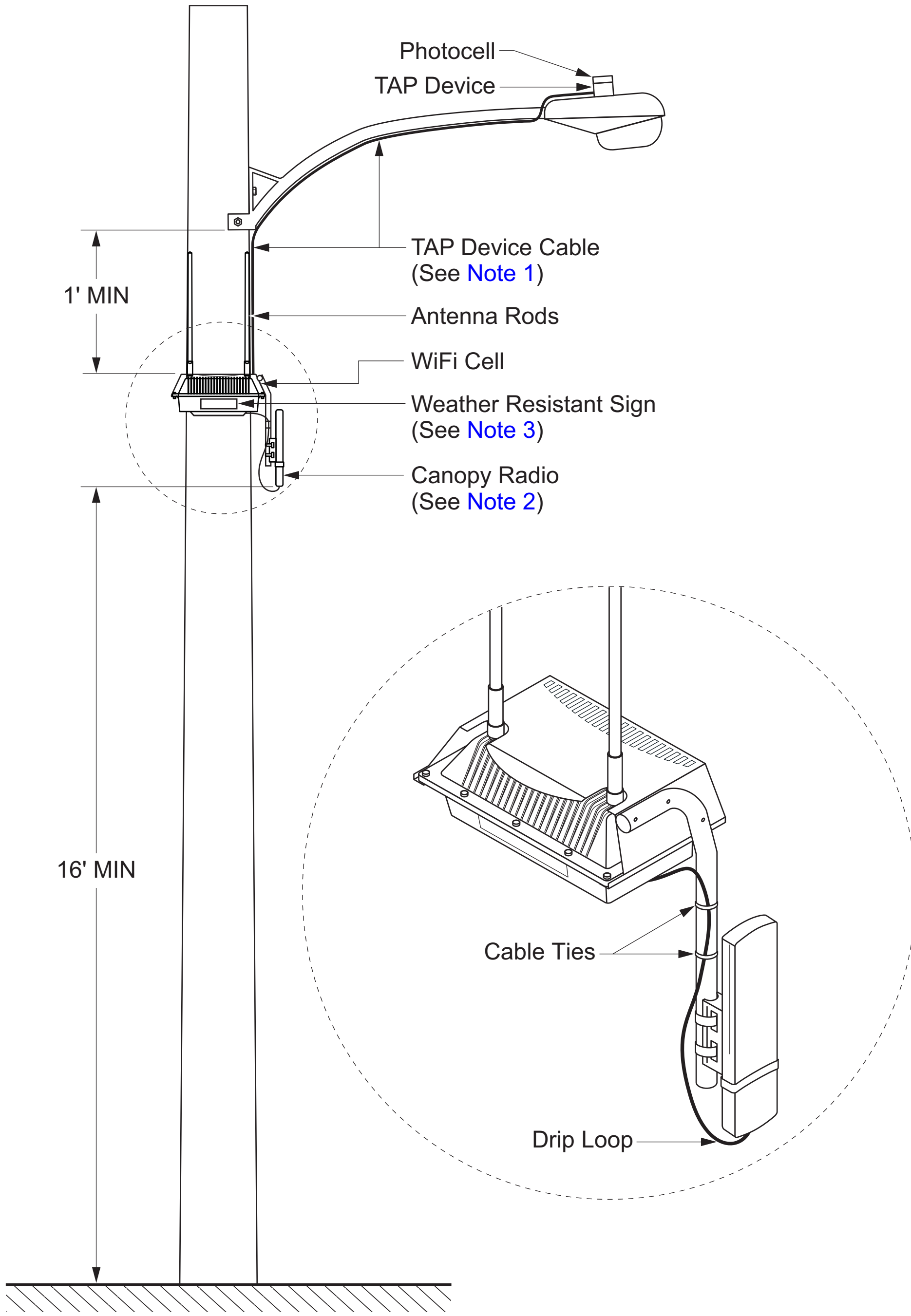
SL 107 WiFi Equipment Installations on SCE Streetlights (OH and UG Feeders)

Scope SL 107.1 WiFi Equipment Installations on SCE Streetlights (OH and UG Feeders)

Figure SL 107–1: WiFi Equipment Installations on SCE Streetlights (OH and UG Feeders)



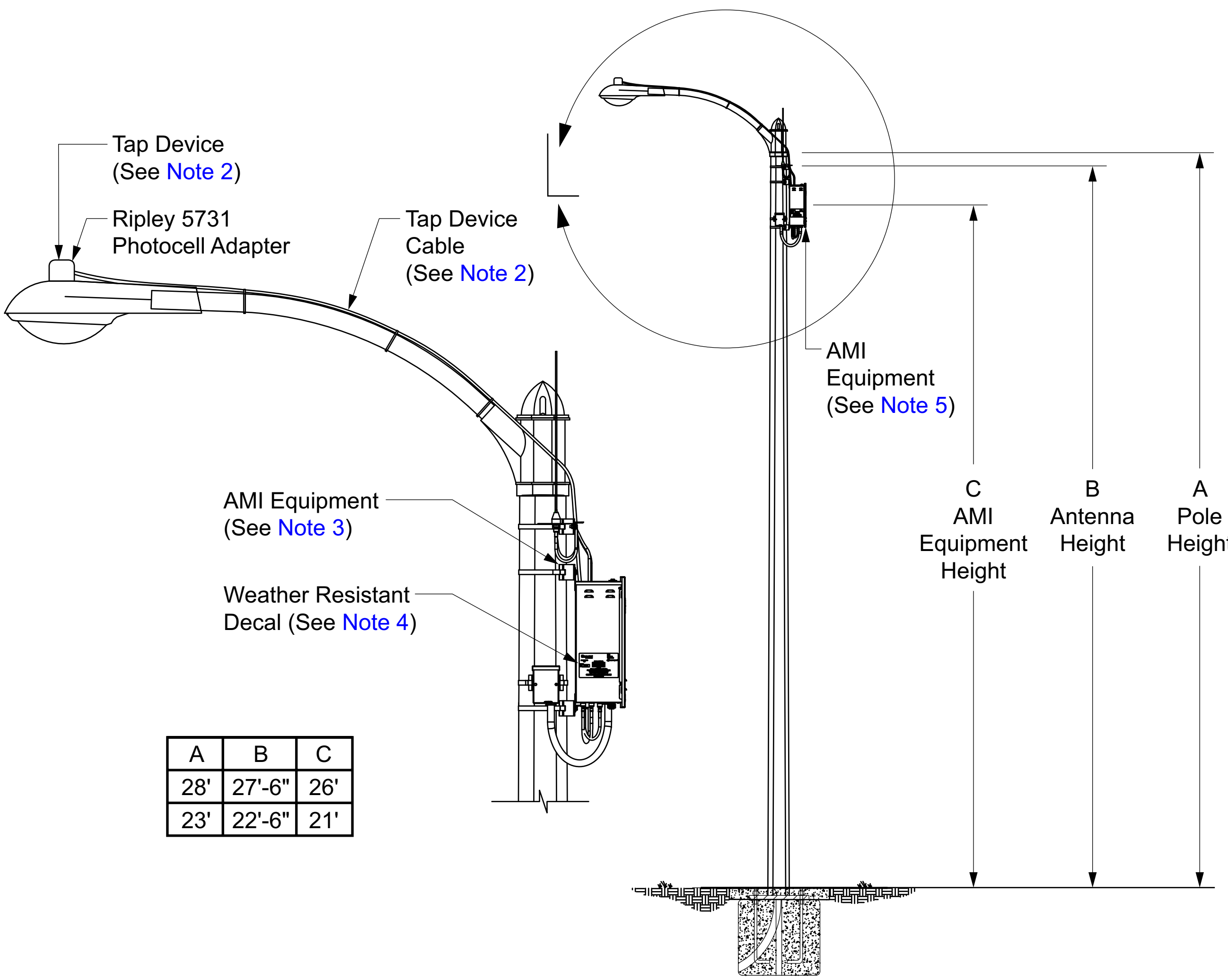
Note(s):

1. One Timed Auxiliary Power (TAP) device is allowed per light fixture. The TAP device cables shall be secured to the mast arm with not less than five (5) evenly spaced 1/8 inch steel bands or threaded pipe clamps. The TAP device cables transitioning from the mast arm to the equipment shall be secured to the pole with not less than two (2) evenly spaced 1/8 inch steel bands or threaded pipe clamps. Surplus TAP device cable shall be coiled and secured to the pole.
2. WiFi Equipment shall be secured to pole with at least two evenly spaced 1/2 inch steel bands or threaded pipe clamps. Equipment requiring a separate ground wire shall only be affixed to wood streetlight poles, and where installed, grounds must be constructed according to G.O. 95, Rule 22.2-A.
3. One weather resistant sign or decal shall be affixed to the equipment identifying the owner/operator and listing a 24-hour emergency contact number. Each sign/decal shall be legible and maintained.
4. Equipment may be installed in any quadrant (below the mast arm), but shall not interfere with the intended illumination pattern.
5. The streetlight pole, mast arm and light fixture shall not be damaged or altered in order to accommodate the installation of equipment.

SL 108 Non-SCE Advance Metering Infrastructure (AMI) Equipment Installations on SCE LS-1 Marbelites (Underground Fed Only)

Scope SL 108.1 Non-SCE Advance Metering Infrastructure (AMI) Equipment Installations on SCE LS-1 Marbelites (Underground Fed Only)

Figure SL 108–1: Non-SCE AMI Equipment Installations on SCE LS-1 Marbelites (Undeground Fed Only)



A	B	C
28'	27'-6"	26'
23'	22'-6"	21'

Note(s):

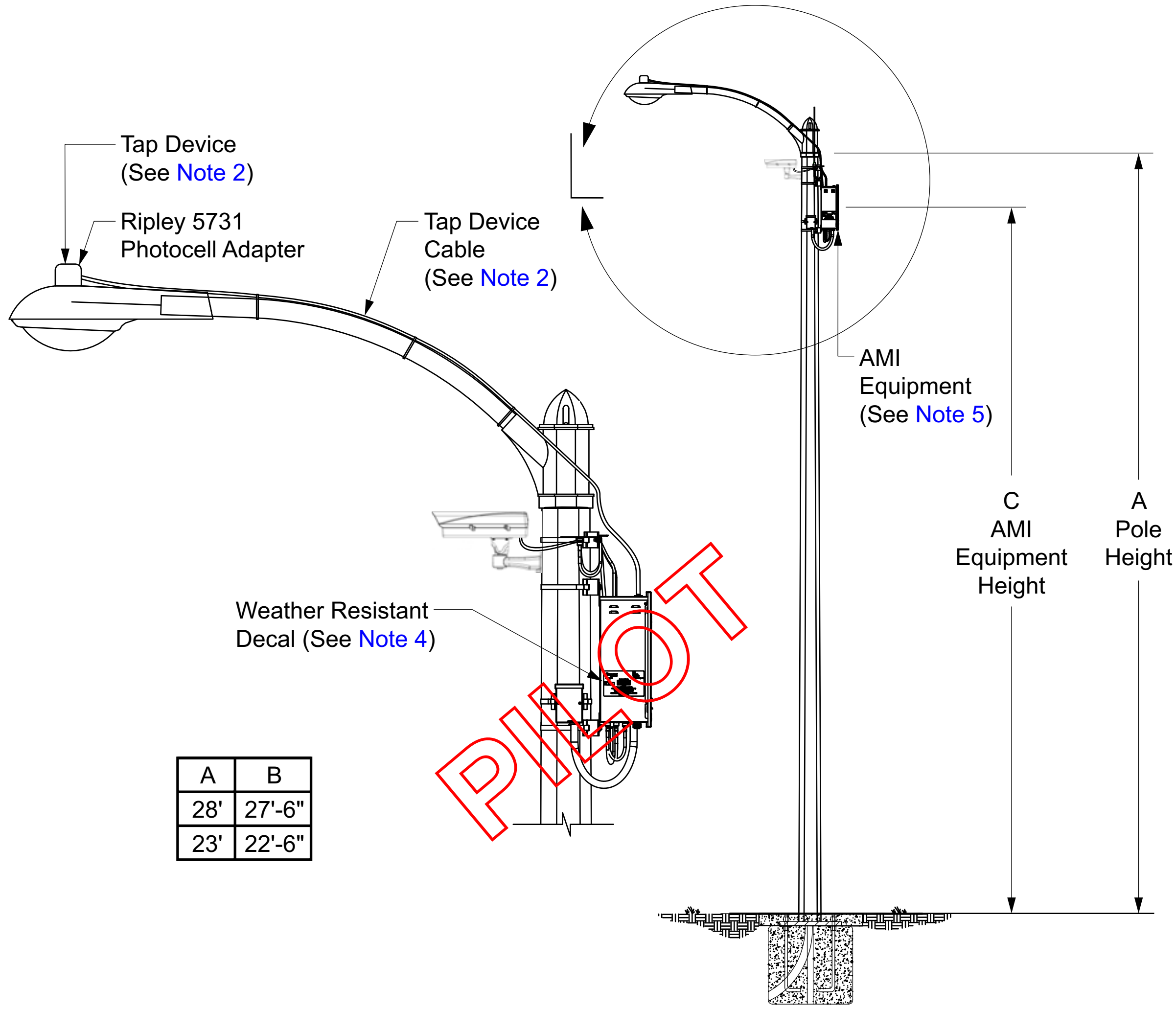
1. This equipment is only allowed on a standard 23 foot or 28 foot marbelites.
2. One Timed Auxiliary Power (TAP) device is allowed per light fixture. The TAP device cables shall be secured to the mast arm with not less than five (5) evenly spaced 1/8 inch steel bands or threaded pipe clamps. The TAP device cables transitioning from the mast arm to the equipment shall be secured to the pole with not less than two (2) evenly spaced 1/8 inch steel bands or threaded pipe clamps. Surplus TAP device cable shall be coiled and secured to the pole.
3. AMI Equipment shall be secured to pole with at least two evenly spaced 1/2 inch steel bands or threaded pipe clamps.

4. One weather resistant sign or decal shall be affixed to the equipment identifying the unit number (serial number). The decal must also identify the owner/operator and listing a 24-hour emergency contact number. Each sign/decal shall be legible from the ground and maintained as such.
5. Equipment must be installed opposite vehicular traffic space and shall not interfere with the intended illumination pattern.
6. The streetlight pole, mast arm and light fixture shall not be damaged or altered in order to accommodate the installation of equipment. Installer shall not drill, burn or punch any holes in a marbelite.
7. A maximum of one hundred twenty five (125) watts or less rated consumption attached to any one streetlight secondary circuit connected to SCE's transformer.
8. For emergency situations (for example, pole has been struck by a car), contact decal number provided on the AMI equipment device.

SL 109P Third Party Attachments on SCE LS-1 Marbelites (Underground Fed Only) Pilot

Scope SL 109P.1 Third Party Attachments on SCE LS-1 Marbelites (Underground Fed Only) Pilot

Figure SL 109P–1: Typical Third Party Attachments on SCE LS-1 Marbelites (Underground Fed Only)



A	B
28'	27'-6"
23'	22'-6"

Note(s):

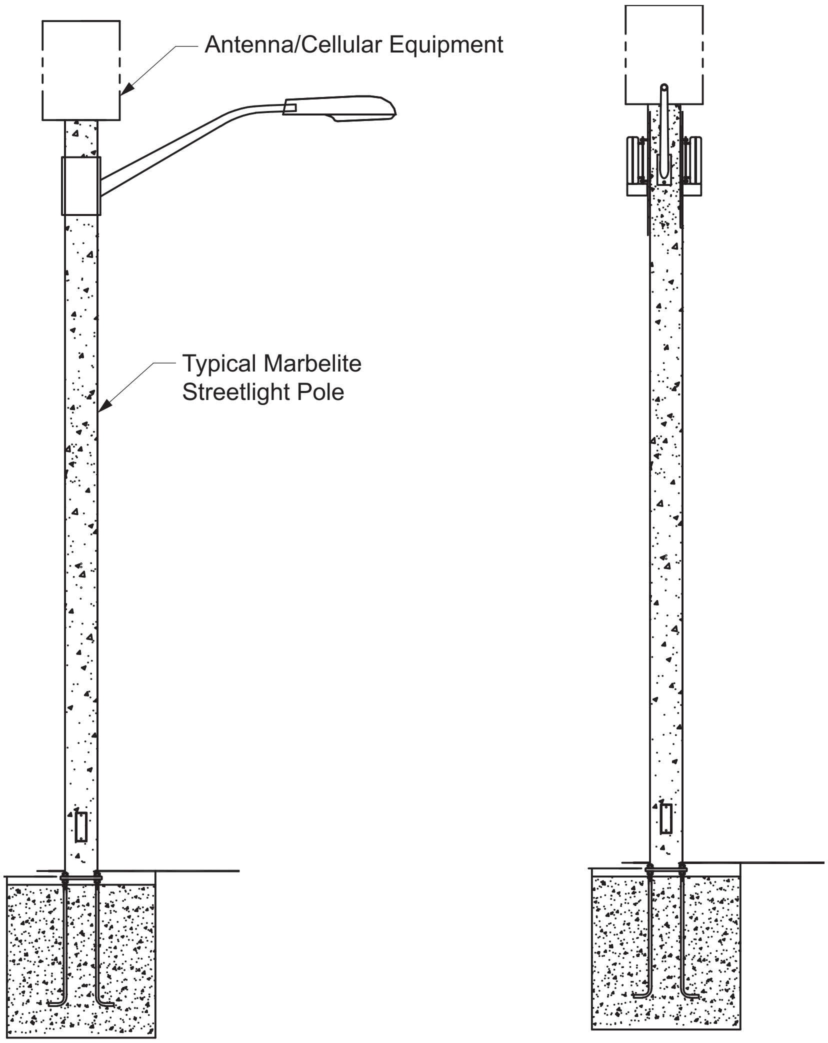
1. Pilot equipment (Camera and/or Sensors) may be installed in the following cities: Rancho Palos Verdes, Santa Monica, 29 Palms, Covina and Grand Terrance.
2. This equipment is only allowed on a standard 23 foot or 28 foot marbelites.
3. One Timed Auxiliary Power (TAP) device is allowed per light fixture. 24-hour operation devices only. The TAP device cables shall be secured to the mast arm with not less than two evenly spaced 1/8 inch steel bands or threaded pipe clamps. The TAP device cables transitioning from the mast arm to the equipment shall be secured to the pole with not less than two evenly spaced 1/8 inch steel bands or threaded pipe clamps. Surplus TAP device cable shall be coiled and secured to the pole.
4. Communication Equipment shall be secured to pole with at least two evenly spaced 1/2 inch steel bands or threaded pipe clamps.

5. One weather resistant sign or decal shall be affixed to the equipment identifying the unit number (serial number). The decal must also identify the owner/operator and listing a 24-hour emergency contact number. Each sign/decal shall be legible from the ground and maintained as such.
6. Equipment must be installed opposite vehicular traffic space and shall not interfere with the intended illumination pattern.
7. The streetlight pole, mast arm and light fixture shall not be damaged or altered in order to accommodate the installation of equipment. Installer shall not drill, burn or punch any holes in a marbelite.
8. A maximum of 125 watts or less rated consumption attached to any one streetlight secondary circuit connected to SCE's transformer.

SL 110 Cellular Equipment Installations on SCE Streetlights (Underground Fed Only)

Scope SL 110.1 Cellular Equipment Installations on SCE Streetlights (Underground Fed Only)

Figure SL 110–1: Cellular Equipment Installations on SCE Streetlights (Underground Fed Only)



Note(s):

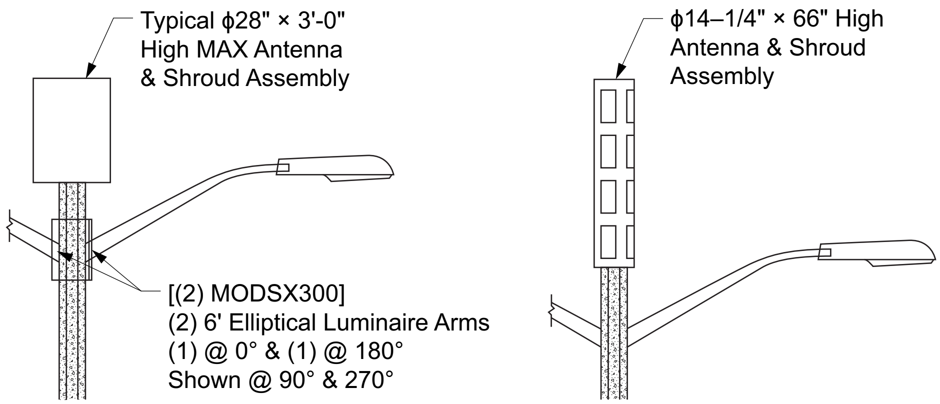
1. Equipment is only allowed on marbelite poles designed for a pole top installation, contact Edison Carrier Solutions (ECS).
2. One weather resistant sign or decal shall be affixed to the antenna/cellular equipment identifying the unit number (serial number). The decal must also identify the owner/operator and listing a 24-hour emergency contact number. Each sign/decal shall be legible from the ground and maintained as such.
3. Equipment must not interfere with vehicular traffic or the intended illumination pattern.
4. The streetlight pole, mast arm and light fixture shall not be damaged or altered in order to accommodate the installation of equipment. Installer shall not drill, burn or punch any holes in a marbelite.
5. See SL 106 for clearances. Clearances apply to any equipment mounted on the pole.

6. Refer to Ameron drawing number 1711-006 Rev B, 1409-040 Rev B, and 1507-034 Rev C for allowable equipment loading.
7. Maximum projected area 11 sq. ft.

Table SL 110–1: Marbelite Streetlight Poles for Cellular/Antenna Equipment Installations SAP Numbers (Only used for Cell Site Streetlight pole)

Description	SAP
23' Round Marbelite Streetlight Pole with 2-6" Elliptical Luminaire Arms	10061160
29'-6" Round Marbelite Streetlight Pole with 2-6" Elliptical Luminaire Arms	10203746
29'-6" Octagonal Marbelite Streetlight Pole with 2-6" Elliptical Luminaire Arms	10211179

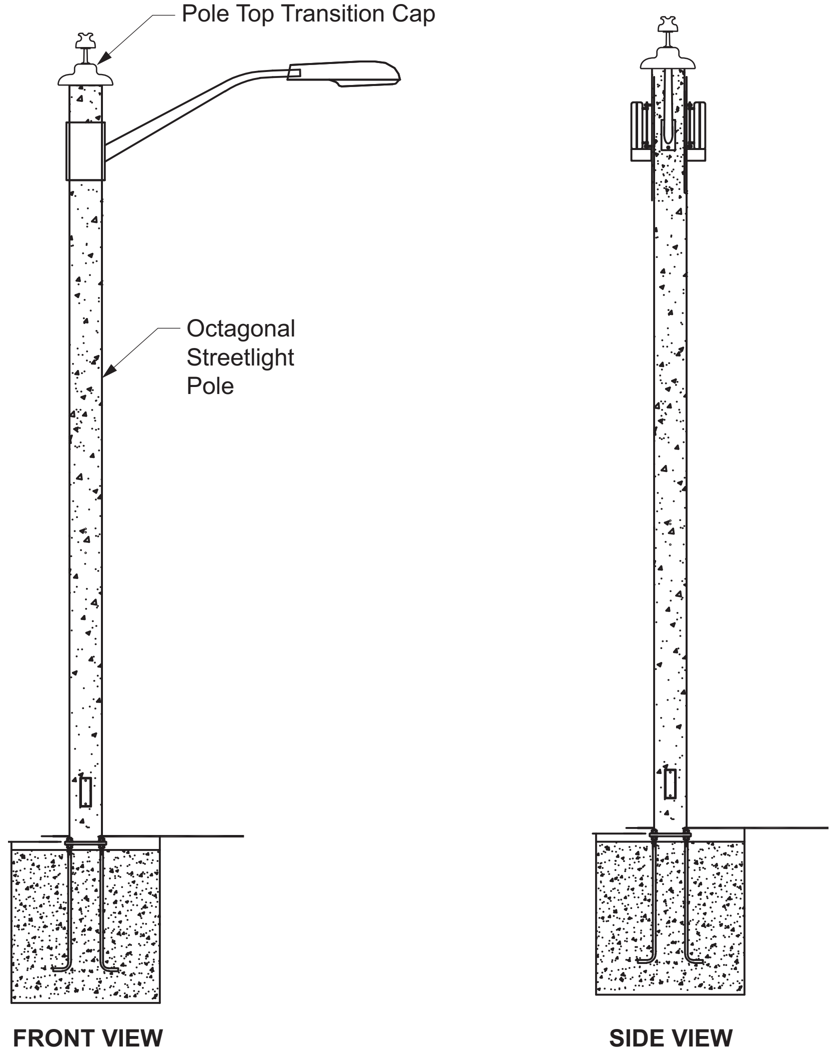
Figure SL 110–2: Examples of Cellular/Antenna Equipment



SL 111 Underground Streetlight Pole with Transition Cap to 120 V Overhead Service

Scope SL 111.1 Underground Streetlight Pole with Transition Cap to 120 V Overhead Service

Figure SL 111–1: Underground Streetlight Pole with Transition Cap to 120 V Overhead Service



Note(s):

1. Equipment is only allowed on marbelite poles designed for a pole top installation, contact Edison Carrier Solutions (ECS).
2. One weather resistant sign or decal shall be affixed to the antenna/cellular equipment identifying the unit number (serial number). The decal must also identify the owner/operator and listing a 24-hour emergency contact number. Each sign/decal shall be legible from the ground and maintained as such.
3. Equipment must not interfere with vehicular traffic or the intended illumination pattern.
4. The streetlight pole, mast arm and light fixture shall not be damaged or altered in order to accommodate the installation of equipment. Installer shall not drill, burn or punch any holes in a marbelite.
5. See SL 106 for clearances. Clearances apply to any equipment mounted on the pole.
6. See Figure SL 425–2 for foundation details.

Figure SL 111–2: Transition Cap Details

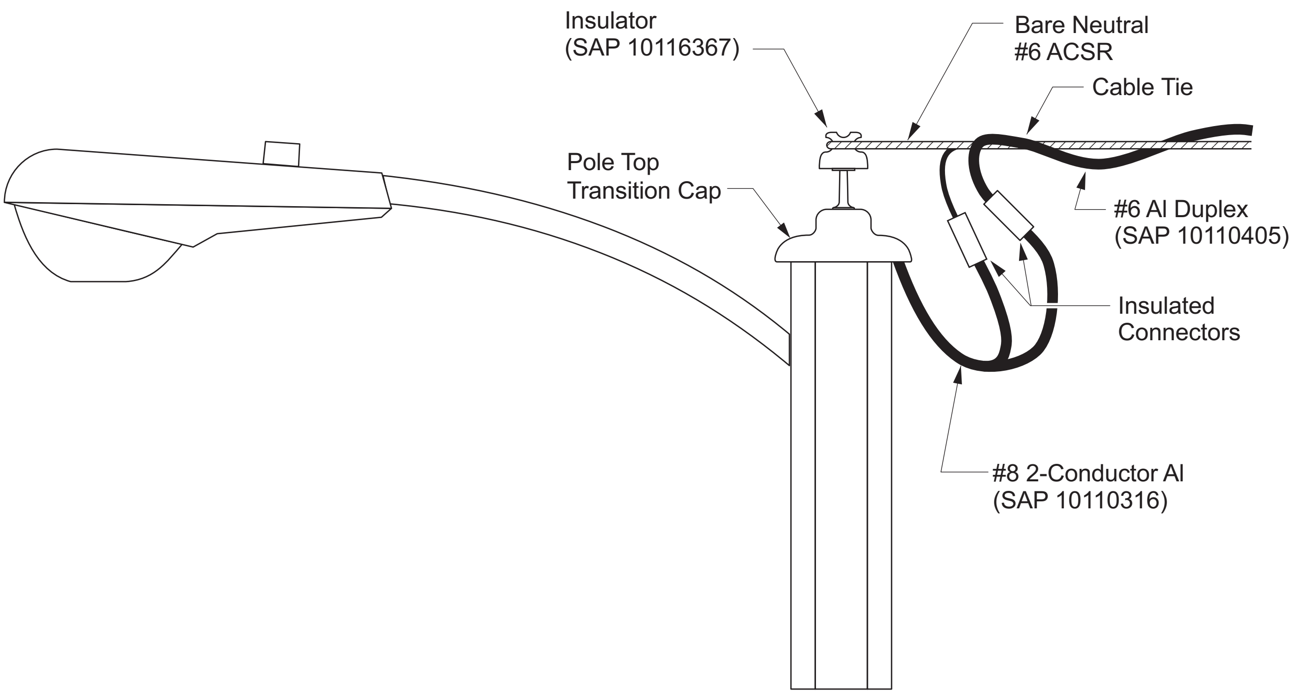


Table SL 111–1: Transition Cap Details

Description	SAP
31' Octagonal Streetlight Pole with 4' Arm	10061168
31' Octagonal Streetlight Pole with 6' Arm	10061169

Note(s):

1. See SL 430 for 120 V Overhead Service for construction details.
2. Alternatively, two sets of #8 2-conductor Al may be fed up through pole base.
3. Largest allowable conductor should not exceed #8.
4. See CO 305 for insulated connector selection.
5. See Figure SL 425–2 for foundation details.
6. Caution to be used when HPSV fixtures are involved. Voltage drop calculations should be performed prior to construction.

Underground Streetlight Pole with Transition Cap to 120 V Overhead Service

What's Changed? Initial issue.

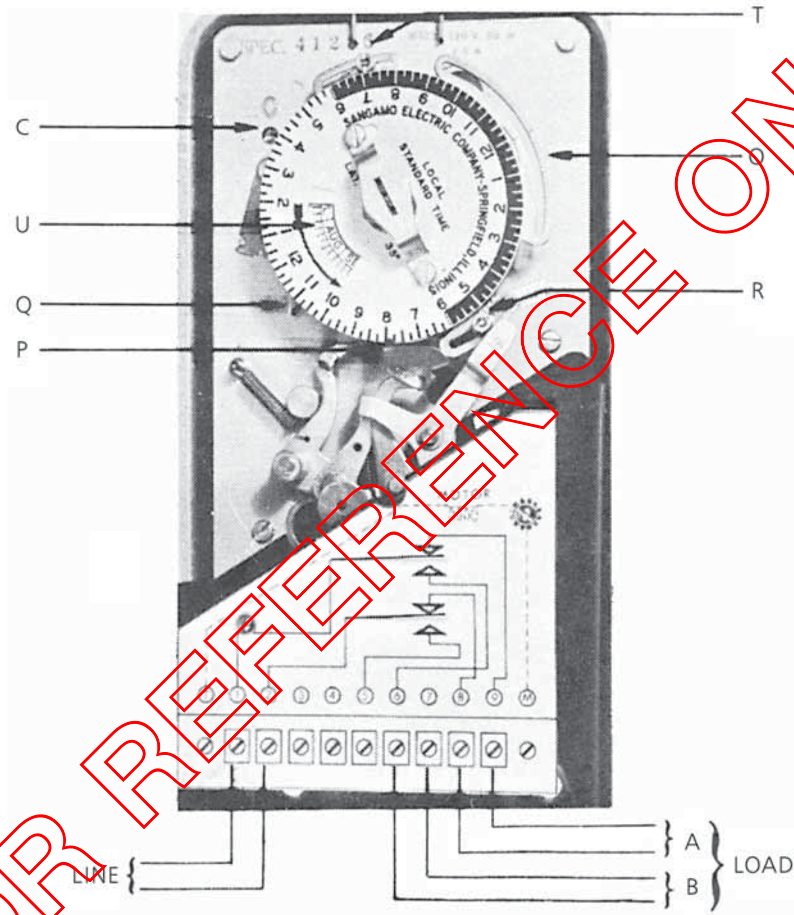
Approved by: RR

Effective Date: 07-30-2021

SL 200 Time Clock — Sangamo

Scope SL 200.1 Sangamo Time Switch Type WHZ-21 SAP 10115419 with Astronomical Dial and Time Carryover for Street Lighting

Figure SL 200–1: Sangamo Time Switch Type WHZ-21 SAP 10115419 with Astronomical Dial and Time Carryover for Street Lighting



1.0 Setting and Operating Instructions

1.1 All Night Operation

A. Set time carryover

1. With the unit connected and the power on, turn shaft “C” clockwise with a small screwdriver to unlock the encasement to permit carryover to operate in the event of a power failure. If the power is off more than 10 hours, the carryover must be reset as instructed in Paragraph 1.1-A-2.

2. With the power restored turn shaft “C” first counterclockwise and then clockwise. This procedure resets the encasement. The carryover spring will rewind electrically in 108 hours if the spring was completely unwound.

B. Set correct day of year by

Turning spoke “Q” until the correct day and month are indicated by index “U” (each spoke “Q” advances the day-month wheel one day: Each graduation on the day-month wheel equals five days). This wheel will then operate automatically.

C. Set for “on” and “off” operating time by

Loosening the roller screws and moving rollers “T” (on) and “R” (off) to the correct time, opposite the 24-hour dial, that corresponds with the street-lighting operating schedule listed on SL 210 for the particular day the setting is made. (The roller-slot indexes and the 24-hour dial are graduated in 15-minute divisions.)

D. Set correct time of day by

Turning the astronomical dial counterclockwise until the correct time (Pacific STANDARD Time) is indicated on the 24-hour dial opposite pointer “P.” The night portion of the dial is shown by a black background for times from 6:00 p.m. to 6:00 a.m.

1.2 Midnight Control

A. Remove roller mechanism “R” from the “off” lever by removing the roller screw, and replace roller “R” on the midnight bridge “O.” Set roller to read 12 midnight.

B. Then follow the directions of Paragraphs 1.1-A through 1.1-D outlined for all night control. Note that Paragraph 1.1-C now applies only to the time “on.”

SL 210 Time Clock — Schedules

Scope SL 210.1 Streetlight Schedule

Applicable to lighting controlled by motor driven astronomical clock. Utilizing the Sangamo Type WHZ-21 Clock (SAP 10115419) with time carryover and special settings to approximate the annual burning hours of our standard photoelectric control relay, assuming clear weather.

Note(s):

1. This schedule should also be used for any hand-set time switches that may still be in service. When the switch is checked at five-day intervals, set the dial at the time shown for that day shown on this schedule.

Table SL 210–1: Street-Lighting Schedule

Time On[a/]		Time Off	
Date	**P.M.**	**Date**	**A.M.**
Jan. 1–Jan. 3	5:00	Jan. 1–Feb. 3	6:45
Jan. 4–Jan. 20	5:15	Feb. 4–Feb. 17	6:30
Jan. 21–Feb. 4	5:30	Feb. 18–Feb. 28	6:15
Feb. 5–Feb. 18	5:45	Mar. 1–Mar. 11	6:00
Feb. 19–Mar. 4	6:00	Mar. 12–Mar. 21	5:45
Mar. 5–Mar. 21	6:15	Mar. 22–Mar. 30	5:30
Mar. 22–Apr. 5	6:30	Mar. 31–Apr. 9	5:15
Apr. 6–Apr. 21	6:45	Apr. 10–Apr. 19	5:00
Apr. 22–May 7	7:00	Apr. 20–May 1	4:45
May 8–May 22	7:15	May 2–May 15	4:30
May 23–July 30	7:30	May 16–July 17	4:15
July 31–Aug. 12	7:15	July 18–Aug. 8	4:30
Aug. 13–Aug. 24	7:00	Aug. 9–Aug. 19	4:45
Aug. 25–Sept. 3	6:45	Aug. 20–Sept. 5	5:00
Sept. 4–Sept. 13	6:30	Sept. 6–Sept. 22	5:15
Sept. 14–Sept. 22	6:15	Sept. 23–Oct. 9	5:30
Sept. 23–Oct. 2	6:00	Oct. 10–Oct. 26	5:45
Oct. 3–Oct. 12	5:45	Oct. 27–Nov. 10	6:00
Oct. 13–Oct. 23	5:30	Nov. 11–Nov. 25	6:15
Oct. 24–Nov. 7	5:15	Nov. 26–Dec. 13	6:30
Nov. 8–Dec. 31	5:00	Dec. 14–Dec. 31	6:45

[a/] The "ON–OFF" operating schedule is based on Pacific Standard Time

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SL 220 Photoelectric Controller Shielding

Scope SL 220.1 Photoelectric Controller Shielding

Luminous signs and advertising lights in the vicinity of photoelectric controllers that control streetlights or street lighting circuits—particularly in business areas—may provide enough illumination to make the photo controller inoperative.

A photo control shield (SAP 10118746), as shown in Figure SL 220–1.1 (Sheet 1), may be installed on photo controllers as shown in Figure SL 220–1.2 (Sheet 1) such that it shades the photo control cell as necessary.

The shield is adaptable to all Edison approved photoelectric controllers, except the Precision-Multiple.

Figure SL 220–1: Photoelectric Controller Shielding

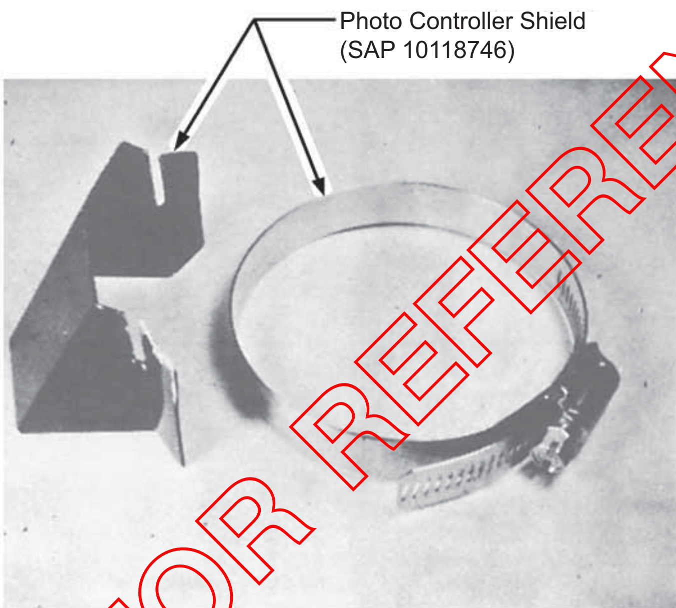


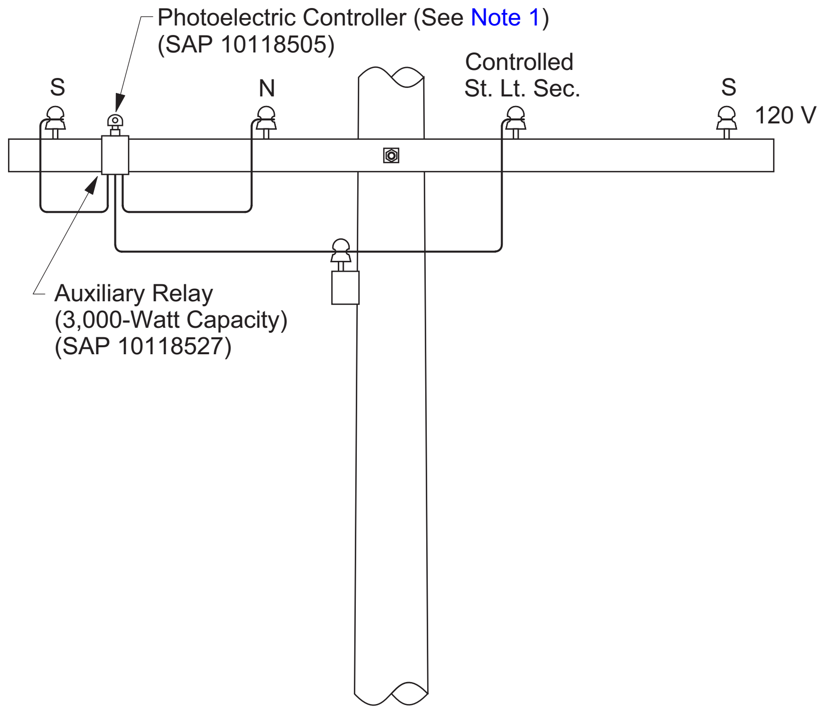
Figure SL 220–1.1

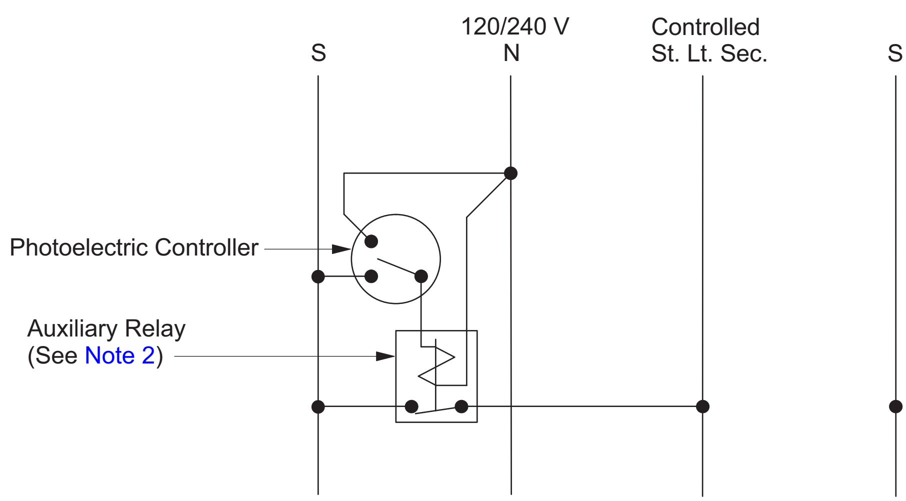
Figure SL 220–1.2

SL 225 Photoelectric Controller — Multiple Streetlights

Scope SL 225.1 Photoelectric Controller — Multiple Streetlights

Figure SL 225–1: Photoelectric Controller — Multiple Streetlights





Wiring Diagram

Note(s):

1. Photoelectric controller must be installed so photocell is exposed to the north sky.
2. This relay is needed if the lamp load exceeds the capacity of the photoelectric controller. (1,000 watts incandescent or 1,800 volt-amps for high pressure sodium, low pressure sodium, metal halide, and mercury vapor.

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SL 230 Film Cutouts — Series Streetlights

Scope SL 230.1 Film Cutouts — Series Streetlights

Table SL 230–1: Film Cutouts for Series Incandescent Lamps

Lamps		Catalog Numbers of Film Cutouts
Lumens	Amps	SAP
1,000	6.6	10118517
2,500	6.6	10118517
4,000	6.6	10118517
6,000	6.6	10118518
10,000	6.6	10118518
15,000 with 1L	20	10118517

Note(s):

1. Film cutouts are not used with mercury vapor lamps and their ballasts.

Table SL 230–2: Film Cutouts for 6.6 A Insulating Transformers (S.L.)

Transformer[a/]	Film Cutouts[b/]
Capacity kVA	SAP
0.25[c/]	10118517
0.50[b/]	Pending
1.00	Pending
2.00	Pending
3.00	Pending
4.00	Pending
5.00	Pending

a/ These transformers are obsolete and are no longer being manufactured. SAP numbers furnished for "FOR REFERENCE ONLY."

b/ These cutouts are for use in protective devices across the secondary of transformer.

c/ The 0.25 kVA and 0.50 kVA transformers do not require protection in case of open circuit: but if provided, use the cutouts as shown in this table.

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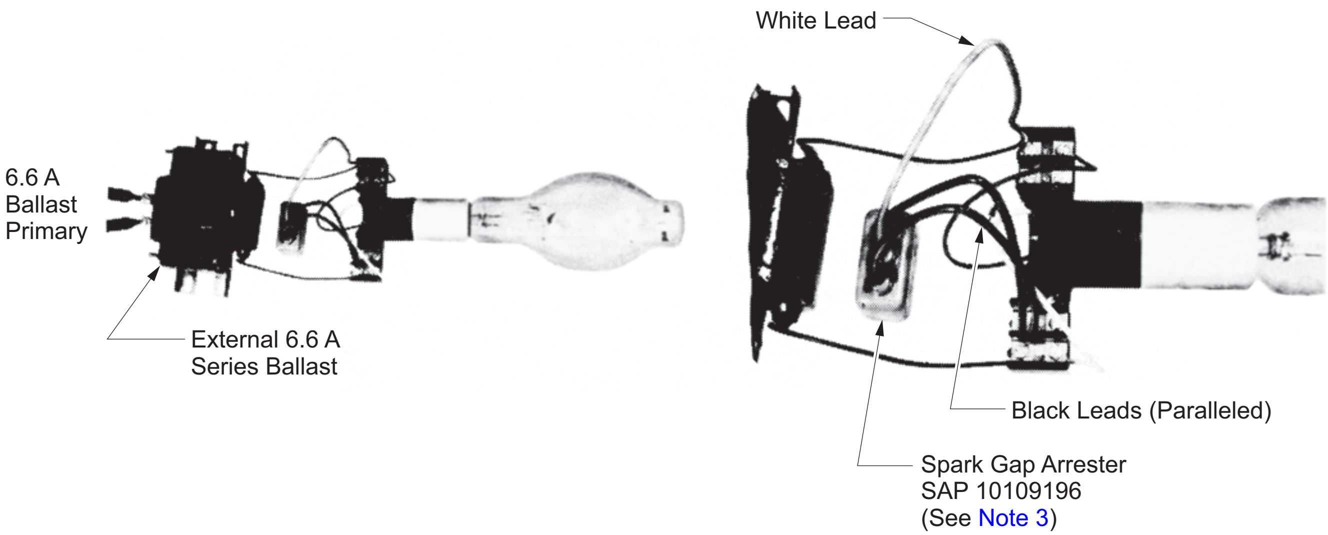
SL 300 6.6 A Circuit — Hot Restart Protection

Scope SL 300.1 6.6 A Circuit — Hot Restart Protection

High-transient voltages may occur at the lamp socket upon re-energizing the series loop circuit when a momentary interruption or voltage dip causes the arc to extinguish in the mercury vapor lamp.

The purpose of the spark gap arrester is to bypass excessive peak voltages and protect the lamp and socket from damage.

Figure SL 300–1: 6.6 A Circuit — Hot Restart Protection



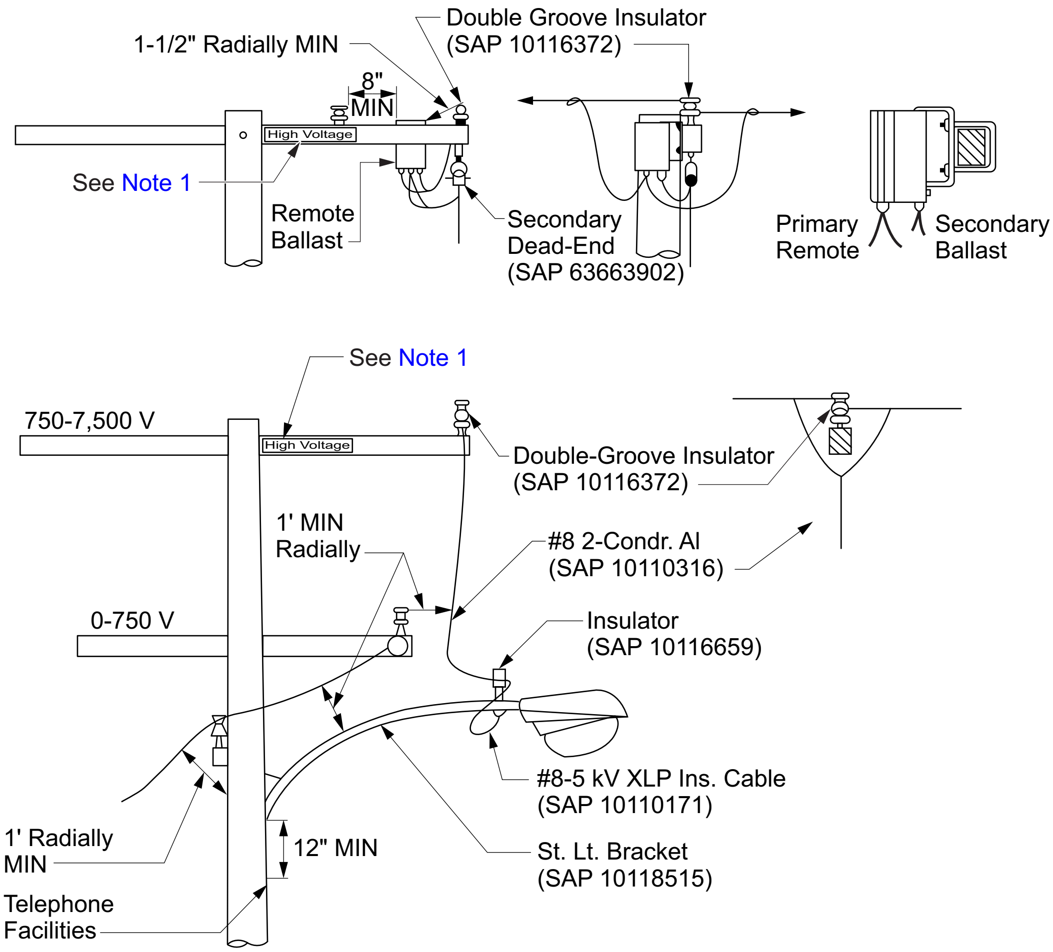
Note(s):

1. Arrester SAP 10109196 to be used on 35,000 lumen (700 watt) and 55,000 lumen (1,000 watt) mercury vapor lights on series 6.6 A circuits only.
2. Do not shorten arrester leads.
3. On older type luminaires where the space is limited, the arrester should be attached to the ballast secondary leads outside the luminaire.

SL 305 6.6 "A" Circuit — 6-Foot Upsweep Brackets

Scope SL 305.1 6.6 "A" Circuit — 6-Foot Upsweep Brackets

Figure SL 305–1: 6.6 "A" Circuit — 6-Foot Upsweep Brackets



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.

Table SL 305–1: Mercury Lamp Luminaires — 6-Foot Upsweep Brackets

Lamp Size Lumens	Mounting Height (ft)	SAP		
		Luminaire with Internal Ballast	Luminaire For Remote Ballast	Remote Ballast
3,500	25–28	10118420	Not Available	
7,000	25–28	10118422	Not Available	
11,000	30–32	10118424	Not Available	
20,000	30–32	10118415	Pending	Pending
35,000	30–32	Not Available	Pending	Pending
55,000	30–32	Not Available	Pending	Pending

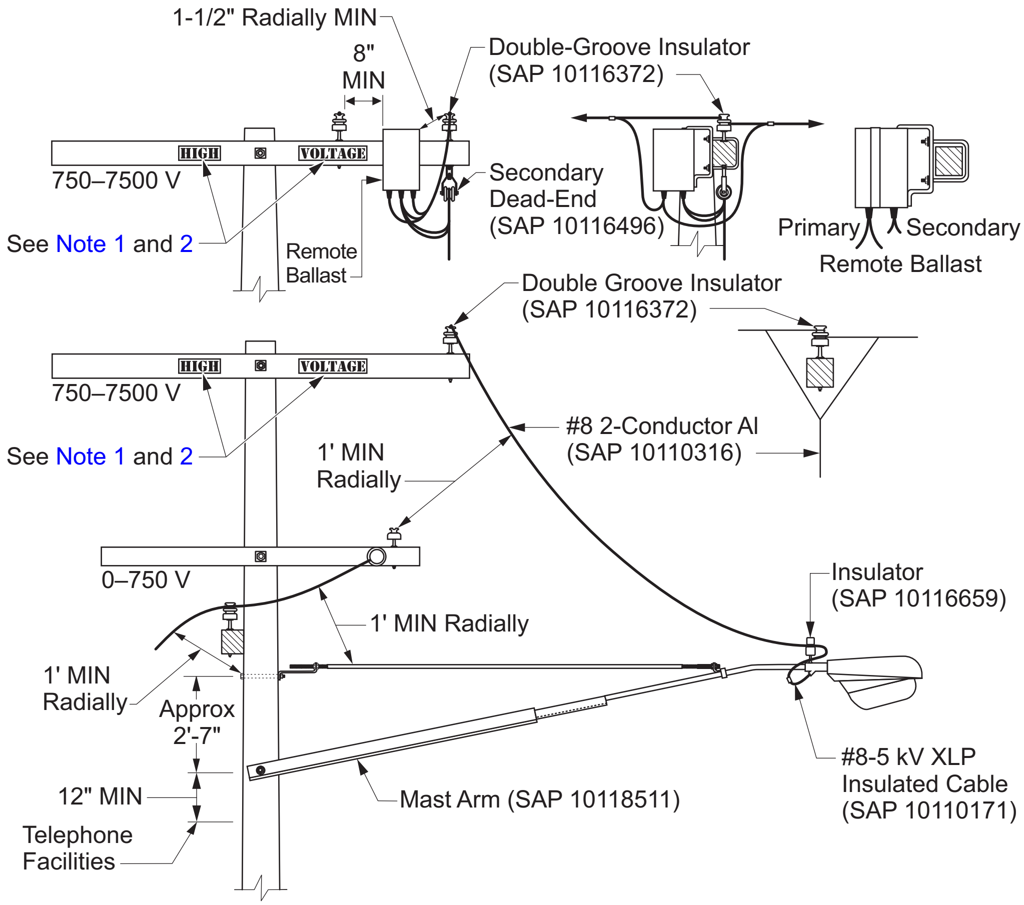
Note(s):

1. #8 cable is also supplied with copper conductor SAP 10109555. Copper should be used only in copper designated areas.

SL 307 6.6 “A” Circuit — 16-Foot Upsweep Mast Arm

Scope SL 307.1 6.6 “A” Circuit — 16-Foot Upsweep Mast Arm

Figure SL 307–1: 6.6 “A” Circuit — 16-Foot Upsweep Mast Arm



Note(s):

1. HIGH VOLTAGE signs mounted on crossarm are for existing installations only. For new or replacement of deteriorated sign installations, encircle the pole with HIGH VOLTAGE sign per PO 120.
2. For maintenance purposes, deteriorated signs on crossarms shall be removed when work permits. Refer to Distribution Operations and Maintenance Policies and Procedures Manual (DOM), IM-2.

Table SL 307–1: Mercury Lamp Luminaires — 16 Foot Upsweep Mast Arm

Lamp Size Lumens	Mounting Height (ft)	SAP		
		Luminaire with Internal Ballast	Luminaire For Remote Ballast	Remote Ballast
3,500	25–28	10118420	Not Available	
7,000	25–28	10118422	Not Available	
11,000	30–32	10118424	Not Available	
20,000	30–32	10118415	Pending[a/]	Pending[a/]
35,000	30–32	Not Available	Pending	Pending
55,000	30–32	Not Available	Pending	Pending

[a/] Obsolete

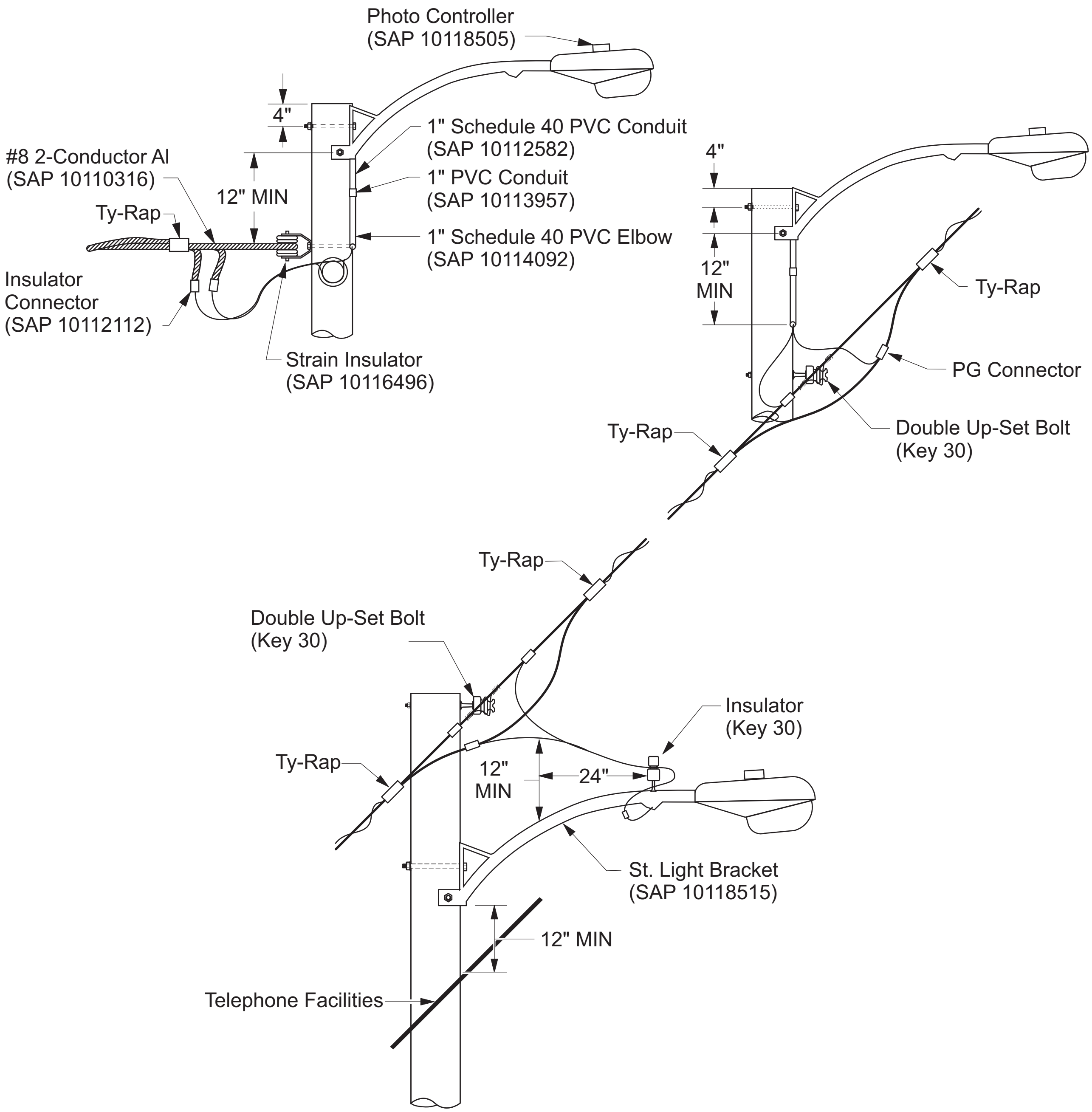
Note(s):

1. #8 Cable is also supplied with copper conductor (SAP 10109555). Copper should be used only in copper designated areas.

SL 310 120 V Multiple — 6-Foot Upsweep Brackets

Scope SL 310.1 120 V Multiple — 6-Foot Upsweep Brackets

Figure SL 310–1: 120 V Multiple — 6-Foot Upsweep Brackets



Note(s):

1. #8 Cable is also supplied with copper conductor, SAP 10109555. Copper should be used only in copper designated areas.

Approved by:	120 V Multiple — 6-Foot Upsweep Brackets	SL 310
Effective Date: 04-28-2006	What's Changed?	Sheet 1 of 1 DOH

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SL 312 120 V Multiple — 16-Foot Mast Arm

Scope SL 312.1 120 V Multiple — 16-Foot Mast Arm

Figure SL 312–1: 120 V Multiple — 16-Foot Mast Arm

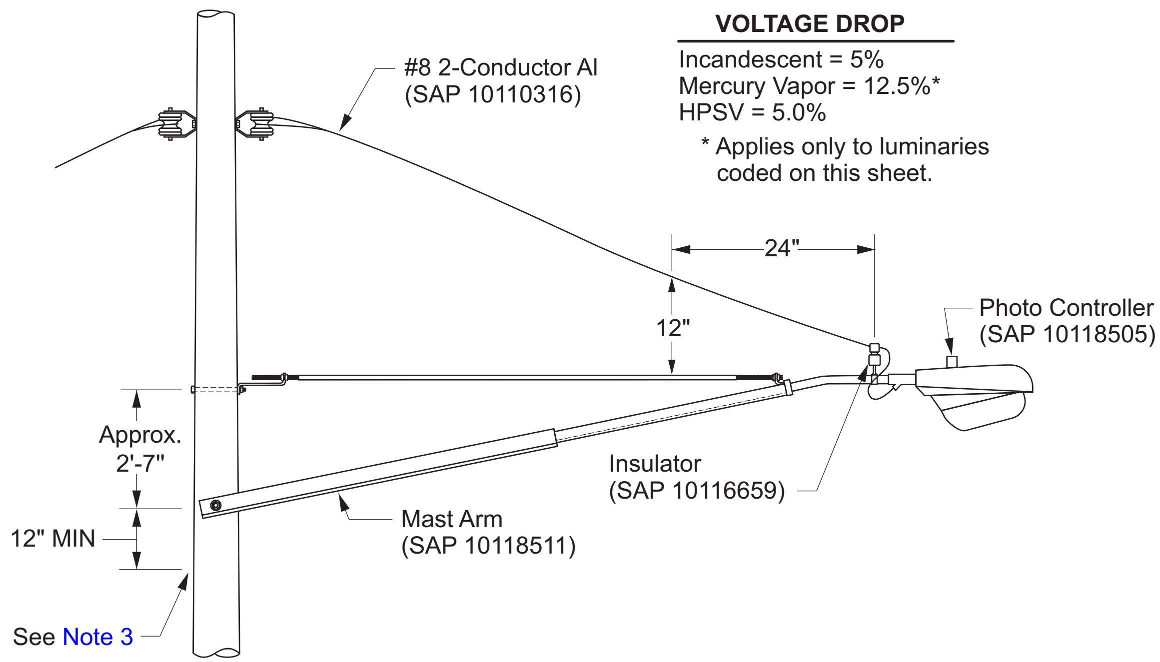

Table SL 312–1: 120 V Multiple — 16-Foot Mast Arm

Incandescent		High Pressure Sodium and Mercury Vapor				
Lamp Size Lumens	Nominal Mounting Height (ft)	Lamp Size Lumens	Mounting Height (ft)	Luminaire SAP	MV	HPS V
1,000	25	3,500	25–28	10118421	X	
2,500	25	7,000	25–28	10118423	X	
4,000	25	11,000	30–32	10118425	X	
6,000	25	20,000	30–32	10118416	X	
10,000	30	35,000	30–32	Pending	X	
		55,000	30–32	Pending	X	
		4,000	25–28	10118409		X
		5,800	25–28	10118429		X
		9,500	25–28	10118430		X
		16,000	30–32	10118431		X
		22,000	30–32	10118441		X
		27,500	30–32	10118427		X
		50,000	30–32	10118428		X

Note(s):

1. HPSV = High-Pressure Sodium Vapor
2. #8 cable is also supplied with copper conductor, SAP 10109555. Copper should be used only in copper designated areas.
3. Telephone cable facilities (SeeTable SL 312–1 [Sheet 1]).

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SL 315 Area Lighting — OL-1 and Alley

Scope SL 315.1 Area Lighting — OL-1 and Alley

Figure SL 315–1: Luminaire IES Type III

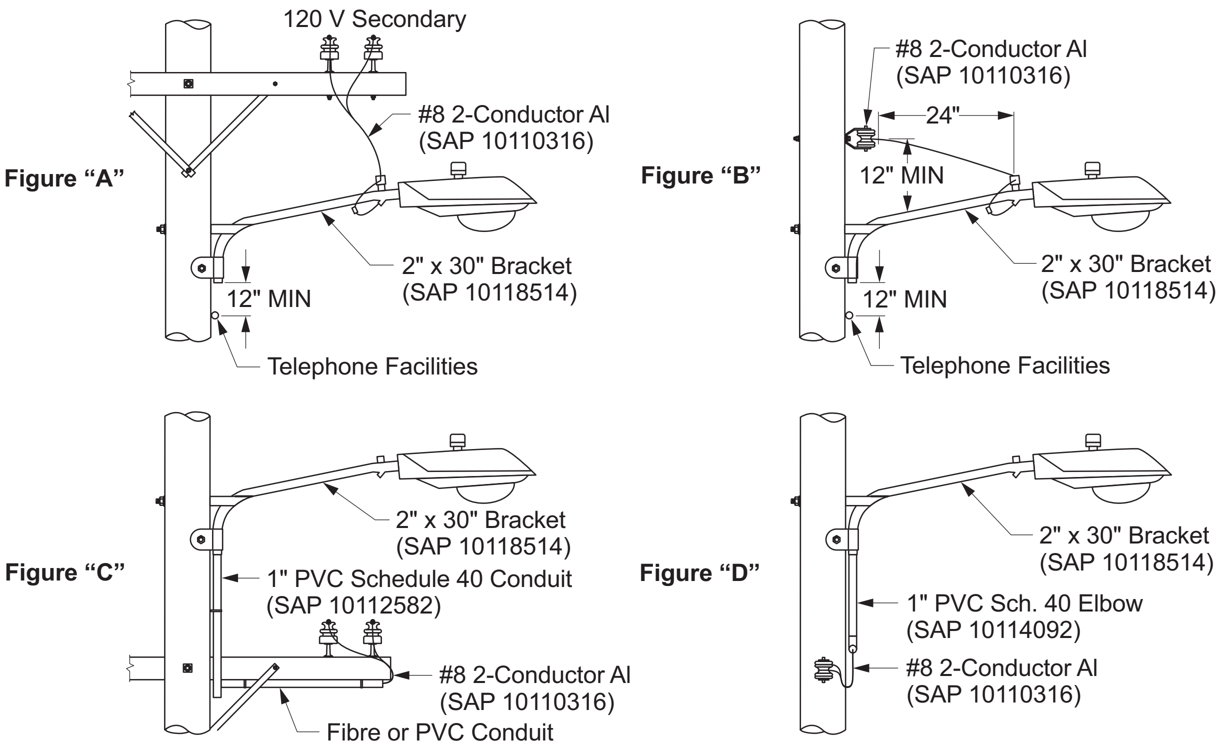


Table SL 315–1: Area Lighting — OL-1 and Alley

Required Wood Pole Lengths for Installations Using High Pressure Sodium Vapor and Luminaires						
Minimum Total Pole Length (ft)	Lumens	SAP Flat Glass	SAP Drop Glass	Mounting Height (ft)	MV [a/]	HPSV
35	3,500		10118421[b/]	25–28	X	
"	7,000[c/]		10118423[b/]	"	X	
40	11,000		10118425[b/]	30–32	X	
"	21,000		10118416[b/]	"	X	
"	35,000		10118417[b/]	"	X	
"	55,000		10118418[b/]	"	X	
"	4,000	10118301	10118409	30–32		X
"	5,800	10118313	10118429	"		X

Required Wood Pole Lengths for Installations Using High Pressure Sodium Vapor and Luminaires						
Minimum Total Pole Length (ft)	Lumens	SAP		Mounting Height (ft)	MV [a/]	HPSV
		Flat Glass	Drop Glass			
"	9,500	10118312	10118430	"		X
"	16,000	10118311	10118431	"		X
"	22,000	10118310	10118441	"		X
"	27,500	10118309	10118427	"		X
"	50,000	10118308	10118424	"		X

[a/] All Mercury Vapor Entries are for Reference Only.
[b/] Customer to select replacement luminaires from approved list of HPSV, LPSV, or MH.
[c/] Lumen Size Available for OL-1 Rate Schedule.

= For Reference Only

Note(s):

1. #8 cable is also supplied with copper conductor SAP 10109555. Copper should be used only in copper designated areas.
2. To obtain 120 V for OL-1 lighting from 240/480 V agricultural power service use dry type step-down transformer SAP 10103843.

SL 317 Area Lighting — OL-1-89W — 11,400L Floodlight

Scope SL 317.1 Area Lighting — OL-1-89W — 11,400L Floodlight

Figure SL 317–1: Area Lighting — OL-1-89W — 11,400L Floodlight

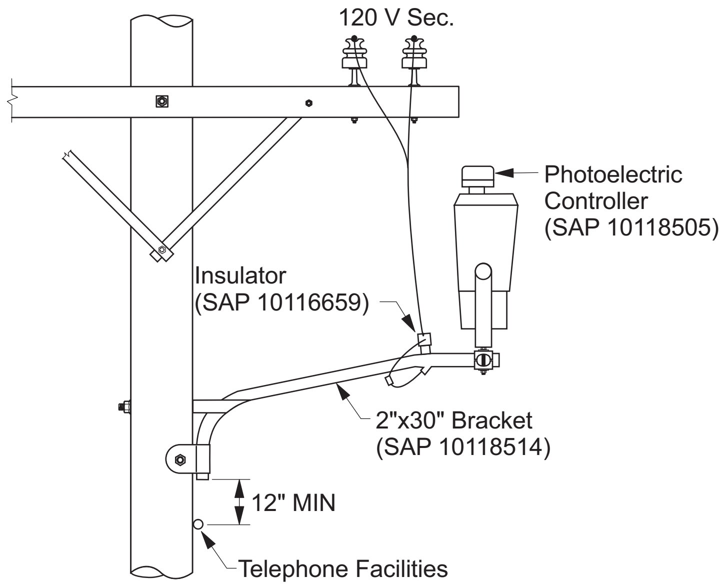


Figure “A”

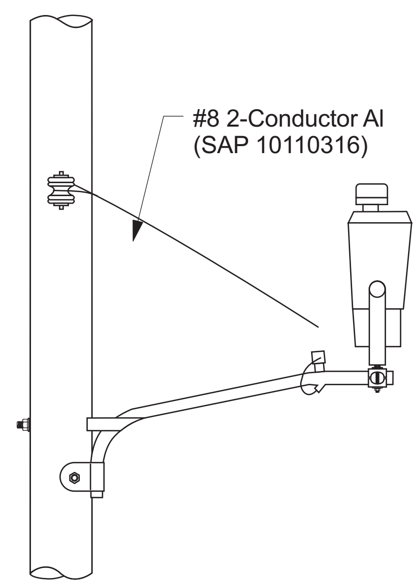


Figure “B”

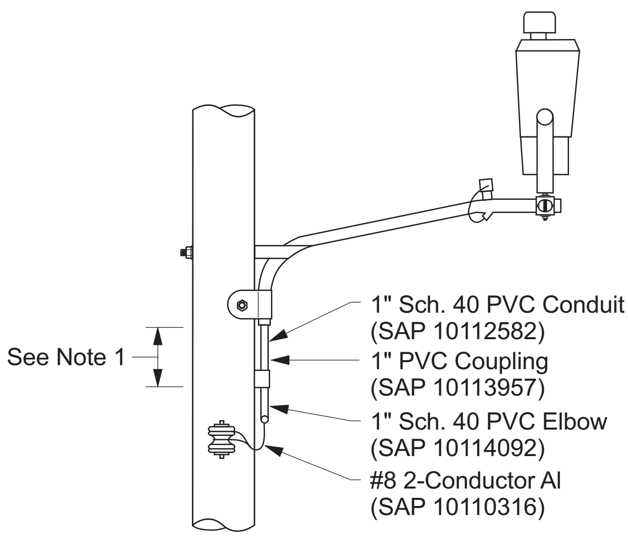
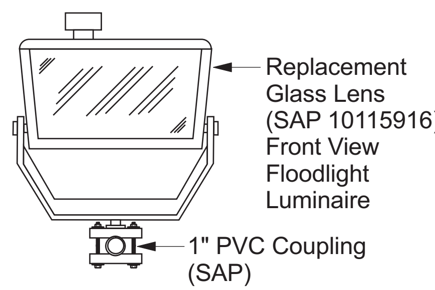


Figure “C”



LED Floodlight Style Luminaire			
Minimum Pole Length	Lumens	Luminaire SAP	Mounting Height
35'	11,400	10208193	30' - 32'

Note(s):

1. 12-inch minimum radial clearance required between all streetlight parts and unprotected conductors. Refer to General Order (G.O.) 95, Rule 58.2-B3b.
2. #8 copper cable (SAP 10109555) is also available. Copper conductor should be used in copper designated areas only.
3. LED lamp type is the standard luminaire offering for all new installations. Prior Lamp Type offerings — High Pressure Sodium Vapor, Low Pressure Sodium Vapor, and Metal Halide are closed to new installations.

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SL 318 Light Emitting Diode (LED) Cobra Head Style Luminaires

Scope SL 318.1 Light Emitting Diode (LED) Cobra Head Style Luminaires

Figure SL 318–1: Cobra Head Style LED Luminaires

Table SL 318–1: Cobra Head Style LED Luminaires

LED Wattage	HPSV[a/] Equivalent Lumen Wattage	SAP
25[b/]	50	10205807
32[b/]	70	10205808
41[b/]	100	10205809
88[b/]	150	10205810
90[c/]	200	10205811
157[c/]	310	10205813
161[c/]	250	10205812
193[c/]	400	10205814

a/ High Pressure Sodium Vapor (HPSV)
b/ 1-Bar Luminaire
c/ 2-Bar Luminaire

Note(s):

1. All Cobra Head style LED Luminaires are outfitted with ‘Cut Off’ style Optics which will help eliminate glare or ‘sky glow’ conditions.

Table SL 318–2: Cobra Head Style LED Luminaires

LED Wattage	HPSV[a/] Equivalent Lumen Wattage	SAP
28[b/]	50	10183629
43[b/]	70	10183631
54[b/]	100	10183633
90[b/]	150	14083634
130[c/]	200	10183635
196[d/]	250	10183636
258[e/]	400	10183637

a/ High Pressure Sodium Vapor (HPSV)
b/ 1-Bar Luminaire
c/ 2-Bar Luminaire
d/ 3-Bar Luminaire
e/ 4-Bar Luminaire

Note(s):

1. All Cobra Head style LED Luminaires are outfitted with ‘Cut Off’ style Optics which will help eliminate glare or ‘sky glow’ conditions.

Figure SL 318–2: Cobra Head Style LED Luminaires

1-Bar

2-Bar

Table SL 318–3: Cobra Head Style LED Luminaires 3000K Light Temp — HPSV Equivalents

LED Wattage	HPSV[a/] Equivalent Lumen Wattage	SAP
22[b/]	50	10210241
31[b/]	70	10210242
39[b/]	100	10210243
71[b/]	150	10210244
82[c/]	200	10210246
136[c/]	250	10210247
137[c/]	310	10210249
174[c/]	400	10210250

[a/] High Pressure Sodium Vapor (HPSV)
[b/] 1-Bar Luminaire
[c/] 2-Bar Luminaire

Note(s):

1. All Cobra Head style LED Luminaires are outfitted with ‘Cut Off’ style Optics which will help eliminate glare or ‘sky glow’ conditions.

Table SL 318–4: Cobra Head Style LED Luminaires 4000K Light Temp — Equivalent for HPSV

LED Wattage	HPSV[a/] Equivalent Lumen Wattage	SAP
22[b/]	50	10210230
31[b/]	70	10210231
39[b/]	100	10210233
71[b/]	150	10210234
82[c/]	200	10210239
136[c/]	250	10210236
137[c/]	310	10210237
174[c/]	400	10210238

[a/] High Pressure Sodium Vapor (HPSV)
[b/] 1-Bar Luminaire
[c/] 2-Bar Luminaire

Note(s):

1. All Cobra Head style LED Luminaires are outfitted with 'Cut Off' style Optics which will help eliminate glare or 'sky glow' conditions.

Table SL 318–5: 480 V Cobra Head Style LED Luminaires 3000K Light Temp — HPSV Equivalents

LED Wattage	HPSV[a/] Equivalent Lumen Wattage	SAP
39[b/]	100	10210298
71[b/]	150	10210300
82[c/]	200	10210299
136[c/]	250	10210301
174[c/]	400	10210302

[a/] High Pressure Sodium Vapor (HPSV)
[b/] 1-Bar Luminaire
[c/] 2-Bar Luminaire

Note(s):

1. All Cobra Head style LED Luminaires are outfitted with 'Cut Off' style Optics which will help eliminate glare or 'sky glow' conditions.

Table SL 318–6: 480 V Cobra Head Style LED Luminaires 4000K Light Temp — Equivalent for HPSV

LED Wattage	HPSV[a/] Equivalent Lumen Wattage	SAP
39[b/]	100	10210293
71[b/]	150	10210294
82[c/]	200	10210295
136[c/]	250	10210297
174[c/]	400	10210296

a/ High Pressure Sodium Vapor (HPSV)
b/ 1-Bar Luminaire
c/ 2-Bar Luminaire

Note(s):

1. All Cobra Head style LED Luminaires are outfitted with ‘Cut Off’ style Optics which will help eliminate glare or ‘sky glow’ conditions.

Table SL 318–7: Cobra Head Style LED Luminaires 3000K Light Temp — LPSV Equivalents

LED Wattage	LPSV[a/] Equivalent Lumen Wattage	SAP
22[b/]	100	10210283
31[b/]	150	10210284
71[b/]	200	10210285
96[c/]	250	10210282

a/ Low Pressure Sodium Vapor (LPSV)
b/ 1-Bar Luminaire
c/ 2-Bar Luminaire

Note(s):

1. All Cobra Head style LED Luminaires are outfitted with ‘Cut Off’ style Optics which will help eliminate glare or ‘sky glow’ conditions.

Table SL 318–8: Cobra Head Style LED Luminaires 3000K Light Temp — MH Equivalents

LED Wattage	MH[a/] Equivalent Lumen Wattage	SAP
31[b/]	100	10210290
39[b/]	150	10210291
39[c/]	175	10210291
71	250	10210292
111[c/]	400	10210303

[a/] Metal Halide (MH)
[b/] 1-Bar Luminaire
[c/] 2-Bar Luminaire

Note(s):

1. All Cobra Head style LED Luminaires are outfitted with 'Cut Off' style Optics which will help eliminate glare or 'sky glow' conditions.

Table SL 318–9: Cobra Head Style LED Luminaires 4000K Light Temp — MH Equivalents

LED Wattage	MH[a/] Equivalent Lumen Wattage	SAP
31[b/]	100	10210286
39[b/]	150	10210287
39[c/]	175	10210287
71[c/]	250	10210288
111[c/]	400	10210289

[a/] Metal Halide (MH)
[b/] 1-Bar Luminaire
[c/] 2-Bar Luminaire

Note(s):

1. All Cobra Head style LED Luminaires are outfitted with 'Cut Off' style Optics which will help eliminate glare or 'sky glow' conditions.

SL 319 High-Pressure Sodium Vapor Cutoff Luminaires

Scope SL 319.1 High-Pressure Sodium Vapor Cutoff Luminaires

Figure SL 319–1: High-Pressure Sodium Vapor Cutoff Luminaires

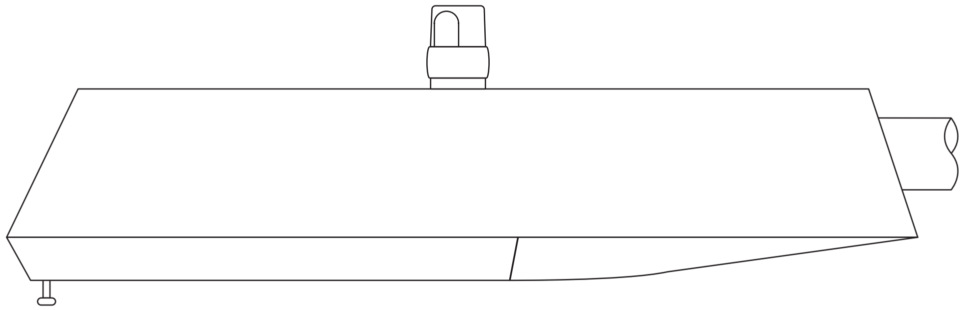

Table SL 319–1: Cutoff Luminaire

Cutoff Luminaire[a/]		
Wattage	**Lumen**	**SAP**
70	5,800	10118436
100	9,500	10118435
150	16,000	10118212
200	22,000	10118434
2350	27,500	10118213
400	50,000	10118433

[a/] Cutoff type luminaire can be used in areas where light pollution (up light) is a problem or a regular luminaire requires shielding.

Table SL 319–2: Replacement Refractor

Wattage	General Electric	American Electric
70	10118604	10118603
100	10118602	10118601

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SL 320 Replacement Refractors — High-Pressure Sodium and Mercury Vapor Luminaires

Scope SL 320.1 Replacement Refractors — High-Pressure Sodium and Mercury Vapor Luminaires

Figure SL 320–1: Replacement Refractors — High-Pressure Sodium and Mercury Vapor Luminaires

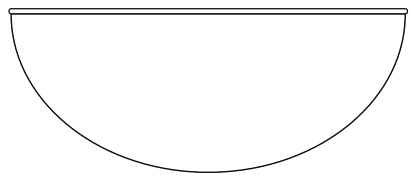


Table SL 320–1: Replacement Refractors

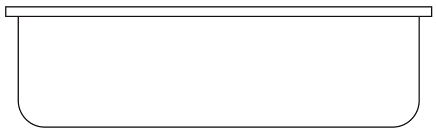
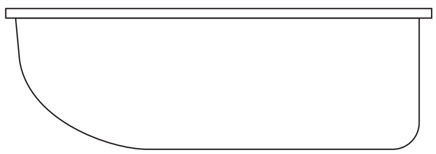
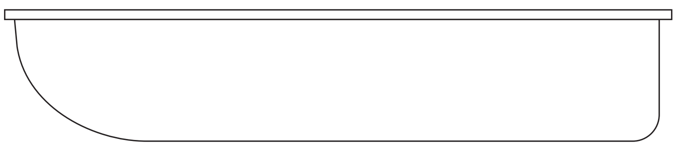
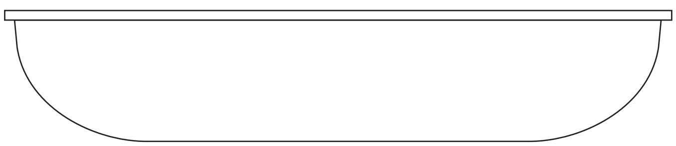
Luminaires		Replacement Refractor SAP Numbers		
Manufacturer	**Lumen Rating**	**Glass**	**Non-Vandal Resistant Plastic**	**Vandal-Resistant Plastic**
General Electric	4,000 through 16,000	NONE	10118728	10118732
	21,000 through 50,000	10118724	NONE	10118733
Crouse Hinds (Westinghouse)	4,000 through 16,000	NONE	10118730	10118732
	21,000 through 50,000	Pending	NONE	NONE
	4,000 through 16,000	NONE	10118731	10118732
	21,000 through 50,000	10118723	NONE	10118734

Note(s):

1. Vandal-resistant plastic refractors are recommended as replacements in problem areas.
2. A non-vandal resistant plastic refractor can be distinguished from a vandal-resistant plastic refractor as follows: On either the top side or the bottom side of the refractor rim are molded the words “NONVANDAL RESISTANT.” Do not replace drop lens refractors with flat glass, unless approved in writing by the city being served.

Scope SL 320.2 Replacement Refractors — Low-Pressure Sodium Vapor Luminaires

Figure SL 320–2: Replacement Refractors — Low-Pressure Sodium Vapor Luminaires

Refractor Profile	Luminaire Model	Wattage	Refractor SAP
	SRX	35/55	10118600
	SRX II	35/55	10118597
	SRP II SRP II SRP II	90 135 180	10118596 10118595 10118594
	SRP SRP	90, 135 180	10118599 10118598

Scope SL 320.3 Bullet-Resistant Shield — Ordering and Installation — U.S. Patent No. 4,460,945

1.0 Application Information

1.1 The shield is for high-pressure sodium-vapor luminaires (cobra head) up to 150 watts, with the refractor removed.

2.0 Material Information:

2.1 SAP number (shield only): 10115910

2.2 Nut and Bolt: 1/4-inch × 20 — 1-1/2-inch round head brass bolt with nut and lock washer (purchase from local hardware stores).

2.3 Rubber Grommet: They are used as spacers and also to reduce shock caused by the impact of bullet on the shield (rubber grommets available from the electrical department of hardware stores can be used).

3.0 Luminaire Preparation

3.1 Use pre-drilled, bullet-resistant shield as a template for drilling 5/16-inch mounting holes on luminaires, see Figure SL 320–3 (Sheet 4), Bottom View:

"A" — holes for G.E. luminaires

"B" — holes for American Electric (ITT) luminaires

"C" — holes for Crouse Hinds (Westinghouse) luminaires

4.0 Mounting Information

4.1 See Figure SL 320–3 (Sheet 4), Side View

5.0 Extra High Vandalism Area

5.1 In areas where one shield proves to be insufficient, two shields can be used. Maintaining an air gap between the shields with rubber grommets increases the effectiveness of the shields.

Figure SL 320–3: Bullet-Resistant Shield

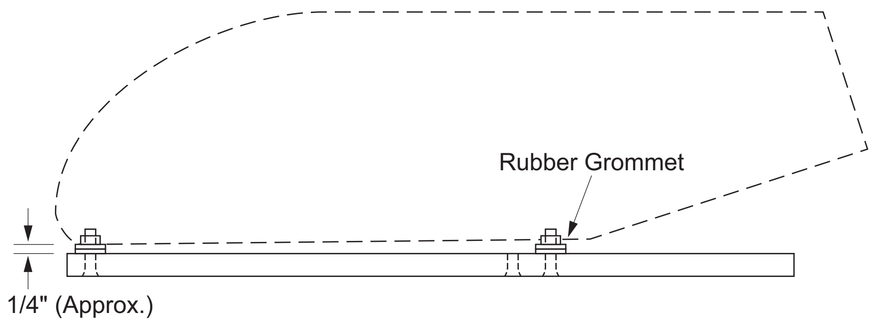


Figure 1 — Side View

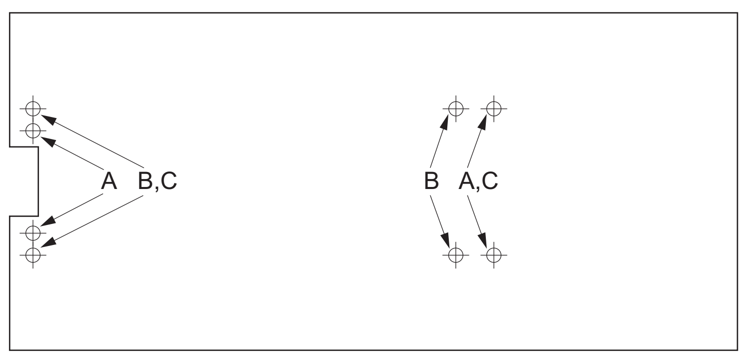
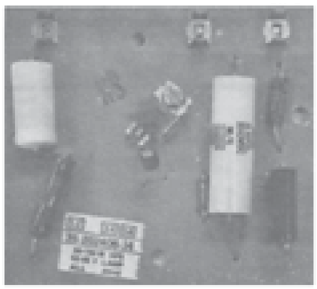


Figure 2 — Bottom View

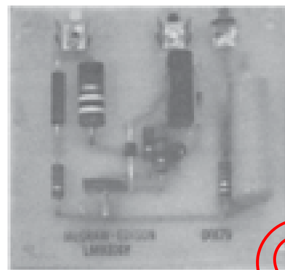
SL 321 High-Pressure Sodium Vapor Streetlight Luminaire Replacement Starters

Scope SL 321.1 Replacement High-Pressure Sodium Vapor Luminaire Starters

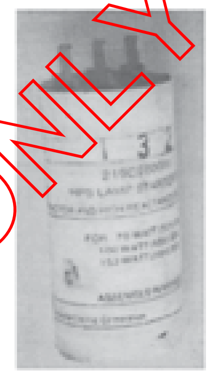
Figure SL 321–1: Replacement High-Pressure Sodium Vapor Luminaire Starters



GE Type



McGraw-Edison Type



Crouse Hinds Type

Table SL 321–1: SAP Numbers for Replacement High-Pressure Sodium Vapor Luminaire Starters

Luminaire Wattage	Lumen	G.E. Plug-In Type	G.E. Board Type	Crouse Hinds	American Electric (ITT)	KIM	McGraw Edison
50 70 100 150	4,000 5,800 9,500 16,000	10118572	10118693	10118692	10118694	Pending	Pending
200 250 400	22,000 27,500 50,000	N/A	10118697	10118696	10118695	10118672	N/A

Note(s):

1. See SL 321 (sheet 2) for Universal Replacement Starters.

Scope SL 321.2 Universal Replacement Starters

1.0 Universal Starter

Figure SL 321–2: Universal Starter

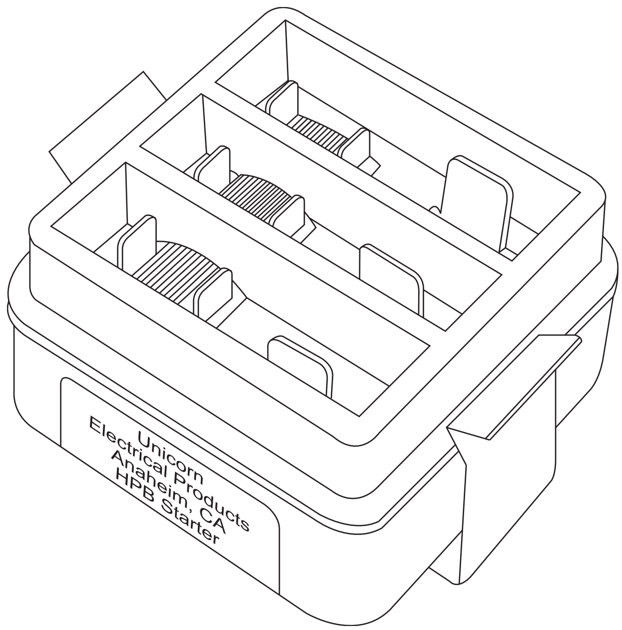


Table SL 321–2: Universal Starters

SAP	Lamp Wattages	Starter Manufacturer	Catalog Number
10118589	50–150	Unicorn Electric	BUST-5AL
10118592	200–400	Unicorn Electric	BUST-10L

Note(s):

1. All three terminals within the same compartment are connected together internally to accommodate different luminaire connectors.

2.0 Application

The Unicorn Electric universal replacement starters can be used to replace all failed multiple high-pressure sodium-vapor starters (except the American Electric, 50–150 watt two-terminal starters, SAP 10118694).

3.0 Wiring Instructions

3.1 De-energize the streetlight by removing the photocontroller.

3.2 Remove mounting clip from universal starter and anchor it to any convenient location with the self-tapping screw provided.

3.3 With the starter in the mounting clip, transfer the starter wires one at a time, using the following Terminal Match-Up Table as a guide:

Table SL 321–3: Terminal Match-Up Table Guide

Manufacturer	**Terminal Match-Up Table**		
Unicorn	Shell	Tap	Tip
GE (Boards)	1,2	5	3,4
American Electric	7	8	9
Westinghouse	2	3	1
Advance	X2	X3	X1
Universal	2	3	1

For starters that are not listed in the table, the following procedure can be used:

A. Transfer the wire(s) connecting the old starter and the lamp socket shell to the universal starter terminal labeled “SHELL.”

B. In like manner, transfer the wire(s) from the lamp socket tip to the terminal labeled “TIP.”

C. Transfer the wire(s) from the ballast to the terminal labeled “TAP.”

3.4 Reinstall the photocontroller and check the operation of the lamp.

Note: For replacement of G.E. plug-in type starters, use the wires provided with the universal starter to make the connections.

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SL 322 G.E. Replacement Power/Door

Scope SL 322.1 G.E. Replacement Power/Door

Figure SL 322–1: General Electric Power/Door Ballasting Assembly

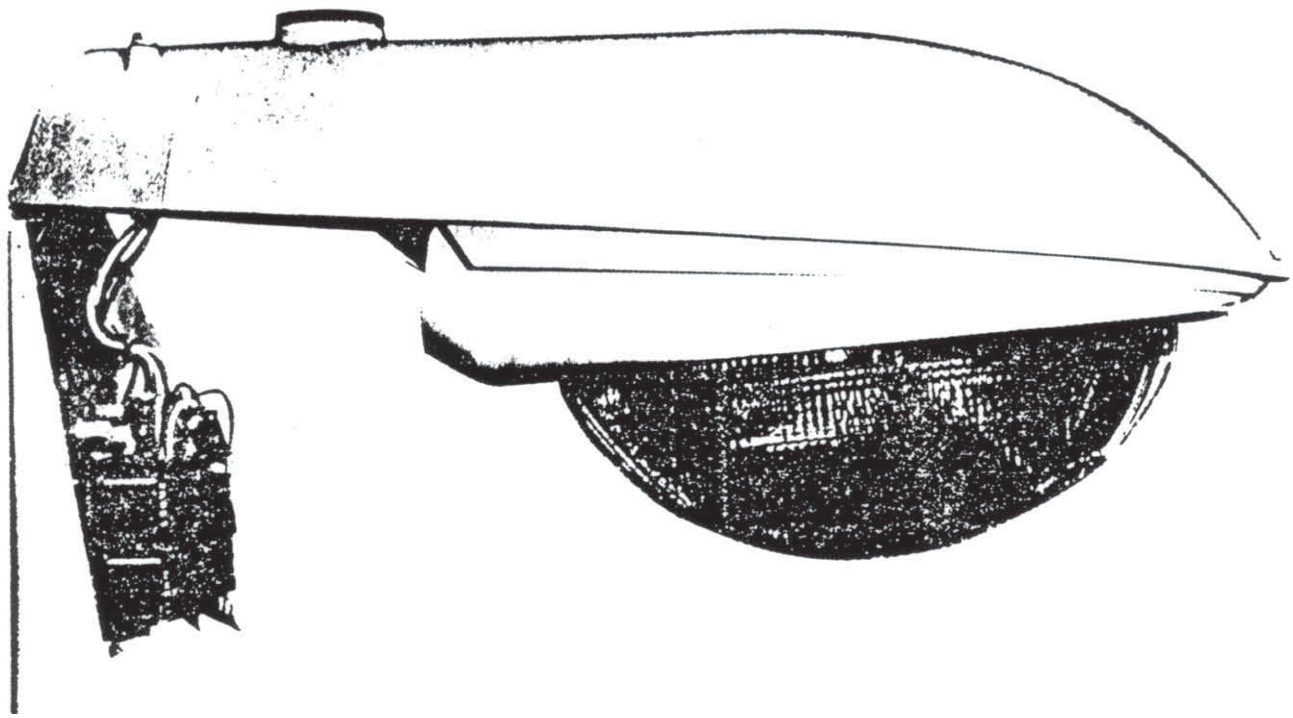


Table SL 322–1: G.E. Replacement Power/Door

Luminaire					Ballasting Assembly SAP
Mercury	HPSV[a/]	Watts	Lumens	SAP	
X		100	3,500	10118421	Pending
X		175	7,000	10118423	Pending
X		250	11,000	10118425	Pending
X		400	20,000	10118416	Pending
	X	50	4,000	10118409	10118668
	X	70	5,800	10118429	10118680
	X	100	9,500	10118430	10118705
	X	150	16,000	10118431	10118704
	X	150	16,000	—	10118717[b/]
	X	200	22,000	10118441	10118667
	X	250	27,500	10118427	10118679
	X	400	50,000	10118428	10118678

[a/] HPSV = High-Pressure Sodium Vapor
[b/] This POWER/DOOR is for the conversion of the 400 watt mercury vapor luminaire only.

SL 330 Luminaire Shielding

Scope SL 330.1 Luminaire Shielding

At the request of the agency authorizing the lighting, the following methods are recommended for shielding undesired light from a streetlight luminaire. In lieu of shielding, a cut-off type luminaire can also be used, see SL 319, with requesting agency approvals in writing.

Figure 1: Scotch Brand No. 49 Aluminum Foil Adhesive Tape (2" × 20' roll) — The preferred method for house side shielding of incandescent and mercury vapor luminaries. The pressure-sensitive tape can be applied to the inside of the globe or refractor.

Figure 2: Glare Shield — Alternate method of shielding mercury vapor and high-pressure sodium vapor luminaires.

Figure SL 330–1: Luminaire Shielding

Figure 1
Mercury Vapor and
High Pressure Sodium Vapor

Figure 2
Mercury Vapor and
High Pressure Sodium Vapor

Table SL 330–1: Luminaire Shielding

	Glare Shield SAP		
	Wattage Rating		
HPSV[a/] Sizes	50, 70, 100, 150	200, 250, 400	—
Mercury Sizes	100, 175, 250	400	700, 1,000
Luminaire Mfg.			
General Electric Type M-250R Type M-250-A pwr/door Type M-400 Type M-400-A pwr/door Type M-1000	 10118742 10118739 	 Pending 10118740 	 10118745
Crouse Hinds (Westinghouse)	10118741	10118744	Pending
American Electric	10118743	NONE	NONE

[a/] HPSV = High-Pressure Sodium Vapor

SL 332 Streetlight Bird Guard

Scope SL 332.1 Externally Mounted Bird Guard for Streetlight

An externally mounted bird guard has been SAP numbered for use on streetlight luminaires. Designed to easily snap on to mast arms, ranging in diameter from 1-1/4 inches to 2 inches, the bird guard prevents entry of birds, squirrels, and insects. These invasions have caused insulation damage, shorting, and component failure due to overheating.

1.0 Installation

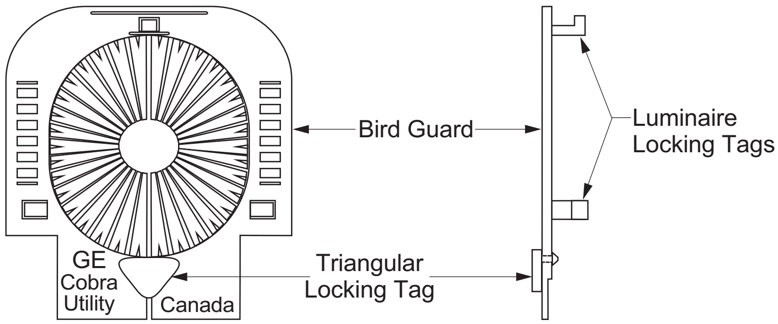
1.1 Place the bird guard into position by splitting and spreading to fit around the mast arm, see Figure SL 332–1 (Sheet 2), Figure 1.

1.2 Lock the guard around the mast arm by pushing the triangular locking tab into the hole of the bird guard. Push the bird guard into the luminaire end, engaging the three luminaire locking tags, see Figure SL 332–1 (Sheet 2), Figure 2. The bird guard will not interfere with relamping.

Table SL 332–1: Bird Guard SAP Numbers

Luminaire Manufacturer	SAP
General Electric	10061023
American Electric Light	10061022

Figure SL 332–1: Externally Mounted Bird Guard for Streetlight



Front View Side View

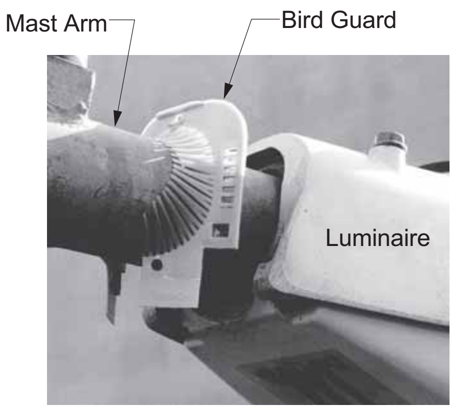


Figure 1

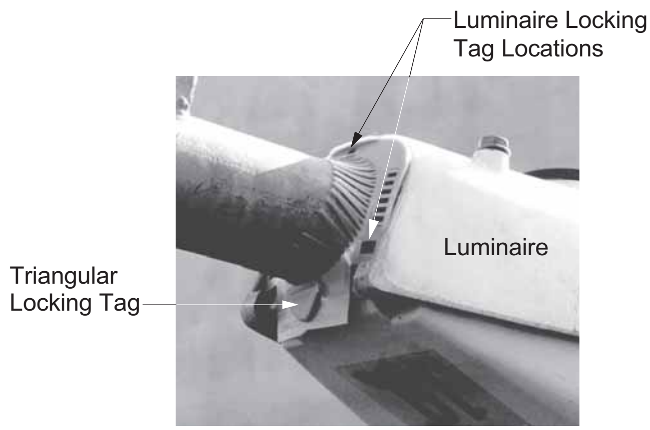


Figure 2

SL 335 Replacement Street-Lighting Lamp Information

Scope SL 335.1 Replacement Street-Lighting Lamp Information

Table SL 335–1: Incandescent Street-Lighting Lamps

Lumens	120 Multiple Lamps		6.6 Amp Series Lamps	
	Watt	SAP	Watt	SAP
1,000	103	10119334	73	10119329
2,500	202	10119335	164	10119330
4,000	327	10119336	251	10119331
6,000	448	10119337	364	10119332

Table SL 335–2: Mercury Vapor Street-Lighting Lamps

Lumens	Watts	SAP
2,800	75	10119339
4,000	100	10119340
7,900	175	10119341
12,000	250	10119342
21,000	400	10119343
41,000	700	Pending
55,000	1,000	10119344

Table SL 335–3: High-Pressure Sodium Vapor Street-Lighting Lamps

SAP	Lamp Rating for Horizontal Burning		Ballast Input		
			120 V Multiple		6.6 Amp Series
	Watts	Lumens	Watts	Amps	Watts
10119363	50	4,000	60	1.20	64
10119356	70	5,800	85	1.65	85
10119361	100	9,500	121	2.20	121
10119362	150	16,000	176	3.30	174
10119345	200	22,000	240	4.67	233
10119349	250	27,500	293	5.70	—
10119350	400	50,000	485	4.20[a/]	—

[a/] High power factor.

Table SL 335–4: Low-Pressure Sodium Vapor Street-Lighting Lamps

SAP	Lamp Rating for Horizontal Burning		Ballast Input		MIN. Ballast Open Circuit Volt
			120 V Multiple		
	Watts	Lumens	Watts[a/]	Amps[a/]	
Pending	35	4,800	63	.58	390
10119160	55	8,000	85	.77	410
10119159	90	13,500	151	1.27	420
10119158	135	22,500	216	1.67	540
10119157	180	33,000	231	2.08	600

[a/] Rating at End of Life.

Note(s):

1. For lamp return procedure of prematurely failed lamps, refer to ESM 47.86.30.

SL 340 LDecal Number for HPSV, LPSV, and MV Luminaires

Scope SL 340.1 Decal Number for HPSV, LPSV, and MV Luminaires

Table SL 340–1: Decals for Field Identification of Streetlight Wattage and Type of Light Source

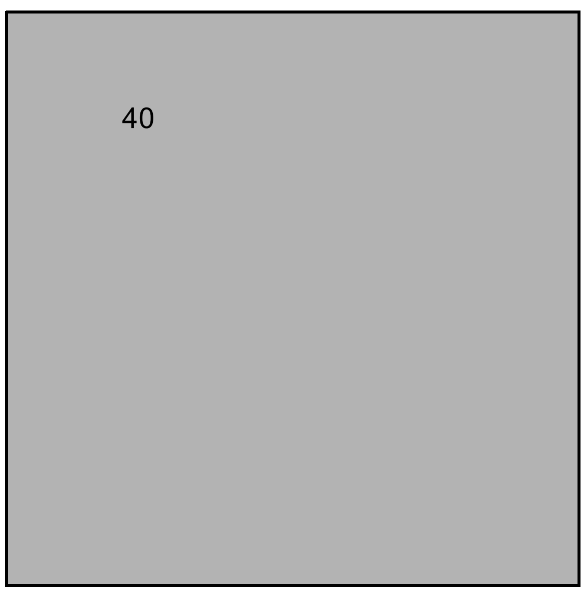
High-Pressure Sodium Vapor			Mercury Vapor			Low-Pressure Sodium Vapor			Metal Halide		
Decal No.	Lamp Wattage	Decal Color	Decal No.	Lamp Wattage	Decal Color	Decal No.	Lamp Wattage	Decal Color	Decal No.	Lamp Wattage	Decal Color
5	50	Gold	10	100	Blue	3	35	Tan	7	70	Silver
7	70	Gold	17	175	Blue	5	55	Tan	10	100	Silver
10	100	Gold	25	250	Blue	9	90	Tan	17	175	Silver
15	150	Gold	40	400	Blue	13	135	Tan	25	250	Silver
20	200	Gold	70	700	Blue	18	180	Tan	40	400	Silver
25	250	Gold	X1	1,000	Blue	—	—	—	—	—	—
40	400	Gold	—	—	—	—	—	—	—	—	—

= For Reference Only

Note(s):

1. The wattage identification decals are applied to the underside of each luminaire by the manufacturers. The use of lumen decals should be discontinued.

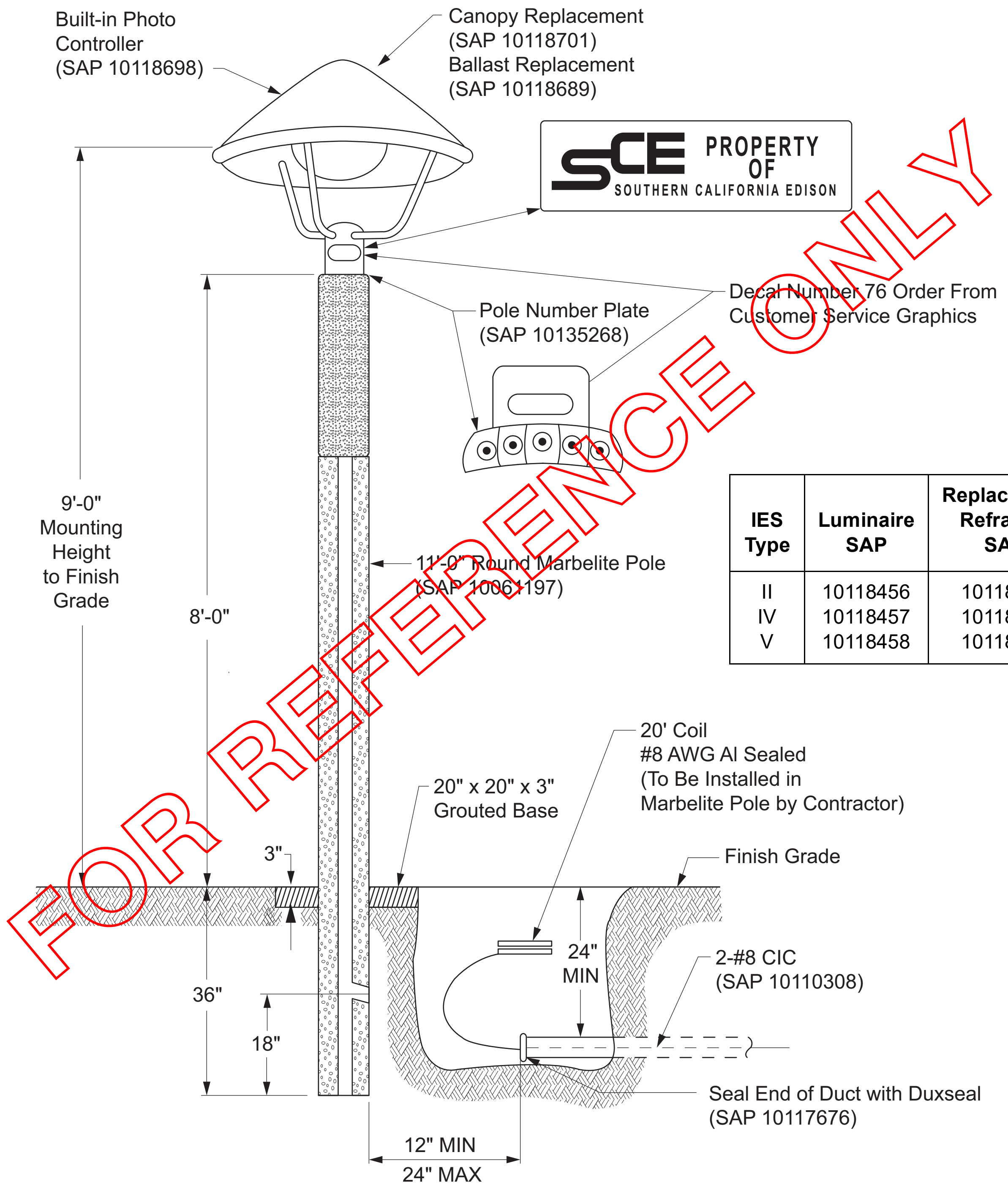
Figure SL 340–1: Wattage Identification Decal — Actual Size



SL 342 DWL — Residential Walk-Way Light

Scope SL 342.1 DWL — Residential Walk-Way Light

Figure SL 342–1: DWL — Residential Walk-Way Light



IES Type	Luminaire SAP	Replacement Refractor SAP
II	10118456	10118726
IV	10118457	10118727
V	10118458	10118727

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SL 343 Light Emitting Diode (LED) Decorative and Nostalgic Style Luminaires

Scope SL 343.1 Light Emitting Diode (LED) Decorative and Nostalgic Style Luminaires

Figure SL 343–1: Nostalgic Acorn Style

Table SL 343–1: Nostalgic Acorn Style

LED Wattage	HPSV Equivalent Wattage	SAP	Light Temp
40	50	10184004	4000K
60	70	10184005	
75	100	10184006	
100	150	10184009	
120	200	10184010	
40	50	10213464	3000K
60	70	10213466	
75	100	10213467	
100	150	10213468	
120	200	10213469	

Figure SL 343–2: Nostalgic Acorn with Decorative Metalwork Style

Table SL 343–2: Nostalgic Acorn with Decorative Metalwork Style

LED Wattage	HPSV Equivalent Wattage	SAP	Light Temp
60	70	10184070	4000K
75	100	10184071	
100	150	10184072	
120	200	10184073	
60	70	10213470	3000K
75	100	10213471	
100	150	10213472	
120	200	10213473	

What's Changed? Table 343-2 was updated to include both 4000K and 3000K light fixtures.

Figure SL 343–3: Colonial Lantern Style

Table SL 343–3: Colonial Lantern Style

LED Wattage	HPSV Equivalent Wattage	SAP	Light Temp
40	50	10184014	4000K
60	70	10184015	
75	100	10184028	
100	150	10184029	
120	200	10184030	
150	250	10184031	
40	50	10213477	3000K
60	70	10213478	
75	100	10213479	
100	150	10213480	
120	200	10213481	
150	250	10213482	

Figure SL 343–4: Teardrop Pendant Mount Style

Table SL 343–4: Teardrop Pendant Mount Style

LED Wattage	HPSV Equivalent Wattage	SAP	Light Temp
60	70	10184034	4000K
75	100	10184035	
100	150	10184042	
120	200	10184043	
150	250	10184044	
60	70	10213490	3000K
75	100	10213491	
100	150	10213492	
120	200	10213493	
150	250	10213494	

What's Changed? Table 343-4 was updated to include both 4000K and 3000K light fixtures.

Figure SL 343–5: Teardrop with Skirt Pendant Mount Style

Table SL 343–5: Teardrop with Skirt Pendant Mount Style

LED Wattage	HPSV Equivalent Wattage	SAP	Light Temp
60	70	10184048	4000K
75	100	10184049	
100	150	10184050	
120	200	10184051	
150	250	10184052	
60	70	10213495	3000K
75	100	10213496	
100	150	10213497	
120	200	10213498	
150	250	10213499	

Figure SL 343–6: Rectilinear "Shoebox" Style

Table SL 343–6: Rectilinear "Shoebox" Style

LED Wattage	HPSV Equivalent Wattage	SAP	Light Temp
36	70/100	10208187	4000K
73	150	10208311	
95	200	10208188	
122	250	10208189	
36	70/100	10214677	3000K
73	150	10214678	
95	200	10214679	
122	250	10214680	

Figure SL 343–7: Lawnaire — DWL Style

Table SL 343–7: Lawnaire — DWL Style

LED Wattage	HPSV/MV[a/] Equivalent Wattage	SAP	Light Temp
40	50 HP/75 MV	10209860	4000K
50	70 HP	10209861	
75	100 HP	10209859	
40	50 HP/75 MV	10213474	3000K
50	70 HP	10213475	
75	100 HP	10213476	

[a/] MV — Mercury Vapor

What's Changed? Tables 343-6 and 343-7 were updated to include both 4000K and 3000K light fixtures. Existing Table 343-6 wattage and SAP numbers were also changed due to new heads being used.

Figure SL 343–8: Mission Bell Style

Table SL 343–8: Mission Bell Style

LED Wattage	HPSV/MV Equivalent Wattage	SAP	Light Temp
30	50	10203301	4000K
50	70	10203297	
80	100	10203302	
91	150	10203300	
119	200	10203303	
150	250	10203298	
220	400	10203299	
30	50	10213483	3000K
50	70	10213484	
80	100	10213485	
91	150	10213486	
119	200	10213487	
150	250	10213488	
220	400	10213489	

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SL 400 Electroliers — Assembly Detail

Scope SL 400.1 Electroliers — Assembly Detail

Table SL 400–1: Marbelite (Concrete) Electrolier Assembly Detail

SAP	Shaft Length	Hand Hole	Pole Top		Bracket (Arm) No. 1			Bracket (Arm) No. 2			2 In End Knob	Design No.	
						Mtg. Height			Mtg. Height				
			Plain Cap	P.E. Cell	Length	Pole	Luminaire	Length	Pole	Luminaire		Pumco	Ameron
Marbelite Electroliers Designed Standard Luminaires													
10061162	23'-3"	Yes	Yes	—	4'	Top	25'-0"	—	—	—	—	LA-7080-A	A0302
10061163	23'-3"	Yes	Yes	—	4'	Top	25'-0"	4'	Top	25'-0"	—	LA-7080-AA	A0303
10061164	23'-3"	Yes	Yes	—	6'	Top	25'-8"	—	—	—	—	5294-G	A0305
10060984	23'-3"	Yes	Yes	—	6'	Top	25'-8"	6'	Top	25'-8"	—	LA-7.080-BB	1-C123-CF6D
10061176	16'-3"	Yes	Yes	—	4'	Top	18'-0"	—	—	—	—	LA-7079	A0330
10061181	28'-3"	Yes	Yes	—	6'	Top	30'-8"	—	—	—	—	LA-7081 -A	A0353
10061182	28'-3"	Yes	Yes	—	6'	Top	30'-8"	6'	Top	30'-8"	—	LA-7081 -B	A0354
Pending	29'-3"	Yes	Yes	—	6'	Top	31'-9"	4'	Top	31'-0"	—	X-5295-B	A0355
Pending	29'-3"	Yes	Yes	—	6'	Top	31'-9"	4'	L-45	26'-9"	—	X-5295-B/L-0	A0356
Pending	29'-3"	Yes	Yes	—	6'	Top	31'-9"	6'	L-54	27'-6"	—	5295-B/L-0	A0357
Marbelite Electroliers Designed Mission Bell Luminaires													
10061165	23'-3"	Yes	—	Yes	4'	Top	25'-0"	—	—	—	Yes	5294-C	A0306
10061166	23'-3"	Yes	—	Yes	4'	Top	25'-0"	4'	Top	25'-0"	Yes	5294-D	A0307
10061170	28'-3"	Yes	—	Yes	4'	Top	30'-0"	—	—	—	Yes	5295-J	A0319
10061173	28'-3"	Yes	—	Yes	4'	Top	30'-0"	4'	Top	30'-0"	Yes	5295-G	A0322
10061171	28'-3"	Yes	—	Yes	6'	Top	30'-8"	—	—	—	Yes	5295-C	A0320
10061172	28'-3"	Yes	—	Yes	6'	Top	30'-8"	6'	Top	30'-8"	Yes	5295-D	A0321
10061174	23'-3"	Yes	—	Yes	6'	Top	25'-8"	—	—	—	Yes	5294-H	A0324
10061175	23'-3"	Yes	—	Yes	6'	Top	25'-8"	6'	Top	25'-8"	Yes	5294-J	A0325
Marbelite Electroliers Designed Rectilinear Luminaires													
10061204	23'-3"	Yes	Yes	—	8"	Top	23'-6"	—	—	—	—	LE-7058-A[a/]	A1495[a/]
10061179	28'-3"	Yes	Yes	—	8"	Top	28'-0"	—	—	—	—	LE-7058-B[a/]	A0341[a/]

[a/] Specify if G.E. or Kim Luminaire is to be used.

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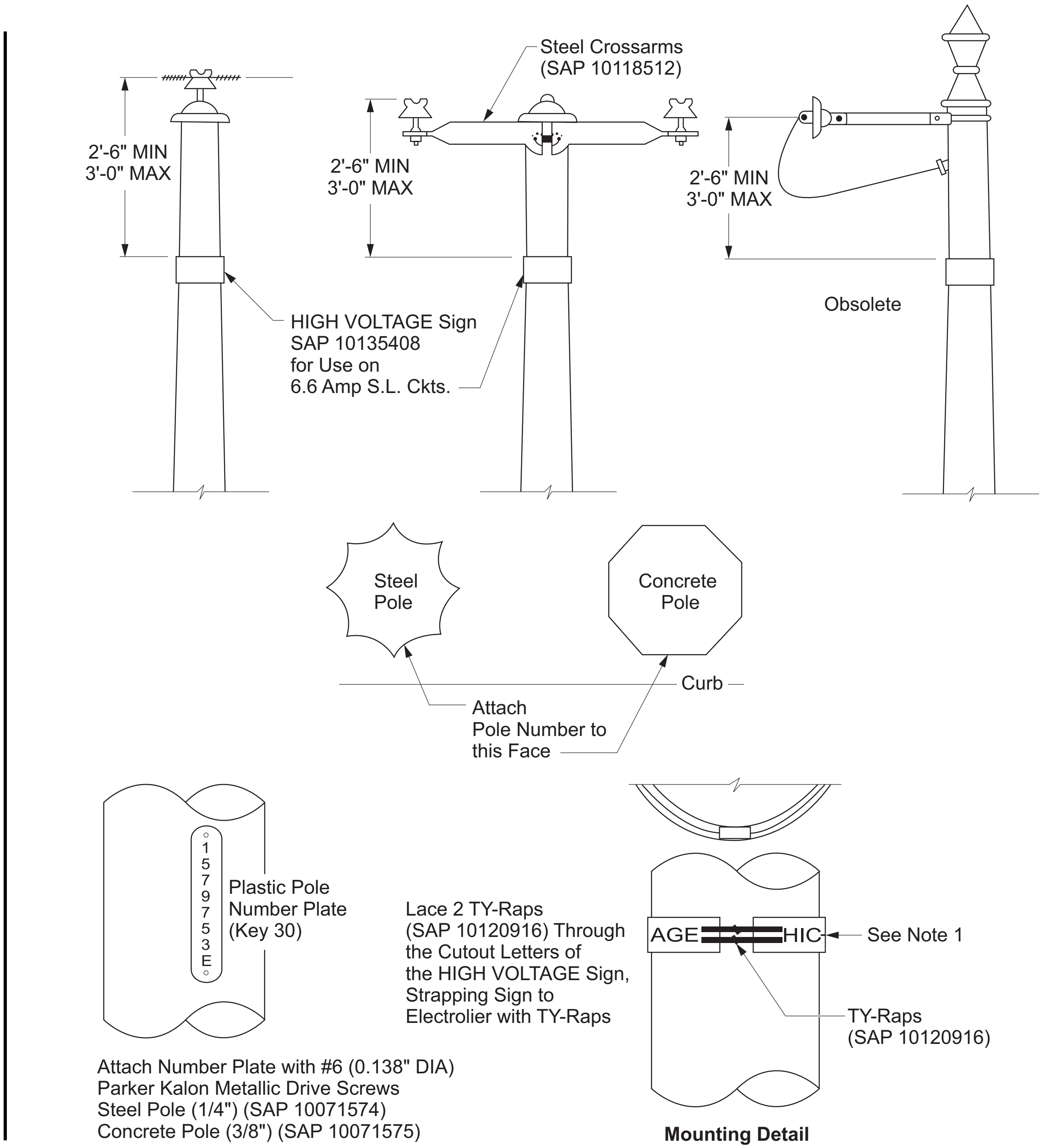
SL 410 Electroliers — Markings

Scope SL 410.1 Electroliers — Markings

Figure SL 410–1: Electroliers — Markings



Effective Date: 04-27-2012

What's Changed? Figure SL 410-1, Note 1 was updated to reference PO 120 for HIGH VOLTAGE sign requirements.

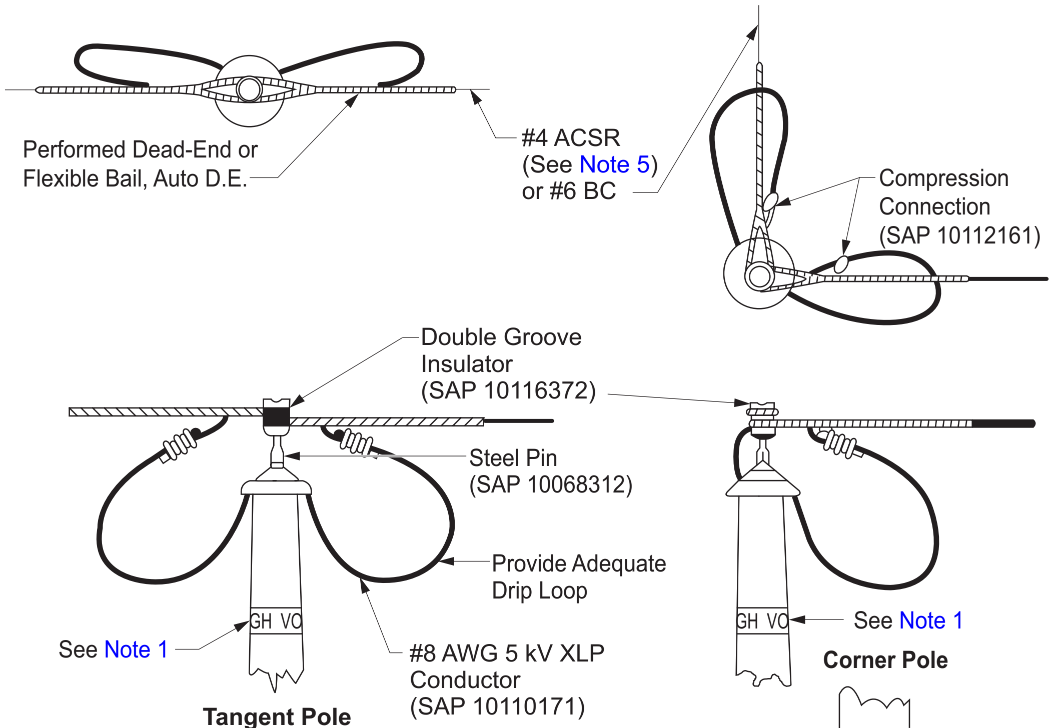
Note(s):

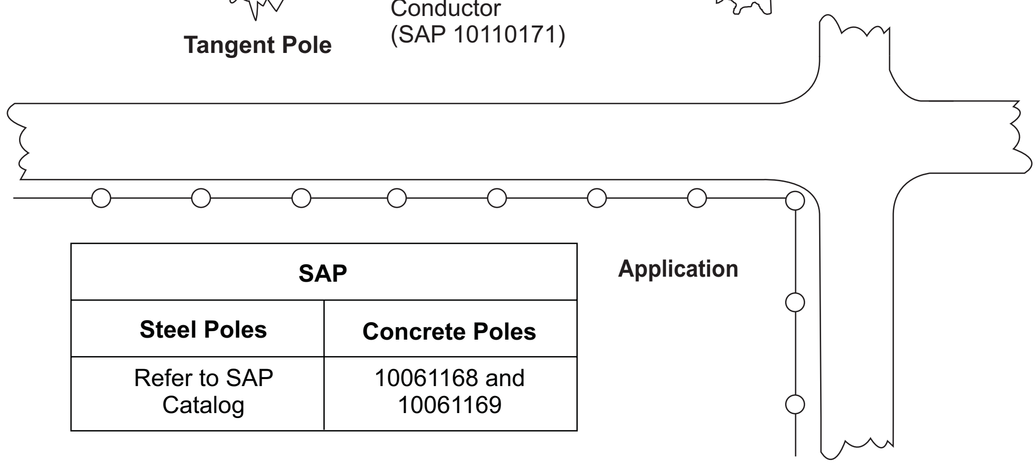
1. See PO 120 for HIGH VOLTAGE sign installation requirements.

SL 420 6.6 “A” Circuit — Tangent and Corner

Scope SL 420.1 6.6 “A” Circuit — Tangent and Corner

Figure SL 420–1: 6.6 “A” Circuit — Tangent and Corner





SAP	
Steel Poles	**Concrete Poles**
Refer to SAP Catalog	10061168 and 10061169

Note(s): (For concrete poles only)

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. For ACSR conductors, allow an additional 50 percent sag. See CO Section.
3. No change in sag for copper conductors.
4. No pole rake is necessary.
5. Not approved for use on new construction.

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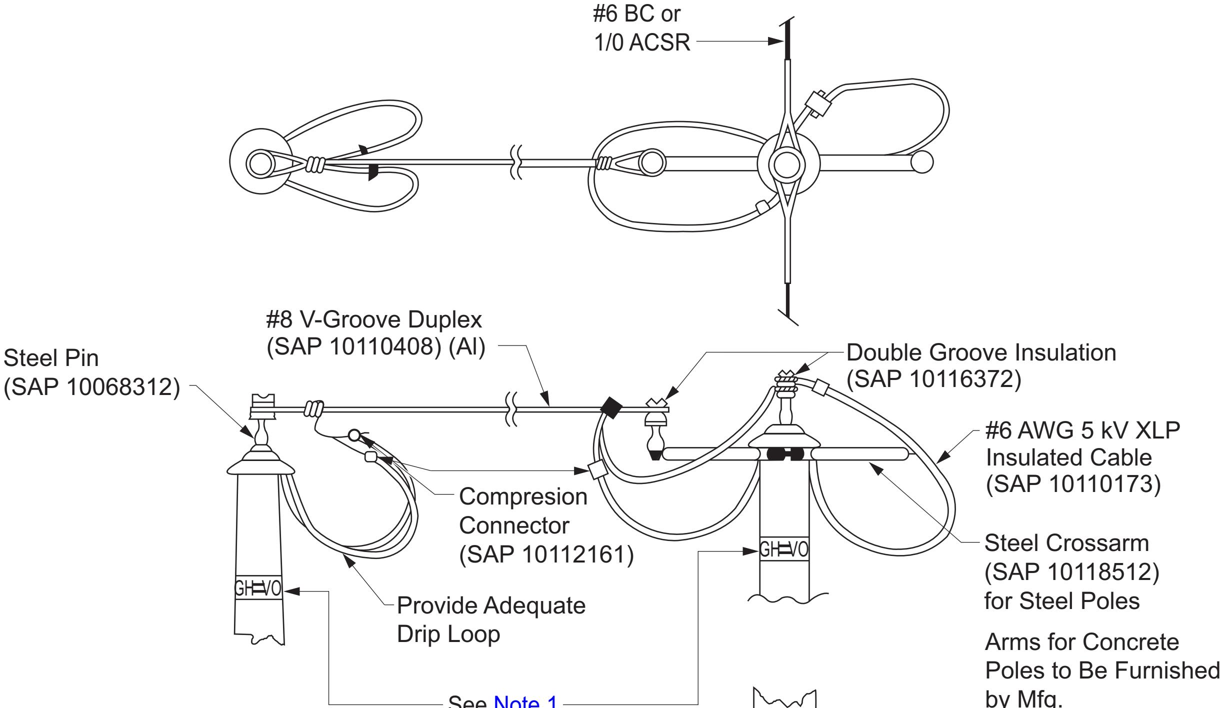
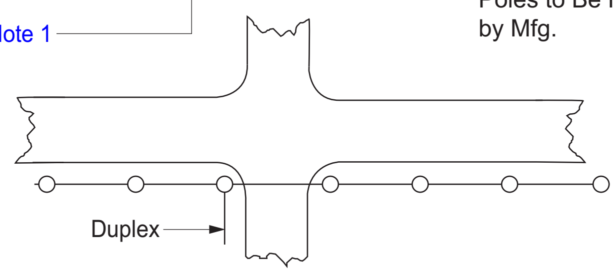
SL 422 6.6 “A” Circuit — “T” Top to Electroliers

Scope SL 422.1 6.6 “A” Circuit — “T” Top to Electroliers

Figure SL 422–1: “T” Top to One Lamp Duplex



SAP	
Steel Poles	**Concrete Poles**
Refer to SAP Catalog	10061168 and 10061169

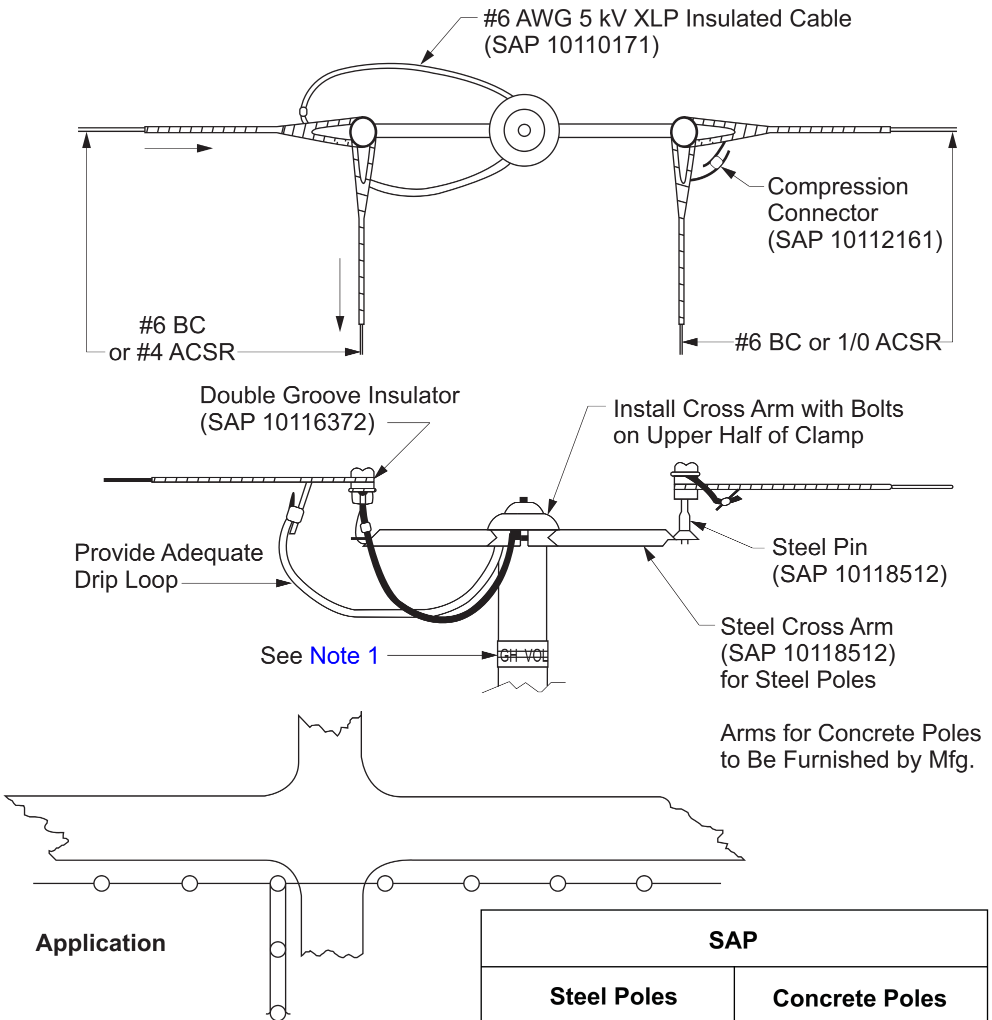


Application

Note(s): (For concrete poles only)

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. For ACSR conductors, allow an additional 50 percent sag from sag tables. See CO Section.
3. No change in sag for copper conductors.
4. No pole rake is necessary.

Figure SL 422–2: "T" Tap to Several Electroliers



SAP	
Steel Poles	**Concrete Poles**
Refer to SAP Catalog	10061168 and 10061169

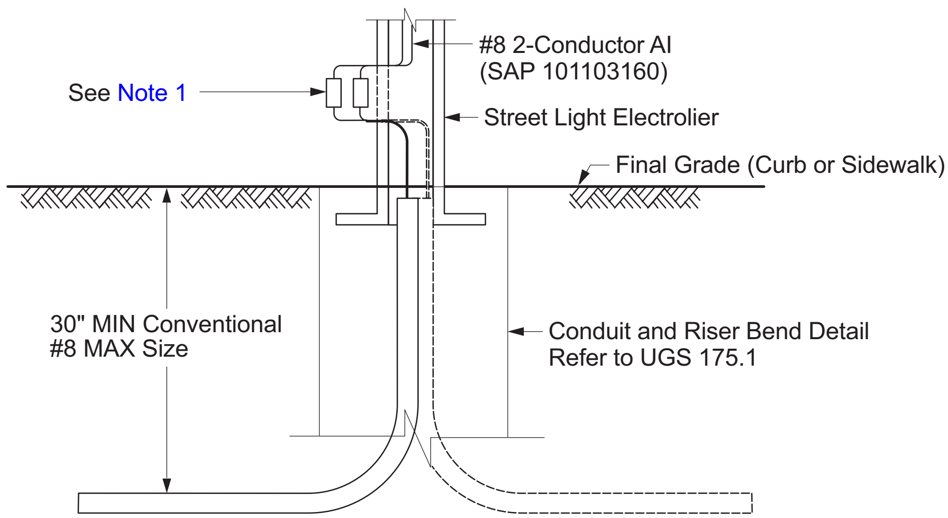
Note(s): (For concrete poles only)

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. For ACSR conductors allow an additional 50 percent sag from sag tables. See CO Section.
3. No change in sag for copper conductors.
4. No pole rake is necessary.

SL 425 Foundation Details

Scope SL 425.1 Foundation Details

Figure SL 425–1: Streetlight Service to One Streetlight Standard or Loop-Through Service Maximum Size Secondary #8



Note(s):

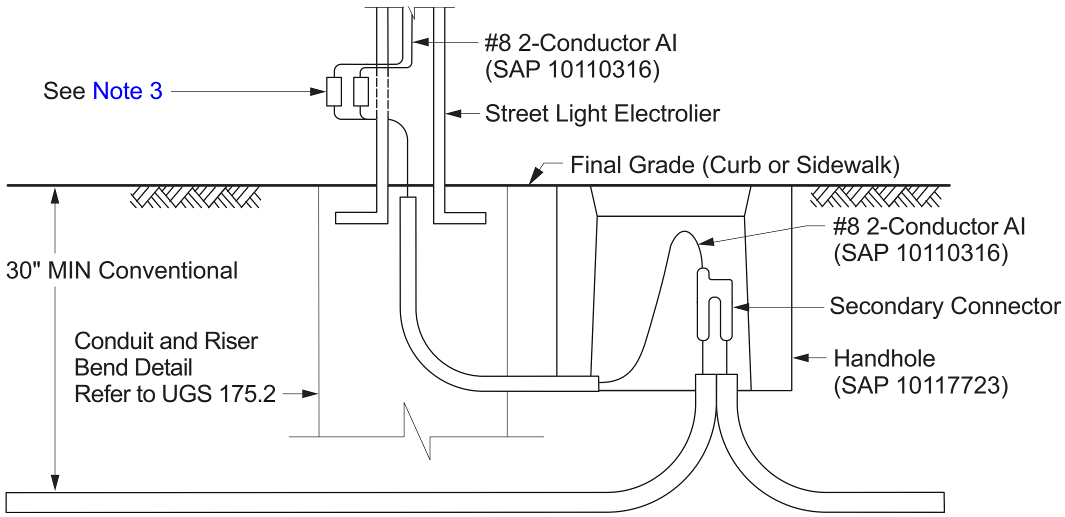
1. Insulated service sleeve see CO 305.

Table SL 425–1: Streetlight Service to One Streetlight Standard or Loop-Through Service Maximum Size Secondary #8

Cable Size	Type of Secondary	Service Tap	Service Run
#8	Direct	#8	#8
#8	Loop[a/]	#8	#8

[a/] Install and crimp the two #8 from the secondary service in the #4 side of the service sleeve and the #8 from luminaire in the #8 side.

Figure SL 425–2: Secondary Service with Pull Box for 3-Wire Secondaries or Secondary Cable #4 and Larger in Conventional Conduit



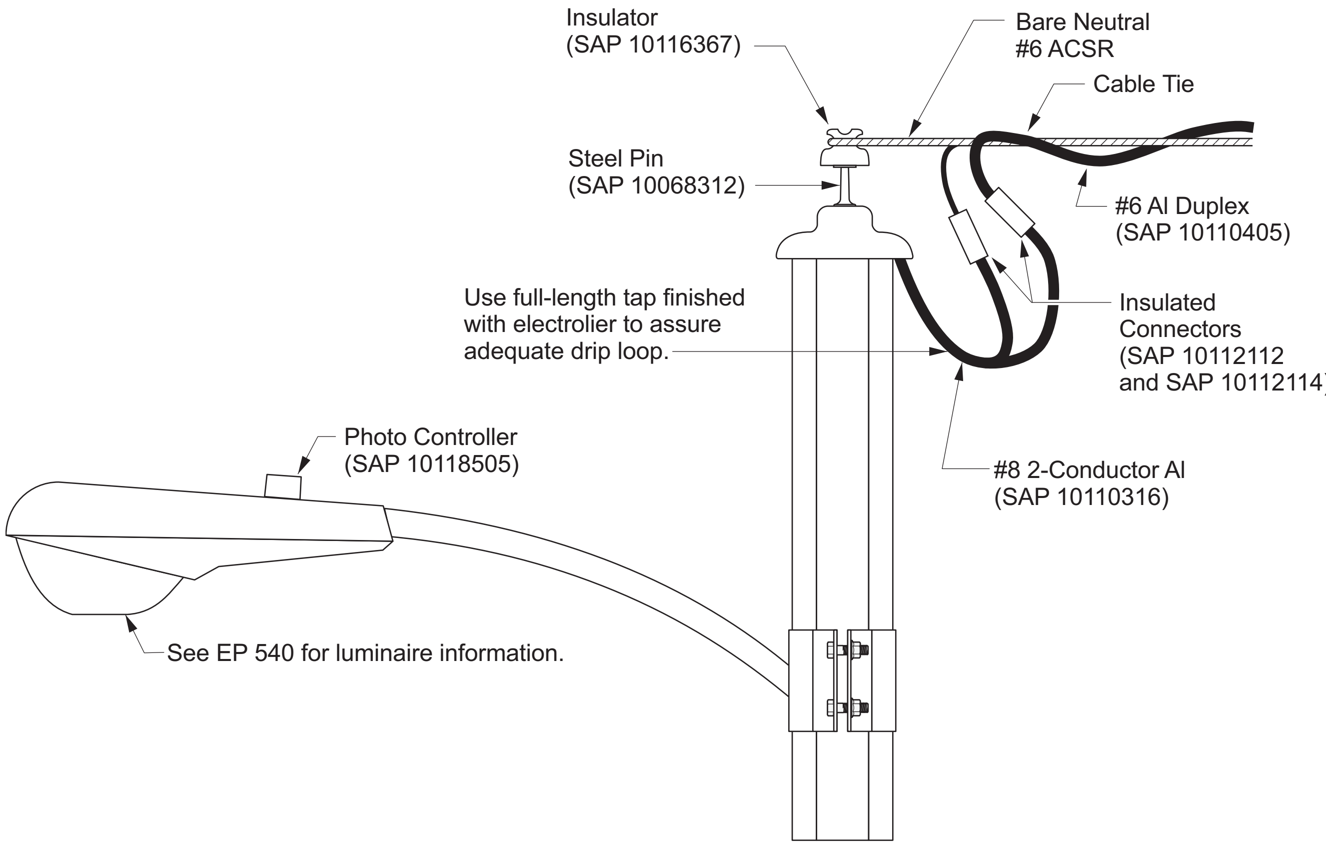
Note(s):

1. Contractor to furnish and install #8 cable.
2. Edison to connect duplex wire to #8 secondary cable with service sleeve.
3. Insulated service sleeve see CO 305.

SL 430 120 V Overhead Service

Scope SL 430.1 120 V Overhead Service

Figure SL 430–1: 120 V Overhead Service



Electrolier — Concrete			
SAP	MIN Insulator Height (ft)	Arm Length (ft)	Luminaire Mounting Height
10061168	29	4	25' ± 6"
10061169	29	6	30' ± 6"

Note(s):

1. For ACSR conductors, allow an additional 50 percent sag from sag tables. See CO Section.
2. No change in sag for copper conductors.
3. No pole rake is necessary.
4. #8 copper cable (SAP 10109555) is also available. Copper conductor should be used in copper designated areas only.

SL 435 Reducing Static Discharge — Steel Electrolier

Scope SL 435.1 Reducing Static Discharge — Steel Electrolier

Figure SL 435–1: Steel Electrolier Wiring

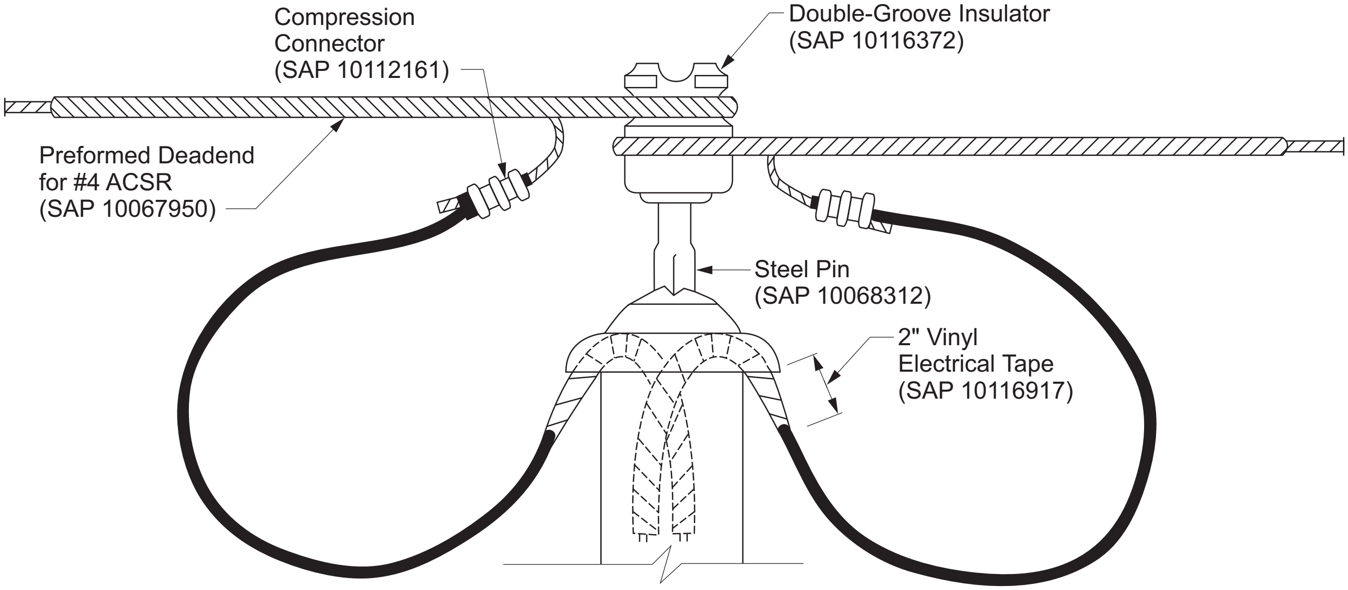
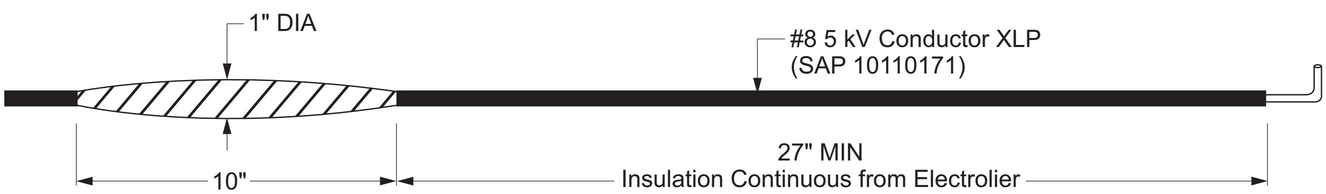


Figure SL 435–2: Conductor Taping Detail



Note(s):

1. To be used only where static discharge causes charring of insulation.

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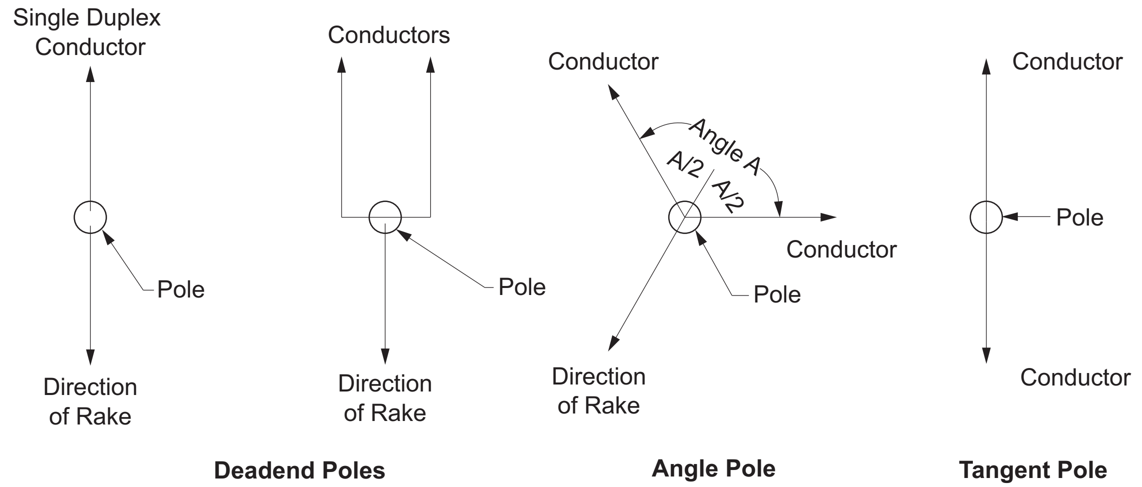
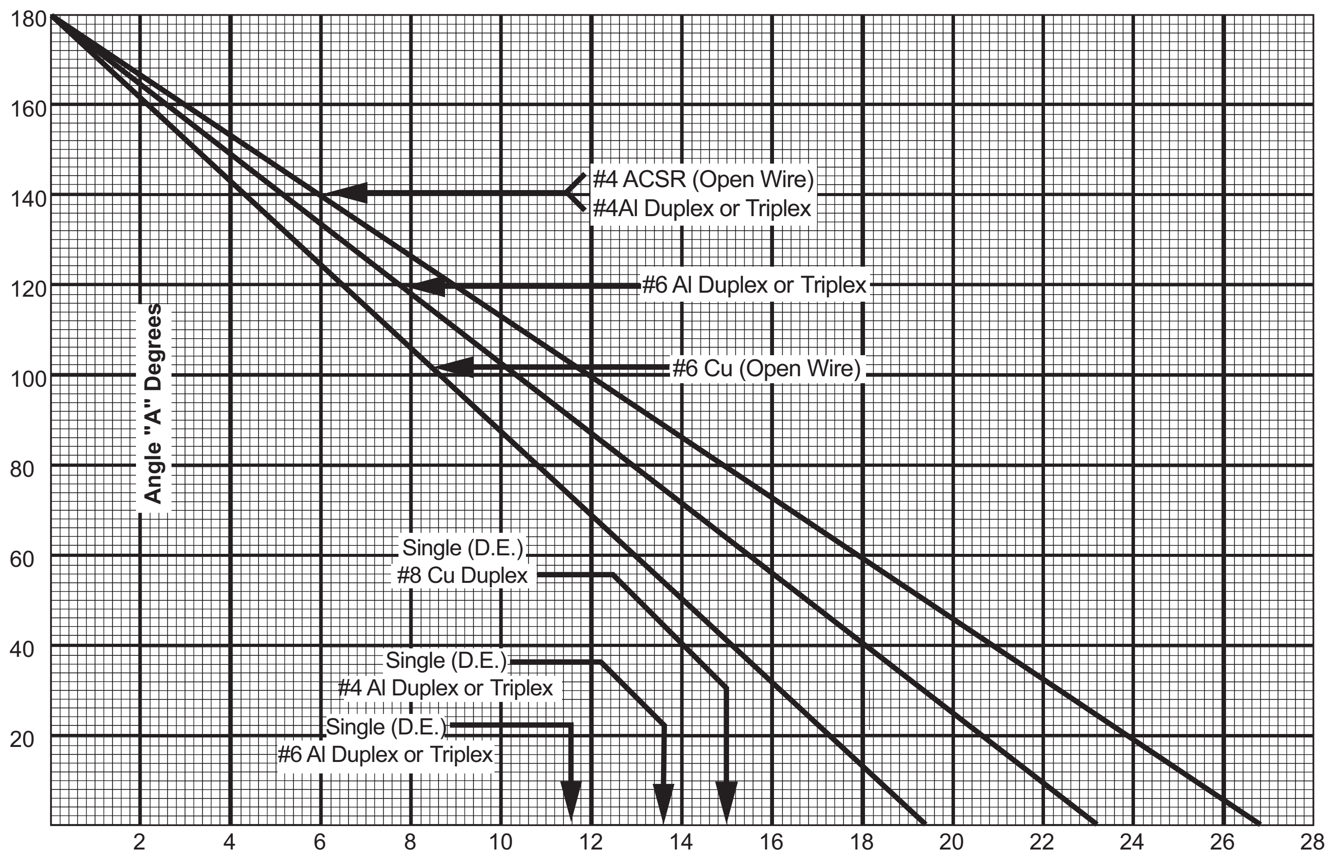
SL 437 Amount of Rake Required for Steel Electrolier when Served Overhead

Scope SL 437.1 Amount of Rake Required for Steel Electrolier when Served Overhead

Figure SL 437–1: Amount of Rake Required for Steel Electrolier when Served Overhead

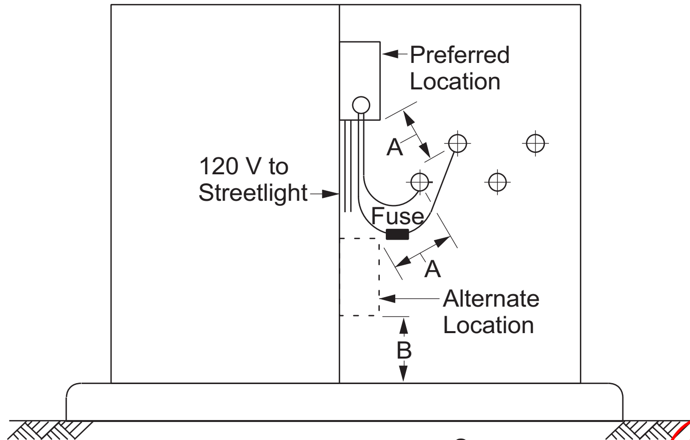


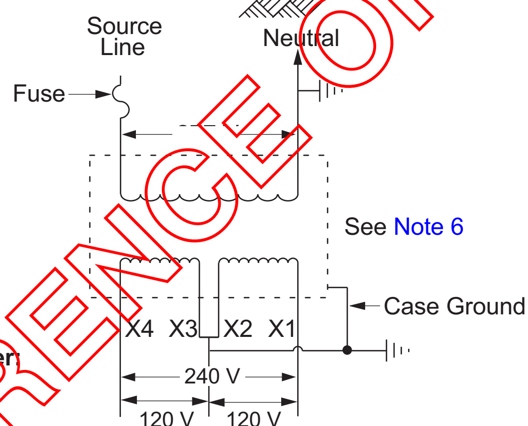


SL 450 120 V Service From 277/480 V Pad-Mounted Transformer

Scope SL 450.1 Procedures for Installing a 1 kVA Dry Transformer in a 277/480 V Pad-Mounted Transformer for Streetlights, and Other Low-Wattage Systems

Figure SL 450–1: Installing a 1 kVA Dry Transformer in a 277/480 V Pad-Mounted Transformer for Streetlights, and Other Low-Wattage Systems





Minimum Clearances:
A = 6"
B = 12"

Transformer Data:
Size: 1 kVA
Voltage: 277 V — 120/240 V
SAP 10105073

Minimum Wire Size for Dry-Type Transformer:
Primary: #12 meter code wire
Secondary: 2- #8 AL streetlight cable

Fuse and Fuseholder Data:
Fuseholder: Inline type for #12 meter code wire
SAP 10107492
Fuse: 10 Amp
SAP 10107730

See Note 6

Output Connections			
Volts	Connect	Output Lines	
		1	2
120	X1 TO X3 X2 TO X4	X1	X4
120/204	X2 TO X3	X1 X2	X4
240	X2 TO X3	X1	X4

Note(s):

1. De-energize primary prior to mounting dry-type transformer on live-front transformers.
2. Use dry-type transformer as template for bolt pattern and secure transformer to center panel ONLY.
3. Connect dry-type transformer to low-voltage phase and neutral bushing.
4. Streetlights served from a dry transformer should be limited to a maximum of 2-9,500 lumen or small HPSV lights or one larger unit, and a maximum voltage drop of 2 percent.
5. Other low-wattage systems are limited to 800 watts (120 V × 7.4 A × 0.9 PF) including starting current and 2 percent maximum voltage drop on cable.
6. Transformer winding configurations may vary. See manufacturer's transformer schematic for actual winding connections.

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SL 455 Direct Buried Fiberglass Light Poles

Scope SL 455.1 Installation Procedures for Direct Buries Fiberglass Light Poles

Figure SL 455–1: Direct Buried Fiberglass Light Poles

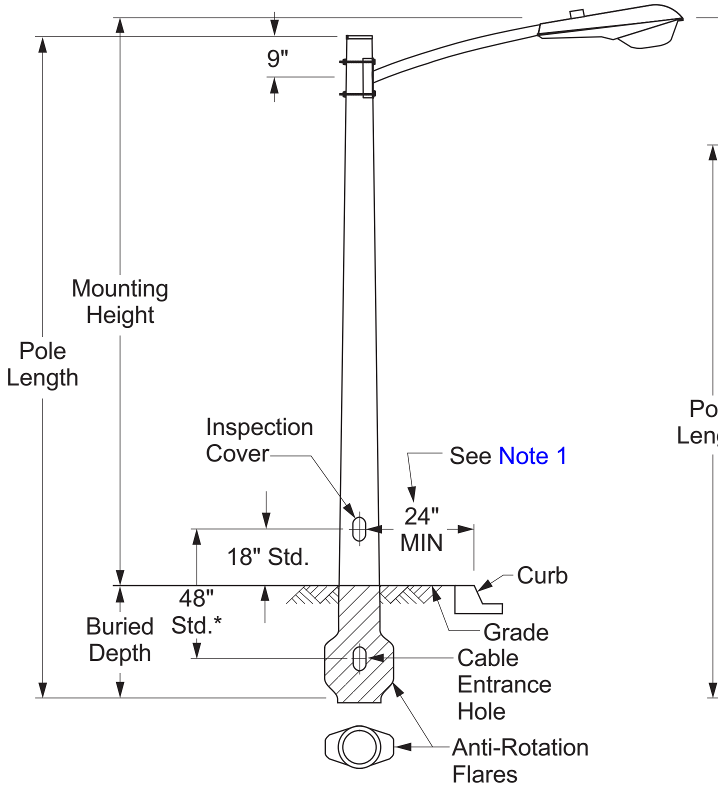


Figure SL 455–1.1
Mast Arm Type

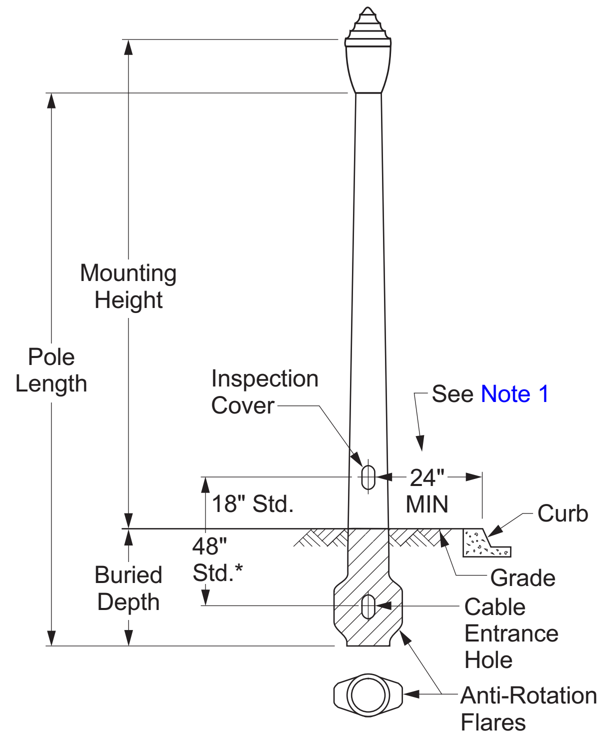
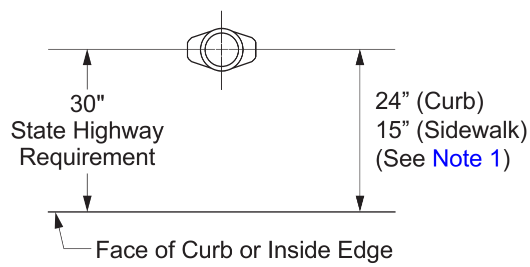
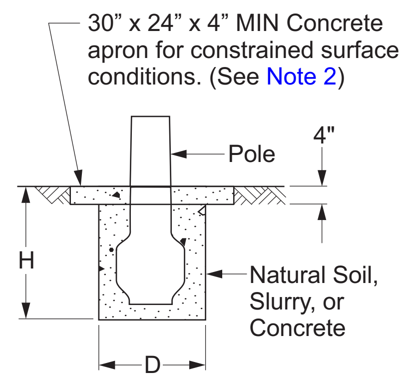


Figure SL 455–1.2
Post Top Type

* 48" on all poles except Fluted (Nostalgic) which is 36".



Streetlight Placement behind Curb or Sidewalk
Figure SL 455–1.3



Detail “A”
See Note 3

Note(s):

1. See Note 1.12 (Sheet 8).
2. See Note 1.11 (Sheet 7).

3. Backfill Requirements See Table SL 455–2 (Sheet 3), Table SL 455–3 (Sheet 4), Table SL 455–4 (Sheet 5), or Table SL 455–5 (Sheet 6).

Table SL 455–1: Natural Finish, Smooth Finish and Fluted Finish (Nostalgic)

Natural Finish				
Pole Length	**Light, Mounting Ht.**	**Mast Arm Length**	**Mast Arm**	**SAP**
21'-0"	18'-0"	4'	Single	10061017
29'-6"	25'-0"	4'	Single	10061016
29'-6"	25'-0"	4'	Double	10061013
29'-6"	25'-8"	6'	Single	10061015
29'-6"	26'-9"	8'	Single	10061014
29'-6"	26'-9"	8'	Double	10061012
34'-6"	30'-8"	6'	Single	10061011
34'-6"	30'-8"	6'	Double	10061010
34'-6"	31'-9"	8'	Single	10061009
34'-6"	31'-9"	8'	Double	10061008
20'-0"	17'-2"	Post Top	—	10061023
27'-0"	24'-2"	Post Top	—	10061024
33'-0"	29'-2"	Post Top	—	10061025
Smooth Finish				
Pole Length	**Light, Mounting Ht.**	**Mast Arm Length**	**Mast Arm**	**SAP**
21'-0"	18'-0"	4'	Single	10061048
29'-6"	25'-0"	4'	Single	10061047
29'-6"	25'-0"	4'	Double	10061044
29'-6"	25'-8"	6'	Single	10061046
29'-6"	26'-9"	8'	Single	10061045
29'-6"	26'-9"	8'	Double	10061043
34'-6"	30'-8"	6'	Single	10061042
34'-6"	30'-8"	6'	Double	10061041
34'-6"	31'-9"	8'	Single	10061040
34'-6"	31'-9"	8'	Double	10061039
20'-0"	17'-2"	Post Top	—	10061052
27'-0"	24'-2"	Post Top	—	10061053
33'-0"	29'-2"	Post Top	—	10061054
Fluted Finish (Nostalgic)				
Pole Length	**Light, Mounting Ht.**	**Mast Arm Length**	**Mast Arm**	**SAP**
18'-6"	16'-3"	Post Top	—	10061018

Figure SL 455–2: Textures for Direct Buried Fiberglass Light Poles

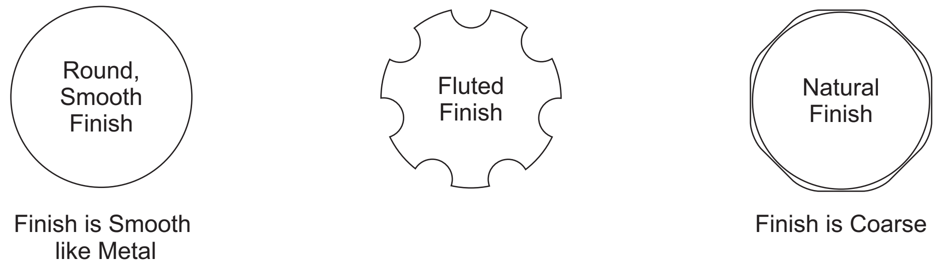


Table SL 455–2: 70 MPH Wind Zone, Constrained Surface Condition

Electrolier Foundation Requirements										
	Soil Type	**Standard**						**Nostalgic**		
	Per UBC[a/]	**25'–30' Shaft**			**14'–24' Shaft**			**18'-6" Shaft**		
		H[b/]	**D[c/]**	**Remarks**	**H[b/]**	**D[c/]**	**Remarks**	**H[b/]**	**D[c/]**	**Remarks**
I.	Massive Crystalline Bedrock	5'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	20" DIA	Direct bury & backfill with compacted soil.
II.	Sedimentary and Foliated Rock	5'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	20" DIA	Direct bury & backfill with compacted soil.
III.	Sandy Gravel, Gravel	5'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	20" DIA	Direct bury & backfill with compacted soil.
IV.	Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel	5'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	20" DIA	Direct bury & backfill with compacted soil.
V.	Clay, Sands, Sandy Clay, Silty Clay, Clayey Silt	5'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	20" DIA	Direct bury & backfill with compacted soil.

[a/] Uniform Building Code, 1991.
[b/] H = Depth of footing.
[c/] D = Diameter of round footing or the side dimension of square footing.

Note(s):

1. See Paragraph 1.11 (Sheet 7).

Table SL 455–3: 70 MPH Wind Zone, Non-Constrained Surface Condition

Electrolier Foundation Requirements											
	Soil Type	**Standard**						**Nostalgic**			
		25'–30' Shaft			**14'–24' Shaft**			**18'-6" Shaft**			
	Per UBC[a/]	**H[b/]**	**D[c/]**	**Remarks**	**H[b/]**	**D[c/]**	**Remarks**	**H[b/]**	**D[c/]**	**Remarks**
I.	Massive Crystalline Bedrock	5'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	20" DIA	Direct bury & backfill with compacted soil.
II.	Sedimentary and Foliated Rock	5'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	20" DIA	Direct bury & backfill with compacted soil.
III.	Sandy Gravel, Gravel	5'-0"	18" DIA	Fill the hole with slurry or concrete.	4'-0"	20" DIA	Fill the hole with slurry or concrete.	4'-0"	20" DIA	Fill the hole with slurry or concrete.
IV.	Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel	5'-0"	18" DIA	Fill the hole with slurry or concrete.	4'-0"	24" DIA	Fill the hole with slurry or concrete.	4'-0"	20" DIA	Fill the hole with slurry or concrete.
V.	Clay, Sands, Sandy Clay, Silty Clay, Clayey Silt	5'-0"	18" DIA	Fill the hole with slurry or concrete.	4'-0"	24" DIA	Fill the hole with slurry or concrete.	4'-0"	20" DIA	Fill the hole with slurry or concrete.

[a/] Uniform Building Code, 1991.
[b/] H = Depth of footing.
[c/] D = Diameter of round footing or the side dimension of square footing.

Table SL 455–4: 90 MPH Wind Zone, Constrained Surface Condition

Electrolier Foundation Requirements										
	Soil Type	Standard						Nostalgic		
		25'–30' Shaft			14'–24' Shaft			18'-6" Shaft		
	Per UBC[a/]	H[b/]	D[c/]	Remarks	H[b/]	D[c/]	Remarks	H[b/]	D[c/]	Remarks
I.	Massive Crystalline Bedrock	5'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	20" DIA	Direct bury & backfill with compacted soil.
II.	Sedimentary and Foliated Rock	5'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	20" DIA	Direct bury & backfill with compacted soil.
III.	Sandy Gravel, Gravel	5'-0"	18" DIA	Fill the hole with slurry or concrete.	4'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	20" DIA	Direct bury & backfill with compacted soil.
IV.	Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel	5'-0"	24" DIA	Fill the hole with slurry or concrete.	4'-0"	12" DIA	Fill the hole with slurry or concrete.	4'-0"	20" DIA	Fill the hole with slurry or concrete.
V.	Clay, Sands, Sandy Clay, Silty Clay, Clayey Silt	5'-0"	24" DIA	Fill the hole with slurry or concrete.	4'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	20" DIA	Fill the hole with slurry or concrete.

[a/] Uniform Building Code, 1991.
[b/] H = Depth of footing.
[c/] D = Diameter of round footing or the side dimension of square footing.

Note(s):

1. See Paragraph 1.11 (Sheet 7).

Table SL 455–5: 90 MPH Wind Zone, Non-Constrained Surface Condition

Electrolier Foundation Requirements											
	Soil Type	Standard						Nostalgic		
		25'–30' Shaft			14'–24' Shaft			18'-6" Shaft		
	Per UBC[a/]	H[b/]	D[c/]	Remarks	H[b/]	D[c/]	Remarks	H[b/]	D[c/]	Remarks
I.	Massive Crystalline Bedrock	5'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	12" DIA	Fill the hole with slurry or concrete.	4'-0"	20" DIA	Direct bury & backfill with compacted soil.
II.	Sedimentary and Foliated Rock	5'-0"	12" DIA	Direct bury & backfill with compacted soil.	4'-0"	12" DIA	Fill the hole with slurry or concrete.	4'-0"	20" DIA	Direct bury & backfill with compacted soil.
III.	Sandy Gravel, Gravel	5'-0"	20" DIA	Fill the hole with slurry or concrete.	4'-0"	20" DIA	Fill the hole with slurry or concrete.	4'-0"	20" DIA	Fill the hole with slurry or concrete.
IV.	Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel	5'-0"	24" DIA	Fill the hole with slurry or concrete.	4'-0"	24" DIA	Fill the hole with slurry or concrete.	4'-0"	24" DIA	Fill the hole with slurry or concrete.
V.	Clay, Sands, Sandy Clay, Silty Clay, Clayey Silt	5'-0"	30" DIA	Fill the hole with slurry or concrete.	4'-0"	24" DIA	Fill the hole with slurry or concrete.	4'-0"	24" DIA	Fill the hole with slurry or concrete.

[a/] Uniform Building Code, 1991.
[b/] H = Depth of footing.
[c/] D = Diameter of round footing or the side dimension of square footing.

1.0 Installation

1.1 Table SL 455–1 (Sheet 2) shows the various pole lengths, mast arms, and SAP numbers for the Direct Buried Fiberglass Light Pole.

1.2 The pole should be set to a depth 18 inches below the center of the inspection cover. See Figure SL 455–1.1 (Sheet 1) and Figure SL 455–1.2 (Sheet 1).

1.3 Consult the local governmental agency for pole loading requirements for the area then determine the soil type, diameter and depth of the pole hole, and backfill requirements. Using Detail "A" (Sheet 1) and Table SL 455–2 (Sheet 3), Table SL 455–3 (Sheet 4), Table SL 455–4 (Sheet 5), or Table SL 455–5 (Sheet 6). Dig or auger the hole.

1.4 Remove protective wrap from pole. Carefully cut wrap along zip string beginning at the top for several inches or until only a double layer of wrap is reached. Place one foot firmly on pole approximately 2–3 feet down from the top and give the zip string a hard upward pull. Repeat until base of pole is reached. Should wrap tend to bunch up, cut wrap down to the pole surface, taking care not to cut or scratch pole surface.

1.5 While pole is easily accessible, install fixture(s) and wire between luminaire and inspection hole. Tape or plug unused holes in the base to prevent backfill from entering the pole. Mast arm bolts should be installed with lock washers. Tighten bolts until the lock washer is collapsed only. Do not over-tighten or egg shape the pole as damage to the pole may result.

1.6 Check hole depth and tamp in backfill if necessary to insure correct pole setting depth.

1.7 Lift and set pole in center of hole either by hand or with a nylon sling attached to a lifting device. The sling should be attached at a point from the top approximately one third of the overall length of the pole. As the pole is being lowered into the hole, the underground cable should be fed through the conductor entrance hole and up toward the inspection hole. (Pole grabbers may be wrapped with rags to protect the surface of the pole from marring.)

1.8 Two cable entrance holes are provided, however, if cabling requires an additional hole, a 2-inch maximum diameter hole may be drilled in the pole base.

1.9 For soil backfill:

A. Add 6 to 9 inches of backfill and plumb pole. Sight in line from a plumb bob to the pole at a 90-degree angle from a convenient distance, straighten pole and tamp backfill. Continue to backfill and thoroughly tamp at no more that 9-inch intervals to the bottom of the cable entrance. To ensure plumb, the pole should be checked with a plumb bob while the tamping procedure is underway.

For slurry or concrete backfill:

B. Slurry to be 150 PSI cement-flyash-sand mix per SCE Concrete Mix Design #15. See SL 455.2 (Sheet 9).

C. Concrete to be 2,500 PSI compressive strength at 28 days.

1.10 Light poles should be set with no rake. Poles using 6 foot mast arm should be set with 1/2 diameter of the pole top and poles with 8 foot mast arm should be set with 1 diameter of the pole top of rake.

1.11 If not performed previously, install underground cable and pull wires out of the inspection hole. Connect feed cable to the luminaire wires, insert into pole and install inspection hole cover. Finish backfilling and tamping to a point 2 inches above the final ground line. Constrained surface conditions require a 30" × 24" × 4" concrete apron around the pole at ground level.

1.12 Centerline of poles shall be 24 inches minimum from the face of curb except on state highways which shall be 30 inches. See Figure SL 455–1.3 (Sheet 1). For new and rebuilt streetlight systems, if space permits or at no additional cost or low cost minor work, maintain a minimum clearance of 36 inches for pedestrian right-of-way access. Avoid streetlight pole placement in wheelchair ramp locations.

Note: On a state highway, the streetlight centerline shall be 6 inches behind the sidewalk when the sidewalk is less than 7 feet wide.

1.13 Inspection covers are secured with tamper proof 1/4-inch screws (use one-way screwdriver SAP 10146314).

1.14 Secure pole numbers to pole using epoxy cement or self-tapping screws.

1.15 Pole weights will vary from 110 pounds to 140 pounds depending on length.

Scope SL 455.2 Slurry Mix Requirements for Direct Buried Fiberglass Light Poles

Slurry mix for backfill shall be as follows:

Description: SCE #15

Flowable “Controlled Low Density Fill” for nominal 150 psi

One Cubic Yard

Contents	Amount
Type II Cement	100 lb
Type “F” Flyash	100 lb
Total Cemetitious	200 lb
Concrete Sand (SSD)	2,681 lb
Vinsol Air Entrainment	4.0 fl. oz
Water Gallons	417 lb (50.0 gallons)
Water Maximum Gallons	424 lb (50.8 gallons)

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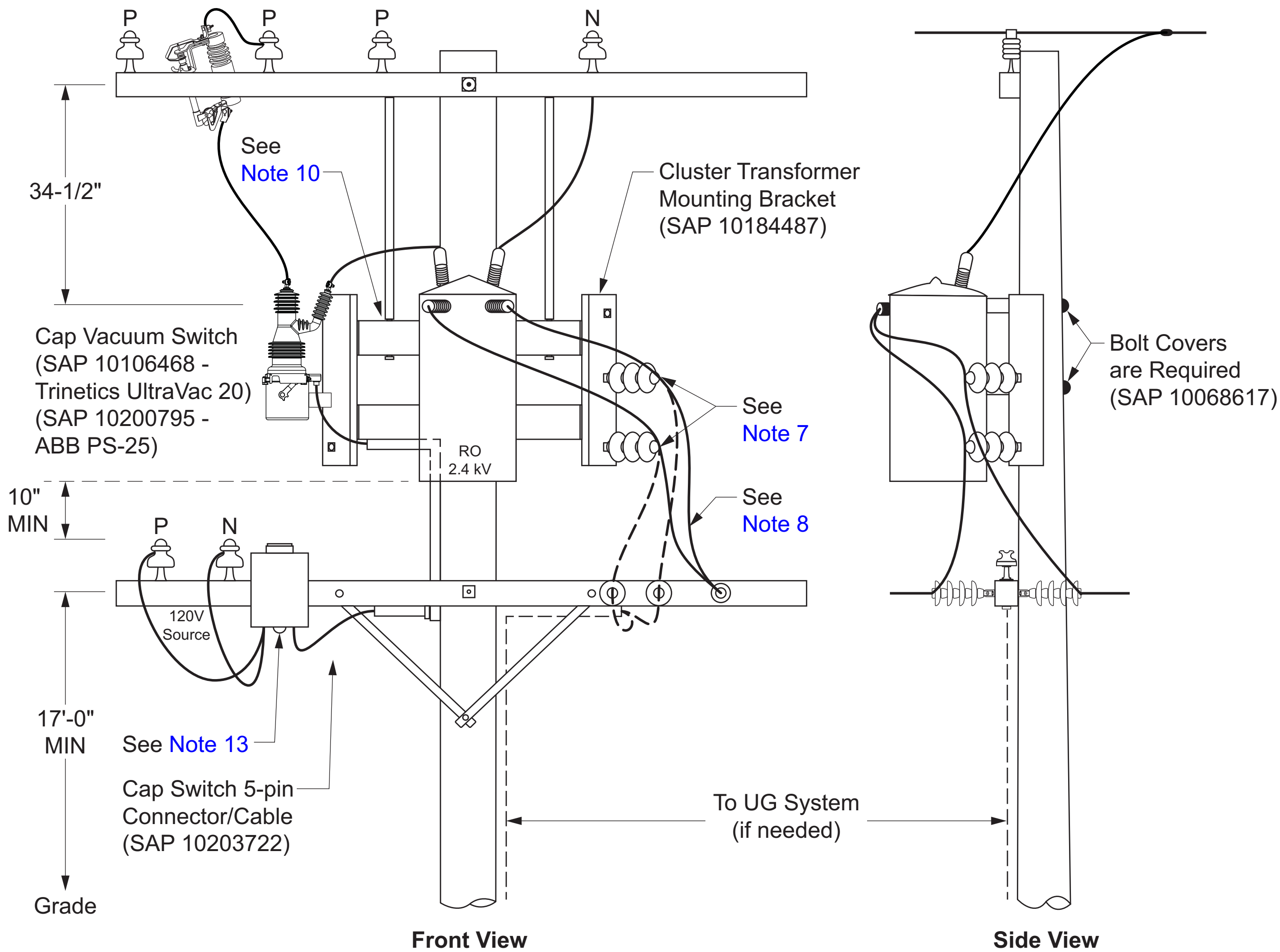
SL 500 6.6 "A" RO Transformer Installation — 2.4 kV

Scope SL 500.1 2.4 kV RO Transformer Installation — Pole Has Existing 120/240 V Control Power

Figure SL 500–1: 2.4 kV RO Installation — with Existing 120/240 V Control Power



Note(s):

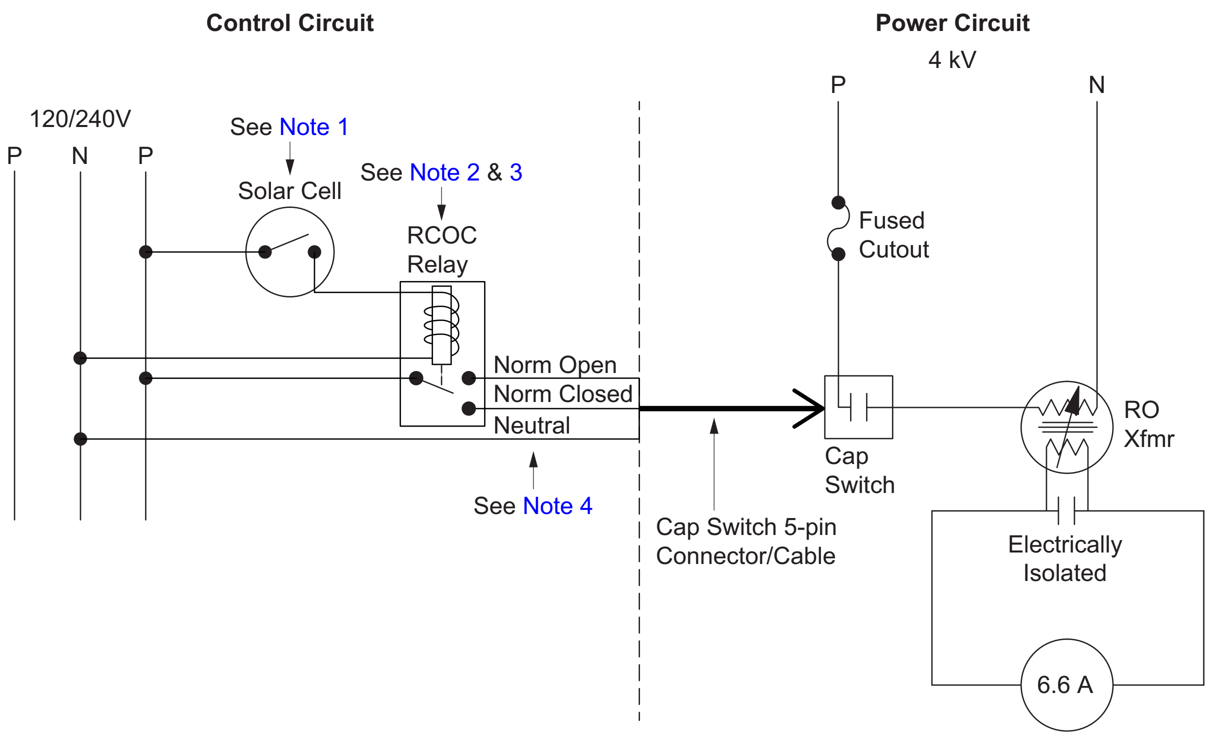
1. This construction standard is for replacement ONLY.
2. See PO 120 for HIGH VOLTAGE sign installation requirements; the 6.6 A circuit is High Voltage.
3. See DC 535 for Wildlife Protection coverage requirements.
4. Refer to DAP, AP 131 for 3-phase cluster bracket installation.
5. See PR 100 for fusing requirements. For RO transformers, "kW" = "kVA" to determine fuse link.
6. Fill open holes of the RCOC Relay box as necessary to keep out bugs and water (SAP 10154125).
7. Install polymer pin type insulators (SAP 10116334) to the cluster bracket with angle bases (SAP 10068619) and short shank steel pins (SAP 10068309). See Figure SL 500–2 for a mock-up photo.

8. If the 6.6 A circuit feeds an underground dip, install two polymer pin-type insulators on the face of the cross-arm to support the 6.6 A leads to the UG riser in lieu of dead-end insulators. Use #6 Keyrite (SAP 10110173).
9. This pole can be built as a mirrored reflection to accommodate existing construction as needed.
10. The vertical braces from the cluster bracket to the crossarm can be cutoff where existing line arms are supported by alternate bracing (V-brace or flat braces). Coat any exposed metal portion of the cut metal to protect from corrosion (SAP 10062945).
11. See Figure SL 500–4 for control and power circuit wiring diagram. See Figure SL 500–7 for internal RCOC wiring diagram.
12. If the existing location does not have 120/240 V power available, install a 25 kVA step-down transformer on an adjacent pole and string secondary conductor over. If this is not feasible (see Scope SL 500.2).
13. Fasten the unistrut (SAP 10073415) to the crossarm with a 1/2" × 6" bolt (SAP 10068944). Install the RCOC Relay (SAP 10118469) to the unistrut using (2) 3/8" × 1-1/2" Everdur Bolts (SAP 10070814) and unistrut nuts (SAP 10073652). Once the RCOC is in place, mount the Photocell (SAP 10118505) onto the RCOC Relay (see Figure SL 500–3).

Figure SL 500–2: Polymer Insulator Installation on Cluster Mounting Bracket

Figure SL 500–3: RCOC Relay Installation on Unistrut

Figure SL 500–4: Wiring Diagram for 6.6 "A" RO with Existing 120/240 V Control Power — 2.4 kV



Note(s):

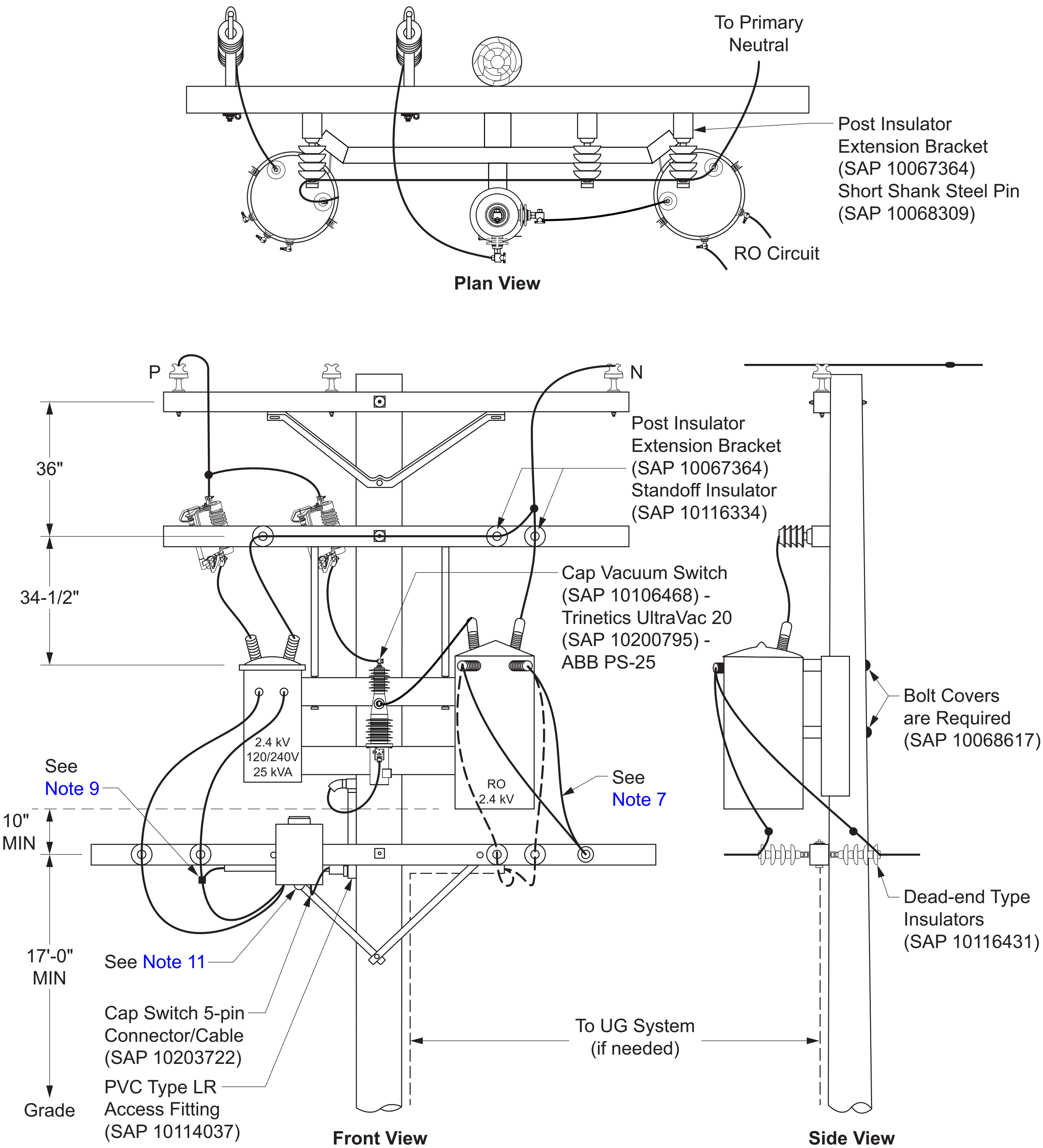
1. Solar cell is normally open during daylight hours and normally closed during evening hours.
2. RCOC load contact is in the normally closed position when the coil is de-energized.
3. Internal wiring diagram of the RCOC relay is shown in Figure SL 500–7.

4. Based on the internal wiring of the RCOC relay, the N/O contact sends the “close” signal and the N/C contact sends the “open” signal to the capacitor switch. Therefore, wire the 5-pin connector as follows:

RCOC Relay	5-pin Connector Wire	Pin
N/O Contact:	Red “close” cable	“B”
N/C Contact:	Black “trip” cable	“C”
Source Neutral:	White “common” neutral	“D”

Scope SL 500.2 **2.4 kV RO Transformer Installation — Pole Requires Dedicated 120/240 V Control Power**

Figure SL 500–5: 2.4 kV RO Installation — with Dedicated 120/240 V Control Power

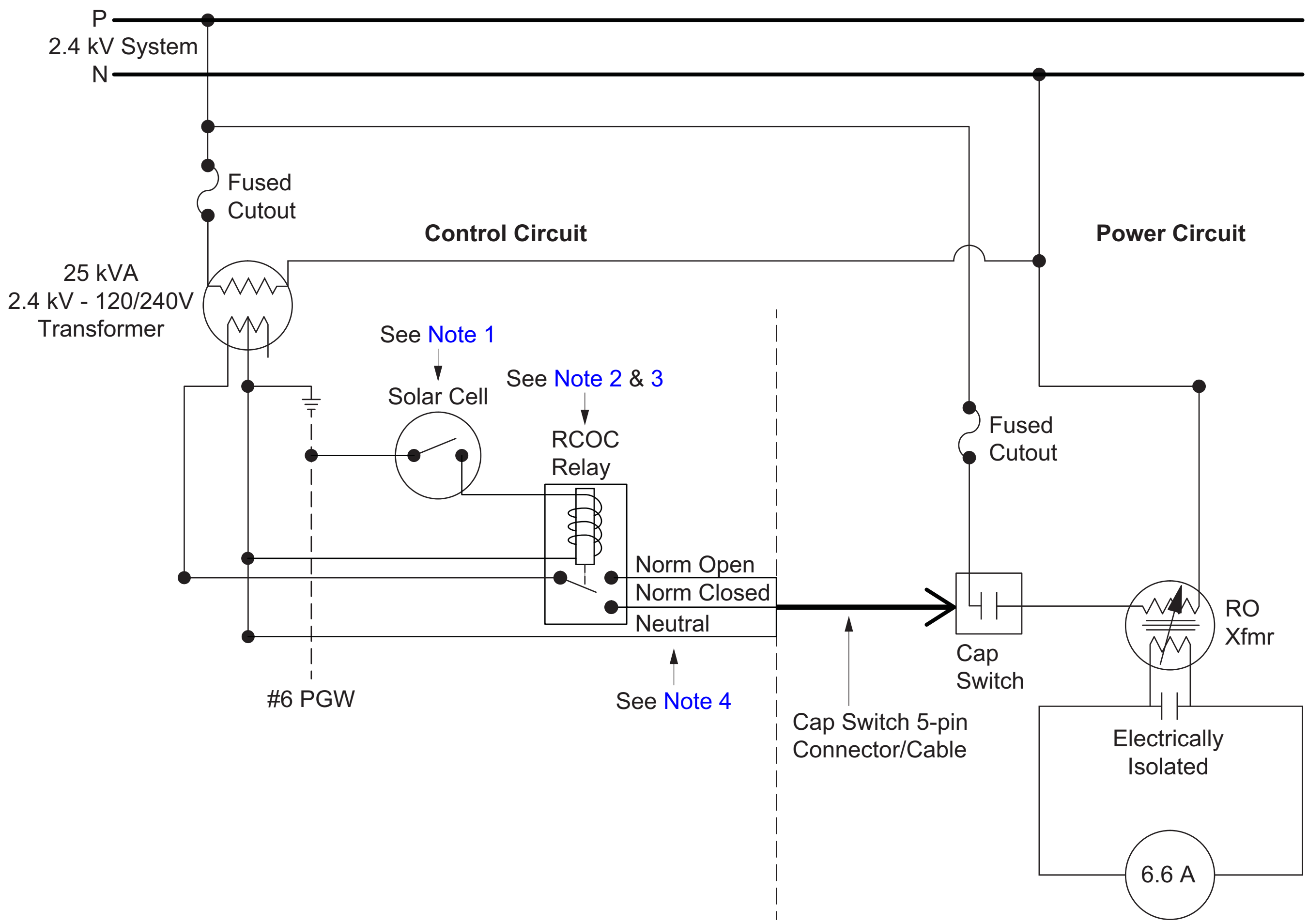


What's Changed? Updated RCOC relay mounting to one crossarm.

Note(s):

1. This construction standard is for replacement ONLY.
2. See PO 120 for HIGH VOLTAGE sign installation requirements; the 6.6 A circuit is High Voltage.
3. See DC 535 for Wildlife Protection coverage requirements.
4. Refer to DAP, AP 131 for 3-Phase cluster bracket installation.
5. See PR 100 for fusing requirements. For RO transformers, “kW” = “kVA” to determine fuse link.
6. Fill open holes of the RCOC Relay box as necessary to keep out bugs and water (SAP 10154125).
7. If the 6.6 A circuit feeds an underground dip, install two polymer pin-type insulators on the face of the cross-arm to support the 6.6 A leads to the UG riser in lieu of dead-end insulators. Use #6 Keyrite (SAP 10110173).
8. This pole can be built as a mirrored reflection to accommodate existing construction as needed.
9. Run #6 PGW under the cross-arm and connect to the secondary 120/240 V neutral.
10. See Figure SL 500–6 for control and power circuit wiring diagram. See Figure SL 500–7 for internal RCOC wiring diagram.
11. Fasten the unistrut (SAP 10073415) to the crossarm with a 1/2" × 6" bolt (SAP 10068944). Install the RCOC Relay (SAP 10118469) to the unistrut using (2) 3/8" × 1-1/2" Everdur Bolts (SAP 10070814) and unistrut nuts (SAP 10073652). Once the RCOC is in place, mount the Photocell (SAP 10118505) onto the RCOC Relay (see Figure SL 500–3).

Figure SL 500–6: Wiring Diagram for 6.6 “A” RO with Dedicated Transformer to Supply 120/240 V Control Power — 2.4 kV

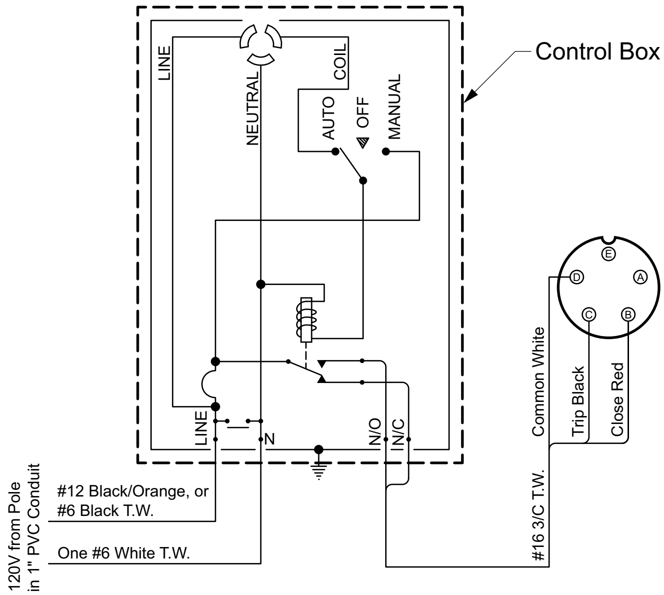


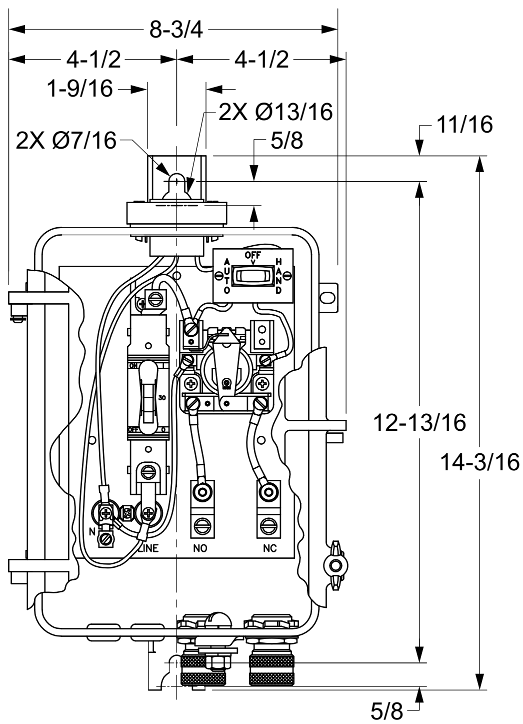
Note(s):

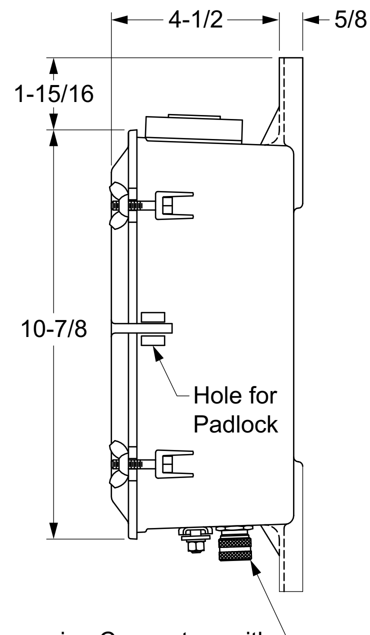
1. Solar cell is normally open during daylight hours and normally closed during evening hours.
2. RCOC load contact is in the normally closed position when the coil is de-energized.
3. Internal wiring diagram of the RCOC relay is shown in Figure SL 500–7.
4. Based on the internal wiring of the RCOC relay, the N/O contact sends the “close” signal and the N/C contact sends the “open” signal to the capacitor switch. Therefore, wire the 5-pin connector as follows:

RCOC Relay	5-pin Connector Wire	Pin
N/O Contact:	Red “close” cable	“B”
N/C Contact:	Black “trip” cable	“C”
Source Neutral:	White “common” neutral	“D”

Figure SL 500–7: Internal Wiring Diagram for RCOC Relay





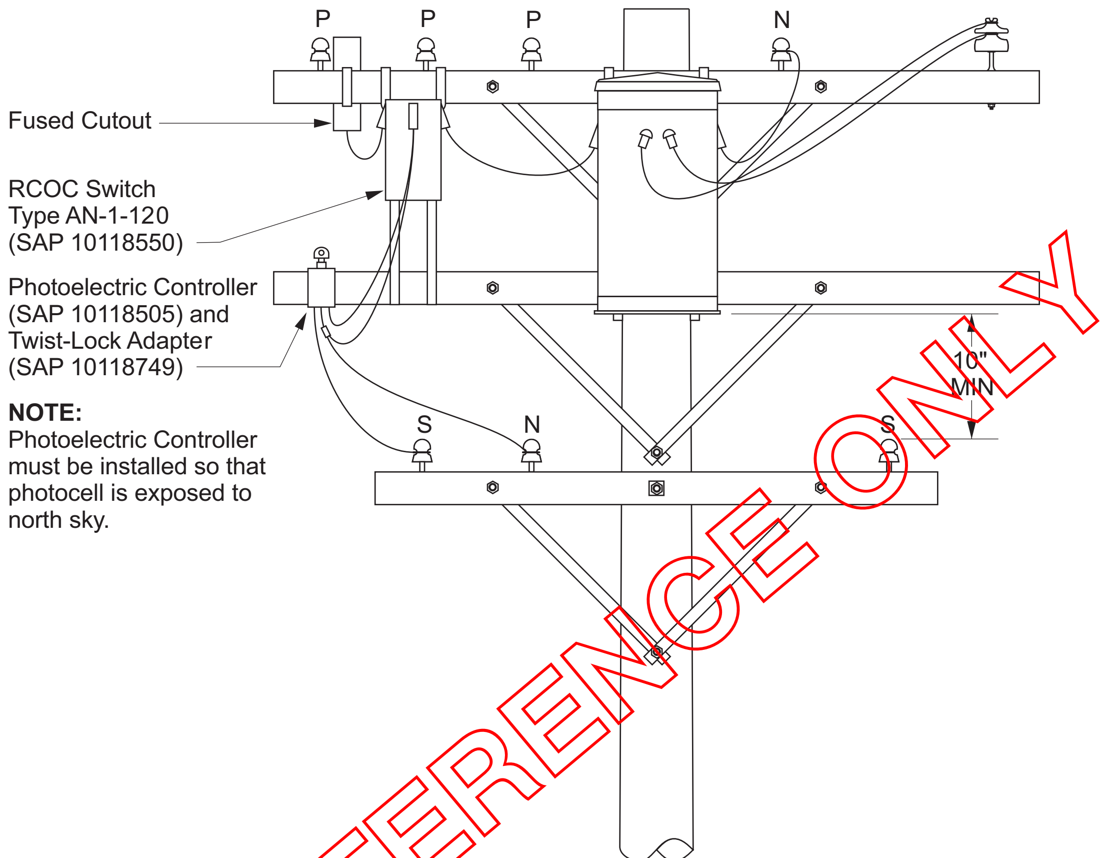


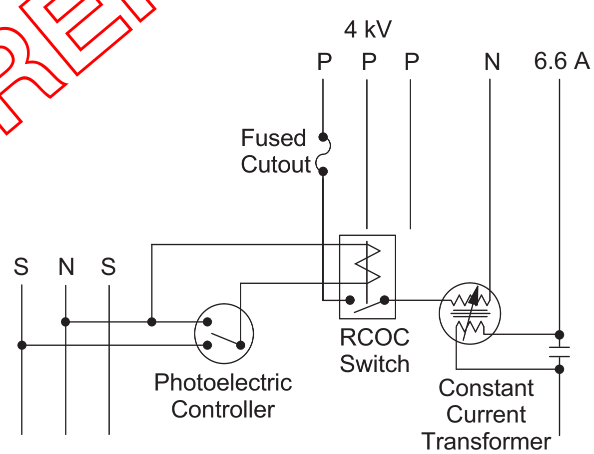
Control Terminals Will Accept #6 Thru #14 AWG Wire
Line/Load Terminals Will Accept #4 Thru #1/0 AWG Wire

(2) Compression Connectors with Neoprene Bushings for .375–.500 OD Cables and (2) Grommets 5/16 MAX Cable OD

Scope SL 500.3 6.6 A RO Transformer Installation — 2.4 kV

Figure SL 500–8: 6.6 A RO Transformer Installation — 2.4 kV





Wiring Diagram

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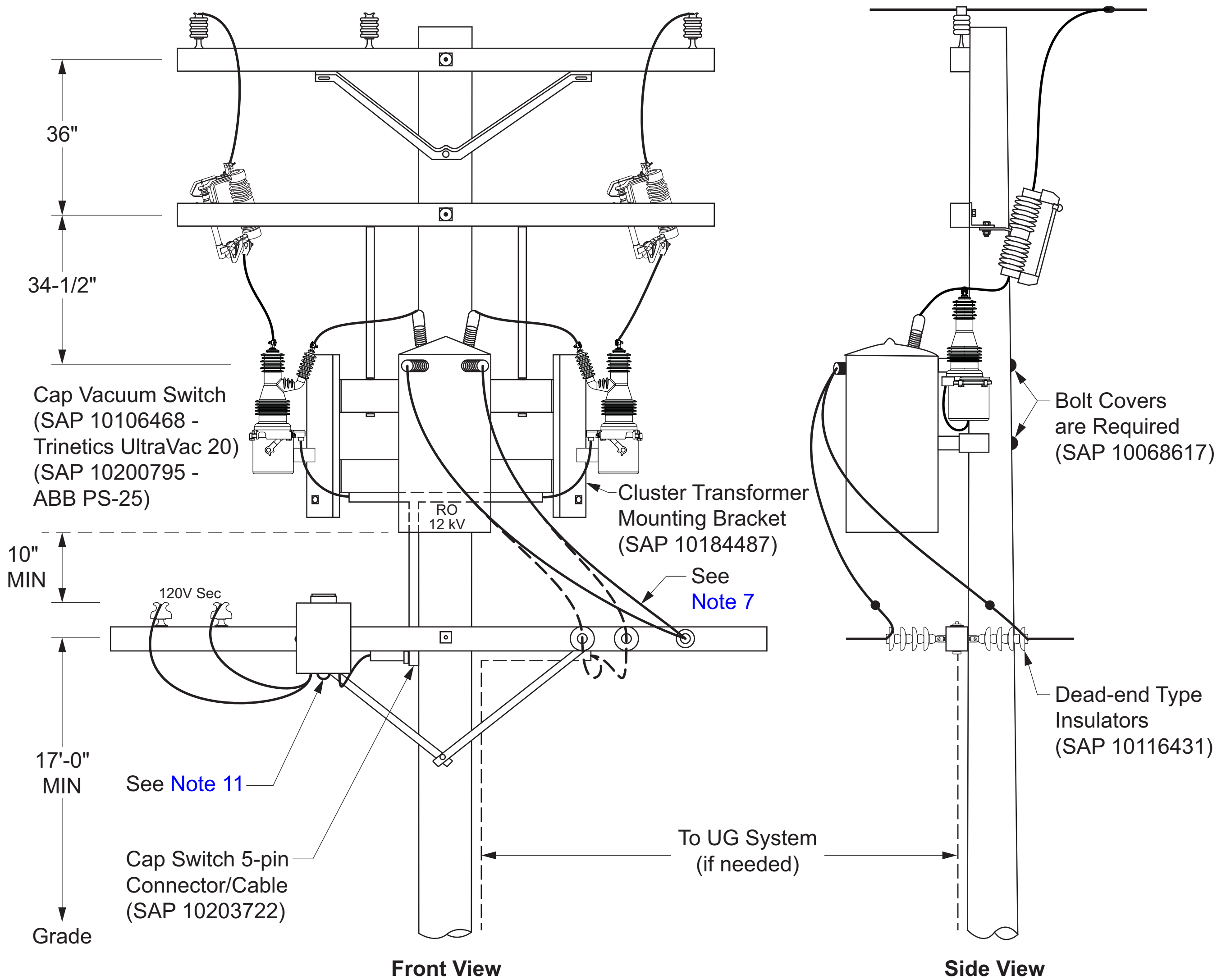
SL 505 6.6 "A" RO Transformer Installation — 12 kV

Scope SL 505.1 12 kV RO Transformer Installation — Pole has Existing 120/240 V Control Power

Figure SL 505–1: 12 kV RO Installation — with Existing 120/240 V Control Power



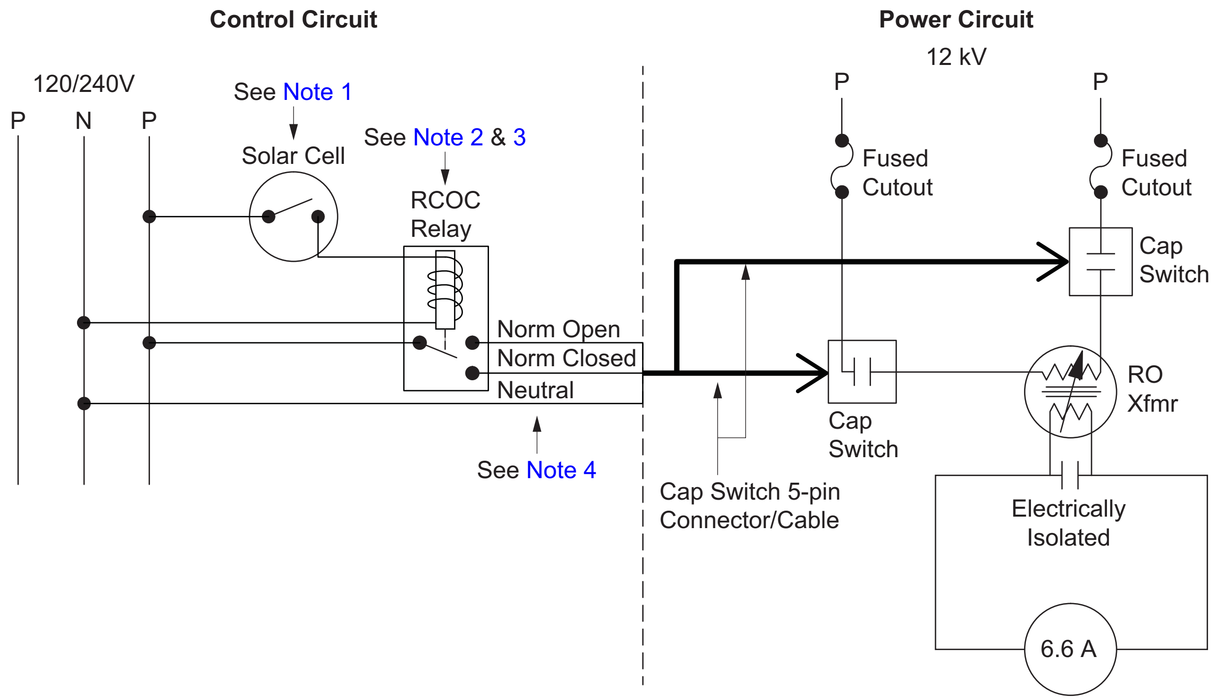
Note(s):

1. This construction standard is for replacement ONLY.
2. See PO 120 for HIGH VOLTAGE sign installation requirements; the 6.6 A circuit is High Voltage.
3. See DC 535 for Wildlife Protection coverage requirements.
4. Refer to DAP, AP 131 for 3-phase cluster bracket installation.
5. See PR 100 for fusing requirements. For RO transformers, "kW" = "kVA" to determine fuse link.
6. Fill open holes of the RCOC Relay box as necessary to keep out bugs and water (SAP 10154125).

7. If the 6.6 A circuit feeds an underground dip, install two polymer pin-type insulators on the face of the cross-arm to support the 6.6 A leads to the UG riser in lieu of dead-end insulators. Use #6 Keyrite (SAP 10110173).
8. This pole can be built as a mirrored reflection to accommodate existing construction as needed.
9. See Figure SL 505–3 for control and power circuit wiring diagram. See Figure SL 505–6 for internal RCOC wiring diagram.
10. If the existing location does not have 120/240 V power available, install a 25 kVA step-down transformer on an adjacent pole and string secondary conductor over. If this is not feasible, see Scope SL 505.2.
11. Fasten the unistrut (SAP 10073415) to the crossarm with a 1/2" × 6" bolt (SAP 10068944). Install the RCOC Relay (SAP 10118469) to the unistrut using (2) 3/8" × 1-1/2" Everdur Bolts (SAP 10070814) and unistrut nuts (SAP 10073652). Once the RCOC is in place, mount the Photocell (SAP 10118505) onto the RCOC Relay (see Figure SL 505–2).

Figure SL 505–2: RCOC Relay Installation on Unistrut

Figure SL 505–3: Wiring Diagram for 6.6 "A" RO Transformer with Existing 120/240 V Control Power — 12 kV



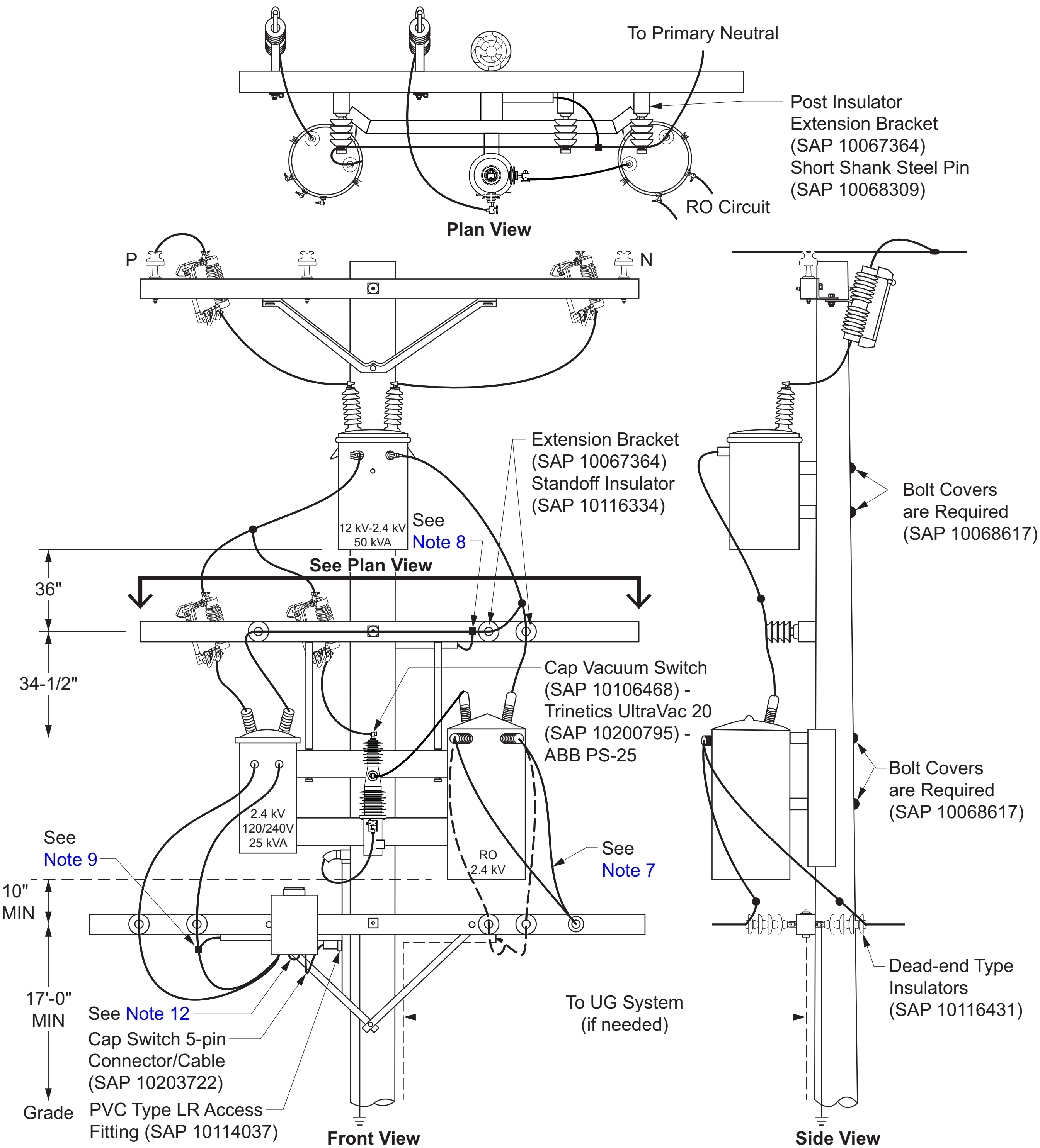
Note(s):

1. Solar cell is normally open during daylight hours and normally closed during evening hours.
2. RCOC load contact is in the normally closed position when the coil is de-energized.
3. Internal wiring diagram of the RCOC relay is shown in Figure SL 505–6.
4. Based on the internal wiring of the RCOC relay, the N/O contact sends the "close" signal and the N/C contact sends the "open" signal to the capacitor switch. Therefore, wire the 5-pin connector as follows:

RCOC Relay	5-pin Connector Wire	Pin
N/O Contact:	Red "close" cable	"B"
N/C Contact:	Black "trip" cable	"C"
Source Neutral:	White "common" neutral	"D"

Scope SL 505.2 **12 kV RO Transformer Installation — Pole Requires Dedicated 120/240 V Control Power**

Figure SL 505–4: 12 kV RO Installation — with Dedicated 120/240 V Control Power



6.6 "A" RO Transformer Installation — 12 kV

Approved by:

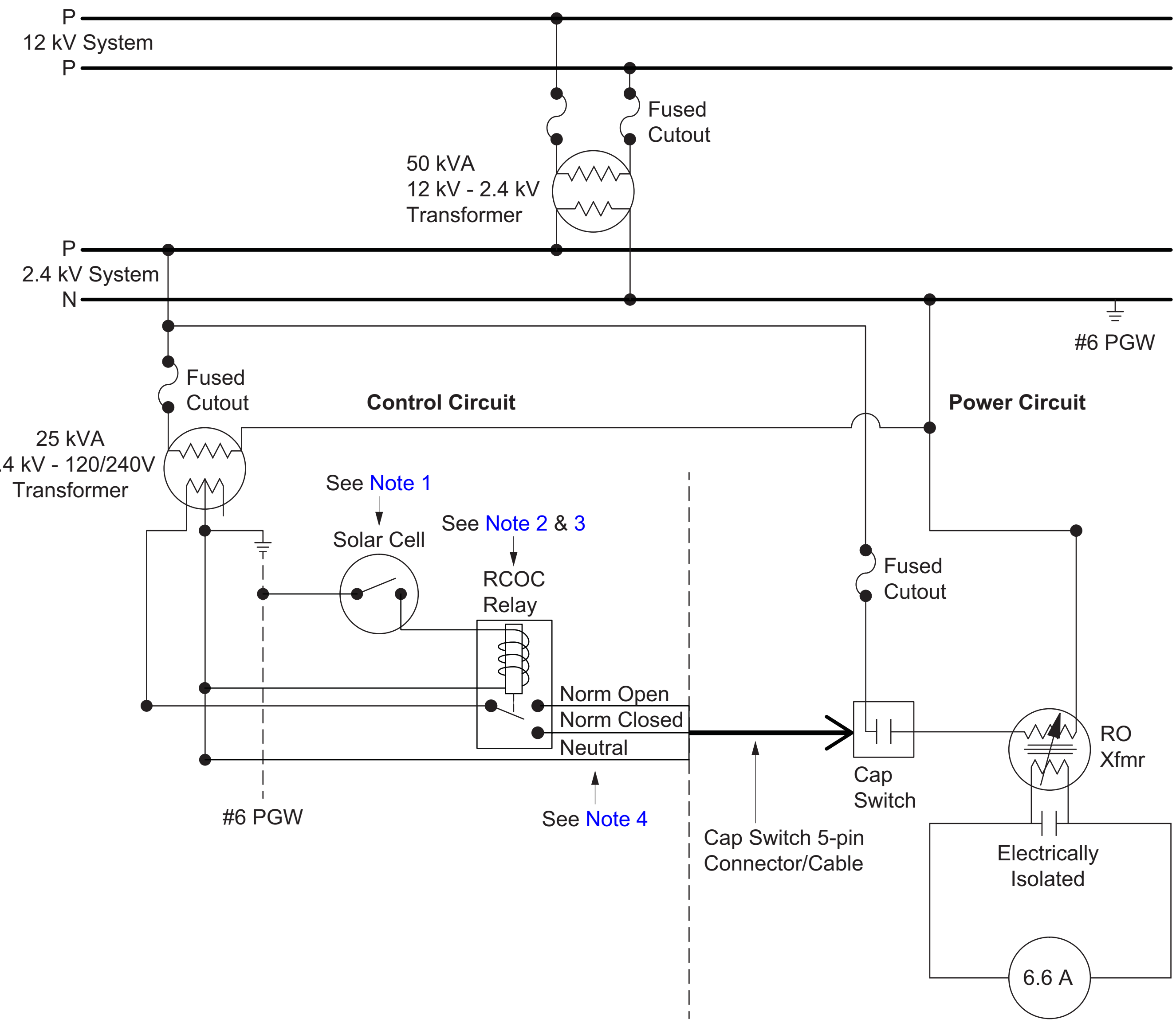
What's Changed? Updated RCOC relay mounting to one crossarm.

Effective Date:
07-29-2016

Note(s):

1. This construction standard is for replacement ONLY.
2. See PO 120 for HIGH VOLTAGE sign installation requirements; the 6.6 A circuit is High Voltage.
3. See DC 535 for Wildlife Protection coverage requirements.
4. Refer to DAP, AP 131 for 3-phase cluster bracket installation.
5. See PR 100 for fusing requirements. For RO transformers, “kW” = “kVA” to determine fuse link.
6. Fill open holes of the RCOC Relay box as necessary to keep out bugs and water (SAP 10154125).
7. If the 6.6 A circuit feeds an underground dip, install two polymer pin-type insulators on the face of the cross-arm to support the 6.6 A leads to the UG riser in lieu of dead-end insulators. Use #6 Keyrite (SAP 10110173).
8. Run #6 PGW under the cross-arm and connect to the primary 2.4 kV neutral.
9. Run #6 PGW under the cross-arm and connect to the secondary 120/240 V neutral.
10. This pole can be built as a mirrored reflection to accommodate existing construction as needed.
11. See Figure SL 505–5 for control and power circuit wiring diagram. See Figure SL 505–6 for internal RCOC wiring diagram.
12. Fasten the unistrut (SAP 10073415) to the crossarm with a 1/2" × 6" bolt (SAP 10068944). Install the RCOC Relay (SAP 10118469) to the unistrut using (2) 3/8" × 1-1/2" Everdur Bolts (SAP 10070814) and unistrut nuts (SAP 10073652). Once the RCOC is in place, mount the Photocell (SAP 10118505) onto the RCOC Relay (see Figure SL 505–2).

Figure SL 505–5: Wiring Diagram for 6.6 "A" RO Transformer with Dedicated 120/240 V Control Power — 12 kV

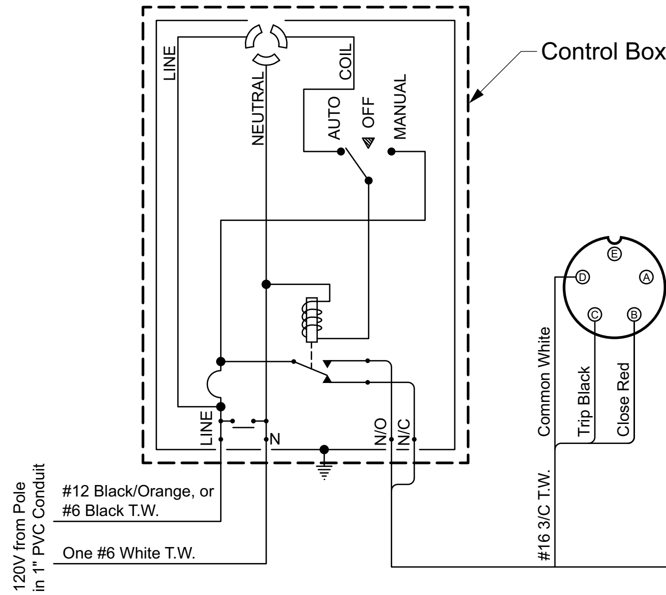


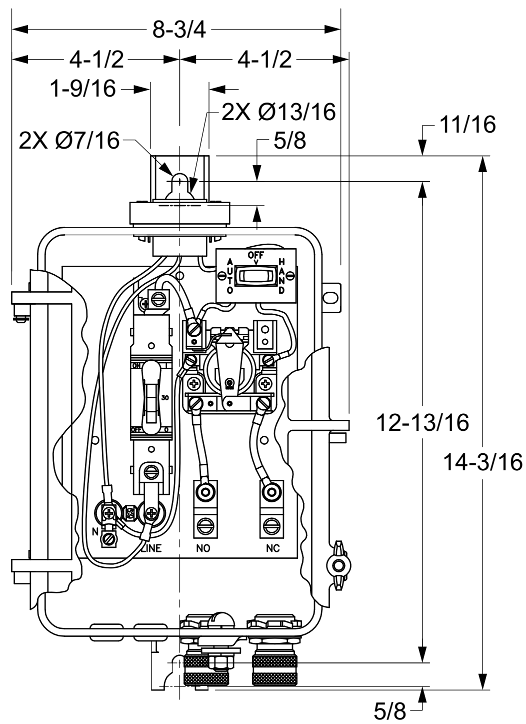
Note(s):

1. Solar cell is normally open during daylight hours and normally closed during evening hours.
2. RCOC load contact is in the normally closed position when the coil is de-energized.
3. Internal wiring diagram of the RCOC relay is shown in Figure SL 505–6.
4. Based on the internal wiring of the RCOC relay, the N/O contact sends the "close" signal and the N/C contact sends the "open" signal to the capacitor switch. Therefore, wire the 5-pin connector as follows:

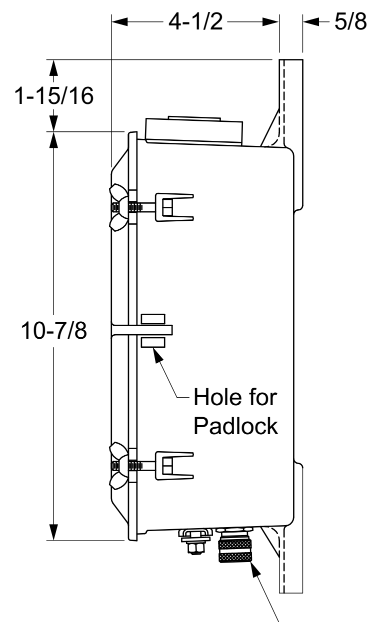
RCOC Relay	5-pin Connector Wire	Pin
N/O Contact:	Red "close" cable	"B"
N/C Contact:	Black "trip" cable	"C"
Source Neutral:	White "common" neutral	"D"

Figure SL 505–6: Internal Wiring Diagram for RCOC Relay





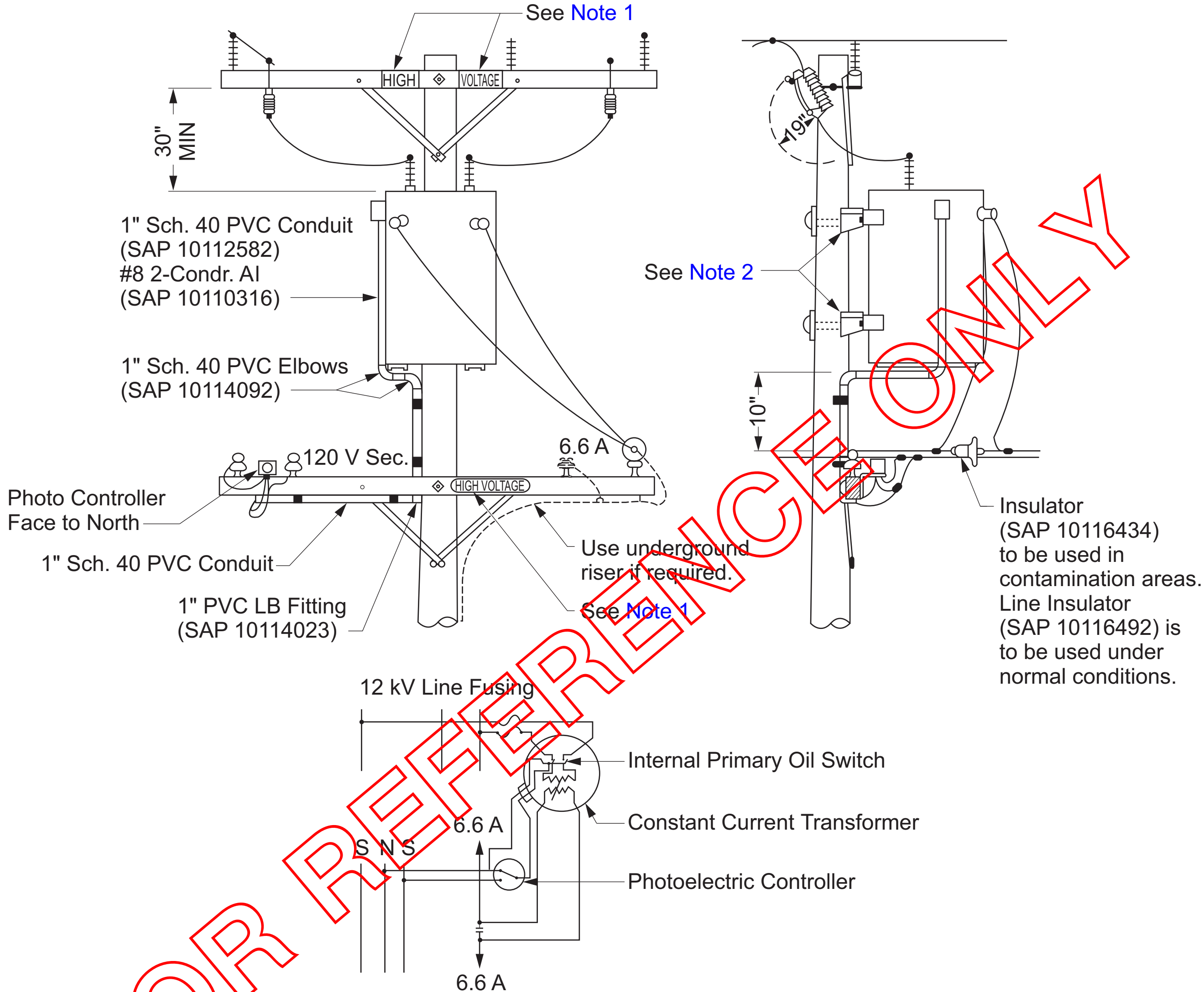
Control Terminals Will Accept #6 Thru #14 AWG Wire
Line/Load Terminals Will Accept #4 Thru #1/0 AWG Wire



(2) Compression Connectors with Neoprene Bushings for .375–.500 OD Cables and (2) Grommets 5/16 MAX Cable OD

Scope SL 505.3 Polemounted RO Transformer

Figure SL 505–7: Polemounted RO Transformer



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Transformer adapter plate (See Table SL 505–1 [Sheet 9]).

Table SL 505–1: Polemounted RO Transformer

Pole Diameter at Point of Transformer Attachment		Transformer Adapter Plate SAP
Transformer Weight (lb)	**MIN DIA[a/]**	
1,000–1,399	9"	10068341
1,400–1,799	10-1/2"	10068342
1,800–2,200	12"	

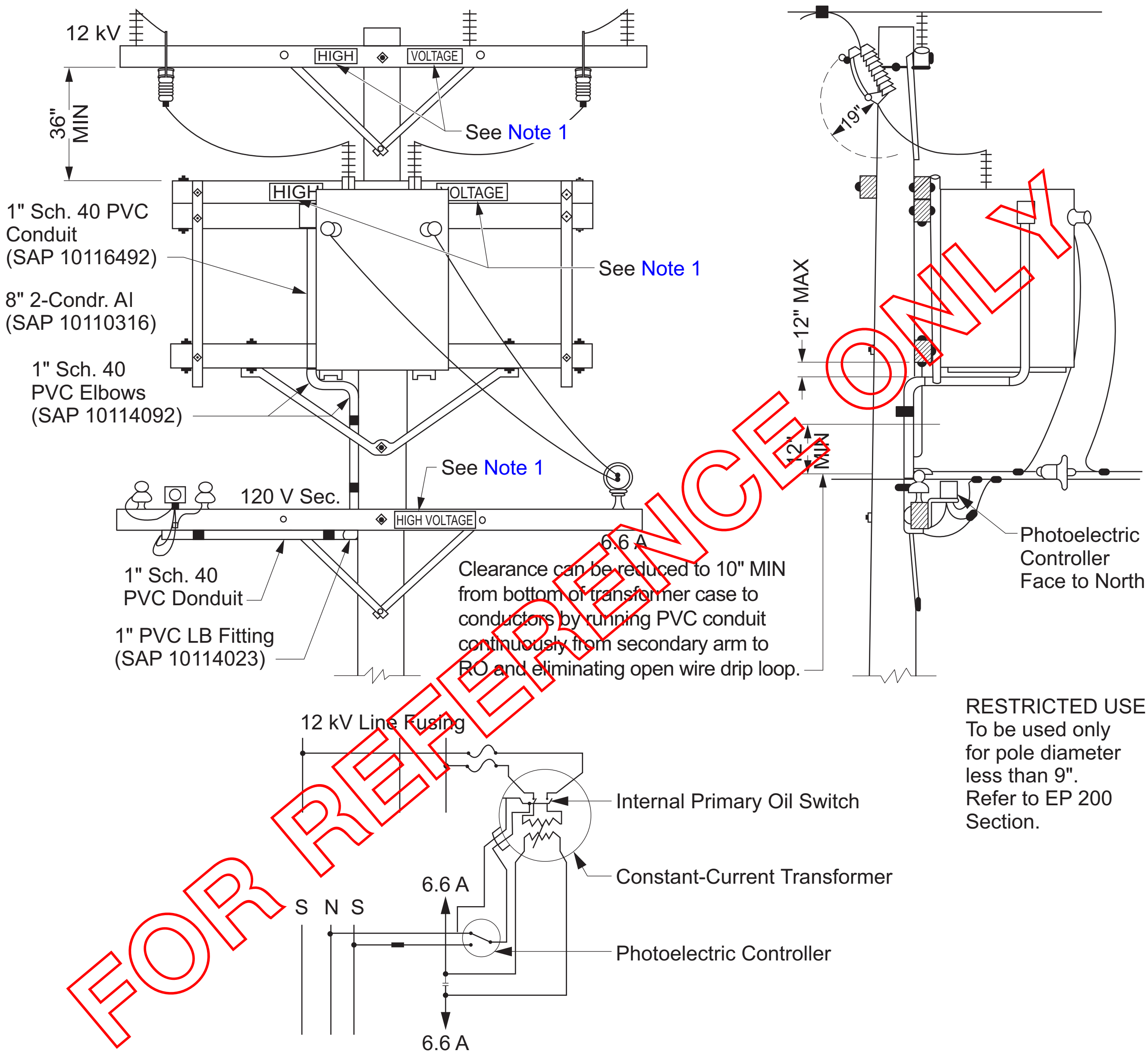
[a/] For smaller diameter poles construct per SL 505.4 (Sheet 10).

Note(s):

1. Refer to Distribution Apparatus Construction Standards (DAP) for RO transformer fuse ratings.
2. Refer to Distribution Apparatus Construction Standards (DAP) for lighting arrester application.

Scope SL 505.4 Crossarm Mounted RO Transformer

Figure SL 505–8: Crossarm Mounted RO Transformer



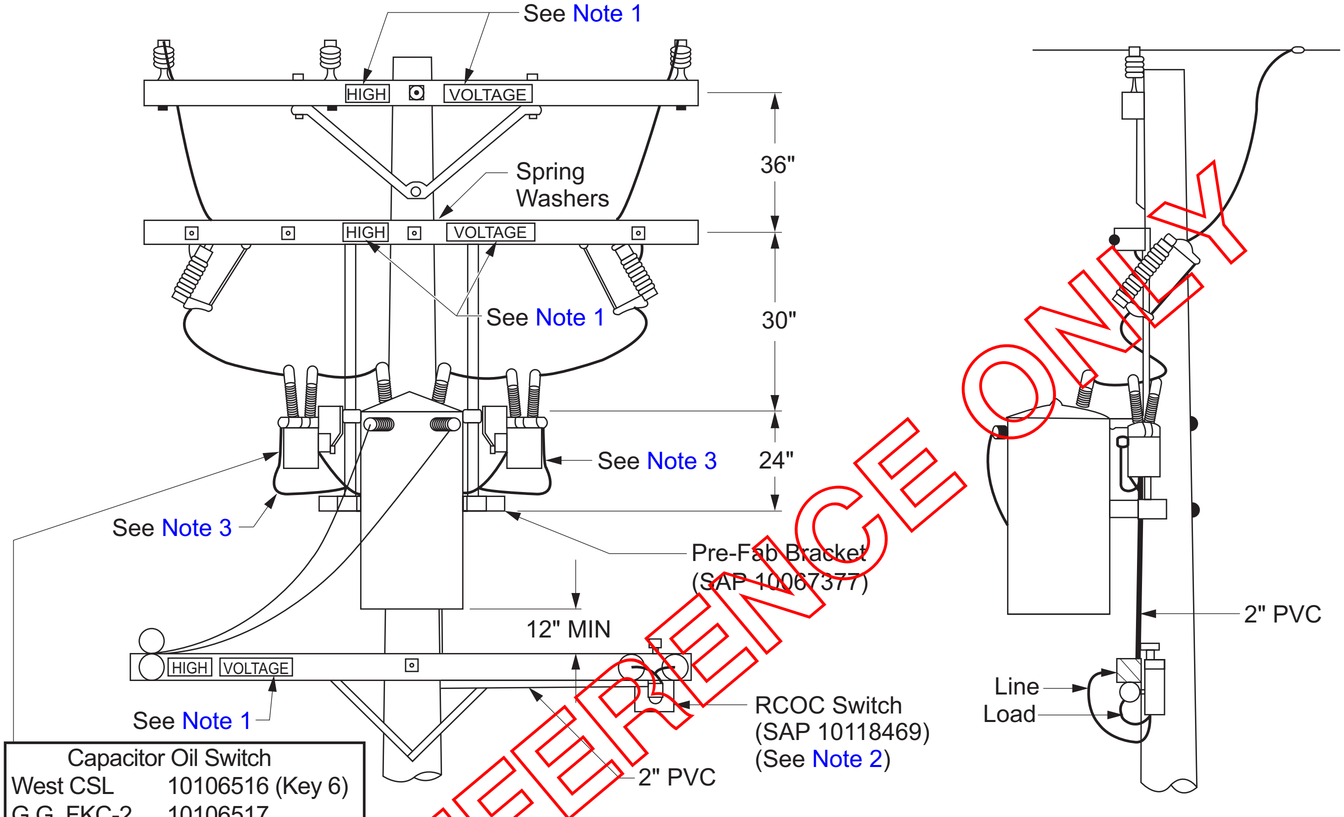
RESTRICTED USE
To be used only for pole diameter less than 9".
Refer to EP 200 Section.

Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Refer to Distribution Apparatus Construction Standards (DAP) for RO transformer fuse ratings.
3. Refer to Distribution Apparatus Construction Standards (DAP) for lighting arrester application.

Scope SL 505.5 Installation Procedures for 6.6 A RO Transformer with External Switches and RCOC Switch — 12 kV

Figure SL 505–9: 6.6 A RO Transformer with External Switches and RCOC Switch — 12 kV



Capacitor Oil Switch	
West CSL	10106516 (Key 6)
G.G. FKC-2	10106517
M.E. NR	10106518
West CSR	10106383

Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. RCOC Switch (Figure SL 505–9 [Sheet 11])
   Manufacturer — Trinetics
   Model #: MR/R-SO
   SAP 10118469
3. Two female Bendix or Cannon receptacles with 20-foot cords, available from apparatus crews, are needed to make connection from the RCOC switch output to the two CSL switches.
4. Maintain 18 inch minimum clearance from center of pole to transformer leads (except at approach to bushings). Bolt RCOC switch to crossarm.
5. Maintain minimum clearance of 1-1/2 inches between hardware.
6. For bonding see GR Section.
7. Refer to DAP, AP 106 for minimum pole diameter and maximum transformer weights. (Single transformer 2,200 lb maximum.)
8. Refer to Distribution Apparatus Construction Standards (DAP) for surge arrester applications. See PR Section for fusing applications.

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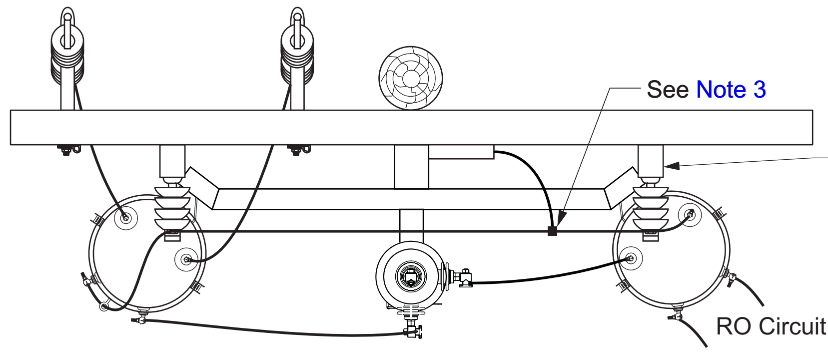
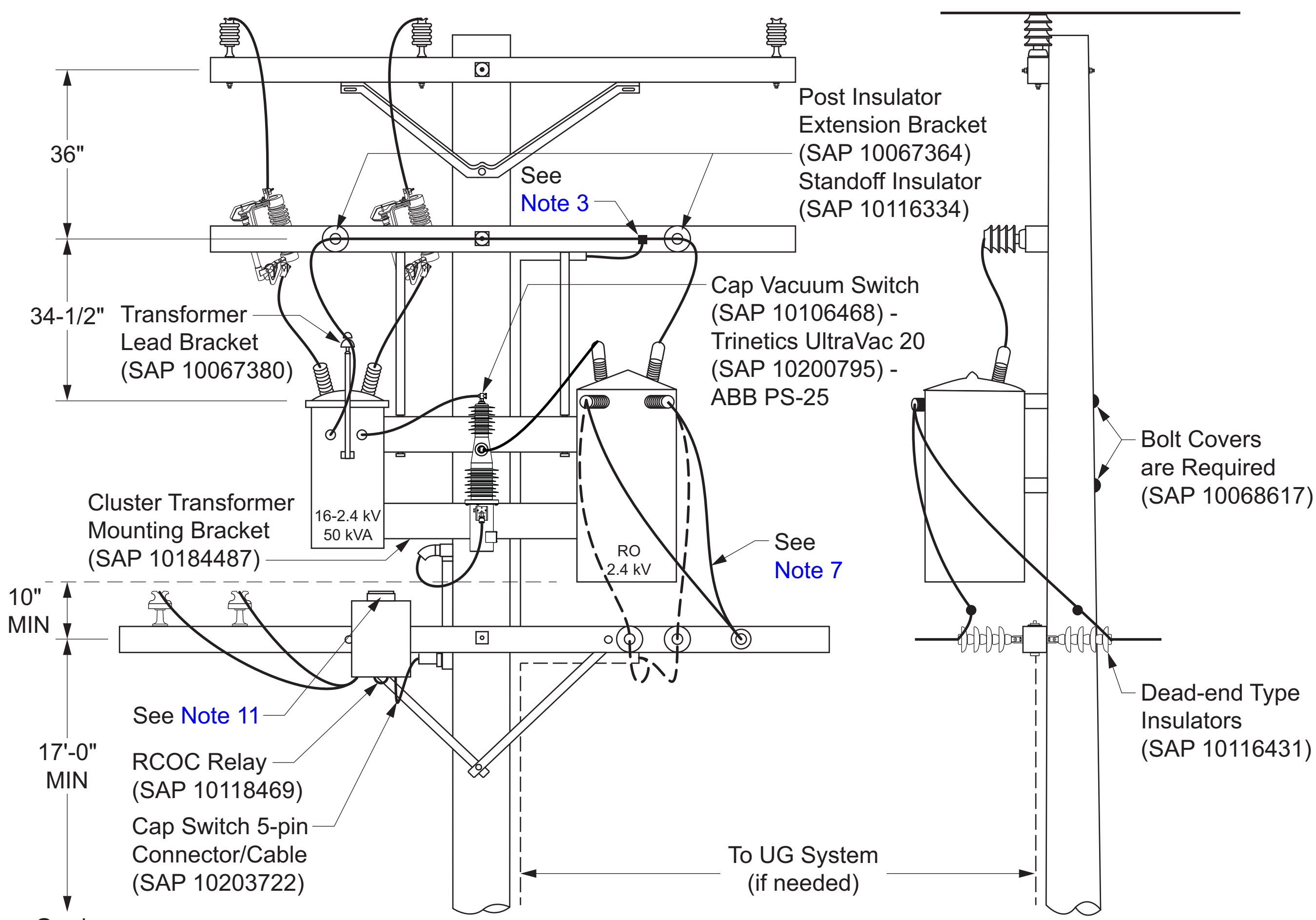
SL 510 6.6 "A" RO Transformer Installation — 16 kV

Scope SL 510.1 16 kV RO Transformer Installation — Pole has Existing 120/240 V Control Power

Figure SL 510–1: 16 kV RO Installation — with Existing 120/240 V Control Power



Plan View



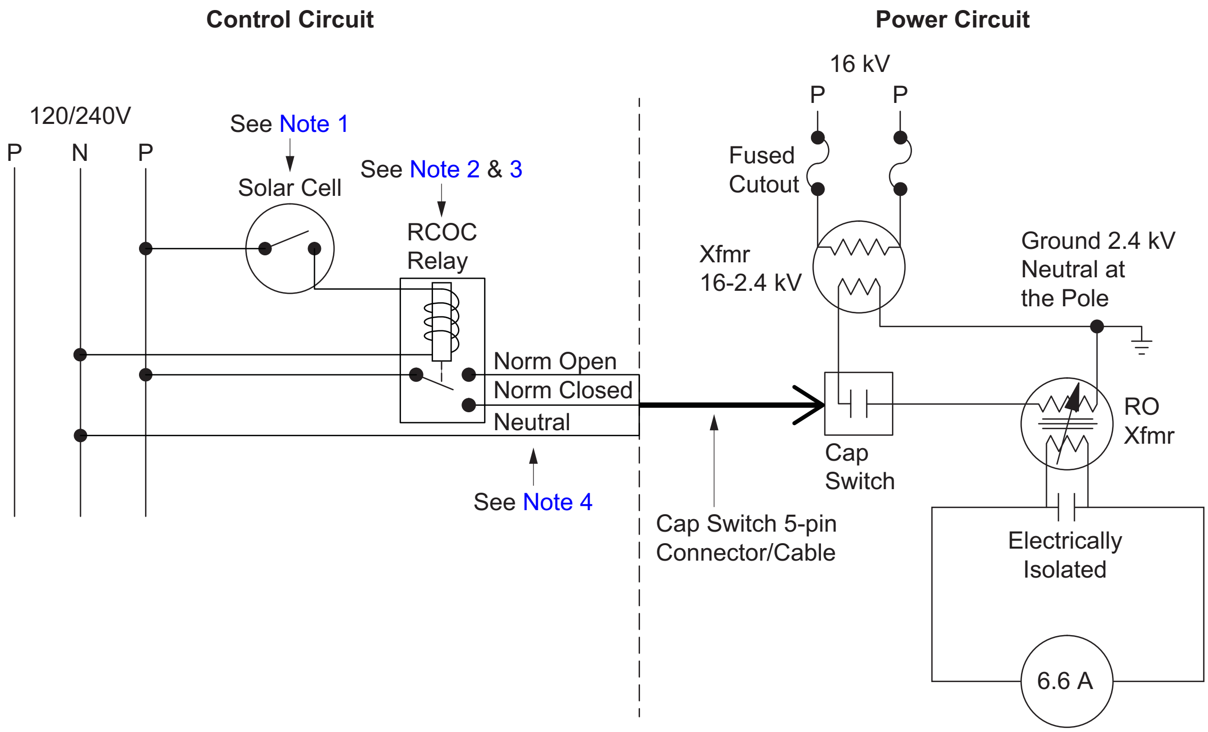
Front View **Side View**

Note(s):

1. This construction standard is for replacement ONLY.
2. See PO 120 for HIGH VOLTAGE sign installation requirements; the 6.6 A circuit is High Voltage.
3. See DC 535 for Wildlife Protection coverage requirements.
4. Refer to DAP, AP 131 for 3-phase cluster bracket installation.
5. See PR 100 for fusing requirements. For RO transformers, “kW” = “kVA” to determine fuse link.
6. Fill open holes of the RCOC Relay box as necessary to keep out bugs and water (SAP 10154125).
7. If the 6.6 A circuit feeds an underground dip, install two polymer pin-type insulators on the face of the cross-arm to support the 6.6 A leads to the UG riser in lieu of dead-end insulators. Use #6 Keyrite (SAP 10110173).
8. This pole can be built as a mirrored reflection to accommodate existing construction as needed.
9. See Figure SL 510–3 for control and power circuit wiring diagram. See Figure SL 510–6 for internal RCOC wiring diagram.
10. If the existing location does not have 120/240 V power available, install a 25 kVA step-down transformer on an adjacent pole and string secondary conductor over. If this is not feasible (see Scope SL 510.2).
11. Fasten the unistrut (SAP 10073415) to the crossarm with a 1/2" × 6" bolt (SAP 10068944). Install the RCOC Relay (SAP 10118469) to the unistrut using (2) 3/8" × 1-1/2" Everdur Bolts (SAP 10070814) and unistrut nuts (SAP 10073652). Once the RCOC is in place, mount the Photocell (SAP 10118505) onto the RCOC Relay (see Figure SL 510–2).

Figure SL 510–2: RCOC Relay Installation on Unistrut

Figure SL 510–3: Wiring Diagram for RO Transformer with Existing 120/240 V Control Power — 16 kV



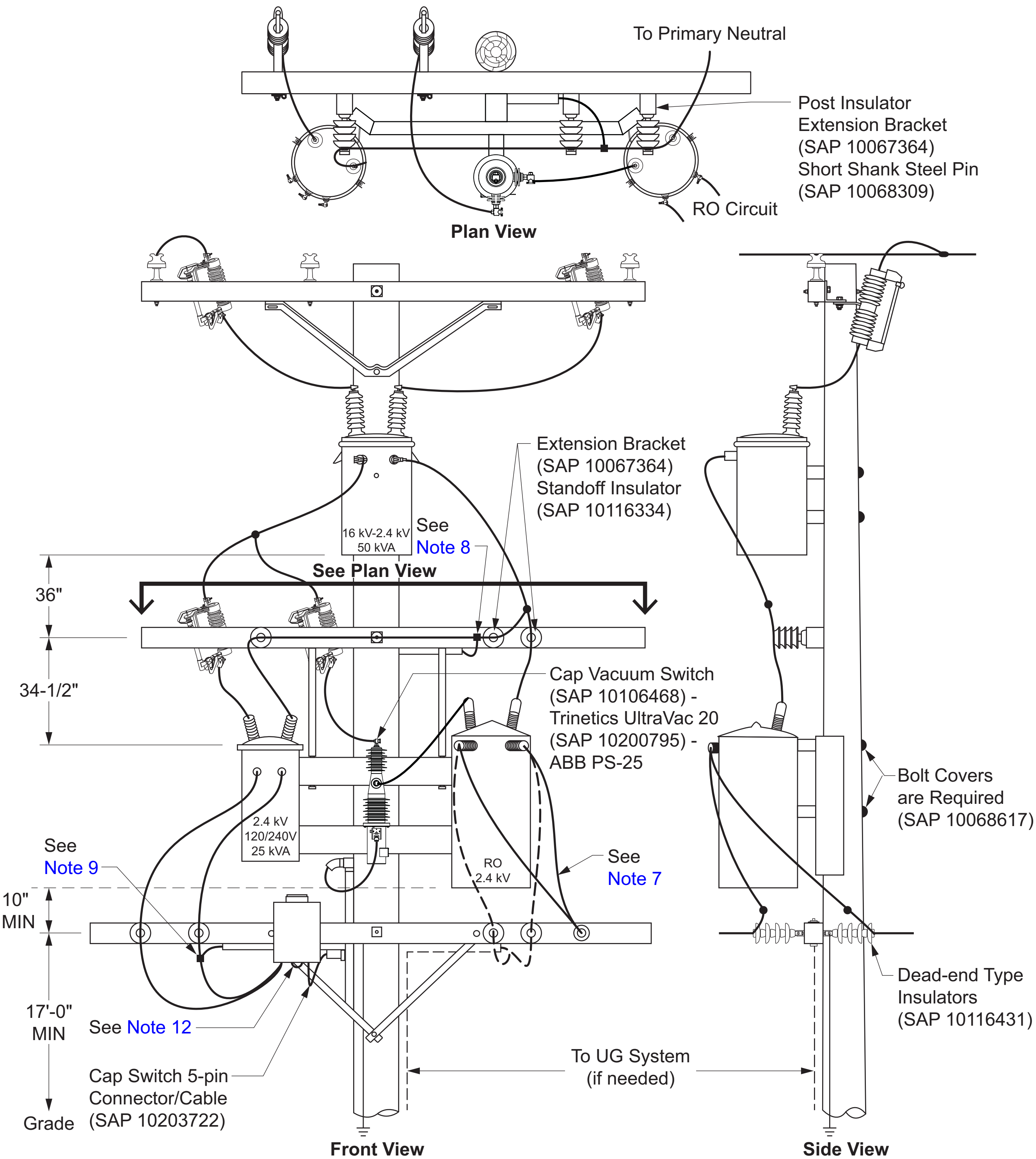
Note(s):

1. Solar cell is normally open during daylight hours and normally closed during evening hours.
2. RCOC load contact is normally open when the coil is de-energized.
3. For internal wiring diagram of the RCOC Relay (see Figure SL 510–6).
4. Based on the internal wiring of the RCOC relay, the N/O contact sends the "close" signal and the N/C contact sends the "open" signal to the capacitor switch. Therefore, wire the 5-pin connector as follows:

RCOC Relay	5-Pin Connector Wire	Pin
N/O Contact:	Red "close" cable	"B"
N/C Contact:	Black "open" cable	"C"
Source Neutral:	White "common" neutral	"D"

Scope SL 510.2 16 kV RO Transformer Installation — Pole Requires Dedicated 120/240 V Control Power

Figure SL 510–4: 16 kV RO Installation — with Dedicated 120/240 V Control Power



6.6 "A" RO Transformer Installation — 16 kV

Approved by:

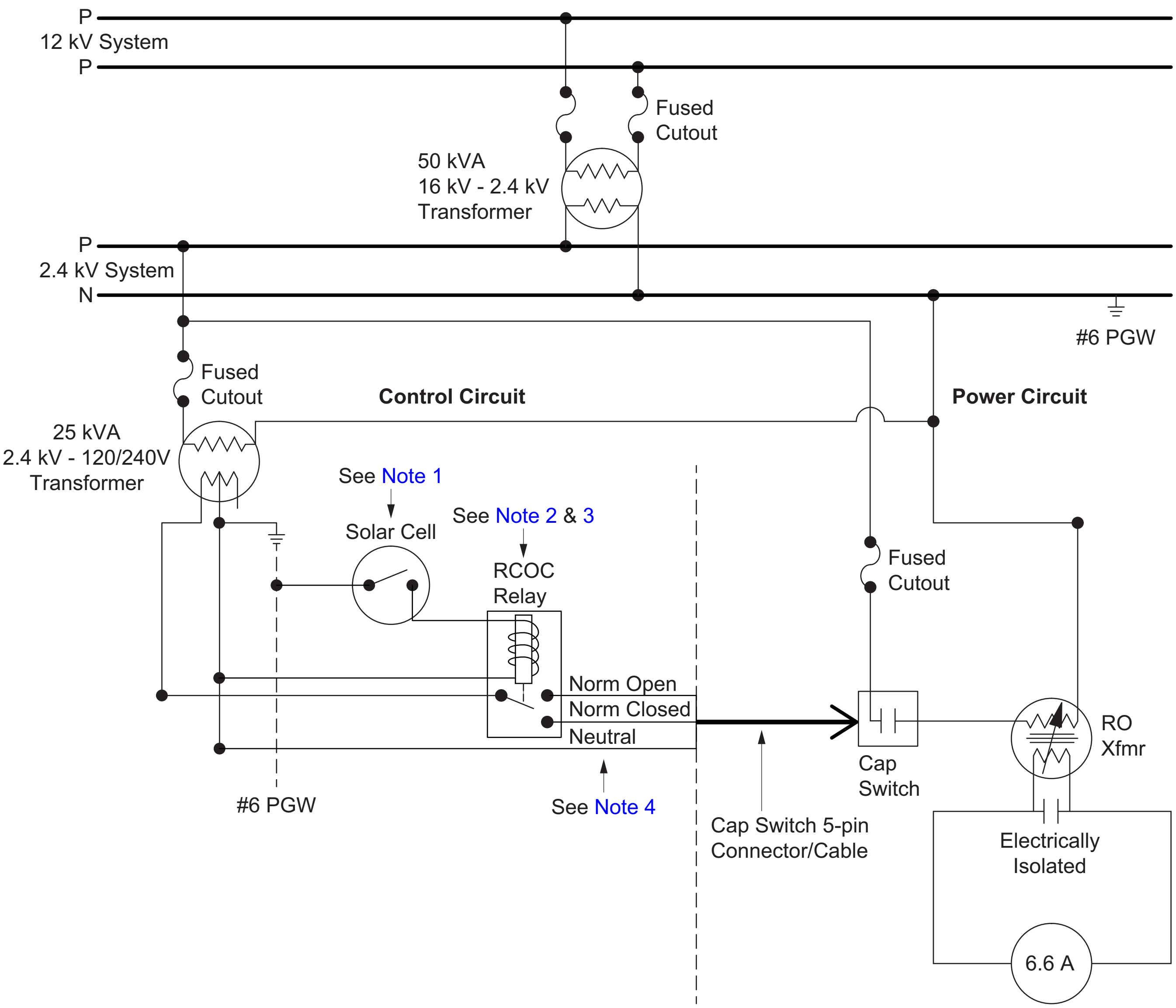
What's Changed? Updated RCOC relay mounting to one crossarm.

Effective Date:
07-29-2016

Note(s):

1. This construction standard is for replacement ONLY.
2. See PO 120 for HIGH VOLTAGE sign installation requirements; the 6.6 A circuit is High Voltage.
3. See DC 535 for Avian Protection coverage requirements.
4. Refer to DAP, AP 131 for 3-phase cluster bracket installation.
5. See PR 100 for fusing requirements. For RO transformers, “kW” = “kVA” to determine fuse link.
6. Fill open holes of the RCOC Relay box as necessary to keep out bugs and water (SAP 10154125).
7. If the 6.6 A circuit feeds an underground dip, install two polymer pin-type insulators on the face of the cross-arm to support the 6.6 A leads to the UG riser in lieu of dead-end insulators. Use #6 Keyrite (SAP 10110173).
8. Run #6 PGW under the cross-arm and connect to the primary 2.4 kV neutral.
9. Run #6 PGW under the cross-arm and connect to the secondary 120/240 V neutral.
10. This pole can be built as a mirrored reflection to accommodate existing construction as needed.
11. See Figure SL 510–5 for control and power circuit wiring diagram. See Figure SL 510–6 for internal RCOC wiring diagram.
12. Fasten the unistrut (SAP 10073415) to the crossarm with a 1/2" × 6" bolt (SAP 10068944). Install the RCOC Relay (SAP 10118469) to the unistrut using (2) 3/8" × 1-1/2" Everdur Bolts (SAP 10070814) and unistrut nuts (SAP 10073652). Once the RCOC is in place, mount the Photocell (SAP 10118505) onto the RCOC Relay (see Figure SL 510–2).

Figure SL 510–5: Wiring Diagram for 6.6 "A" RO Transformer with Dedicated 120/240 V Control Power — 16 kV

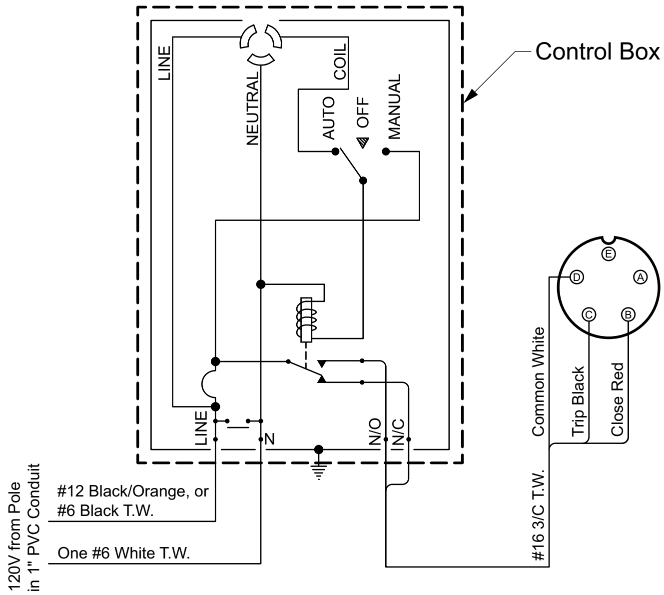


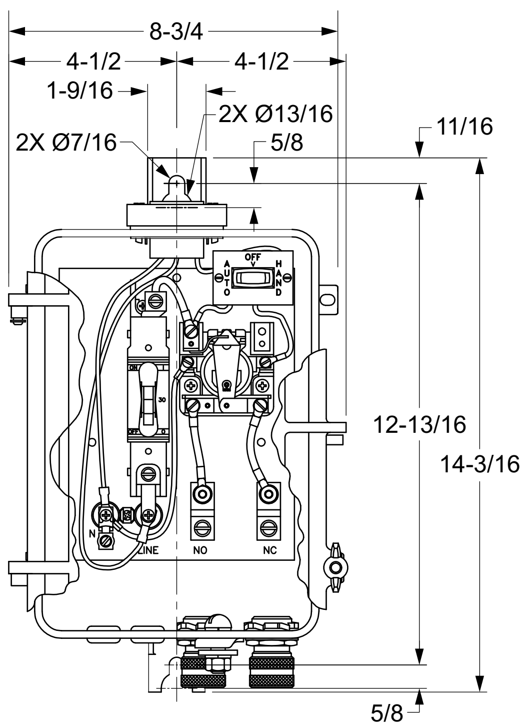
Note(s):

1. Solar cell is normally open during daylight hours and normally closed during evening hours.
2. RCOC load contact is in the normally closed position when the coil is de-energized.
3. Internal wiring diagram of the RCOC relay is shown in Figure SL 510–7.
4. Based on the internal wiring of the RCOC relay, the N/O contact sends the "close" signal and the N/C contact sends the "open" signal to the capacitor switch. Therefore, wire the 5-pin connector as follows:

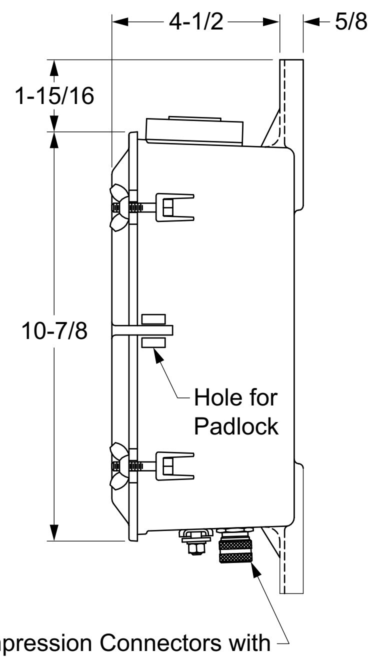
RCOC Relay	5-pin Connector Wire	Pin
N/O Contact:	Red "close" cable	"A"
N/C Contact:	Black "trip" cable	"B"
Source Neutral:	White "common" neutral	"C"

Figure SL 510–6: Internal Wiring Diagram for RCOC Relay





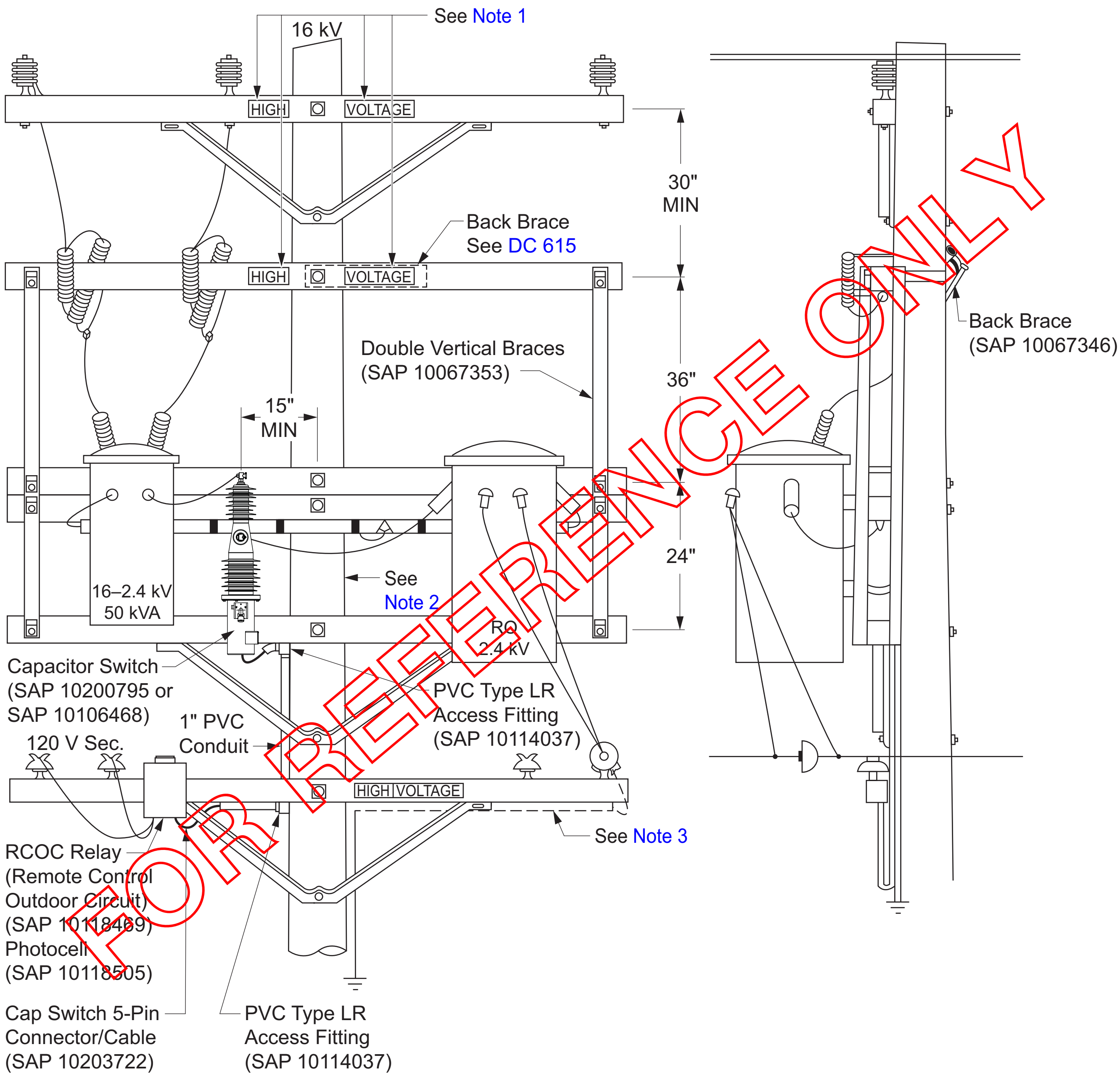
Control Terminals Will Accept #6 Thru #14 AWG Wire
Line/Load Terminals Will Accept #4 Thru #1/0 AWG Wire



(2) Compression Connectors with
Neoprene Bushings for .375–.500 OD Cables
and (2) Grommets 5/16 MAX Cable OD

Scope SL 510.3 6.6 A RO Transformer — 16 kV–2.4 kV

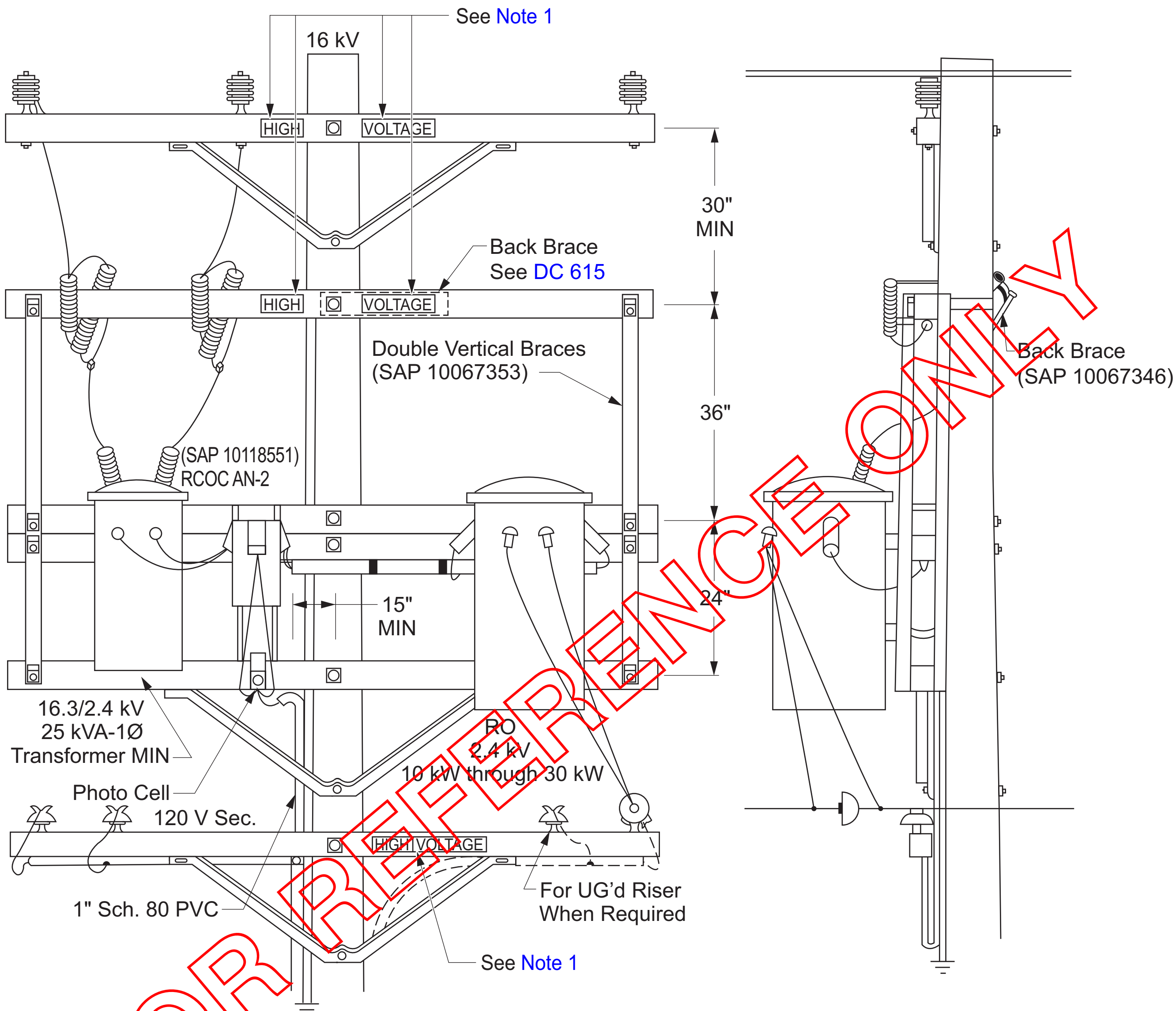
Figure SL 510–7: 6.6 A RO Transformer — 16 kV–2.4 kV



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. #6 PGW (Protected Ground Wire) from the pole ground to the 2.4 kV neutral.
3. PVC conduit riser to underground the RO (Regulated Output) circuit (if necessary).

Figure SL 510–8: 6.6 A RO Transformer — 16 kV–2.4 kV (Using RCOC Switch)



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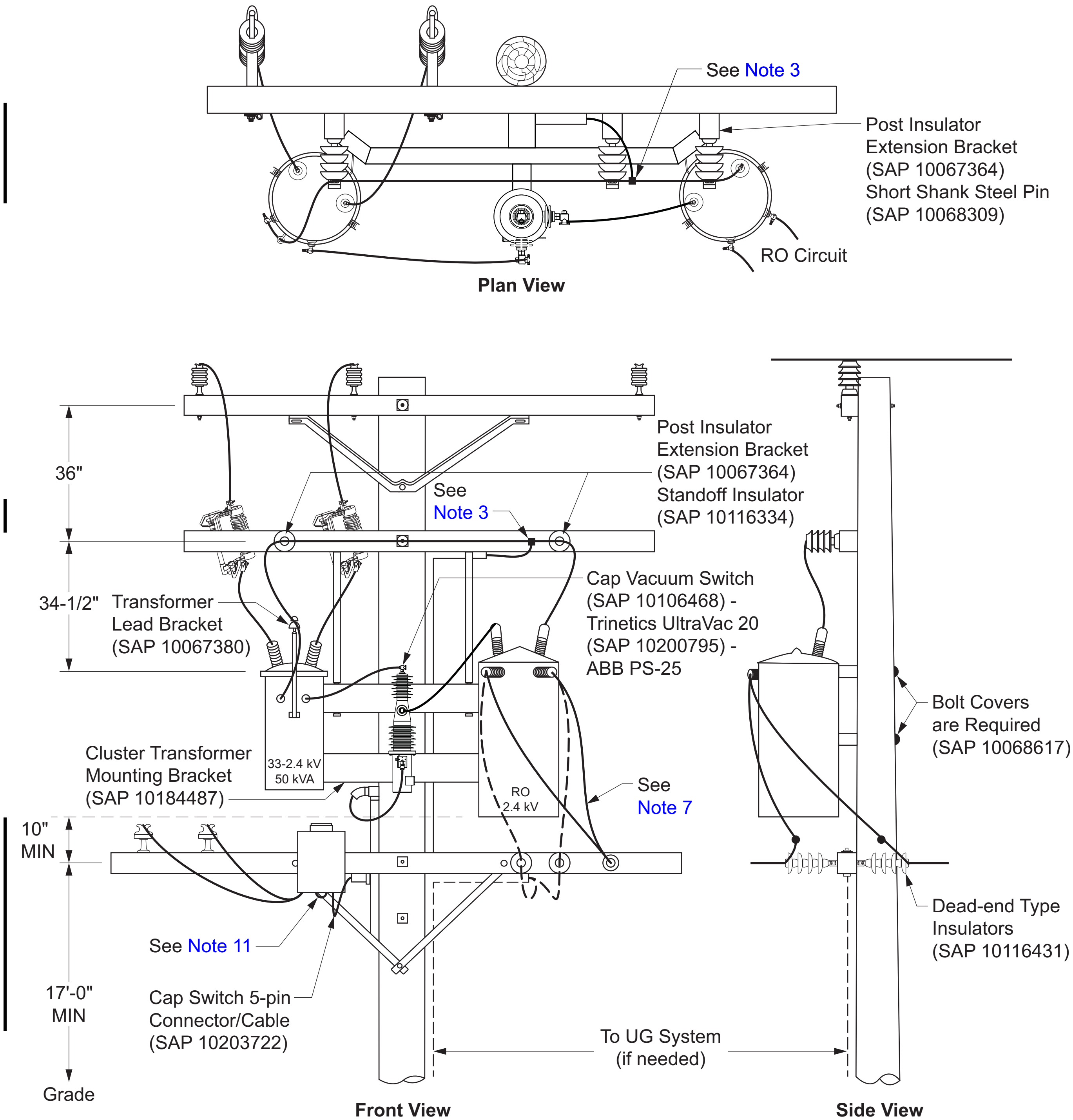
SL 515 6.6 "A" RO Transformer Installation — 33 kV

Scope SL 515.1 33 kV RO Transformer Installation — Pole has Existing 120/240 V Control Power

Figure SL 515–1: 33 kV RO Installation — with Existing 120/240 V Control Power

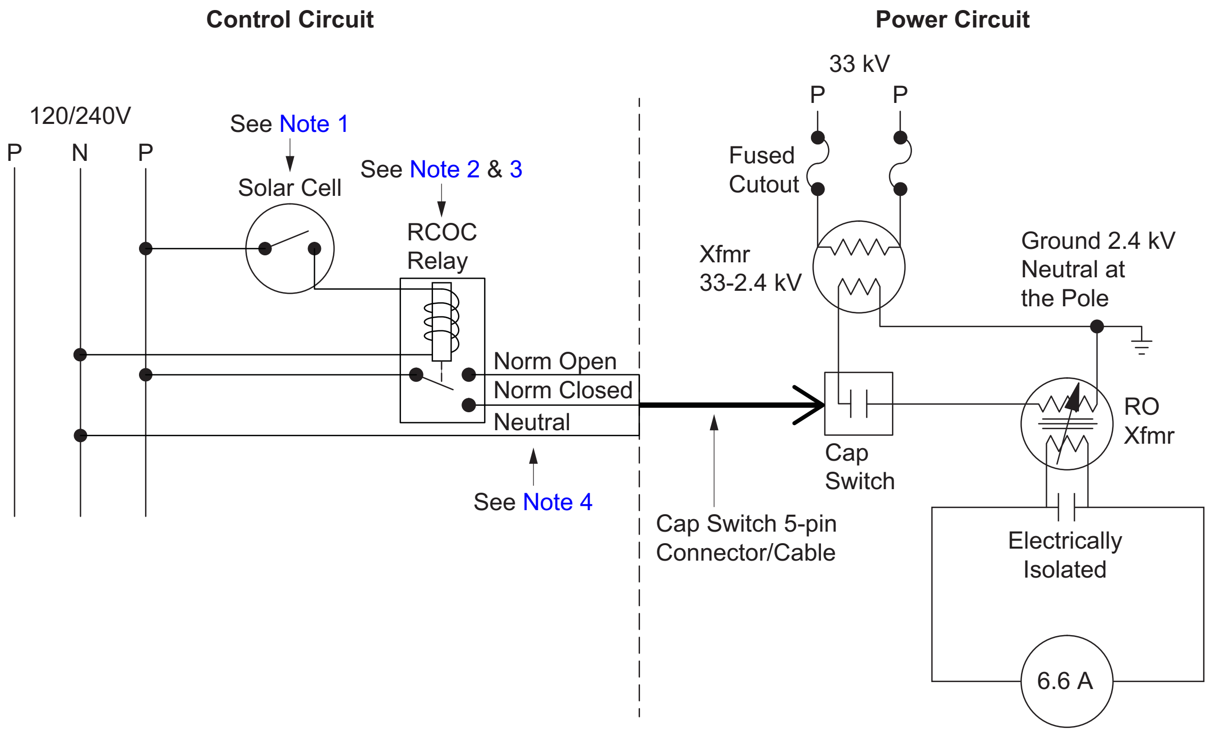


Note(s):

1. This construction standard is for replacement ONLY.
2. See PO 120 for HIGH VOLTAGE sign installation requirements; the 6.6 A circuit is High Voltage.
3. See DC 535 for Wildlife Protection coverage requirements.
4. Refer to DAP, AP 131 for 3-phase cluster bracket installation.
5. See PR 100 for fusing requirements. For RO transformers, “kW” = “kVA” to determine fuse link.
6. Fill open holes of the RCOC Relay box as necessary to keep out bugs and water (SAP 10154125).
7. If the 6.6 A circuit feeds an underground dip, install two polymer pin-type insulators on the face of the cross-arm to support the 6.6 A leads to the UG riser in lieu of dead-end insulators. Use #6 Keyrite (SAP 10110173).
8. This pole can be built as a mirrored reflection to accommodate existing construction as needed.
9. See Figure SL 515–3 for control and power circuit wiring diagram. See Figure SL 515–6 for internal RCOC wiring diagram.
10. If the existing location does not have 120/240 V power available, install a 25 kVA step-down transformer on an adjacent pole and string secondary conductor over. If this is not feasible (see Scope SL 515.2).
11. Fasten the unistrut (SAP 10073415) to the crossarm with a 1/2" × 6" bolt (SAP 10068944). Install the RCOC Relay (SAP 10118469) to the unistrut using (2) 3/8" × 1-1/2" Everdur Bolts (SAP 10070814) and unistrut nuts (SAP 10073652). Once the RCOC is in place, mount the Photocell (SAP 10118505) onto the RCOC Relay (see Figure SL 515–2).

Figure SL 515–2: RCOC Relay Installation on Unistrut

Figure SL 515–3: Wiring Diagram for RO Transformer with Existing 120/240 V Control Power — 33 kV



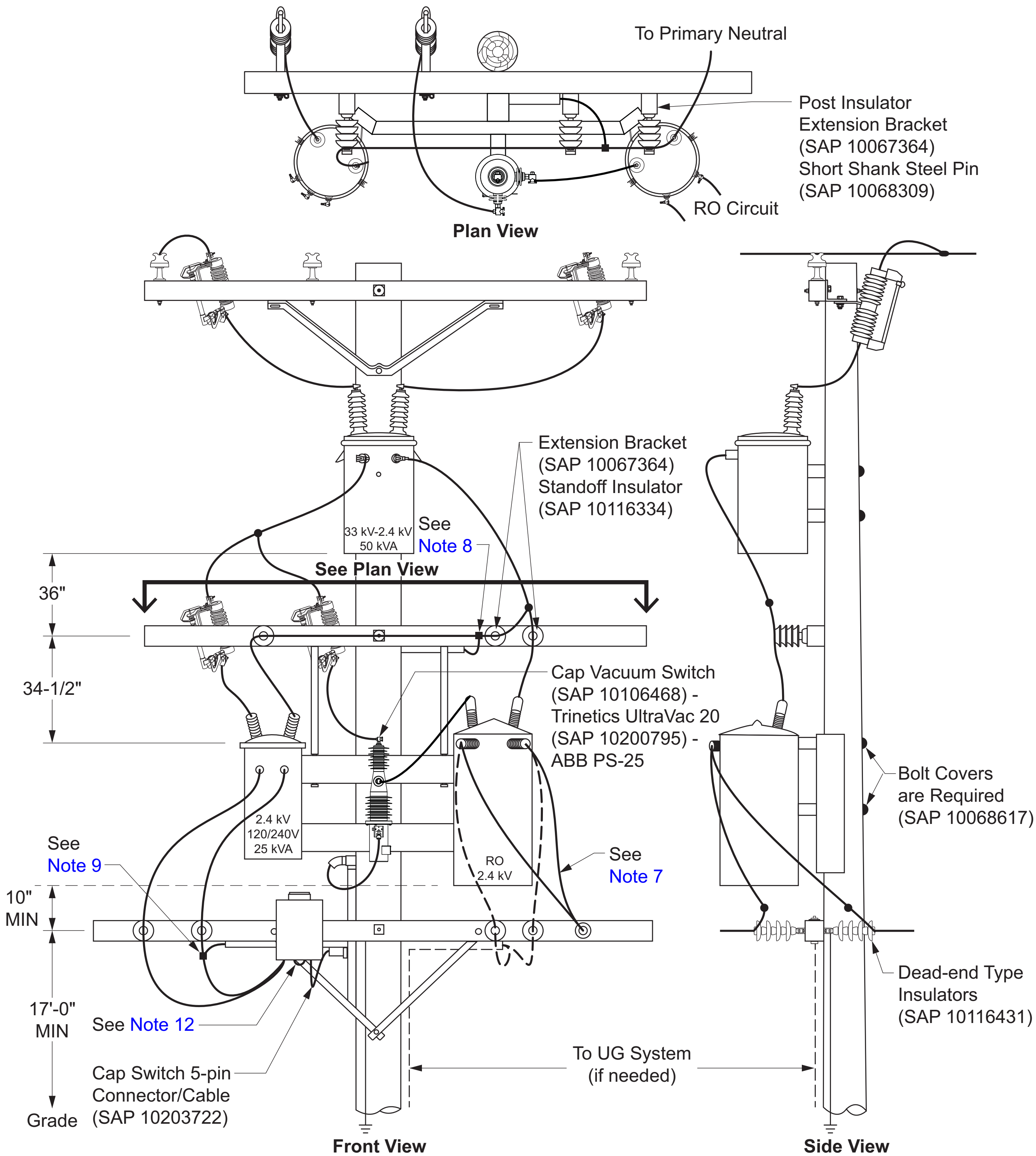
Note(s):

1. Solar cell is normally open during daylight hours and normally closed during evening hours.
2. RCOC load contact is normally open when the coil is de-energized.
3. For internal wiring diagram of the RCOC Relay (see Figure SL 515–6).
4. Based on the internal wiring of the RCOC relay, the N/O contact sends the “close” signal and the N/C contact sends the “open” signal to the capacitor switch. Therefore, wire the 5-pin connector as follows:

RCOC Relay	5-Pin Connector Wire	Pin
N/O Contact:	Red “close” cable	“B”
N/C Contact:	Black “open” cable	“C”
Source Neutral:	White “common” neutral	“D”

Scope SL 515.2 33 kV RO Transformer Installation — Pole Requires Dedicated 120/240 V Control Power

Figure SL 515–4: 33 kV RO Installation — with Dedicated 120/240 V Control Power



6.6 “A” RO Transformer Installation — 33 kV

Approved by:

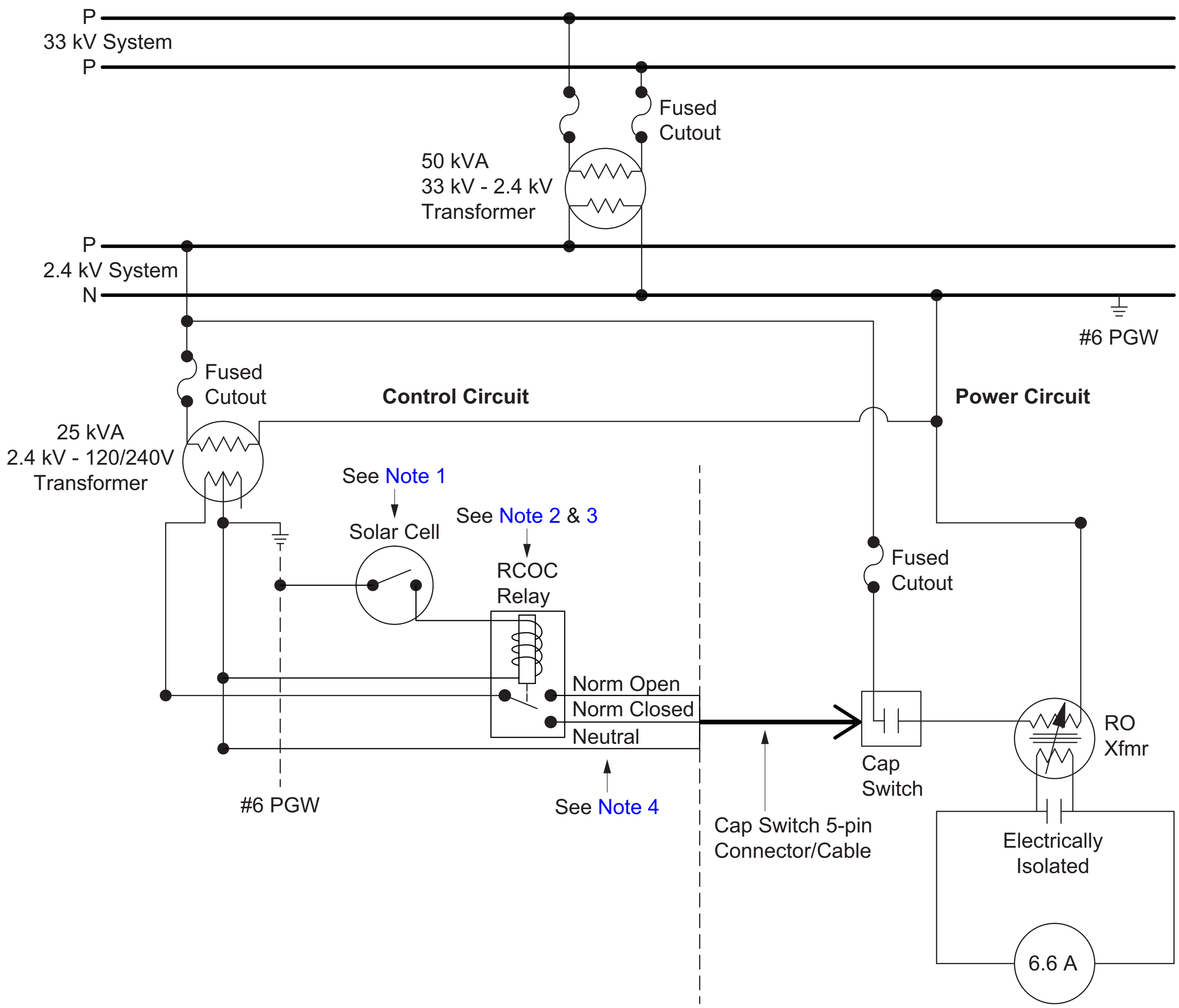
What’s Changed? Updated RCOC relay mounting to one crossarm.

Effective Date:
07-29-2016

Note(s):

1. This construction standard is for replacement ONLY.
2. See PO 120 for HIGH VOLTAGE sign installation requirements; the 6.6 A circuit is High Voltage.
3. See DC 535 for Wildlife Protection coverage requirements.
4. Refer to DAP, AP 131 for 3-phase cluster bracket installation.
5. See PR 100 for fusing requirements. For RO transformers, “kW” = “kVA” to determine fuse link.
6. Fill open holes of the RCOC Relay box as necessary to keep out bugs and water (SAP 10154125).
7. If the 6.6 A circuit feeds an underground dip, install two polymer pin-type insulators on the face of the cross-arm to support the 6.6 A leads to the UG riser in lieu of dead-end insulators. Use #6 Keyrite (SAP 10110173).
8. Run #6 PGW under the cross-arm and connect to the primary 2.4 kV neutral.
9. Run #6 PGW under the cross-arm and connect to the secondary 120/240 V neutral.
10. This pole can be built as a mirrored reflection to accommodate existing construction as needed.
11. See Figure SL 515–5 for control and power circuit wiring diagram. See Figure SL 515–6 for internal RCOC wiring diagram.
12. Fasten the unistrut (SAP 10073415) to the crossarm with a 1/2" × 6" bolt (SAP 10068944). Install the RCOC Relay (SAP 10118469) to the unistrut using (2) 3/8" × 1-1/2" Everdur Bolts (SAP 10070814) and unistrut nuts (SAP 10073652). Once the RCOC is in place, mount the Photocell (SAP 10118505) onto the RCOC Relay (see Figure SL 515–2).

Figure SL 515–5: Wiring Diagram for 6.6 “A” RO Transformer with Dedicated 120/240 V Control Power — 33 kV

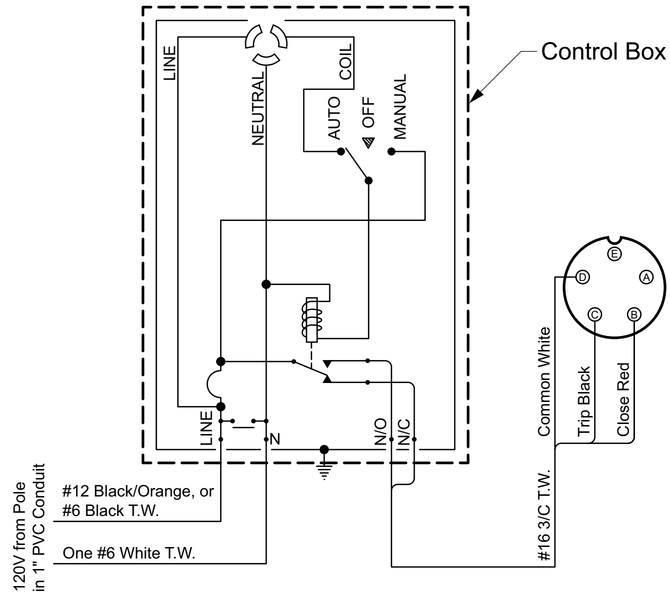


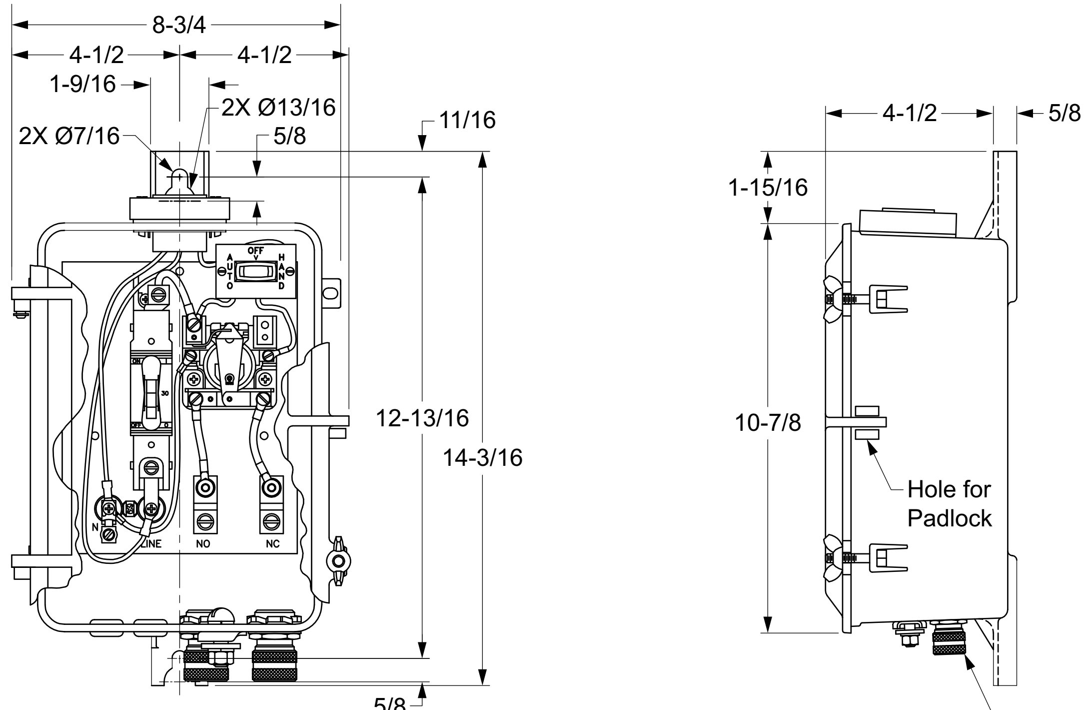
Note(s):

1. Solar cell is normally open during daylight hours and normally closed during evening hours.
2. RCOC load contact is in the normally closed position when the coil is de-energized.
3. Internal wiring diagram of the RCOC relay is shown in Figure SL 515–6.
4. Based on the internal wiring of the RCOC relay, the N/O contact sends the “close” signal and the N/C contact sends the “open” signal to the capacitor switch. Therefore, wire the 5-pin connector as follows:

RCOC Relay	5-pin Connector Wire	Pin
N/O Contact:	Red “close” cable	“A”
N/C Contact:	Black “trip” cable	“B”
Source Neutral:	White “common” neutral	“C”

Figure SL 515–6: Internal Wiring Diagram for RCOC Relay



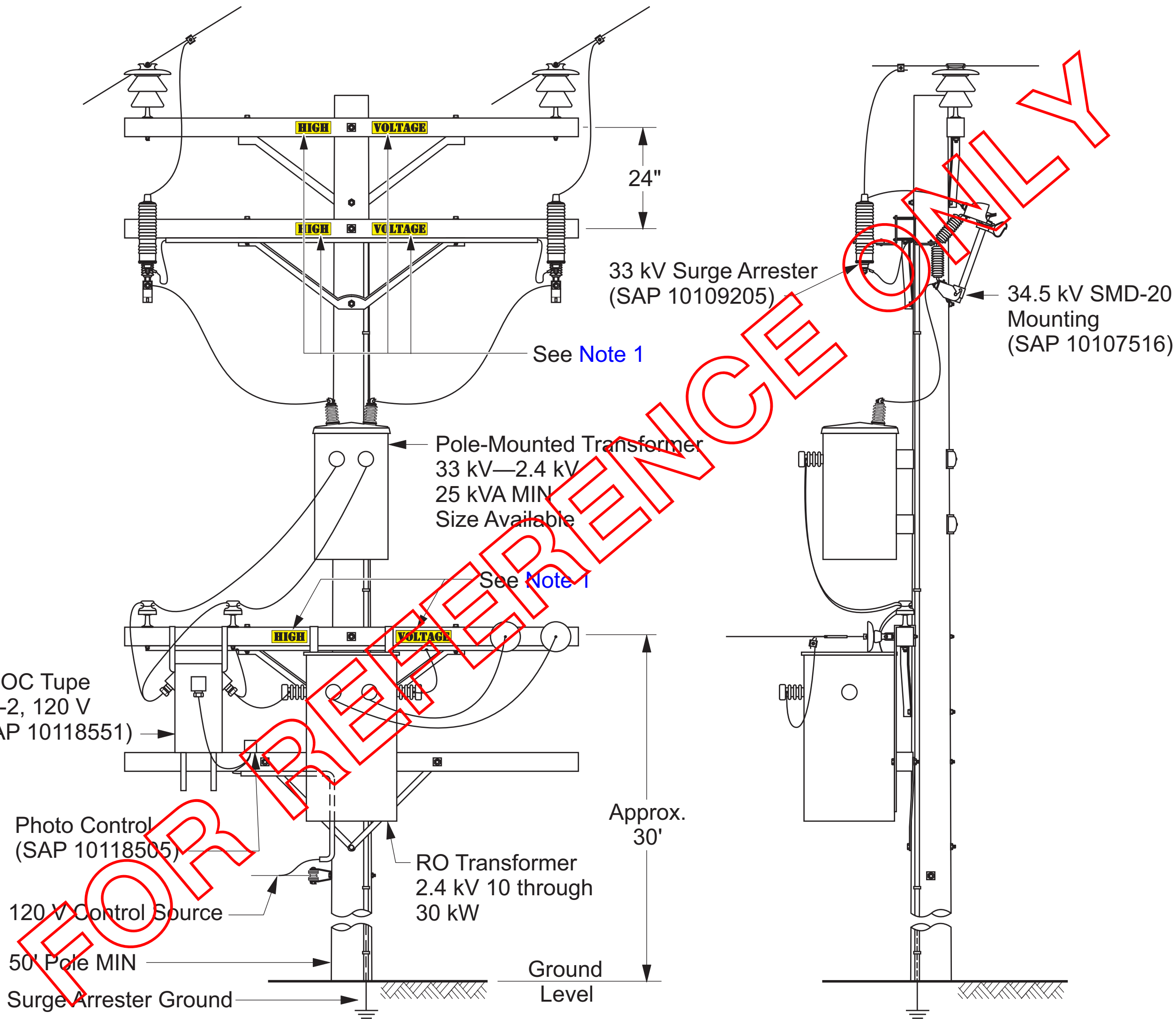


Control Terminals Will Accept #6 Thru #14 AWG Wire
Line/Load Terminals Will Accept #4 Thru #1/0 AWG Wire

(2) Compression Connectors with Neoprene Bushings for .375–.500 OD Cables and (2) Grommets 5/16 MAX Cable OD

Scope SL 515.3 6.6 "A" RO Transformer — 33 kV–2.4 kV

Figure SL 515–7: 6.6 "A" RO Transformer — 33 kV–2.4 kV (Using RCOC Switch)



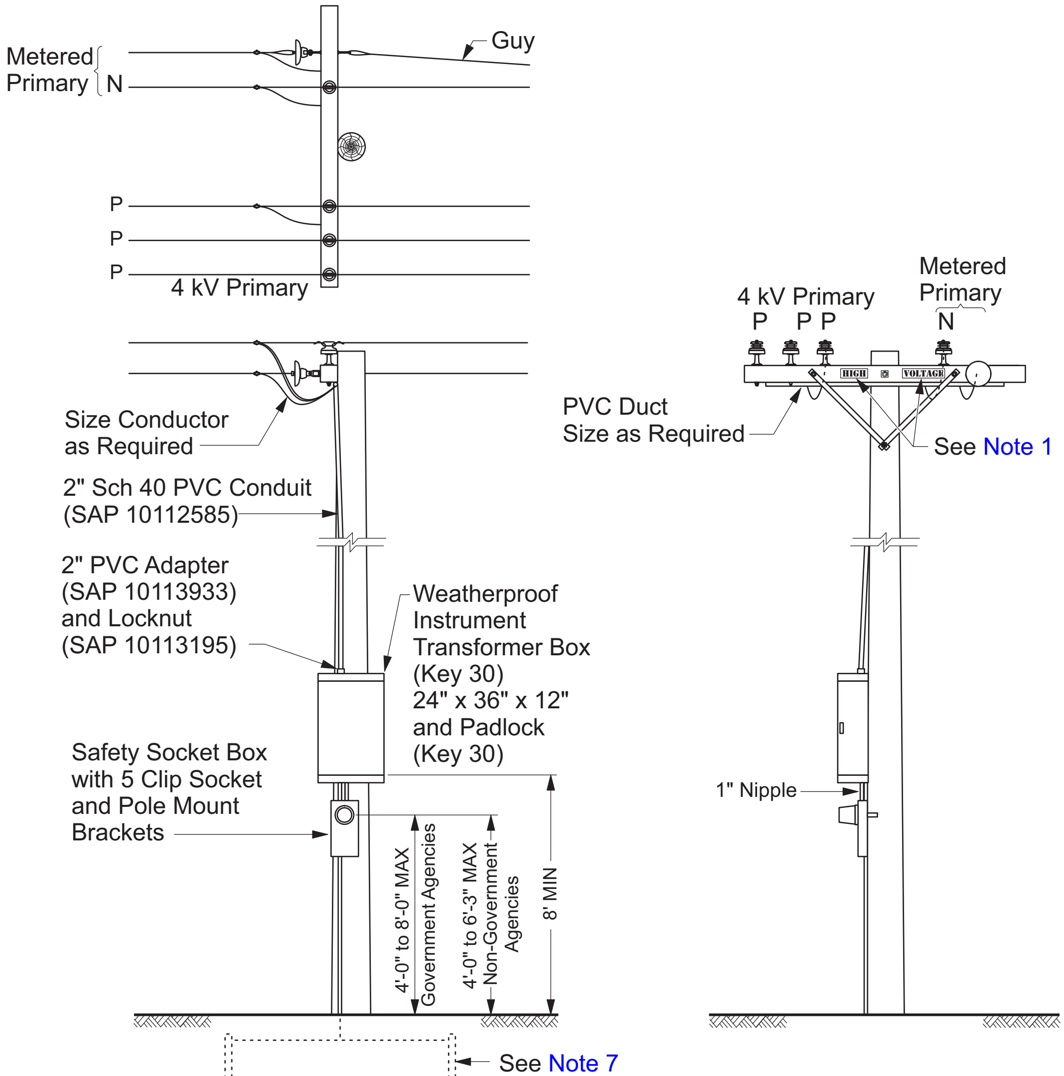
Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.

SL 520 1Ø Meter Installation — 2.4 kV

Scope SL 520.1 1Ø Meter Installation — 2.4 kV

Figure SL 520–1: 1Ø Meter Installation — 2.4 kV



Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. All 4 kV neutral conductors in any conduit entering or leaving the instrument transformer box shall have the same insulation as the phase conductors and shall be fully insulated from the box and any conduits attached thereto.
3. All couplings are to be cemented to PVC conduit at the top socket of coupling. Do not cement the lower socket of coupling. This allows for expansion and contraction of conduit.
4. The 8 foot maximum meter height is available to governmental agencies and other utilities only.
5. Riser poles shall be stepped.
6. See TM section for wiring diagram.
7. For grounds see GR Section.

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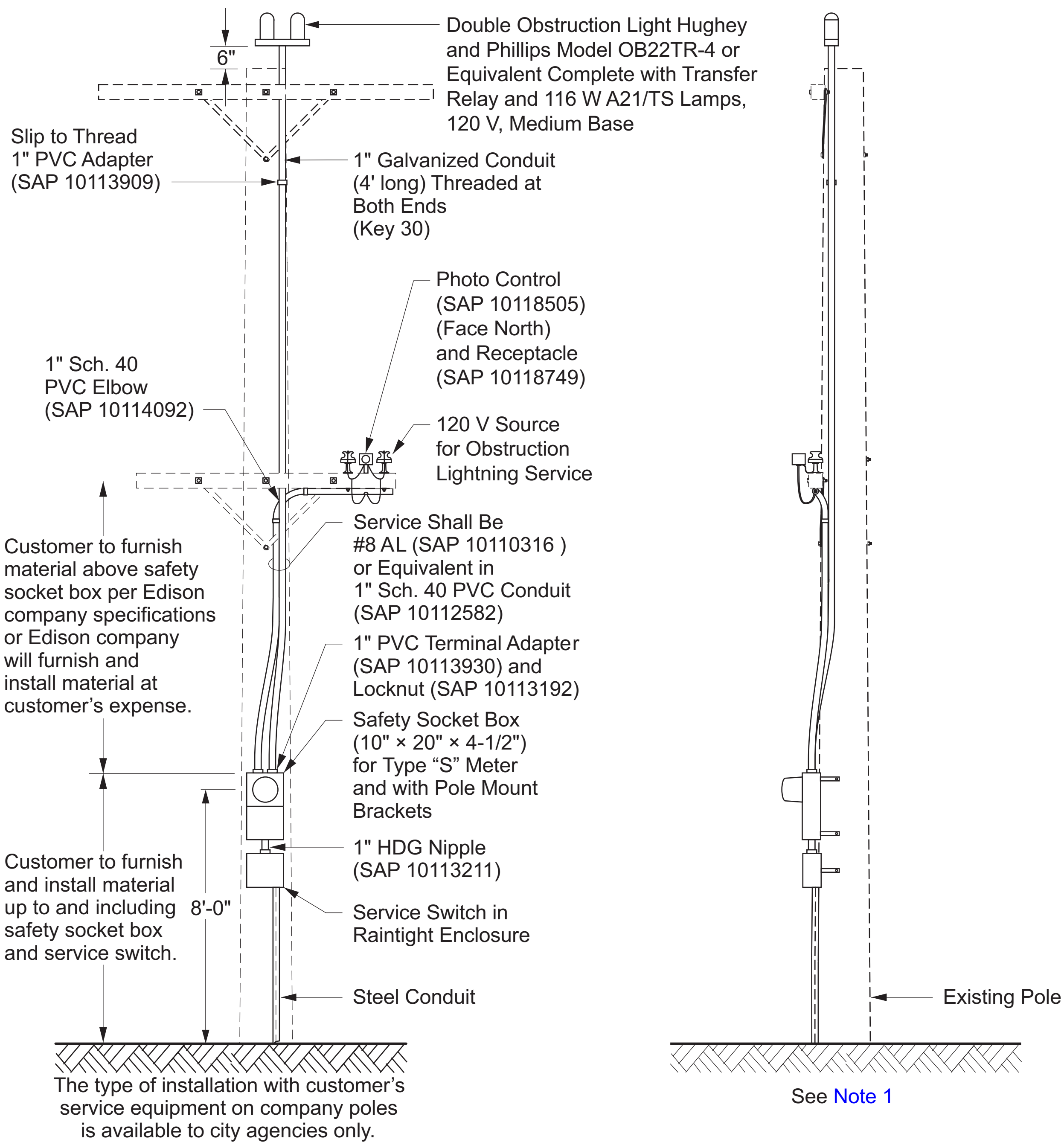
SL 600 120 V — Airport Obstruction Lighting

Scope SL 600.1 120 V — Airport Obstruction Lighting

Figure SL 600–1: 120 V — Airport Obstruction Lighting



Note(s):

1. See T Section for metering. See GR Section for grounding.

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SL 601 FAA Lights on Distribution Poles

Scope SL 601.1 FAA Lights on Distribution Poles

1.0 General Information

The Federal Aviation Administration (FAA) requires FAA lights to be installed atop specified structures within four miles of an airport or one mile of a heliport. Some distribution poles fall within this regulation and are now being required to have FAA lights installed.

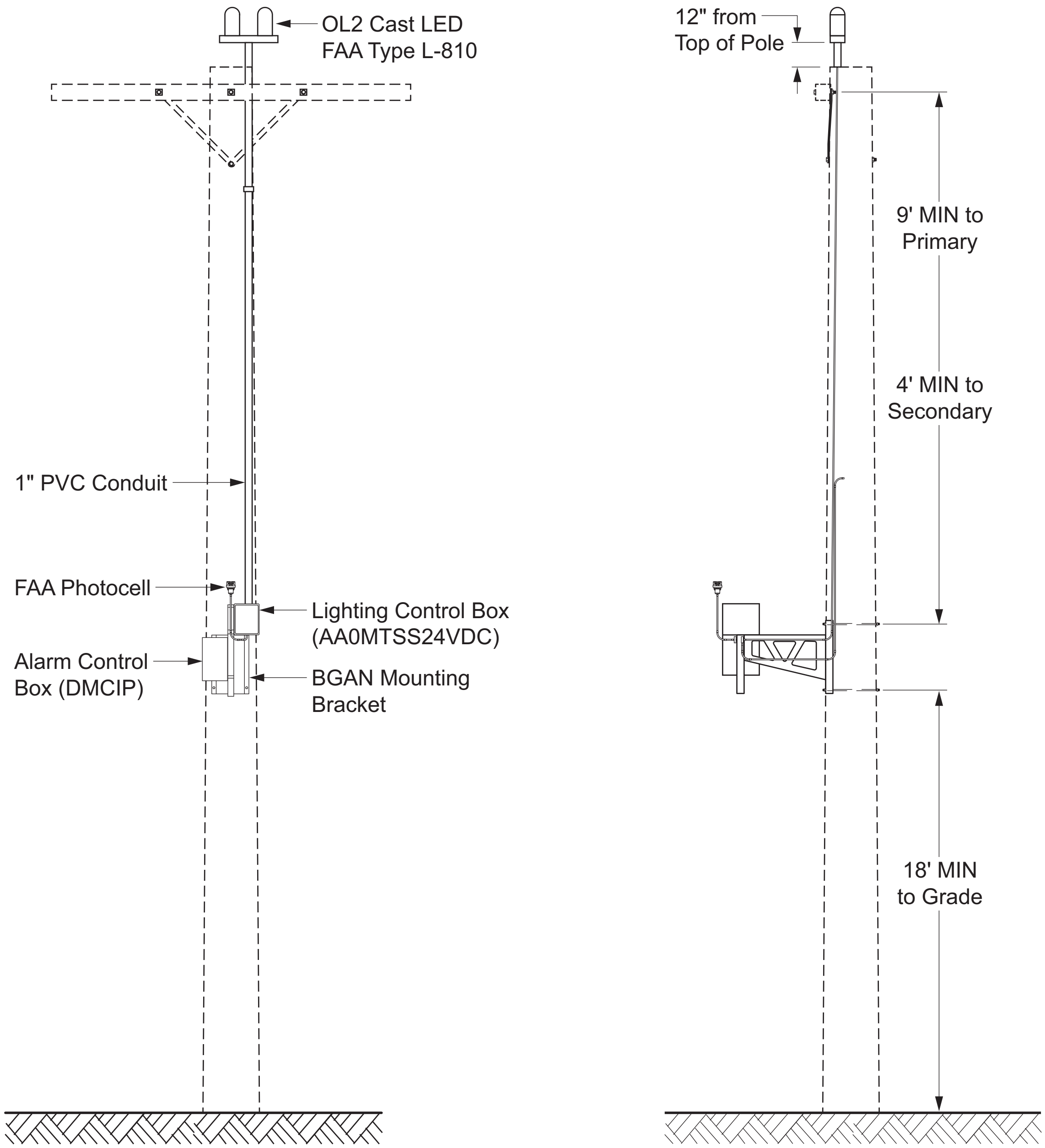
Refer to Distribution Design Standard (DDS) DDS-10 for design standard related to FAA lighting.

For more information, please see AF&M-04, Distribution Lighting, Monitoring Troubleshooting and Reporting Procedure and AF&M-05, Distribution Monitoring & Notification Procedure.

For additional information, please see the Navigable Airspace Obstruction Evaluation, Notification, and Marking Policy. Document ID: SCE-FPM-PWRCONST-PL-1. Contact MIPO@SCE.com for additional information on the Aviation & Filing Maintenance Compliance Program.

Figure SL 601–1: Typical Installation of FAA Lights on Distribution Poles

Figure SL 601–2: Typical Installation of FAA Lights on Distribution Poles (Clearances)



Note(s):

1. FAA lights and control panels shall be installed on distribution poles around airports as deemed necessary by the FAA.
2. All clearances shown specify the minimum required for installation.
3. Bracket must be mounted above communication lines.

Table SL 601–1: Typical Material for FAA Lights on Distribution Poles

TWR Lighting Components	Quantity	SAP
Kit, Light, Master Lighting, 12 × 10 Unistrut		10212336
Kit, Light, LED w/Cable, 3/4 inch Conduit	1	10212337
Kit, Mounting, Pipe Unistrut 10 × 8 inch	1	10212338
Kit, Mounting, Photocell, Small Enclosure	1	10212339
Monitor, Digital Unit 4g	1	10212340
Mount, Pipe, Unistrut 12 × 10 inch	1	10212341
Antenna, Mount, External Cellular (If Needed)	1	10212342
Antenna, Mount, External (If Needed)	1	10212343
Cord, Sow, 16/5, Cord Sow	10' min	10212344
Wire, 18/6 Type TC, VNTC, Wire	10' min	10212345
Separate Material		
Weather Station/FAA Lighting Bracket	1	10211724
PVC Conduit, 1" Schedule 40	30'	10112585
1" Pipe Straps	15	10112990
90° Elbows, 1" Schedule 40	3	10114092
Nails	30	Dist. yard stock

2.0 FAA Lights

The FAA lighting kit will use an OL2 Cast LED FAA Type L-810 (OL2CLED).

Figure SL 601–3: Typical Installation of FAA Lights on Distribution Poles (Lights)

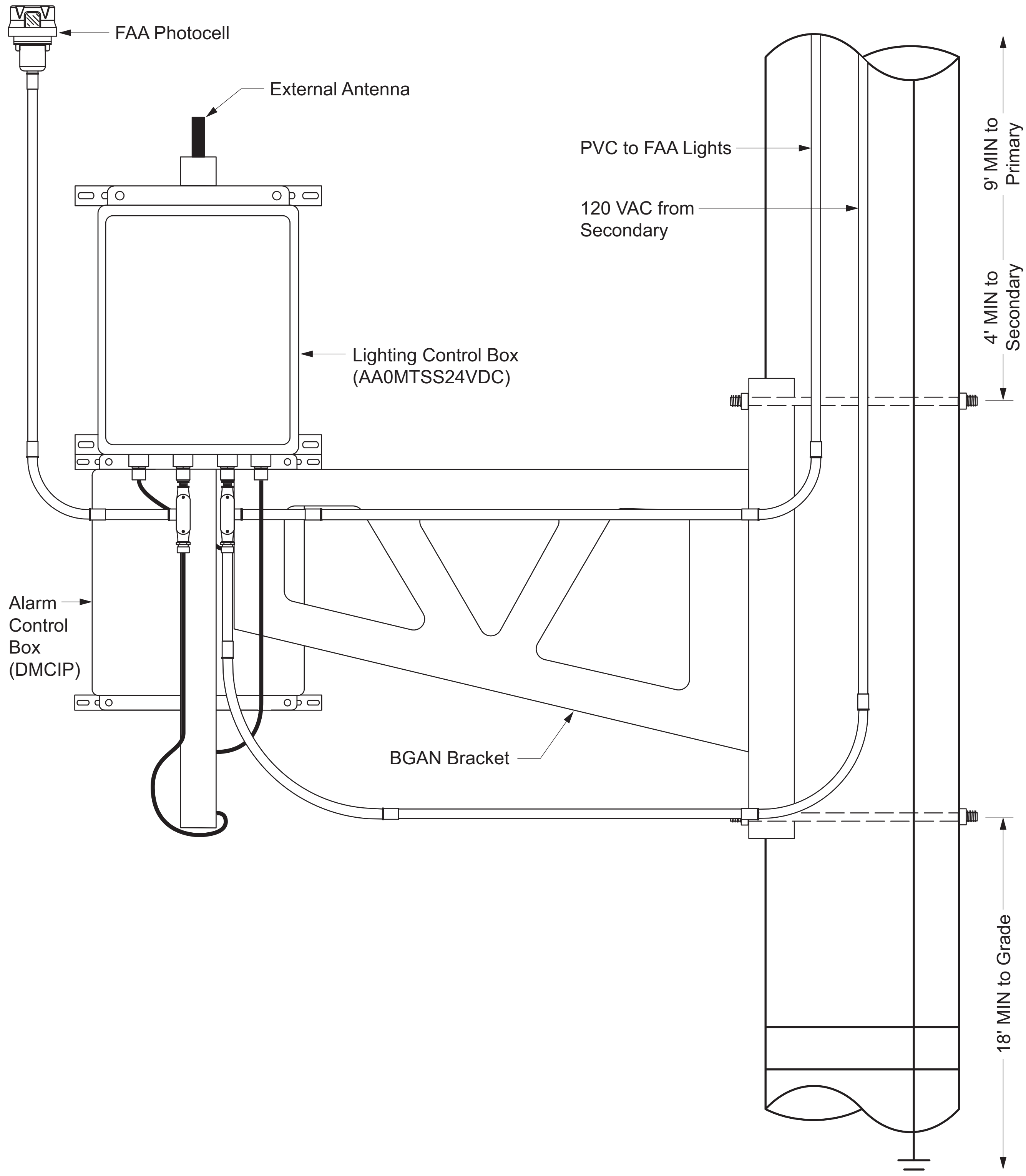
3.0 BGAN Bracket (Control Panels and Photocell)

Each FAA lighting system shall have two control boxes: lighting control (AA0MTSS24VDC) and alarm control (DMCIP). Both the lighting and alarm control boxes shall be powered by 120 V. The alarm control box will be accompanied with a back-up battery. The panels shall both be mounted to the BGAN Bracket for climbing purposes. Connect ground lead to ground connector in each enclosure.

An FAA compliant photocell shall also be included in the FAA lighting system kit. Photocell must be installed such that it is facing north.

Figure SL 601–4: Typical Installation of FAA Lights on Distribution Poles (Control Panels and Photocell)

Figure SL 601–5: Typical Installation of FAA Lights on Distribution Poles (Control Panels and Photocell)



4.0 Panel Wiring

The alarm control box shall be connected to the lighting control box. The lighting control box shall then be connected up to the FAA light LEDs on top of the pole through PVC and provided junction box. The photocell shall be connected to the lighting control box through steel conduit. A wiring diagram is provided to connect the control panels to each other. Cable entrances shall be sealed to be watertight.

5.0 FAA Lights Commissioning

5.1 System Test

Once all the wiring is complete, test the system by placing a glove over the photocell. All lights should come on. Remove the glove and all lights should go off. If the lights do not work, recheck wiring.

5.2 Contact TWR

Contact the TWR NOC (Network Operation Center) to check communication between the FAA Lighting unit and TWR NOC:

1 (800) 679-8724
Option 5: NOC or
Extensions 151 or 162, or
Option 4: Technical Support

SL 605 Single-Phase Service to Street Lighting, Traffic Lights, and so on

Scope SL 605.1 Single-Phase Service to Unmetered Street Lighting (LS-2), and Metered Traffic Lights, and so on

Figure SL 605–1: Single-Phase Service to Unmetered Street Lighting (LS-2), and Metered Traffic Lights, and so on

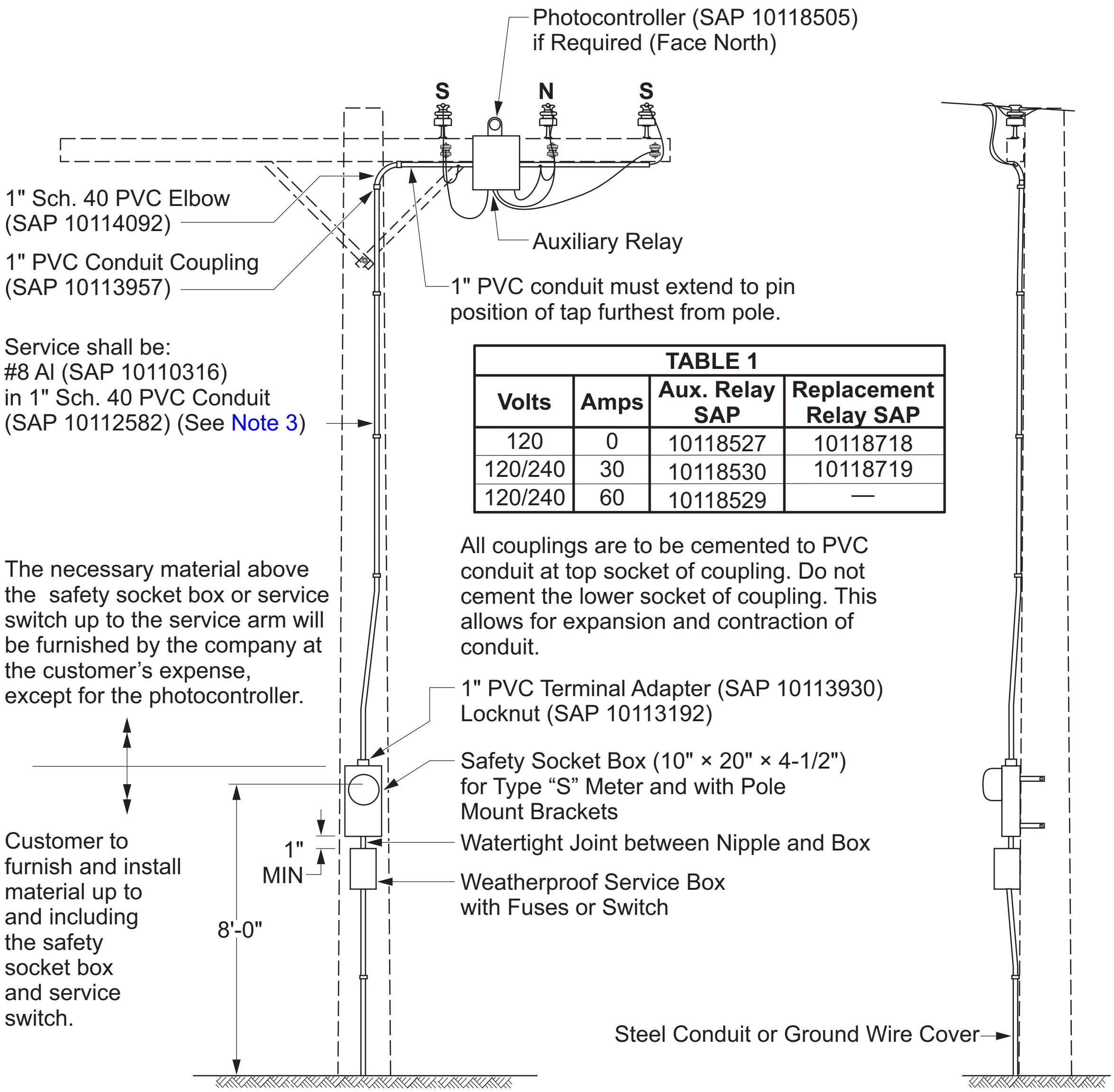


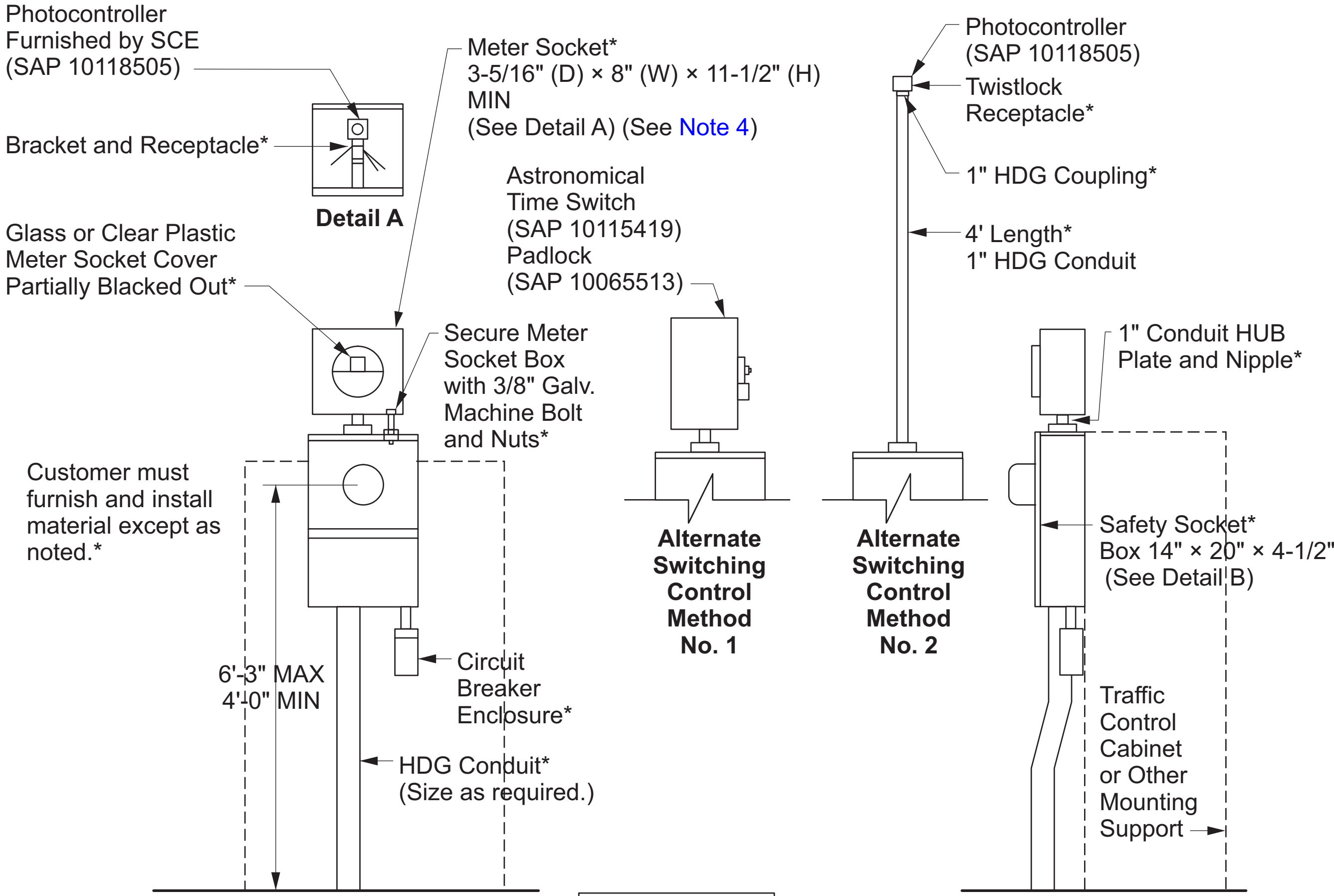
TABLE 1			
Volts	Amps	Aux. Relay SAP	Replacement Relay SAP
120	0	10118527	10118718
120/240	30	10118530	10118719
120/240	60	10118529	—

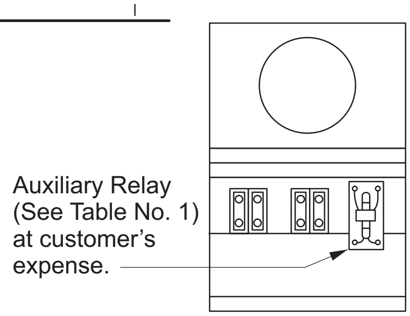
This type of installation with customer's service equipment on company poles is available to city agencies only.

Note(s):

1. If customer's load exceeds the 1000 W capacity of photocontroller, an auxiliary relay is required. (See Table 1 above.)
2. For more than three #8 Al and less than six #2 Al conductors, use 2-inch Schedule 40 PVC conduit.
3. Safety Socket Box will not be required when installation is only for unmetered street lighting.
4. For metering, see T Section (T 128 and T 137).

Figure SL 605–2: Single-Phase Service to Street Lighting, Traffic Lights, and so on





Detail B

Table No. 1		
Volts	Amps	Aux. Relay SAP
120	30	10118718

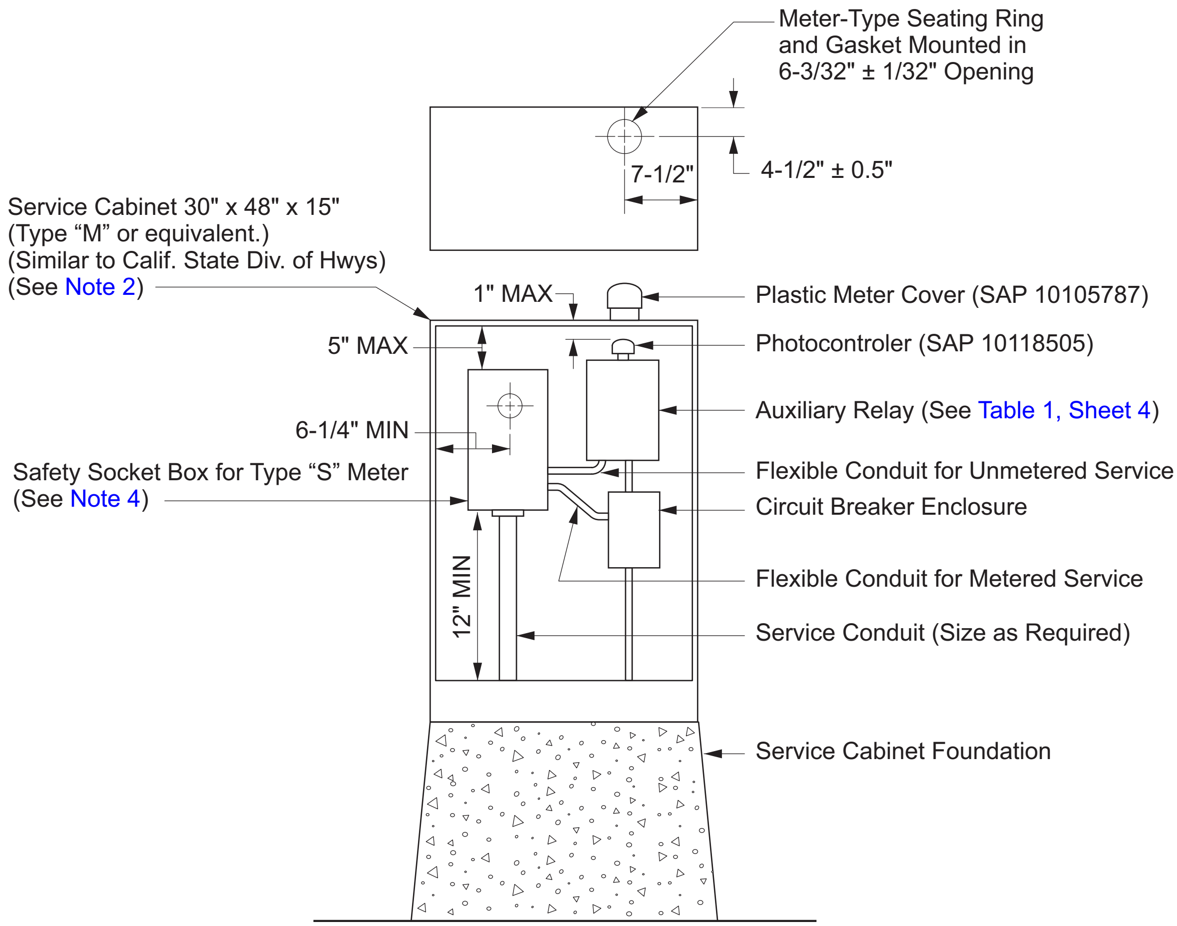
This type of installation with customer's service equipment is available to governmental agencies and other utilities only.

*Customer Furnished

Note(s):

1. If customer's load exceeds the 1000 W capacity of photocontroller, auxiliary relay is required.
2. Customer to furnish and install all of the material up to and including Safety Socket Box except the following: a) Meter, b) Service Conductors, and c) Photocontroller.
3. On underground installations exceeding 120 V, the auxiliary relay shall be placed in the customer's section and shall be located ahead (line side) of the customer's unmetered circuit breaker bus.
4. Apply a thin film of Mobilgrease 28 (SAP 10153459) to both sides of each current circuit meter blade prior to insertion into the socket (see T 73 for more details).

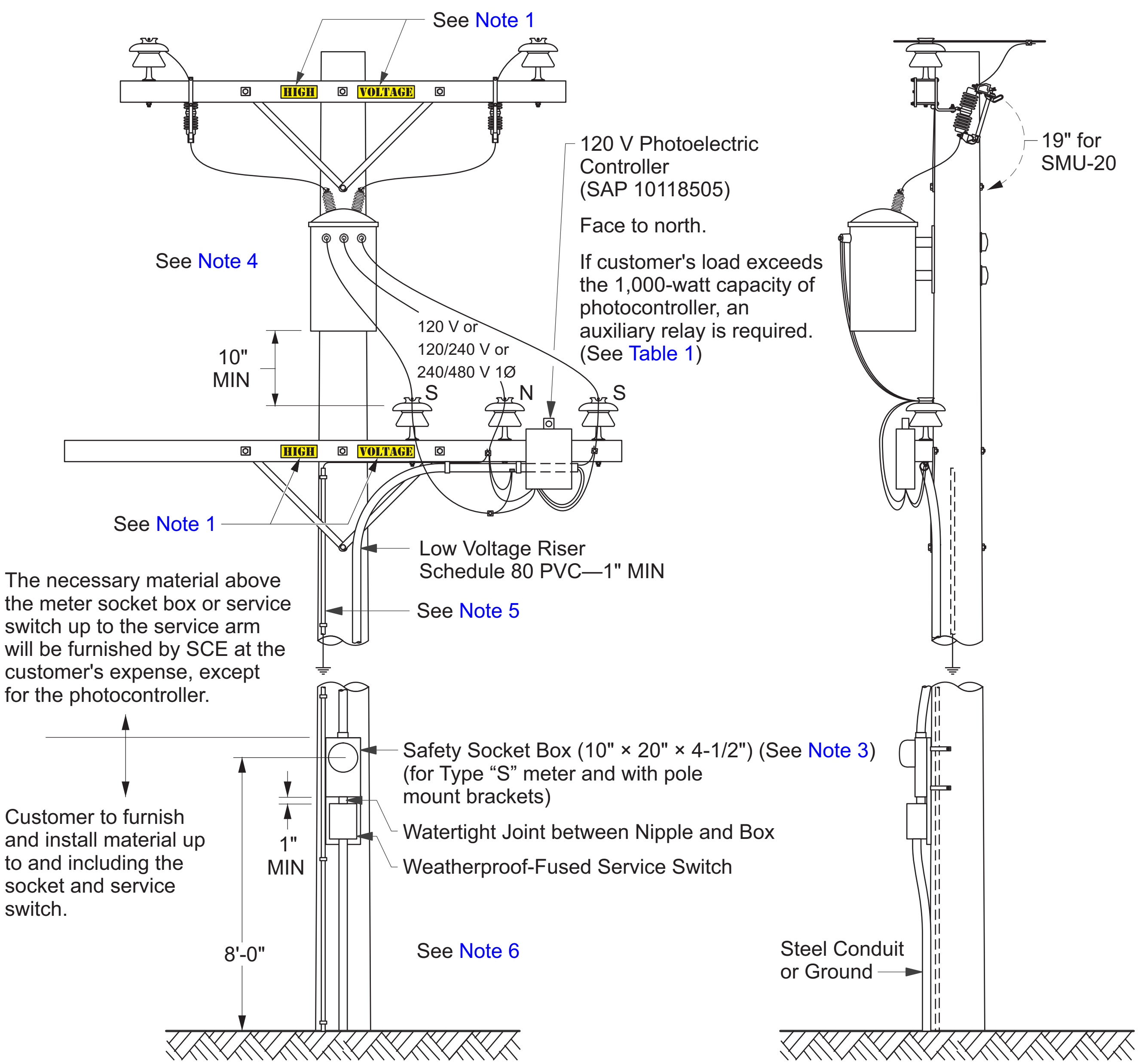
Figure SL 605–3: Single-Phase Service to Street Lighting, Traffic Lights, and so on



Note(s):

1. Customer to furnish and install all material except:
   A. Photocontroller
   B. Service Conductors
   C. Single-Pole, 120 V Auxiliary Relay (when required)
   D. Meter
   E. Plastic Meter Cover
2. Customer provides Edison a mutually agreeable entry to the service cabinet.
3. On underground installations exceeding 120 V, the customer shall provide the auxiliary relay. The relay shall be placed in the customer's section and shall be located ahead (line side) of the customer's unmetered circuit breaker bus.
4. See T 2 for metering.

Figure SL 605–4: Single-Phase Service to Street Lighting, Traffic Lights, and so on



This type of installation with customer's service equipment on company poles is available to governmental agencies and other utilities only.

TABLE 1			
Volts	**2-Pole, 1-Ø Amp**	**Auxiliary Relay SAP**	**Replacement Relay SAP**
120	30	10118527	10118718
120/240	30	10118530	10118719
120/240	60	10118529	—
240/480	60	10118528	—

Single-Phase Service to Street Lighting, Traffic Lights, and so on

What's Changed? Figure SL 605-4, Note 1 was updated to reference PO 120 for HIGH VOLTAGE sign requirements.

Approved by:

Effective Date: 04-27-2012

Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Safety socket box will not be required when installation is only for unmetered street lighting (LS-2).
3. Apply a thin film of Mobilgrease 28 (SAP 10153459) to both sides of each current circuit meter blade prior to insertion into the socket (see T 73 for more details).
4. For details of transformers installation, refer to Distribution Apparatus Construction Standards (DAP).
5. For neutral ground installation details, see GR Section.
6. See T Section for metering T 128 120 V/240 V T 137 240 V/480 V.

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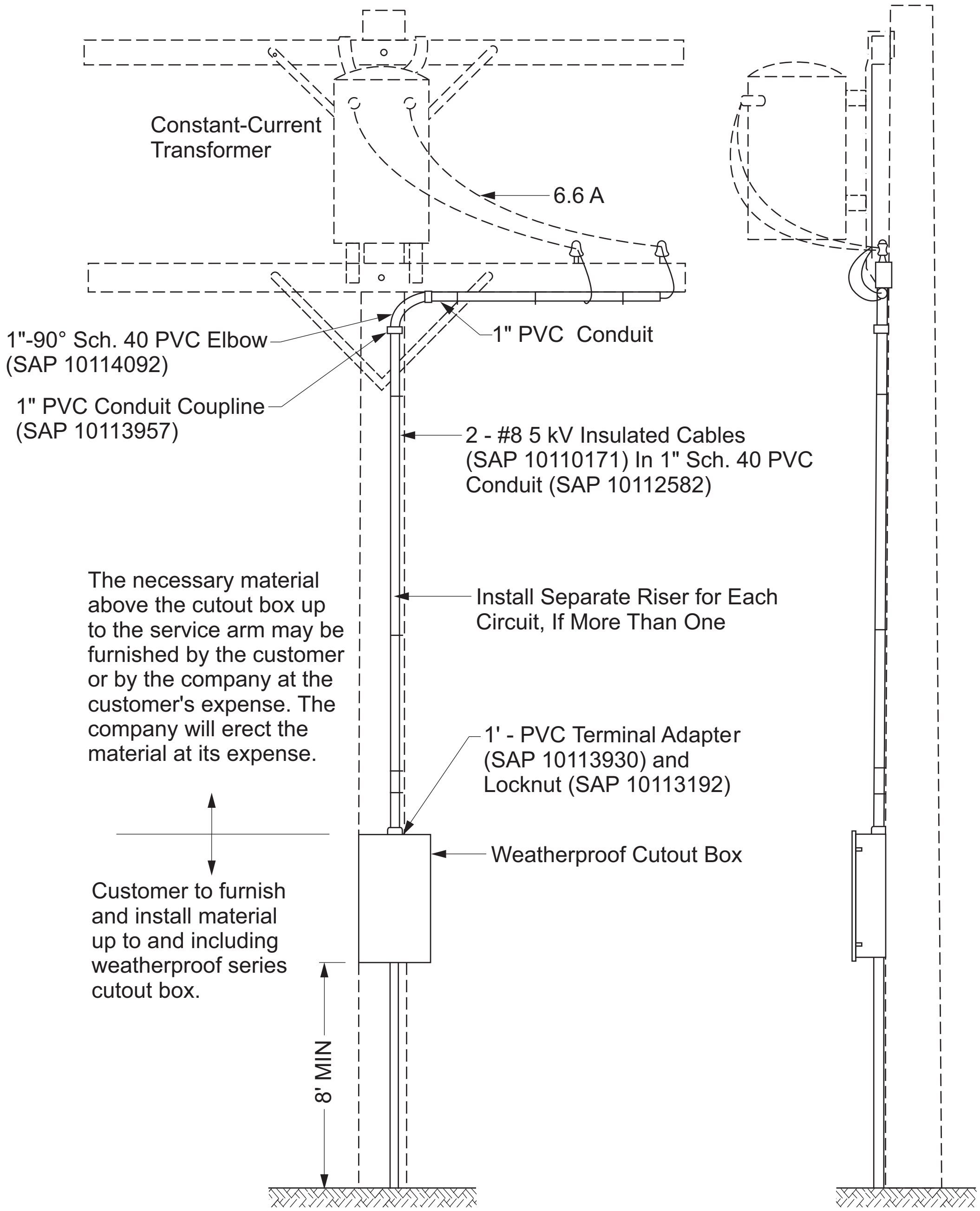
SL 610 6.6 A Service to Ornamental Lights

Scope SL 610.1 6.6 A Service to Ornamental Lights

Figure SL 610–1: 6.6 A Service to Ornamental Lights



Note(s):

1. All couplings are to be cemented to PVC conduit at top socket of coupling. This allows for expansion and contraction of conduit.
2. See PO 100.4 for pole step requirements.

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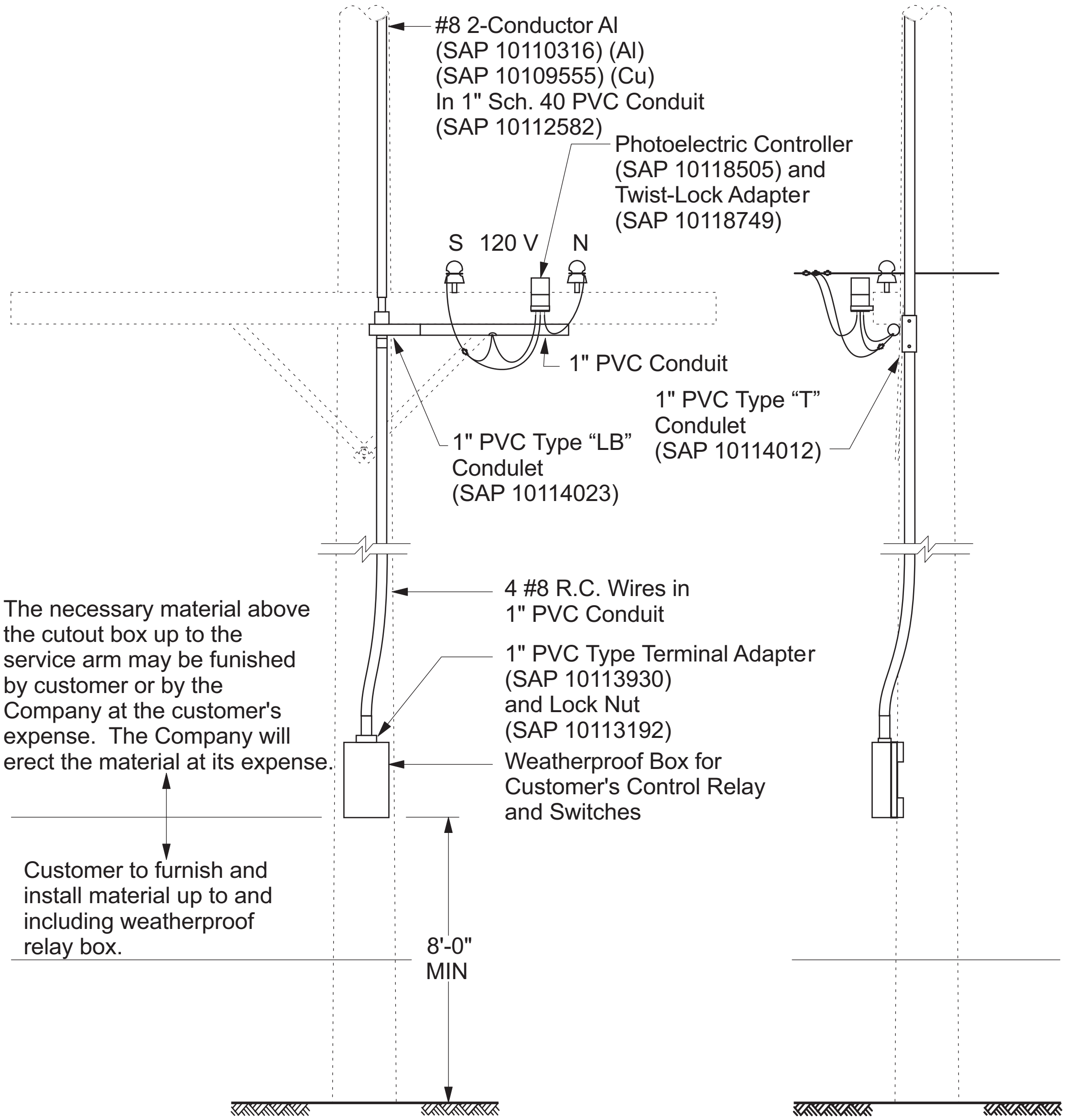
SL 615 Vehicular Tunnel Lighting

Scope SL 615.1 Vehicular Tunnel Lighting

Figure SL 615–1: Vehicular Tunnel Lighting



Note(s):

1. If customer's load exceeds 1,000 watt capacity of photocontroller, auxiliary relay is required. (SAP 10118527) (3,000 W).
2. All couplings are to be cemented to PVC conduit at top of couplings only. This allows for expansion and contraction of conduit.
3. See PO 100.4 for pole step requirements.

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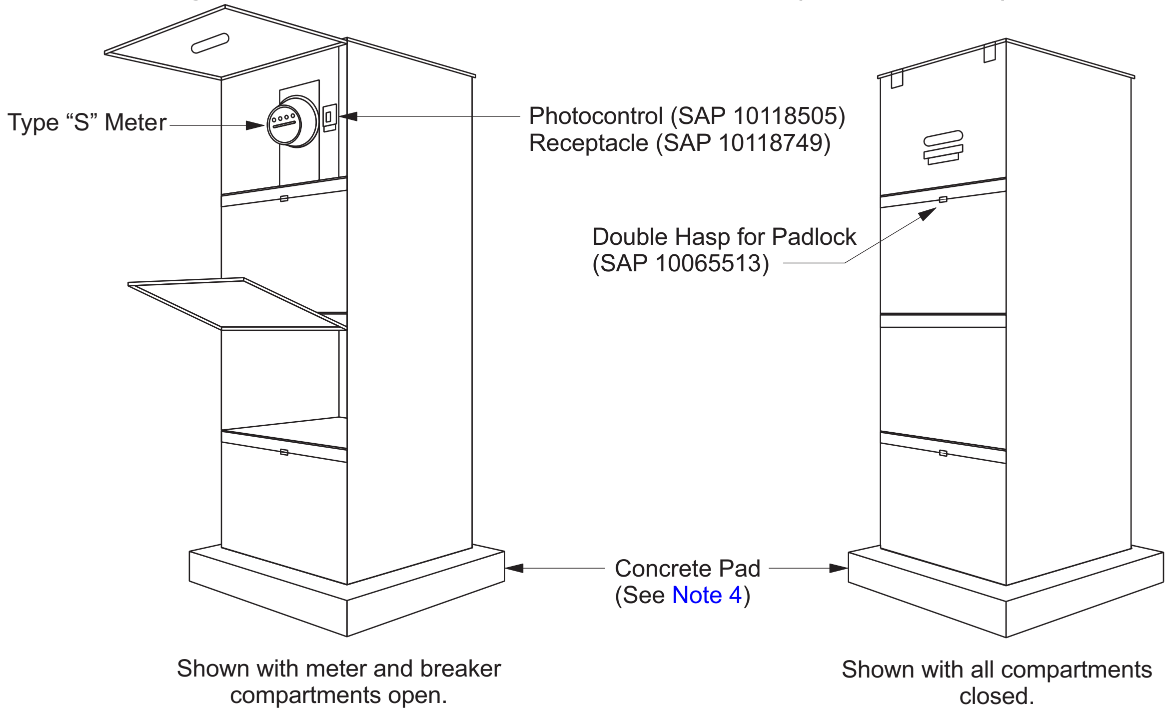
SL 620 Meter Cabinet and Pedestal

Scope SL 620.1 Meter Cabinet and Pedestal (SAP 10114287)

Figure SL 620–1: Meter Cabinet and Pedestal (SAP 10114287)



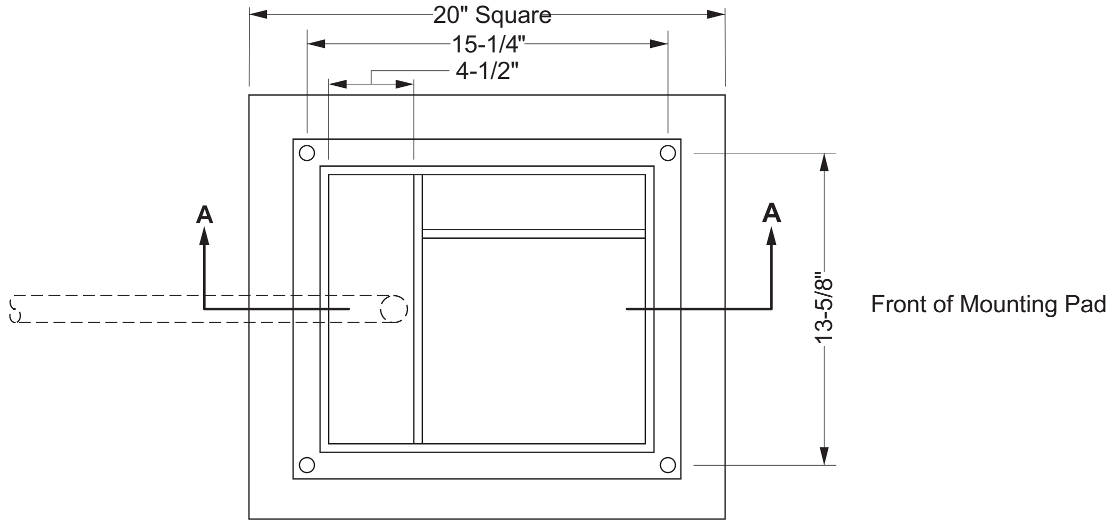
Note(s):

1. Underground pedestals for streetlight application shall be provided with a test block perch and factory-wired test blocks.
2. SCE to furnish and install:
   A. Meter cabinet and pedestal.
   B. Meter when required, for example TC-1 or LS-3 or when application does not require a meter, such as LS-2, a meter socket bypass cover (SAP 10120626) can be installed.
   C. Photocontroller.
   D. Auxiliary relay (as necessary), see Table SL 620–1 (Sheet 1) for type. See T 127 for wiring information.
3. If customer's load exceeds the 1,000-watt capacity of the photocontroller, an auxiliary relay is required.
4. See Figure SL 620–2 (Sheet 2) for foundation details.
5. Underground pedestals shall have clear lenses for photocontrollers and face away from automobile headlights when possible.
6. Refer to ESR, for customer owned streetlight installations.
7. SCE will furnish the auxiliary relay for this installation because the cost will be included in the Rule 20A work. This installation usually occurs when agencies, such as CalTrans, do not recognize Rule 20A's. Other installations require the customer to furnish or pay for the relays.

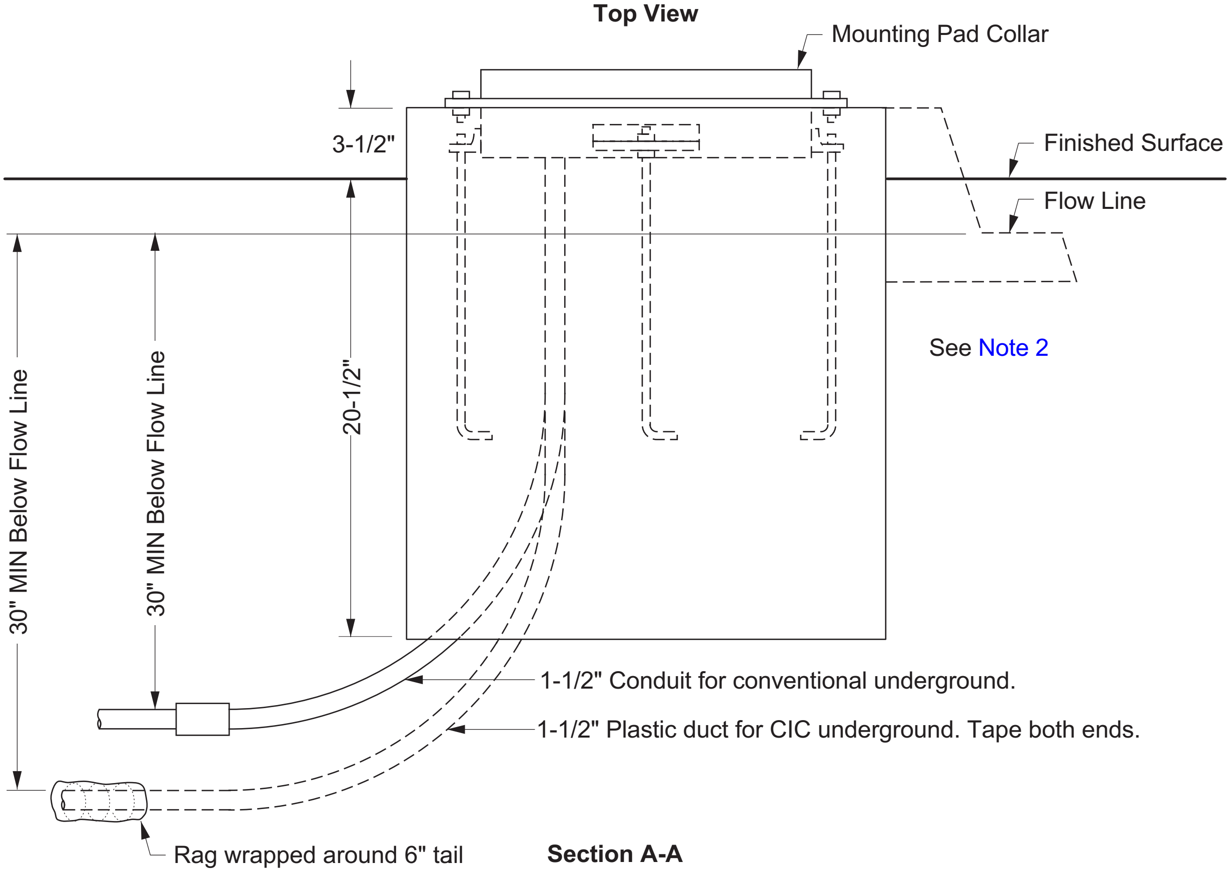
Table SL 620–1: Auxiliary Relays

Volt	Amp	Relay SAP
120	30	10118718
120/240	30	10118719

Figure SL 620–2: Meter Cabinet and Pedestal



Top View



Section A-A

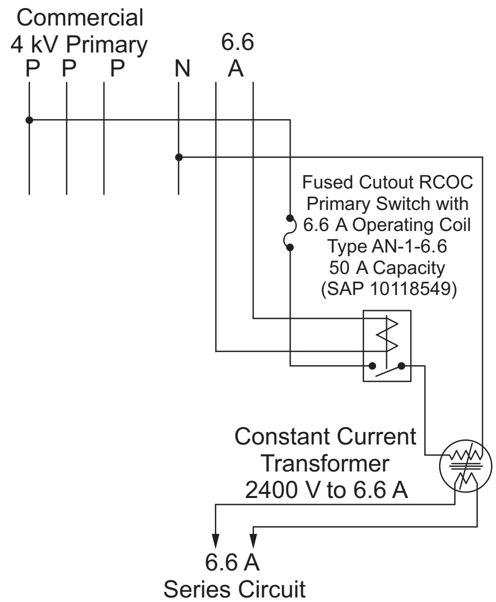
Note(s):

1. Dry tamp earth below foundation to original density.
2. See SL 620 (Sheet 1) for pedestal details.

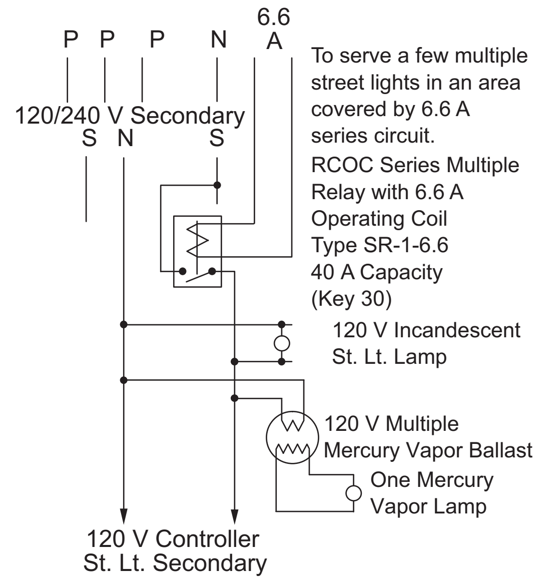
SL 700 120 V Areas — Cascading Methods of Control

Scope SL 700.1 120 V Areas — Cascading Methods of Control

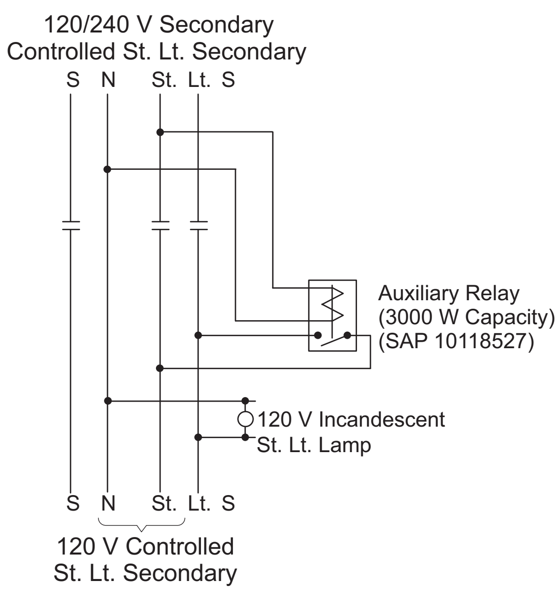
Figure SL 700–1: V Areas — Cascading Methods of Control



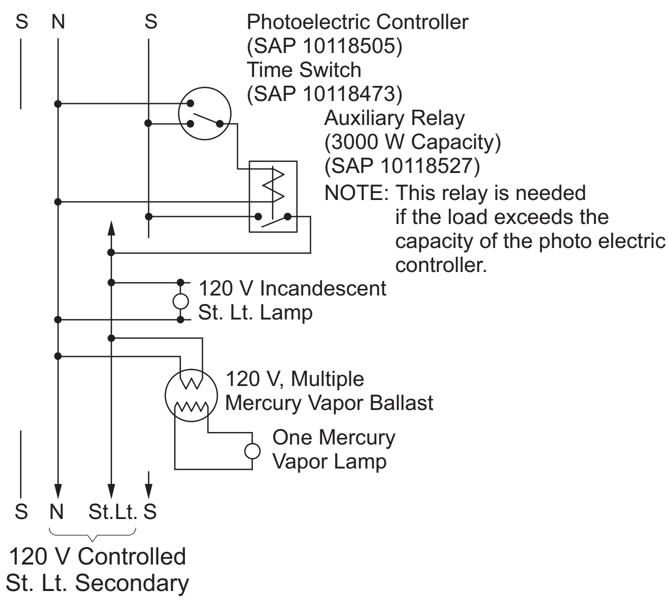
Control of Primary Circuit by Cascading
from a 6.6 A Series Circuit
Figure SL 700–1.1



Control of 120 V Secondary Circuit by
Cascading from a 6.6 A Series Circuit
Figure SL 700–1.2



Control of 120 V Secondary Circuit by
Cascading form 120 V CONTROLLED Secondary
Figure SL 700–1.3



Photoelectric or Time Switch Control of
120 V Secondary Circuit for Multiple Lamps
Figure SL 700–1.4

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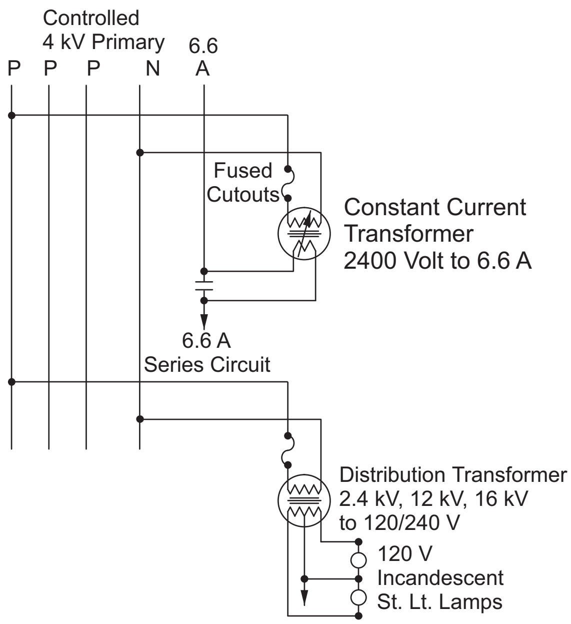
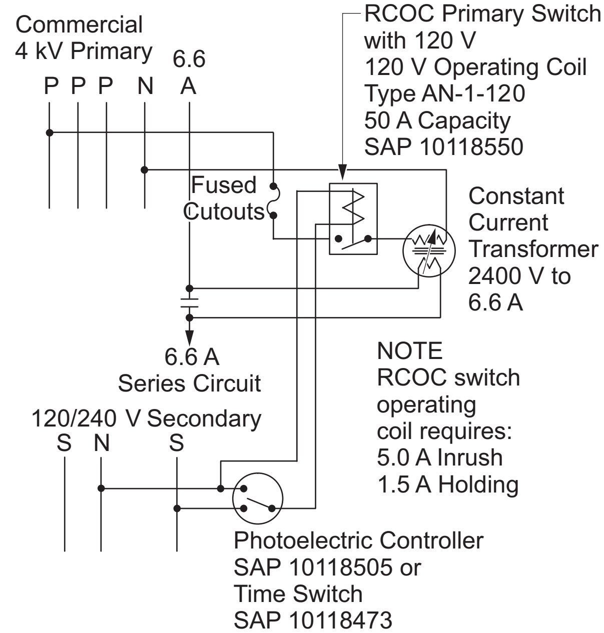
SL 705 4 kV — Wiring Diagram

Scope SL 705.1 4 kV — Wiring Diagram

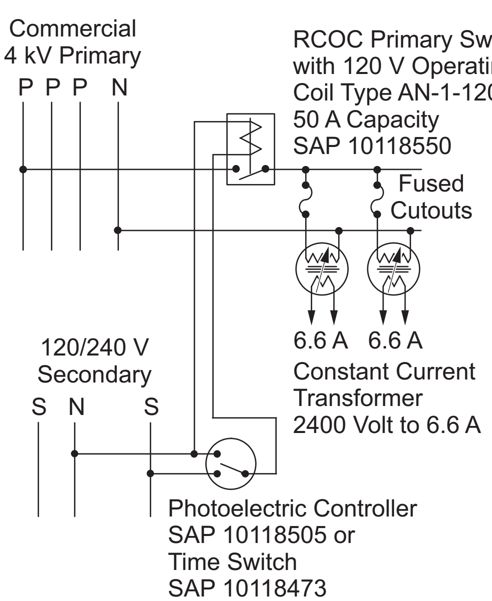
Figure SL 705–1: 4 kV — Wiring Diagram



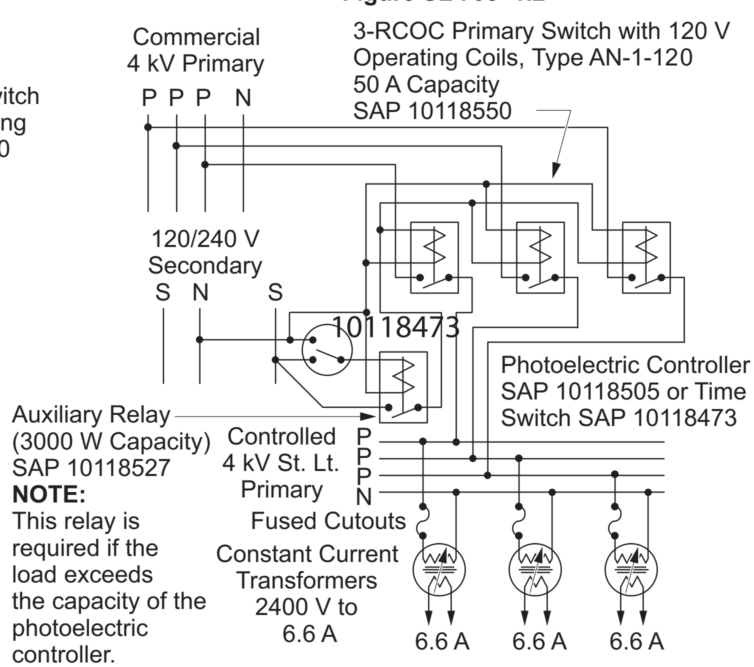
Controlled Primary from Substation
or Pole-Mounted Equipment
Figure SL 705–1.1



Photoelectric or Time Switch Control to Establish a
4-Wire Controlled 4 kV Primary Street-Lighting Circuit
Figure SL 705–1.2



Photoelectric or Time Switch Control of Primary Circuit
to More Than One Constant Current Transformer
Figure SL 705–1.3



Photoelectric or Time Switch Control to Establish a
4-Wire Controlled 4 kV Primary Street-Ligthing Circuit
Figure SL 705–1.4

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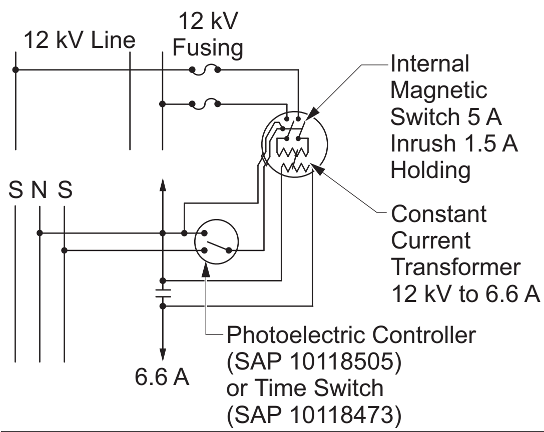
SL 710 12 kV — Wiring Diagram

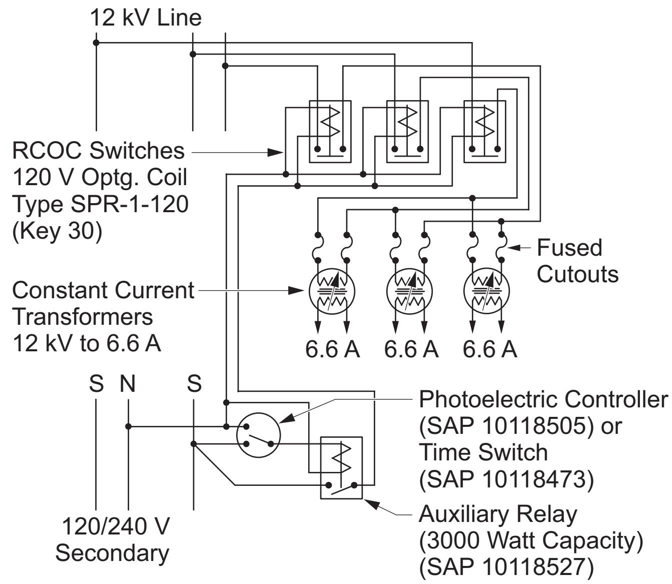
Scope SL 710.1 12 kV — Wiring Diagram

Figure SL 710–1: 12 kV — Wiring Diagram



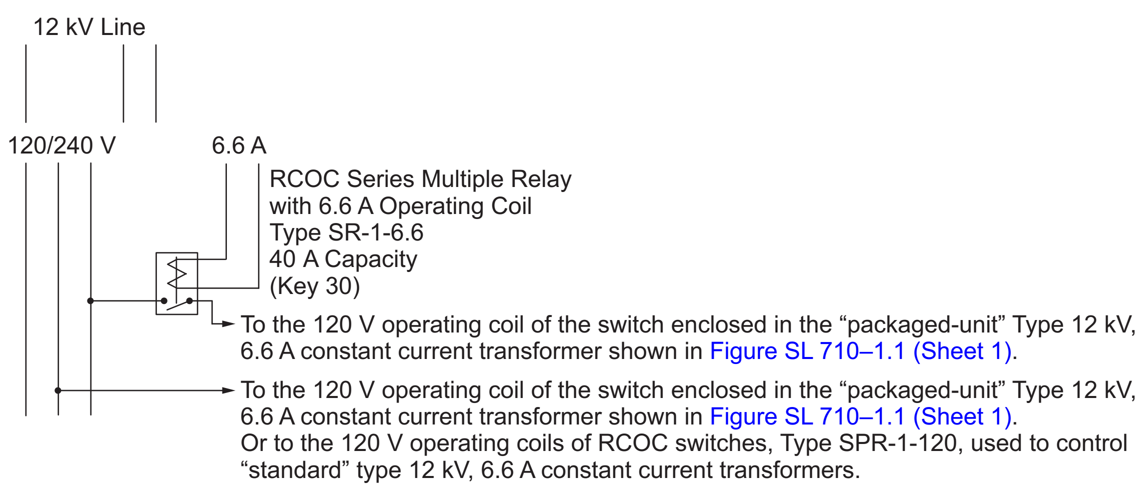
Package Type Constant Current Transformer
Supplying 6.6 A Series Circuit from 12 kV Lines

Figure SL 710–1.1



Control of 12 kV to 6.6 A Constant Current
Transformers by External Magnetic Switches

Figure SL 710–1.2



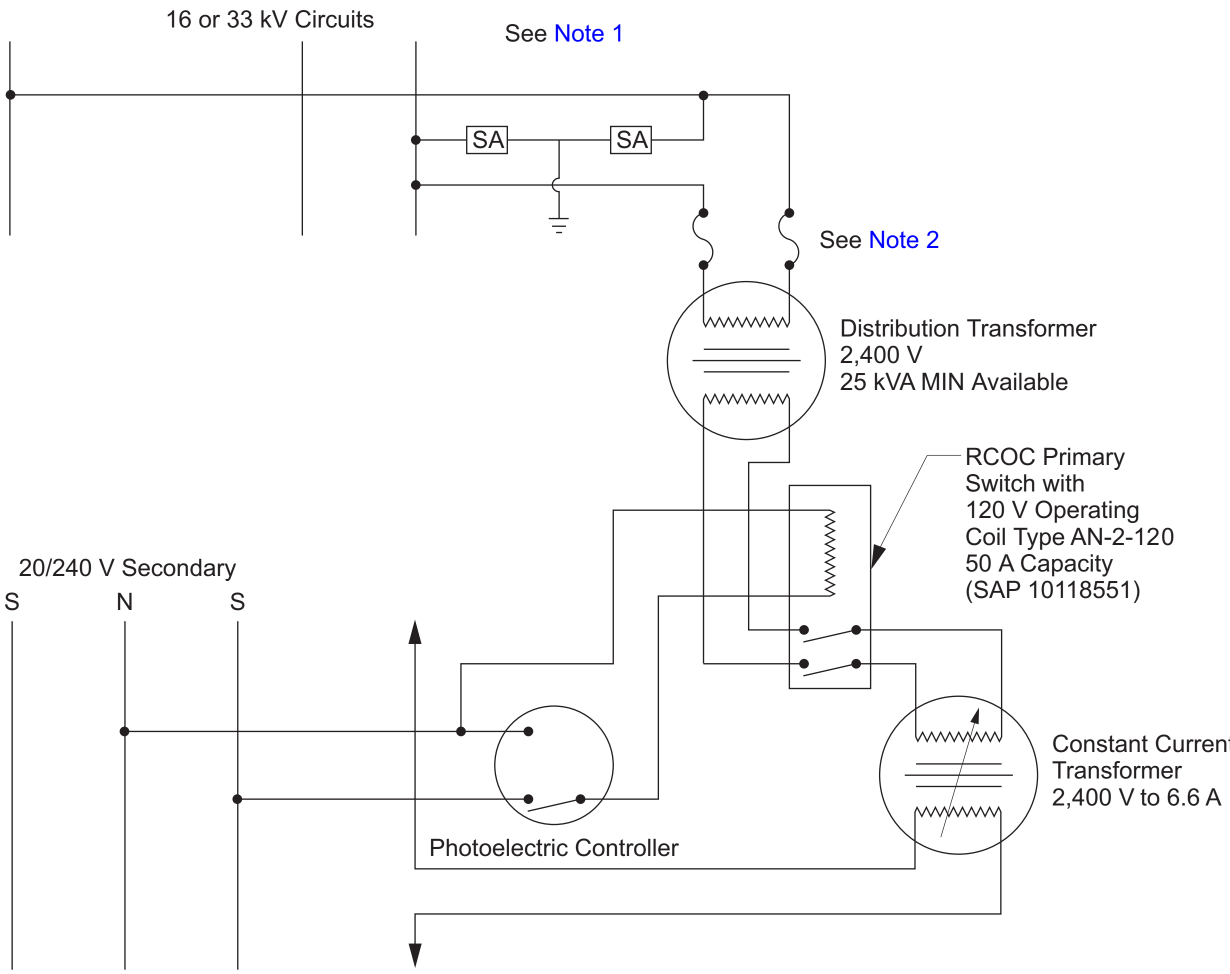
METHOD OF CONTROLLING THE 12 KV PACKAGE TYPE CURRENT TRANSFORMER AND
STANDARD TYPE CONSTANT CURRENT TRANSFORMER BY CASCADING FROM A 6.6 AMP CIRCUIT

Figure SL 710–1.3

SL 715 16/33 kV — Wiring Diagram

Scope SL 715.1 Method of Supplying 6.6 A Series Streetlights in Areas Served by 16/33 kV Lines

Figure SL 715–1: 16/33 kV — Wiring Diagram



Note(s):

1. Refer to Distribution Apparatus Construction Standards (DAP) for light arrestors (when required).
2. Fuses (refer to Distribution Apparatus Construction Standards (DAP)).

R.O. Transformer	
Size kW	**Input kVA**
10	14.10
15	21.00
20	27.80
25	34.60
30	41.50

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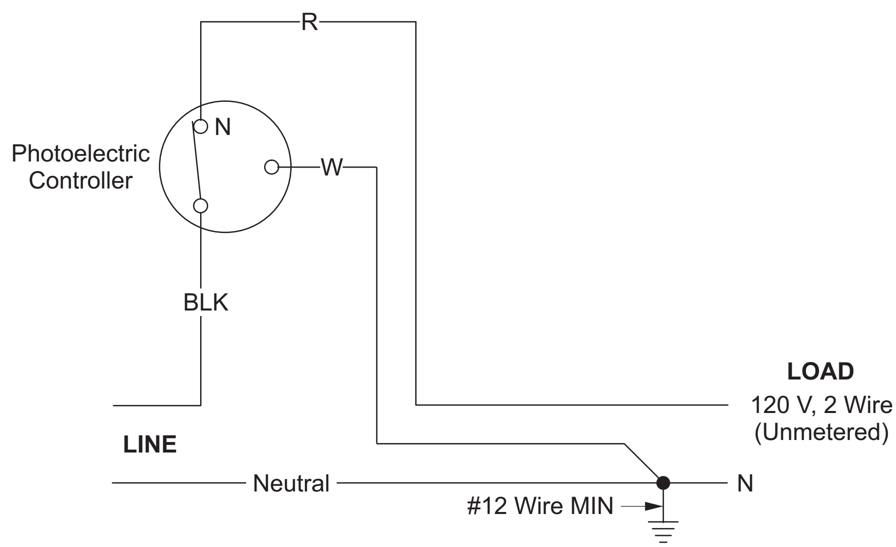
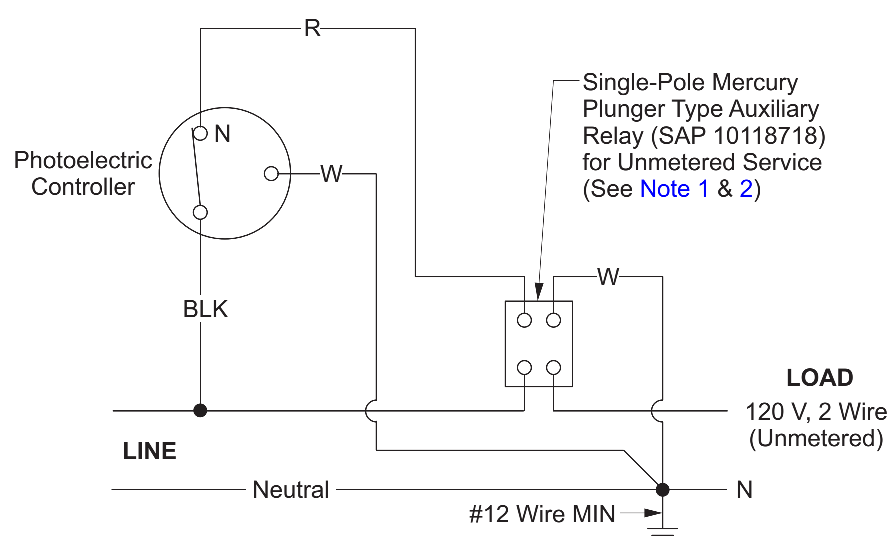
SL 720 **LS-2 Lighting Systems, Served Underground: Schematic Wiring Diagrams with and without Auxiliary Relay**

Scope SL 720.1 **LS-2 Lighting Systems, Served Underground: Schematic Wiring Diagrams with and without Auxiliary Relay**

Figure SL 720–1: LS-2 Lighting Systems, Served Underground: Schematic Wiring Diagrams with and without Auxiliary Relay

Front View





Note(s):

1. If customer's load exceeds the 1000 W capacity of photocontroller, and auxiliary relay is required.
2. Customer to provide and install auxiliary relays for pedestal installations.
3. All other type relays, for example poles, will be furnished and installed by SCE at customer's expense.

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DOH–T: Testing and Metering

Table of Contents

STANDARD	TITLE

T 2 General Instructions for Revenue Metering — Meters

Scope T 2.1 SAP Numbers for Single-Phase Meters

Table T 2–1: Single-Phase kWH

Amp	Volts	Wire	Form	SAP		
				Meter S-Base (Key 6)	Meter S-Base (Key 02 or 04)	A to S Base Adapter
15	120	2	1S	—	10105255	10106018
15	240	3	2S	10105353	—	10106018
30	240	3	2S	—	10105402	10106018
30	480	3	2S	10105636	—	10106018
50[a/]	240	3	2S	10105257	—	—

[a/] Denotes that meter is a Class 320 meter and that it is to be used only on single-phase self-contained 400 A meter panels.

Table T 2–2: Single-Phase Smart Connect kWH

Amp	Volts	Wire	Form	SAP	A to S Base Adapter
15	120	2	1S	10158735	10106018
30	240	3	2S	10168079	10106018
50	240[a/]	3	2S	10158782	—
2.5	240	2	3S	10158738	10106018
30	120[b/]	3	12S	10158737	10106009

[a/] Denotes that meter is a Class 320 meter and that it is to be used only on single-phase self-contained 400 A meter panels.
[b/] Denotes a network meter.

Table T 2–3: Single-Phase KWH — Demand (15 Minutes)

Amp	Volts	Wire	Form	SAP		
				Meter S-Base (Key 06)	Meter S-Base (Key 02 or 04 w/Optical Port)	A to S Base Adapter
2-1/2	Multi	2	3S	10105290 & 10105297	10105523	10106095
30	Multi	3	2S	10105292 & 10105298	10105522	10106018
15	Multi	2	1S	10105521	—	10106018
50	Multi	3	2S	10105550	10105223	—

Scope T 2.2 SAP Numbers for 3Ø kWh Meter (Non-Demand)

Table T 2–4: Polyphase kWh

Amp	Volts	Elem	Wire	Form	SAP		
					S to A Adapter	S-Base	Optical Port
2-1/2	120	2	3	5S	10106101	10105278[a/]	10105307
2-1/2	120	3	4	9S	10106102	10105282[a/]	Pending
15	120	2	3	12S	10106099	10105291	10105357
15	120	3	4	16S	10106100	10105283	10105348
15	120	2	4	14S	10106100	10105289	10105355
30	120	2	3	12S	10106099	10105555	
30	120	3	4	16S	10106100	10105283	10105348
30	120	2	4	14S	10106100	10105289	10105355
2-1/2	240	2	3	5S	10106101	10105277	10105343
2-1/2	240	3	4	10S	10106102	10105285[a/]	10105350
15	240	2	3	12S	10106099	10105279	10105344
30	240	2	3	12S	10106099	10105279	10105344
2-1/2	277	3	4	9S	10106102	10105284	10105349
15	277	3	4	16S	10106100	10105286	10105351
15	277	2	4	14S	10106100	10105354	10105354
30	277	3	4	16S	10106100	10105286	10105351
2-1/2	480	2	3	5S	10106101	10105281[a/]	10105346
15	480	2	3	12S	10106099	10105280	10105345
30	480	2	3	12S	10106099	10105280	10105345

Table T 2–5: Polyphase kWh — 40 Constant

Amp	Volts	Elem	Wire	Form	SAP		
					S to A Adapter	S-Base	Optical Port
30	277	3	4	16S	10106100	10105286[a/]	10105351
30	480	2	3	12S	10106099	10105280	10105345

Table T 2–6: Polyphase kWh — Delta

Amp	Volts	Elem	Wire	Form	SAP		
					S to A Adapter	S-Base	Optical Port
2-1/2	240	2	4	8S	10106102	10105287[a/]	10105352
15	240	2	4	15S	10106100	10105293	10105359
30	240	2	4	15S	10106100	10105293	10105359

[a/] Key 6 Item

Meters with pulse initiators are used with all “TOU” devices and recorders. These meters have special codes and will be supplied by Shop Services and Instrumentation Division.

The Company no longer buys non-demand polyphase meters.

Scope T 2.3 SAP Numbers for 3Ø kWh Meters (Demand)

Table T 2–7: Polyphase kWh

Amp	Volts	Elem	Wire	Form	Demand	SAP Meter S-Base (Key 06)	SAP Meter S-Base (Key 02 or Key 04 w/Optical Port)	SAP A to S Base Adapter
2-1/2	Multi	2	3	5S	15	10105278 10105277 10105281 10105513	10105524[a/]	10106101
2-1/2	Multi	3	4	9S	15	10105282 10105285 10105284	10105525	10106102
30	Multi	2	3	12S	15	10105291[b/] 10105280 10105363 10105279	10105526	10106009
30	Multi	3	4	16S	15	10105283 10105289 10105286 10105288	10105527	10106010

= For Reference Only

[a/] Denotes that the meter's form is actually 45S (5S).
[b/] Denotes a network meter.

Table T 2–8: Smart Connect Polyphase kWh — Delta — Demand (15 Minutes)

Amp	Volts	Wire	Form	SAP	SAP A to S Base Adapter
2-1/2	Multi	3	45S	10175800	10106101
2-1/2	Multi	4	9S	10175799	10106102
30	Multi	3	12S	10158741	10106009
30	Multi	4	16S	10158742	10106010

Table T 2–9: Polyphase kWh — Delta — Demand (15 Minutes)

Amp	Volts	Elem	Wire	Form	Demand	SAP Meter S-Base (Key 06)	SAP Meter S-Base (Key 02 or Key 04 w/Optical Port)	SAP A to S Base Adapter
2-1/2	Multi	2	4	9S	15	10105287	10105525[a/]	10106102
30	Multi	2	4	16S	15	10105293	10105527[b/]	10106010

= For Reference Only

[a/] Denotes that the meter's form is actually 9S (8S).
[b/] Denotes that the meter's form is actually 16S (15S).

Note: *Meters with pulse initiators will be supplied by Metering Services Organization.*

Scope T 2.4 SAP Numbers for 3Ø Reactive Meters

Table T 2–10: Polyphase RkVAh

Polyphase RkVAh						
					SAP	
Amp	Volts	Elem	Wire	Form	S to A Adapter	S-Base
2-1/2	120	2	3	5S	10106101	10105598
2-1/2	120	3	4	10S	10106102	10105601
2-1/2	240	2	3	5S	10106101	10105599
2-1/2	240	3	4	10S	10106102	10105602[a]
2-1/2	277	3	4	10S	10106102	10105603
2-1/2	480	2	3	5S	10106101	10105600

[a] Key 6 Item

Table T 2–11: Polyphase RkVAh — Delta

					SAP	
Amp	Volts	Elem	Wire	Form	S to A Adapter	S-Base
2-1/2	240	3	4	8S	10106102	10110298

Note: *Meters with pulse initiators are used with all "TOU" devices and recorders. These meters have special codes and will be supplied by Shop Services and Instrumentation Division.*

Table T 2–12: Polyphase RkVAh Demand

					SAP	
Amp	Volts	Elem	Wire	Form	S to A Adapter	S-Base
2-1/2	120	2	3	5S	10106101	10105295
2-1/2	120	3	4	10S	10106101	10105294
2-1/2	240	2	3	5S	10106101	10105305
2-1/2	277	3	4	10S	10106102	10105303
2-1/2	480	2	3	5S	10106101	10105603

Scope T 2.5 SAP Numbers for 3Ø Reactive Meters

Table T 2–13: Polyphase kWh/kVARh

Amp	Volts	Elem	Wire	Form	Demand	SAP		
						Meter S-Base	Meter S-Base	A to S Base Adapter
2-1/2	Multi	2	3	5S	15	10105598	10105519[a/]	10106101
2-1/2	Multi	3	4	9S	15	NA	10105520[b/]	10106102

= For Reference Only

[a/] Denotes that the meter's form is actually 45S(5S).
[b/] Denotes that the meter's form is actually 9S(8S).

FOR REFERENCE ONLY

T 3 General Instructions for Revenue Metering — Meters

Scope T 3.1 Time-of-Use Metering Installations Employing Recorders

All new meter installations or changes to existing installations that require pulse initiators on revenue meters for the operation of tape and printing recorders, circuit totalizing relays, or other special devices, require an engineering evaluation for the purpose of:

1. Establishing current transformer ratios that are compatible with available pulse initiator gear ratios and consistent with the expected maximum demand and input pulse rate capabilities of the recorder, relays, and other devices used.
2. Establishing an appropriate demand billing constant (fractions are avoided where possible).
3. Determining if standard “T” drawings are adequate or if special drawings are required.

The engineering evaluation will be made by SSID at the request of the CSD District and upon receipt of the Request for Time-of-Use Metering report, see T 3.2 (Sheet 2), including the following information:

1. General information about the installation, including customer’s name, location, service voltage, planned in-service date, and service rate schedule.
2. Single-line and metering panel drawings, if available, showing bank capacity, bus conductor size and ampere capacity, and metering equipment layout (indicate if weatherproof equipment is required).
3. Estimate of initial and future maximum demands.

The SSID Engineering Section will evaluate the job requirements and issue an Engineering Report, see T 3.3 (Sheet 3), and TOU Metering Data Sheet (PSST 123) to the Service Planner to assist in ordering the correct equipment. Upon receipt of the report, the Service Planner should order equipment and instrument transformers with ratio as listed on upper section. SSID will order and supply all TOU equipment indicated on the lower section of the Engineering Report.

The installation of the metering equipment will be cooperative effort. The district will furnish and install the normal sockets, instrument transformers, test switches, and phasing transformers; SSID will furnish and install the TOU equipment. This TOU equipment may be installed after the service is energized; however, for most efficiency, it should preferably be done at the same time as the Service Crew’s installation, prior to energization. Hence, for most efficiency, SSID should be notified a minimum of two weeks prior to the installation date so that coordination between the two installation crews can be arranged.

Scope T 3.2 Request for Time-of-Use Metering/Customer Pulses

DATE ______

TO: AREA REVENUE METERING ENGINEER, SHOP SERVICES & INSTRUMENTATION DIVISION
SUBJECT: TIME-OF-USE METERING
Please provide Time-of-Use Metering and/or customer Pulses for the customer listed below:

Customer ______ District ______

Account No. ______ District W.O. ______

Address ______

Thomas Bros. Map, Page No. ______ Grid Coordinates ______

Planned In-Service Date ______ Rate Schedule ______

Data Acquisition No. ______

SERVICE INFORMATION	EXISTING	PLANNED
Service Voltage		
3- or 4- wire Metering		
Transformer Size (kVA)		
Initial Demands (kW)		
Future Demands (Date if known)		
Meter Panel Layout or (ESR page)		
kWh Meter No.		
RKVAH Meter No.		
Printing Demand Meter No.		
Magnetic Tape Recorder No.		
Main Switch amp. Capacity		
No. of Metered Circuits		
Bus Size (4 or 5 inches)		
Current Transformer Ratio		
Voltage Transformer Ratio		
Remarks:		

Service Planner ______ District ______ PAX ______

DISTRICT NOTES:

1. On changes to existing metering, attach photograph of meter panel.
2. FOR TOTALIZED METERING, include single line diagram showing main switch sizes, transformer sizes and method of service.
3. Contact Shop Services & Instrumentation Division (minimum) two weeks before in-service date to install metering equipment.

Form 14-36

Scope T 3.3 **Shop Services and Instrumentation Engineering Report**

SHOP SERVICES & INSTRUMENTATION DIVISION
ENGINEERING REPORT

Revenue Metering Equipment description for Time-of-Use Metering

____
Date

TO: ______________________
DISTRICT: ______________________
SUBJECT: Time-of-Use Billing Metering for ______________________
____

Planned In-Service Date ______________________

Per your request for Time-of-Use Metering for the subject customer, we are submitting the following information for the metering installation.

1. Customer service division shall provide and install the instrument transformers and meter panel(s) per the following drawings and equipment list:

Description	Material Code	Quantity Required
ESR page ______	______	______
Metering "T" Drawing ______	______	______
*kWh Meter, Meter, ______ Volts, ______ Wire	______	______
*RKVAH Meter, ______ Volts, ______ Wire	______	______
Meter Test Switch	______	______
Test Switch Cover	______	______
Phasing Transformer, ______ Volt	______	______
Voltage Transformers, ______ Ratio	______	______
Current Transformers, ______ Ratio ______ RF	______	______
Other ______	______	______

*Normal Shop Services & Instrumentation Division will supply the meters listed under Paragraph 2 below. However, in the event that those meters are not available at the time that the service is installed, install these meters for temporary service.

2. Shop Services & Instrumentation Division shall provide and install, upon proper notification by Customer Service, the following Time-of-Use metering and recording equipment. (See attached TOU metering data sheet.)

Description	Code	Required
Shop & Test Drawing ______	______	______
kWh Meter, ______ Volts, ______ Wire, R/I= ______	______	______
RKVAH Meter, ______ Volts, ______ Wire, R/I= ______	______	______
Control Transformer 480/120 Volt	______	______
HGA Relay, 120 Volt	______	______
Two-Pole Knife Switch with Cover	______	______
Totalizing Relay, Type ______ Ratio ______	______	______
Insolation Relay, Type ______	______	______
Recorder, ______ Type ______	______	______
Other ______	______	______
______	______	______

Please contact the undersigned if you have further questions.

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T 4 General Instructions for Revenue Metering — Meters

Scope T 4.1 Adaptation of 5-Blade Meter for Use on an 8-Clip Socket

Figure T 4–1: Bottom View of 5-Blade Meter with Potential Blade in OFFSET Position for Installation on 8-Clip Socket

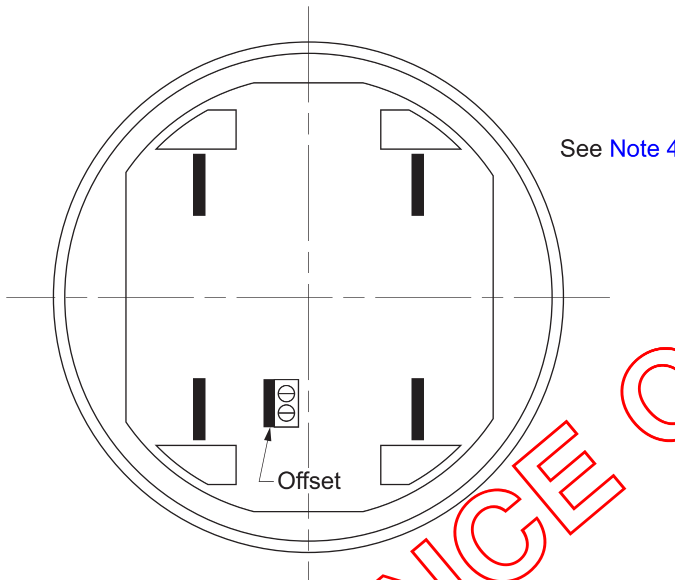
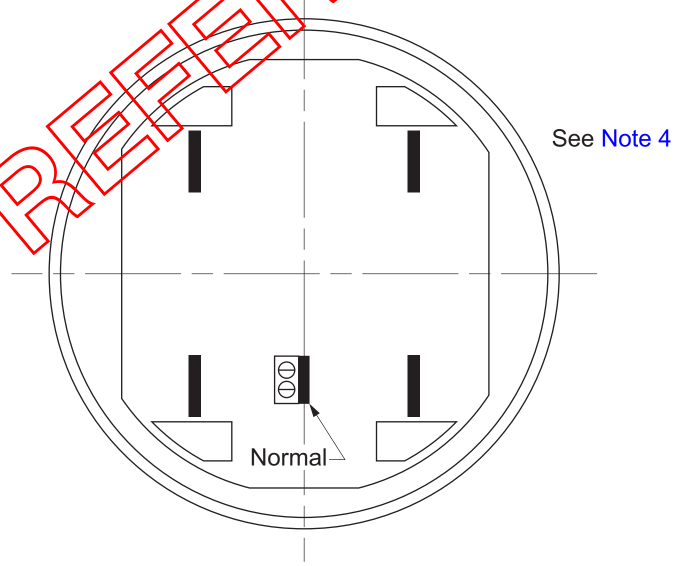


Figure T 4–2: Bottom View of 5-Blade Meter with Potential Blade in NORMAL Position for Installation on 5-Clip Socket



What's Changed? This standard was updated as "FOR REFERENCE ONLY."

Figure T 4–3: Metal Meter Tag (SAP Pending)

Potential Blade
in
OFFSET Position

Pending

Note(s):

Installation of Meter on 8-Clip Socket:

1. Place potential blade in offset position as indicated by arrow in Figure T 4–1 (Sheet 1).
2. Place meter in socket.
3. Install metal meter tag (Figure T 4–3 [Sheet 2]) on the meter sealing ring.
4. Apply a thin film of Mobilgrease 28 (SAP 10153459) to both sides of each current circuit meter blade prior to insertion into the socket. See T 73 for more details.

Removal of Meter for Return to Stock:

1. Remove seal and metal meter tag (Figure T 4–3 [Sheet 2]).
2. Remove meter from socket.
3. Change potential blade to normal position as indicated by arrow in Figure T 4–2 (Sheet 1).

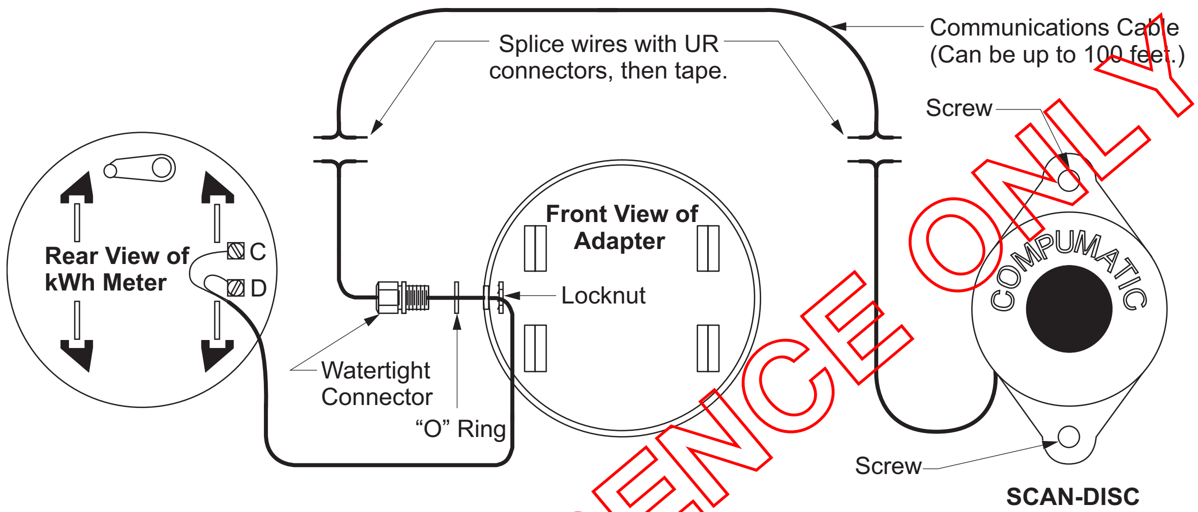
T 5 General Instructions for Revenue Metering — Meters

Scope T 5.1 Remote kWh Meter Reading System (Replaces Hexagram)

1.0 General

This system permits the non-visual reading of a single-phase 120 V or 240 V kilowatt-hour meter some distance away from the meter. The criteria for installation of meters of this type is detailed in Edison System of Manuals (ESM), Section 7.40.11.

Figure T 5–1: Remote kWh Meter Reading System (Replaces Hexagram)



Installation:

1. Prior to installation, attach scan-disc to meter and initiate scan read using a DataCap. Verify that kWh meter number and reading match the scanned information on the DataCap.
2. Mount scan-disc with two screws. Mounting location must be within operators reach to permit scanning (if possible, mount no higher than 6 feet).
3. Complete the installation shown below. Wiring should be run inconspicuously. Install wiring under eaves if possible. Tighten watertight connector until cable is firmly gripped.
4. Upon completion, re-scan to verify integrity of installation.

1.0 Material

The following material is necessary for a scan-disc–based, remote meter installation:

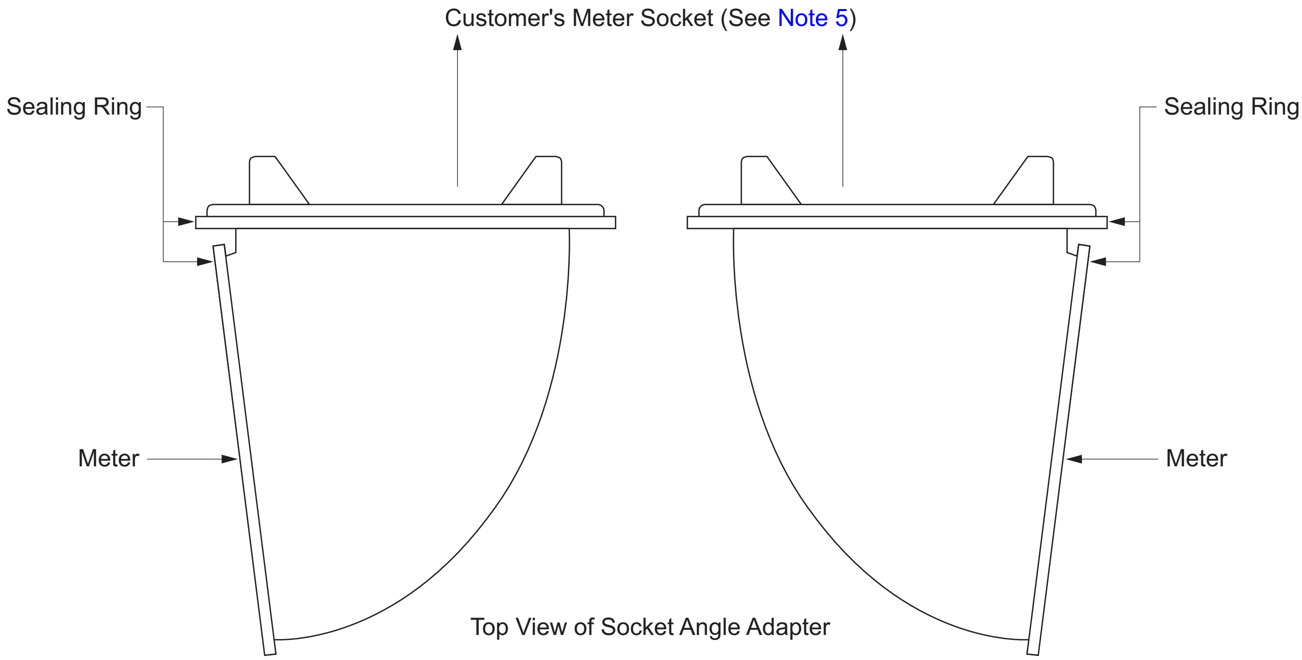
SAP	Description	Quantity
10105360 (120 V) OR 10105361 (240 V)	Meter, kWh, single-phase, Form 1s (120 V) or Form 2s (240 V), equipped with a scan-disc extension dial system	1
10105997	Adapter for wiring to scan-disc	1
10113059	Connector, watertight	1
10113190	Locknut for connector	1
10113142	Sealing "O" ring for connector	1
10110096	Communication cable, AWG 22, jacketed, 2-conductor	1
10127215	UR wire connector	4
10115546	Sealing ring	2

Scope T 5.2 Socket Angle Adapter

1.0 General

This system permits the direct, visual reading of a single-phase 120 V or 240 V kilowatt-hour meter from a location where the mounting angle of the meter needs altering to permit reading the meter register. The criteria for installation of equipment of this type are detailed in ESM, Section 7.40.11.

Figure T 5–2: Socket Angle Adapter



Adapter may face left OR Adapter may face right

Installation:

1. Attach meter to the adapter with the meter upright for the direction from which it is to be read.
2. Secure meter to the adapter with a sealing ring.
3. Attach the adapter/meter assembly to the customer's meter socket.
4. Secure adapter/meter assembly to the customer's meter socket with a sealing ring.
5. Apply a thin film of Mobilgrease 28 (SAP 10153459) to both sides of each current circuit meter blade prior to insertion into the socket. See T 73 (Sheet 1) for more details.

1.0 Material

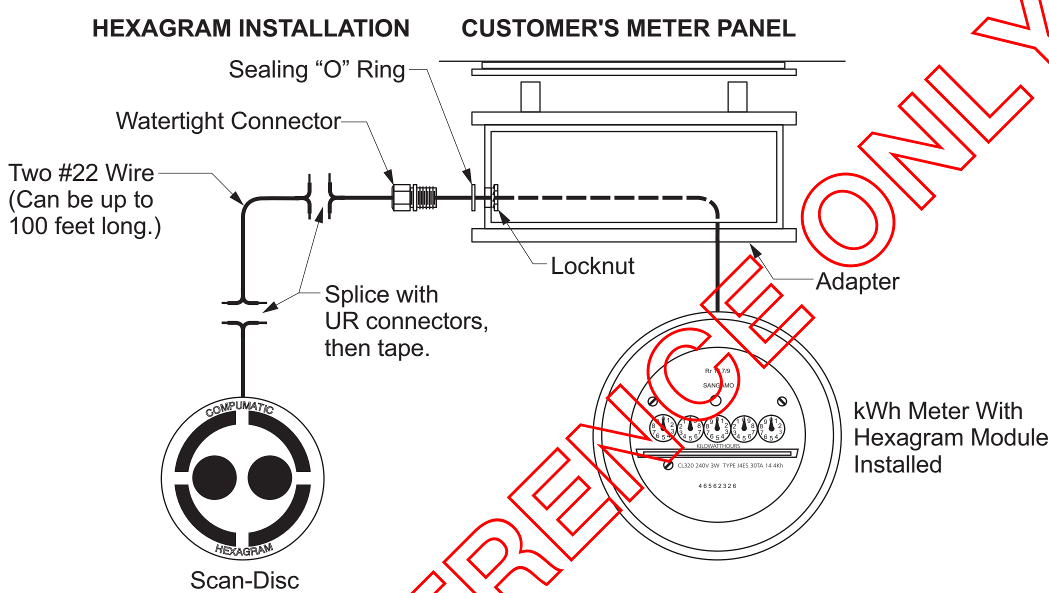
The following material is necessary for a meter socket angle adapter installation:

SAP	Description	Quantity
10106103	kWh meter socket angle adapter	1
10115546	Sealing Ring	2

Scope T 5.3 Hexagram Meters

1.0 Hexagram Installation

Figure T 5–3: Hexagram Meters



Installation:

1. Prior to installation, attach scan-disc to meter and initiate scan read using a DataCap. Verify that the kWh meter number and reading match the scanned information on the DataCap.
2. Mount scan-disc with two screws. Mounting location must be within operator's reach to permit scanning (if possible, mount no higher than 6 feet).
3. Complete the installation shown on T 5.2 (Sheet 2). Wiring should be run inconspicuously. Install wiring under eaves if possible. Tighten watertight connector until conductor is firmly gripped.
4. Upon completion, re-scan to verify integrity of installation.

1.0 Material

The following material is necessary for a Hexagram installation:

SAP	Description	Quantity
10105296	Meter, kWh, Form 2s, 30 A, 240 V, single-phase, equipped with a scan-disc extension dial system	1
10105997	Adapter for wiring to scan-disc	1
10113059	Connector, watertight	1
10113190	Locknut for connector	1
10113142	Sealing "O" ring for connector	1
10110096	Communication cable, AWG 22, jacketed, 2-conductor	1
10127215	UR wire connector	4

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T 24 General Instructions for Revenue Metering — Meter Sockets

Scope T 24.1 Circuit-Closing Devices in Meter Sockets

1.0 Circuit-Closing Devices in Meter Sockets

Our electrical service requirements prohibit the installation of meter sockets in which circuit closing devices (sometimes referred to as bypass clips) are installed. These devices automatically maintain service after a meter has been removed from the socket and sometimes accidentally shunt out the meter when it is in-service on the socket.

An increasing number of meter sockets containing circuit-closing devices has been discovered on operating service equipment. The most preponderant cases have been 13-Jaw sockets on switchboards. However, these devices may appear in any type of meter socket.

Every effort is being made to prevent the sale and installation of meter sockets containing circuit closing devices in Southern California, but due to the scarcity of 13-Jaw sockets, manufacturers of switchboards have purchased any type available. In some cases they, have failed to remove the circuit-closing devices.

Prior to connecting or energizing any service, the meter setter shall ascertain that the meter socket or sockets involved do not contain circuit-closing devices. Where inspection reveals that circuit-closing devices exist, the meter setter is to remove them prior to wiring or installing the meter. These devices are usually operated by small buttons which are pushed to the side by the entering meter prongs, thus opening the contacts of the device. The entire device must be removed at each meter socket jaw. Removal of the buttons only merely leaves the meter inoperative at all times due to leaving the by-pass contacts permanently closed.

2.0 Grounding of A-Base to Socket Adapters

To ensure proper operation of the surge protection gaps in socket type kWh meters, all A-base-to-socket adapters will be equipped with grounding provisions if installed or maintained after May, 1981. The grounding provision must be bonded to the customer's ground terminal to be effective.

To provide adequate grounding, the mounting bracket on the A-base-to-socket adapter must be bonded to the customer's grounded metal enclosure by a minimum #8 AWG solid copper conductor.

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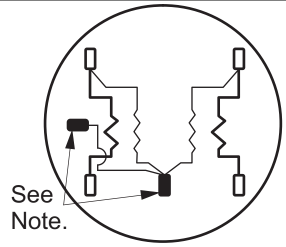
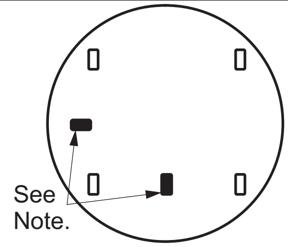
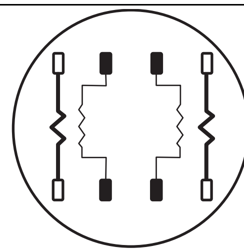
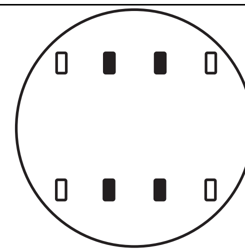
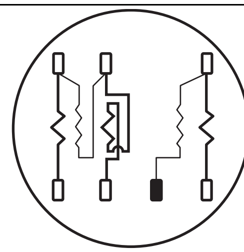
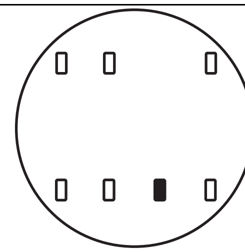
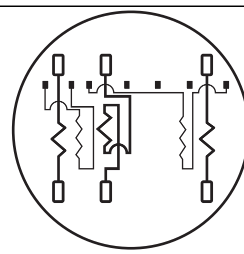
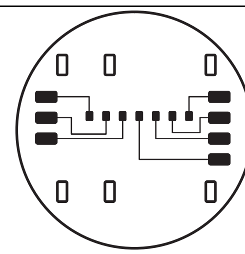
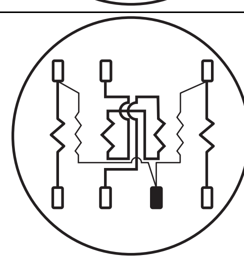
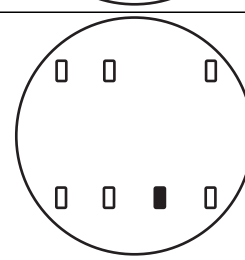
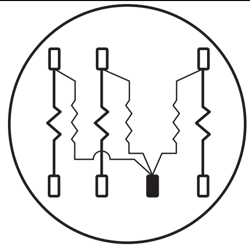
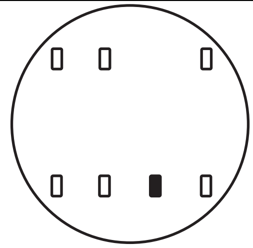
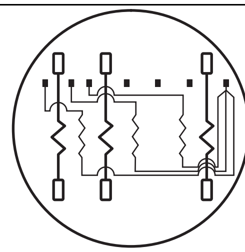
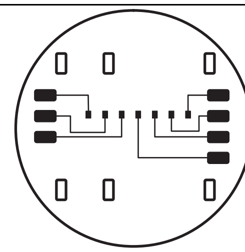
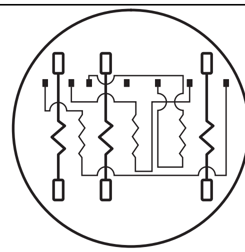
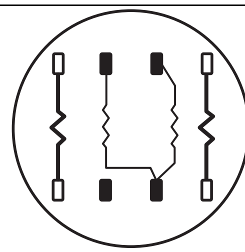
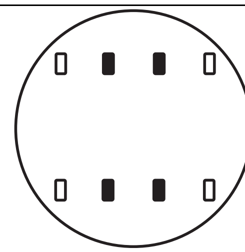
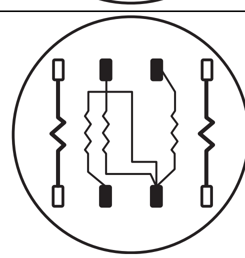
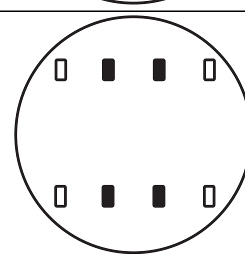
T 25 General Instructions for Revenue Metering — Meter Sockets

Scope T 25.1 Meter and Socket Diagrams for Multi-Stator Meters — Front View

Meter Type	Form	Meter Diagrams	Socket Diagrams
3-Phase, 3-Wire, 2-Stator Self-Contained or 1-Phase, 3-Wire, 120/208 V network services. **Note:** 5th clip may be in either position	12S		
3-Phase, 3-Wire 2-Stator For Use with Instrument Transformers	5S		
3-Phase, 4-Wire 2-Stator Self-Contained	15S		
3-Phase, 4-Wire 3-Stator Delta For Use with Instrument Transformers	8S		
3-Phase, 4-Wire 2-Stator Wye Self-Contained	14S		

Meter Type	Form	Meter Diagrams	Socket Diagrams
3-Phase, 4-Wire 3-Stator Wye Self-Contained	16S		
3-Phase, 4-Wire 3-Stator Wye For Use with Instrument Transformers	9S		
3-Phase, 4-Wire 3-Stator Wye For Use with Instrument Transformers (Used as a Totalizing or Reactive Meter)	10S		Same As Above
3-Phase, 3-Wire 2-Stator For Use with Instrument Transformers (Not to be Used on 4-Wire Delta Service)	35S		
3-Phase, 3- or 4-Wire 2-Stator Delta For Use with Instrument Transformers (Replaces Form 5S in 3-Phase Prints)	45S		

T 30 General Instructions for Revenue Metering — Test Blocks

Scope T 30.1 Meter Test Blocks and Barriers (General)

Test blocks (sometimes designated safety blocks or test/bypass blocks) are required for all self-contained metering on commercial and industrial occupancies including public buildings, on multi-family occupancies that are not separately metered, and on 3-phase agricultural services. Exceptions to this general requirement are listed in the Electrical Service Requirements Manual (ESR).

With exception noted in ESR, the test blocks, see T 32, are to be furnished, installed, and wired or bussed to the meter socket by the manufacturer or the contractor. The test block/meter socket combination must be a UL listed assembly. The wiring sequence shall be clearly and permanently labeled in 3/4-inch block letters below the test-bypass terminals by the Installer in accordance with a LINE-LOAD, LINE-LOAD wiring sequence and must have rigid insulating inter-block barriers as detailed on T 32.

Test block/meter socket that assemblies are rated at 100 A or 200 A, continuous duty. The maximum size conductor which may be terminated in a 100-A test block is 1/0 AWG and the maximum meter switch rating for use with this test block is 125 A. The maximum conductor size that may be terminated in a 200 A test block is 250 kcmil and the maximum meter switch rating for use with this test block is 200 A.

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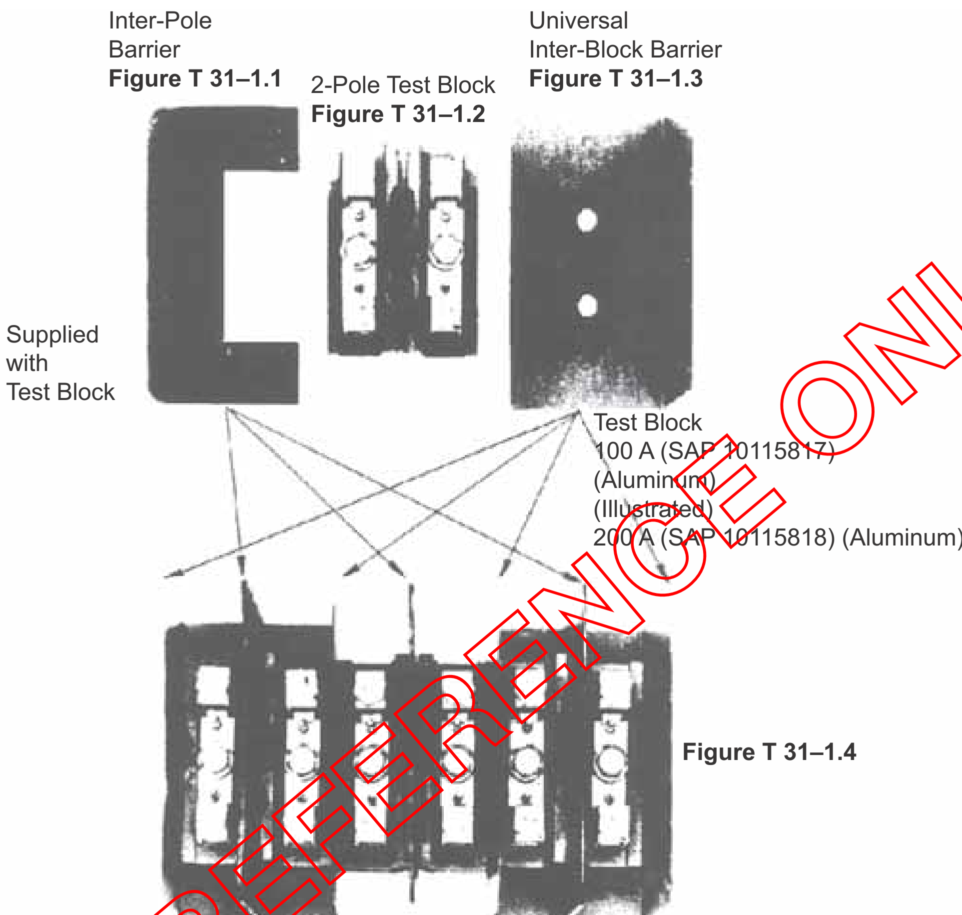
T 31 General Instructions for Revenue Metering — Test Blocks

Scope T 31.1 100/200 A Test Blocks and Barriers

Figure T 31–1: 100/200 A Test Block and Barriers and Assembly of Three Test Blocks with Interpole and Interblock Barriers in Place



Instructions:

An interpole barrier, Figure T 31–1.1 (Sheet 1), shall be installed in **every** 2-pole test block, Figure T 31–1.2 (Sheet 1).

Whenever a group of three 2-pole test blocks is to be installed, an inter-block barrier, Figure T 31–1.3 (Sheet 1), shall be installed between each two adjacent blocks and at both ends of the group of blocks as shown in Figure T 31–1.4 (Sheet 1). Note that tapped holes on 3-inch centers in the mounting pan should be used even though some gap exists between the blocks.

In cases where two 2-pole test blocks are installed for a single phase 120 V, 240 V, or 480 V, 2-wire, 120/240 V, 3-wire, or 120/208 V, 3-wire service, the two blocks shall be mounted with a separation of 3 inch or more. In these cases inter-block barriers, Figure T 31–1.3 (Sheet 1), are to be installed only at the left-hand and right-hand ends of groups of 100 A blocks.

Note(s):

1. Do not use 200 A blocks in 100 A safety socket boxes.

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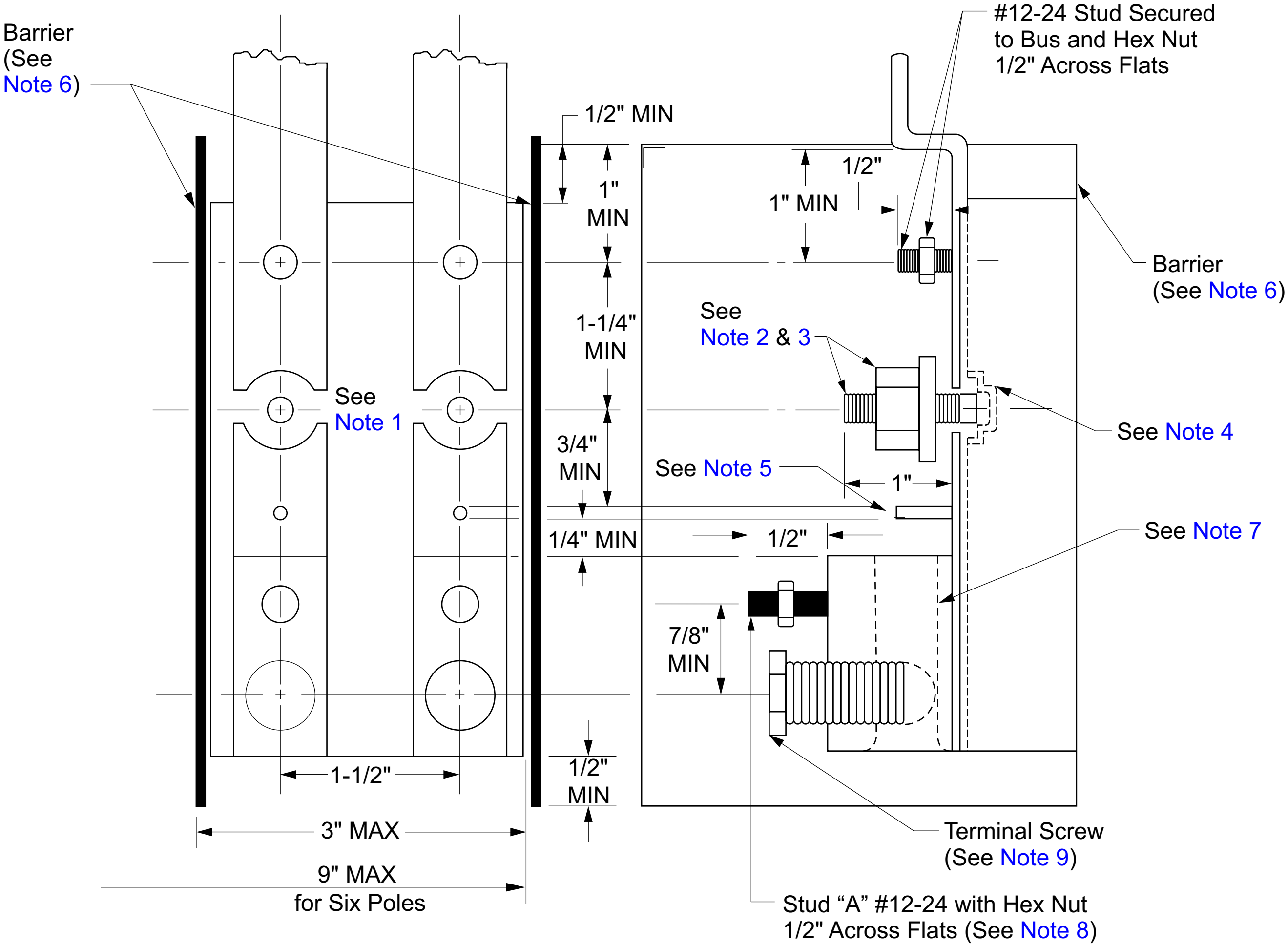
T 32 General Instructions for Revenue Metering — Test Blocks

Scope T 32.1 Factory (Contractor) Installed 100/200 A Test Blocks and Barriers

Figure T 32–1: Factory (Contractor) Installed 100/200 A Test Blocks and Barriers



Note(s):

1. Strike distance between upper and lower bus sections shall not be less than 1/4 inch when shorting nut is backed off.
2. Circuit-closing nut shall be a hex nut 5/8 inch across flats with plated copper washer attached and have threads counterpart at bottom to facilitate reinstallation. Bolt head shall be secured in place to prevent turning and backout.
3. Circuit-closing nut and bolt assembly shall maintain the applied contact pressure between the plated copper washer and the bus members of the test-bypass block.
4. Insulating washer shall be made from dimensionally stable, non-tracking material and shall provide a minimum of 1/8-inch creep distance between the bolt and the bus sections. Bus sections shall be plated.
5. Wire stops shall extend to center of terminal opening or beyond.
6. Rigid insulating barriers shall project at least 1/4 inch beyond any energized parts when the maximum wire size is installed.
7. Terminals shall be aluminum bodied. For required conductor range, see T 30. The opening shall extend through the terminal body and, if wire hole is round, shall be chamfered as necessary to facilitate installation of the largest size wire.

8. Stud “A” shall be located in the clear area between the terminating lug and the circuit-closing nut, and may be positioned on the terminal body, on the terminal screw, on the bus member, or incorporated as part of the wire stop.
9. The terminal screw may be of the Allen type (3/16 inch for 100 A, 5/16 inch for 200 A). If Stud “A” is part of the terminal screw, the terminal screw shall be 5/8-inch hex across flats.

T 34 General Instructions for Revenue Metering — Test Blocks

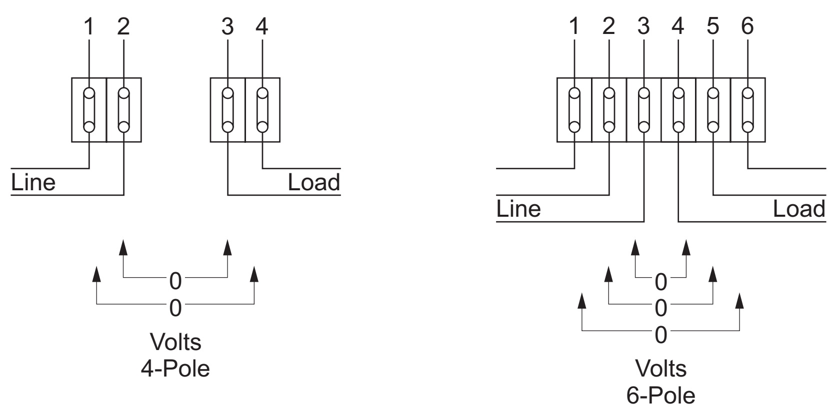
Scope T 34.1 Meter and Test Block Connections

The purpose of a test block is to allow isolation of the kWh meter for purposes of test and replacement, and to furnish a means of maintaining service to the customer during these operations by installing by-pass jumpers or links. There are a number of possible connection methods, hence, it is imperative that the connection sequence to any meter test block be ascertained prior to any work being performed. An observation of the leads as to which is line or load, or as to which leads are the same phase, is **never** enough assurance as to the type of connection sequence that is used. The observation **must** always be supplemented with voltage checks on the test blocks.

1.0 Company Installed Test Blocks (For Reference Only)

Company-installed test blocks are connected in a **line-line-line, load-load-load** wiring sequence. It is extremely important to maintain the correct phase relationship in the wiring between the meter socket and **both** the **line** and **load** terminals of the test block assembly. This phase relationship is assured **only** when the wiring is in the exact accordance with the wiring diagrams applicable to Company-Installed Test Blocks found elsewhere in the T-Section. Voltage checks are to be performed as illustrated below.

Figure T 34–1: Line-Line-Line, Load-Load-Load Sequence



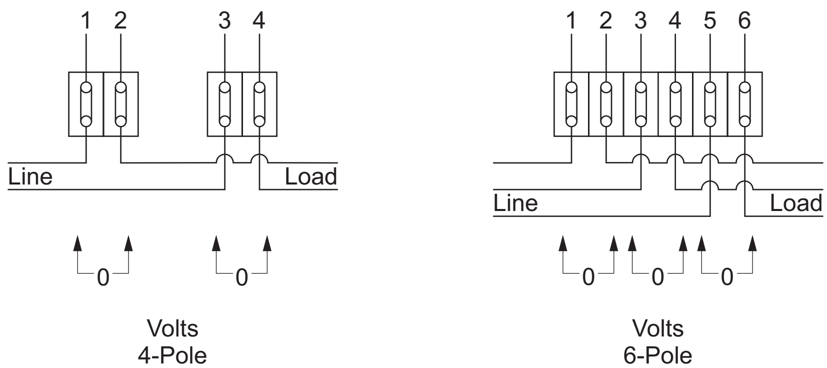
In the 4-pole assembly, pole # 1 must **always** be the same phase as pole #4. And pole #2 must **always** be the same phase as pole #3. Similarly, in the 6-pole assembly, the pairs of poles of like phase must **always** be #1–#6, #2–#5, and #3–#4.

If any **line** leads or **load** leads are transposed between the test blocks and the meter socket, this phase relationship will be destroyed, and even though the meter may operate correctly, the serious hazard of a **phase-to-phase short circuit** will exist whenever it becomes necessary to **Jumper** the meter.

2.0 Factory (or Contractor) Installed Test Blocks

Factory (or contractor) Installed Test Blocks are connected in a **line-load, line-load, line-load** wiring sequence. All such installations require permanent labeling in minimum 3/4-inch high block letters designating each test block pole as being **line** or **load**. In addition, rigid, insulating inter-block barriers are required on both sides of each block. Labeling and barriers must be provided by the factory (or contractor). Voltage checks are to be performed as illustrated below.

Figure T 34–2: Line-Load, Line-Load, Line-Load Sequence



3.0 Test Blocks In Old California Electric Power company (CEP) Territory

In former CEP Territory of the Eastern Division, the **line-line-line, load-load-load** sequence of wiring test blocks was changed in about 1952 to **line-load, line-load, line-load** sequence. The CEP test blocks used for this later sequence employ a hex screw on the terminals for testing and jumpering connections. Inter-block barriers were used, but no interpole barriers were employed. Subsequent to the merger, the use of Edison test blocks employing the threaded stud for testing and jumpering connections was initiated, but the wiring sequence remained **line-load, line-load, line-load**. The phase relationship for this sequence is the same as illustrated for factory (or contractor) installed test blocks.

In 1965, the wiring sequence in the former CEP territory was changed to **line-line-line, load-load-load**. However, since both sequences and both types of blocks may be found in any combination, it cannot be assumed that the type of block used establishes the connection method. It is essential for reasons of safety that voltage checks be made to verify the connection sequence.

4.0 Bypass Procedure — All Test Blocks

For the purpose of maintaining service to a customer during a meter test or while replacing a meter bypass jumpers or links shall only be used between terminals where there is a zero voltage reading.

T 50 General Instructions for Revenue Metering — Grounding

Scope T 50.1 Correct Connections of Neutral or Grounded Service Conductors in Meter Installations

T 51 illustrates that a delta connected transformer bank, with either a grounded phase or ground midpoint, must be connected to the metering so that the grounded connector does not run through the series coils of the meters and so that the voltage on the conductors that connect to the series coils does not exceed 120 volts to ground.

A universal rule applicable to all meter installations is that **in no case** should the **neutral** or the **grounded conductor** be routed through the **current coil** or **current transformer** of any metering installation.

Where an error in meter connection is discovered by the testman, a report of the conditions will be made. Upon receipt of such reports by the district, corrections are to be made on all installations even though only power is served, except on isolated agricultural plants.

On isolated agricultural plants where only power is served at not over 240 V and where no evidence of tampering exists, no report will be made and correction will not be made unless it becomes necessary to replace an existing meter.

When a crew foreman changes the voltage to ground from any given 240 V phase conductor of an existing secondary system supplied from 3-phase delta connected transformer windings due to transformer replacement, or for any other reason, he shall ascertain that the neutral of any single-phase, 120/240-V system remains grounded. He shall also arrange, as directed by the district operations manager, for the checking of the connections of all 3-phase meters supplied from an existing 3-phase, 240 volt secondary system fed by delta connected transformer windings. For compliance with these instructions, T 52 shows transformer grounding methods.

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T 51 General Instructions for Revenue Metering — Grounding

Scope T 51.1 240 V, 3Ø, 3-Wire Meters Connected to Open or Closed Delta Transformer Banks

Figure T 51–1: 240 V, 3Ø, 3-Wire Meters Connected to Open or Closed Delta Transformer Banks

Figure T 51–1.1

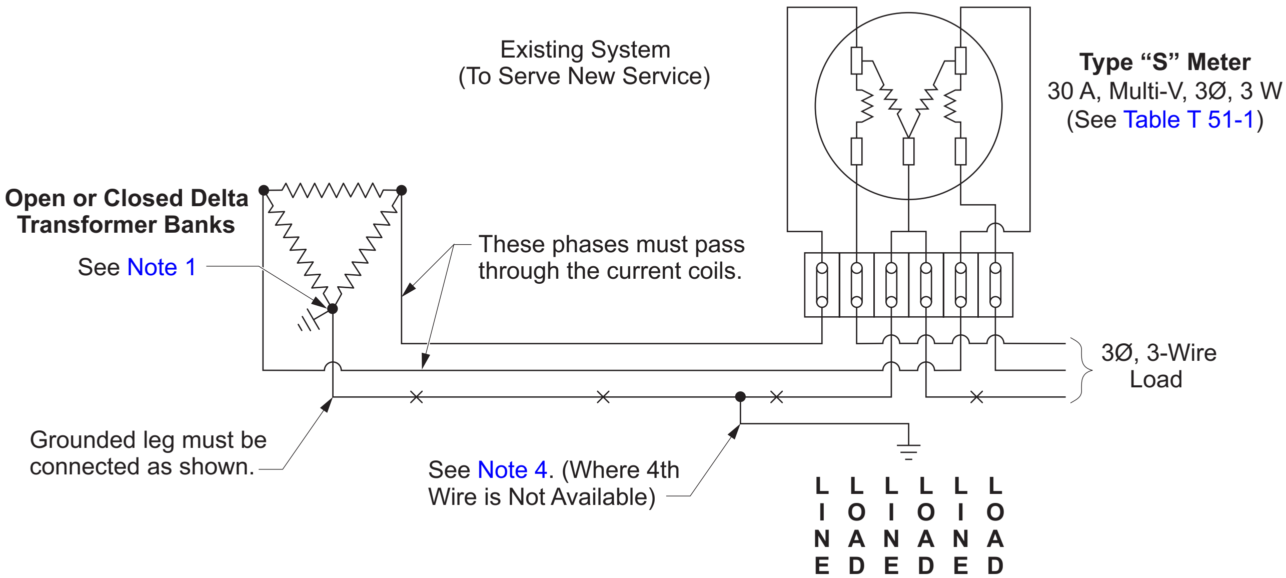


Figure T 51–1.2

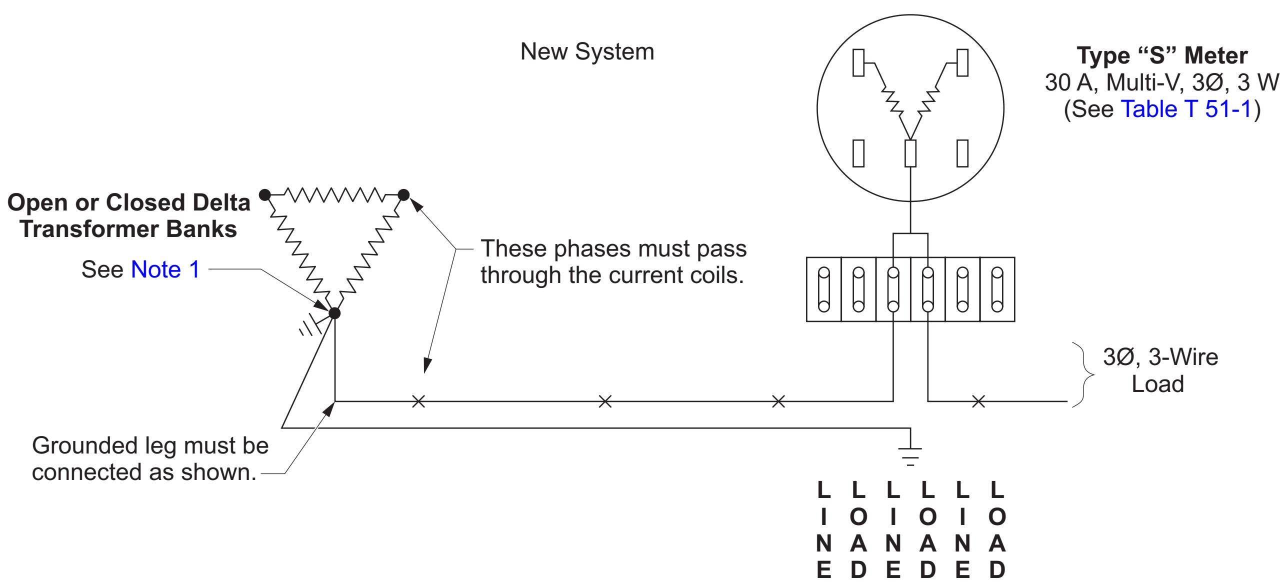


Table T 51–1: 240 V, 3Ø, 3-Wire Meters Connected to Open or Closed Delta Transformer Banks

Meter Form	Meter Description	SAP
12S	30 A, Multi-V, 3 Wire	10105526
12S ESC [a/]	30 A, Multi-V, 3 Wire	10158741

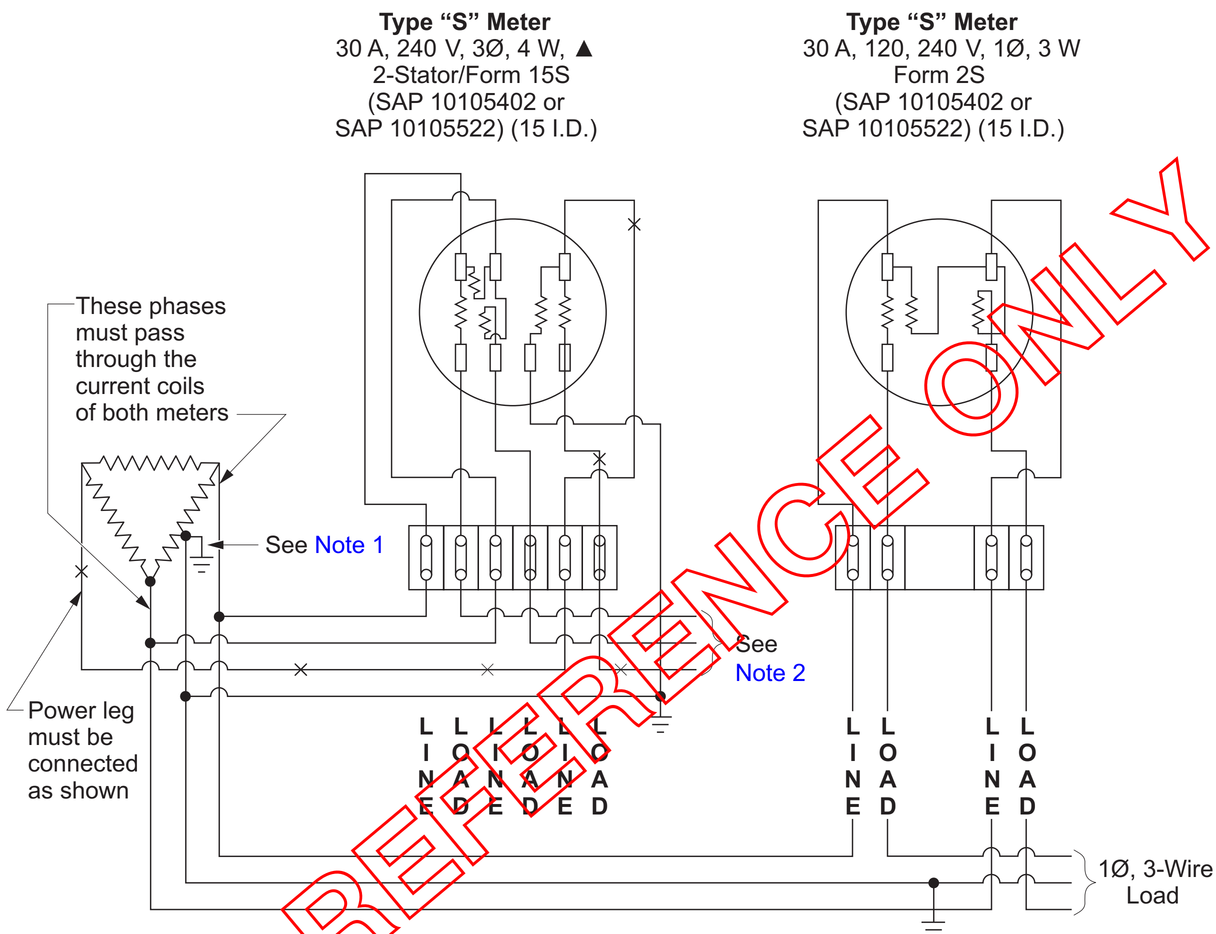
[a/] Edison SmartConnect (ESC)

Note(s):

1. For 3Ø, 3-wire systems, grounding one corner (a point common to two windings) is required.
2. For existing service connection, the grounded phase conductor must be connected to the customer’s grounding electrode.
3. For new service connection, a fourth (grounding) conductor must be run and connected to the customer’s grounding electrodes. The fourth (grounding) conductor shall be connected to the grounded phase conductor on the pole or point from which the service originates (for existing systems, see Figure T 51–1.1); or connected to the transformer bank ground (for new systems, see Figure T 51–1.2), whichever applies.
4. See T 50 and T 53 for additional metering and grounding information.

Scope T 51.2 240 V, 1Ø, 3-Wire and 3Ø, 4-Wire Delta Meter Connected to Open or Closed Delta Transformer Banks

Figure T 51–2: 24 V, 1Ø, 3-Wire and 3Ø, 4-Wire Delta Meter Connected to Open or Closed Delta Transformer Banks



Note(s):

1. Where the midpoint of a transformer is grounded, the grounded conductor must be run with both 1Ø and 3Ø services for connection to the customer's grounding electrodes. All 3Ø metering on this system must be 4-wire whether or not the customer uses a neutral in his system (see Figure T 51–2).
2. See T 50 and T 53 for additional metering and grounding information.

Scope T 51.3 **240 V, 3Ø, 4-Wire Meter and 1Ø, 3-Wire Meter Connected to Open or Closed Delta Transformer Banks**

Figure T 51–3: 240 V, 3Ø, 4-Wire Meter and 1Ø, 3-Wire Meter Connected to Open or Closed Delta Transformer Banks

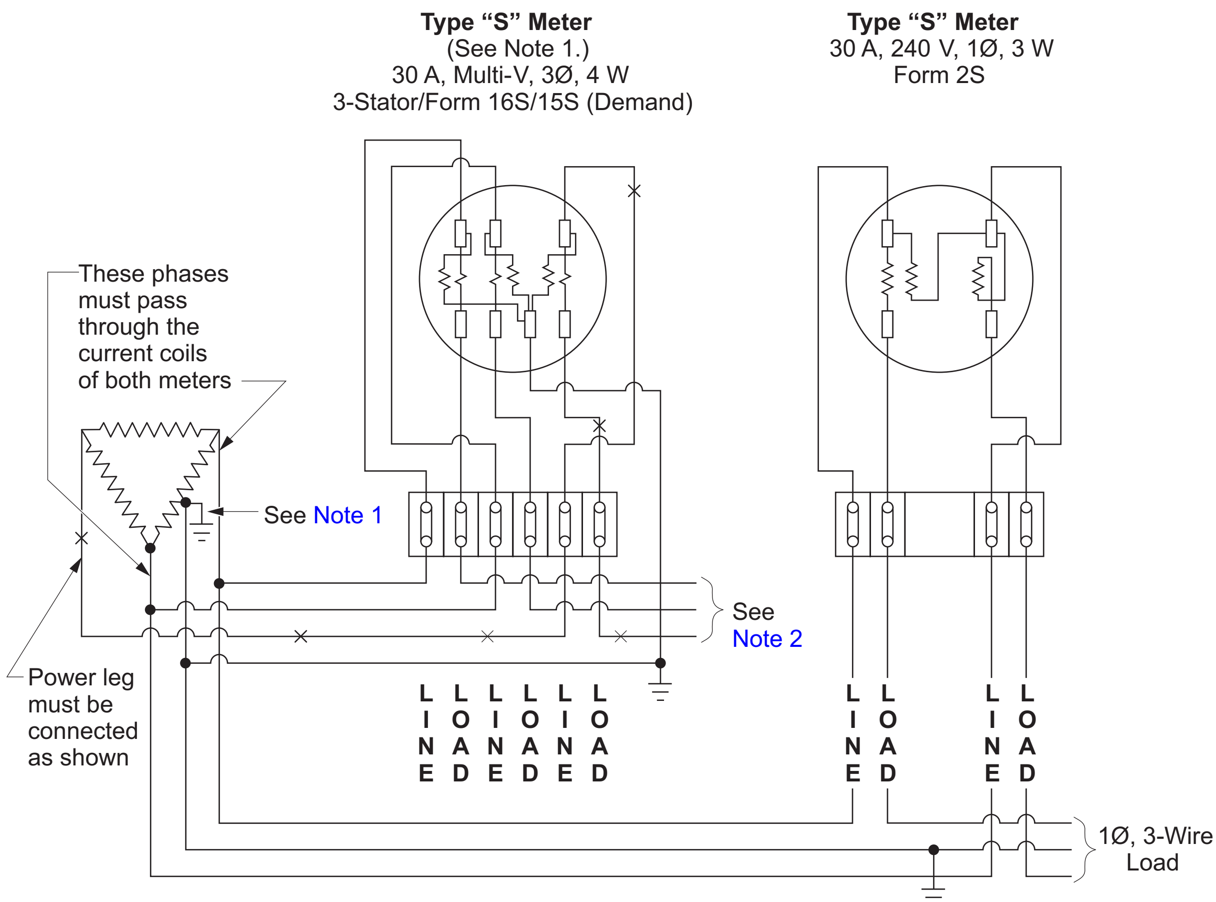


Table T 51–2: 240 V, 3Ø, 4 Wire Meter and 1Ø, 3-Wire Meter Connected to Open or Closed Delta Transformer Bank

Meter Form	Meter Description	SAP
16S/15S (See Note 1)	30 A, Multi-V, 3Ø, 4 W	10105527
2S	30 A, 240 V, 1Ø, 3 W	10105402
2S	30 A, 240 V, 1Ø, 3 W	10105522
2S ESC [a/]	30 A, 240 V, 1Ø, 3 W	10168079
2S ESC Cell Relay [a/] (See Note 4)	30 A, 240 V, 1Ø, 3 W	10168499

[a/] Edison SmartConnect (ESC)

Note(s):

1. Where the midpoint of a transformer is grounded, the grounded conductor must be run with both 1Ø and 3Ø services for connection to the customer's grounding electrodes. All 3Ø metering on this system must be 4-wire whether or not the customer uses a neutral in his system (see Figure T 51–2).
2. See T 50 and T 53 for additional metering and grounding information.
3. Affix a "Meter Voltage" sticker to the meter panel, two inches below the meter's rim. See T 75 for sticker selection.
4. The Edison SmartConnect (ESC) cell relay meter types are used as receivers for the surrounding SmartConnect meters and for forwarding these meter broadcasts to a central location for reading. Installation/location of these meters are pre-determined and have identification tags attached to them. Before conducting any servicing of these meters, please call; the Grid Services Advanced Metering Operations (AMO) at (626) 543-6393.

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T 52 General Instructions for Revenue Metering — Grounding

Scope T 52.1 Grounding of Distribution Transformer Secondaries

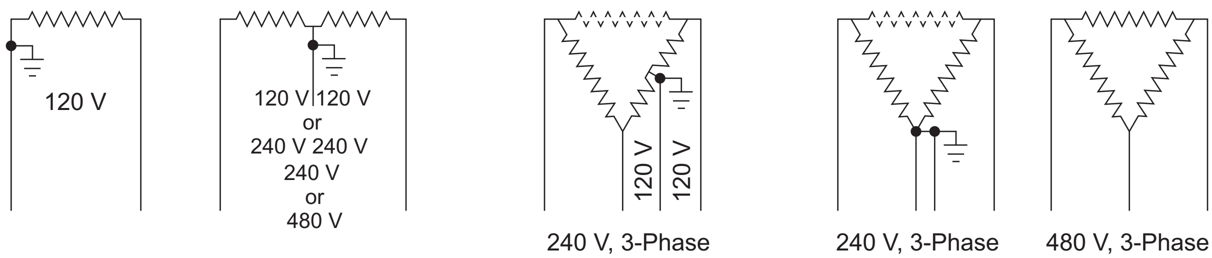
Figure T 52–1: Single-Phase Transformers

One Transformer — Single-Phase Service Only

- 120 V — Figure 1
- 120/240 V or 240/480 V — Figure 2

Two or Three Transformers

- 120/240 V, 1-Phase and/or 240 V, 3-Phase Service or 3-Phase, 4-Wire Delta — Figure 3
- 3-Phase Service Only: 240 V — Figure 4
- 3-Phase Service Only: 480 V — Figure 5 — Reference Only —



Figures 1, 2, 3, or 4 One Ground as Shown Shall Be Used

Note(s):

1. Where light and power are served from separate transformers, each source shall have a separate ground connection. Refer to G.O. 95, Rule 58.2A1.

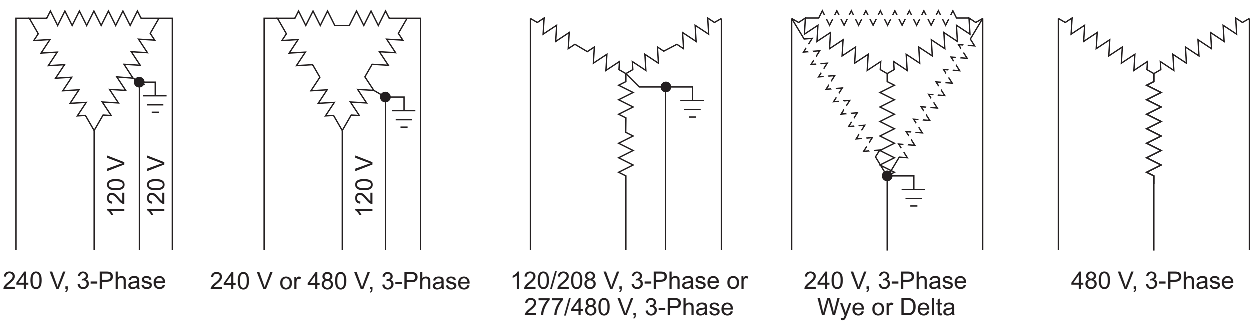
Figure T 52–2: Three-Phase Transformers

Single-Phase and 3-Phase Service

- 120/240 V 1-Phase, 3-Phase 4-Wire Delta — Figure 6
- 120 V, 1-Phase and 240 or 480 V, 3-Phase — Figure 7 — Reference Only —
- 120/208 V, 3-Phase or 277/480 V, 3-Phase — Figure 8

3-Phase Service Only

- 240 V, 3-Phase — Figure 9
- 480 V, 3-Phase — Figure 10 — Reference Only —



Note(s):

1. Do not ground when connected for 480-V service unless lighting tap is used.
2. Location of grounds in order of preference:
   - A. At transformer pole
   - B. At a pole adjacent to transformer

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T 53 General Instructions for Revenue Metering — Grounding

Scope T 53.1 Requirements for 240 V, 3Ø Grounding and Metering

Until 1975, 240 V, 3Ø, 3-wire services were supplied from delta connected transformer banks grounded either at the mid-point of one transformer or at one corner of the delta. Regardless of the grounding method, the grounded conductor was not connected to ground at the customer's service equipment, and the service was metered 3-wire (that is, using a Form 12S meter and socket for self-contained metering and a Form 5S meter and socket for instrument transformer metering).

In 1975, revisions of G.O. 95 and G.O. 128 Rule, 36.5-A1 required the grounded conductor of any grounded secondary system (250 V or less) to be run to each service. The purpose was to provide a low-impedance ground return path to ensure proper operation of the customer's protective equipment in the event of a ground fault on his system. This revision affected 240 V, 3Ø, 3-wire metering and service as follows:

1. For 3Ø, 3-wire (4th wire for grounding only) services, the required method is to ground a point common to two windings (one-phase wire) and to meter the service 3-wire. See T 51, T 326, and T 356. The grounded phase conductor is not to be grounded at the customer's service equipment. Instead, a fourth (grounding) conductor is to be run as detailed on T 51.
2. When 3Ø service is served from a midpoint grounded transformer bank, a fourth (grounding) conductor is to be run as detailed on T 51, and the service is to be metered with a 4-wire delta meter. See T 51, T 431, T 454, and T 455.
3. On all 240-volt, 3Ø services, regardless of grounding method, a fourth (grounding) conductor shall be run with each service and connected to an identified grounding conductor provided by the customer. The service grounding conductor shall be sized as follows:
   a. General Requirement

Table T 53–1: National Electrical Code Table 250-94

Size of Largest Service Conductor or Equivalent for Parallel Conductors		Minimum Size of Grounding Conductor	
Copper	**Aluminum**	**Copper**	**Aluminum**
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250 kcmil	4	2
over 3/0 through 350 kcmil	over 250 kcmil through 500 kcmil	2	1/0
over 350 kcmil through 600 kcmil	over 500 kcmil through 900 kcmil	1/0	3/0
over 600 kcmil through 1100 kcmil	over 900 kcmil through 1750 kcmil	2/0	4/0
over 1100 kcmil	over 1750 kcmil	3/0	250 kcmil

1. On underground cable, use the neutral conductor of a four-conductor cable assembly.
2. On quadruple cable, use the bare ACSR conductor.

4. The identified grounding conductor provided by the customer must be sized in accordance with National Electrical Code, Table 250-94 (Table T 53–1 [Sheet 1]), based on the service entrance conductors. The grounding conductor must run with the service entrance conductors and connect to the premise's grounding electrode. The grounding conductor may be bare or insulated and may run through the metering enclosure; however, where a bare ground wire is run through the metering enclosure, it must be barriered or in a raceway.
5. Wherever a fourth (grounding) conductor is run to the customer's premises, the type of metering at that location must always be consistent with the serving transformer bank grounding method (that is, corner grounding requires 3-wire, Form 5S or 12S meters and sockets and midpoint grounding requires 4-wire, Form 8S or 15S or solid-state 9S (8S) or 16S (15S) meters and sockets). Transformer grounding should not be changed without verifying that the metering will remain correct on all services.

Note(s):

1. 240 V, 3Ø, 3-wire (fourth wire provided for grounding only, see T 51) and 240 V, 3Ø, 4-wire delta (with midpoint ground, see T 51) services are not to be served from the same transformer bank unless facilities for 240 V, 3Ø, 4-wire delta metering are provided for both services.
2. 240 V, 3Ø, 3-wire (no ground provided with service) is compatible with either 240 V, 3Ø, 3-wire (fourth wire for grounding only); or 240 V, 3Ø, 4-wire delta installations.

T 60 General Instructions for Revenue Metering — Instrument Transformers

Scope T 60.1 Rating Factors of Current Transformers for Proper Selection of Current Transformer Capacity

Most modern current transformers are designed to operate continuously at loads greater than their nameplate rating — sometimes as much as double that value.

This overload capability is marked on the nameplate of most CTs as follows:

1. Directly as overload current

   Example: A 50:5 Amp, Type JKM-3, General Electric CT is marked –
   "Max. Cont. Amp – 75"
   The overload capacity of this unit is 75 A.

2. By an overload rating factor (RF)

   Example: A 200:5 Amp, Type S-6 Sangamo CT is marked –
   "RF = 2 at 30°C", or "RF at 30°C = 2"
   The overload capacity of this unit is 2 × 200 or 400 A.

Typical rating factors are 1.0, 1.25. 1.33, 1.5, 2.0, 2.5, and 3.0. In each case, the overload capability is the ampere rating multiplied by the rating factor.

CTs that do not have nameplate marking as above may be assumed to have a rating factor = 1.0.

To avoid or minimize undesirable over-metering (too small secondary current through the meter), it is very important that this overload capability be used in making the proper selection of CTs for a given installation.

Where a sweep pointer type demand register having a 4.0 kW scale or any clock dial type demand register is employed, the overload rating of any available CT may be fully utilized except that the load must never exceed 300% of the CT nameplate rating. In those cases where a 2.0 kW scale sweep pointer type demand register is employed, the CT must not be loaded beyond 150% of their nameplate rating to prevent offscale readings.

Example:

1. Rating of customer's service switch = 400 A
2. Maximum load (estimated) = 350 A
3. CTs available:

CT Rating	Rating Factor	Maximum Load
200:5	1.5	300 A
200:5	2.0	400 A
400:5	1.0	400 A
400:5	1.25	500 A

4. The correct CT choices are:
   a. 200:5, RF = 2.0 for 4.0 kW sweep pointer or clock type demands, or
   b. Either of the two 400:5 ratings for 2.0 kW sweep pointer type demand

Table T 60–1: 600 V Class CTs

Manufacturer	Model	Construction	Amp Rating	Rating Factor
GEC Durham	TCB	Miniature Bar	200–600	2.0
	TCB61	Miniature Bar	600	2.0
	ACL	Window	800	2.0
	ACL	Window	2,000	2.0
	ACL	Window	3,000	2.0
	ACL	Window	4,000	1.5
	AD	Window	200–400	3.0
	AD	Window	800–2,000	2.0
	AD	Window	3,000	1.5
G.E.	JCT-O	Miniature Bar	200–600	2.0
	JCT-OS	Miniature Bar	600	2.0
	JKP-O	Conventional Bar	200–400	2.0
	JAD-O	Window	800–1,200	2.0
	JAD-O	Window	2,000–3,000	1.5
Itron	R6B	Miniature Bar	600	2.0
	R6BA	Miniature Bar	200–400	2.0
ABB	CBT	Miniature Bar	200–600	2.0
	CBT-S	Miniature Bar	600	2.0
	CLC	Window	800–2,000	2.0
	CLC	Window	3,000	1.33
	CLE	Window	2,000–3,000	2.0
	CLE	Window	4,000	1.5

Note(s):

1. 200:5 and 400:5 window type CTs (SAP 10105833) and (SAP 10105859) are now available in the Corporate Warehouse for use in panels with 4-inch bus, when the load is considerably below capacity, and the use of 800:5 CTs would result in serious over-metering. Similarly, 800:5 window type CTs (SAP 10105861) are available for use in panels with 5-inch bus where the use of 2000 A CTs would result in serious over-metering. Refer to manufacturers above for rating factors of individual current transformers.

Table T 60–2: 5 kV Class CTs

Mfr.	Model	Construction	Application	Amp Rating	Rating Factor
ABB	KOT-60	Conventional Bar	Outdoor	1,200	2.0
	KOT-60	Conventional Bar	Outdoor	1,500	2.0
	KOT-60	Conventional Bar	Outdoor	2,000	1.5
	KIR-60	Wound	Indoor	10–600	1.5
	KIR-60	Wound	Indoor	800	1.33
	KOR-60	Wound	Outdoor	10–400	1.5
	KOR-60	Wound	Outdoor	600	1.33
G.E.	JCM-3	Conventional Bar	Indoor	1,200–3,000	1.33
	JCM-3	Conventional Bar	Indoor	4000	1.0
	JCW-3	Conventional Bar	Outdoor	1,200–2,000	1.33
	JKM-3	Wound	Indoor	5–600	1.5
	JKM-3	Wound	Indoor	800	1.33
	JKW-3	Wound	Outdoor	10–600	1.5
	JKW-3	Wound	Outdoor	800	1.25

Table T 60–3: 15 kV Class CTs

Mfr.	Model	Construction	Application	Amp Rating	Rating Factor
ABB	KOT-15	Conventional Bar	Outdoor	1,200	2.0
	KOT-15	Conventional Bar	Outdoor	1,500	2.0
	KOT-15	Conventional Bar	Outdoor	2,000	1.5
	KOT-15	Conventional Bar	Outdoor	3,000	1.33
	KOT-15	Conventional Bar	Outdoor	4,000	1.0
	KIR-11	Wound	Indoor	10–400	1.5
	KIR-11	Wound	Indoor	800	1.33
	KOR-11	Wound	Outdoor	10–600	1.5
	KOR-11	Wound	Outdoor	800	1.33
Kuhlman	BB-15	Wound	Outdoor	10–600	1.5
	BB-15	Wound	Outdoor	800	1.2
G.E.	JCW-5	Conventional Bar	Outdoor	1,200–3,000	1.33
	JCW-5	Conventional Bar	Outdoor	4000	1.0
	JKM-5	Wound	Indoor	10–600	1.5
	JKM-5	Wound	Indoor	800	1.2
	JKM-5	Wound	Outdoor	10–600	1.5
	JKM-5	Wound	Outdoor	800	1.2

T 62 General Instructions for Revenue Metering — Instrument Transformers

Scope T 62.1 SAP Numbers for 600 V/5 kV Class Potential and Current Transformers for Metering

Table T 62–1: 600 V Class CTs

Amp Rating	Construction	SAP
200	Miniature Bar	10105854[a/]
400	Miniature Bar	10105855[a/]
600	Miniature Bar	10105856[a/]
600	Miniature Bar	10207286
400	Window - 4"	10105859
800	Window - 4"	10105860
1,200	Window - 4"	10105862
2,000	Window - 4"	10105863
3,000	Window - 4"	10105865
800	Window - 5"	10105861
2,000	Window - 5"	10105864
3,000	Window - 5"	10105866
4,000	Window - 5"	10105867

[a/] Key 6

Table T 62–2: 5 kV Class CTs

Amp Rating	Construction	Application	SAP
1,000	Conventional Bar	Indoor	10105878[a/]
1,200	Conventional Bar	Indoor	10105879
1,500	Conventional Bar	Indoor	10105880
4,000	Conventional Bar	Indoor	10105881
1,200	Conventional Bar	Outdoor	10106060
1,500	Conventional Bar	Outdoor	10106061
2,000	Conventional Bar	Outdoor	10106062
10	Wound	Indoor	10105870
25	Wound	Indoor	10105871
50	Wound	Indoor	10105872
100	Wound	Indoor	10105873
200	Wound	Indoor	10105875
400	Wound	Indoor	10105876
800	Wound	Indoor	10105877
10	Wound	Outdoor	10106054
100	Wound	Outdoor	10106056
200	Wound	Outdoor	10106057
400	Wound	Outdoor	10106058
600	Wound	Outdoor	10106059

[a/] Key 6

Table T 62–3: 15 kV Class CTs

Amp Rating	Construction	Application	SAP
1,200	Conventional Bar	Indoor	10105895
2,000	Conventional Bar	Indoor	10105894
3,000	Conventional Bar	Indoor	10105831
1,200	Conventional Bar	Outdoor	10106073
1,500	Conventional Bar	Outdoor	10106074
2,000	Conventional Bar	Outdoor	10106075
3,000	Conventional Bar	Outdoor	10106076
4,000	Conventional Bar	Outdoor	10106077
10	Wound	Indoor	10105882
25	Wound	Indoor	10105883
50	Wound	Indoor	10105884
100	Wound	Indoor	10105885
200	Wound	Indoor	10105886
400	Wound	Indoor	10105887
10	Wound	Outdoor	10106063
25	Wound	Outdoor	10106065
50	Wound	Outdoor	10106066
100	Wound	Outdoor	10106067
200	Wound	Outdoor	10106068
400	Wound	Outdoor	10106070
800	Wound	Outdoor	10106072

Table T 62–4: 34.5 kV Class CTs

Amp Rating	Construction	Application	SAP
100 × 200:5	Wound	Outdoor	10105960
200 × 400:5	Wound	Outdoor	10105957
300 × 600:5	Wound	Outdoor	10105956
400 × 800:5	Wound	Outdoor	10105955
600 × 1,200:5	Wound	Outdoor	10105954

Table T 62–5: SAP Numbers for Voltage Transformers for Metering (PTs)

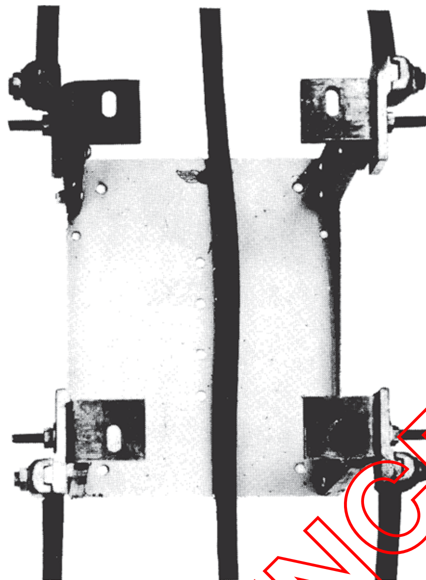
Voltage Rating	Voltage Ratio	Application	SAP
2,400/120	20:1	Indoor	10105889
2,400/120	20:1	Outdoor	10105896
4,160/120	35:1	Indoor	10105891
4,800/120	40:1	Indoor	10105892
7,200/120	60:1	Indoor/Outdoor	10106084
12,000/120	100:1	Indoor/Outdoor	10106089
12,000/120	100:1	Indoor/Outdoor	10105897
12,000/120	100:1	Indoor	10105838[a/]
14,400/120	120:1	Indoor/Outdoor	10106090
16,500/120	150:1	Indoor/Outdoor	10106091
34,500/120	300:1	Outdoor	10106087

[a/] Two 0.5 Amp fuses in primary winding.

T 63 **General Instructions for Revenue Metering — Instrument Transformers**

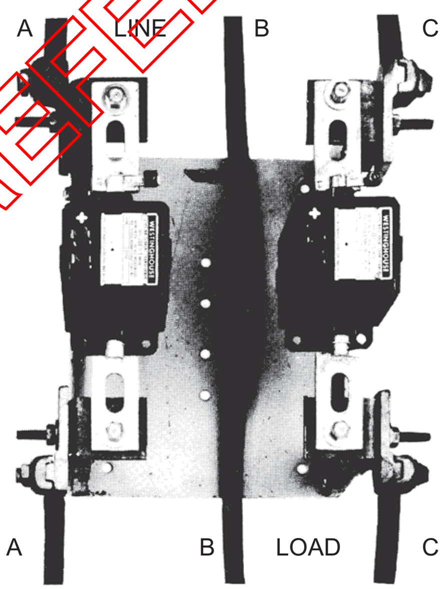
Scope T 63.1 **Use of the Transformer Mounting Base**

Figure T 63–1: Transformer Mounting Base



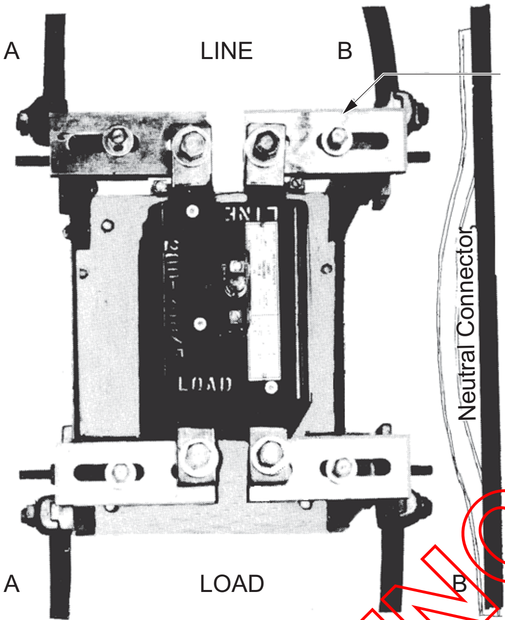
Wired for 3Ø, 3-Wire Service
240 V and 480 V

Figure T 63–2: Bar-Type Current Transformer



Installed on Transformer Mounting Base
for 3Ø, 3-Wire Service 240 V and 480 V

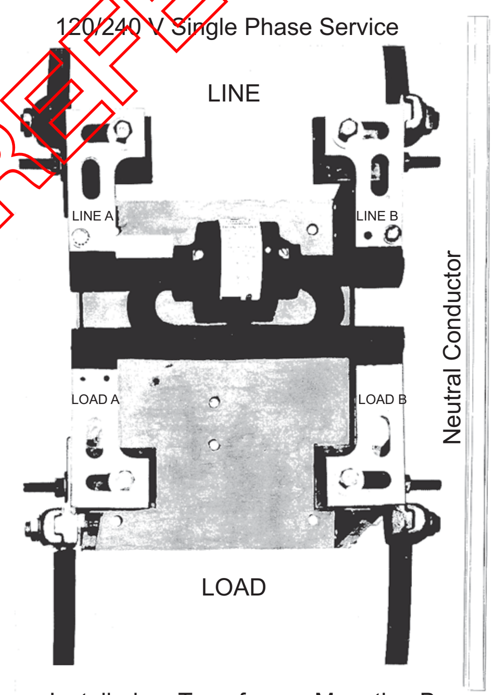
Figure T 63–3: 3-Wire Current Transformer



Installed on Transformer Mounting Base
for 120/240 V 1Ø Service

Figure T 63–4: Miniature 3-Wire Current Transformer

120/240 V Single Phase Service



Installed on Transformer Mounting Base

What's Changed? The standard was made "For Reference Only". We no longer install this type of instrument transformer.

T 64 General Instructions for Revenue Metering — Instrument Transformers

Scope T 64.1 Switchboards Above 1,001 A 0–600 V

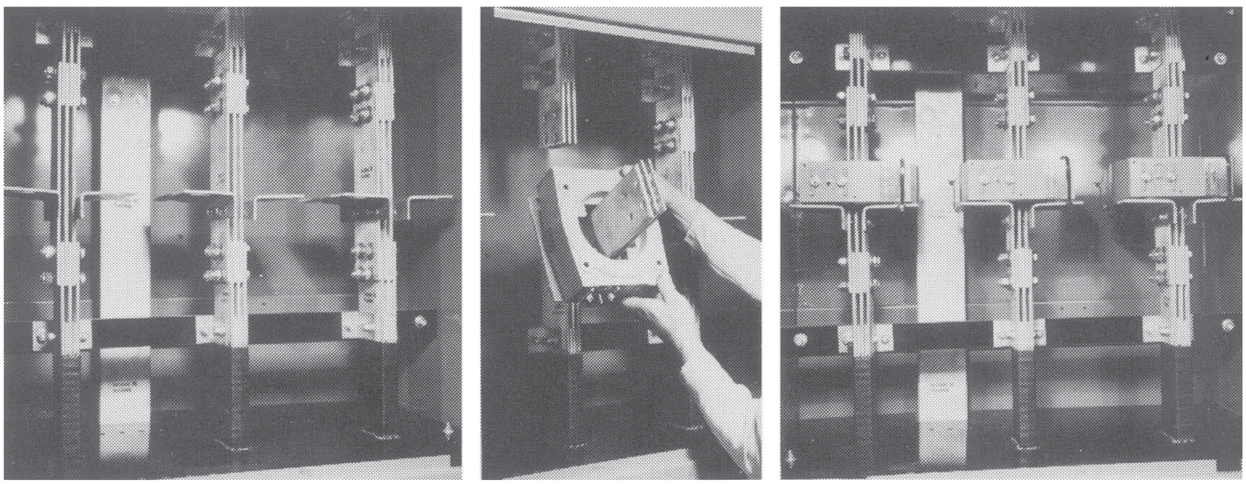
The illustrations below show the general procedure for installing window-type Current Transformers (CTs) in a switchboard metering section.

The secondary terminals should be positioned to face the front of the board.

In the event of a bottom-to-top feed, it will be necessary to install each transformer with its primary polarity mark facing downward.

Secure each CT to its mounting bracket with two nylon wiring straps, SAP 10120915, placed on opposite corners as shown in the right-hand illustration.

Figure T 64–1: Switchboards Above 1,001A 0–600 V



Note(s):

1. 600 V CTs are okay for primary voltages of 2400 V, 4,160 V, or 4800 V on switchboards when installed with plastic sleeves (see SAP numbers listed below).

Bus Bar Width (in)	Maximum Number of Bus Bars	Mounting Sleeve SAP
4	4-1/4" spaced 1/4"	10106118
5	6-1/4" spaced 1/4" or 4-3/8" spaced 3/8"	10106119 10106119

T 65 General Instructions for Revenue Metering — Instrument Transformers

Scope T 65.1 Proper Use of Polarity Marking in Correct Connection of Instrument Transformers

A number of instances have been found by the Test Division where meters newly installed with instrument transformers are running backward. This appears to be due to the possibility that some service crews are following the physical arrangement of the schematic wiring diagrams in the T Section of the Distribution and Transmission Construction Methods Book instead of observing the proper relative polarity of the potential and current circuits.

Please note that all meter connection diagrams (T Prints) are **schematic only** and are not intended to show the physical location of connections, as they might appear to the eye, for every type of instrument transformer. Proper polarity is obtained only if the connections are made in accordance with the actual polarity markings.

In all T Prints, the polarity is indicated by the conventional symbol of a “plus sign” (+).

A variety of symbols, such as H, X, + or a black or white spot, are used by the different manufacturers to indicate polarity, but in any event, every instrument transformer has both the primary and secondary polarity designated by some distinguishing mark.

To properly install instrument transformers, the following rules must be observed.

1.0 Bar or Window CTs

1.1 The **primary** polarity terminal or mark shall always attach to or face the “line” (source). That is, if the “line” comes in from the bottom, face the CT toward the bottom.

1.2 The **secondary** polarity terminal shall attach to the colored lead indicated in the “T” print regardless of the physical (top, bottom, or side) location of the terminal.

2.0 3-Wire CTs

2.1 The **primary** terminals marked “line” shall always attach to the “line” (source). The “line” side of the CT can usually be identified, when not otherwise marked, by two small screws or clamps for attaching potential leads.

2.2 Manufacturers have two methods of marking the **primary** “line” polarity on 3-wire “spider”-type CTs — polarity on the right terminal, or polarity on the left. Regardless of the method used, the “T” print shall be followed schematically, that is, the polarity potential lead will attach to polarity whether it is on the right or left terminal.

2.3 The physical position of the **secondary** polarity mark is immaterial, that is, the polarity current lead will attach to the polarity terminal regardless of position.

3.0 Voltage Transformers

3.1 Voltage transformer primary and secondary polarity terminals vary in relative location on different transformers. The polarity voltage wire will attach to the polarity terminal regardless of position. (An exception would be when the primary has been reversed for physical reasons.)

3.2 Whenever practicable, upon completion of a meter installation, the correct direction of rotation of the disc should be ascertained.

T 66 General Instructions for Revenue Metering — Instrument Transformers

Scope T 66.1 Secondary Wire Color Code For Instrument Transformer Installations

The 1965 revisions of the “T” section of the D&T Methods Book introduced a new 11-color combination scheme for instrument transformer secondary wiring. The current revision expands the number of combinations to 14. The three new color combinations are used primarily to simplify the wiring of certain 1-phase totalizing installations. **All wire is size #12 stranded,** for universal current and voltage circuit applications.

The fourteen color combinations are:

Table T 66–1: Fourteen Color Combinations (Secondary Wire Color Code) for Instrument Transformer Installations

Color	Abbreviations or Drawings	SAP
Red	R	10109775
Black	BLK	10109776
Blue	BLU	10109777
White	W	10109778
Red with White Tracer	R/W	10109780
Black with White Tracer	BLK/W	10109783
Blue with White Tracer	BLU/W	10109786
Red with Orange Tracer	R/O	10109782
Black with Orange Tracer	BLK/O	10109785
Blue with Orange Tracer	BLU/O	10109788
White with Orange Tracer	W/O	10109789
Red with Green Tracer	R/G	10109781
Black with Green Tracer	BLK/G	10109789
Blue with Green Tracer	BLU/G	10109787

Table T 66–2: Scheme Used in “T” Drawings Single Phase

Use	Circuits		
	No. 1	No. 2	No. 3
Voltage (Polarity)	BLU	BLK	R
Voltage (Non-polarity)	BLU/G[a/]	BLK/G	R/G
Current (Polarity)	BLU/W	BLK/W	R/W
Current (Non-polarity)	BLU/O[b/]	BLK/O	R/O

[a/] White (W) if grounded.
[b/] White/Orange (W/O) if grounded.

Table T 66–3: 3-Phase (including Network)

Use	Phases			
	A	B	C	N
Voltage	BLU	BLK[a/]	R	W
Current (Polarity)	BLU/W	BLK/W	R/W	—
Current (Non-Polarity)	BLU/O	BLK/O[b/]	R/O	W/O

[a/] White (W) if grounded.
[b/] White/Orange (W/O) if grounded.

T 70 General Instructions for Revenue Metering — Miscellaneous

Scope T 70.1 RkVAh Meters — Checking and Correcting Phase Rotation

The phase rotation of the voltage applied to an RkVAh meter and its associated phasing transformer must be correct for proper metering. For a lagging power factor load, the RkVAh meter will run forward if the phase rotation is correct and will try to run backward (backward rotation is prevented by a ratchet or detent on the disk shaft) if the phase rotation is incorrect.

Proper phase rotation can be checked by attaching a phase rotation (sequence) indicator at the line terminals of the phasing transformer. With reference to the color of the rubber insulators on the phase rotation indicator and the numbered phasing transformer terminals connect the rotation indicator to the three-line terminals of the phasing transformer as follows: red to #1, white to #2, and blue to #3. Correct rotation will be indicated by clockwise rotation of the rotation indicator. If the phase rotation is incorrect, changes must be made in the primary or secondary connections, as outlined in one and two below.

When altering secondary wiring for any reason, it should be kept in mind that splices are not permitted.

All 3-phase, 3-wire, delta and 4-wire Wye installations can be corrected by one of the two following procedures given in the order of preference.

1. Change secondary wiring at the instrument transformers as follows:
   a. Interchange Red and Blue voltage wires at the point of connection to the line or to the Voltage Transformer (VT) secondary terminals, **and**
   b. Interchange the BLU/W and R/W wires at the Current Transformer (CT) secondary terminals.

Important : If wiring changes are made with load on the service, normal precautionary measures should be taken with respect to maintaining the CT secondaries closed during the change.

2. Change wiring at phasing transformer as follows:
   a. Interchange the red and blue wires at bottom terminals one and three, **and**
   b. At the top terminals, make the following changes:

	3-Wire	4-Wire
Interchange	Red and Blue (4 and 6)	Red and Blue (4 and 8)
and Interchange	Red/Green and Blue/Green (5 and 7)	Red/Green and Blue/Green (5 and 9)

Note(s):

1. The above does not apply for 240 V, **4-wire delta** installations. For these installations, special instructions for correcting phase rotation are given on the "T" drawing.

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T 71 General Instructions for Revenue Metering — Miscellaneous

Scope T 71.1 Method of Wiring Low-Voltage, Hinged Panel Switchboard Service Sections

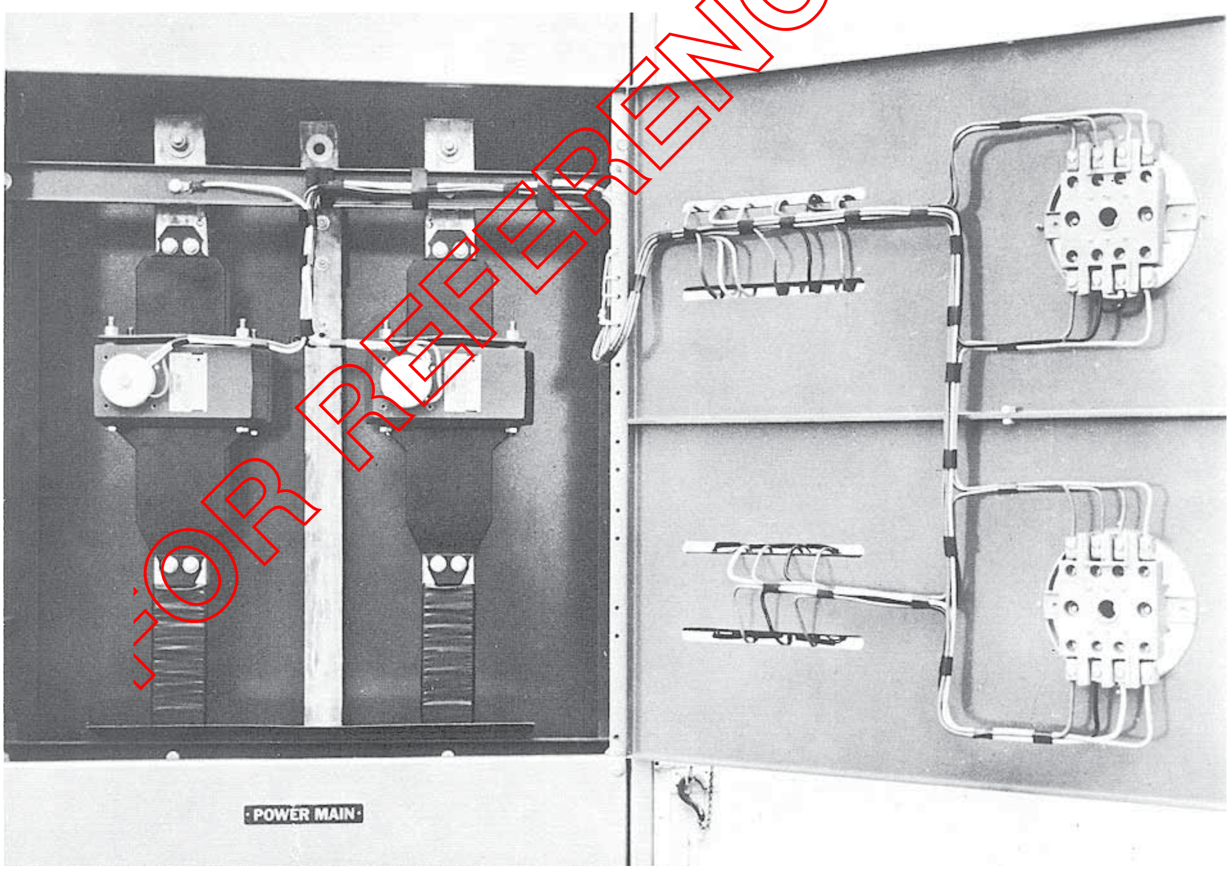
The hinged panels on low-voltage service sections are designed for reversal, that is, hinge on right or left. In the event that a wall or other obstruction would prevent the panels from swinging open a full 90 degrees (meters, test switch, and so on installed) as installed, then **both** panels shall be reversed so as to hinge from the opposite side.

The kWh meter shall always be installed in the upper panel and the RkVah meter, if any, in the bottom panel. If no RkVah meter is to be installed, the bottom panel shall be blank. In this case, the bolt(s) tying the two together shall be removed so that the two panels can be opened and closed independently.

The illustration shows the method for cabling the secondary wire for a kWh and RkVah job. Note that a hairpin loop about 6 inches to 8 inches long is made in the cabled wire at the hinge. Cabled wire should be secured with cord or tape to inhibit movement except at the loop.

Note that the cabled wire is brought to the center of the bus support member, then downward and fanning out left and right to the buses and Current Transformers (CTs). This arrangement facilitates the interchange of wires between phases in the event it is subsequently necessary to change the phase rotation, see T 70.

Figure T 71–1: Method of Wiring Low-Voltage, Hinged-Panel Switchboard Service Sections



Note(s):

1. 600 V CTs are okay for primary voltages of 2400 V, 4160 V, or 4800 V on switchboards when installed with plastic sleeves. (See SAP numbers listed in Table T 71–1 [Sheet 2].)

Table T 71–1: Mounting Sleeve SAP Numbers

Bus Bar Width (in)	Maximum Number of Bus Bars	Mounting Sleeve SAP
4	4-1/4" spaced 1/4"	10106118
5	6-1/4" spaced 1/4" or 4-3/8" spaced 3/8"	10106119 10106119

Scope T 71.2 Method of Wiring Low-Voltage, Hinged-Panel Switchboard Service Sections Using kWh/kVAh Meters

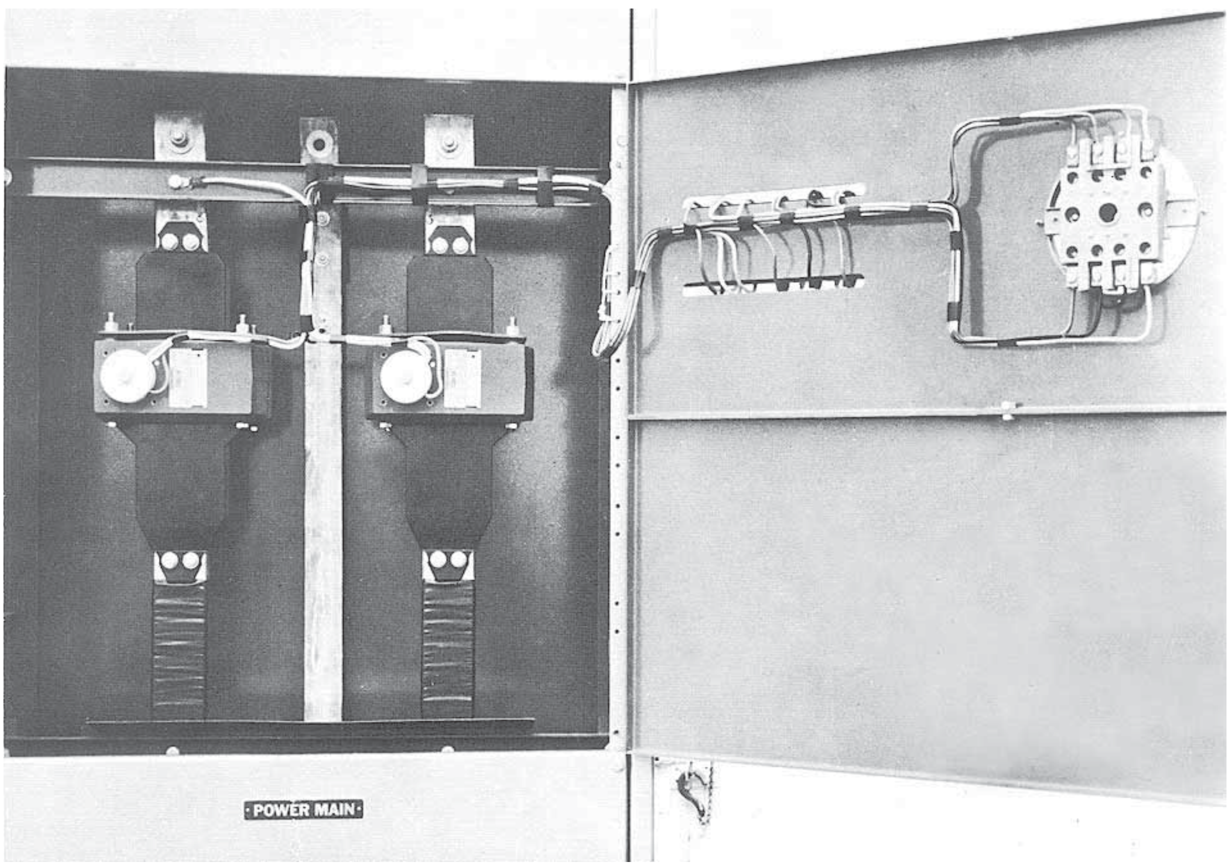
The hinged panels on low-voltage service sections are designed for reversal, that is, hinge on right or left. In the event that a wall or other obstruction would prevent the panels from swinging open a full 90 degrees (meters, test switch, and so on installed) as installed, then **both** panels shall be reversed so as to hinge from the opposite side.

The kWh meter shall always be installed in the upper panel. In this case, the bolt(s) tying the two together shall be removed so that the two panels can be opened and closed independently.

The illustration shows the method for cabling the secondary wire for a kWh/RkVah job. Note that a hairpin loop about 6 inches to 8 inches long is made in the cabled wire at the hinge. Cabled wire should be secured with cord or tape to inhibit movement except at the loop.

Note that the cabled wire is brought to the center of the bus support member, then downward and fanning out left and right to the buses and Current Transformers (CTs).

Figure T 71–2: Method of Wiring Low-Voltage, Hinged-Panel Switchboard Service Sections Using kWh/kVAh Meter



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T 72 General Instructions for Revenue Metering — Miscellaneous

Scope T 72.1 Sealing Practices

Meter seals help protect our customers from access to potentially hazardous service components, and act as an indicator of theft when broken. Reported services with broken seals must be thoroughly inspected before resealing to avoid sealing over a theft condition.

The following are standard seals and practices to be used throughout the Edison service territory.

1. Plastic padlock with wire bail (Brooks type). See Figure T 72–1.1 (Sheet 2). These come in three colors and can be used on lock rings, snap rings, and other apertures that will accept them. They have the following advantages:
   a. Plastic and wire seal are more difficult to tamper with.
   b. Bright color and large body make them highly visible. These seals come in three colors.
      1) Green (SAP 10105794) indicates service is "normal."
      2) Red (SAP 10105796) indicates service is off; for example, turned off, cut for nonpayment, new set (off) meter.
      3) Orange (SAP 10105795) is a temporary seal indicating a service investigation is pending.
2. SCE tab seal (SAP 10105780) is the standard seal for the meter cover. See Figure T 72–1.2 (Sheet 2).

   Note: Star-tab lead seals are no longer used by SCE. See Figure T 72–1.3 (Sheet 2).
3. Wire seals are used where plastic padlock or demand seals will not fit; for example, current transformer compartments, pull sections, test switch covers, and so on. These seals come in three colors.
   a. Green (SAP 10105754 and SAP 10105776 [Kevlar wire]) indicates service is "normal." See Figure T 72–1.4 (Sheet 2).
   b. Red (SAP 5775 and SAP 10105771 [Kevlar wire]) indicates that service is off. That is, turned off, cut for nonpayment, new set (off) meter. See Figure T 72–1.4 (Sheet 2).
   c. Yellow (SAP 10105772) indicates service has had a Revenue Protection Investigator attach the seal. See Figure T 72–1.5 (Sheet 2).
4. Demand Seal: These seals come in three colors so they can be randomly rotated each month. They are to be used on the re-set mechanism or demand meters only. These seals are easily installed or removed and do not require the use of tools. See Figure T 72–1.6 (Sheet 2).
   a. Blue (SAP 10105755)
   b. Purple (SAP 10105756)
   c. Yellow (SAP 10105757)

Figure T 72–1: Sealing Practices

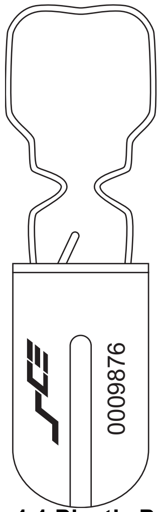

Figure T 72–1.1 Plastic Padlock Seal

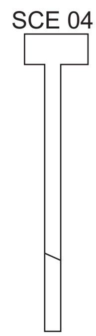

Figure T 72–1.2 SCE Tab Seal

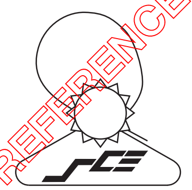

Figure T 72–1.3 Star-Tab Lead Seal

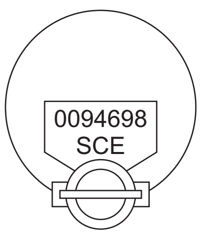

Figure T 72–1.4 Wire Seal

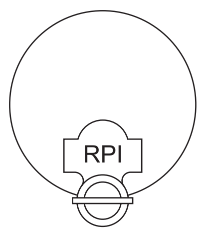

Figure T 72–1.5 Wire Seal

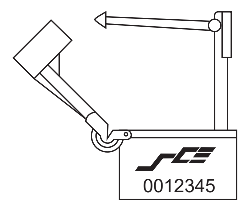

Figure T 72–1.6 Demand Seal

T 73 General Instructions for Revenue Metering — Meter Sockets

Scope T 73.1 Lubrication and Inspection Instructions for Electricity Meter Sockets

This standard establishes a uniform meter socket lubricant and application practice among all meter installers.

1.0 Application

Lubricant is required to reduce the physical force needed to install a meter into the socket. Uniformity in the type and quantity of lubricant applied will help to reduce tracking between meter and socket components of different potentials.

2.0 Instructions

2.1 Inspect the meter socket for loose jaws. Should loose jaws be found, contact supervision for the appropriate action required.

2.2 **Do not ever** pry apart tight jaws with any object. Forcing socket jaws apart with something other than a meter blade can compromise the jaw tension.

2.3 Only use Mobilgrease 28 (SAP 10153459) lubricant on all meter installations.

2.4 Using lubricants other than Mobilgrease 28 can cause destructive panel failures.

2.5 Mobilgrease 28 is supplied in 5-pound containers. An 8-ounce capacity plastic bottle with brush attached to the cap (SAP 10144462) is also available for storing and applying the lubricant.

2.6 Apply a thin film to both sides of each current circuit meter blade prior to insertion into the socket.

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T 75 Labeling Practice for Metering Panels and AC Isolation Disconnects

Scope T 75.1 Labeling Practice for Metering Panels Containing Expanded Voltage Watthour/VARhour Demand Meter(s)

1.0 Labeling Practice for Metering Panels Containing Expanded Voltage Watthour/VARhour Demand Meter(s)

Labels are required to identify the “meter voltage” in metering panels containing “expanded voltage” meters. The nameplate voltage in these meters reads “120–480 V.” A voltage label is to be affixed on the meter panel so its top edge, with the lettering upright, is approximately two inches below the meter’s rim.

Select an appropriate label from the list below:

Table T 75–1: Voltage Labels

Metered Voltage	SAP	Description
120 V	10131716	Single Phase or Primary Service
120/208 V	10131712	120/208 V Wye, Network, or Primary Service
120/240 V	10131714	120/240 V Delta or 120/240 V Single Phase
240 V	10131711	240 V Delta
240/480 V	10131717	Single Phase
277/480 V	10131713	277/480 V Wye or 277/480 V Network
480 V	10131715	480 V Single Phase or 480 V Delta
Totalized	10131727	Indicates that the service is totalized. This sticker is to be used together with any of the above metered voltage stickers.

Scope T 75.2 Labeling Practice for Meter Panels and AC Isolation Disconnects with Generation

1.0 Labeling Practice for Meter Panels and AC Isolation Disconnects with Generation

Labels are required for meter panels and AC isolation disconnects with customer-connected generation.

Select an appropriate label from the list below:

Table T 75–2: Labels for Meter Panels and AC Isolation Disconnects with Generation

Customer Type	Form #	Description
Residential		
	15-40-A	AC Isolation Disconnect
	15-41-A	Meter panel has a customer owned generator
Commercial		
	15-40-B	AC Isolation Disconnect
	15-42-B	Meter panel when the customer's generator is connected to the line side of the main breaker
	15-43-B	Meter panel when the customer's generator is connected to the load side of the main breaker

Figure T 75–1: : Example of Labeling Practice for an AC Isolation Disconnect with Generation

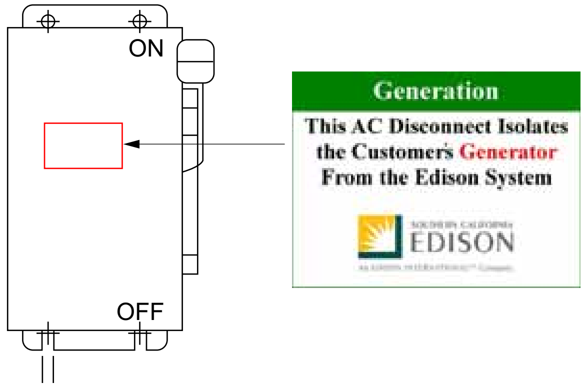


Figure T 75–2: Example of Labeling Practice for a Residential Meter Panel with Generation

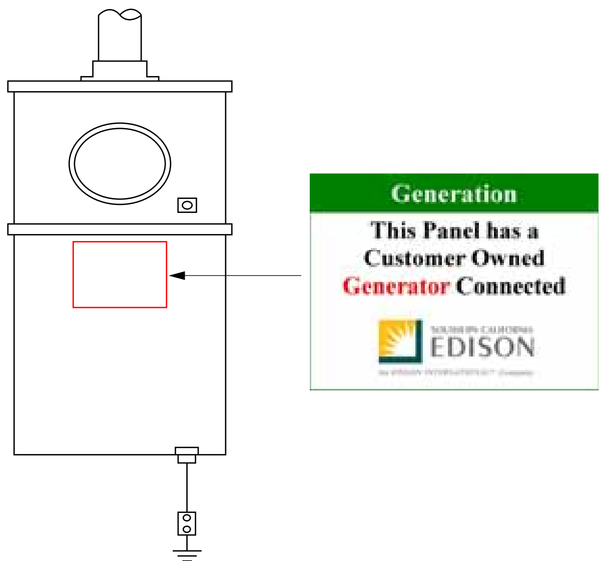
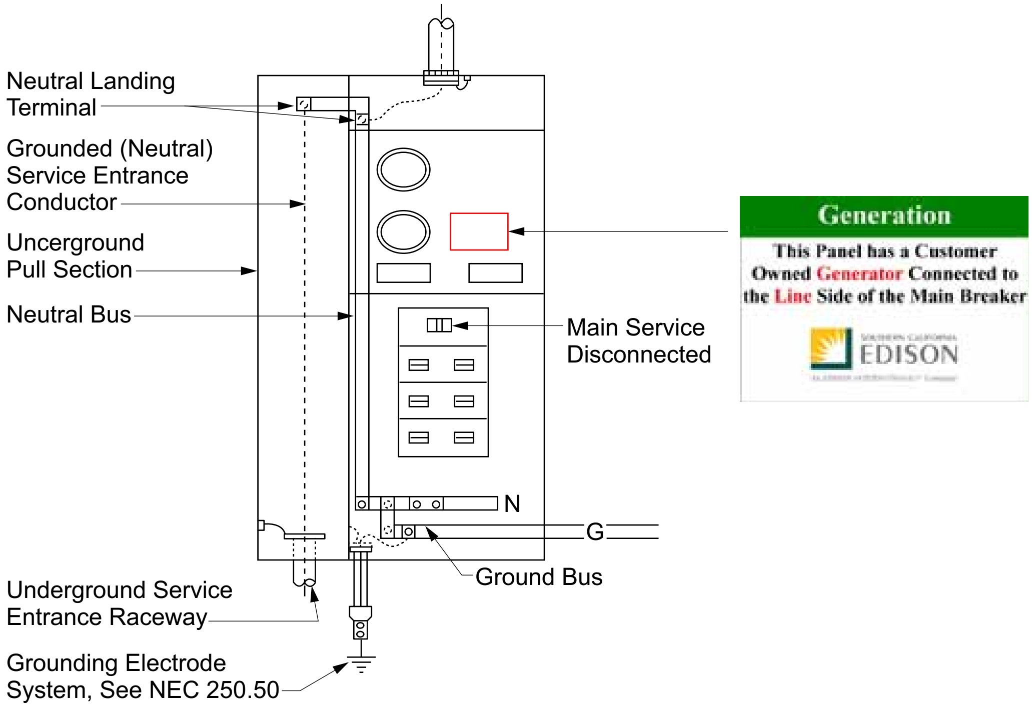


Figure T 75–3: Example of Labeling Practice for a Commercial Meter Panel with Generation (Customer with interconnection on the line side of the main circuit breaker)



T 126 Single-Phase Metering — Using Self-Contained Meters

Scope T 126.1 120/240 V, 1Ø Connections for Type “S” Meter, 2- and 3-Wire

Figure T 126–1: Line Connections to Meter Sockets Single-Phase, 2-Wire Type “S” Meters

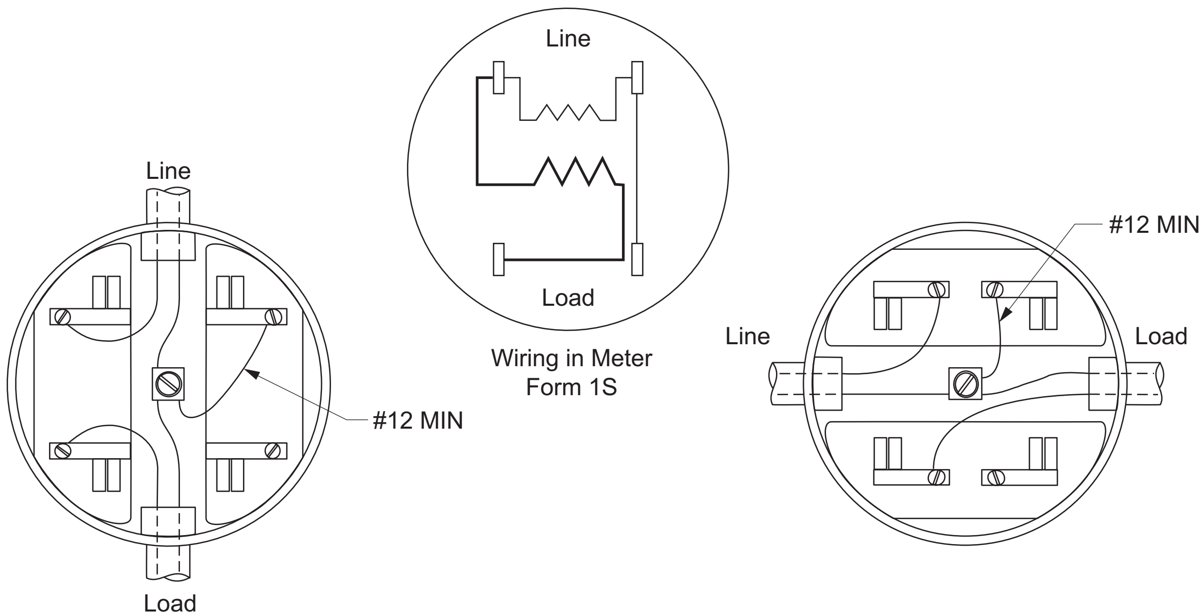
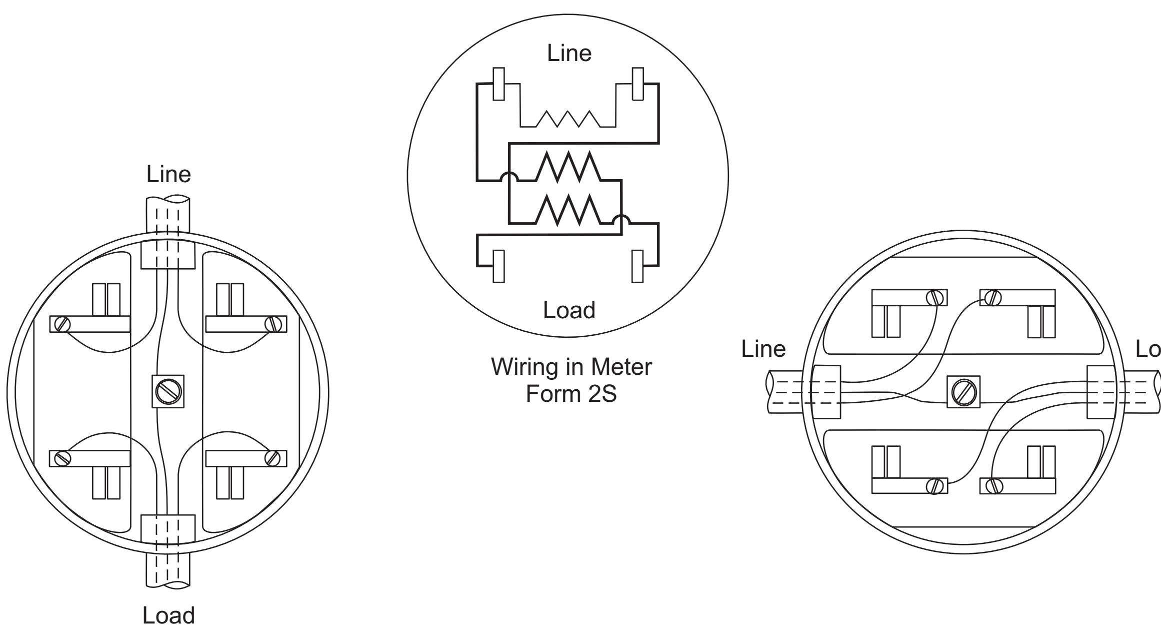


Figure T 126–2: Line Connections to Meter Sockets Single-Phase, 3-Wire Type “S” Meters



Note(s):

1. Generation Meter Adapter may be installed between meter panel and meter, refer to ESR-1 Section 12.2 for more details.

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T 127 Single-Phase Metering — Using Self-Contained Meters

Scope T 127.1 120/240 V or 240/480 V, 3-Wire (Served from a 240/480 V 1Ø Source) or 120 V, 2-Wire, 1Ø Service Using Test Blocks and Self-Contained Meters

Figure T 127–1: 120/240 V, 3-Wire (Served from a 240/480 V 1Ø Source) or 120 V, 2-Wire, 1Ø Service Using Test Blocks and Self-Contained Meters

Front Views

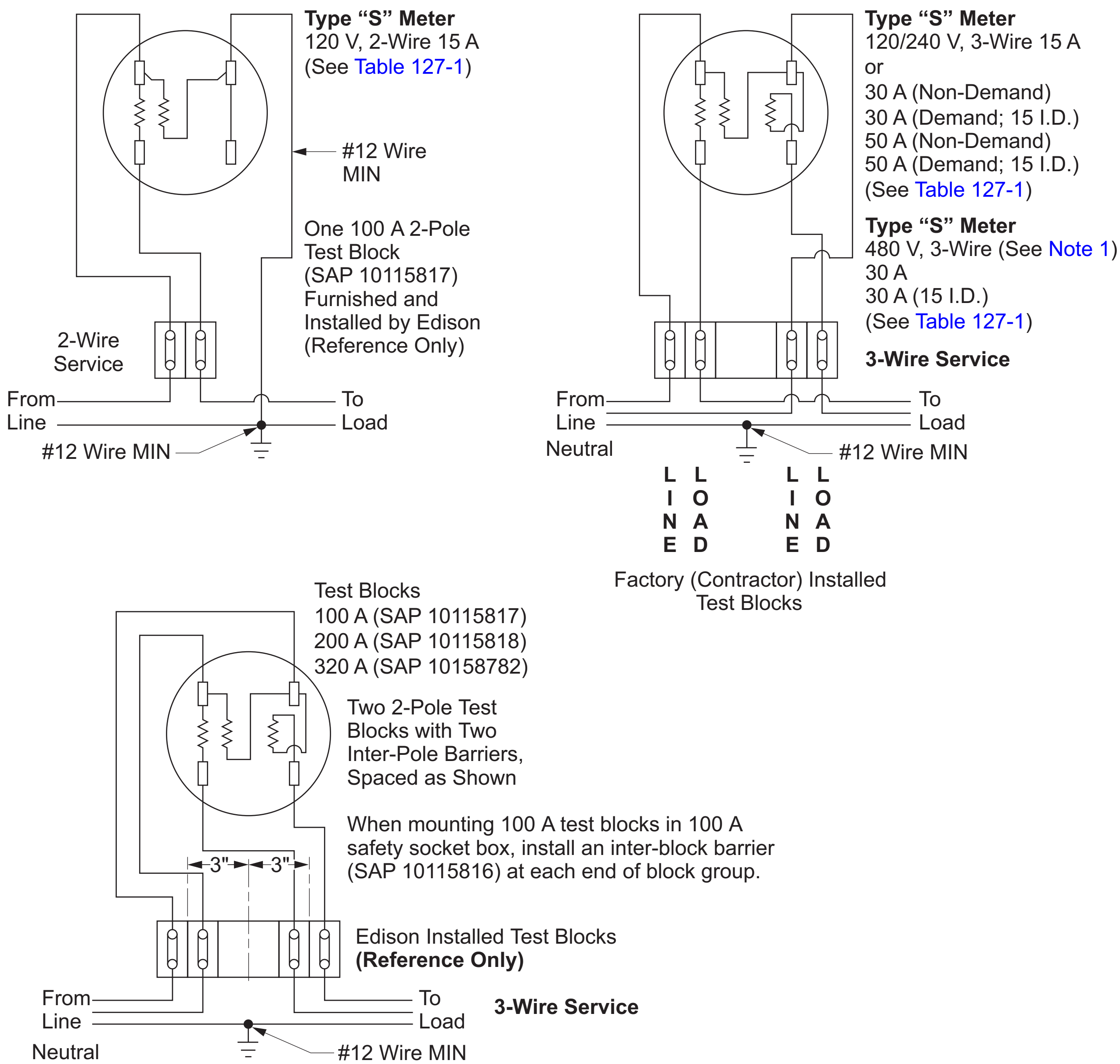


Table T 127–1: 120/240 V or 240/480 V, 3-Wire or 120 V, 2-Wire Single Phase Metering

Meter Type	Meter Description	SAP
1S	120 V, 2 Wire 15 A	10105255
1S ESC	120 V, 2 Wire 15 A	10158735
2S (Key 6)	240 V 15A, 3-Wire	—
2S	30 A (Non-Demand)	10105402
2S	240 V, 3-Wire 30 A	10105522
2S ESC [a/]	240 V, 3-Wire 30 A	10168079
2S ESC [a/]	240 V, 3-Wire 50 A	10158782
2S ESC Cell Relay [a/] (See Note 3)	240 V, 3-Wire 30 A	10168499
2S ESC SBR Base Meter [a/] [b/] (See Note 3)	240 V, 3-Wire, 30 A	10212261
2S (Key 6)	480 V, 3-Wire, 30 A	—
2S	Multi Volt V, 3-Wire 30 A (Demand)	10105522

[a/] Edison SmartConnect (ESC)
[b/] Socket Based Router (SBR)

Note(s):

1. On 480 V, 1Ø, 3-wire installation, a “480 V” sticker shall be affixed to both the inside and outside surface of the socket box and the serving transformer as a warning to Company personnel that the circuit is 480 V. **Use Scotchlite “numbers” and “V” decals.**
2. For test precautions, see T 34.
3. The Edison SmartConnect (ESC) cell relay meter and SBR Base Meter types are used as receivers for the surrounding SmartConnect meters and for forwarding these meter broadcasts to a central location for reading. Installation/location of these meters are pre-determined and has identification tags attached to them. Before conducting any servicing of these meters, please call; the Grid Services Advanced Metering Operations (AMO) at (626) 543-6393.
4. See Scope T 725.1 for NET Generation Output Meter (NGOM) used in Paired Storage, NEM-ST, NEM-MT-ST, and NEM-A Applications.
5. See Scope T 725.2 for NET Generation Output Meter (NGOM) used in MASH, V-NEM, NEM-V, NEM-V-ST, or SOMAH Application.

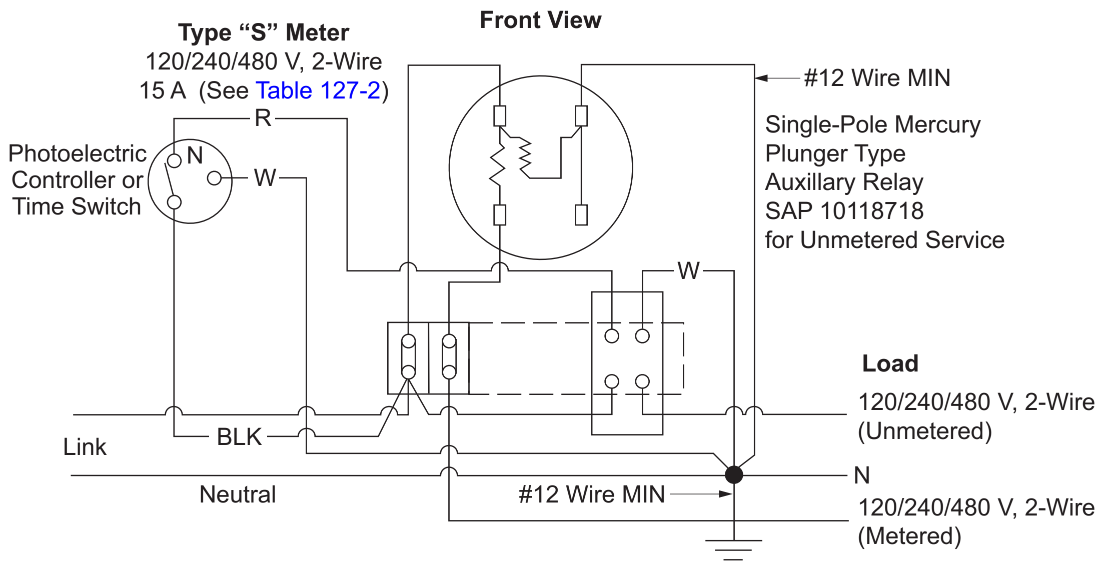
Figure T 127–2: Socket Based Router (SBR)

Figure T 127–2.1: SBR Exterior

Figure T 127–2.2: SBR Interior

Scope T 127.2 **120/240 V, 3-Wire or 120/240/480 V, 2-Wire, 1Ø Service Using Test Blocks and Self-Contained Meters, with Unmetered Streetlight Service Using Single Pole Auxiliary Relay**

Figure T 127–3: 120/240 V, 3-Wire or 120/240/480 V, 2-Wire, 1Ø Service Using Test Blocks and Self-Contained Meters, with Unmetered Streetlight Service Using Single Pole Auxiliary Relay



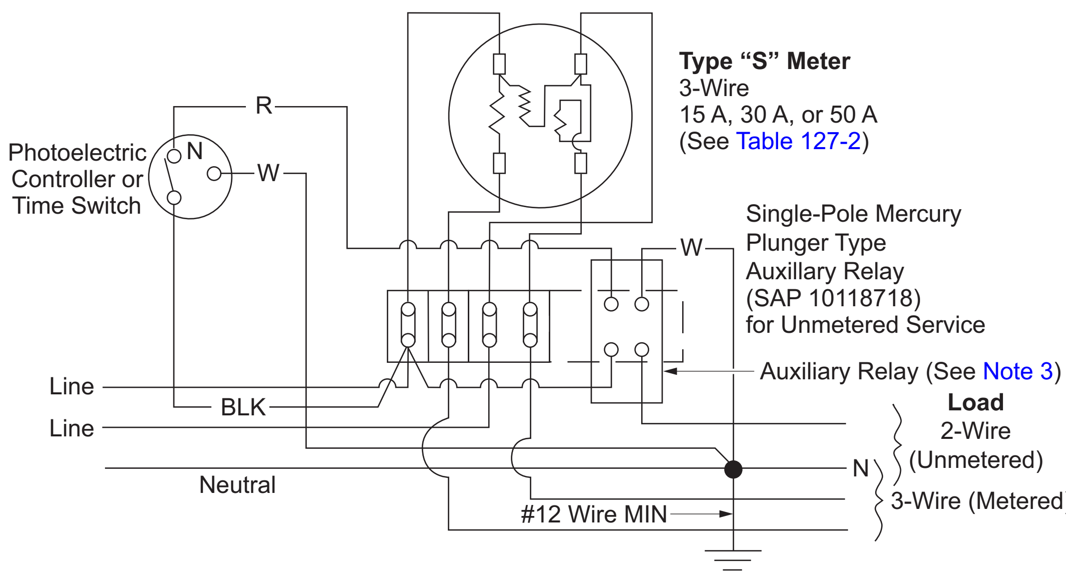


Table T 127–2: 120/240/480 V, 3-Wire or 120 V, 2-Wire Single Phase Metering

Meter Type	Meter Description	SAP
1S	120 V, 2 Wire 15 A	10105255
1S ESC [a/]	120 V, 2 Wire 15 A	10158735
1S ESC [a/]	120/240/480 V, 2 Wire 15 A	10182258
2S (Key 6)	120/240 V, 3-Wire 15 A	—
2S	120/240 V, 3-Wire 30 A	10105522
2S ESC [a/]	240 V, 3-Wire 30 A	10168079
2S ESC [a/]	240 V, 3-Wire 50 A	10158782
2S ESC Cell Relay [a/] (See Note 4)	240 V, 3-Wire 30 A	10168499

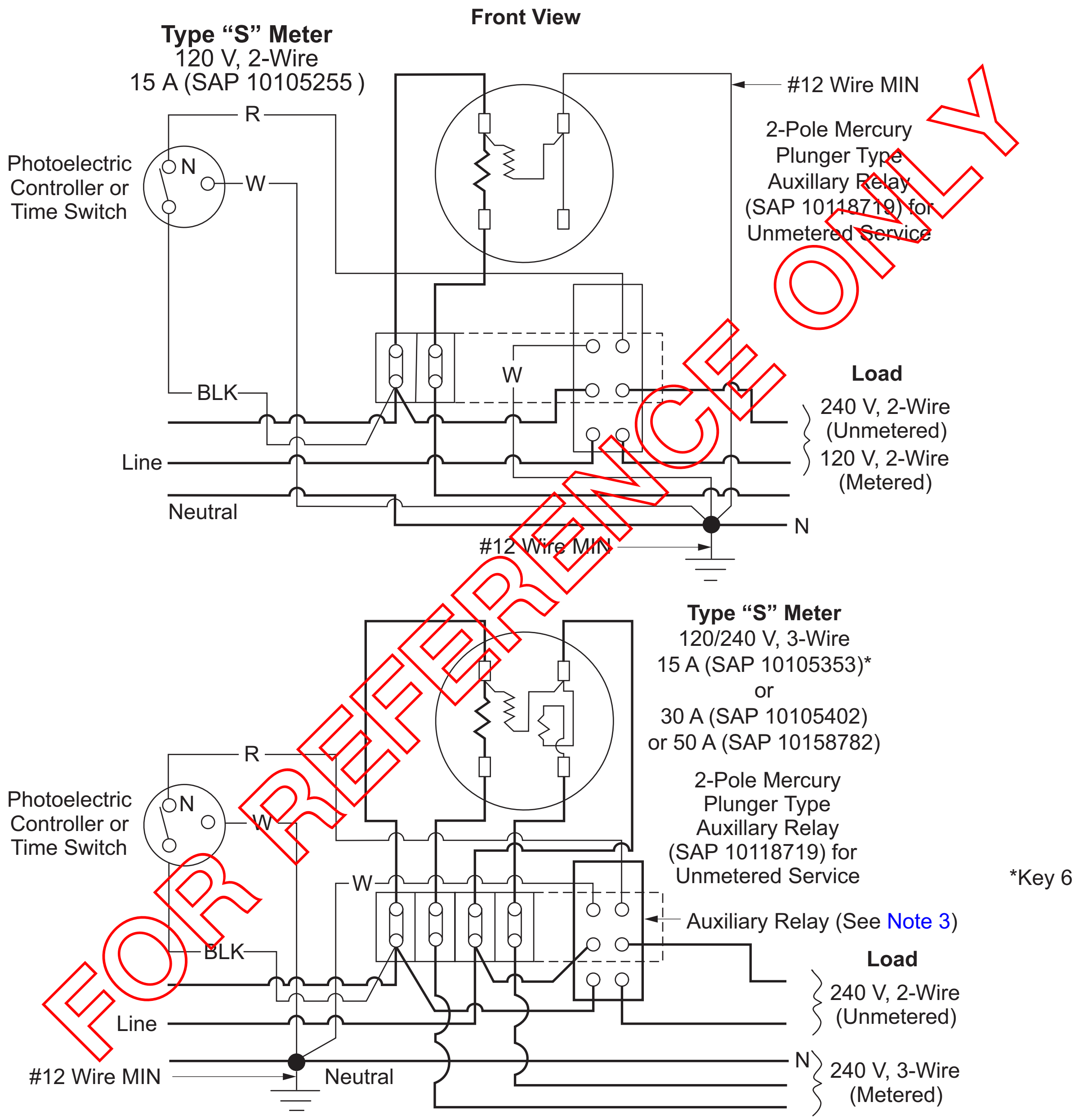
[a/] Edison SmartConnect (ESC)

Note(s):

1. One barrier is to be installed between test bypass block and relay.
2. For alternate position where relay is mounted between the two test blocks, install two barriers—one on each side of relay.
3. Wire auxiliary relay per wiring diagram supplied with relay.
4. The Edison SmartConnect (ESC) cell relay meter types are used as receivers for the surrounding SmartConnect meters and for forwarding these meter broadcasts to a central location for reading. Installation/location of these meters are pre-determined and has identification tags attached to them. Before conducting any servicing of these meters, please call; the Grid Services Advanced Metering Operations (AMO) at (626) 543-6393.
5. See Scope T 725.1 for NET Generation Output Meter (NGOM) used in Paired Storage, NEM-ST, NEM-MT-ST, and NEM-A Applications.
6. See Scope T 725.2 for NET Generation Output Meter (NGOM) used in MASH, V-NEM, NEM-V, NEM-V-ST, or SOMAH Application.

Scope T 127.3 **120/240 V, 3-Wire or 120 V, 2-Wire, 1Ø Service Using Test Blocks and Self-Contained Meters, with 120V Unmetered Streetlight Service Using 2-Pole Auxiliary Relay**

Figure T 127–4: 120/240 V, 3-Wire or 120 V, 2-Wire, 1Ø Service Using Test Blocks and Self-Contained Meters, with 120 V Unmetered Streetlight Service Using 2-Pole Auxiliary Relay



Note(s):

1. One barrier is to be installed between test bypass block and relay.
2. For alternate position where relay is mounted between the two test blocks, install two barriers—one on each side of relay.
3. Wire auxiliary relay per wiring diagram supplied with relay.

T 128 Single-Phase Metering — Using Self-Contained Meters

Scope T 128.1 Typical Method of Serving Multiple Metered Streetlights, Traffic Signals, Illuminated Signs, and so on, Employing Two 120/240/480 V, 2-Wire Meters

Figure T 128–1: Method of Serving Multiple Metered Streetlights, Traffic Signals, Illuminated Signs, and so on, Employing Two 120/240/480 V, 2-Wire Meters

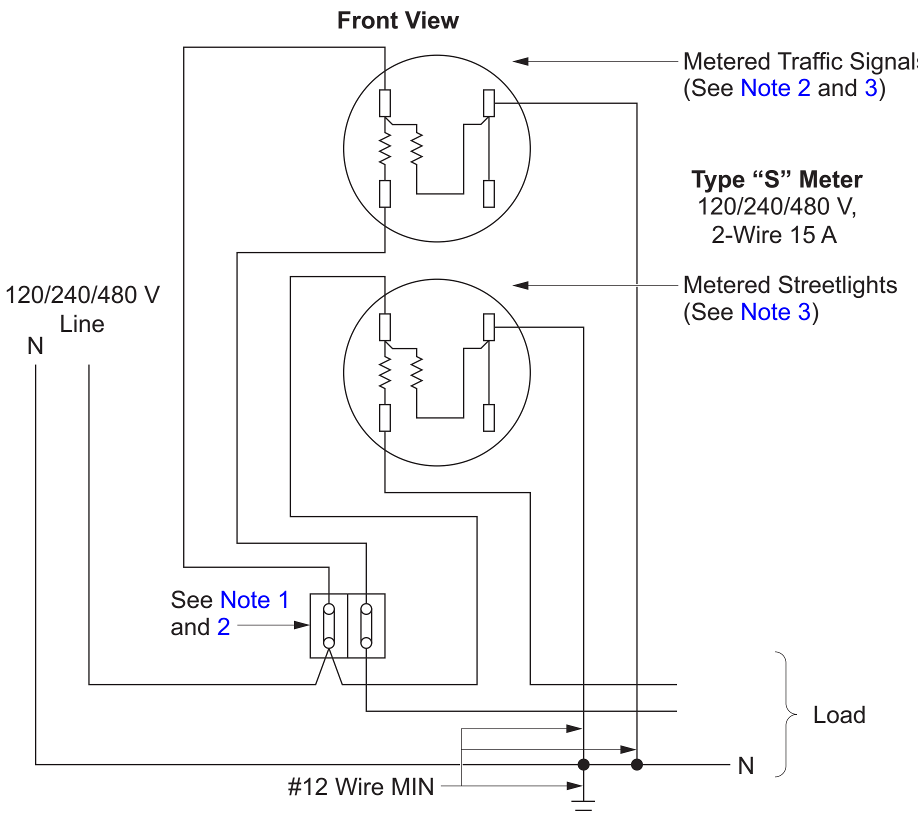


Table T 128–1: 120 V, 2-Wire Meter

Meter Type	Meter Description	SAP
1S	120 V, 2-Wire	10105255
1S ESC[a/]	120 V, 2-Wire	10158735

[a/] Edison SmartConnect (ESC)

Table T 128–2: 120/240/480 V, 2-Wire Meter

Meter Type	Meter Description	SAP
1S ESC[a/]	120/240/480 V, 2-Wire	10182258

[a/] Edison SmartConnect (ESC)

Note(s):

1. For traffic signals, test bypass blocks are required per Electrical Service Requirements (ESR) 5-14.
2. For streetlights, test bypass blocks are not required.
3. Meter positions may be reversed depending on customer's panel provisions, as long as Notes 1 and 2 are met.

Scope T 128.2 Typical Method of Serving Multiple Metered Streetlights, Traffic Signals, Illuminated Signs, and so on, with One 3-Wire and One 2-Wire Meter

Figure T 128–2: Method of Serving Multiple Metered Streetlights, Traffic Signals, Illuminated Signs, and so on, with One 3-Wire and One 2-Wire Meter

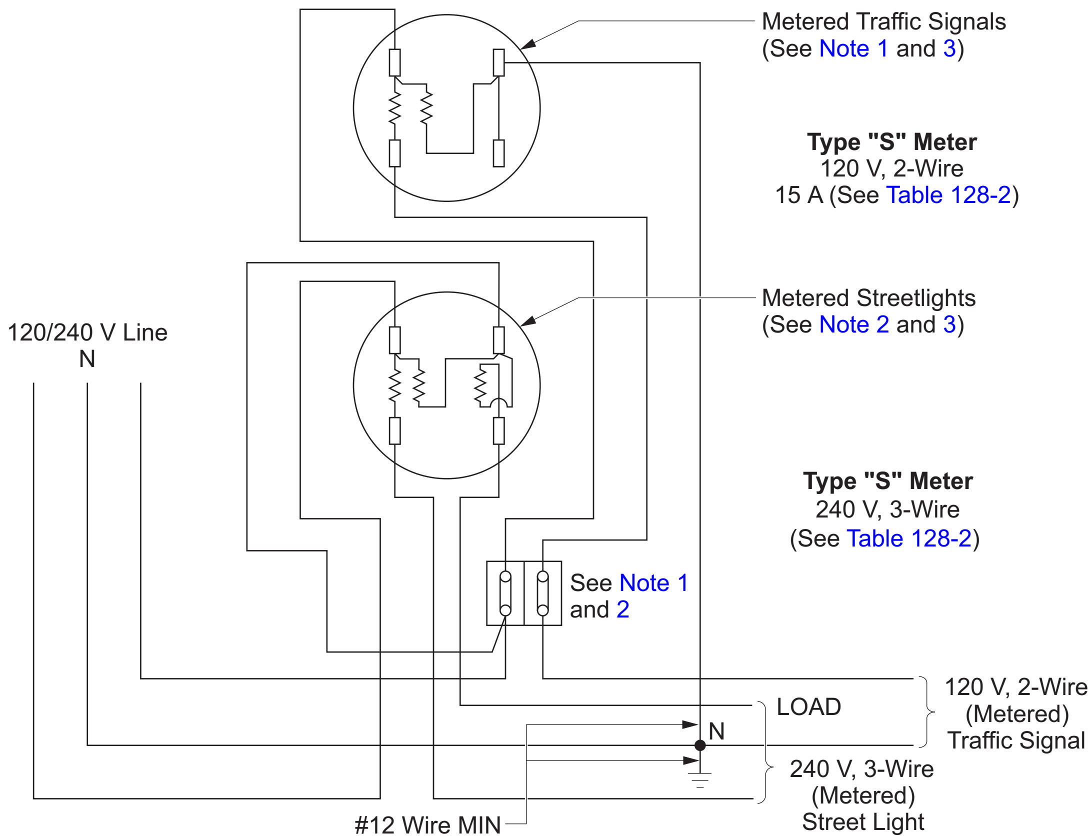


Table T 128–3: 120 V, 2-Wire and 240 V, 3-Wire Meters

Meter Type	Meter Description	SAP
1S	120 V, 2-Wire 15 A	10105255
1S ESC[a/]	120 V, 2-Wire 15 A	10158735
2S (Key 6)	240 V, 3-Wire 15 A	—
2S	240 V, 3-Wire 30 A	10105402
2S ESC[a/]	240 V, 3-Wire 30 A	10168079
2S ESC[a/]	240 V, 3-Wire 50 A	10158782
2S ESC Cell Relay[a/] (See Note 4)	240 V, 3-Wire 30 A	10168499

[a/] Edison SmartConnect (ESC)

Note(s):

1. For traffic signals, test bypass blocks are required per ESR 5-14.
2. For streetlights, test bypass blocks are not required.
3. Meter positions may be reversed depending on customer's panel provisions, as long as Notes 1 and 2 are met.
4. The Edison SmartConnect (ESC) cell relay meter types are used as receivers for the surrounding SmartConnect meters and for forwarding these meter broadcasts to a central location for reading. Installation/location of these meters are pre-determined and has identification tags attached to them. Before conducting any servicing of these meters, please call; the Grid Services Advanced Metering Operations (AMO) at (626) 543-6393.

Scope T 128.3 **Typical Method of Serving Multiple Metered Streetlights, Traffic Signals, Illuminated Signs, and so on, with Two 240 V, 3-Wire Meters**

Figure T 128–3: Method of Serving Multiple Metered Streetlights, Traffic Signals, Illuminated Signs, and so on, with Two 240 V, 3-Wire Meters

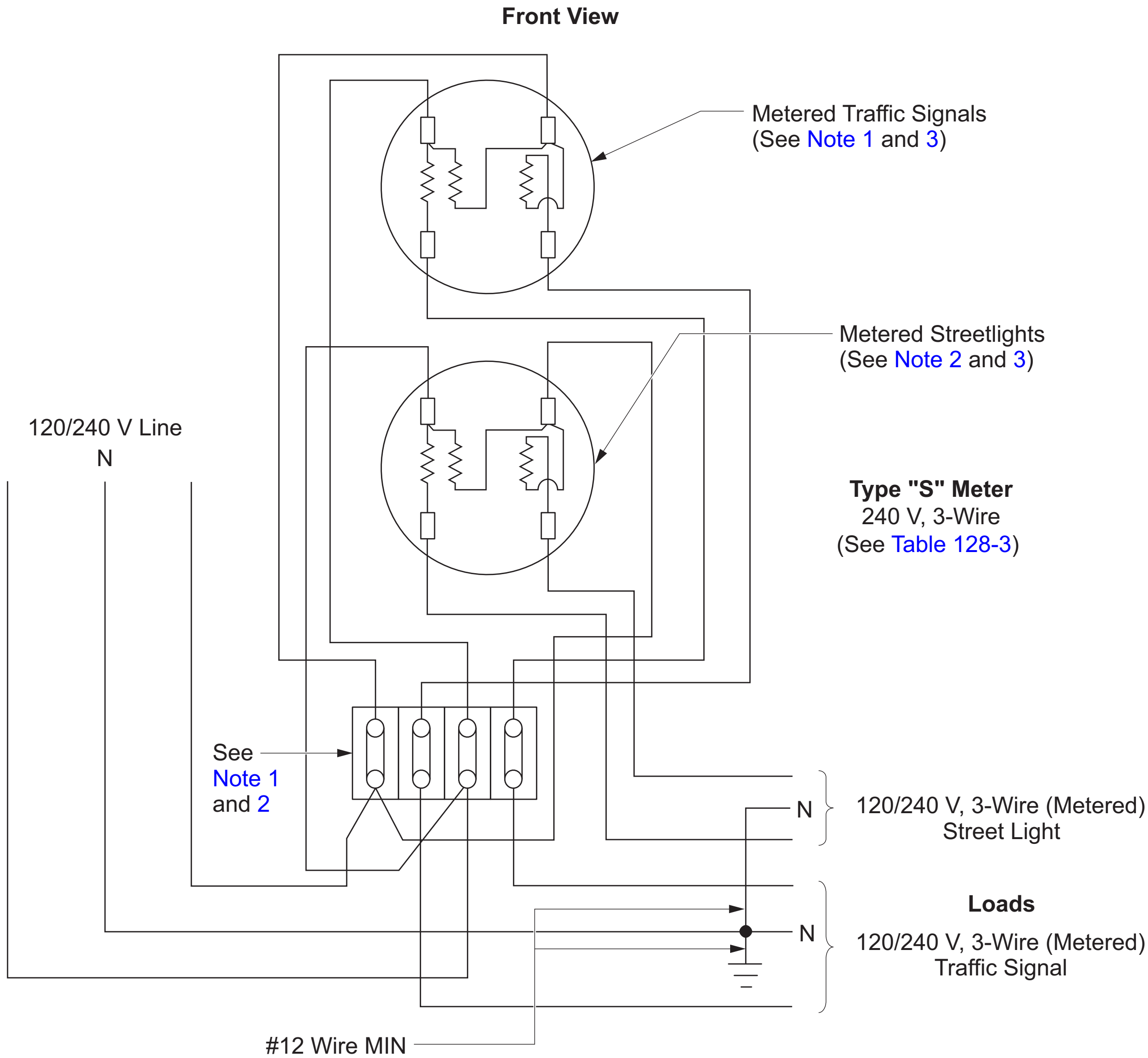


Table T 128–4: 240 V, 3-Wire Meters

Meter Type	Meter Description	SAP
2S (Key 6)	240 V, 3-Wire 15 A	—
2S	240 V, 3-Wire 30 A	10105402
2S ESC[a/]	240 V, 3-Wire 30 A	10168079
2S ESC[a/]	240 V, 3-Wire 50 A	10158782
2S ESC Cell Relay[a/] (See Note 4)	240 V, 3-Wire 30 A	10168499

[a/] Edison SmartConnect (ESC)

Note(s):

1. For traffic signals, test bypass blocks are required per ESR 5-14.
2. For streetlights, test bypass blocks are not required.
3. Meter positions may be reversed depending on customer's panel provisions, as long as Notes 1 and 2 are met.
4. The Edison SmartConnect (ESC) cell relay meter types are used as receivers for the surrounding SmartConnect meters and for forwarding these meter broadcasts to a central location for reading. Installation/location of these meters are pre-determined and has identification tags attached to them. Before conducting any servicing of these meters, please call; the Grid Services Advanced Metering Operations (AMO) at (626) 543-6393.

Scope T 128.4 **Method of Serving Multiple Unmetered Streetlights and Metered Traffic Signals, Flashers, Illuminated Street Signs, and so on, Employing One 120 V, 2-Wire Meter for Pole Installations**

Figure T 128–4: Method of Serving Multiple Unmetered Streetlights and Metered Traffic Signals, Flashers, Illuminated Street Signs, and so on, Employing One 120 V, 2-Wire Meter for Pole Installations

Front View

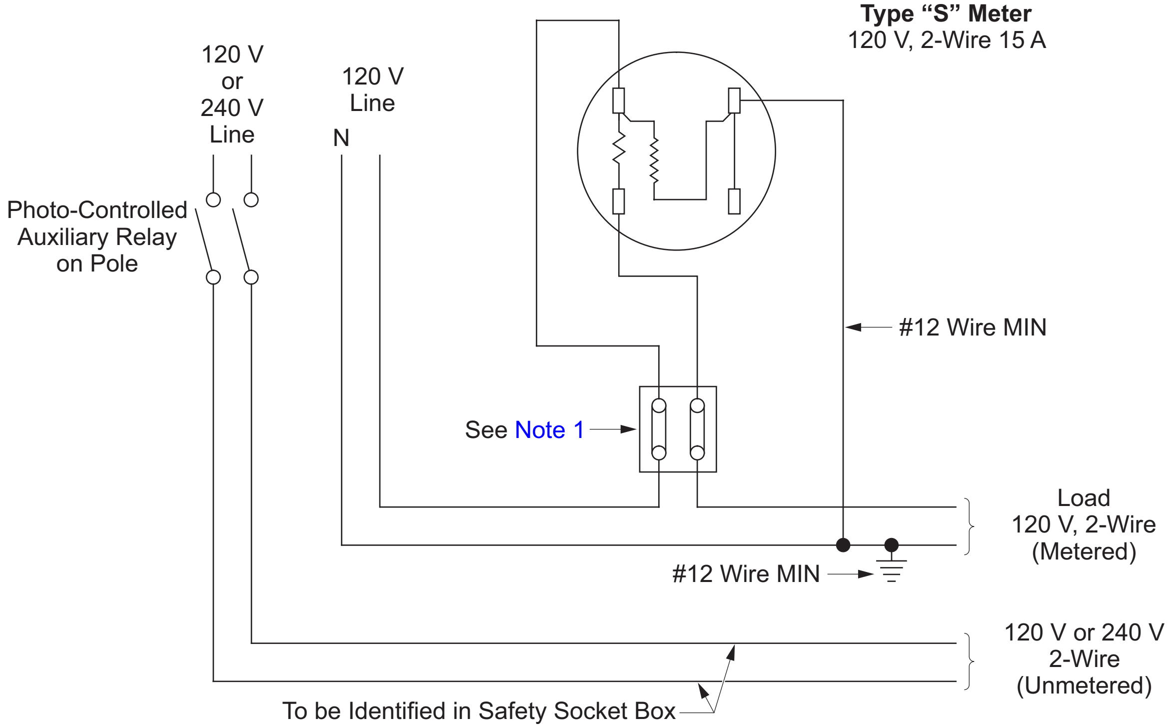


Table T 128–5: 120 V, 2-Wire Meters for Pole Installations

Meter Type	Meter Description	SAP
1S	120 V, 2-Wire 15 A	10105255
1S ESC[a/]	120 V, 2-Wire 15 A	10158735

[a/] Edison SmartConnect (ESC)

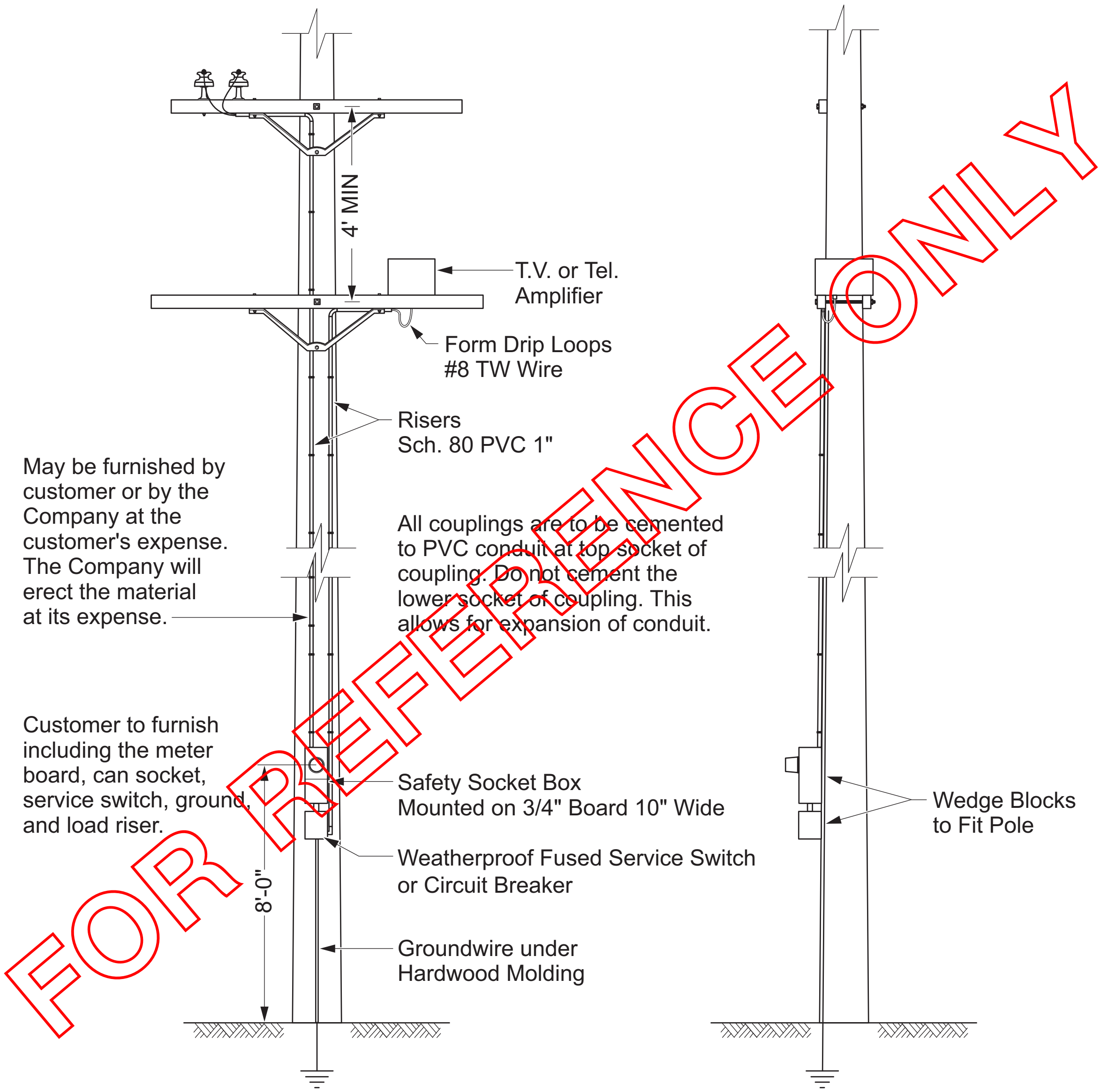
Note(s):

1. This is a factory installed test bypass block per ESR 5-14.

T 130 Single-Phase Metering — Using Self-Contained Meters

Scope T 130.1 Metering Installation for TV or Telephone Amplifier

Figure T 130–1: Metering Installation for TV or Telephone Amplifier



This type of installation with customer service equipment on company poles is available to governmental/city agencies and other utilities only, and only with Planning Department approval.

Note(s):

1. See Scope PO 100.4 for pole step requirements.

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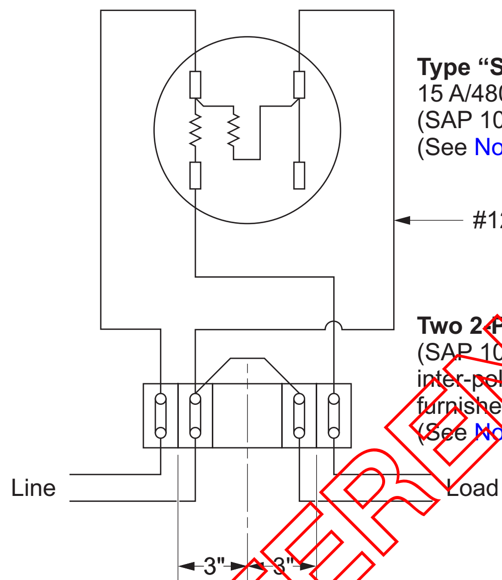
T 135 **Single-Phase Metering — Using Self-Contained Meters**

Scope T 135.1 **480 V, 1Ø, 2-Wire Meter Service Using a Self-Contained Meter**

Figure T 135–1: 480 V, 1Ø, 2-Wire Meter Service Using a Self-Contained Meter

Front View



Note(s):

1. This 2-wire service to be supplied only from an undergrounded, 480 V, 1Ø or 3Ø system. See T 135.2 (Sheet 2), for grounded system.
2. When mounting 100 A test blocks in 100 A safety socket box, install an inter-block barrier (SAP 10115816) at each end of the block group.
3. When metered with a 3-wire meter, see T 135.3 (Sheet 4).

Scope T 135.2 **480 V, 1Ø, 3-Wire Service (Served from a 277/480 V Source) Using a Multi-Volt, 2-Stator, Self-Contained Meter**

Figure T 135–2: 480 V, 1Ø, 3-Wire Service (Served from a 277/480 V Source) Using a Multi-Volt, 2-Stator, Self-Contained Meter

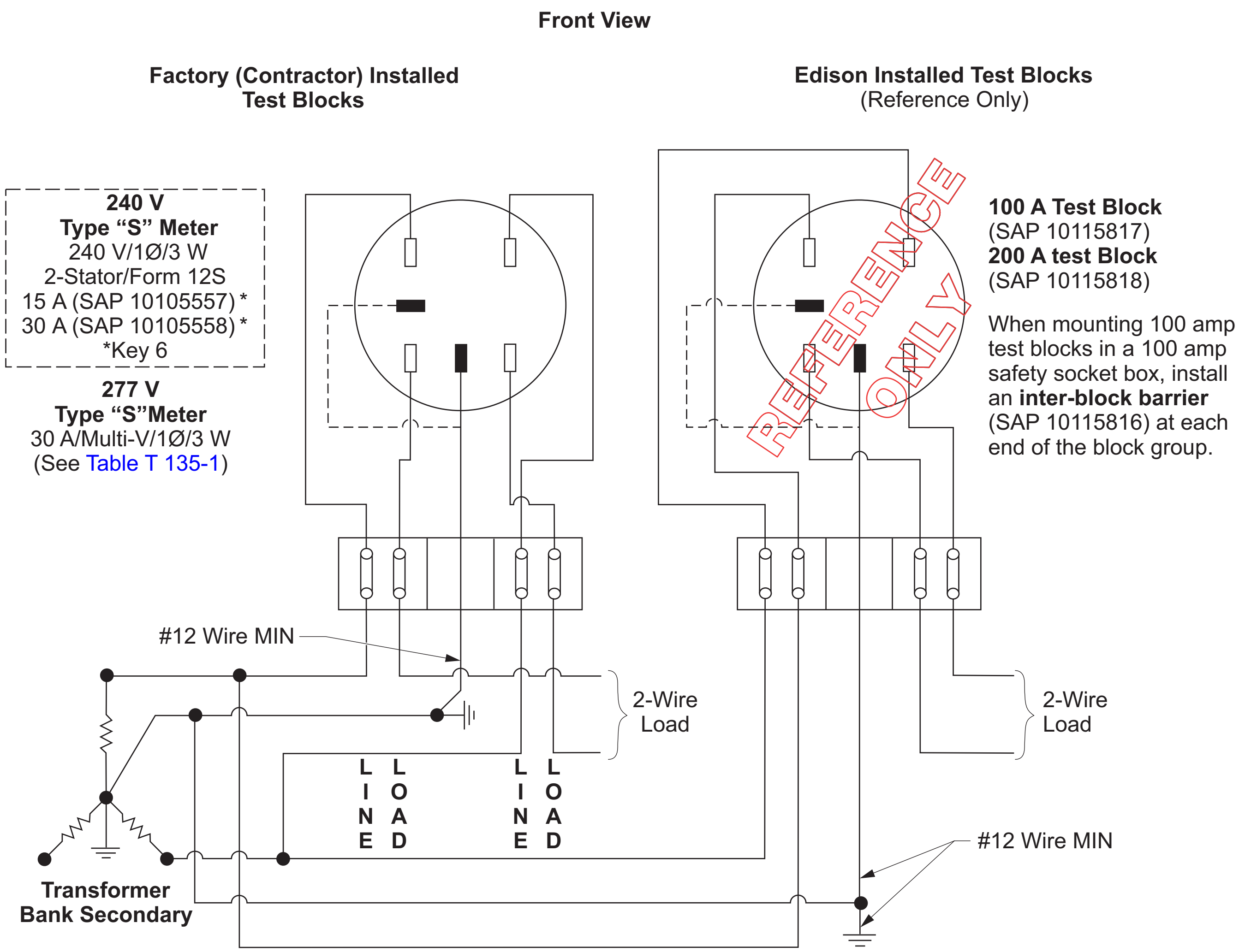


Table T 135–1: 480 V, 1Ø, 3-Wire Service (Served from a 277/480 V Source) Using a Multi-Volt, 2-Stator, Self-Contained Meter

Meter Type	Meter Description	SAP
12S	30 A, Multi-V, 3 Wire	10105526
12S ESC[a/]	30 A, Multi-V, 3 Wire	10158741

[a/] Edison SmartConnect (ESC)

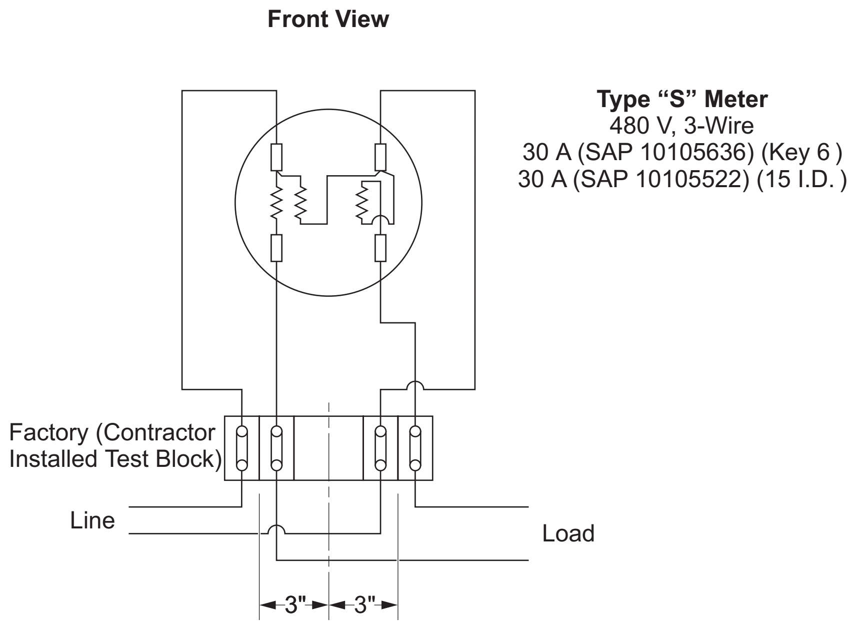
What's Changed? Addition of new 12S ESC meter. Removed MC codes and added SAP numbers.

Note(s):

1. This drawing is to be used only when necessary to serve 480 V, 1Ø, 2-wire load from a grounded 277/480 V bank or system. For ungrounded 2-wire service, see T 135.1 (Sheet 1).
2. A "480 VOLT" label shall be affixed to both the inside and outside of the safety socket box as a warning to company personnel. (The circuit is 480 V though the meter is rated 120–480 V.)
3. For test precautions, see T 34.
4. Some existing field installations may still exist using 240 V meters, however, 240 V meters are no longer purchased for this application.

Scope T 135.3 480 V, 1Ø, 2-Wire Service Using a 3-Wire, Self-Contained Meter

Figure T 135–3: 480 V, 1Ø, 2-Wire Service Using a 3-Wire, Self-Contained Meter



Note(s):

1. This 2-wire service to be supplied only from an ungrounded, 480 V, 3Ø, 3-wire system. See T 127 or T 135.2 (Sheet 2) for grounded system.
2. Affix a "METER VOLTAGE" sticker to the meter panel, two inches below the meter's rim. See T 552 for sticker selection.

What's Changed? Removed MC codes and added SAP numbers.

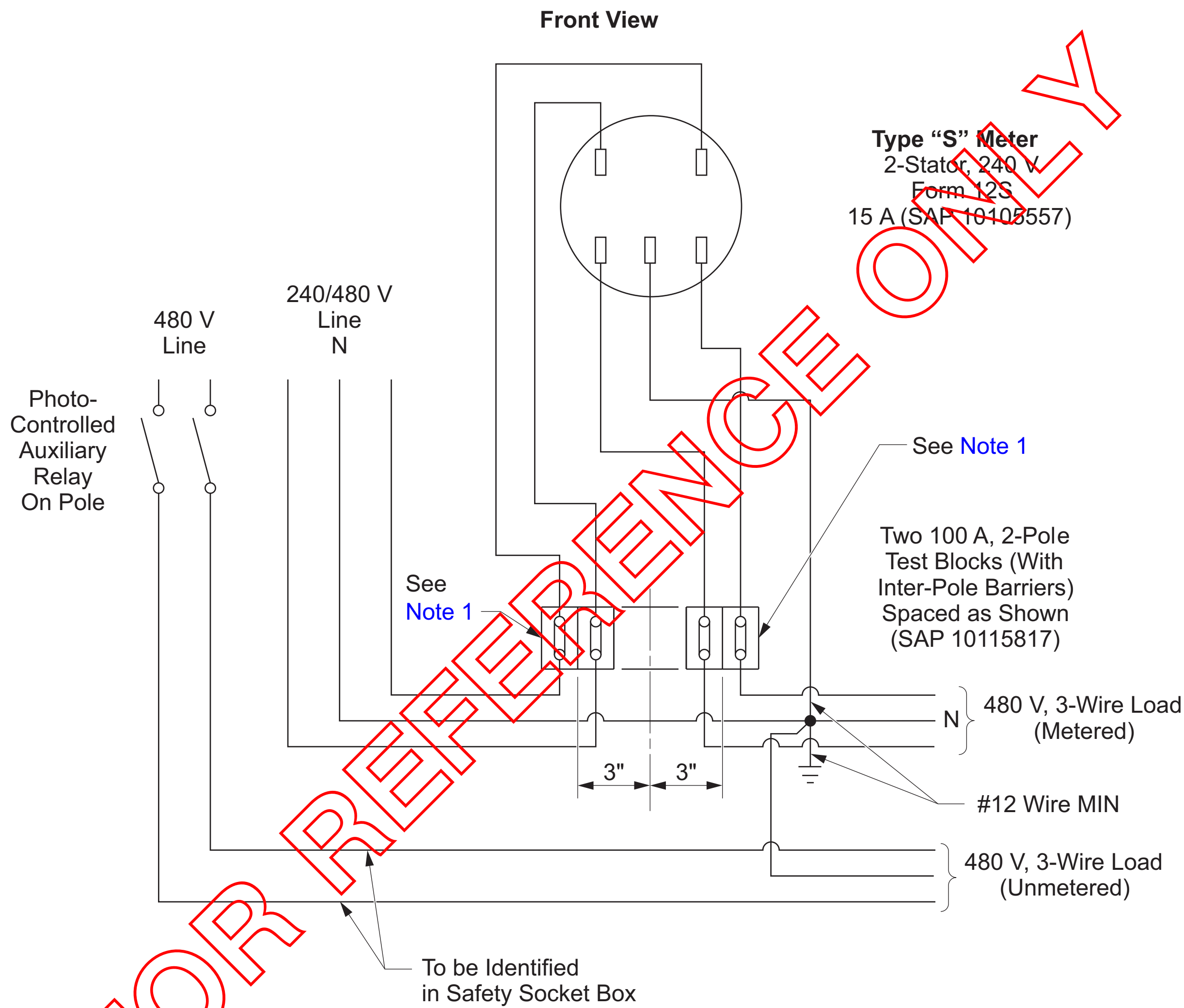
Approved by:

Effective Date: 02-25-2011

T 137 Single-Phase Metering — Using Self-Contained Meters

Scope T 137.1 240/480 V, 1Ø, 3-Wire Service for Metered Illuminated Signs, and so on, and Unmetered Streetlights Using 480 V, 1Ø, 3-Wire, Self-Contained Meter

Figure T 137–1: 240/480 V, 1Ø, 3-Wire Service for Metered Illuminated Signs, and so on, and Unmetered Streetlights Using 480 V, 1Ø, 3-Wire, Self-Contained Meter



Note(s):

1. When mounting blocks in safety box, install an interblock barrier (SAP 10115816) at each end of the block group.
2. A "480 VOLT" label shall be affixed to both the inside and outside surface of the socket box as a warning to company personnel that the circuit is 480 V although the meter is rated 240 V.

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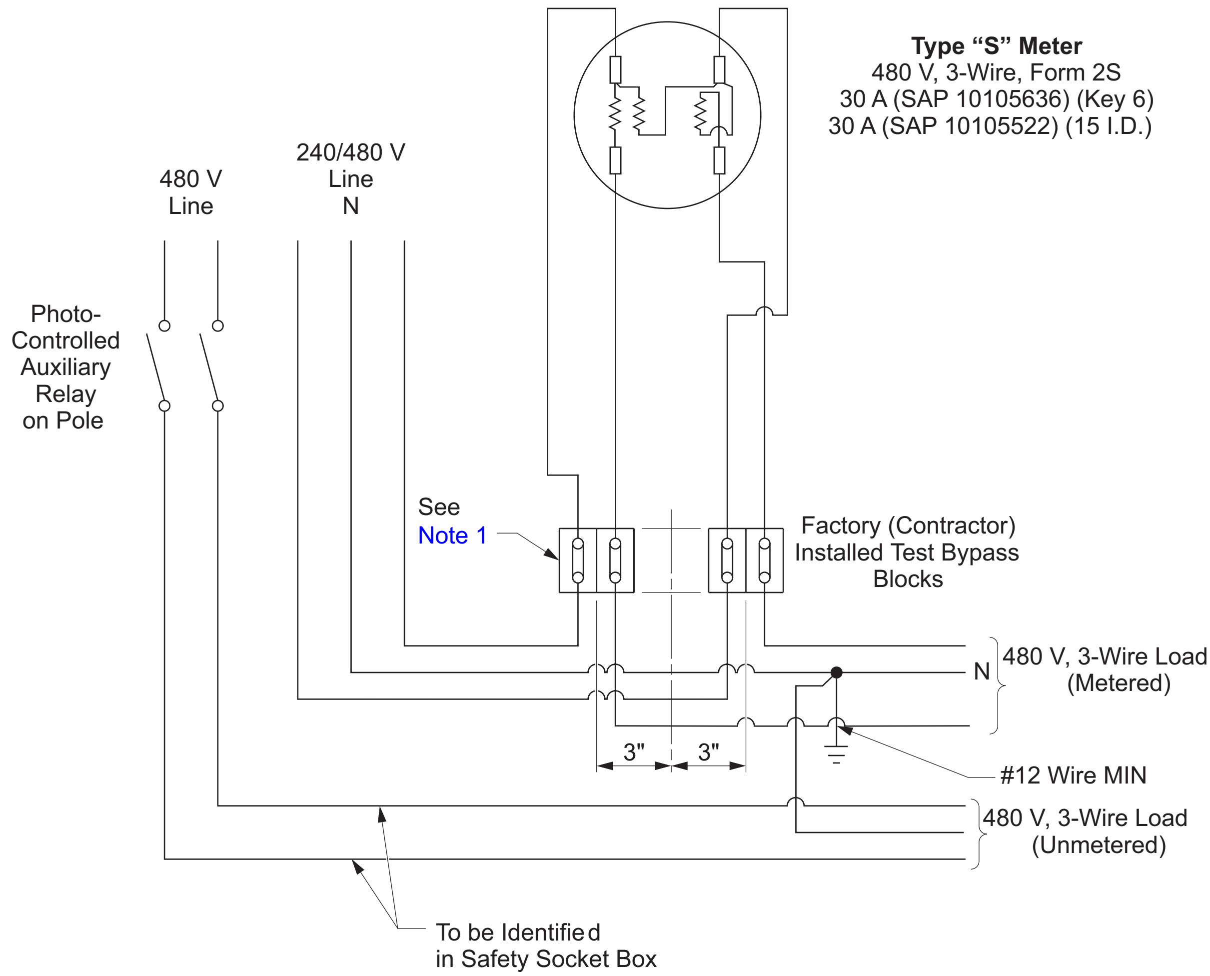
T 138 **Single-Phase Metering — Using Self-Contained Meters**

Scope T 138.1 **240/480 V, 1Ø, 3-Wire Service for Metered Illuminated Signs, and so on, and Unmetered Streetlights Using 480 V, 1Ø, 3-Wire Self-Contained Meter**

Figure T 138–1: 240/480 V, 1Ø, 3-Wire Service for Metered Illuminated Signs, and so on, and Unmetered Streetlights Using 480 V, 1Ø, 3-Wire Self-Contained Meter

Front View



Note(s):

1. Factory installed test bypass blocks must have barriers at each end of the block group.
2. A "480 VOLT" label shall be affixed to both the inside and outside surface of the socket box as a warning to company personnel that the circuit is 480 V.

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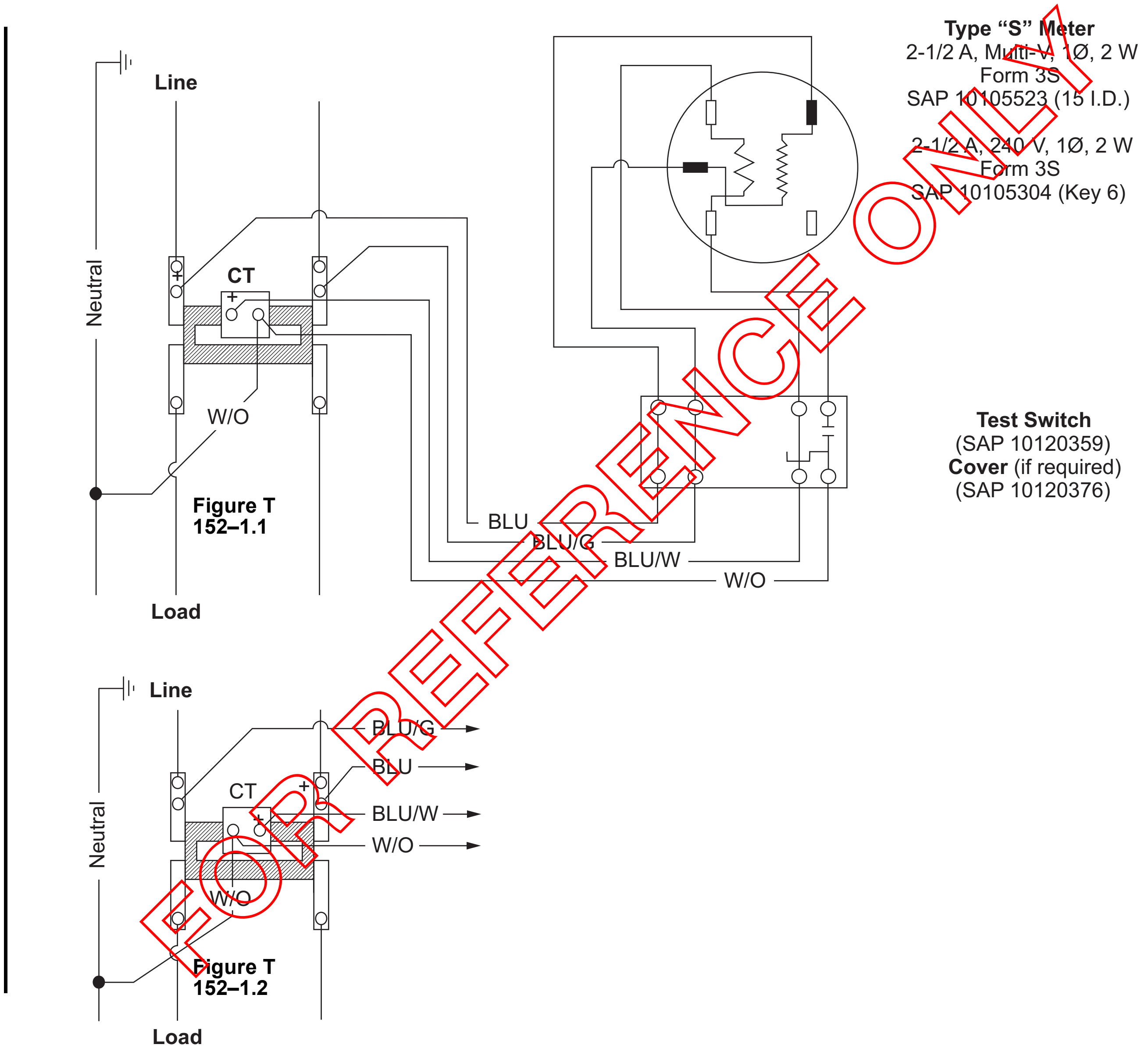
T 152 **Single-Phase Metering — Using Current and Potential Transformers**

Scope T 152.1 **120/240 V or 240/480 V, 3-Wire, 1Ø Service Using 3-Wire CT and 2-Wire Meter**

Figure T 152–1: 120/240 V or 240/480 V, 3-Wire, 1Ø Service Using 3-Wire CT and 2-Wire Meter



Note(s):

1. See T 63 for CT mounting on transformer base.
2. Polarity marks on 3-wire CTs vary in position. Use the connections (Figure T 152–1.1 [Sheet 1] or Figure T 152–1.2 [Sheet 1]) applicable to the CT being installed.
3. See T 65 for other CT polarity information.
4. Affix a "METER VOLTAGE" sticker to the meter panel, two inches below the meter's rim. See T 75 for sticker selection.

T 155 **120/240 V or 240/480 V (See Table T 155-1), 1Ø, 3-Wire Services Using 2-Wire CTs and a 2-Wire Meter**

Scope T 155.1 **Connections for Making up 120/240 V or 240/480 V (See Table T 155-1), 1Ø, 3-Wire Services Using 2-Wire CTs and a 2-Wire Meter**

Figure T 155–1: Connections for Making up 120/240 V or 240/480 V (See Table T 155-1), 1Ø, 3-Wire Services Using 2-Wire CTs and a 2-Wire Meter

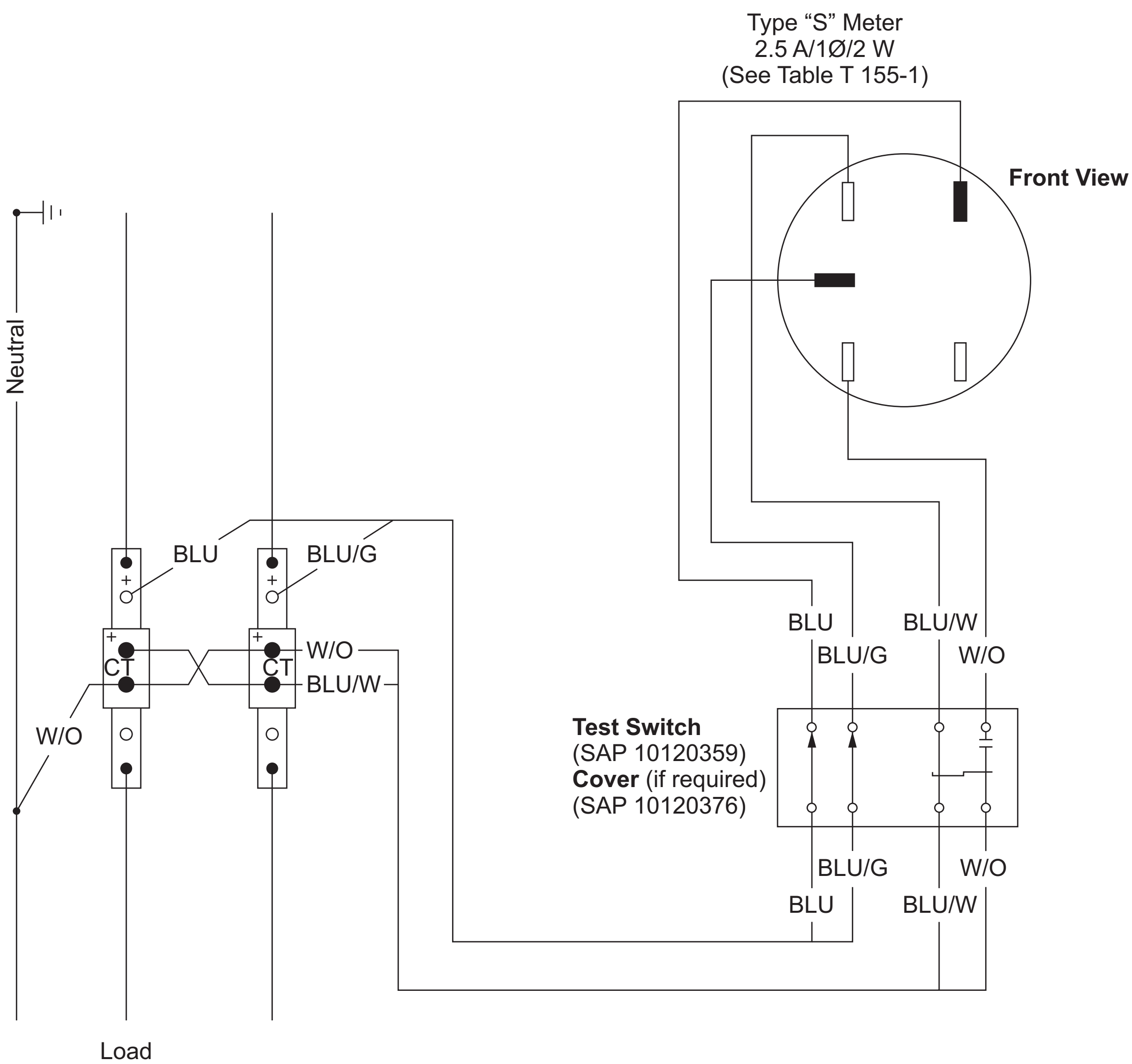


Table T 155–1: Connections for Making up 120/240 V or 240/480 V, 1Ø, 3-Wire Services Using 2-Wire CTs and a 2-Wire Meter

Meter Type	Meter Description	SAP
3S	2.5 A, 120/240 V or 240/480 V, 2 Wire	10105523
3S ESC[a/]	2.5 A, 240 V, 2 Wire	10158738

[a/] Edison SmartConnect (ESC)

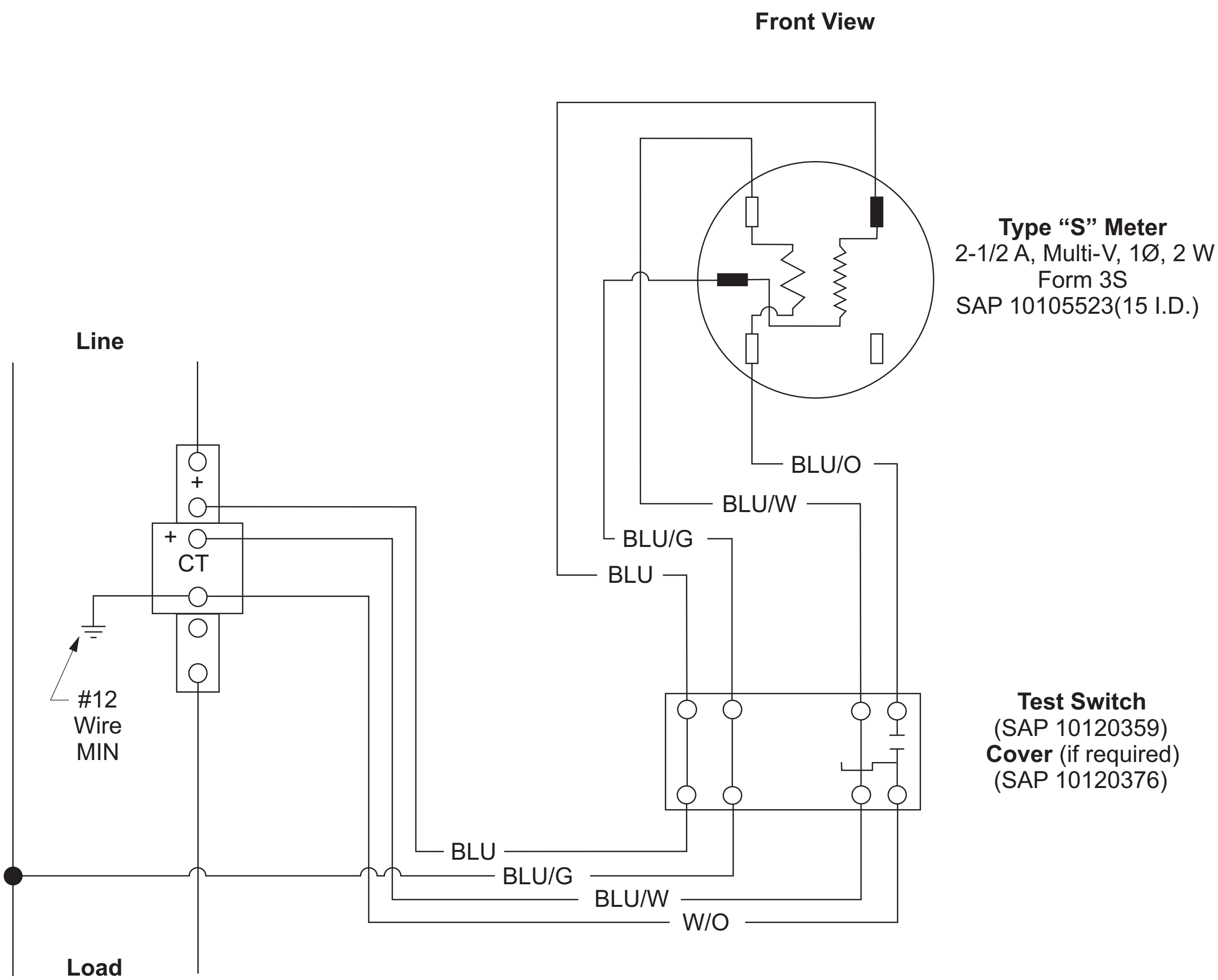
Note(s):

1. All CTs must have the same ratio.
2. See T 65 for additional polarity information.
3. The meter's multiplying constant is 1/2 the nameplate ratio of the CTs multiplied by the dial constant of the meter.
4. Affix a "METER VOLTAGE" sticker to the meter panel, two inches below the meter's rim. T 75 for sticker location.

T 165 **Single-Phase Metering — Using Current and Potential Transformers**

Scope T 165.1 **480 V, 1Ø, 2-Wire Service Using CTs and 2-Wire Meter**

Figure T 165–1: 480 V, 1Ø, 2-Wire Service Using CTs and 2-Wire Meter



Note(s):

1. This 2-wire service to be supplied only from an ungrounded 480 V, 3Ø system or bank. When served from grounded 277/480 V bank or system, use T 165.2 (Sheet 2).
2. See T 65 (Sheet 1) for CT polarity information.
3. Affix a “METER VOLTAGE” sticker to the meter panel, two inches below the meter’s rim. See T 75 (Sheet 1) for sticker selection.

Scope T 165.2 **480 V, 1Ø, 2-Wire Service (Served from a 277/480 V Source) Using Current Transformers and 277 V, 2-Stator Meter**

Figure T 165–2: 480 V, 1Ø, 2-Wire Service (Served from a 277/480 V Source) Using Current Transformers and 277 V, 2-Stator Meter

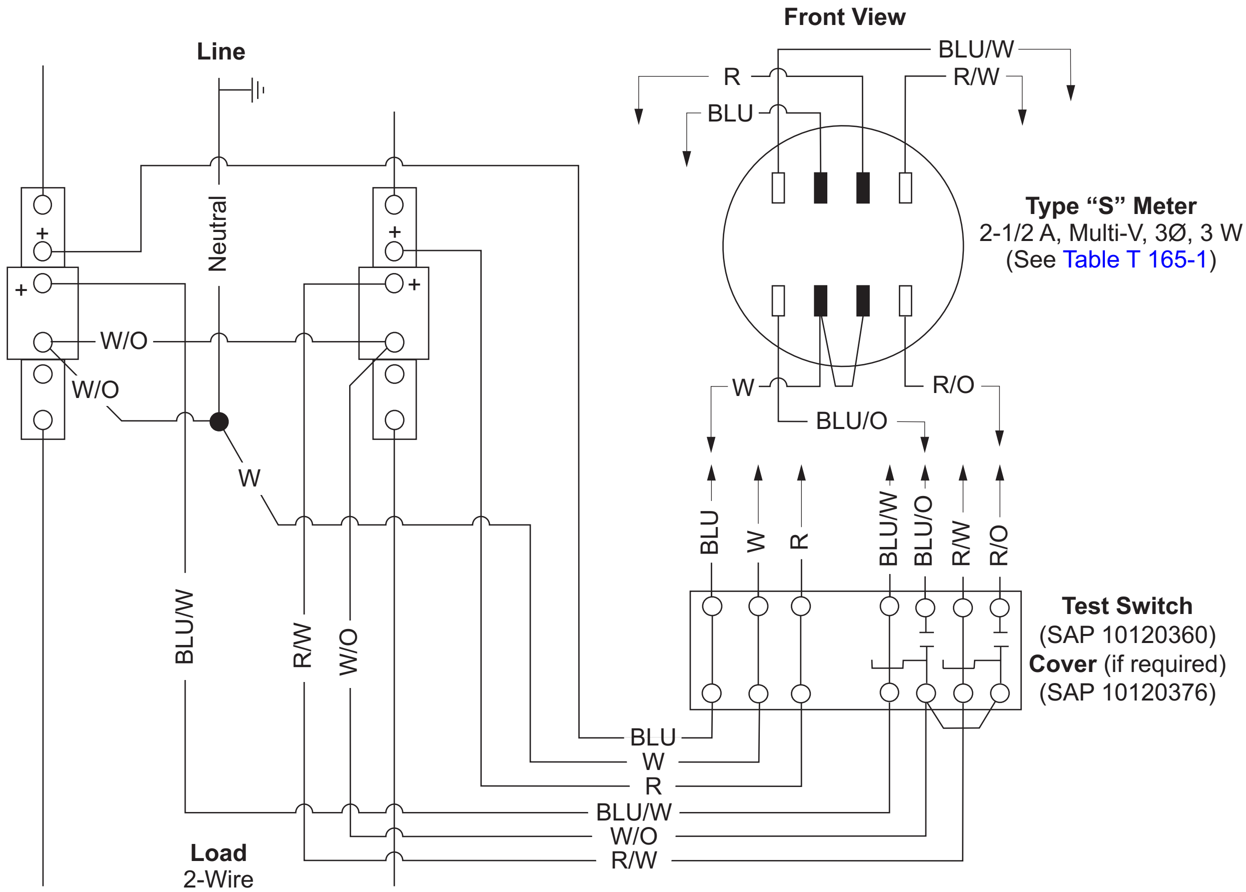


Table T 165–1: 480 V, 1Ø, 2-Wire Service (Served from a 277/480 V Source) Using Current Transformers and 277 V, 2-Stator Meter

Meter Type	Meter Description	SAP
45S	2.5 A, Multi-V, 3 Wire	10105524
45S ESC[a/]	2.5 A, Multi-V, 3 Wire	10175800

[a/] Edison SmartConnect (ESC)

Note(s):

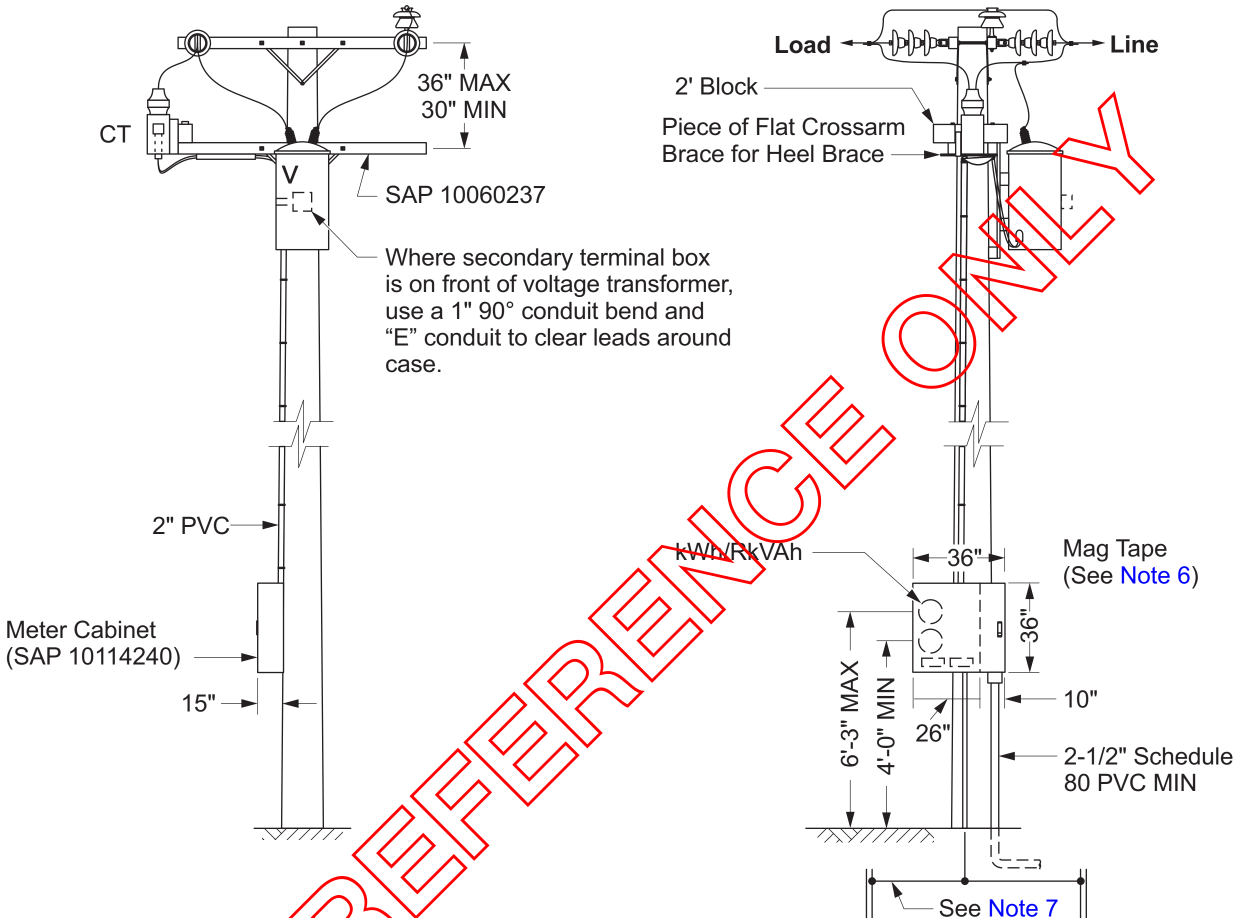
1. This drawing is to be used only when necessary to serve 480 V, 1Ø, 2-wire from a grounded 277/480 V bank or system. For ungrounded 2-wire services see T 165.1 (Sheet 1).
2. A "480 VOLT" label shall be affixed to both the inside and outside surface of the current transformer enclosure as a warning to company personnel. (The circuit is 480 volts though the meter is rated 120–480 V.)
3. See T 65 for CT polarity information.

What's Changed? Addition of new 45S ESC meter. Removed MC codes and added SAP numbers.

T 199 Single-Phase Metering — Using Current and Potential Transformers

Scope T 199.1 12/16 kV, 1Ø Pole Top Metering Installation

Figure T 199–1: 12/16 kV, 1Ø Pole Top Metering Installation

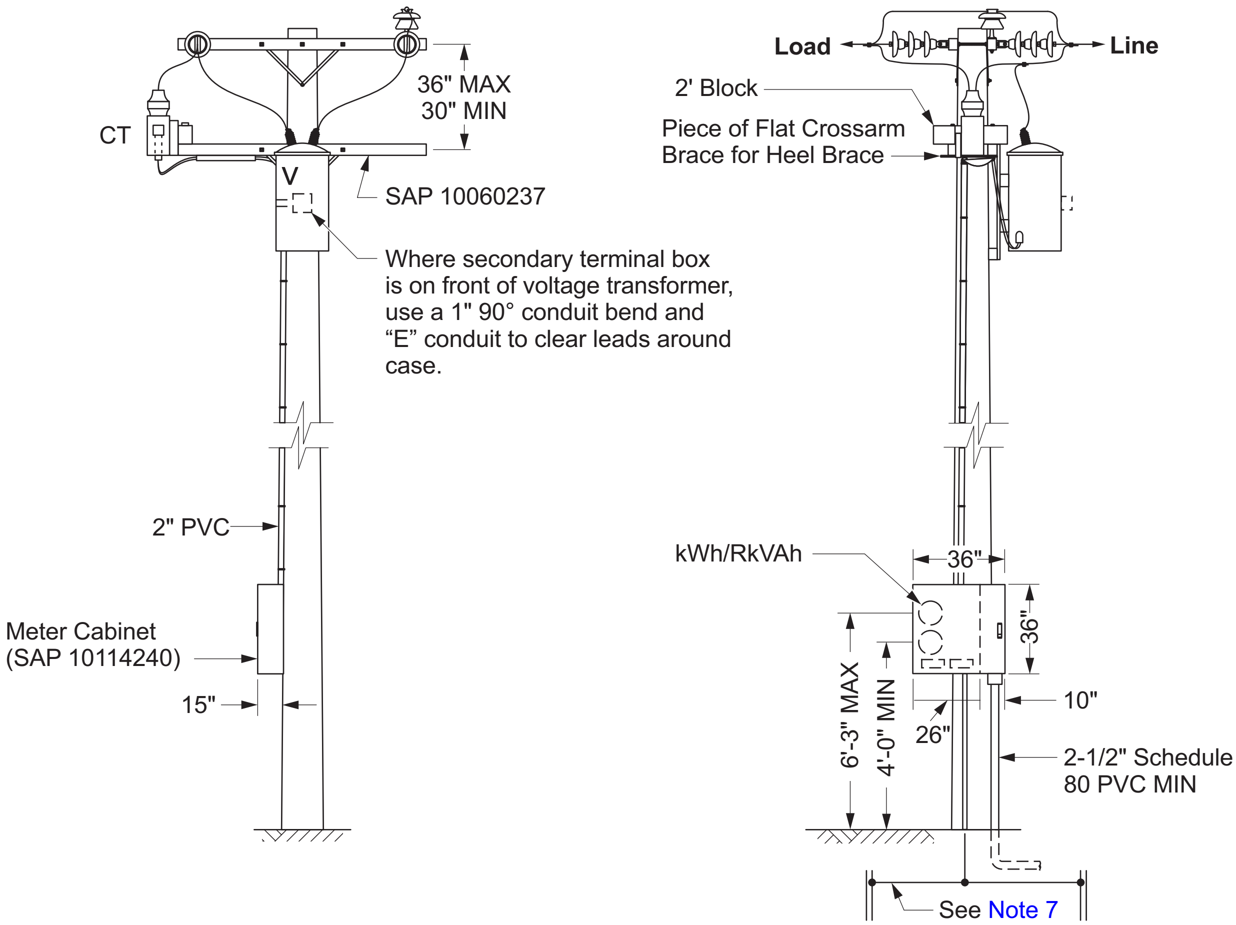


Note(s):

1. The complete metering installation, including enclosure, will be furnished and installed by the Company.
2. The completed wiring of each new meter installation, or any change or replacement of any part of an existing installation, shall be checked by a representative of the metering services organization before energizing the installation.
3. Where an instrument transformer is installed on the pole so that its primary polarity marked terminal is reversed with respect to the connections shown of the applicable meter wiring drawing, its secondary connections must be reversed accordingly.
4. The line conductors shall be dead-ended at the next adjacent pole on the supply side of the master pole to permit opening of taps, or jumps, for isolation of the metering installation.
5. See Scope PO 100.4 for pole step requirements.
6. When RkVah and/or Mag Tape Demand meters are installed in conjunction with a kWh meter, mounting shall be as shown in Figure T 199–1.
7. Installation shall be grounded with #6 BC minimum wire and standard ground assembly.
8. Meter cabinet is acceptable for overhead or underground installations.

Scope T 199.2 12/16 kV, 1Ø Pole Top Metering Installation

Figure T 199–2: 12/16 kV, 1Ø Pole Top Metering Installation Using a kWh/kVAh Meter

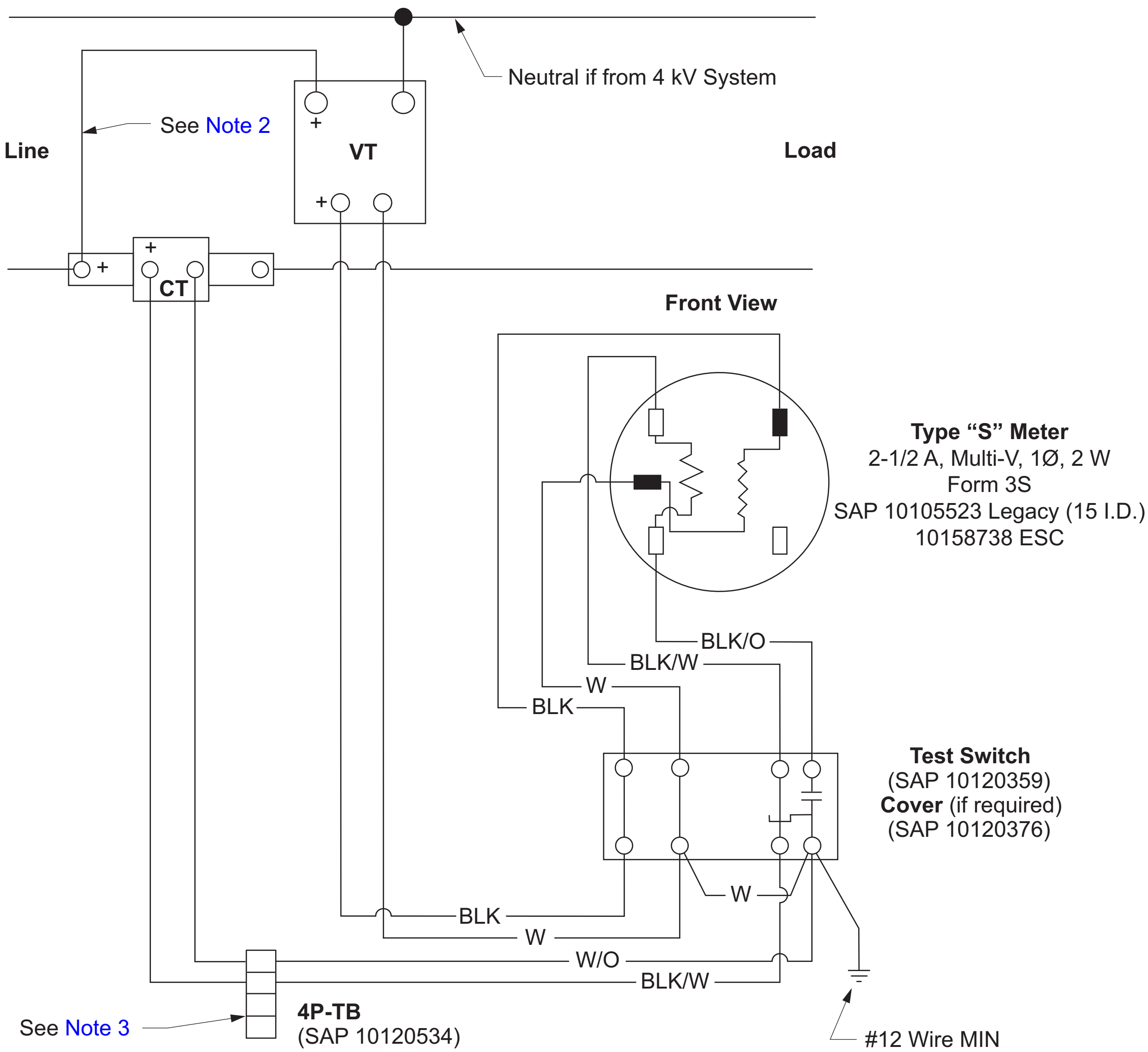


Note(s):

1. The complete metering installation, including enclosure, will be furnished and installed by the Company.
2. The completed wiring of each new meter installation, or any change or replacement of any part of an existing installation, shall be checked by a representative of the metering services organization before energizing the installation.
3. Where an instrument transformer is installed on the pole so that its primary polarity marked terminal is reversed with respect to the connections shown of the applicable meter wiring drawing, its secondary connections must be reversed accordingly.
4. The line conductors shall be dead-ended at the next adjacent pole on the supply side of the master pole to permit opening of taps, or jumps, for isolation of the metering installation.
5. See Scope PO 100.4 for pole step requirements.
6. Installation shall be grounded with #6 BC minimum wire and standard ground assembly.
7. Meter cabinet is acceptable for overhead or underground installations.

Scope T 199.3 **2.4/12/16 kV 1Ø Pole Top Service Using Instrument Transformers and 2-Wire Meter**

Figure T 199–3: 2.4/12/16 kV 1Ø Pole Top Service Using Instrument Transformers and 2-Wire Meter



Note(s):

1. Where an instrument transformer is installed on the pole so that its primary polarity is reversed with respect to the above connections, the secondary connections must also be reversed.
2. The Voltage Transformer (VT) tap to the Current Transformer (CT) primary tap must always be connected to the "line" side of the CT
3. To be located on the backside of the meter panel door.
4. For services above 5 kV, the completed wiring of each new meter installation or any change or replacement of any part of an existing installation shall be inspected by a representative of the meter services organization before energizing the installation.
5. Affix a "METER VOLTAGE" sticker to the meter panel, two inches below the meter's rim. See T 75 for sticker selection.

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T 225 3-Wire Network (1-Phase) Metering — Using Self-Contained Meters

Scope T 225.1 120/208 V, 1Ø, Network Service Using a Self-Contained 2-Stator Meter

Figure T 225–1: 120/208 V, 1Ø, Network Service Using a Self-Contained 2-Stator Meter

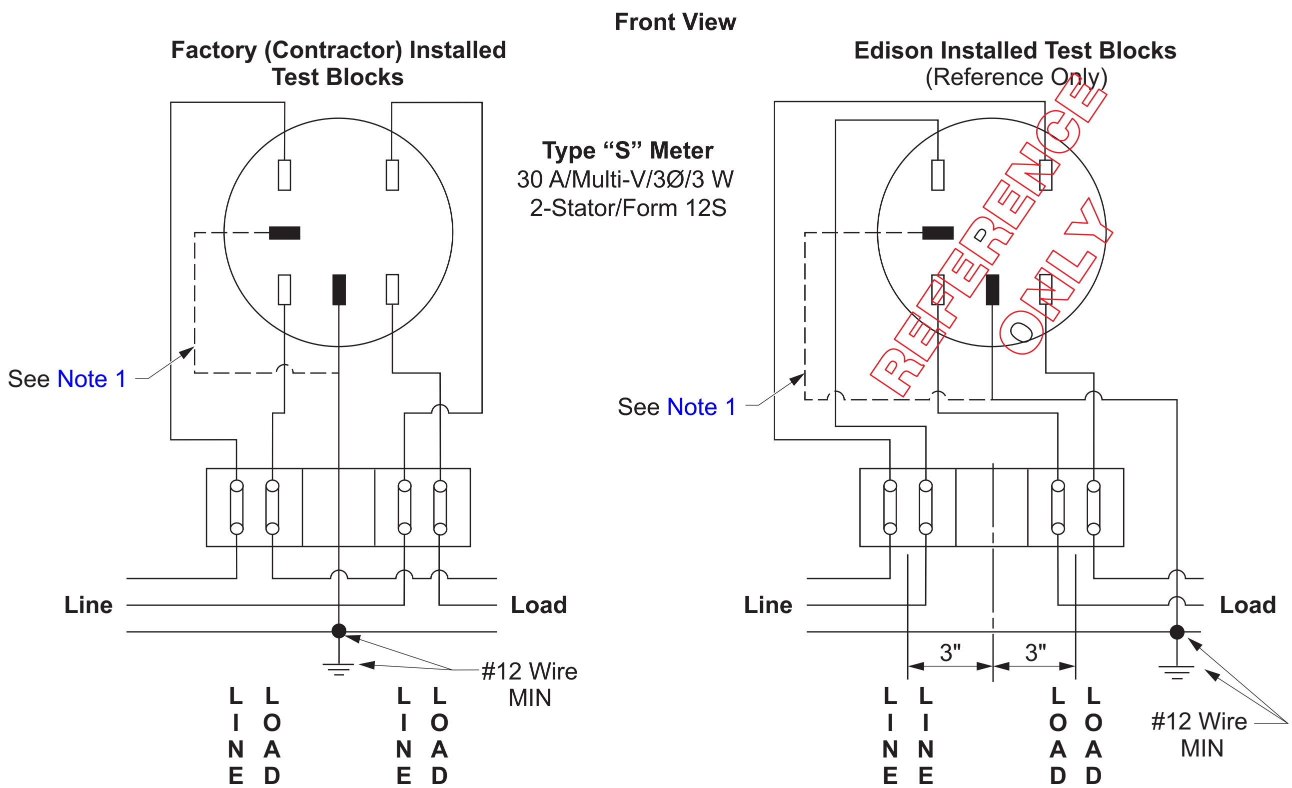

Figure T 225–1.1

Figure T 225–1.2

Table T 225–1: /208 V, 1Ø, Network Service Using a Self-Contained 2-Stator Meter

Meter Type	Meter Description	SAP
12 S[a/]	30 A, Multi-V, 3-Wire, 2 Stator	—
12S[a/]	30 A, Multi-V, 3-Wire, 2 Stator (15 minute, Demand)	—
12S	30 A, Multi-V, 3-Wire, 2 Stator (15 minute, Demand)	10105526
12 ESC[b/]	120/208 V, 3-Wire 200 A	10158737

[a/] Key 6
[b/] Edison SmartConnect (ESC)

Note(s):

1. The neutral may be connected to the socket at either the six o'clock or the nine o'clock position.
2. Single occupancy residential installations do not require test blocks.
3. For test precaution, see T 34.
4. Affix a "METER VOLTAGE" sticker to the meter panel, two inches below the meter's rim. See T 75 for sticker selection.\

What's Changed? New Table 225-1 was developed to provide clarity for SCE existing meters and New SmartConnect Meter (ESC). Table information includes the meter form, meter description, Material Codes and SAP Numbers.

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T 250 3-Wire Network (Single-Phase) Metering — Using Current Transformers

Scope T 250.1 120/208 V, 1Ø, Network Service Using CTs and 2-Stator Meter

Figure T 250–1: 120/208 V, 1Ø, Network Service Using CTs and 2-Stator Meter

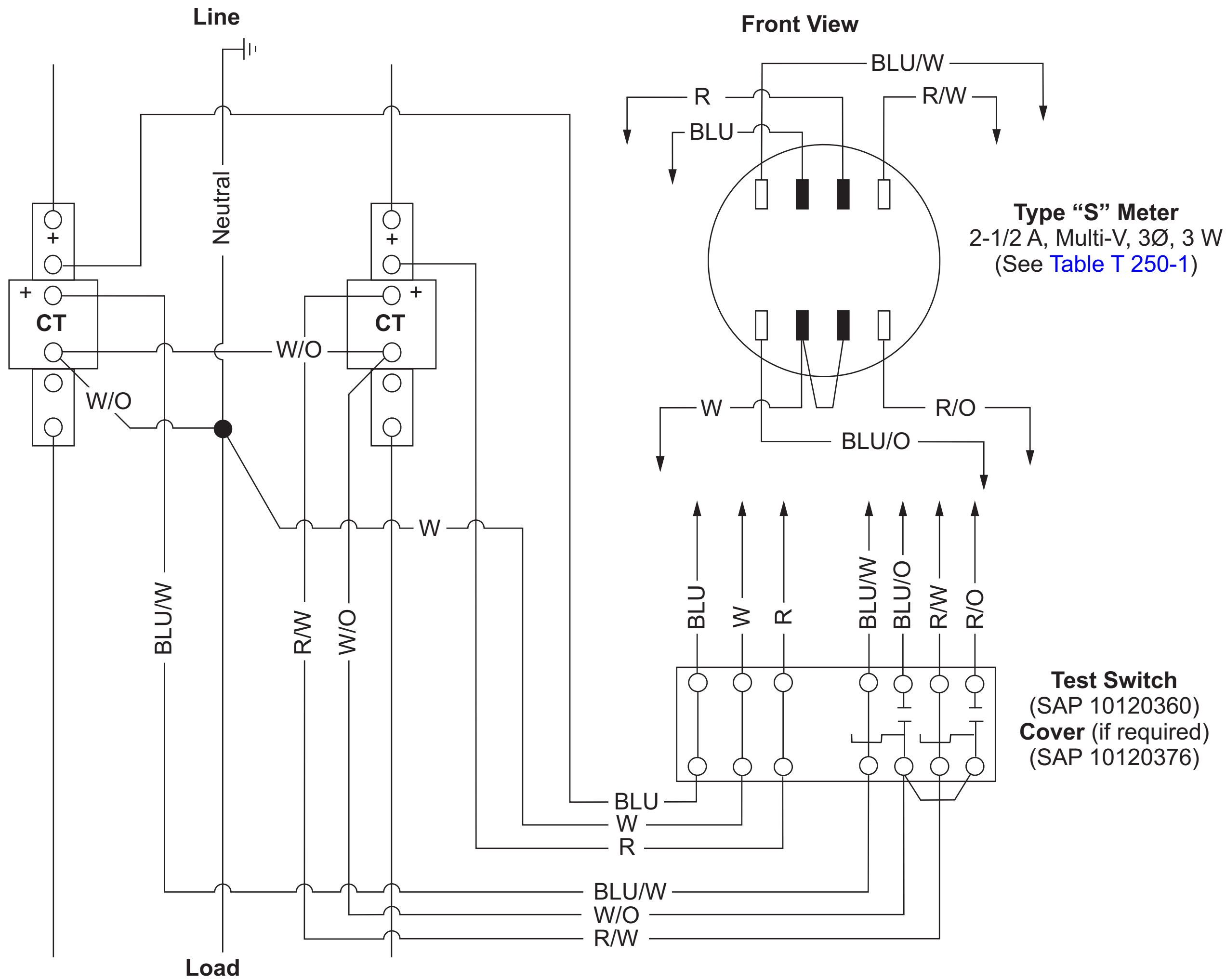

Table T 250–1: 120/208 V, 1Ø, Network Service Using CTs and 2-Stator Meter

Meter Type	Meter Description	SAP
45S	2.5 A, Multi-V, 3 Wire	10105524
45S ESC[a/]	2.5 A, Multi-V, 3 Wire	10175800

[a/] Edison SmartConnect (ESC)

Note(s):

1. See T 65 for CT Polarity information.
2. **For Long Beach network extensions only.** Use this print also for existing 120/240 V 1Ø services, or as authorized by customer service engineering staff.
3. Affix a "METER VOLTAGE" sticker to the meter panel, two inches below the meter's rim. See T 75 for sticker selection.

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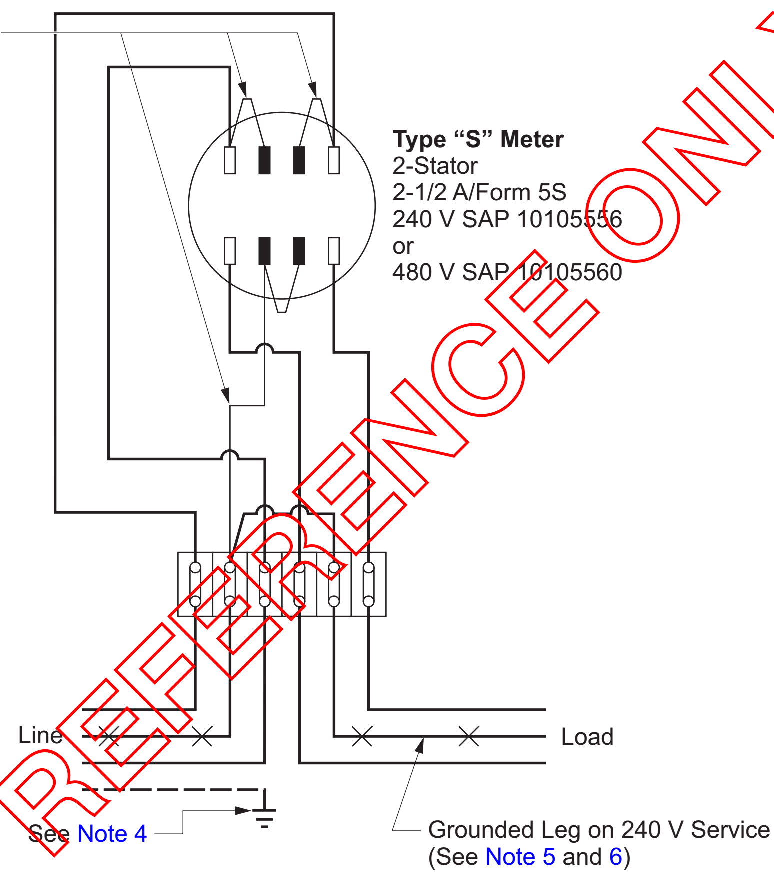
T 325 3-Wire, 3-Phase Metering — Using Self-Contained Meters

Scope T 325.1 240/480 V, 3Ø, 3-Wire Service Using a 2-1/2A Primary Type Meter as Self-Contained

Figure T 325–1: 240/480 V, 3Ø, 3-Wire Service Using a 2-1/2A Primary Type Meter as Self-Contained



Note(s):

1. The 480 V, 3-wire service to be supplied only from an ungrounded 3Ø system or bank or as authorized by customer service engineering staff.
2. Use #12 minimum wire for potential leads.
3. Install inter-block barriers (SAP 10115816) as shown in T 30 and T 31.
4. On 240 V, 3Ø, 3-wire service with one-phase grounded a fourth conductor, connecting the grounded transformer phase to the customer's grounding electrode, must be run with the service (see T 53).
5. See T 50 for additional information on metering connection for grounded leg.
6. On many existing 240 V installations, this conductor may be a power leg (208 V to ground). Where a fourth (grounding) conductor, connected to the transformer bank midpoint ground, and a power leg is run to a service, 4-wire metering is required (see T 431).

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T 326 3-Wire, 3-Phase Metering — Using Self-Contained Meters

Scope T 326.1 Typical 240/480 V, 3Ø, 3-Wire Service Using a Self-Contained Meter Line-Load, Line-Load, Line Load Sequence

Figure T 326–1: 240/480 V, 3Ø, 3-Wire Service Using a Self-Contained Meter Line-Load, Line-Load, Line Load Sequence

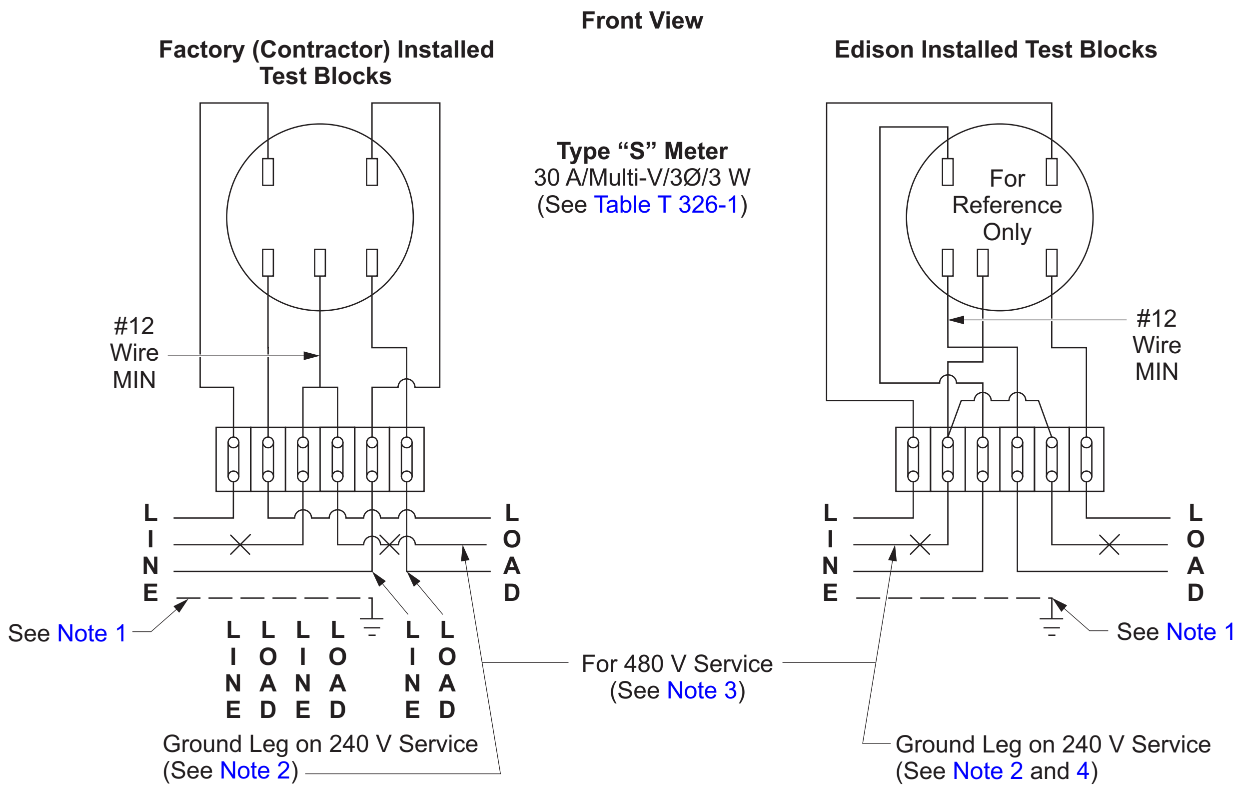


Table T 326–1: 240/480 V, 3Ø, 3-Wire Service Using a Self-Contained Meter Line-Load, Line-Load, Line Load Sequence

Meter Type	Meter Description	SAP
12S	30 A, Multi-V, 3 Wire	10105526
12S ESC[a/]	30 A, Multi-V, 3 Wire	10158741

[a/] Edison SmartConnect (ESC)

Note(s):

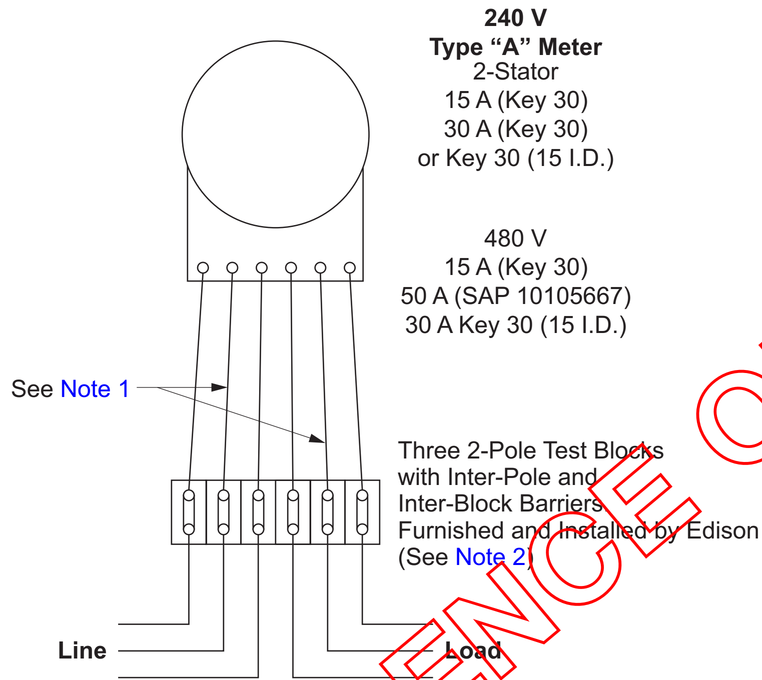
1. On 240 V, 3Ø, 3-wire service with one phase grounded, a fourth conductor (connecting the grounded transformer phase to the customer's grounding electrode) must be run with the service (see T 53).
2. See T 50 for additional information on metering connection for grounded leg.
3. The 480 V, 3-wire service is to be supplied only from an ungrounded 3Ø system or bank or as authorized by the district office.

4. On many existing 240 V installations, this conductor may be a power leg (208volts to ground). Where a fourth (grounding) conductor, connected to the transformer bank midpoint ground and a power leg are both run to a service, 4-wire metering is required (see T 431).
5. For test precautions, see T 34.
6. Affix a “METER VOLTAGE” sticker to the meter panel, two inches below the meter’s rim. See T 75 for sticker selection.
7. See Scope T 725.1 for NET Generation Output Meter (NGOM) used in Paired Storage, NEM-ST, NEM-MT-ST, and NEM-A Applications.
8. See Scope T 725.2 for NET Generation Output Meter (NGOM) used in MASH, V-NEM, NEM-V, NEM-V-ST, or SOMAH Application.

Scope T 326.2 240/480 V, 3Ø, 3-Wire Service Using a Self-Contained “A” Base Meter

Figure T 326–2: 240/480 V, 3Ø, 3-Wire Service Using a Self-Contained “A” Base Meter

Front View



Note(s):

1. The 208 V leg or grounded leg is positioned as shown for 240 V, 3-wire service.
2. Install inter-block barriers (SAP 10115816) as shown in T 30, T 31, and T 32. Test Block: 100 A—(SAP 10115817); 200 A—(SAP 10115818).
3. THIS DRAWING FOR SOUTHERN DIVISION ONLY, TO BE USED WHEN METER AND TEST BLOCKS OR TEST BLOCKS ONLY ARE CHANGED.

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T 356 3-Wire, 3-Phase Metering — Using Current Transformers

Scope T 356.1 240/480 V, 3Ø, 3-Wire Service Using Current Transformers and 2-Stator Expanded Voltage Watthour Demand Meter

Figure T 356–1: 240/480 V, 3Ø, 3-Wire Service Using Current Transformers and 2-Stator Expanded Voltage Watthour Demand Meter

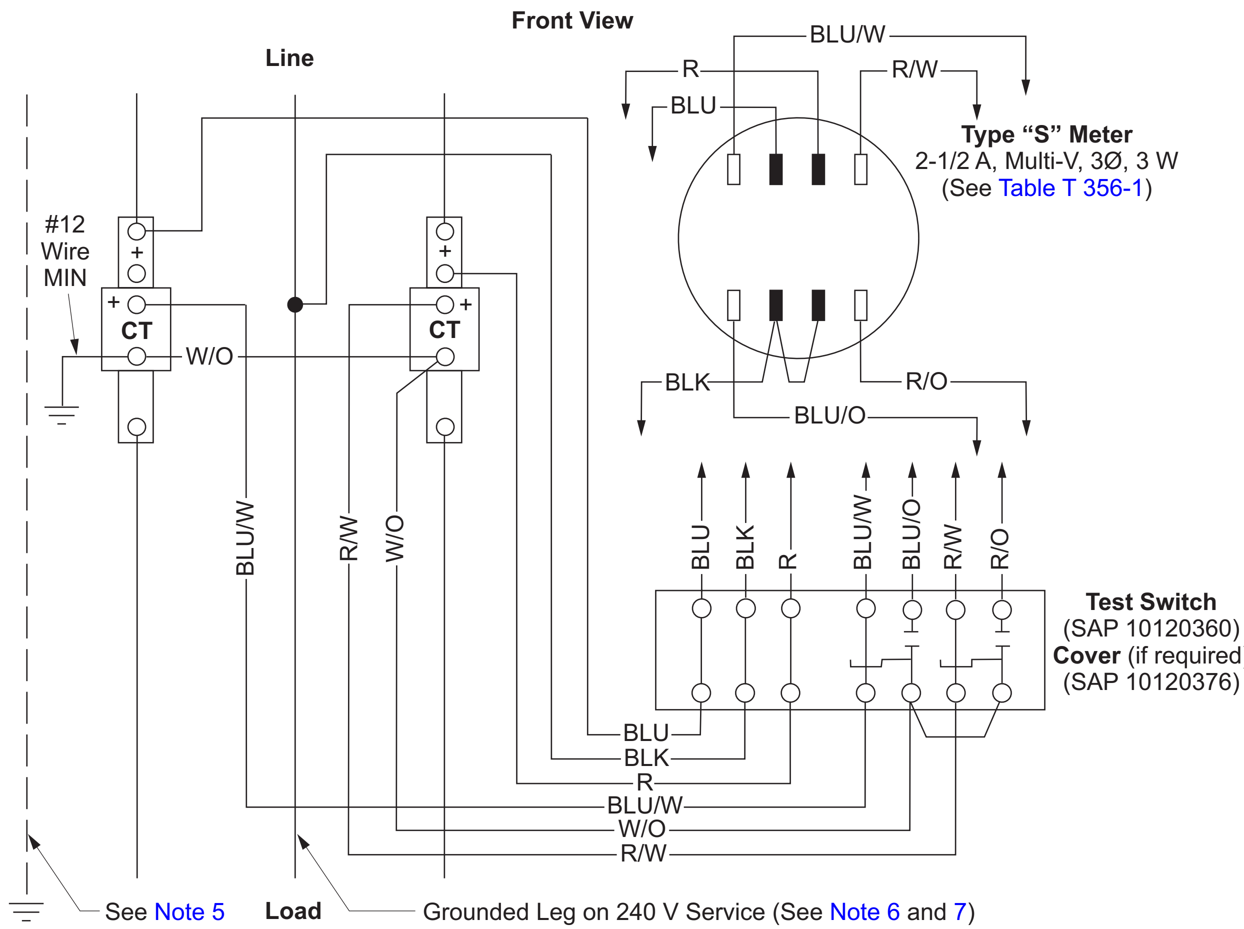


Table T 356–1: 240/480 V, 3Ø, 3-Wire Service Using Current Transformers and 2-Stator Expanded Voltage Watthour Demand Meter

Meter Type	Meter Description	SAP
45S	2.5 A, Multi-V, 3 Wire	10105524
45S ESC[a/]	2.5 A, Multi-V, 3 Wire	10175800

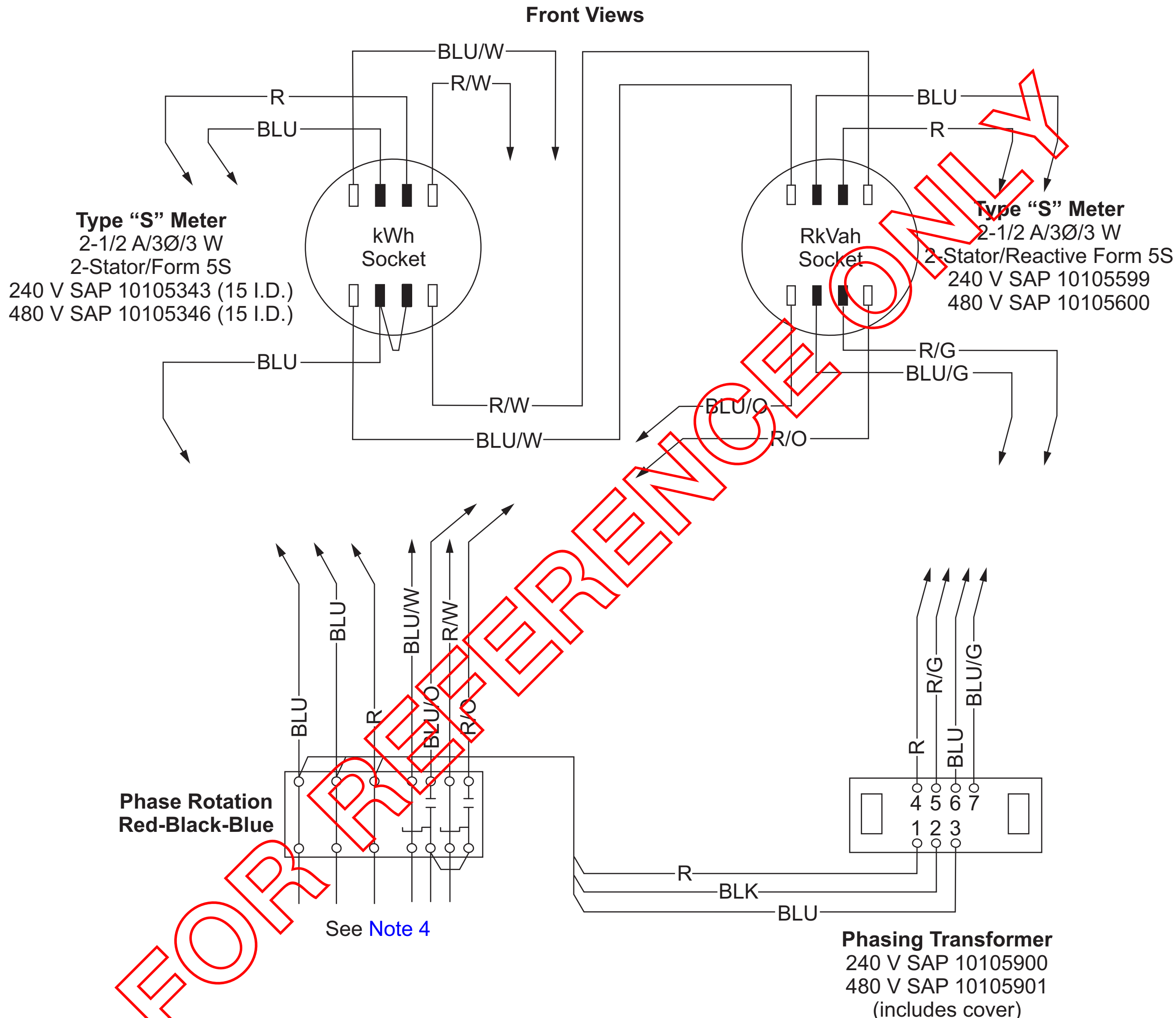
[a/] Edison SmartConnect (ESC)

Note(s):

1. A 480 V, 3-wire service is to be supplied only from an ungrounded 3Ø system or bank.
2. For installations requiring kWh and RkVah meters, see T 356 (Sheet 1). All wiring is identical between the CTs and the test switch for both installations.
3. For mounting window-type current transformers (CTs), see T 64.
4. See T 65.
5. On 240 V, 3Ø, 3-wire service with one-phase grounded, a fourth conductor (connecting the grounded transformer phase to the customer's grounding electrode) must be run with the service (see T 53).
6. See T 50 for additional information on metering connections for grounded leg.
7. On many existing 240 V installations, this conductor may be a power leg (208 V to ground). Where a fourth (grounding) conductor connected to the transformer midpoint ground and a power leg are both run to a service, 4-wire metering is required. See T 454.
8. For alternative method of totalizing two-service installations, see T 559.
9. If switchboards are not contiguous, a 1.25-inch conduit must be installed by the customer for metering purposes.
10. Affix a "Meter Voltage" sticker to the meter panel two inches below the meter's rim. For sticker selection, see T 75.
11. See Scope T 725.1 for NET Generation Output Meter (NGOM) used in Paired Storage, NEM-ST, NEM-MT-ST, and NEM-A Applications.
12. See Scope T 725.2 for NET Generation Output Meter (NGOM) used in MASH, V-NEM, NEM-V, NEM-V-ST, or SOMAH Application.

Scope T 356.2 **240/480 V, 3Ø, 3-Wire Service Using kWh and RkVah Meters with Current Transformers**

Figure T 356–2: 240/480 V, 3Ø, 3-Wire Service Using kWh and RkVah Meters with Current Transformers



Note(s):

1. See T 25 for internal meter connections.
2. See T 70 for phase rotation information.
3. For new installations, see T 356.1 (Sheet 1).
4. See T 356.1 (Sheet 1) for Connections to CTs.

Scope T 356.3 **240/480 V, 3Ø, 3-Wire Service Using a kWh/kVARh Meter with Current Transformers**

Figure T 356–3: 240/480 V, 3Ø, 3-Wire Service Using a kWh/kVARh Meter with Current Transformers

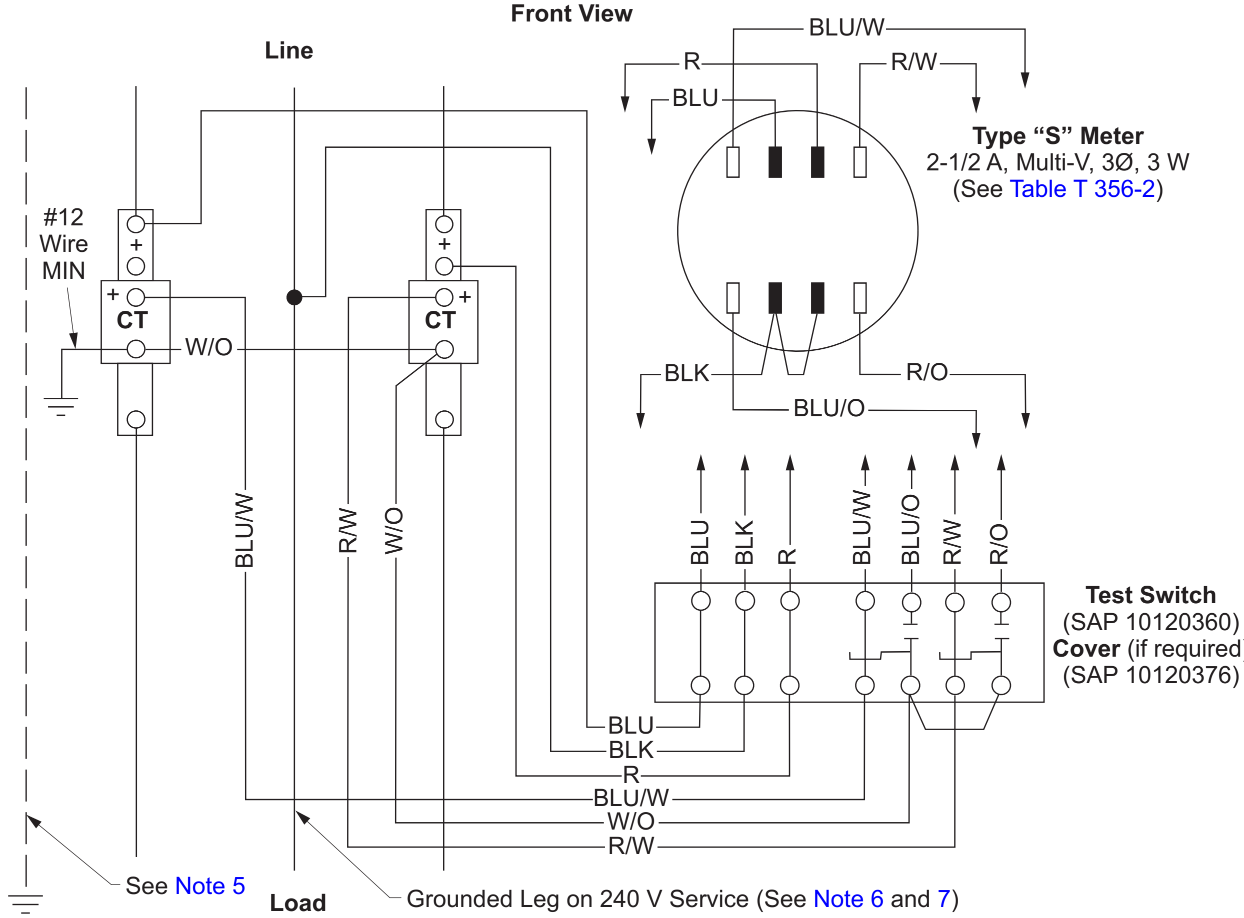


Table T 356–2: 240/480 V, 3Ø, 3-Wire Service Using a kWh/kVARh Meter with Current Transformers

Meter Type	Meter Description	SAP
45S	2.5 A, Multi-V, 3 Wire	10105519
45S ESC[a/]	2.5 A, Multi-V, 3 Wire	10175800

[a/] Edison SmartConnect (ESC)

Note(s):

1. A 480 V, 3-wire service is to be supplied only from an ungrounded 3Ø system or bank.
2. Affix a "Meter Voltage" sticker to the meter panel, two inches below the meter's rim. For sticker selection, see T 75.
3. For mounting window-type current transformers (CTs), see T 64.

4. See T 65 for CT polarity information.
5. On 240 V, 3Ø, 3-wire service with one-phase grounded, a fourth conductor (connecting the grounded transformer phase to the customer's grounding electrode) must run with the service (see T 53).
6. See T 50 for additional information on metering connections for grounded leg.
7. On many existing 240 V installations, this conductor may be a power leg (208 V to ground). Where a fourth (grounding) conductor is connected to the transformer midpoint ground and a power leg are both run to a service, four-wire metering is required. See T 454.1 and T 454.2.
8. For alternative method of totalizing two-service installations, see T 559.
9. If switchboards are not contiguous, a 1.25-inch conduit must be installed by the customer for metering purposes.
10. Affix a "Meter Voltage" sticker to the meter panel, two inches below the meter's rim. See T 75 for sticker selection.
11. See Scope T 725.1 for NET Generation Output Meter (NGOM) used in Paired Storage, NEM-ST, NEM-MT-ST, and NEM-A Applications.
12. See Scope T 725.2 for NET Generation Output Meter (NGOM) used in MASH, V-NEM, NEM-V, NEM-V-ST, or SOMAH Application.

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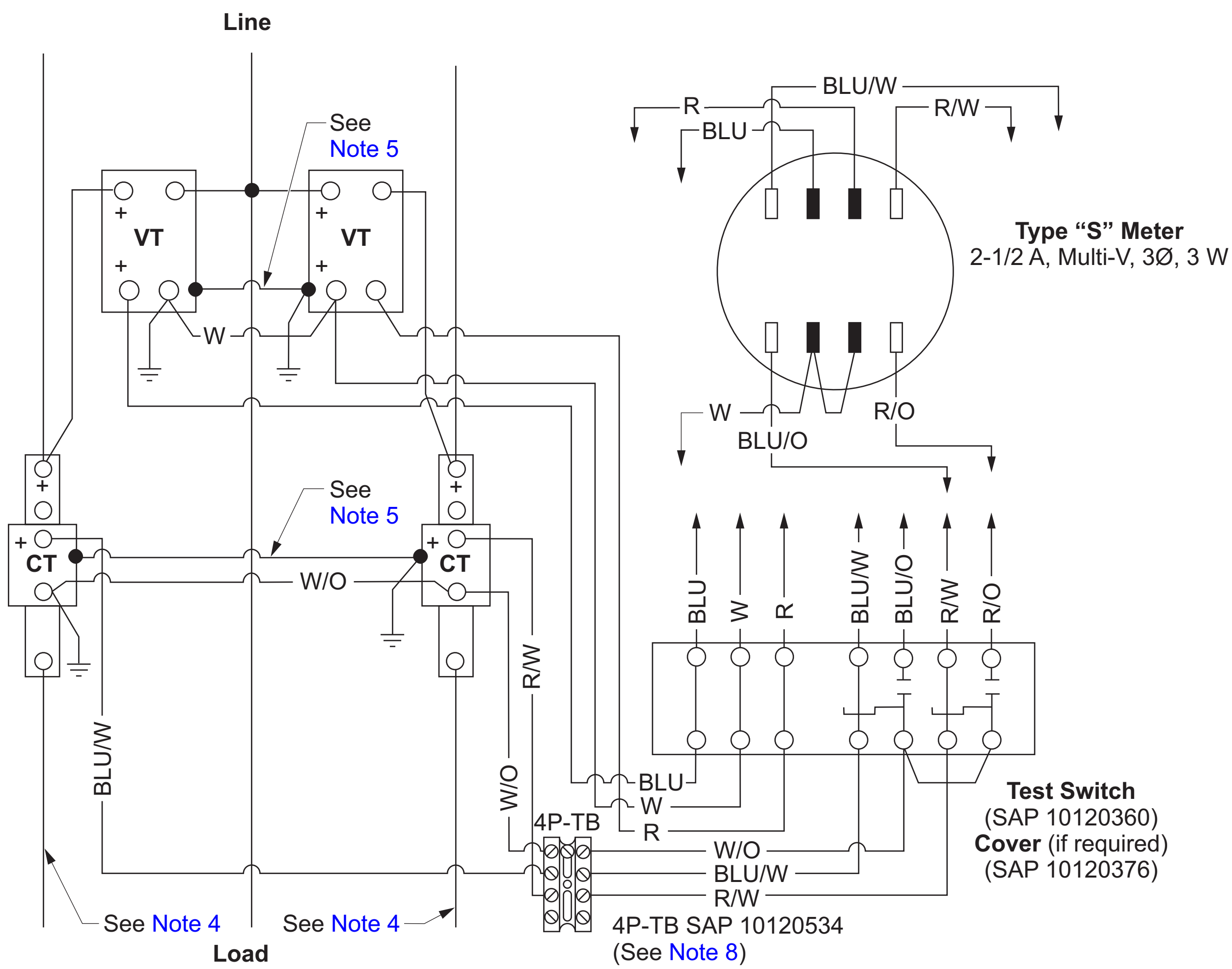
T 376 3-Wire, 3-Phase Metering — Using Current and Potential Transformers

Scope T 376.1 2.4 kV, 4.16 kV, 4.8 kV, 6.9 kV, 12 kV, 16 kV, 33 kV, and 69 kV, 3Ø, 3-Wire Service Using Instrument Transformers and 2-Stator Meter

Figure T 376–1: 2.4 kV, 4.16 kV, 4.8 kV, 6.9 kV, 12 kV, 16 kV, 33 kV, and 69 kV, 3Ø, 3-Wire Service Using Instrument Transformers and 2-Stator Meter

Front View



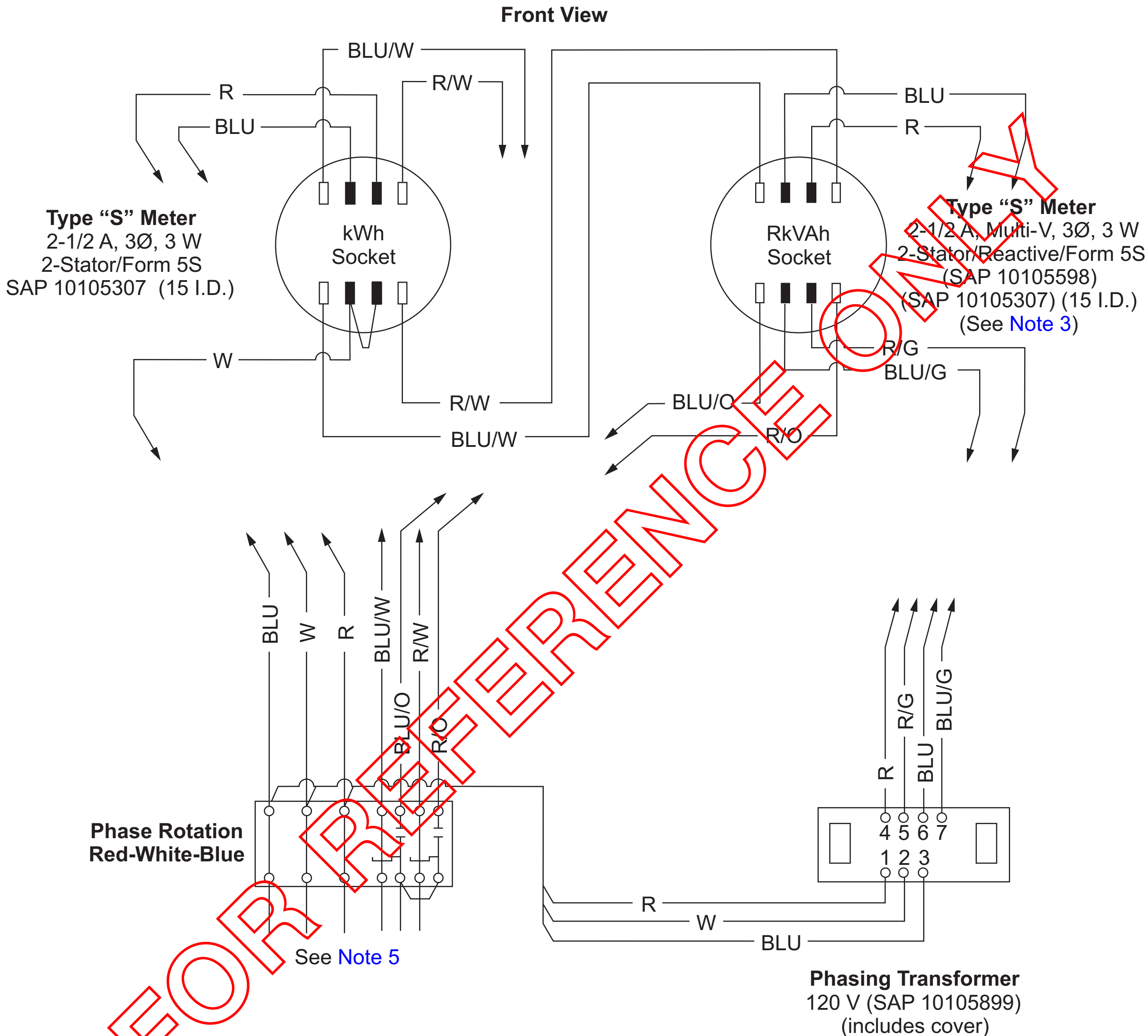
Note(s):

1. For 4 kV, 3-wire only with supply transformer grounded through a resistor and 35:1 ratio VTs.
2. For installation requiring kWh/kVARh demand metering, see T 376 (Sheet 1).
3. For 2.4 kV and 4 kV where the leads exist through the top of the instrument transformer compartment, loops for “split-core” cut in below the current transformer (CTs) must be provided.
4. See T 65 for CT polarity information.

5. Ground and bond all instrument transformer cases with #12 wire minimum. Pole-mounted CTs and voltage transformers (VTs) must be bonded. However, they do not require case ground when mounted eight feet or more above ground. Ground all CTs and VTs secondaries at their common point.
6. The completed wiring of each new meter installation or any change or replacement of any part of an existing installation shall be inspected by an Electrical Metering Services (EMS) Meter Technician qualified for primary voltages before energizing the installation.
7. When the CTs and VTs are located in the substation bus or on a pole, order meter cabinet SAP 10114241.
8. Place the current-shunting block (SAP 10120534) at the back side of the meter panel.
9. This drawing may also be used for 12 kV, 16 kV, 34 kV, and 69 kV where the transformer bank neutral is grounded, providing there is only 3-wire service to the customer.
10. Affix a "Meter Voltage" sticker to the meter panel, two inches below the meter's rim. For sticker selection, see T 75.
11. This type of installation is acceptable for 12 kV, 16 kV, and 33 kV pole-top metering.
12. For 25 kV installations contact Meter Service Organization (MSO) Engineering.
13. See Scope T 725.1 for NET Generation Output Meter (NGOM) used in Paired Storage, NEM-ST, NEM-MT-ST, and NEM-A Applications.
14. See Scope T 725.2 for NET Generation Output Meter (NGOM) used in MASH, V-NEM, NEM-V, NEM-V-ST, or SOMAH Application.

Scope T 376.2 **Typical Metering for 2.4, 4.16, 4.8, 6.9, 12, 16, and 33 kV, 3Ø, 3-Wire Service Using kWh and RkVah Meters with Instrument Transformers**

Figure T 376–2: 2.4, 4.16, 4.8, 6.9, 12, 16, and 33 kV, 3Ø, 3-Wire Service Using kWh and RkVah Meters with Instrument Transformers

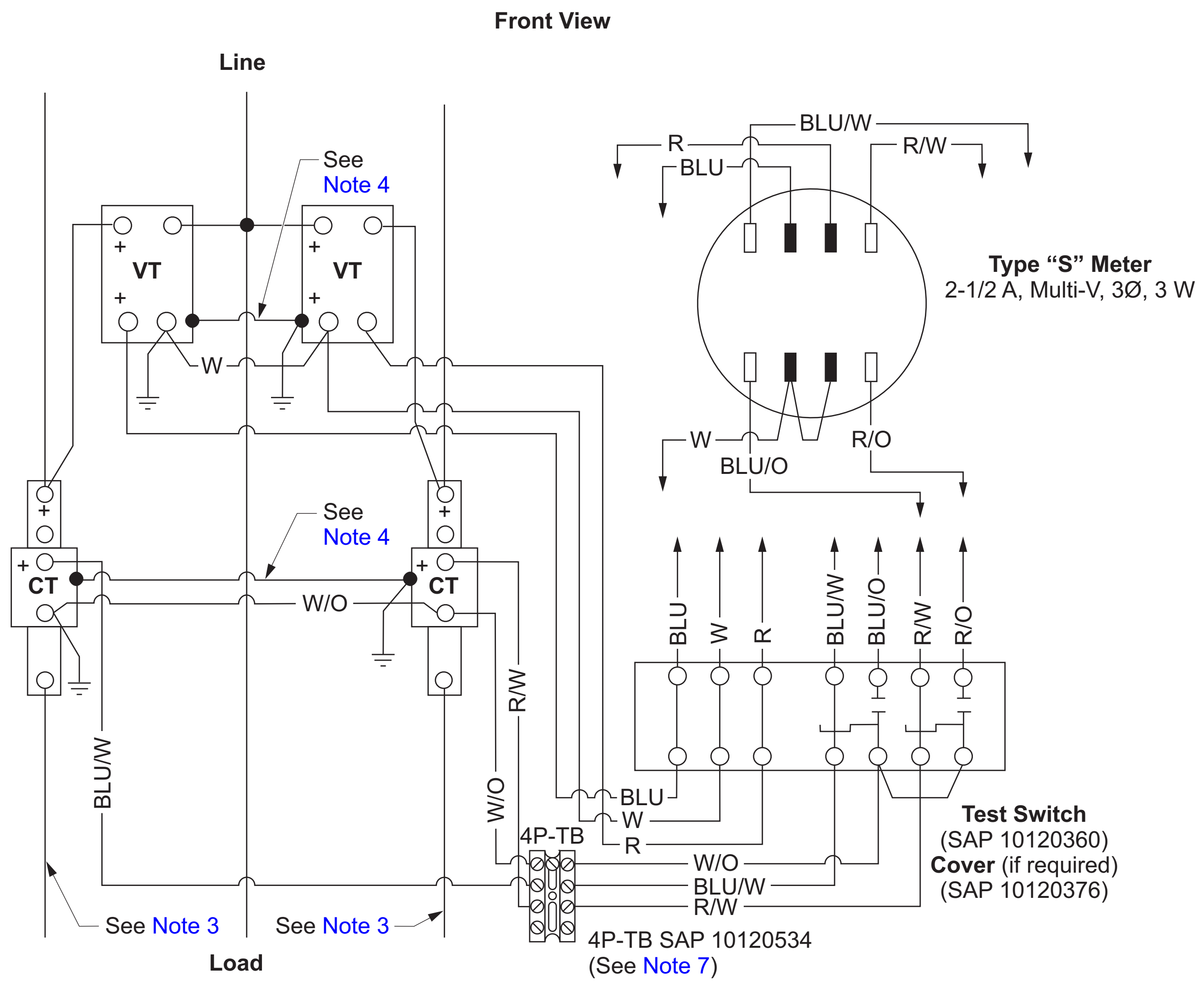


Note(s):

1. See T 25 for internal meter connections.
2. See T 70 for phase rotation information.
3. RkVAh demand meter required on service voltage 4 kV and above.
4. For new watthour installations, see Figure T 376–1 (Sheet 1).
5. See Figure T 376–1 (Sheet 1) for Connections to CTs and VTs.

Scope T 376.3 **Typical Metering for 2.4 kV, 4.16 kV, 4.8 kV, 6.9 kV, 12 kV, 16 kV, 33 kV, and 69 kV, 3Ø, 3-Wire Service Using Instrument Transformers and 2-Stator Meter**

Figure T 376–3: Typical Metering for 2.4 kV, 4.16 kV, 4.8 kV, 6.9 kV, 12 kV, 16 kV, 33 kV, and 69 kV, 3Ø, 3-Wire Service Using a kWh/kVARh Meter with Instrument Transformers and 2-Stator Meter



Note(s):

1. For 4 kV, 3-wire metering only with supply transformer grounded through a resistor and 35:1 VTs.
2. For 2.4 kV and 4 kV where the leads exist through the top of the instrument transformer compartment, loops for “split-core” cut in below the current transformers (CTs) must be provided.
3. See T 65 for CT polarity information.
4. Ground and bond all instrument transformer cases with #12 wire minimum. Polemounted CTs and voltage transformers (VTs) must be bonded. However, they do not require case ground when mounted eight feet or more above ground. Ground all CTs and VTs secondaries at their common point.
5. The completed wiring of each new meter installation or any change or replacement of any part of an existing installation shall be inspected by an Electrical Metering Services (EMS) Meter Technician qualified for primary voltage before energizing the installation.

6. When the CTs and VTs are located in the substation bus or on a pole, order meter cabinet SAP 10114241.
7. Place the current-shunting block (SAP 10120534) at the back of the meter panel.
8. This drawing may also be used for 12 kV, 16 kV, 34 kV, and 69 kV where the transformer bank neutral is grounded, providing there is only 3-wire service to the customer.
9. Affix a “Meter Voltage” sticker to the meter panel, two inches below the meter’s rim. For sticker selection, see T 75.
10. This type of installation is acceptable for 12 kV, 16 kV, and 33 kV pole-top metering.
11. See Scope T 725.1 for NET Generation Output Meter (NGOM) used in Paired Storage, NEM-ST, NEM-MT-ST, and NEM-A Applications.
12. See Scope T 725.1 for NET Generation Output Meter (NGOM) used in MASH, V-NEM, NEM-V, NEM-V-ST, or SOMAH Application.

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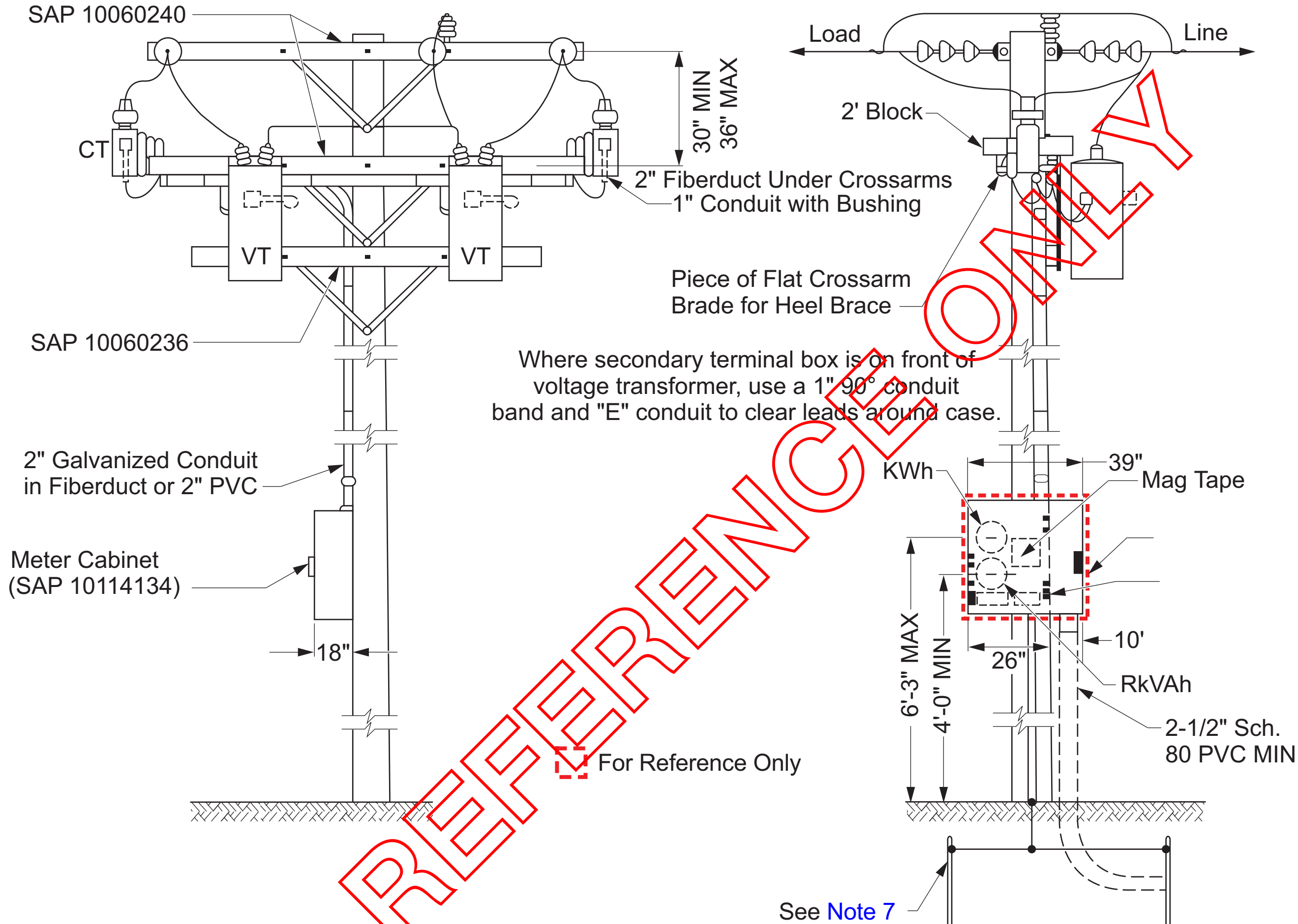
T 399 3-Wire, 3-Phase Metering — Using Current and Potential Transformers

Scope T 399.1 12/16 kV, 3Ø, 3-Wire Pole Top Metering Installation

Figure T 399–1: 12/16 kV, 3Ø, 3-Wire Pole Top Metering Installation

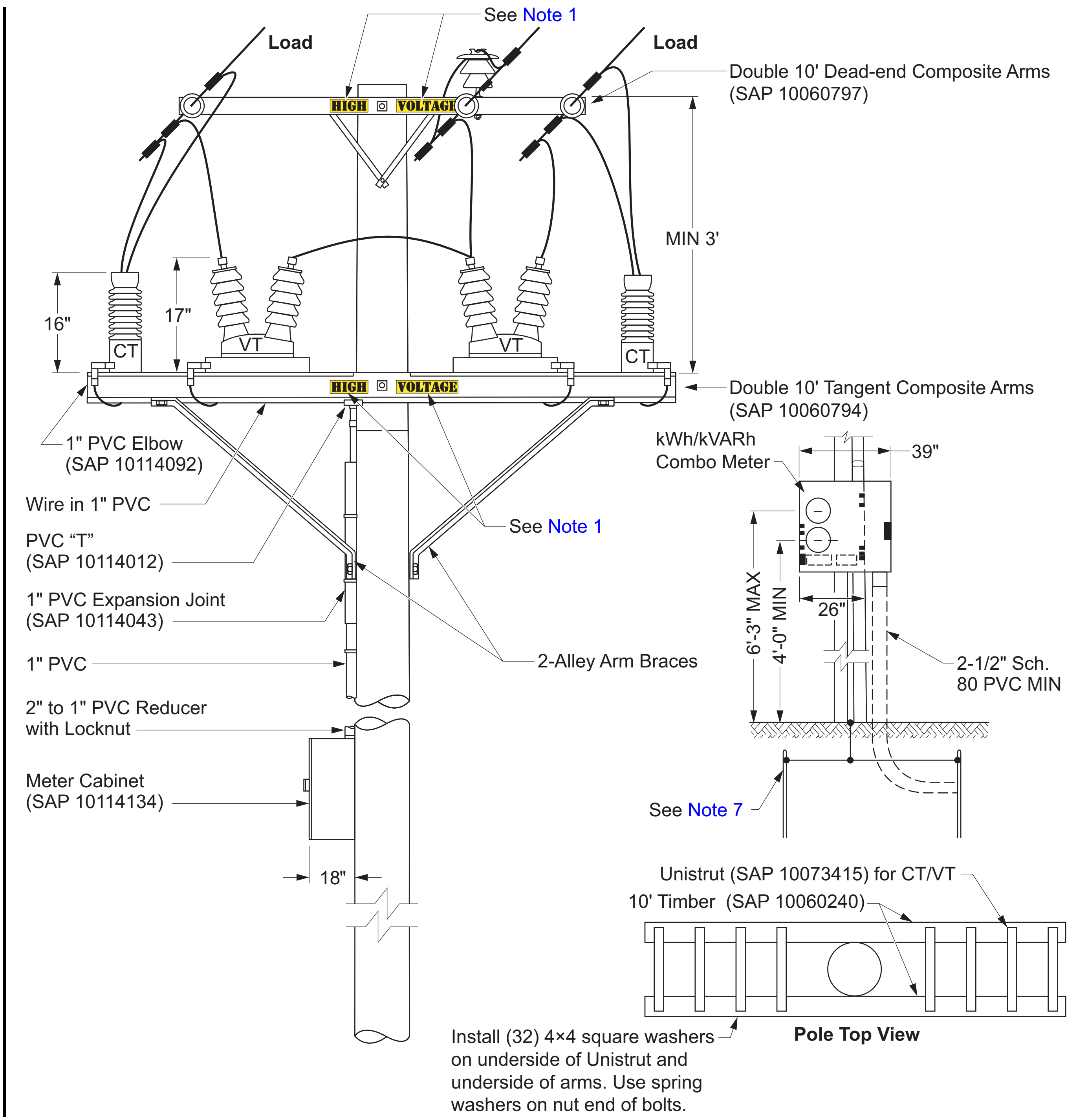


Note(s):

1. The complete metering installation, including enclosure, will be furnished and installed by the Company.
2. The completed wiring of each new meter installation, or any change or replacement of any part of an existing installation, shall be checked by a representative of the test division before energizing the installation.
3. Where an instrument transformer is installed on the pole so that its primary polarity marked terminal is reversed with respect to the connections shown on the applicable meter wiring drawing, its secondary connections must be reversed accordingly.
4. The line conductors shall be dead-ended at the next adjacent pole on the supply side of the meter pole to permit opening of taps or jumps for isolation of metering installation.
5. See Scope PO 100.4 for pole step requirements.
6. When RkVar and/or Mag Tape Demand meters are installed in conjuction with a kWh meter, mounting shall be as shown in Figure T 399–3.
7. Installation shall be grounded with #6 BC minimum wire and standard ground assembly.
8. Meter cabinet is acceptable for overhead or underground installation.
9. Use metering cabinet diagram in Figure T 399–3 for 33 kV, 3Ø, 3-Wire metering.

Scope T 399.2 **12/16 kV, 3Ø, 3-Wire Pole Top Metering Installation**

Figure T 399–2: 12/16 kV, 3Ø, 3-Wire Pole Top Metering Installation



3-Wire, 3-Phase Metering — Using Current and Potential Transformers

Approved by: RR

What's Changed? Figure T 399-2: showed composite arms without braces; Revised too view description to include spring washer installation details.

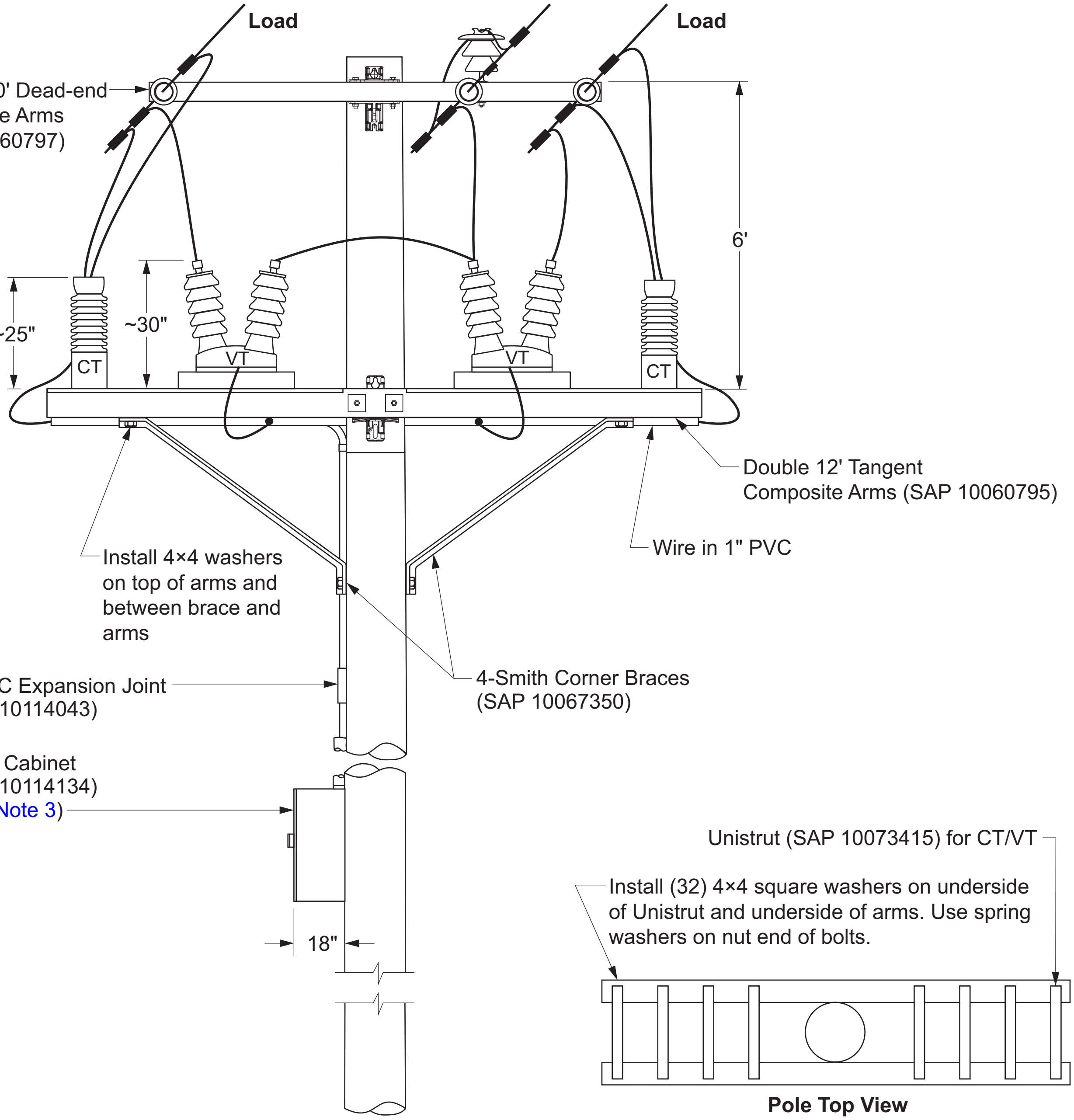
Effective Date: 10-29-2021

Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. The completed wiring of each new meter installation, or any change or replacement of any part of an existing installation shall be checked by an Electrical Metering Services (EMS) Meter Technician qualified for primary voltages before energizing the installation.
3. The complete metering installation, including enclosure, will be furnished and installed by the Company.
4. Where an instrument transformer is installed on the pole so that its primary polarity marked terminal is reversed with respect to the connections shown on the applicable meter wiring drawing, its secondary connections must be reversed accordingly.
5. The line conductors shall be dead-ended at the next adjacent pole on the supply side of the meter pole to permit opening of taps or jumps for isolation of metering installation.
6. See Scope PO 100.4 for pole step requirements.
7. Installation shall be grounded with #6 BC minimum wire and standard ground assembly.
8. Meter cabinet is acceptable for Overhead or Underground installation.
9. Use metering cabinet diagram in Figure T 399–3 for 33 kV, 3Ø, 3-Wire metering.
10. Ground and bond all instrument transformer cases with #12 wire minimum. Pole-mounted CTs and voltage transformers (VTs) must be bonded. However, they do not require case ground when mounted eight feet or more above ground. Ground all CT's and VT's secondaries at their common point.
11. See DC 520 if above 5,000 feet elevation.

Scope T 399.3 **Typical Construction for a 33 kV, 3Ø, 3-Wire Pole Top Metering Installation**

Figure T 399–3: 33 kV, 3Ø, 3-Wire Pole Top Metering Installation



Pole Top View

Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. See T 376 for meter wiring details.
3. See Scope T 399.2 for cabinet diagram and notes.
4. See surge arresters in appropriate area.
5. See DC 520 if above 5,000 feet elevation.

3-Wire, 3-Phase Metering — Using Current and Potential Transformers

Approved by: RR

What's Changed? Figure T 399-2: use double 12 ft composite arms; removed 16' Timbers; revised top view to show unistrut only.; Included approx. height of CT and VT. Added Note 5.

Effective Date: 10-29-2021

T 425 4-Wire Wye and 4-Wire Delta, 3-Phase Metering — Using Self-Contained Meters

Scope T 425.1 Typical Metering for 120/208 V or 277/480 V, 3Ø, 4-Wire Service Using Self-Contained Meters

Figure T 425–1: 120/208 V or 277/480 V, 3Ø, 4-Wire Service Using Self-Contained Meters

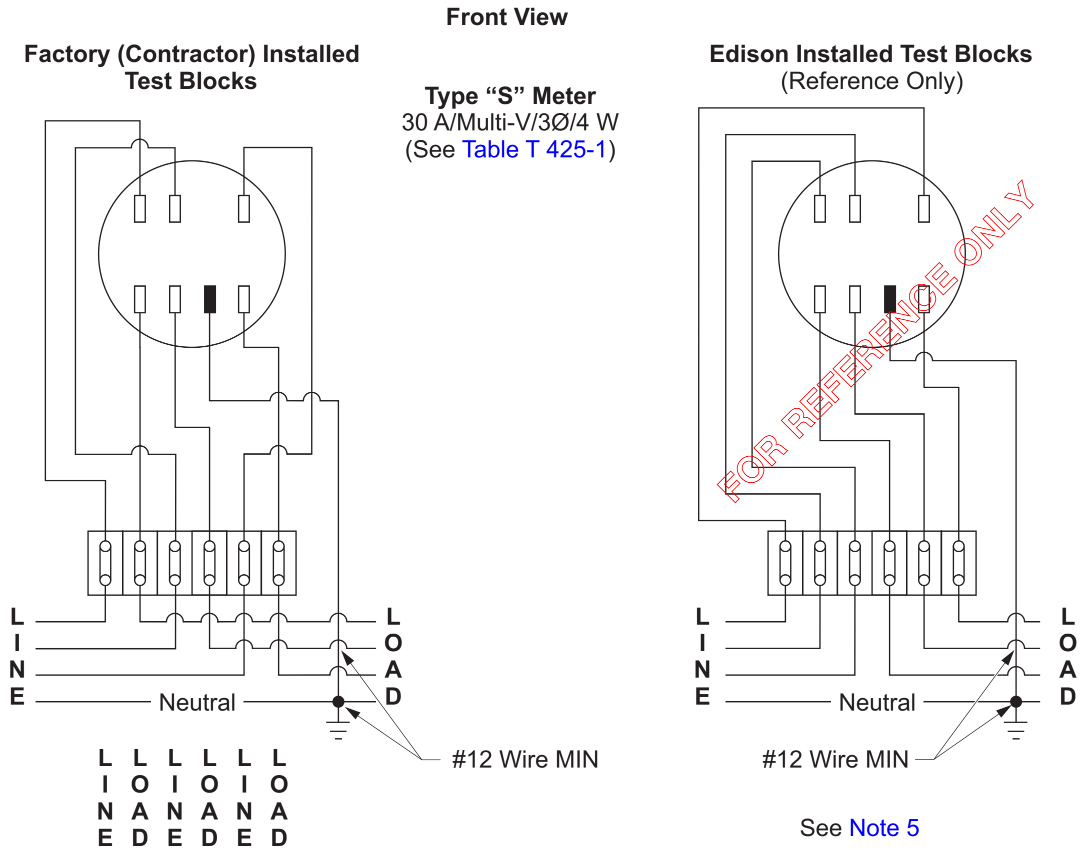


Table T 425–1: Typical Metering for 120/208 V or 277/480 V, 3Ø, 4-Wire Service Using Self-Contained Meters

Meter Type	Meter Description	SAP
16S/15S	30 A, Multi-V, 4 Wire (See Note 1)	10105527
16S ESC[a/]	30 A, Multi-V, 4 Wire	10158742

[a/] Edison SmartConnect (ESC)

Note(s):

1. 2-stator, Form 14S meters are being replaced with 3-Stator, Form 16S meters.
2. On separately metered multiple-occupancy residential dwellings served at 120/208 V, 3Ø, 4-wire, test blocks are not required.
3. For test precautions, see T 34.
4. Affix a "Meter Voltage" sticker to the meter panel, two inches below the meter's rim. See T 75 for sticker selection.
5. Three 2-Pole test blocks with interpole and interblock barriers. 100 A (SAP 10115817). 200 A (SAP 10115818). Install interblock barrier (SAP 10115816, as shown in T 31)

T 430 Wye and 4-Wire Delta, 3-Phase Metering — Using Self-Contained Meters

Scope T 430.1 Typical Metering for 120/240V Combination 1Ø/3Ø, 4-Wire Delta Service Using a Self-Contained Meter — Residential

Figure T 430–1: 120/240V Combination 1Ø/3Ø, 4-Wire Delta Service Using a Self-Contained Meter — Residential

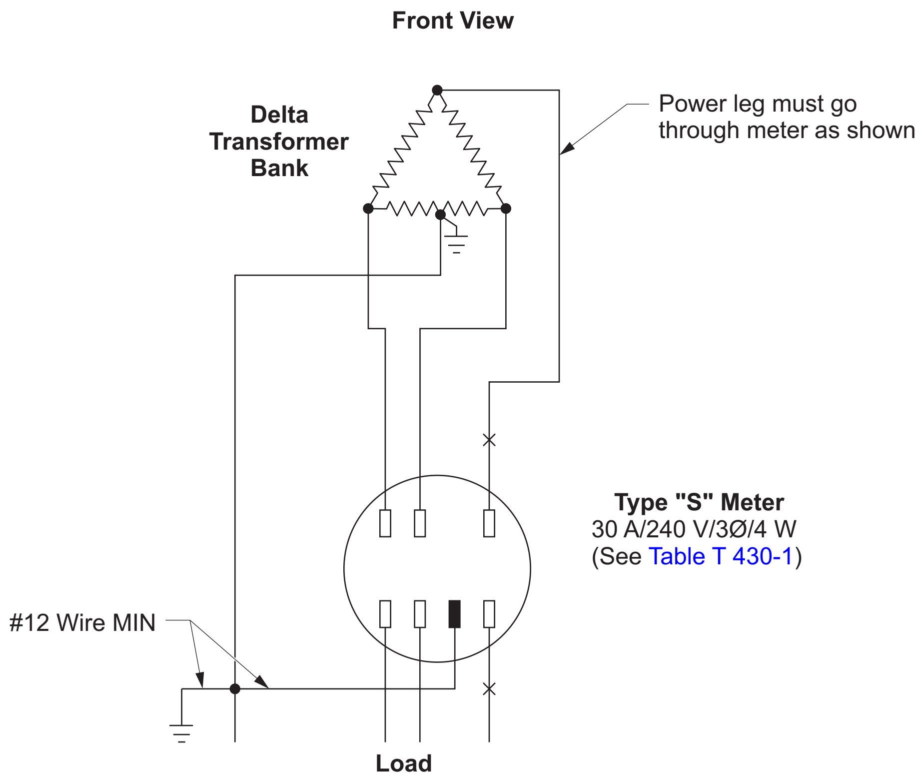


Table T 430–1: Typical Metering for 120/240 V Combination 1Ø/3Ø, 4-Wire Delta Service Using a Self-Contained Meter – Residential

Meter Type	Meter Description	SAP
15S[a/]	30 A, 240 V, 4 Wire	10105293
16S/15S	30 A, Multi-V, 4 Wire	10105359
16S ESC[b/]	30 A, Multi-V, 4 Wire	10158742

[a/] Key 06
[b/] Edison SmartConnect (ESC)

Note(s):

1. Affix a “Meter Voltage” sticker to the meter panel, two inches below the meter’s rim. See T 75 for sticker selection.

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T 431 **4-Wire Wye and 4-Wire Delta, 3-Phase Metering — Using Self-Contained Meters**

Scope T 431.1 **Typical Metering for 120/240 V Combination 1Ø/3Ø, 4-Wire Delta Service Using a Self-Contained Meter — Commercial**

Figure T 431–1: 120/240 V Combination 1Ø/3Ø, 4-Wire Delta Service Using a Self-Contained Meter — Commercial

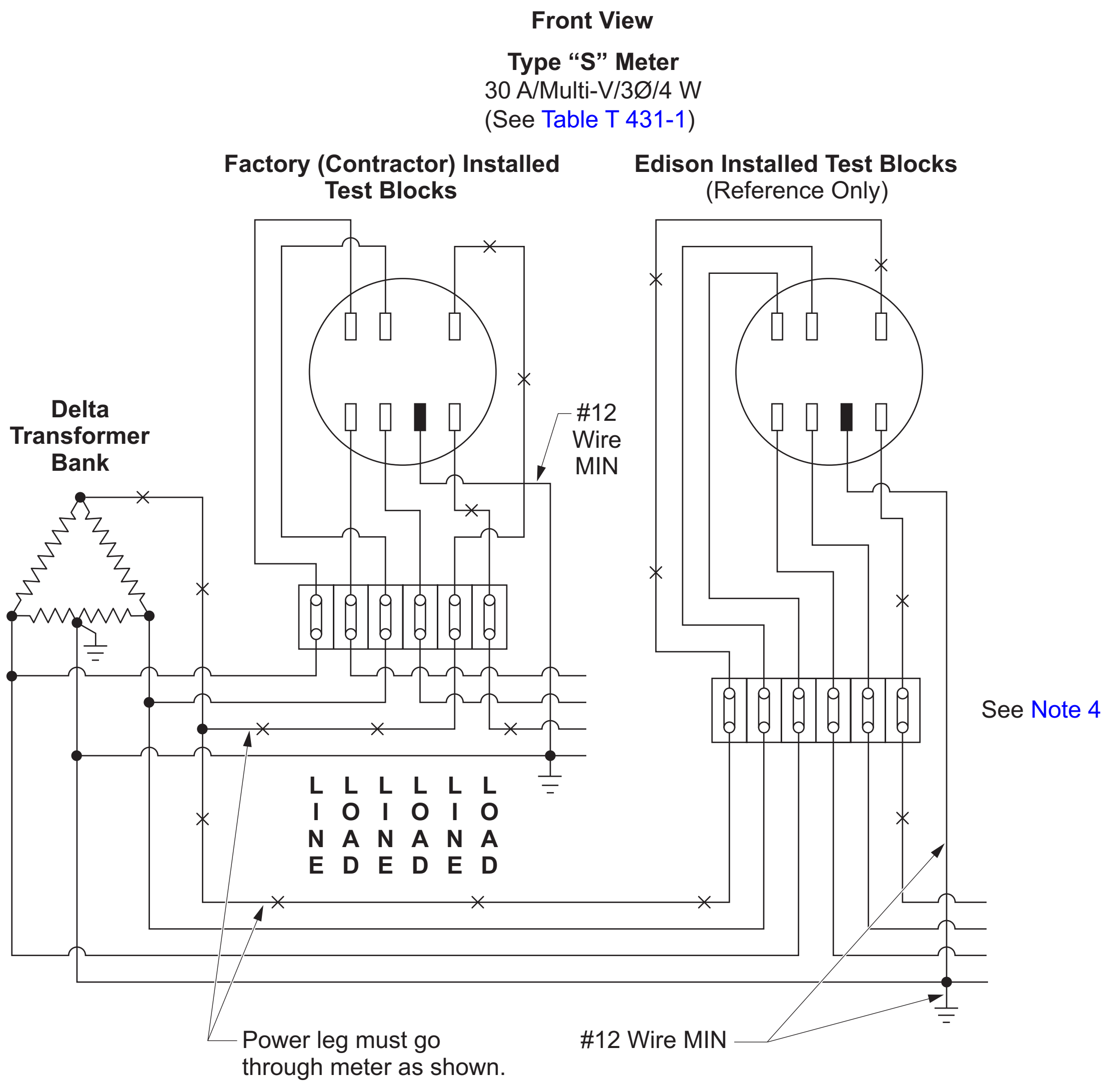


Table T 431–1: Typical Metering for 120/240 V Combination 1Ø/3Ø, 4-Wire Delta Service Using a Self-Contained Meter – Commercial

Meter Type	Meter Description	SAP
16S/15S	30 A, Multi-V, 4 Wire	10105527
16S ESC[a/]	30 A, Multi-V, 4 Wire	10158742

[a/] Edison SmartConnect (ESC)

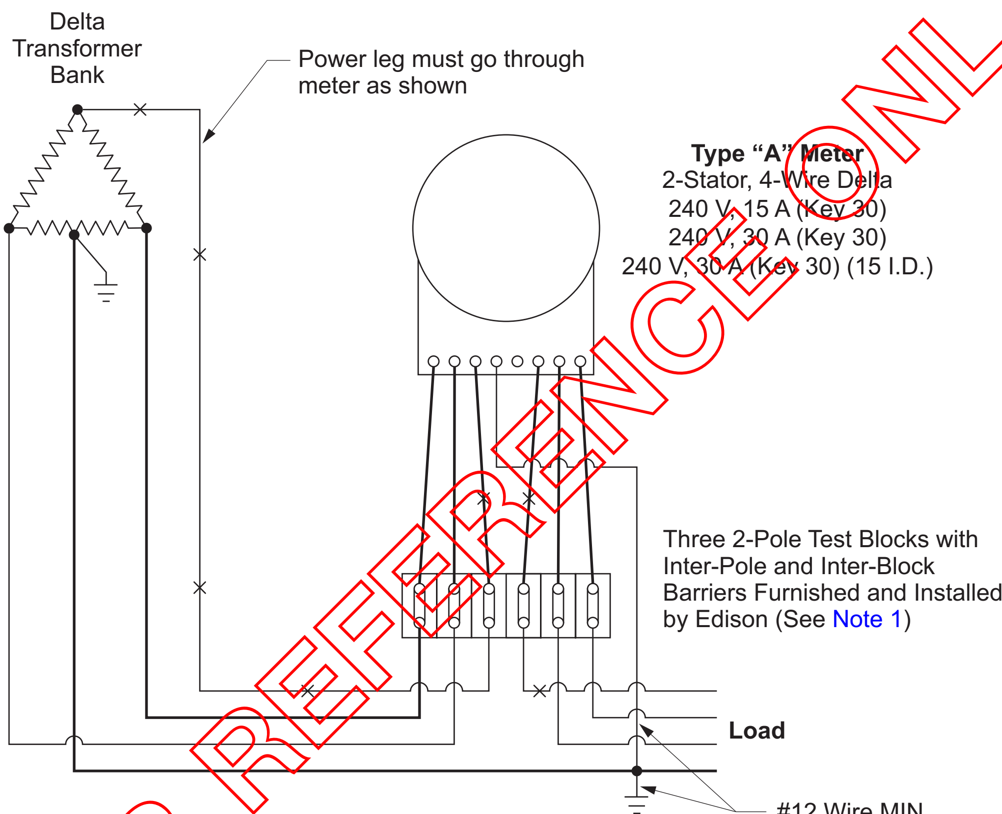
Note(s):

1. On residential installation, test blocks are not required.
2. For test precautions, see T 34.
3. Affix a “Meter Voltage” sticker to the meter panel, two inches below the meter’s rim. See T 75 for sticker selection.
4. Three 2-Pole test blocks with interpole and interblock barriers. 100 A (SAP 10115817). 200 A (SAP 10115818). Install interlock barrier (SAP 10115816, as shown in T 31).
5. See Scope T 725.1 for NET Generation Output Meter (NGOM) used in Paired Storage, NEM-ST, NEM-MT-ST, and NEM-A Applications.
6. See Scope T 725.2 for NET Generation Output Meter (NGOM) used in MASH, V-NEM, NEM-V, NEM-V-ST, or SOMAH Application.

Scope T 431.2 Typical Metering for 120/240 V Combination 1Ø/3Ø, 4-Wire Delta Service Using a Self-Contained “A” Base Meter — Commercial

Figure T 431–2: 120/240 V Combination 1Ø/3Ø, 4-Wire Delta Service Using a Self-Contained “A” Base Meter “Commercial”

Front View



Note(s):

1. Test block SAP numbers: 100 A—(SAP 10115817), 200 A—(SAP 10115818). Install inter-block barriers (SAP 10115816) as shown in T 31.
2. This drawing for SOUTHERN DIVISION ONLY. To be used when meter and test blocks or test blocks only are changed.

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T 451 4-Wire Wye and 4-Wire Delta, 3-Phase Metering — Using Current Transformers

Scope T 451.1 Typical Metering for a 120/208 V or 277/480V, 3Ø, 4-Wire Service Using Three Current Transformers and 3-Stator Meter

Figure T 451–1: 120/208 V or 277/480 V, 3Ø, 4-Wire Service Using kWh Meter with Three Current Transformers and 3-Stator Meter

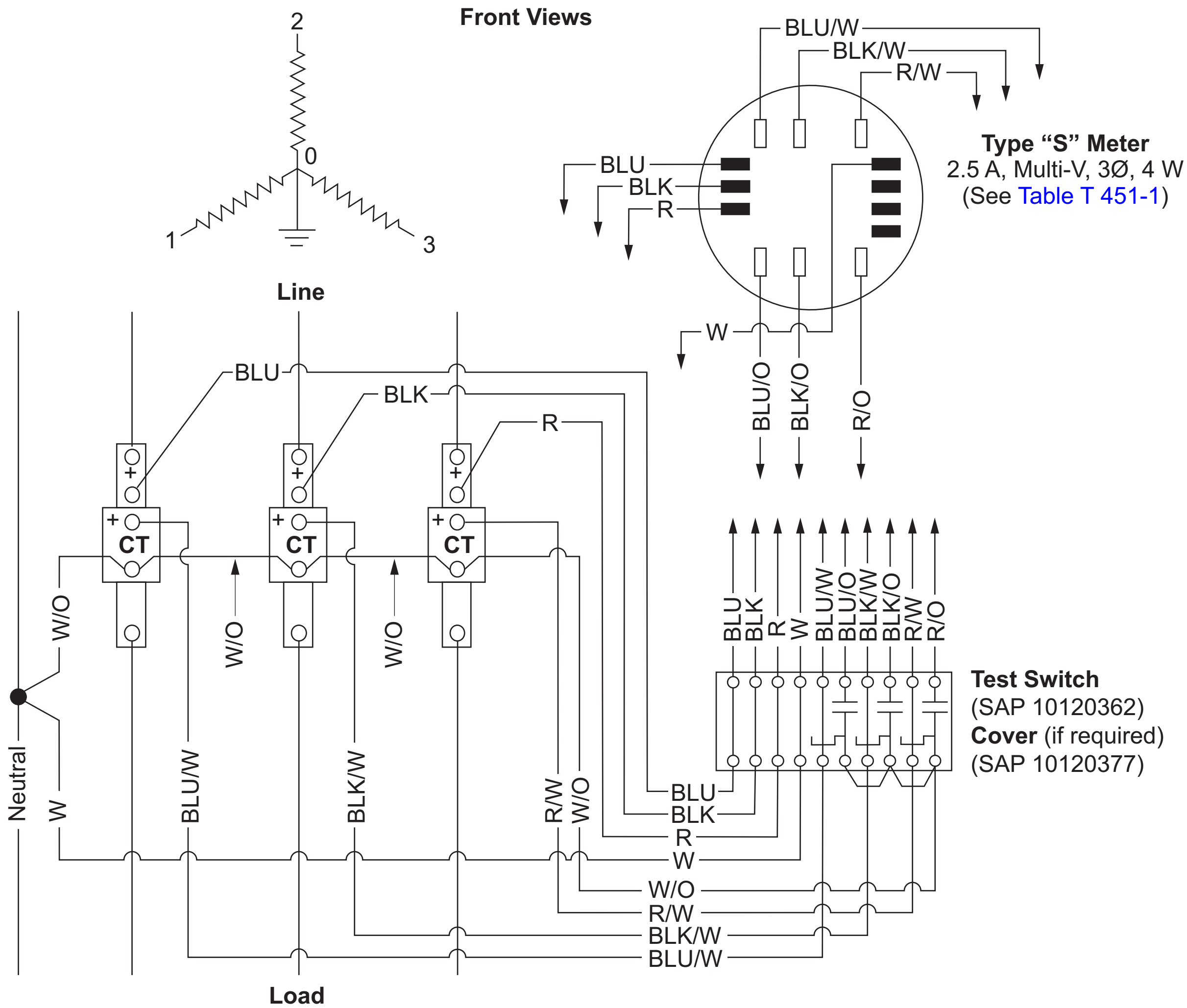


Table T 451–1: Typical Metering for a 120/208 V or 277/480 V, 3Ø, 4-Wire Service Using Three Current Transformers and 3-Stator Meter

Meter Type	Meter Description	SAP
9S	2.5 A, Multi-V, 4 Wire	10105525
9S ESC[a/]	2.5 A, Multi-V, 4 Wire	10175799

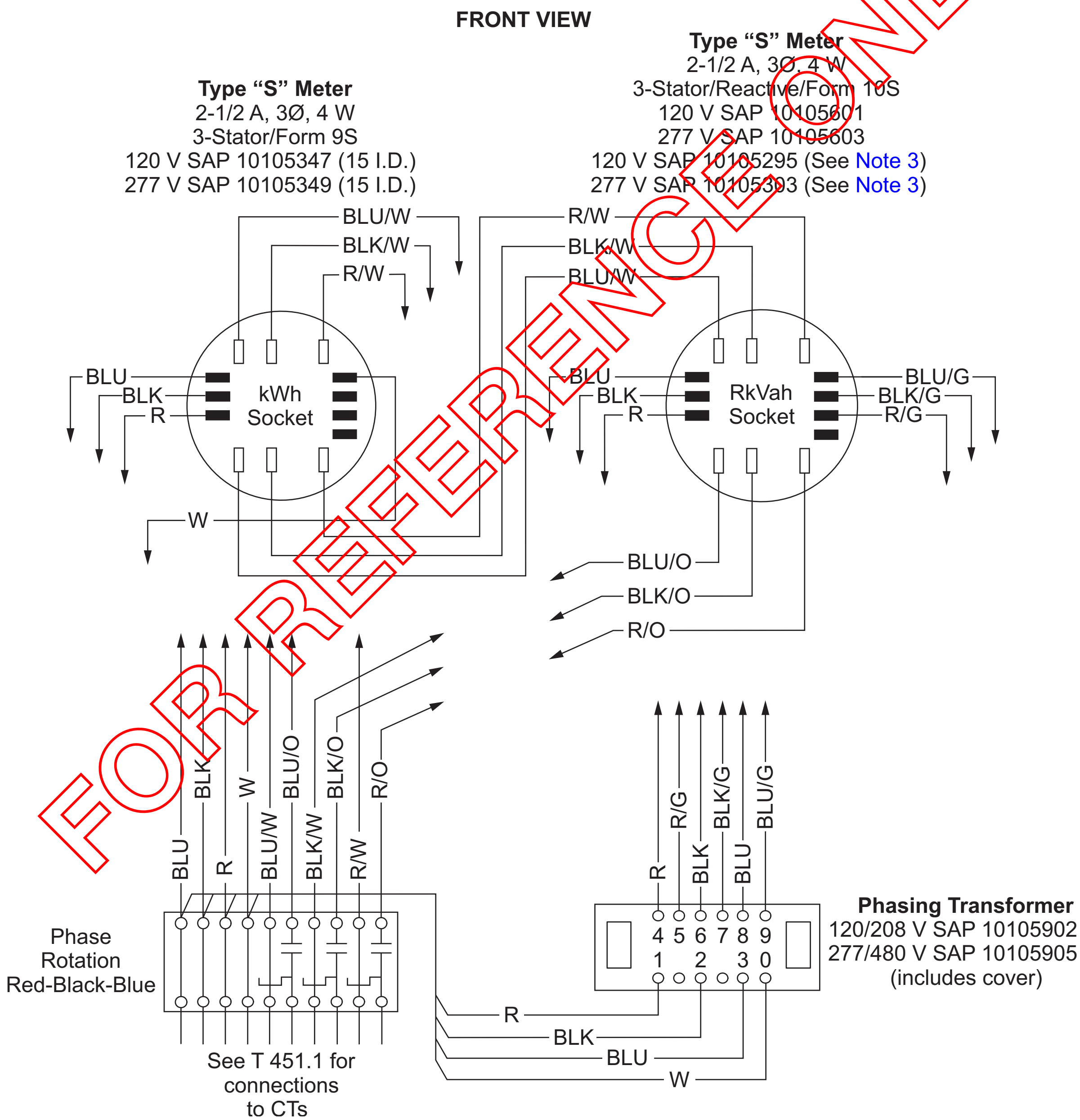
[a/] Edison SmartConnect (ESC)

Note(s):

1. For installations requiring kWh/kVARh demand metering, see T 451.2 (Sheet 3).
2. See T 65 for CT polarity information.
3. See T 25 for internal wiring of socket and meter.
4. For mounting window-type current transformers (CTs), see T 64.
5. Groundfault protection is required on low-voltage, grounded electrical wye services of more than 150 V to ground when the service disconnecting means is rated 1,000 A or more (NEC article 230-95), but may be used when the service disconnecting means is rated less than 1,000 A.
6. For alternative method of totalizing two-service installations, see T 560.
7. If switchboards are not contiguous, a 1-1/4-inch conduit must be installed by the customer for metering purposes.
8. Affix a “Meter Voltage” sticker to the meter panel, two inches below the meter’s rim. For sticker selection, see T 75.
9. See Scope T 725.1 for NET Generation Output Meter (NGOM) used in Paired Storage, NEM-ST, NEM-MT-ST, and NEM-A Applications.
10. See Scope T 725.2 for NET Generation Output Meter (NGOM) used in MASH, V-NEM, NEM-V, NEM-V-ST, or SOMAH Application.

Scope T 451.2 **120/208 V or 277/480 V, 3Ø, 4-Wire Service Using Three Current Transformers (CTs) and 3-Stator Meter**

Figure T 451–2: 120/208 V or 277/480 V, 3Ø, 4-Wire Service Using Three Current Transformers (CTs) and 3-Stator Meter



Note(s):

1. See T 25 for internal wiring of meters.
2. See T 70 for phase rotation information.
3. Reactive demand required on all cogeneration and small power production customers.

Scope T 451.3 **120/208 V or 277/480 V, 3Ø, 4-Wire Service Using Three Current Transformers and 3-Stator Meter**

Figure T 451–3: 120/208 V or 277/480 V, 3Ø, 4-Wire Service Using a kWh/kVARh Meter with Three Current Transformers and 3-Stator Meter

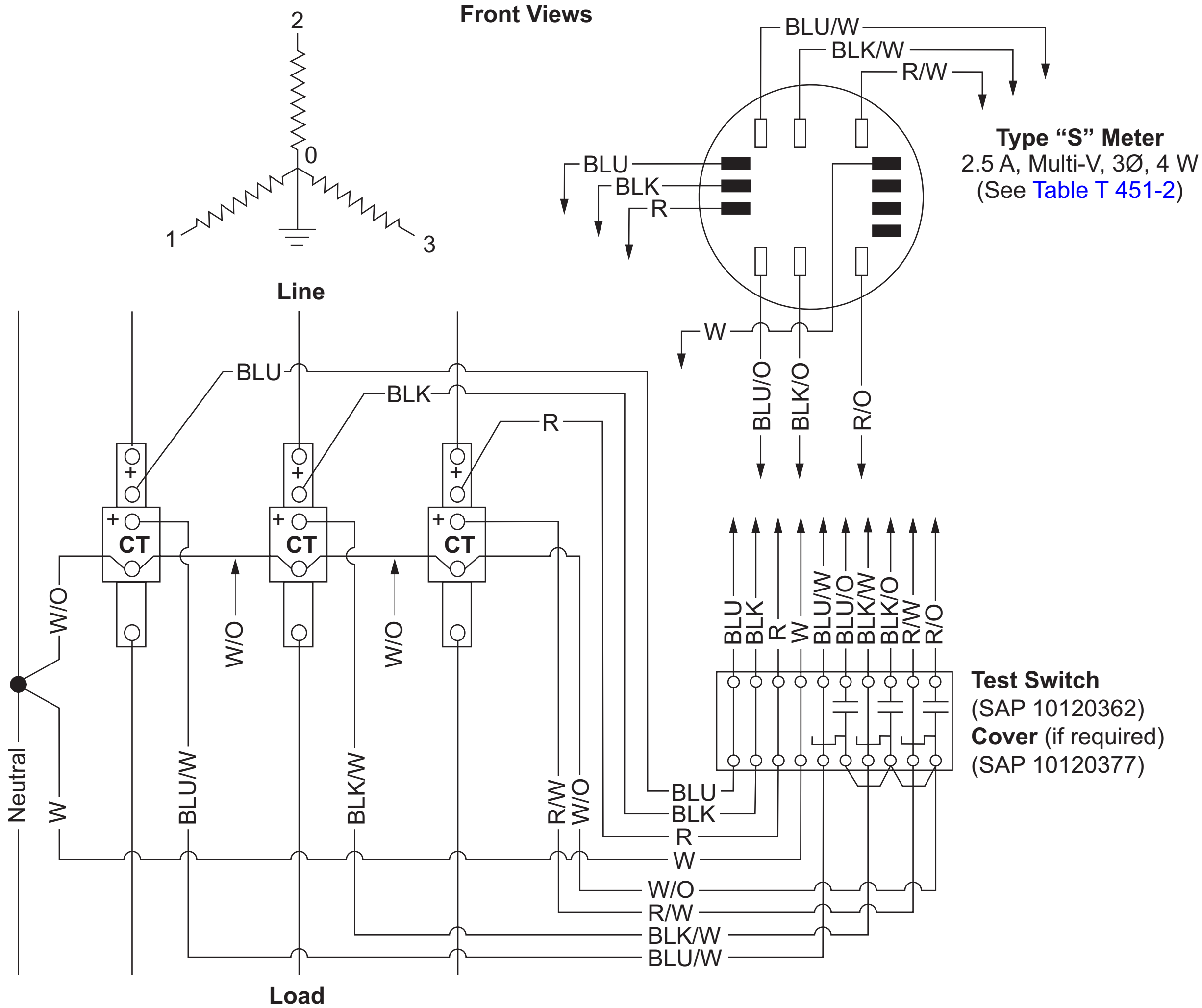


Table T 451–2: 120/208 V or 277/480 V, 3Ø, 4-Wire Service Using Three Current Transformers and 3-Stator Meter

Meter Type	Meter Description	SAP
9S	2.5 A, Multi-V, 4 Wire	10105525
9S ESC[a/]	2.5 A, Multi-V, 4 Wire	10175799

[a/] Edison SmartConnect (ESC)

Note(s):

1. See T 65 for CT polarity information.
2. See T 25 for internal wiring of socket and meter.
3. For mounting window-type current transformers (CTs), see T 64.
4. Ground fault protection is required on low-voltage, grounded electrical wye services of more than 150 V to ground when the service disconnecting means is rated 1,000 A or more (NEC article 230-95), but may be used when the service disconnecting means is rated less than 1,000 A.
5. For alternative method of totalizing two-service installations, see T 560.
6. If switchboards are not contiguous, a 1-1/4-inch conduit must be installed by the customer for metering purposes.
7. Affix a “Meter Voltage” sticker to the meter panel two inches below the meter’s rim. For sticker selection, see T 75.
8. See Scope T 725.1 for NET Generation Output Meter (NGOM) used in Paired Storage, NEM-ST, NEM-MT-ST, and NEM-A Applications.
9. See Scope T 725.2 for NET Generation Output Meter (NGOM) used in MASH, V-NEM, NEM-V, NEM-V-ST, or SOMAH Application.

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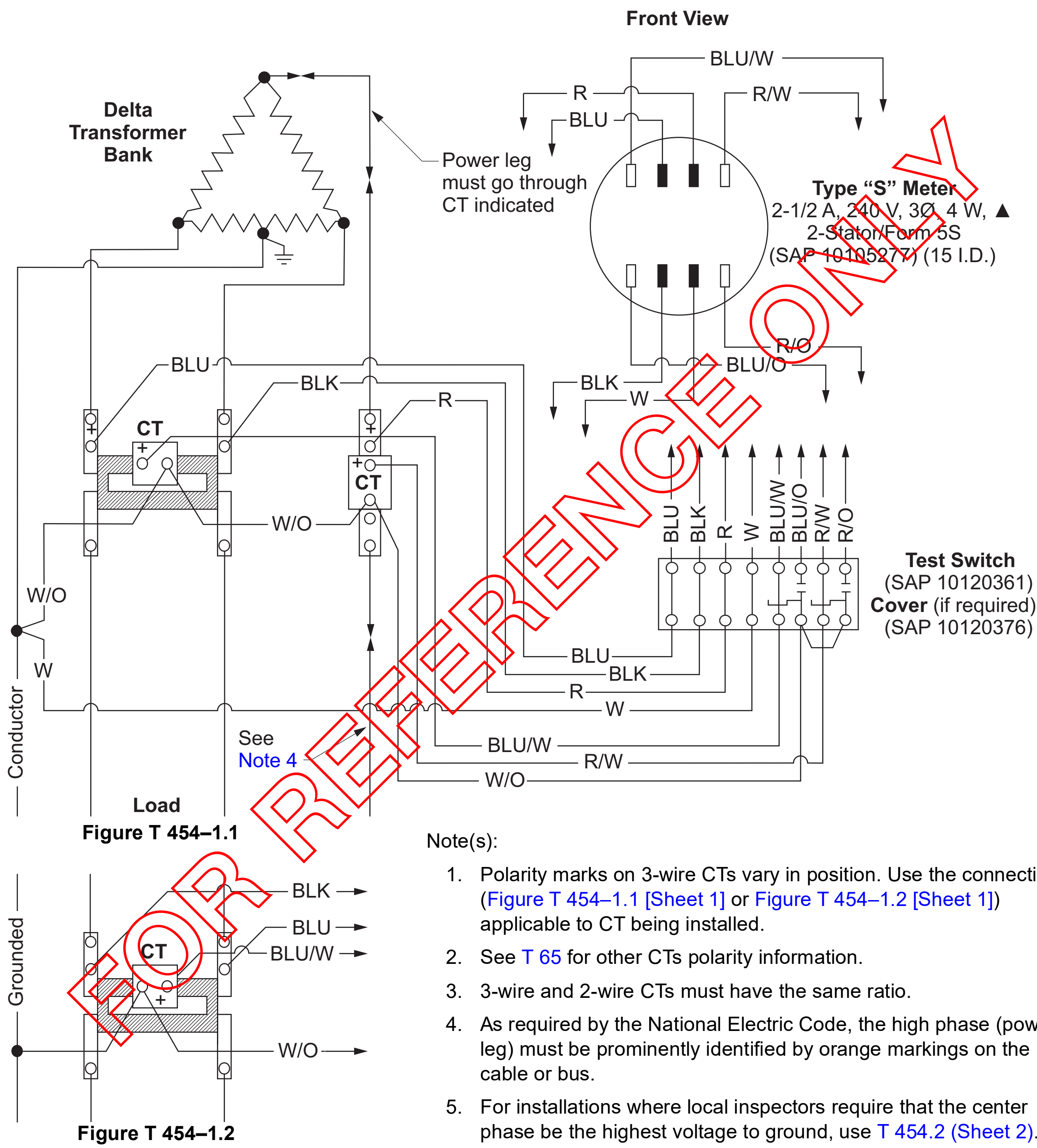
T 454 **4-Wire Wye and 4-Wire Delta, 3-Phase Metering — Using Current Transformers**

Scope T 454.1 **240 V, 3Ø, 3-Wire Service with Midpoint Grounded or 120/240 V Combination 1Ø and 3Ø, 4-Wire Delta Service Using 3- and 2-Wire CTs and 2-Stator Meter**

Figure T 454–1: 240 V, 3Ø, 3-Wire Service with Midpoint Grounded or 120/240 V Combination 1Ø and 3Ø, 4-Wire Delta Service Using 3-Wire and 2-Wire CTs and 2-Stator Meter

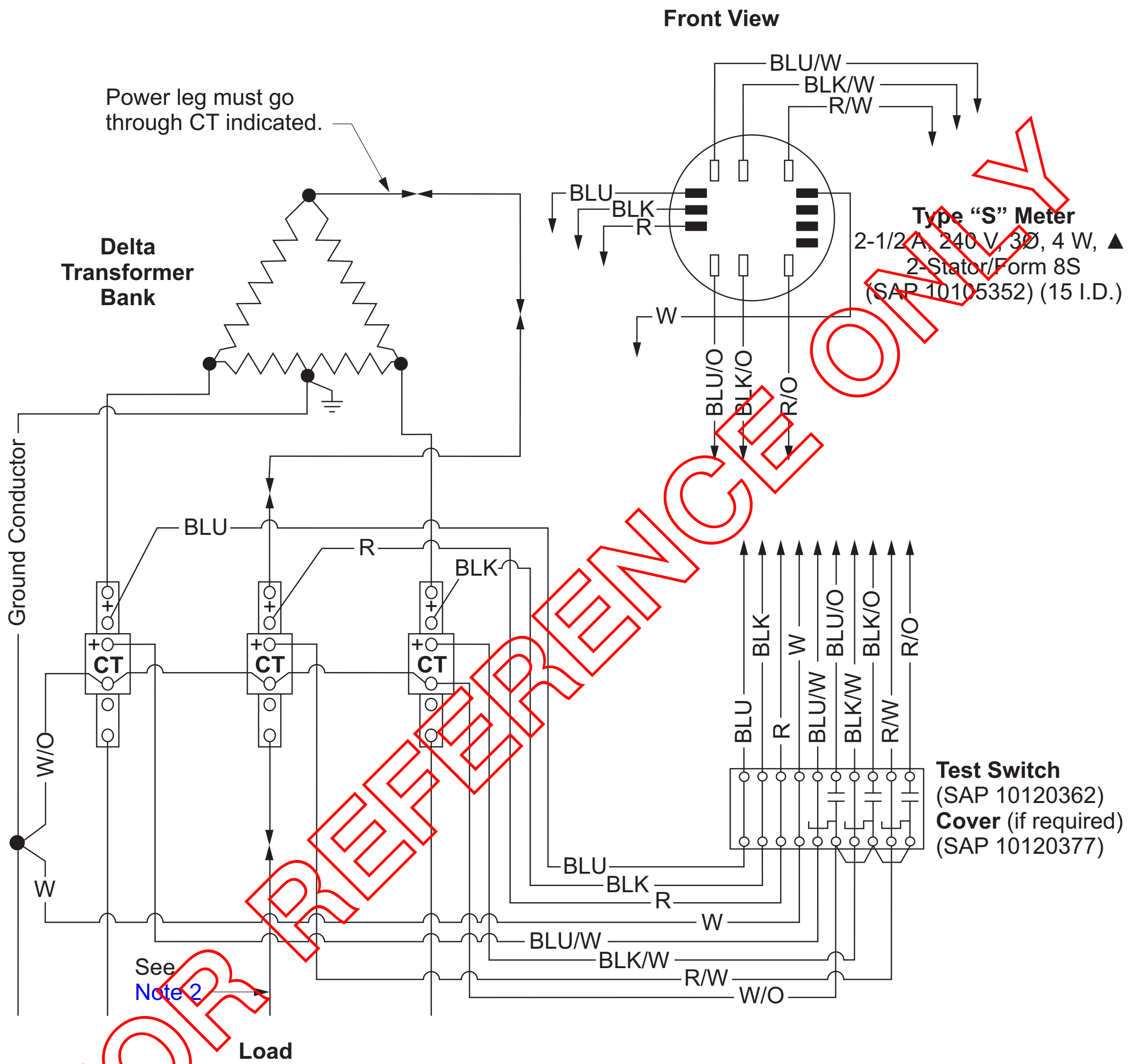


Note(s):

1. Polarity marks on 3-wire CTs vary in position. Use the connections (Figure T 454–1.1 [Sheet 1] or Figure T 454–1.2 [Sheet 1]) applicable to CT being installed.
2. See T 65 for other CTs polarity information.
3. 3-wire and 2-wire CTs must have the same ratio.
4. As required by the National Electric Code, the high phase (power leg) must be prominently identified by orange markings on the cable or bus.
5. For installations where local inspectors require that the center phase be the highest voltage to ground, use T 454.2 (Sheet 2).

Scope T 454.2 **Typical Metering for 240 V, 3Ø, 3-Wire Service with Midpoint Grounded or 120/240 V Combination 1Ø and 3Ø, 4-Wire Delta Service Using Three 2-Wire CTs**

Figure T 454–2: 240 V, 3Ø, 3-Wire Service with Midpoint Grounded or 120/240 V Combination 1Ø and 3Ø, 4-Wire Delta Service Using Three 2-Wire CTs



Note(s):

1. This drawing will be used when the high phase-to-ground (power leg) is located in the center position.
2. As required by the National Electric Code, the high phase (power leg) must be prominently identified by orange marking on the cable or bus.

4-Wire Wye and 4-Wire Delta, 3-Phase Metering — Using Current Transformers

Approved by:

What's Changed?

Effective Date: 10-29-2010

Scope T 454.3 **240 V, 3Ø, 3-Wire Service with Midpoint Grounded or 120/240 V Combination 1Ø/3Ø, 4-Wire Delta Service Using Three 2-Wire CTs**

Figure T 454–3: 240 V, 3Ø, 3-Wire Service with Midpoint Grounded or 120/240 V Combination 1Ø/3Ø, 4-Wire Delta Service Using Three 2-Wire CTs

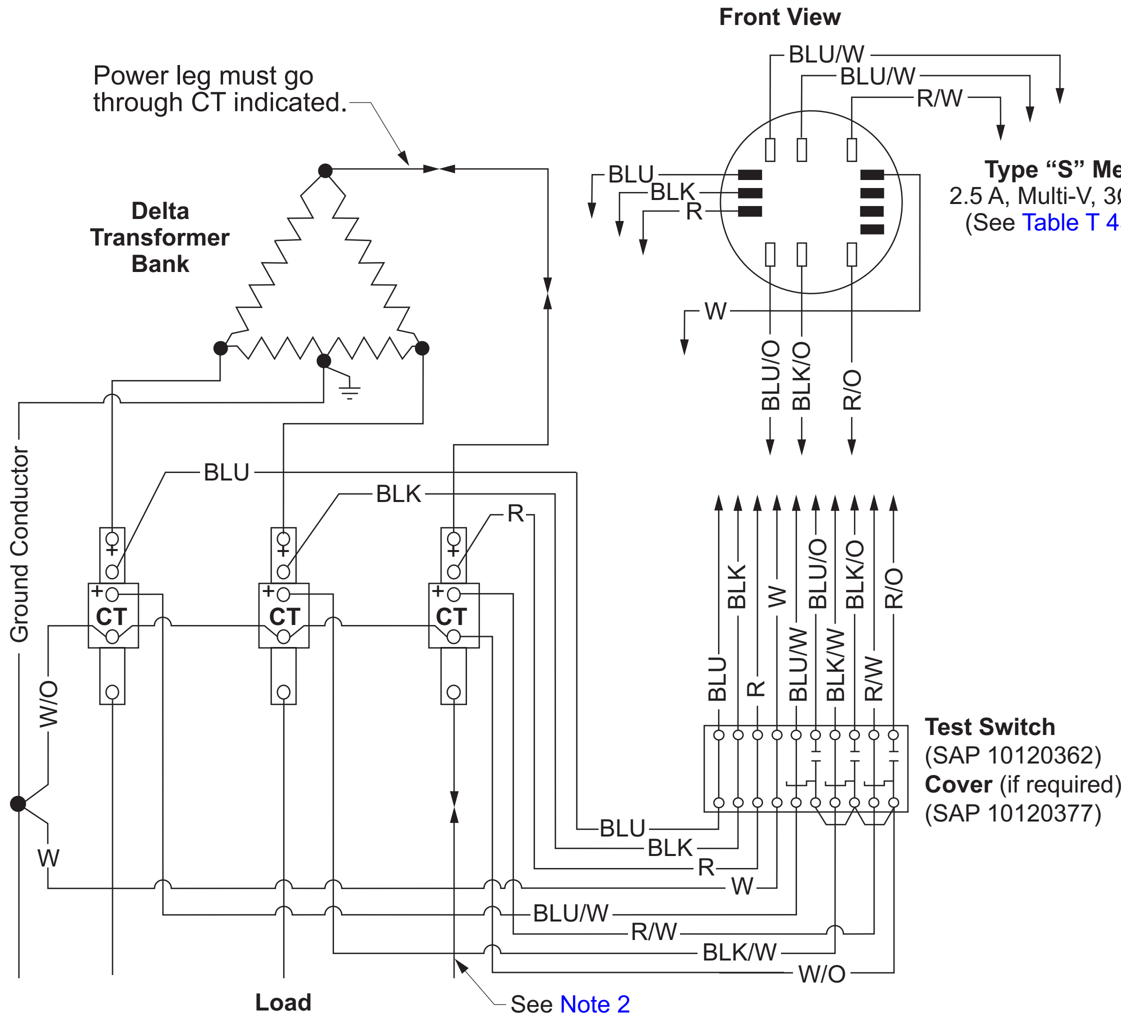


Table T 454–1: 240 V, 3Ø, 3-Wire Service with Midpoint Grounded or 120/240 V Combination 1Ø/3Ø, 4-Wire Delta Service Using Three 2-Wire CTs

Meter Type	Meter Description	SAP
9S/8S	2.5 A, Multi-V, 4 Wire	10105525
9S ESC[a/]	2.5 A, Multi-V, 4 Wire	10175799

[a/] Edison SmartConnect (ESC)

Note(s):

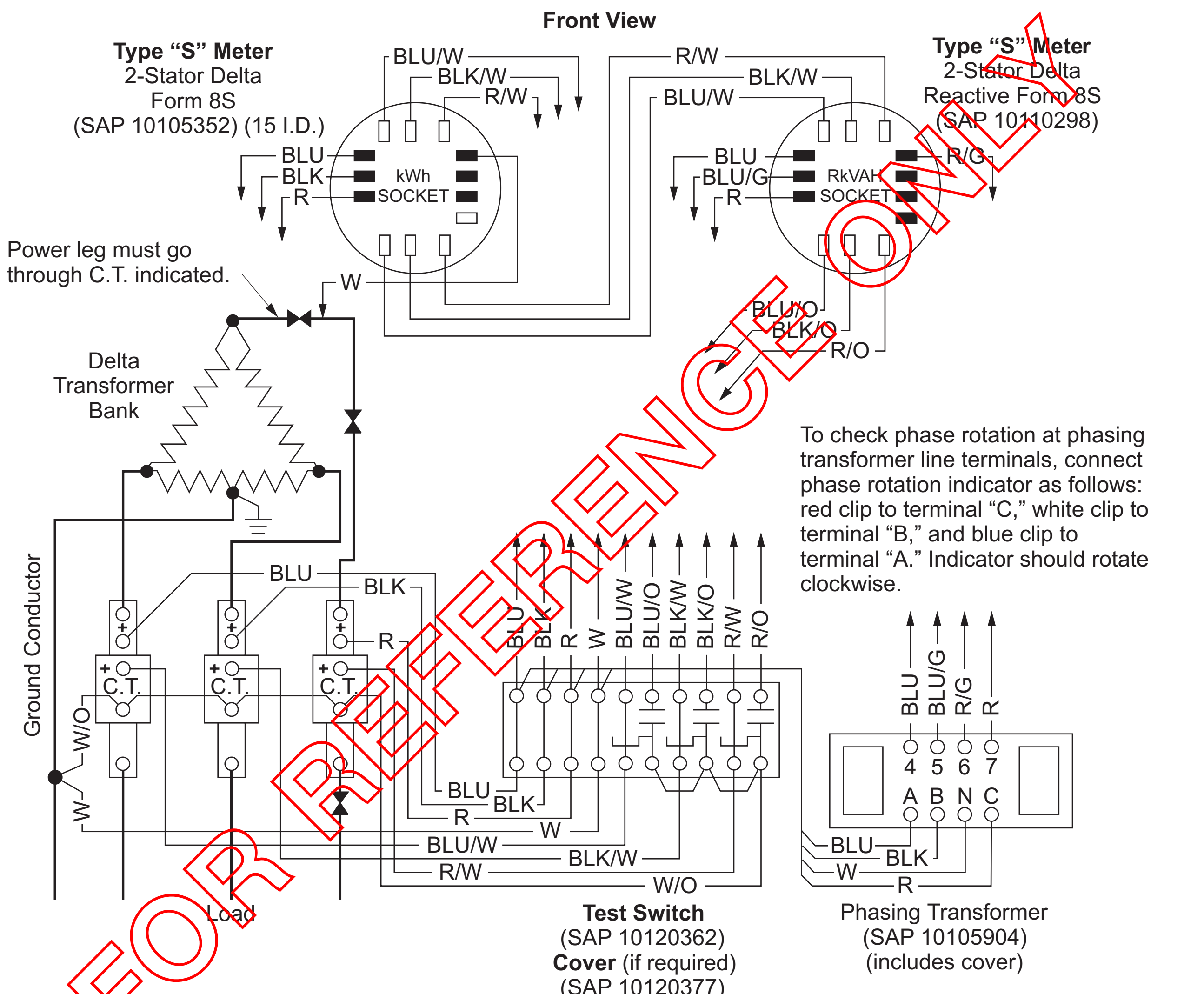
1. This drawing will be used when the high phase to ground (power leg) is located in the right hand position.

2. As required by the National Electric Code, the high phase (power leg) must be prominently identified by orange marking on the cable or bus.
3. Affix a “Meter Voltage” sticker to the meter panel, two inches below the meter’s rim. See T 75 for sticker selection.

T 455 4-Wire Wye and 4-Wire Delta, 3-Phase Metering — Using Current Transformers

Scope T 455.1 240 V, 3Ø, 3-Wire Service with Midpoint Ground or 120/240 V Combination 1Ø/3Ø, 4-Wire Delta Service Using Three 2-Wire CTs kWh and RkVAh Meters (Power Leg to C Phase)

Figure T 455–1: 240 V, 3Ø, 3-Wire Service with Midpoint Ground or 120/240 V Combination 1Ø/3Ø, 4-Wire Delta Service Using Three 2-Wire CTs kWh and RkVAh Meters

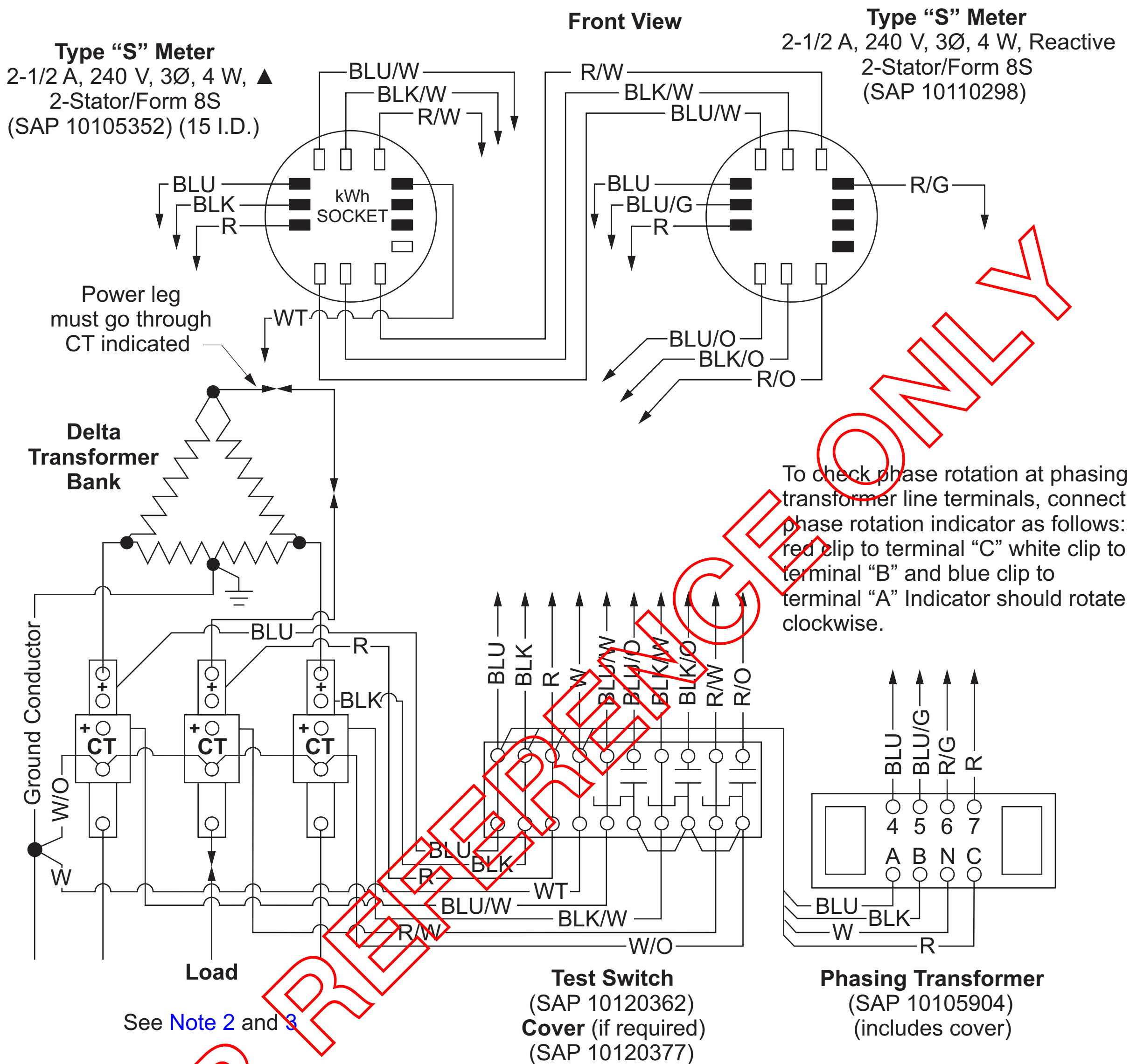


Note(s):

1. Phase rotation must be as indicated. In cases where the rotation is incorrect, the secondary wiring must be altered. Interchange BLU and BLK potential wires at CT primary bus terminals and interchange BLU/W and BLK/W wires at CT secondary terminals.
2. For installations where local inspectors require that the center phase be the highest voltage to ground, use.
3. As required by the National Electric Code, the highest phase (power leg) must be prominently identified by orange markings on the cable or bus.

Scope T 455.2 240 V, 3Ø, 3-Wire Service with Midpoint Ground or 120/240 V Combination 1Ø/3Ø, 4-Wire Delta Service Using Three 2-Wire CTs kWh and RkVAh Meters (Power Leg to B Phase)

Figure T 455–2: 240 V, 3Ø, 3-Wire Service with Midpoint Ground or 120/240 V Combination 1Ø/3Ø, 4-Wire Delta Service Using Three 2-Wire CTs kWh and RkVAh Meters



Note(s):

1. Phase rotation must be as indicated. In cases where the rotation is incorrect, the secondary wiring must be altered. Interchange BL and BK potential wires at CT primary bus terminals and interchange BL/WT and BK/WT wires at CT secondary terminals.
2. This drawing will be used only where local inspectors require that the center phase be the highest voltage-to-ground. Use T 455 (Sheet 1) where the highest voltage phase-to-ground is located on the right.
3. As required by the National Electric Code, the highest phase (power leg) must be prominently identified by orange markings on the cable or bus.

Scope T 455.3 **240 V, 3Ø, 3-Wire Service with Midpoint Ground or 120/240 V Combination 1Ø/3Ø, 4-Wire Delta Service Using Three 2-Wire CTs kWh/RkVAh Meter**

Figure T 455–3: 240 V, 3Ø, 3-Wire Service with Midpoint Ground or 120/240 V Combination 1Ø/3Ø, 4-Wire Delta Service Using Three 2-Wire CTs kWh/RkVAh Meter

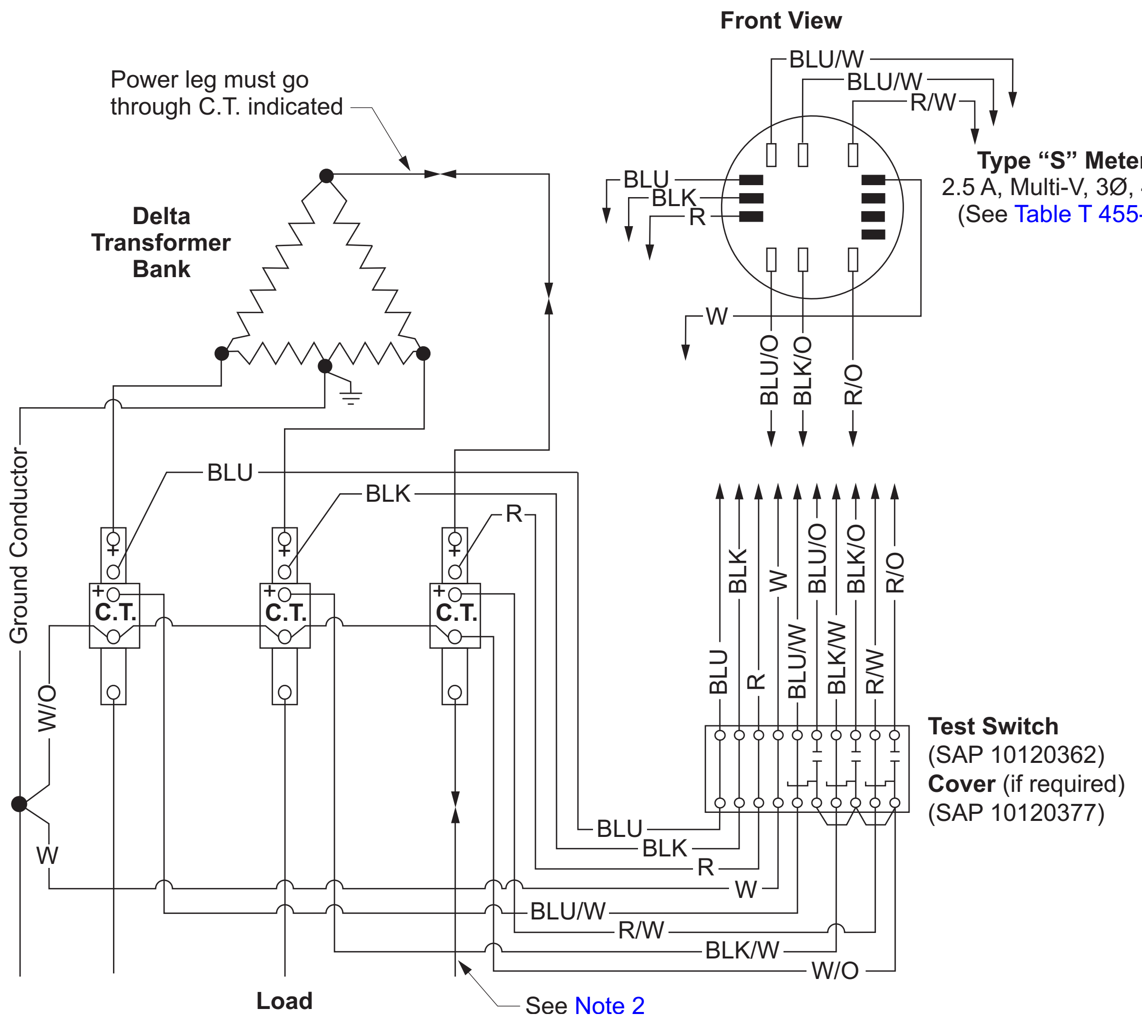


Table T 455–1: 240 V, 3Ø, 3-Wire Service with Midpoint Ground or 120/240 V Combination 1Ø/3Ø, 4-Wire Delta Service Using Three 2-Wire CTs kWh/RkVAh Meter

Meter Type	Meter Description	SAP
9S/8S	2.5 A, Multi-V, 4 Wire	10105525
9S ESC[a/]	2.5 A, Multi-V, 4 Wire	10175799

[a/] Edison SmartConnect (ESC)

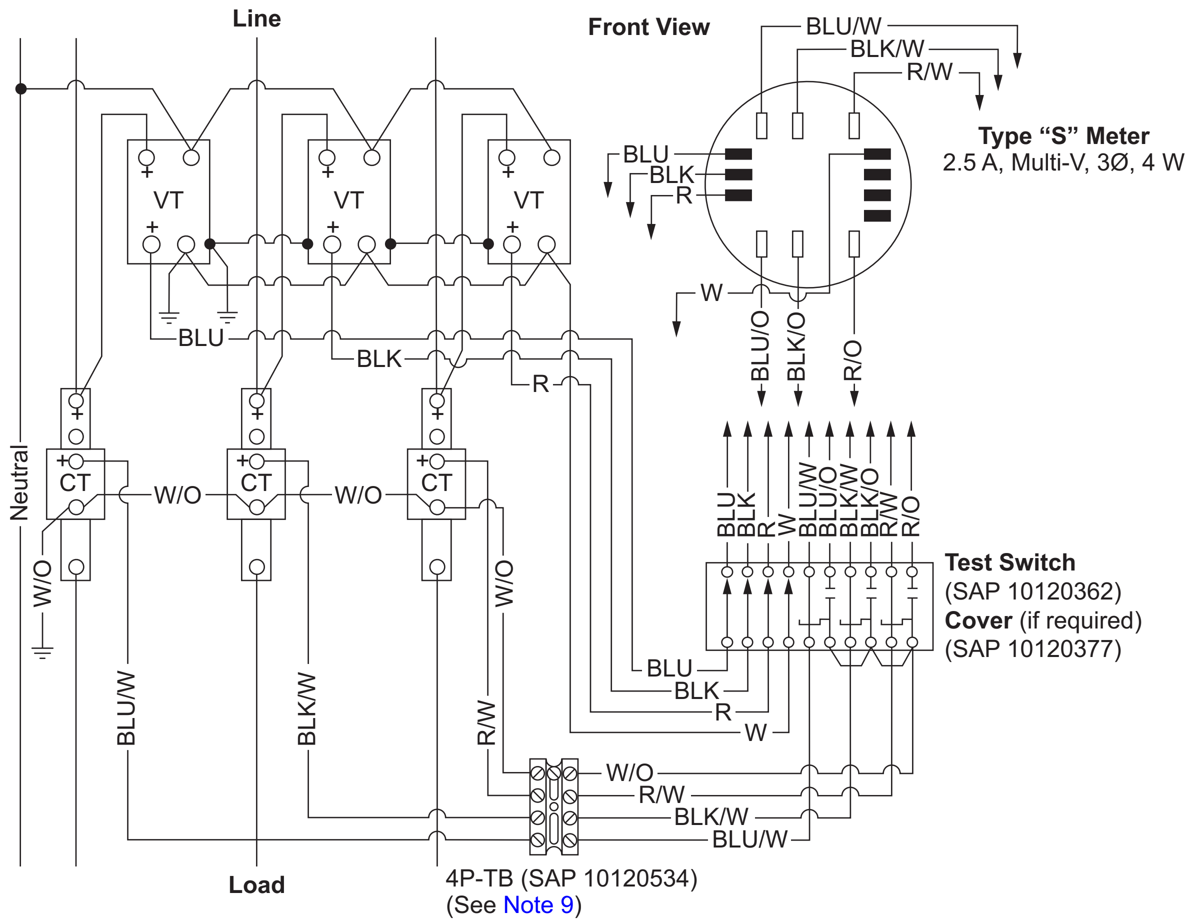
Note(s):

1. This drawing will be used when the high phase (power leg) is located in the right-hand position.
2. As required by the National Electric Code, the highest phase (power leg) must be prominently identified by orange markings on the cable or bus.
3. Affix a “Meter Voltage” sticker to the meter panel, two inches below the meter’s rim. See T 75 (Sheet 1) for sticker selection.

T 478 4-Wire Wye and 4-Wire Delta, 3-Phase Metering — Using Current and Potential Transformers

Scope T 478.1 4 kV, 12 kV, 33 kV, 69 kV, and 115 kV 3Ø, 3/4-Wire Service Using Instrument Transformers and 3-Stator Meter

Figure T 478–1: 4 kV, 12 kV, 33 kV, 69 kV, and 115 kV 3Ø, 3/4-Wire Service Using Instrument Transformers and 3-Stator Meter



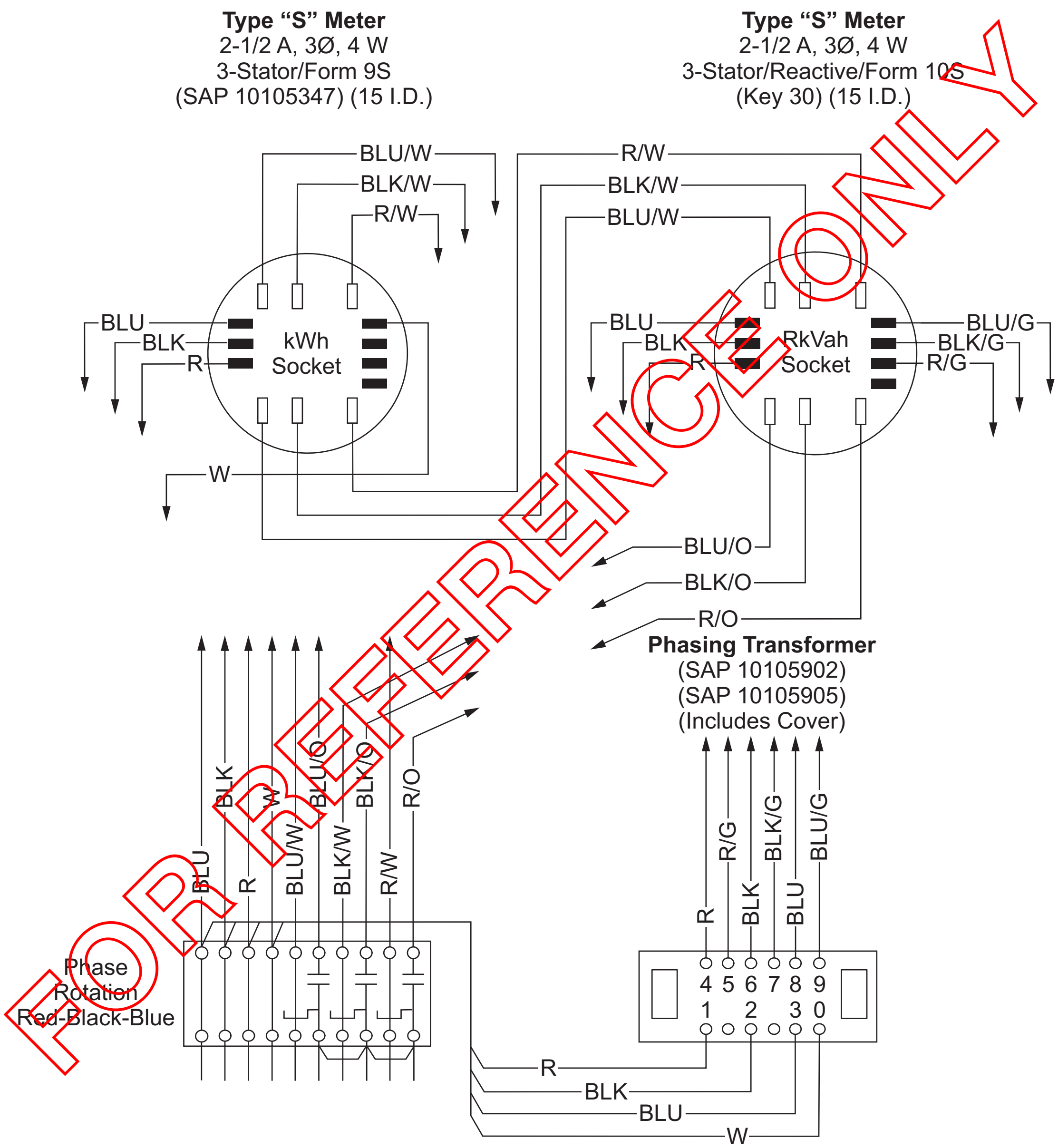
Note(s):

1. Use for 3-wire and 4-wire, 4 kV service fed from a system having a solidly grounded neutral. Where primary neutral is grounded through a resistor, the service shall be metered 3-wire per T 376, 35:1 ratio voltage transformer (VT) shall be used (see Note 3).
2. For installation requiring kWh/kVARh demand metering, see T 478.3 (Sheet 4).
3. Where a 3-wire service is supplied from a system having a solidly grounded neutral, the neutral wire is carried into the metering section only to provide a neutral connection for the three VT primaries (5 kV, #6 minimum).
4. Ground VT and current transformer (CT) secondaries directly to the metal enclosure or other approved ground. **Do not connect to the primary neutral.** Use #12 wire minimum.
5. Affix a Meter Voltage sticker to the meter panel, two inches below the meter's rim. For sticker selection, see T 75.
6. See T 65 for CT polarity information.

7. Ground and bond all instrument transformer cases with #12 wire minimum. Polemounted CTs and VTs must be bonded. However, they do not require case ground when mounted 8 feet or more above ground. Ground all CT and VT secondaries at their common point.
8. For outdoor primary metering installations, the CTs and VTs are located in the substation bus or on a pole. Order meter cabinet (SAP 10114241) with 13 clip meter socket, as displayed on T 399.
9. Place the current-shunting block (4P-TB) (SAP 10120534) at the back side of the meter panel.
10. This type of installation is acceptable for 4 kV, 12 kV, and 33 kV pole top metering.
11. The completed wiring of each meter installation or any change or replacement of any part of an existing installation shall be inspected by an Electrical Metering Services (EMS) Meter Technician qualified for primary voltage before energizing the installation.
12. See Scope T 725.1 for NET Generation Output Meter (NGOM) used in Paired Storage, NEM-ST, NEM-MT-ST, and NEM-A Applications.
13. See Scope T 725.2 for NET Generation Output Meter (NGOM) used in MASH, V-NEM, NEM-V, NEM-V-ST, or SOMAH Application.

Scope T 478.2 **4 kV, 3Ø, 4-Wire Service Using kWh/RkVAh Meter with Instrument Transformers**

Figure T 478–2: 4 kV, 3Ø, 4-Wire Service Using kWh/RkVAh Meter with Instrument Transformers

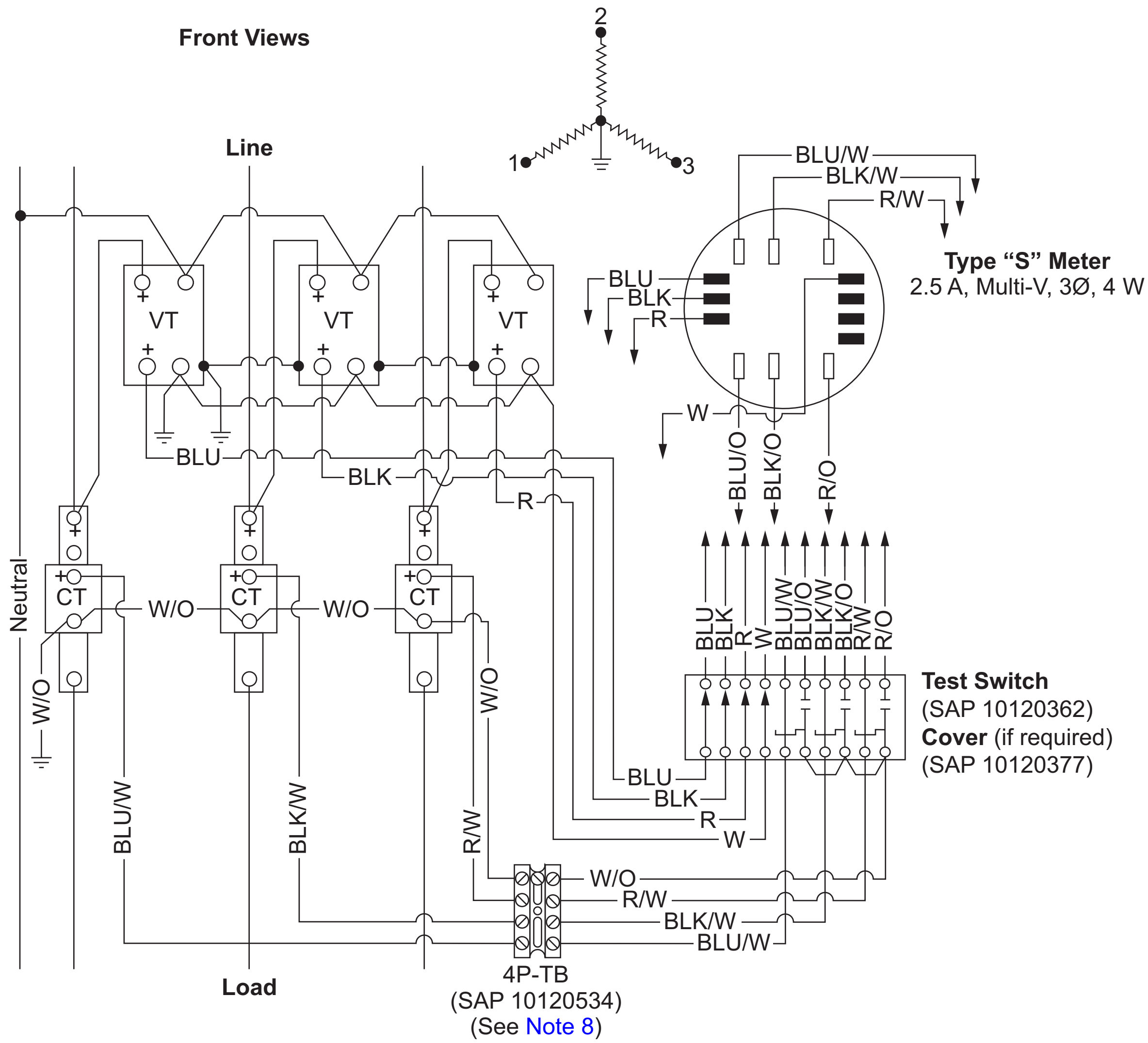


Note(s):

1. See T 25 for internal wiring of meters.
2. See T 70 for phase rotation information.
3. RkVAh demand meter is required for service voltage of 4 kV and above.

Scope T 478.3 **4 kV, 12 kV, and 69 kV, 3Ø, 4-Wire Service Using kWh/RkVAh Meter with Instrument Transformers**

Figure T 478–3: 4 kV, 12 kV, and 69 kV, 3Ø, 4-Wire Service Using kWh/RkVAh Meter with Instrument Transformers



Note(s):

1. Use for 3-wire and 4-wire, 4 kV service fed from a system having a solidly grounded neutral. Where primary neutral is grounded through a resistor, the service shall be metered 3-wire per T 376; 35:1 ratio voltage transformer (VT) shall be used (see Note 2).
2. Where a 3-wire service is supplied from a system having a solidly grounded neutral, the neutral wire is carried into the metering section only to provide a neutral connection for the three VT primaries (5 kV, #6 minimum).
3. Ground VT and current transformer (CT) secondaries directly to the metal enclosure or other approved ground. **Do not connect to the primary neutral.** Use #12 wire minimum.
4. Affix a "Meter Voltage" sticker to the meter panel, two inches below the meter's rim. For sticker selection, see T 75.

5. See T 65 for CT polarity information.
6. Ground and bond all instrument transformer cases with #12 wire minimum. Polemounted CTs and VTs must be bonded. However they do not require case ground when mounted 8 feet or more above ground. Ground all CT and VT secondaries at their common point.
7. For outdoor primary metering installations, the CTs and VTs are located in the substation bus or on a pole, order meter cabinet (SAP 10114241) (with 13-clip meter socket), as displayed on T 399.
8. Place the current-shunting block (4P-TB) (SAP 10120534) at the back side of the meter panel.
9. This type of installation is acceptable for 4 kV, 12 kV, and 33 kV pole top metering.
10. The completed wiring of each meter installation or any change or replacement of any part of an existing installation shall be inspected by an Electrical Meter Services (EMS) Meter Technician qualified for primary voltage before energizing the installation.
11. See Scope T 725.1 for NET Generation Output Meter (NGOM) used in Paired Storage, NEM-ST, NEM-MT-ST, and NEM-A Applications.
12. See Scope T 725.2 for NET Generation Output Meter (NGOM) used in MASH, V-NEM, NEM-V, NEM-V-ST, or SOMAH Application.

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T 499 4-Wire 3Ø Metering — Using Current and Potential Transformers

Scope T 499.1 4-kV, 12 kV, and 33 kV, 3Ø, 4-Wire Pole Top Metering Installation

Figure T 499–1: 4 kV, 12 kV, and 33 kV, 3Ø, 4-Wire Pole Top Metering Installation

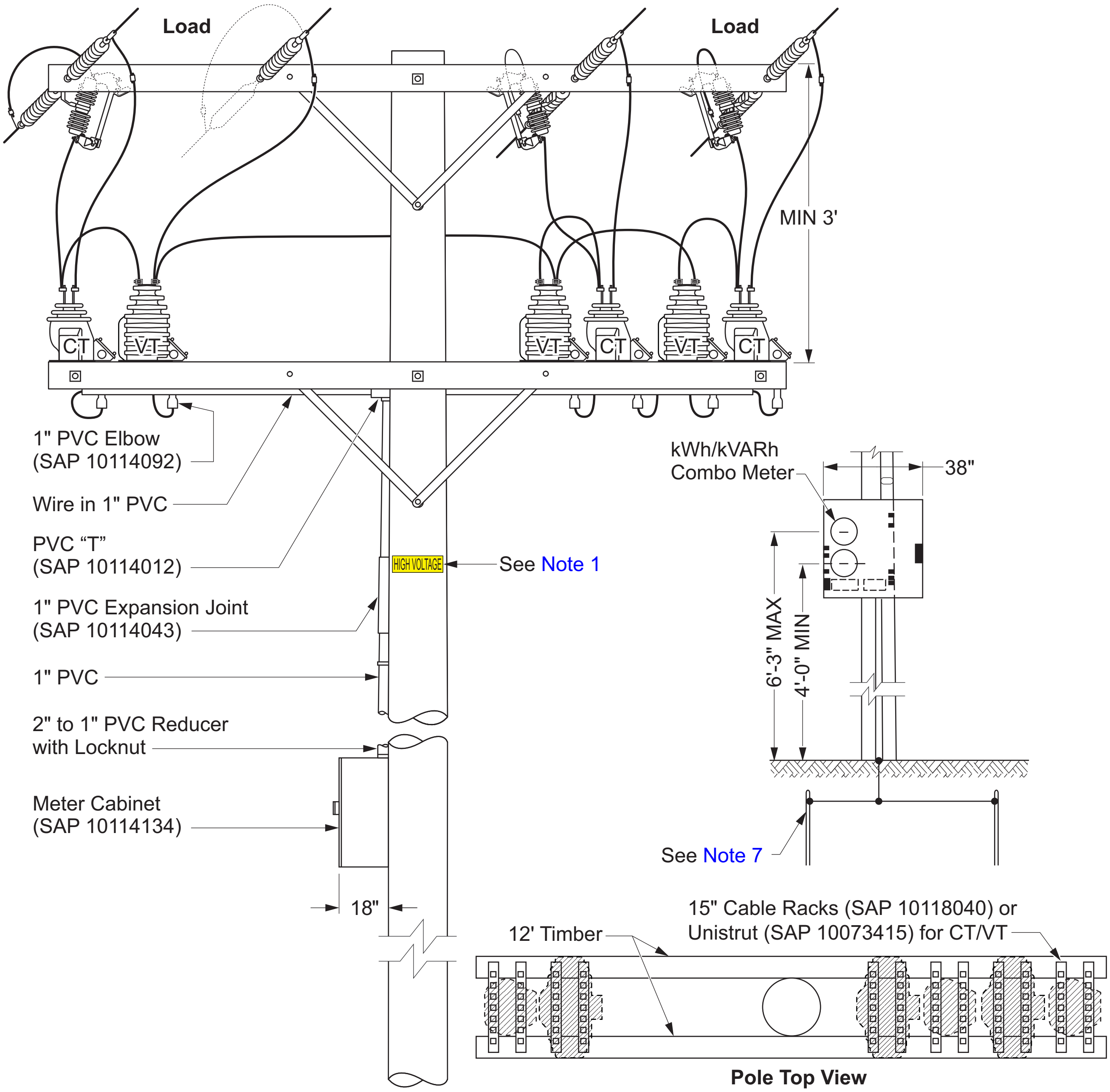
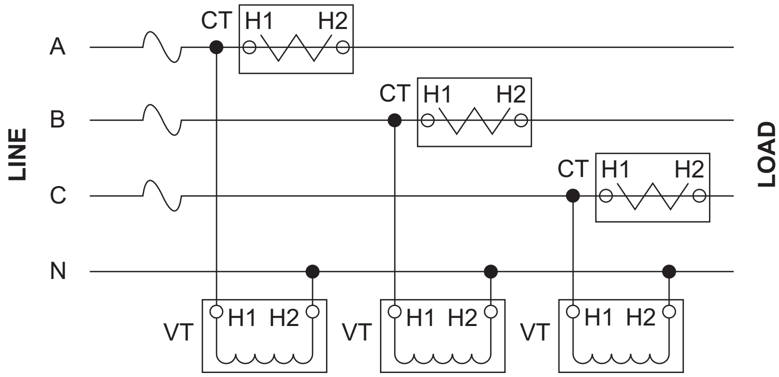


Figure T 499–2: 4 kV, 12 kV, and 33 kV, 3Ø, 4-Wire Pole Top Metering Schematic



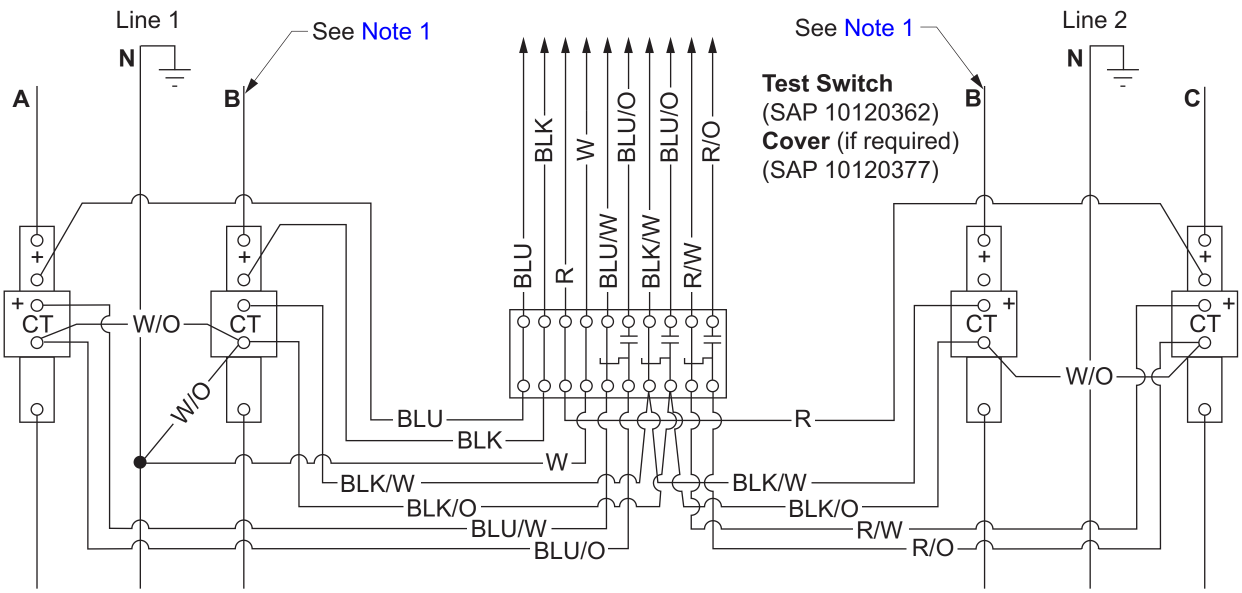
Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. The completed wiring of each new meter installation, or any change or replacement of any part of an existing installation shall be checked by an Electrical Metering Services (EMS) Meter Technician qualified for primary voltages before energizing the installation.
3. The complete metering installation, including enclosure, will be furnished and installed by the Company.
4. Where an instrument transformer is installed on the pole so that its primary polarity marked terminal is reversed with respect to the connections shown on the applicable meter wiring drawing, its secondary connections must be reversed accordingly.
5. The line conductors shall be dead-ended at the next adjacent pole on the supply side of the meter pole to permit opening of taps or jumpers for isolation of metering installation.
6. Steps are required on all riser poles, except solely-owned Edison poles with one low voltage riser (3 inches or less).
7. Installation shall be grounded with #6 minimum Protected Ground Wire (PGW) (see GR 100 and GR 105).

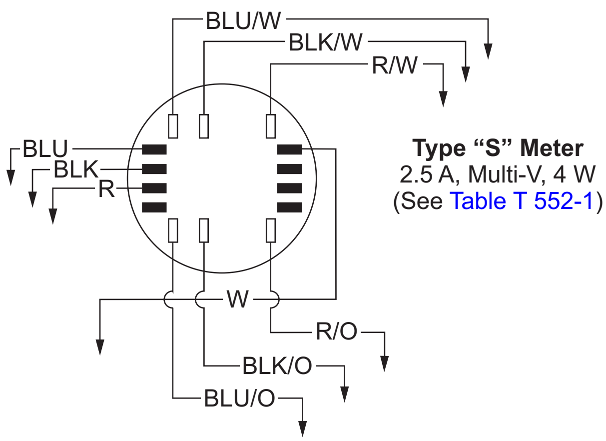
T 552 Totalized Metering — Using Current Transformers

Scope T 552.1 **Metering for Totalizing Two 120/208 V, Single-Phase, Three-Wire Network Services Using 2-Wire CTs and 3-Stator Demand Meter Sourced by a Single, 3-Phase Transformer or Transformer Bank**

Figure T 552–1: Totalizing Two 120/208 V, Single-Phase, Three-Wire Network Services Using 2-Wire CTs and 3-Stator Demand Meter Sourced by a Single, 3-Phase Transformer or Transformer Bank



Front View



Type "S" Meter
2.5 A, Multi-V, 4 W
(See Table T 552-1)

Transformer Bank Secondary

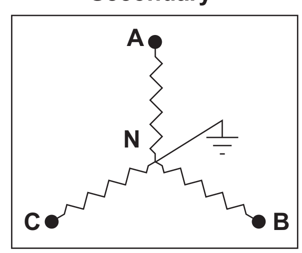


Table T 552–1: Metering for Totalizing Two 120/208 V, Single-Phase, Three-Wire Network Services Using 2-Wire CTs and 3-Stator Demand Meter Sourced by a Single, 3-Phase Transformer or Transformer Bank

Meter Type	Meter Description	SAP
9S/8S	2.5 A, Multi-V, 4 Wire	10105525
9S ESC[a/]	2.5 A, Multi-V, 4 Wire	10175799

[a/] Edison SmartConnect (ESC)

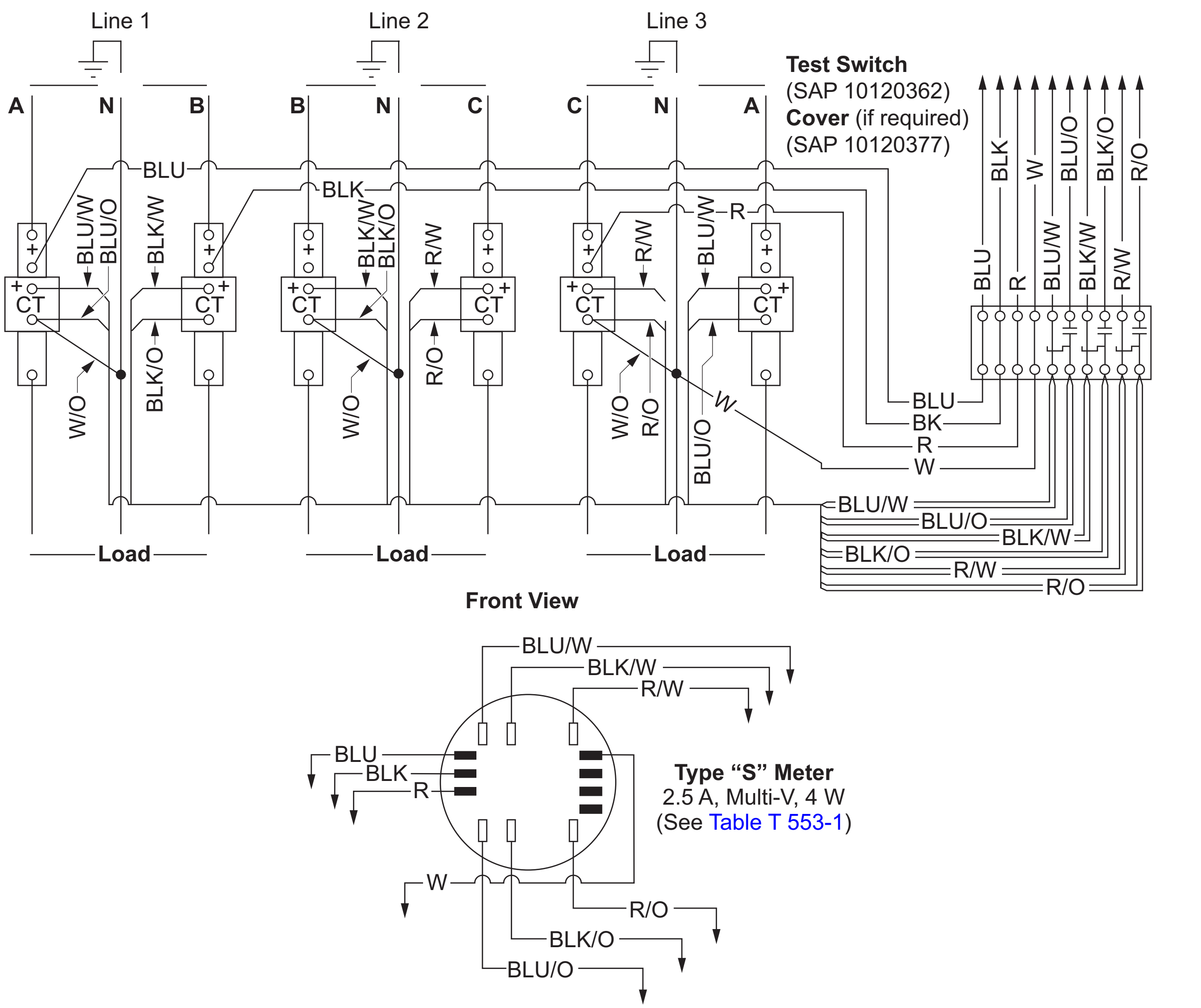
Note(s):

1. Polarity marks on 3-wire CTs vary in position. Regardless of the position of the polarity marks (either right or left terminal), follow the above connections schematically and attach the polarity terminals (see T 152).
2. For additional CT polarity information, see T 65.
3. All CTs must have the same ratio.
4. The multiplying constant of the meter is the nameplate ratio of the CTs multiplied by the dial constant of the meter.
5. Affix a “Meter Voltage” sticker to the meter panel, two inches below the meter’s rim. See T 75 for sticker selection.

T 553 Totalized Metering — Using Current Transformers

Scope T 553.1 Metering for Totalizing Two 120/208 V, 1Ø, 3-Wire Network Services Using Six 2-Wire CTs and 3-Stator Demand Meter Sourced by a Single 3-Phase Transformer or Transformer Bank

Figure T 553–1: Totalizing Two 120/208 V, 1Ø, 3-Wire Network Services Using Six 2-Wire CTs and 3-Stator Demand Meter Sourced by a Single 3-Phase Transformer or Transformer Bank



What's Changed? Addition of new 9S ESC meter. Removed MC codes and added SAP numbers.

Table T 553–1: Metering for Totalizing Two 120/208 V, 1Ø, 3-Wire Network Services Using Six 2-Wire CTs and 3-Stator Demand Meter Sourced by a Single 3-Phase Transformer or Transformer Bank

Meter Type	Meter Description	SAP
9S	2.5 A, Multi-V, 4 Wire	10105525
9S ESC[a/]	2.5 A, Multi-V, 4 Wire	10175799

[a/] Edison SmartConnect (ESC)

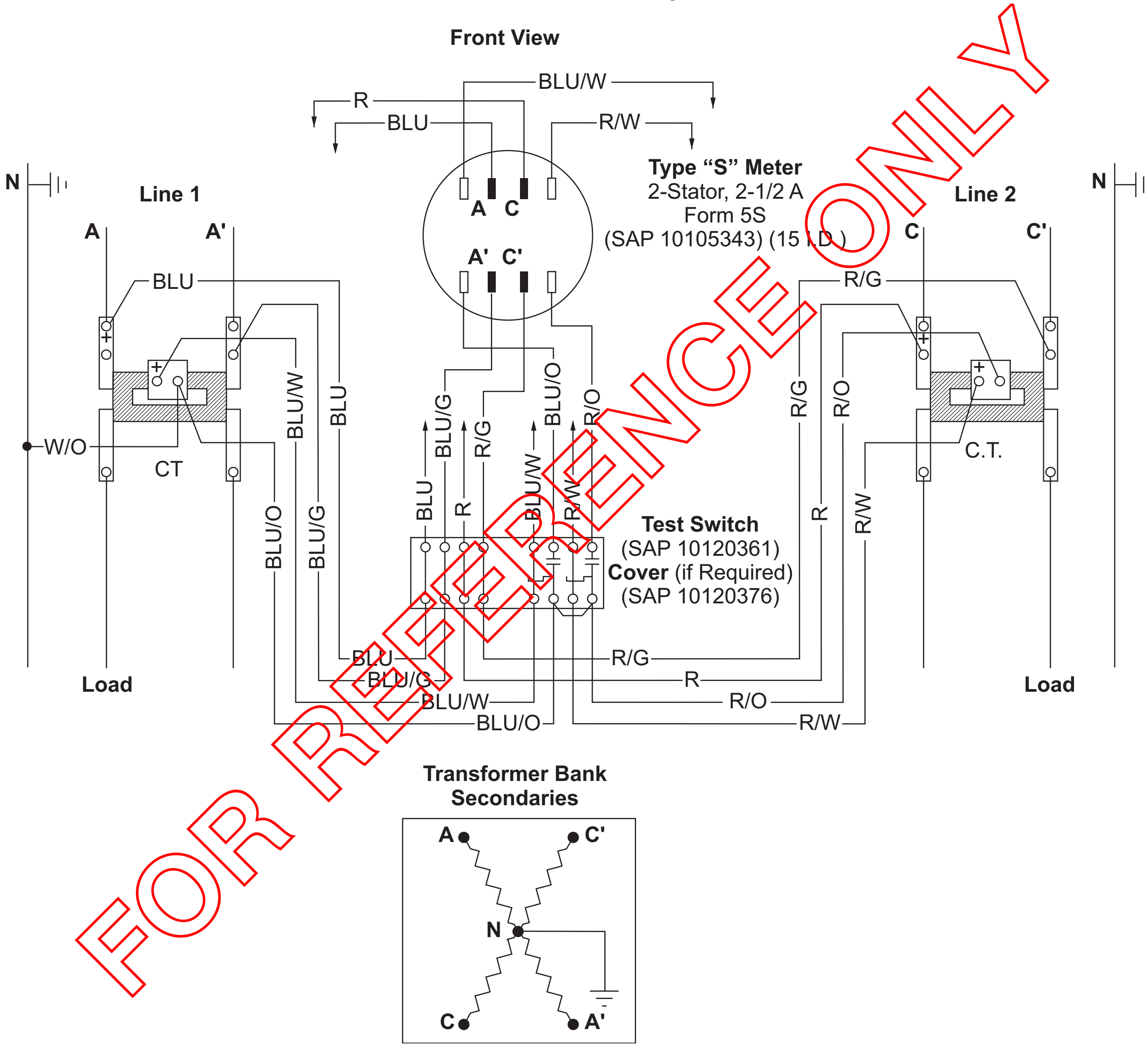
Note(s):

1. Polarity marks on 3-wire CTs vary in position. Regardless of the position of the polarity marks (either right or left terminal), follow the above connections schematically and attach the polarity terminals (see T 152).
2. For additional CT polarity information, see T 65.
3. All CTs must have the same ratio.
4. The multiplying constant of the meter is the nameplate ratio of the CTs multiplied by the dial constant of the meter.
5. Affix a “Meter Voltage” sticker to the meter panel, two inches below the meter’s rim. See T 75 for sticker selection.

T 554 Totalized Metering — Using Current Transformers

Scope T 554.1 Metering for Totalizing Two 120/240 V, 1Ø, 3-Wire Services Using Two 3-Wire CTs and 2-Stator Demand Meter

Figure T 554–1: Totalizing Two 120/240V, 1Ø, 3-Wire Services Using Two 3-Wire CTs and 2-Stator Demand Meter Sourced by Two Transformers



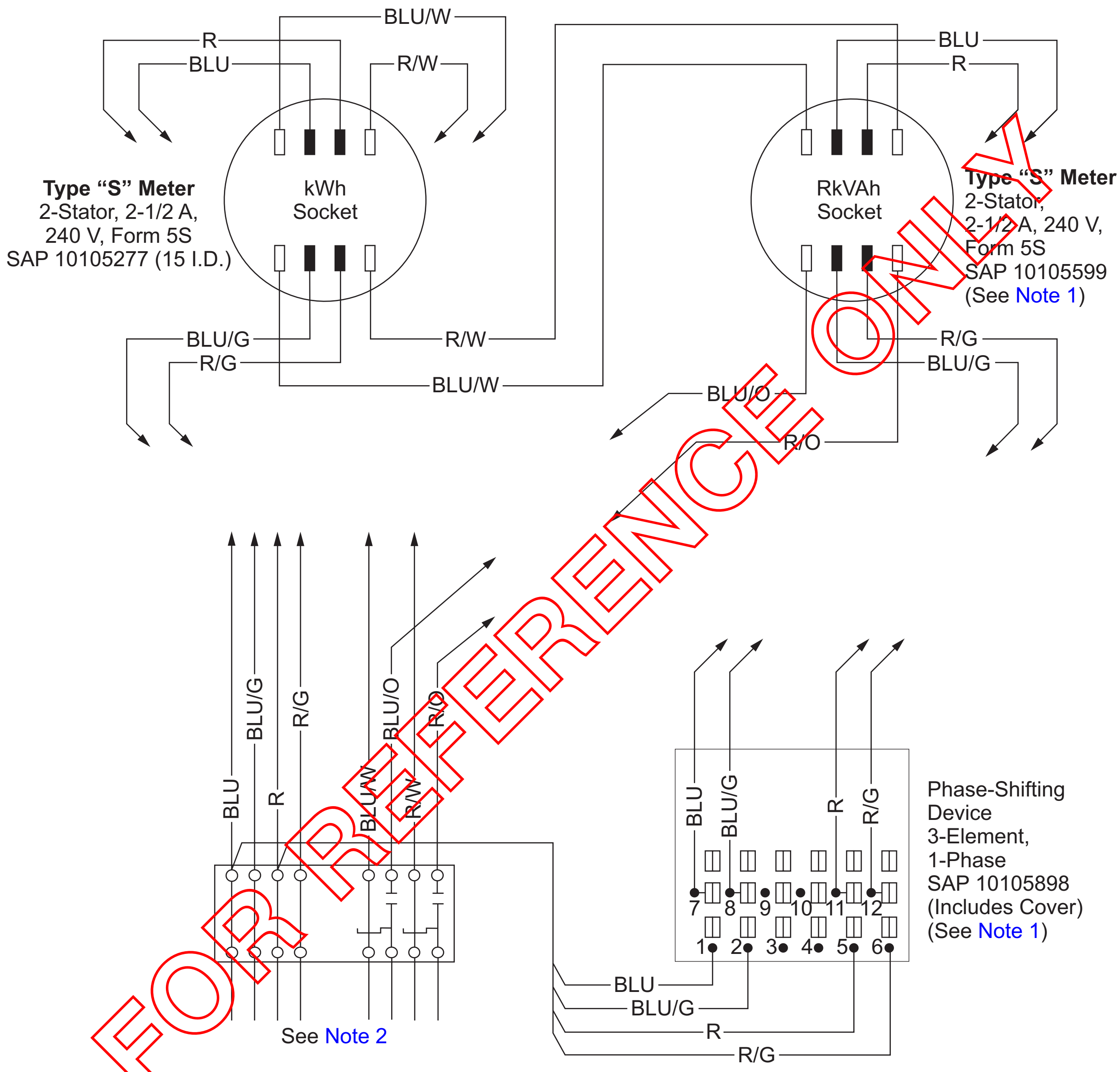
Note(s):

1. Polarity marks on 3-wire CTs vary in position. Regardless of the position of the polarity marks (either right or left terminal), follow the above connections schematically and attach the polarity terminals (see T 152).
2. For additional CT polarity information, see T 65.
3. All CTs must have the same ratio.
4. The multiplying constant of the meter is the nameplate ratio of the CTs multiplied by the dial constant of the meter.

Scope T 554.2 **Metering for Totalizing Two 120/240 V, 1Ø, 3-Wire Services Using 2-Stator Demand Meter and 2-Stator RkVAh Meter with Current Transformers**

Figure T 554–2: Totalizing Two 120/240 V, 1Ø, 3-Wire Services Using 2-Stator Demand Meter and 2-Stator RkVAh Meter with Current Transformers

FRONT VIEW



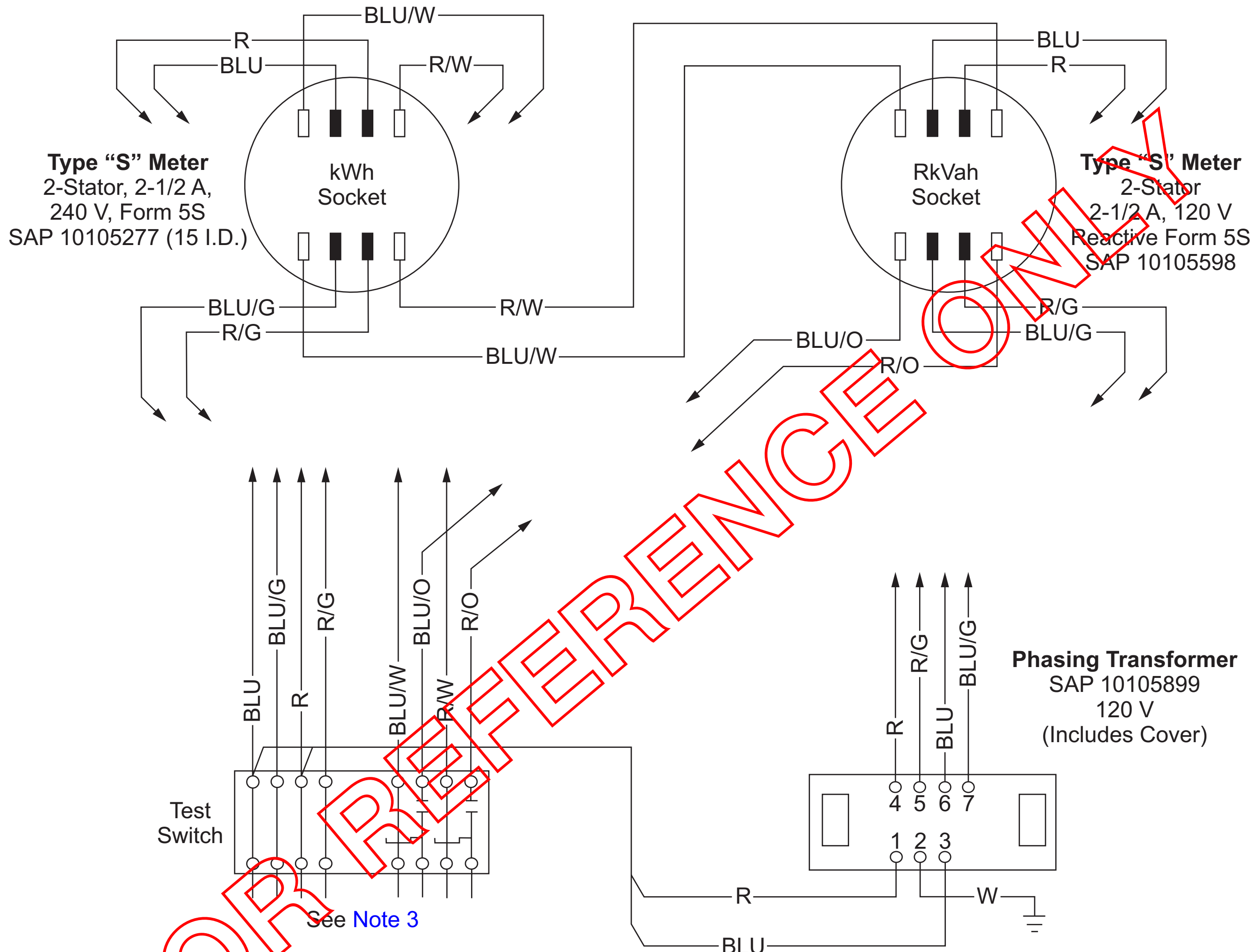
Note(s):

1. Meter and phase-shifting device must be ordered together on a form SD 196 marked "transfer" and request calibration as a unit in SSID.
2. See T 554.1 (Sheet 1) for secondary connections.

Scope T 554.3 Metering for Totalizing Two 120/240 V, 1Ø, 3-Wire Services Using 2-Stator Demand Meter and 2-Stator RkVAh Meter with Current Transformers

Figure T 554–3: Totalizing Two 120/240 V, 1Ø, 3-Wire Services Using 2-Stator Demand Meter and 2-Stator RkVAh Meter with Current Transformers

FRONT VIEW



Note(s):

1. Use this drawing only if each circuit is sourced from a separate primary phase.
2. The multiplying constant for the meter is the nameplate ratio of the CTs multiplied by the dial constant of the meter multiplied by the following applicable factors:

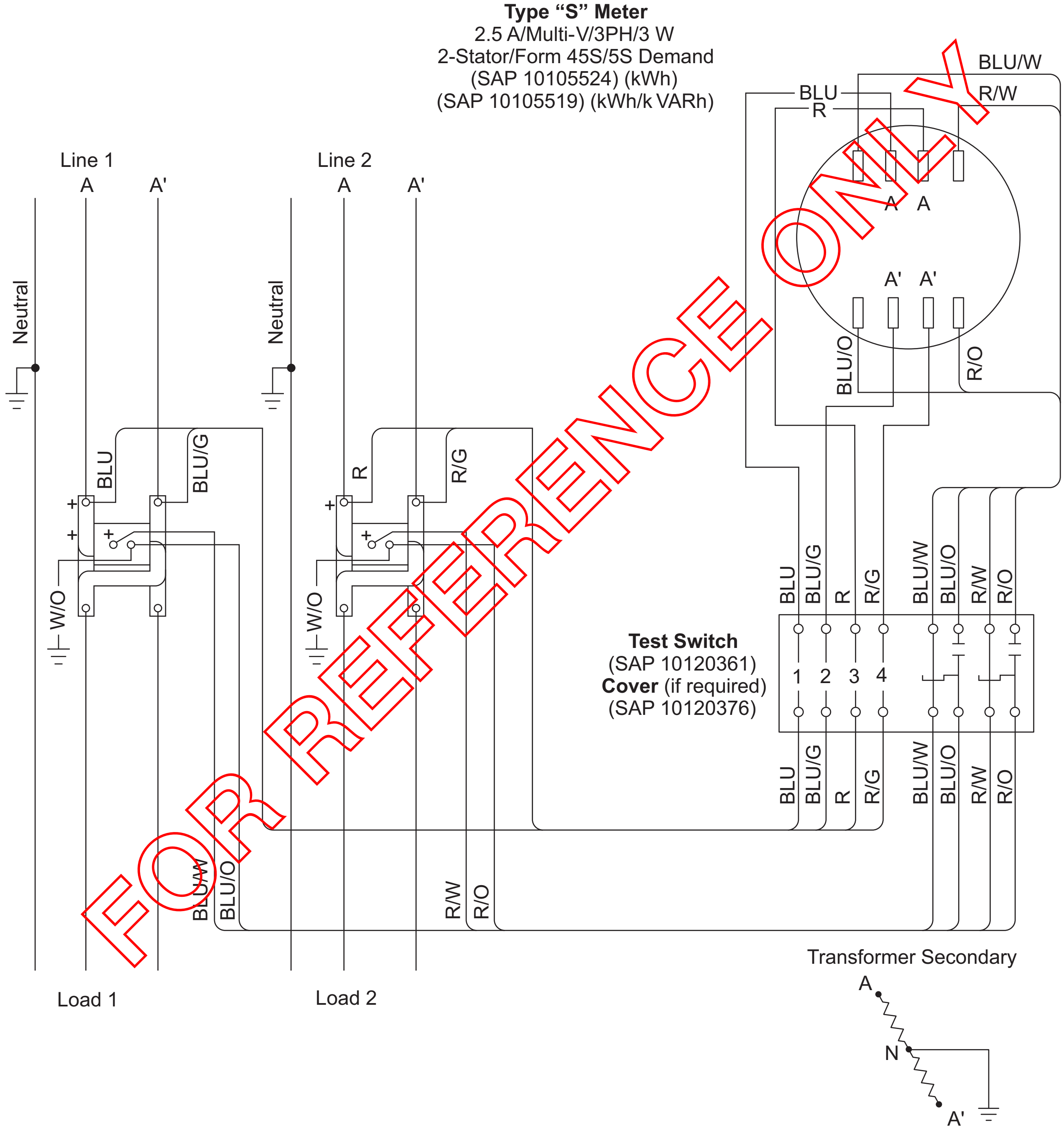
kWh Meter	RkVah Meter
1	2

3. See T 554.1 (Sheet 1) for secondary connections.

CAUTION **When energized, measure the voltage between terminals 1 and 3 of the phasing transformer. If 208 volts is measured, reverse both voltage and current leads of line 2. The voltage measured between terminals 1 and 3 must be 120 volts.**

Scope T 554.4 **Totalizing Two 120/240 V, 1Ø, 3-Wire Services Using Two 3-Wire CTs and a 2-Stator Demand Meter Sourced by a Single Transformer**

Figure T 554–4: Totalizing Two 120/240 V, 1Ø, 3-Wire Services Using Two 3-Wire CTs and a 2-Stator kWh or kWh/kVARh Demand Meter Sourced by a Single Transformer

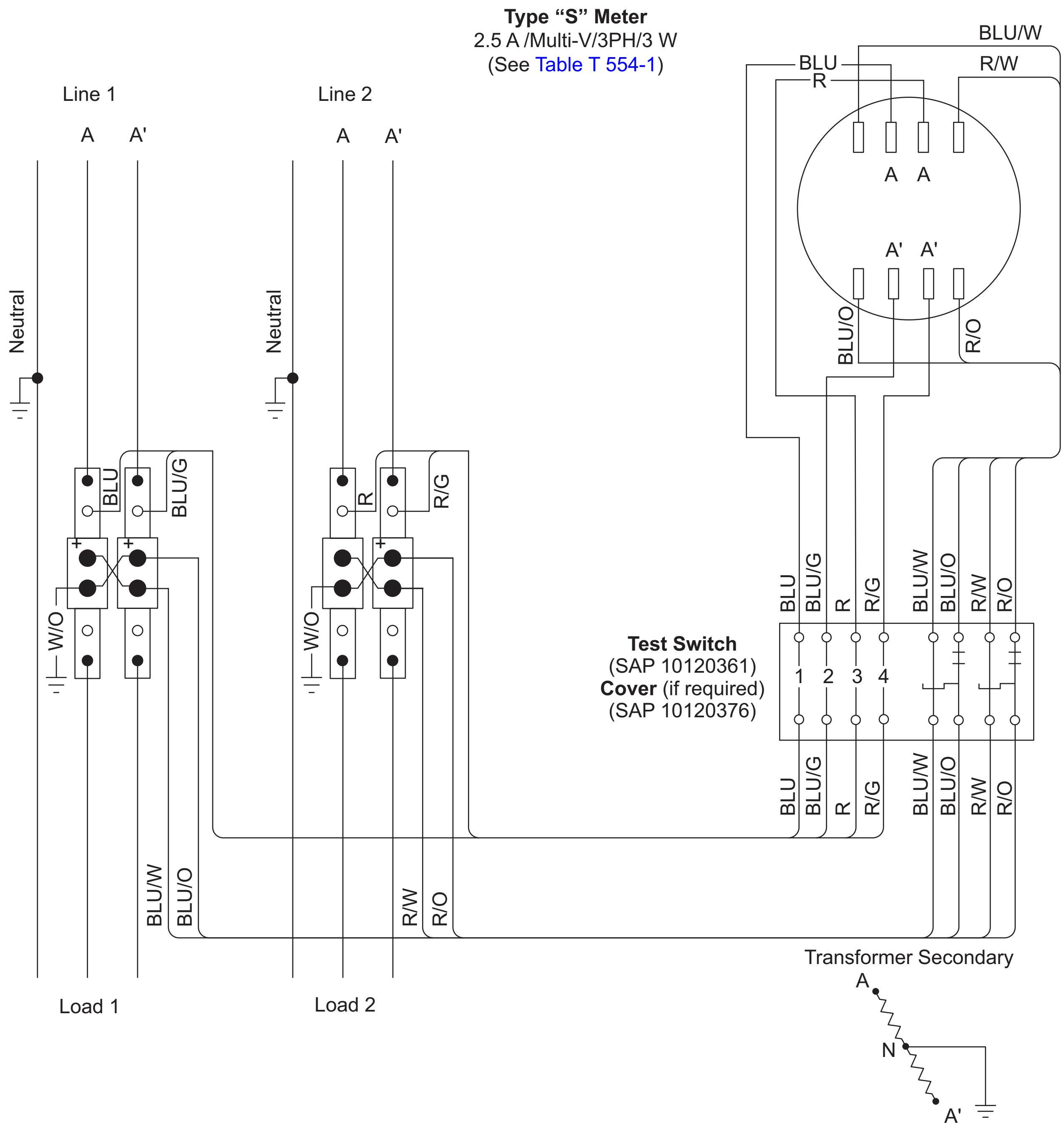


Note(s):

1. Use this drawing only if each circuit is sourced from the same primary phase.
2. Polarity marks on 3-wire CTs vary in position. Regardless of the position of the polarity marks (either right or left terminal), follow the above connections schematically and attach the polarity leads to the polarity terminals.
3. All CTs must have the same ratio.
4. See T 65 for additional polarity information.
5. The meter's multiplying constant is the nameplate ratio of the CTs multiplied by the dial constant of the meter.
6. Affix Meter Voltage & Totalizer sticker to the meter panel, two inches below the meter's rim. See T 75 for sticker selection.
7. The voltages measured between 1 and 3 at the test switch MUST be 0 V.
8. For all new totalized metering installations and any existing installations where the above service conditions cannot be met, wire each service panel separately per T 152 and software totalize by using two IDR meters.

Scope T 554.5 **Totalizing Two 120/240 V, 1Ø, 3-Wire Services Using Four 2-Wire CTs and a 2-Stator Demand Meter Sourced by a Single Transformer**

Figure T 554–5: Totalizing Two 120/240 V, 1Ø, 3-Wire Services Using Four 2-Wire CTs and a 2-Stator kWh or kWh/kVARh Demand Meter Sourced by a Single Transformer



What's Changed? Addition of new 45S ESC meter. Removed MC codes and added SAP numbers.

Table T 554–1: Totalizing Two 120/240 V, 1Ø, 3-Wire Services Using Four 2-Wire CTs and a Stator kWh or kWh/kVARh Demand Meter Sourced by a Single Transformer

Meter Type	Meter Description	SAP
45S	2.5 A, Multi-V, 3 Wire (kWh)	10105524
45S	2.5 A, Multi-V, 3 Wire (kWh/kVARh)	10105519
45S ESC[a/]	2.5 A, Multi-V, 3 Wire	10175800

[a/] Edison SmartConnect (ESC)

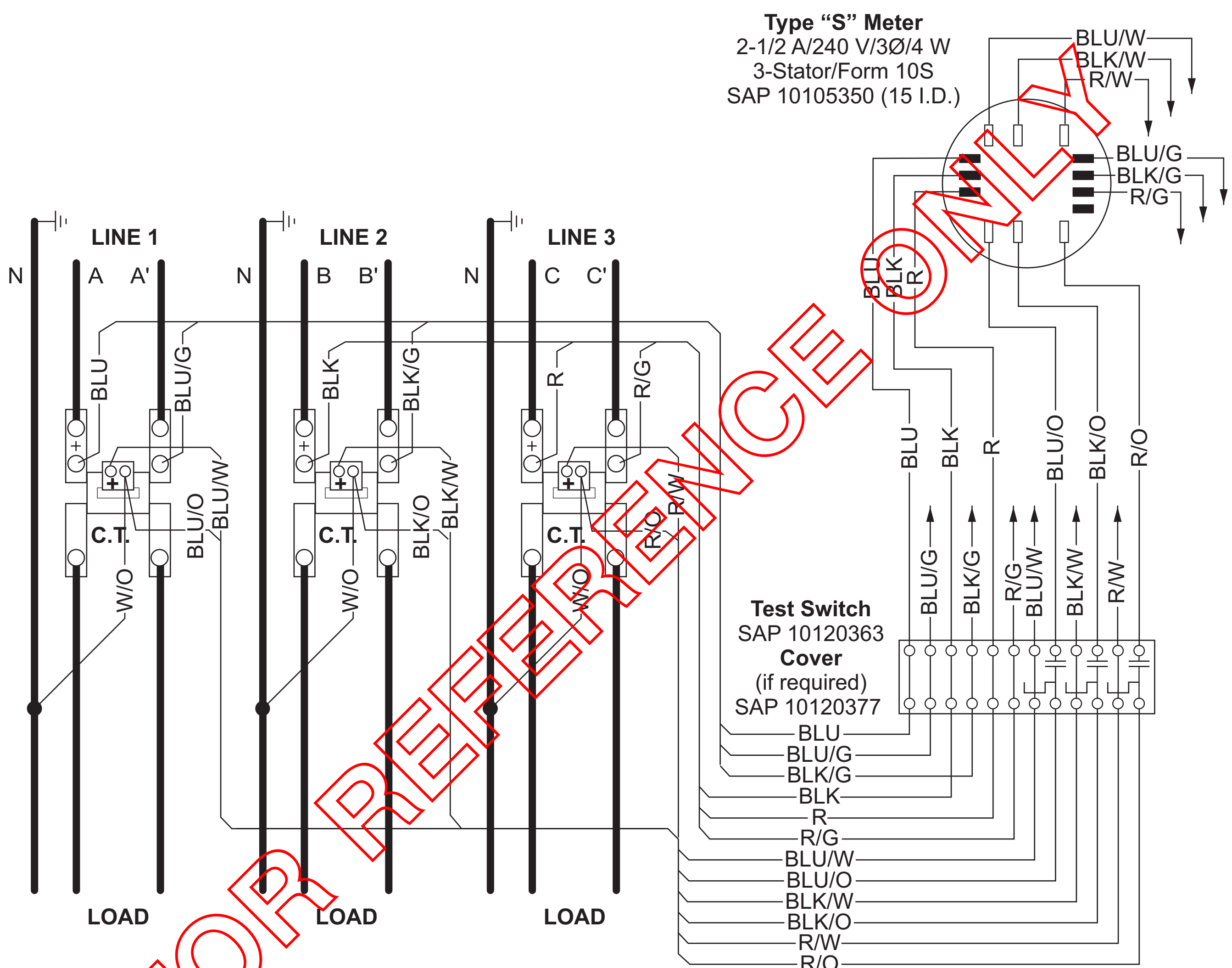
Note(s):

1. Use this drawing only if each circuit is sourced from the same primary phase.
2. All CTs must have the same ratio.
3. See T 65 for additional polarity information.
4. The meter's multiplying constant is one-half the nameplate ratio of the CTs multiplied by the dial constant of the meter.
5. Affix Meter Voltage & Totalizer sticker to the meter panel, two inches below the meter's rim. See T 75 for sticker selection.
6. The voltages measured between 1 and 3 at the test switch MUST be zero volts.
7. For all new totalized metering installations and any existing installations where the above service conditions cannot be met, wire each service panel separately per T 155 and software totalize by using two IDR meters.

T 555 Totalized Metering — Using Current Transformers

Scope T 555.1 Metering for Totalizing Three 120/240 V, 1Ø, 3-Wire Services Using Three 3-Wire CTs and 3-Stator Demand Meter

Figure T 555–1: Totalizing Three 120/240 V, 1Ø, 3-Wire Services Using Three 3-Wire CTs and 3-Stator Demand Meter



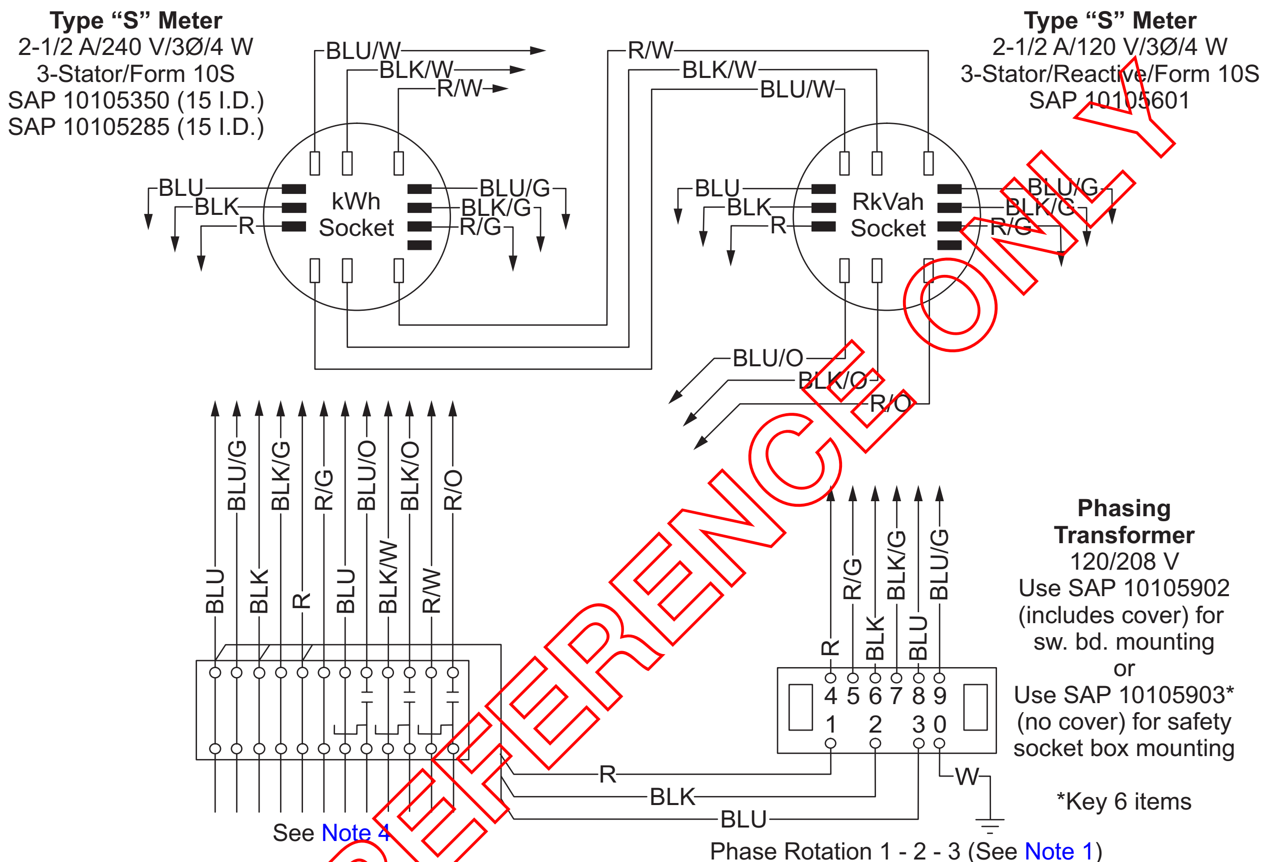
Note(s):

1. Polarity marks on 3-wire CTs vary in position. Regardless of the position of the polarity marks (either right or left terminal), follow the above connections schematically and attach the polarity leads to the polarity terminals.
2. For additional polarity information, see T 65.
3. All CTs must have the same ratio.
4. The multiplying constant of the meter is the nameplate ratio of the CTs multiplied by the dial constant of the meter.

Scope T 555.2 Totalizing Three 120/240 V, 1Ø, 3-Wire Services Using 3-Stator Demand and RkVAh Meters with Current Transformers

Figure T 555–2: Totalizing Three 120/240 V, 1Ø, 3-Wire Services Using 3-Stator Demand and RkVAh Meters with Current Transformers

FRONT VIEW



Note(s):

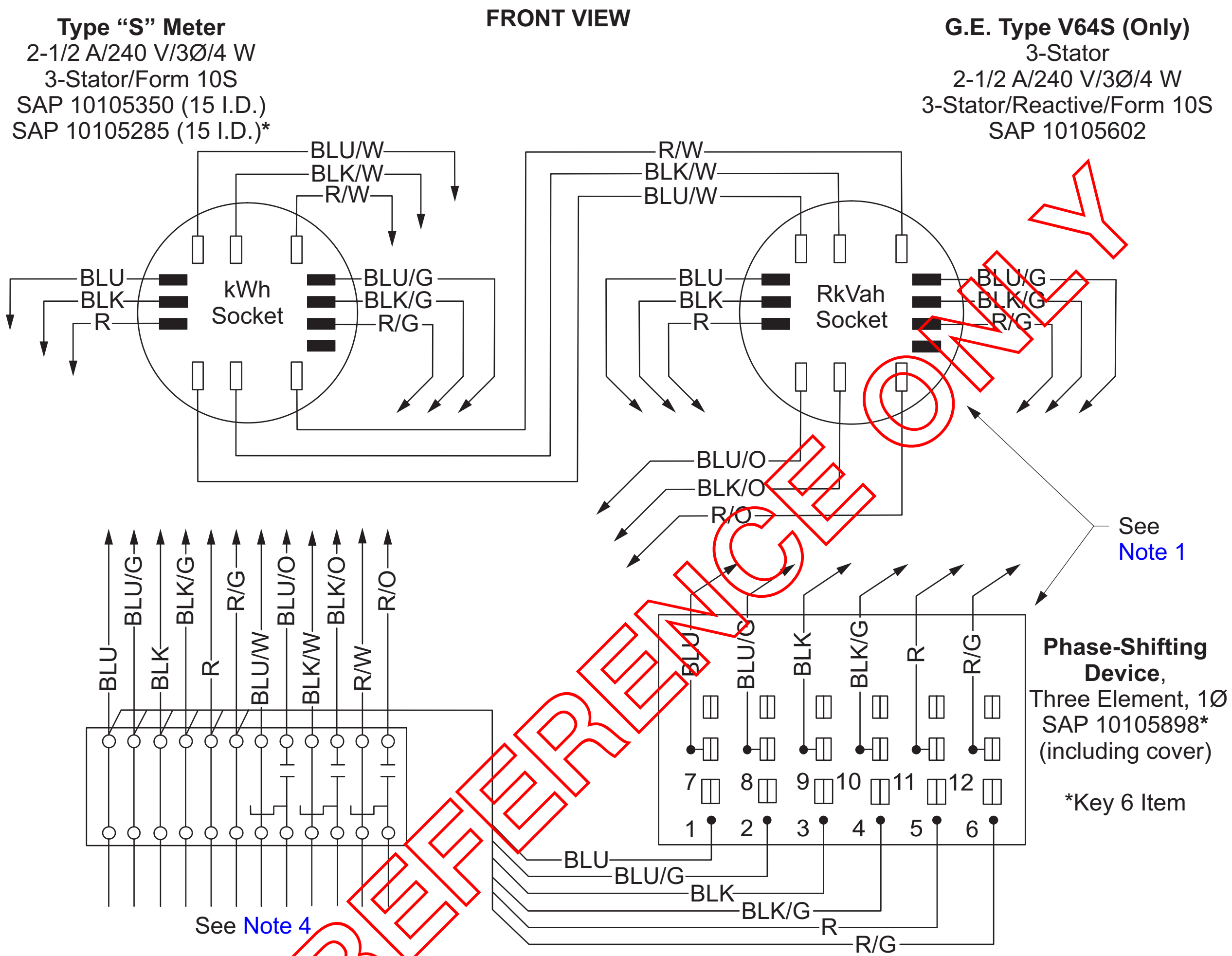
1. If phase rotation is incorrect, use Method #3 (for 4-wire) on T 70 to correct.
2. The multiplying constant for the meter is the nameplate ratio of the CTs multiplied by the dial constant of the meter multiplied by the following applicable factor:

Type of CTs Used	kWh Meter	RkVAh Meter
2-Wire	1/2	1
3-Wire	1	2

3. Use this drawing only if each circuit is sourced from a separate primary phase. If sourced from one or two phases, use T 555.3 (Sheet 3).
4. See T 555.1 (Sheet 1) or T 556 for secondary connections.

Scope T 555.3 **Metering for Totalizing Three 120/240 V, 1Ø, 3-Wire Services (Each Circuit not on Separate Primary Phase) Using 3-Stator Demand and RkVAh Meters with Current Transformers**

Figure T 555–3: Totalizing Three 120/240 V, 1Ø, 3-Wire Services (Each Circuit not on Separate Primary Phase) Using 3-Stator Demand and RkVAh Meters with Current Transformers



Note(s):

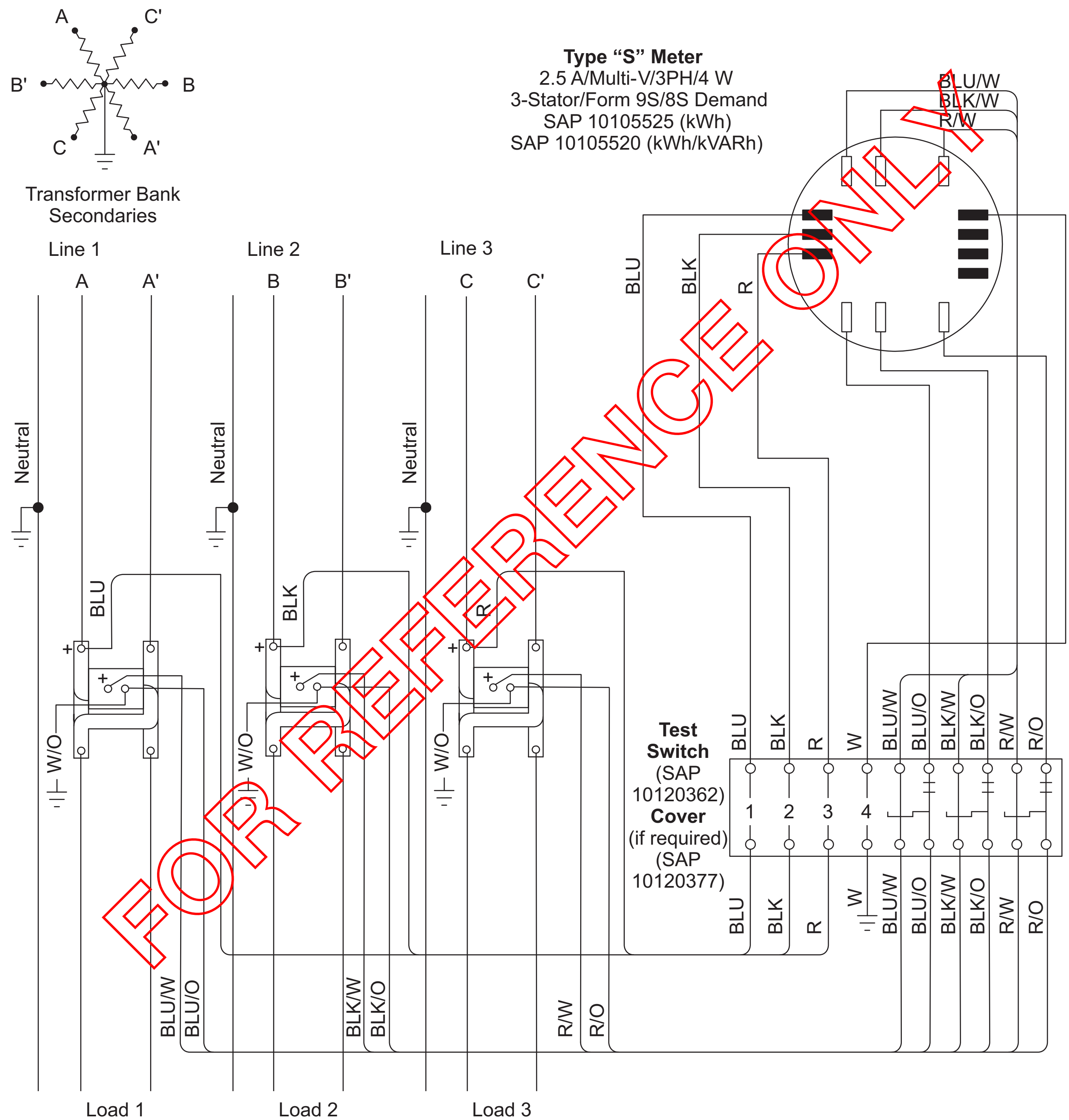
1. Meter and phase-shifting device must be ordered together on a form SD 196 marked “transfer” and request calibration as a unit in SSID Meter Shop.
2. The multiplying constant for the meter is the nameplate ratio of the CTs multiplied by the dial constant of the meter multiplied by the following applicable factor:

Type of CTs Used	Factor
2-Wire	1/2
3-Wire	1

3. Use this drawing only if each circuit is not sourced from a separate primary phase. If sourced from separate primary phases, useT 555.2 (Sheet 2).
4. See T 555.1 (Sheet 1) or T 556 for secondary connections.

Scope T 555.4 **Totalizing Three 120/240 V 1Ø, 3-Wire Services Using Three 3-Wire CTs and a 3-Stator 9S Meter Sourced from Separate Phases**

Figure T 555–4: Totalizing Three 120/240 V, 1Ø, 3-Wire Services Using Three 3-Wire CTs and a 3-Stator kWh or kWh/kVARh 9S Meter Sourced from Separate Phases



Note(s):

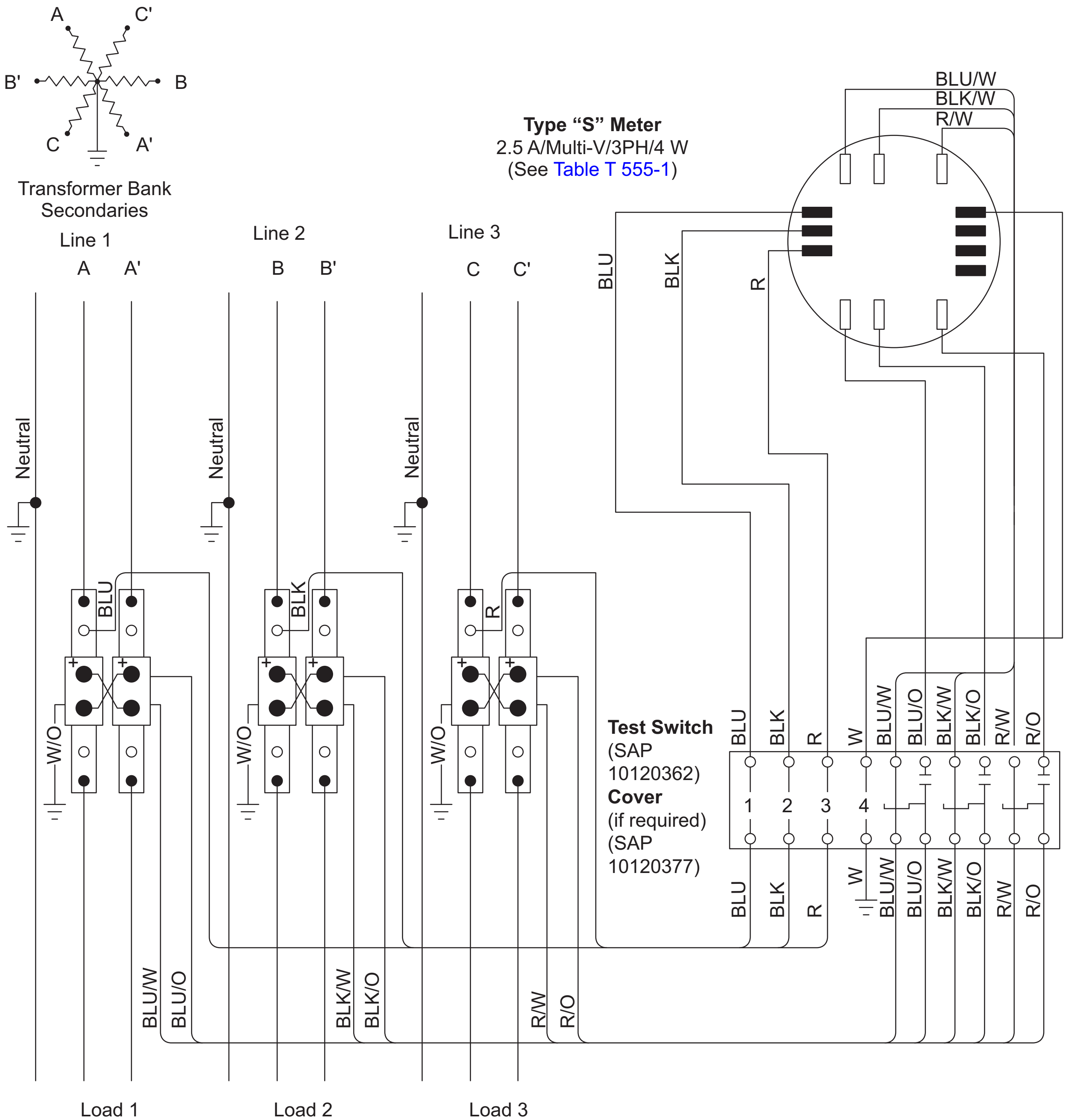
1. Use this drawing only if each circuit is sourced from separate primary phases. If sourced from the same primary phase, see T 555.6 (Sheet 8) and T 555.7 (Sheet 10).
2. Polarity marks on 3-wire CTs vary in position. Regardless of the position of the polarity marks (either right or left terminal), follow the above connections schematically and attach the polarity leads to the polarity terminals.
3. All CTs must have the same ratio.
4. See T 65 for additional polarity information.
5. The multiplying constant for the meter is the nameplate ratio of the CTs, multiplied by the dial constant of the meter, multiplied by the following applicable factor of 2.
6. Note that the application factor is used due to the meter being energized at 120 V instead of 240 V.
7. Affix Metered Voltage and Totalizing stickers to the meter panel, two inches below the meter's rim. See T 75 for sticker selection.

CAUTION **The voltages between polarities (1, 2, and 3) at the test switch MUST be approximately 208 V.**

8. For all new totalized metering installations and any existing installations where the above service conditions cannot be met, wire each service panel separately per T 152, and software totalize by using three IDR meters.

Scope T 555.5 **Totalizing Three 120/240 V, 1Ø, 3-Wire Services Using Six 2-Wire CTs and a 3-Stator 9S Meter Sourced from Separate Phases**

Figure T 555–5: Totalizing Three 120/240 V, 1Ø, 3-Wire Services Using Six 2-Wire CTs and a 3-Stator kWh or kWh/kVARh 9S Meter Sourced from Separate Phases



Totalized Metering — Using Current Transformers

Approved by:

What's Changed? Addition of new 9S ESC meter. Removed MC codes and added SAP numbers.

Effective Date:
10-29-2010

Table T 555–1: Totalizing Three 120/240 V, 1Ø, 3-Wire Services Using Six 2-Wire CTs and a 3-Stator 9S Meter Sourced from Separate Phases

Meter Type	Meter Description	SAP
9S/8S	2.5 A, Multi-V, 4 Wire	10105525
9S ESC[a/]	2.5 A, Multi-V, 4 Wire	10175799

[a/] Edison SmartConnect (ESC)

Note(s):

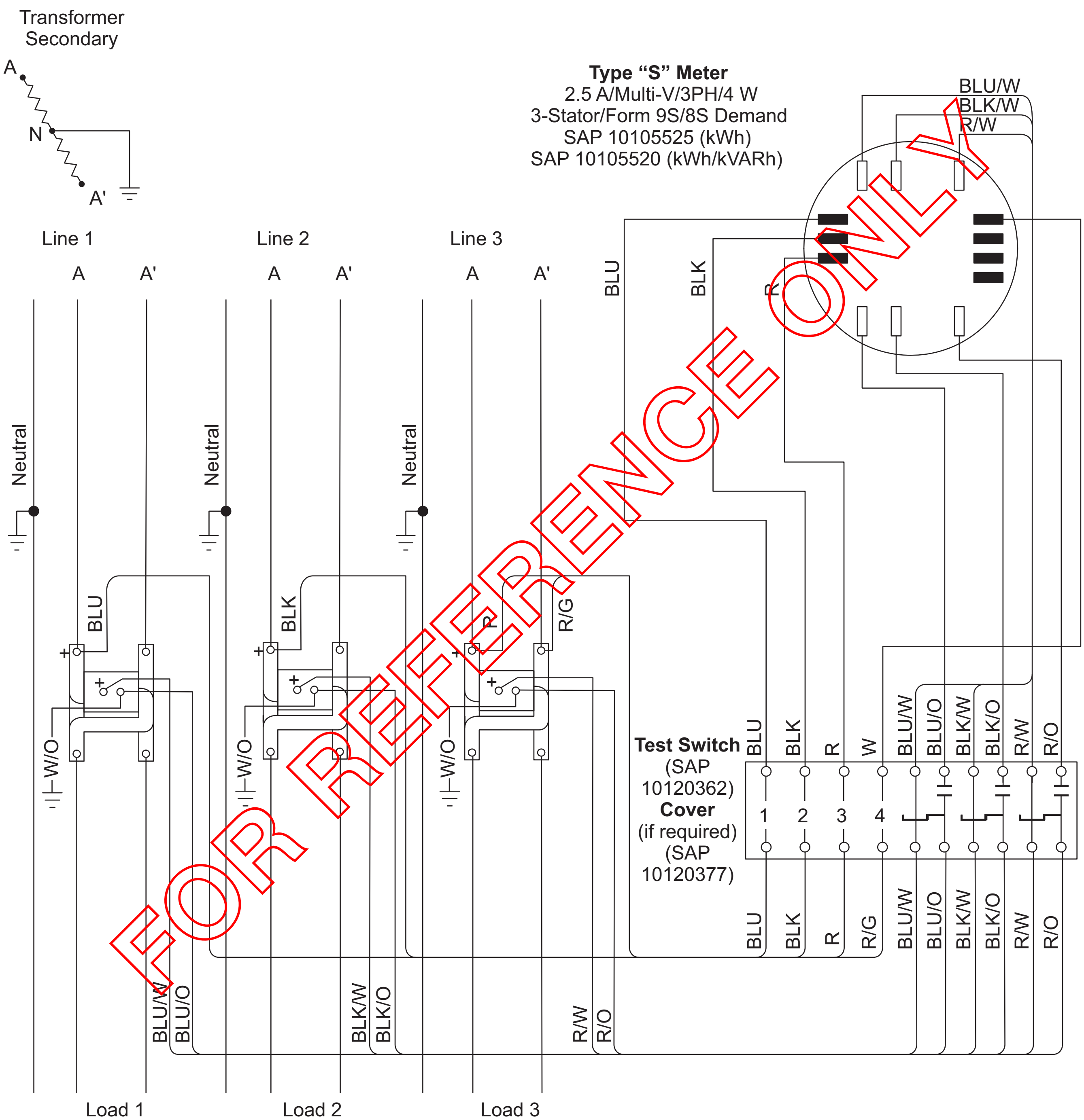
1. Use this drawing only if each circuit is sourced from separate primary phases. If sourced from the same primary phases, see T 555.6 (Sheet 8) and T 555.7 (Sheet 10).
2. All CTs must have the same ratio.
3. See T 65 for additional polarity information.
4. The multiplying constant for the meter is one-half the nameplate ratio of the CTs, multiplied by the dial constant of the meter, multiplied by the following applicable factor of 2.
5. Note that the application factor is used due to the meter being energized at 120 V instead of 240 V.
6. Affix Metered Voltage and Totalizing stickers to the meter panel, two inches below the meter's rim. See T 75 for sticker selection.

CAUTION **The voltages between polarities (1, 2, and 3) at the test switch MUST be approximately 208 V.**

7. For all new totalized metering installations and any existing installations where the above service conditions cannot be met, wire each service panel separately per T 155 and software totalize by using three IDR meters.

Scope T 555.6 **Totalizing Three 120/240 V, 1Ø, 3-Wire Services Using Three 3-Wire CTs and a 3-Stator 9S Meter Sourced by a Single Transformer**

Figure T 555–6: Totalizing Three 120/240 V, 1Ø, 3-Wire Services Using Three 3-Wire CTs and a 3-Stator kWh or kWh/kVARh 9S Meter Sourced by a Single Transformer

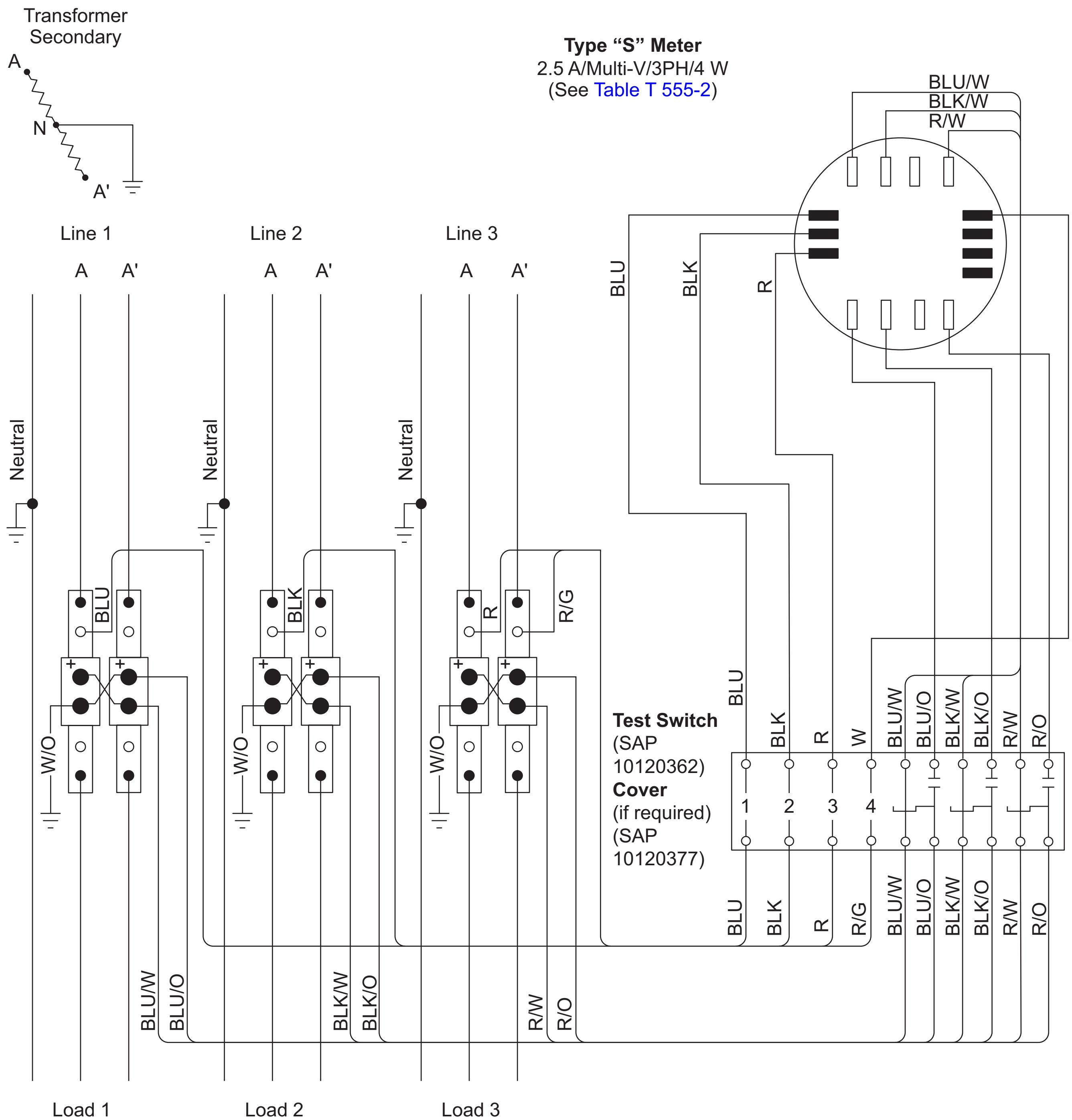


Note(s):

1. Use this drawing only if each circuit is sourced from the same primary phase. If sourced from separate primary phases, see T 555.4 (Sheet 4) and T 555.5 (Sheet 6).
2. Polarity marks on 3-wire CTs vary in position. Regardless of the position of the polarity marks (either right or left terminal), follow the above connections schematically and attach the polarity leads to the polarity terminals.
3. All CTs must have the same ratio.
4. See T 65 for additional polarity information.
5. The multiplying constant for the meter is the nameplate ratio of the CTs multiplied by the dial constant of the meter.
6. Affix "Metered Voltage" and "Totalizing" stickers to the meter panel, two inches below the meter's rim. See T 75 for sticker selection.
7. For all new totalized metering installations and any existing installations where the above service conditions cannot be met, wire each service panel separately per T 152, and software totalize by using three IDR meters.

Scope T 555.7 **Totalizing Three 120/240 V, 1Ø, 3-Wire Services Using Six 2-Wire CTs and a 3-Stator 9S Meter Sourced by a Single Transformer**

Figure T 555–7: Totalizing Three 120/240 V, 1Ø, 3-Wire Services Using Six 2-Wire CTs and a 3-Stator kWh/kVARh 9S Meter Sourced by a Single Transformer



Totalized Metering — Using Current Transformers

Approved by:

What's Changed? Addition of new 9S ESC meter. Removed MC codes and added SAP numbers.

Effective Date: 10-29-2010

Table T 555–2: Totalizing Three 120/240 V, 1Ø, 3-Wire Services Using Six 2-Wire CTs and a 3-Stator 9S Meter Sourced by a Single Transformer

Meter Type	Meter Description	SAP
9S/8S	2.5 A, Multi-V, 4 Wire	10105525
9S ESC[a/]	2.5 A, Multi-V, 4 Wire	10175799

[a/] Edison SmartConnect (ESC)

Note(s):

1. Use this drawing only if each circuit is sourced from the same primary phase. If sourced from separate primary phases, see T 555.4 (Sheet 4) and T 555.5 (Sheet 6).
2. All CTs must have the same ratio.
3. See T 65 for additional polarity information.
4. The multiplying constant for the meter is one-half the nameplate ratio of the CTs, multiplied by the dial constant of the meter.
5. Affix Metered Voltage and Totalizing stickers to the meter panel, two inches below the meter's rim. See T 75 for sticker selection.
6. For all new totalized metering installations and any existing installations where the above service conditions cannot be met, wire each service panel separately per T 155, and software totalize by using three IDR meters.

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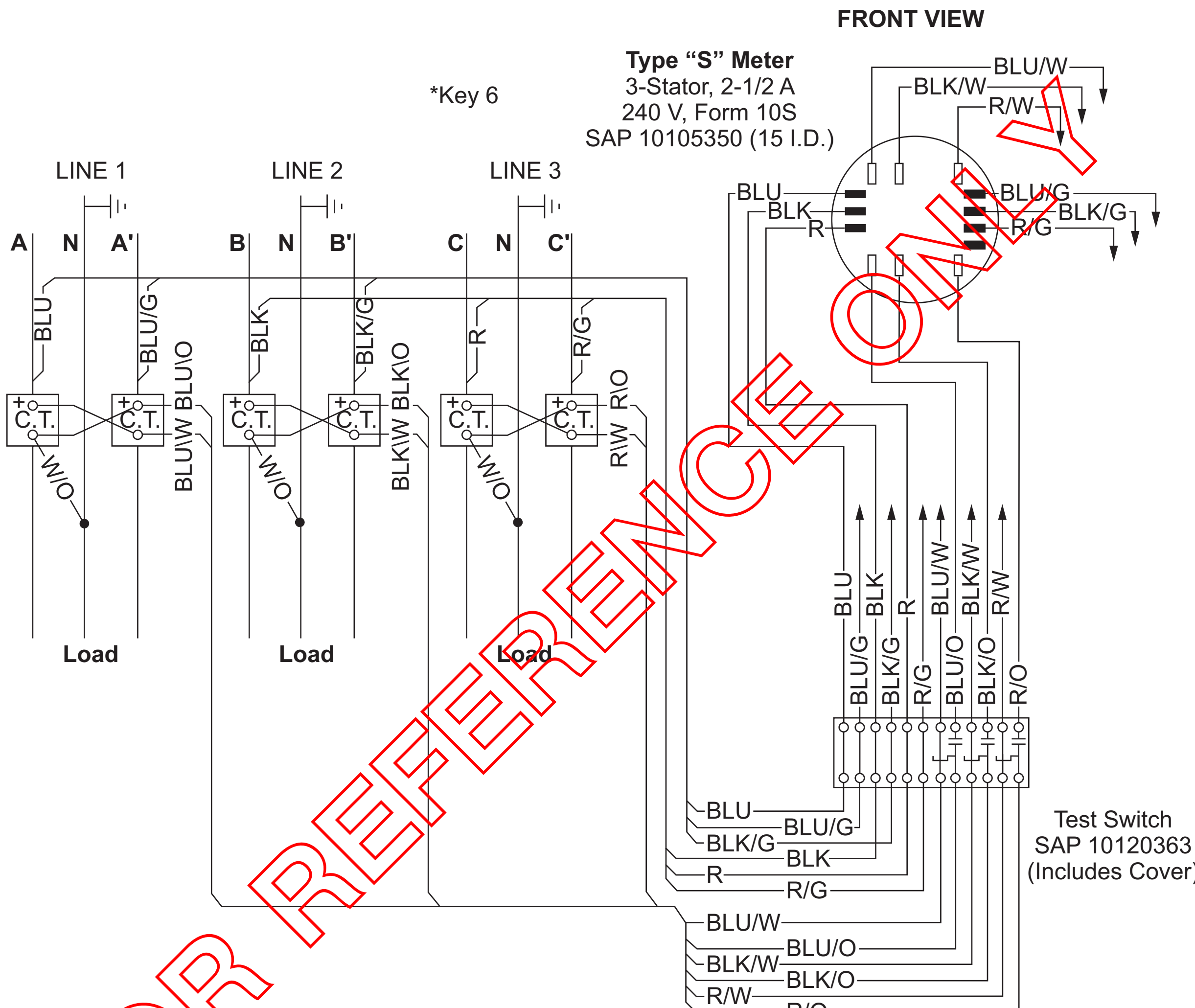
T 556 Totalized Metering — Using Current Transformers

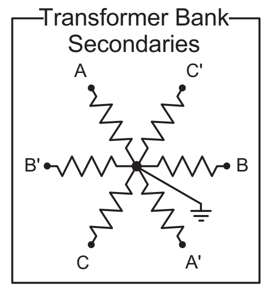
Scope T 556.1 Metering for Totalizing Three 120/240 V, 1Ø, 3-Wire Services Using Six 2-Wire Window-Type CTs and 3-Stator Demand Meter

Figure T 556–1: Totalizing Three 120/240 V, 1Ø, 3-Wire Services Using Six 2-Wire Window-Type CTs and 3-Stator Demand Meter



Note(s):

1. All CTs must have the same ratio.
2. The multiplying constant of the meter is one-half the nameplate ratio of the CTs multiplied by the dial constant of the meter.
3. For additional polarity information, see T 65.
4. For window CT mounting instructions, see T 64.



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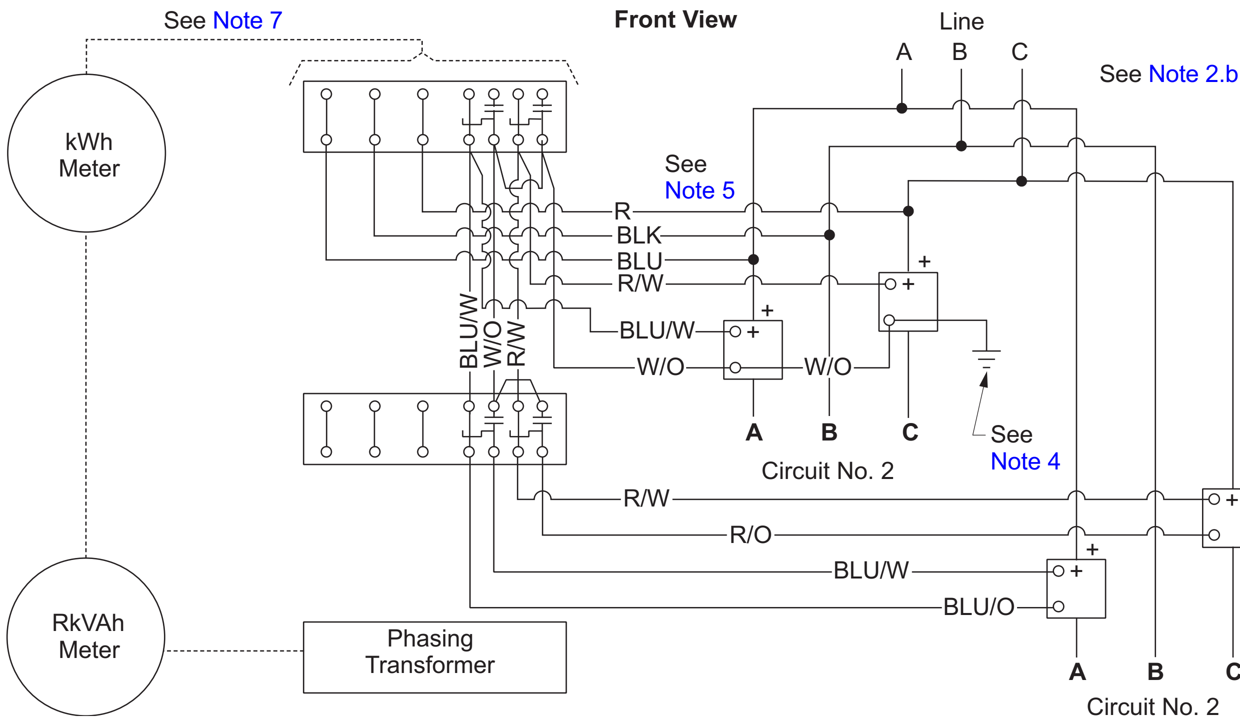
T 559 Totalized Metering — Using Current Transformers

Scope T 559.1 Metering for Totalizing Two 240/480 V, 3Ø, 3-Wire Services by Paralleling Current Transformers

Figure T 559–1: Totalizing Two 240/480 V, 3Ø, 3-Wire Services by Paralleling Current Transformers



Note(s):

1. The 480 V, 3-wire service to be supplied only from an ungrounded 3Ø system or bank or as authorized by Customer Service engineering staff.
2. This metering method for paralleling CT installations shall be used only when all of the following service conditions can be met:
   a. The two CT compartments are less than 15 feet apart (unobstructed walking distance).
   b. Both circuits are fed from a single transformer bank.
   c. The two service entrance circuits are of approximately equal capacity and length (25 feet maximum).
   d. The secondary raceway between the remote CT compartment and the meter panel shall be less than 15 feet in length. A 1-1/4-inch minimum conduit shall be provided for this purpose. Use only modern CTs of the same make, type, and ratio.
3. Only one ground permitted on CT secondaries. Use #12 wire minimum.
4. Potential taps from CT compartment nearest meter panel.
5. For meter panel layout refer to Electrical Service Requirements (ESR) Manual.
6. On installations where the above service conditions cannot be met, each service panel shall be wired separately per T 356 and software totalized by using two IDR meters.
7. See T 356 for meter connections.

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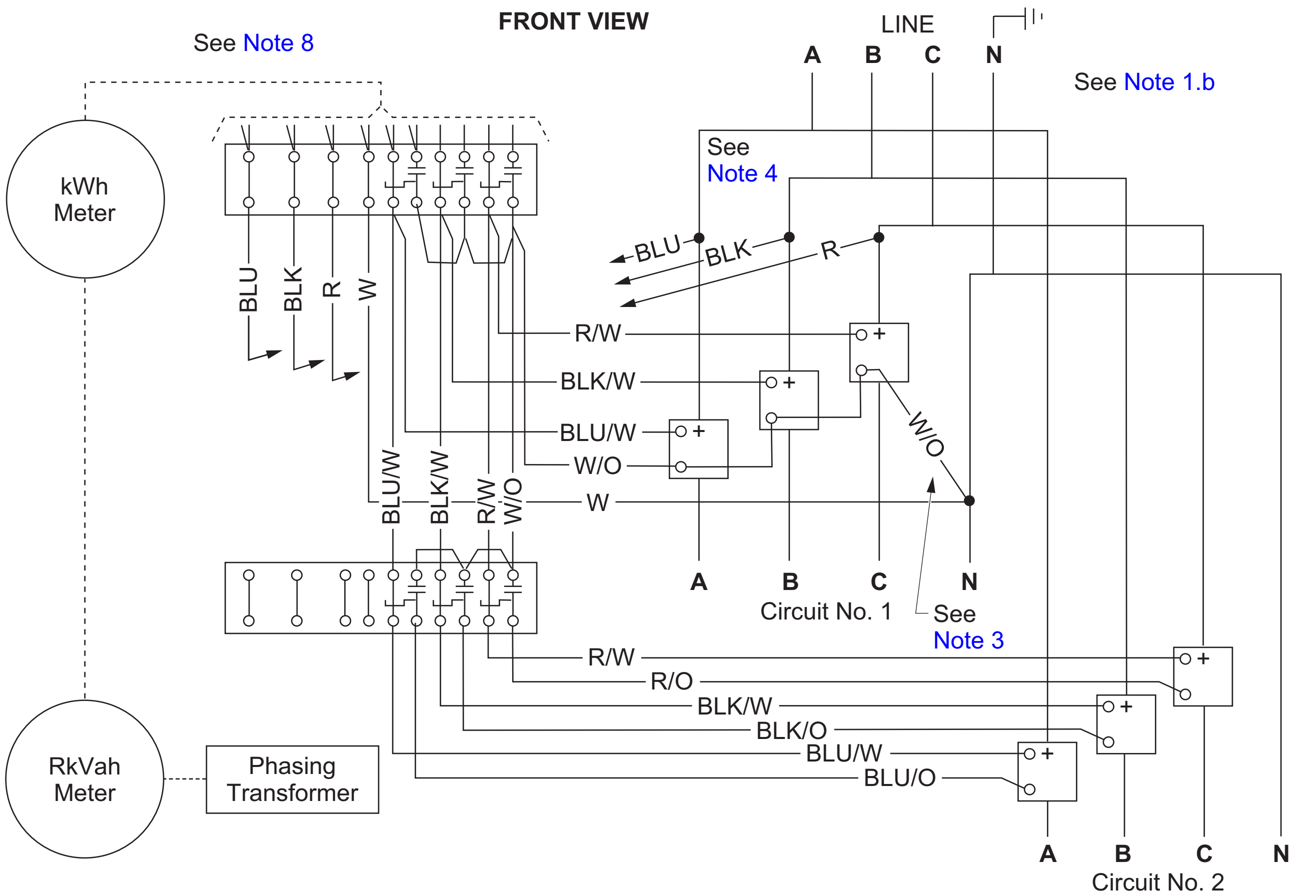
T 560 Totalized Metering — Using Current Transformers

Scope T 560.1 Metering for Totalizing Two 120/208 V or 277/480 V, 3Ø, 4-Wire Services by Paralleling Current Transformers

Figure T 560–1: Totalizing Two 120/208 V or 277/480 V, 3Ø, 4-Wire Services by Paralleling Current Transformers



Note(s):

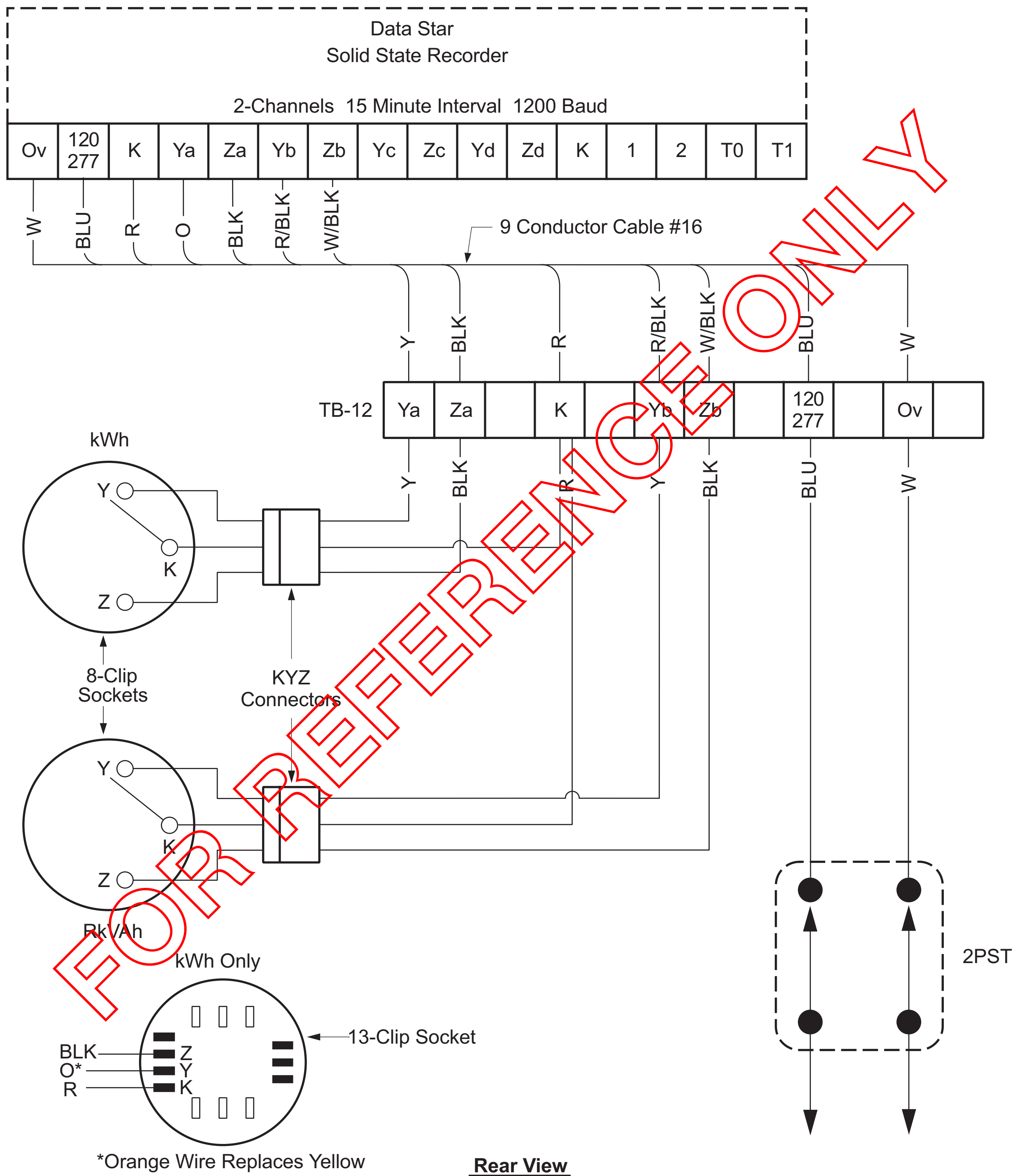
1. This metering method for paralleling CT installations shall be used only when all of the following service conditions can be met:
   a. The two CT compartments are less than 15 feet apart (unobstructed walking distance).
   b. Both circuits are fed from a single transformer bank.
   c. The two service entrance circuits are of approximately equal capacity and length (25 feet maximum).
   d. The secondary raceway between the remote CT compartment and the meter panel shall be less than 15 feet in length. A 1-1/4 inch minimum conduit shall be provided for this purpose. Only one ground permitted on CT secondaries. Use #12 wire minimum.
2. Use only modern CTs of the same make, type, ratio, and rating factor.
3. Only one neutral connection permitted on CT secondaries. Use #12 wire minimum.
4. Potential taps from CT compartment nearest meter panel.
5. For meter panel layout refer to ESR, Chapter 5.

6. Ground fault protection is required on low-voltage, grounded electrical Wye services of more than 150 volts to ground when the service disconnecting mean is rated less than 1000 A or more (N.E.C. article 230-95), but may be utilized even when the service disconnecting means is rated less than 1000 A.
7. On installations where the above service conditions cannot be met, each service panel shall be wired separately per T 451 and software totalized by using two IDR meters.
8. See T 451 for meter connections.

T 650 Metering Using Pulse Initiators — Wiring Diagrams

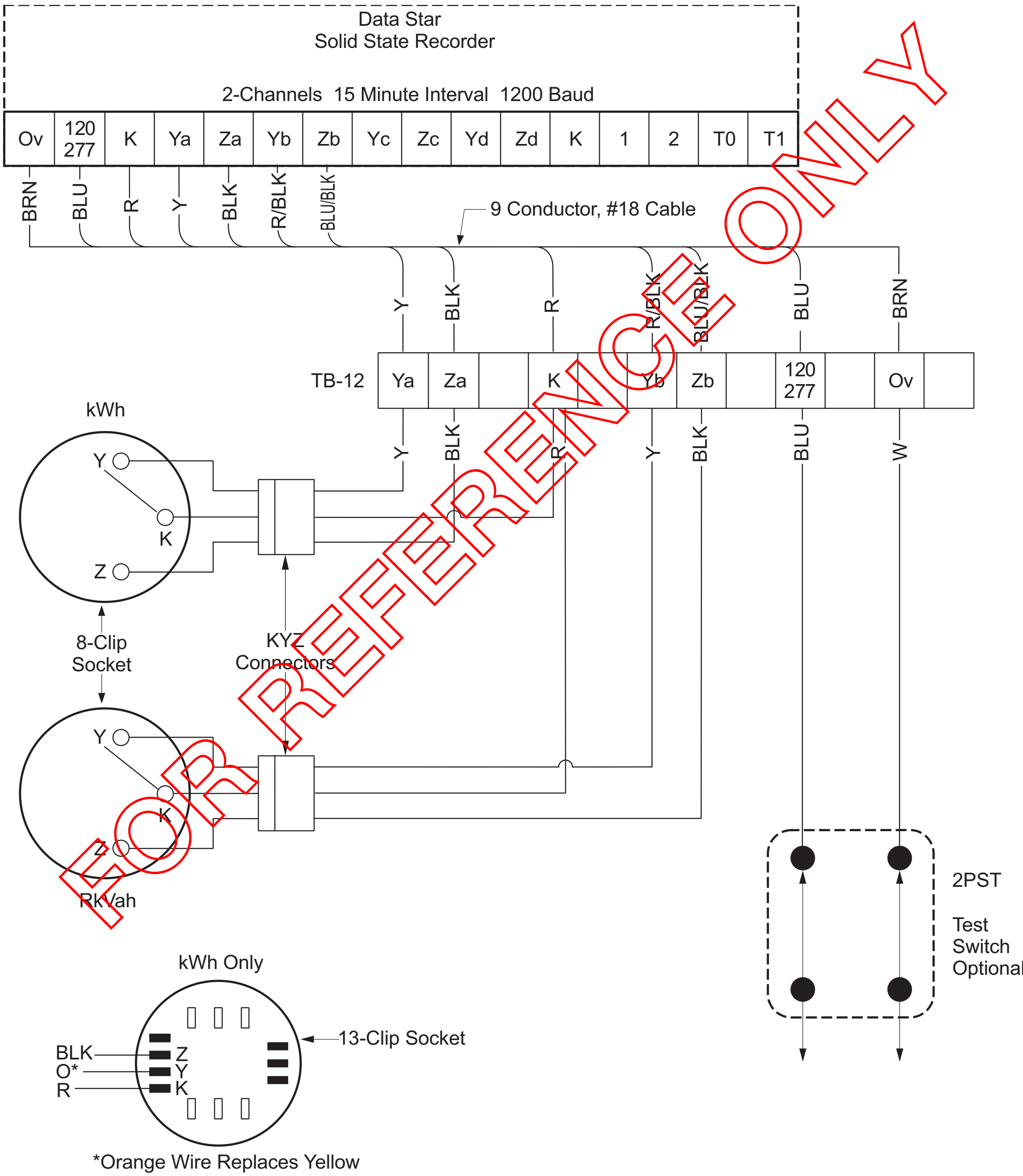
Scope T 650.1 Single Circuit Using Data Star Recorder

Figure T 650–1: Single Circuit Using Data Star Recorder



Scope T 650.2 Single Circuit Using Data Star Recorder

Figure T 650–2: Single Circuit Using Data Star Recorder



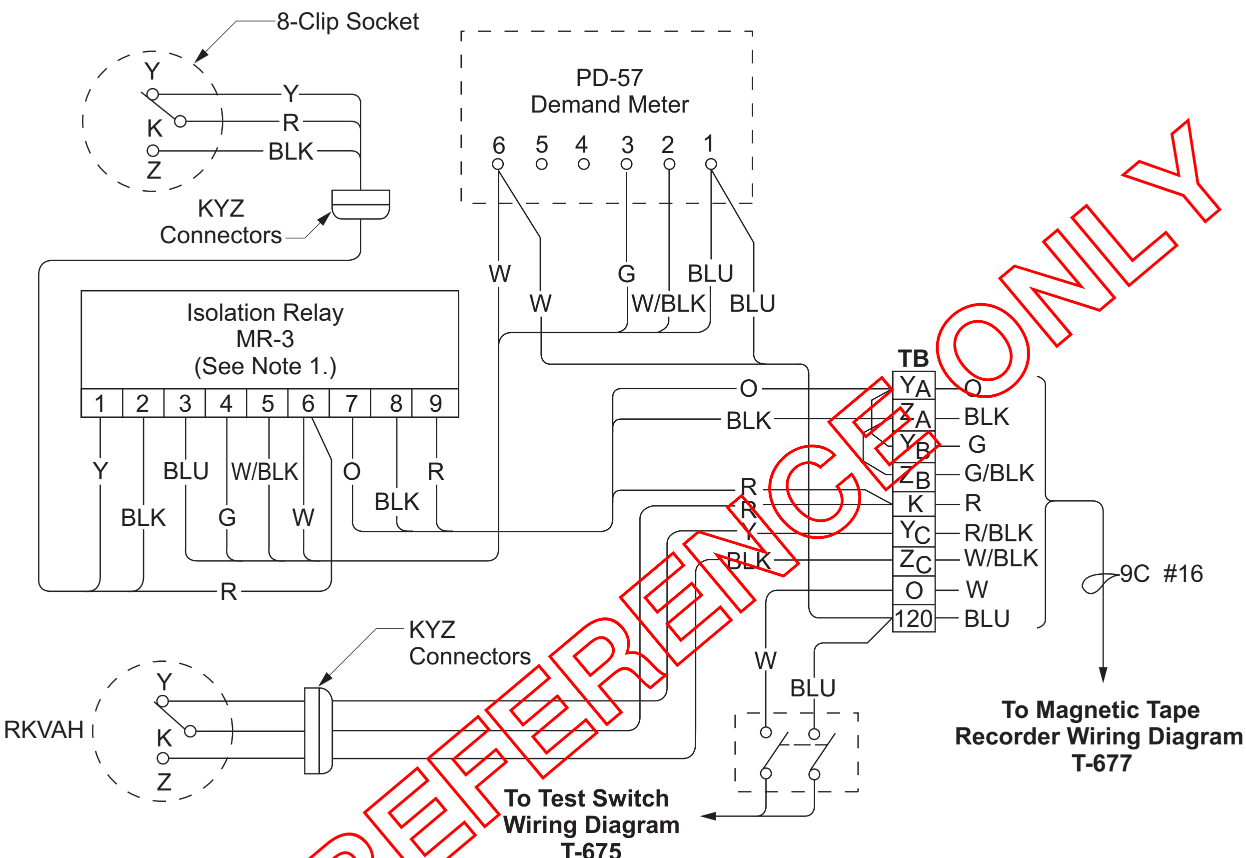
Rear View

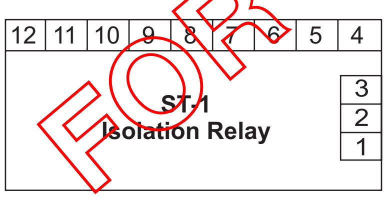
T 652 **Metering Using Pulse Initiators — Wiring Diagrams**

Scope T 652.1 **Single Circuit Using Tape Recorder and Printing Demand — Wiring Diagram**

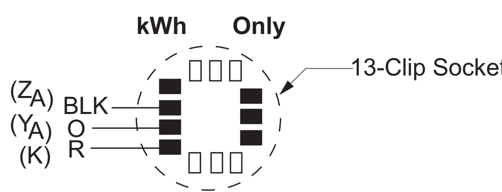
Figure T 652–1: Single Circuit Using Tape Recorder and Printing Demand — Wiring Diagram

Rear Views





Can be Substituted for MR-3 Relay, Use Same Numbered Terminals



Orange Wire Replaces Yellow

Note(s):

1. The MR-3 relay may be substituted by an ST-1 relay.

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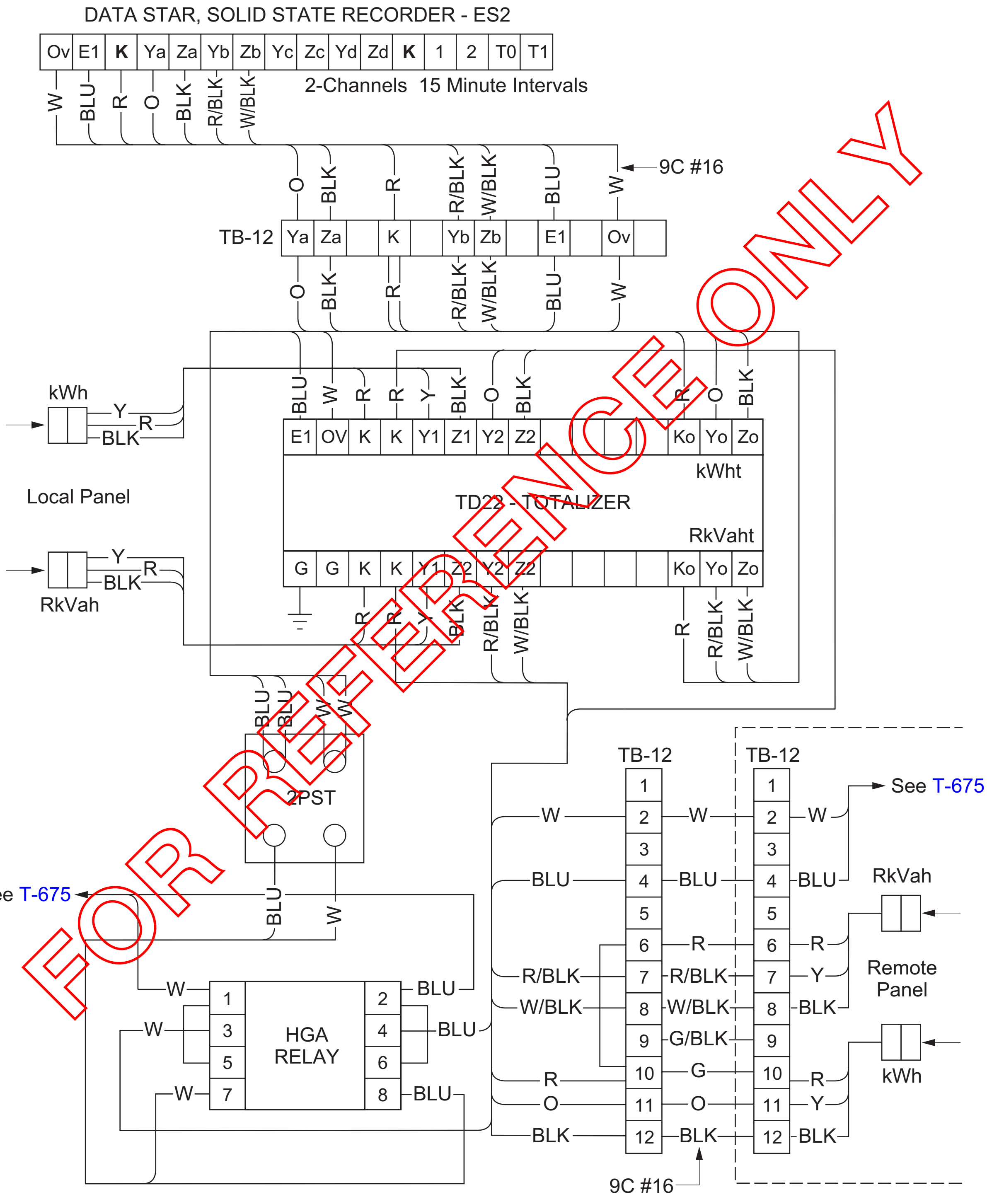
T 654 Metering Using Pulse Initiators — Wiring Diagrams

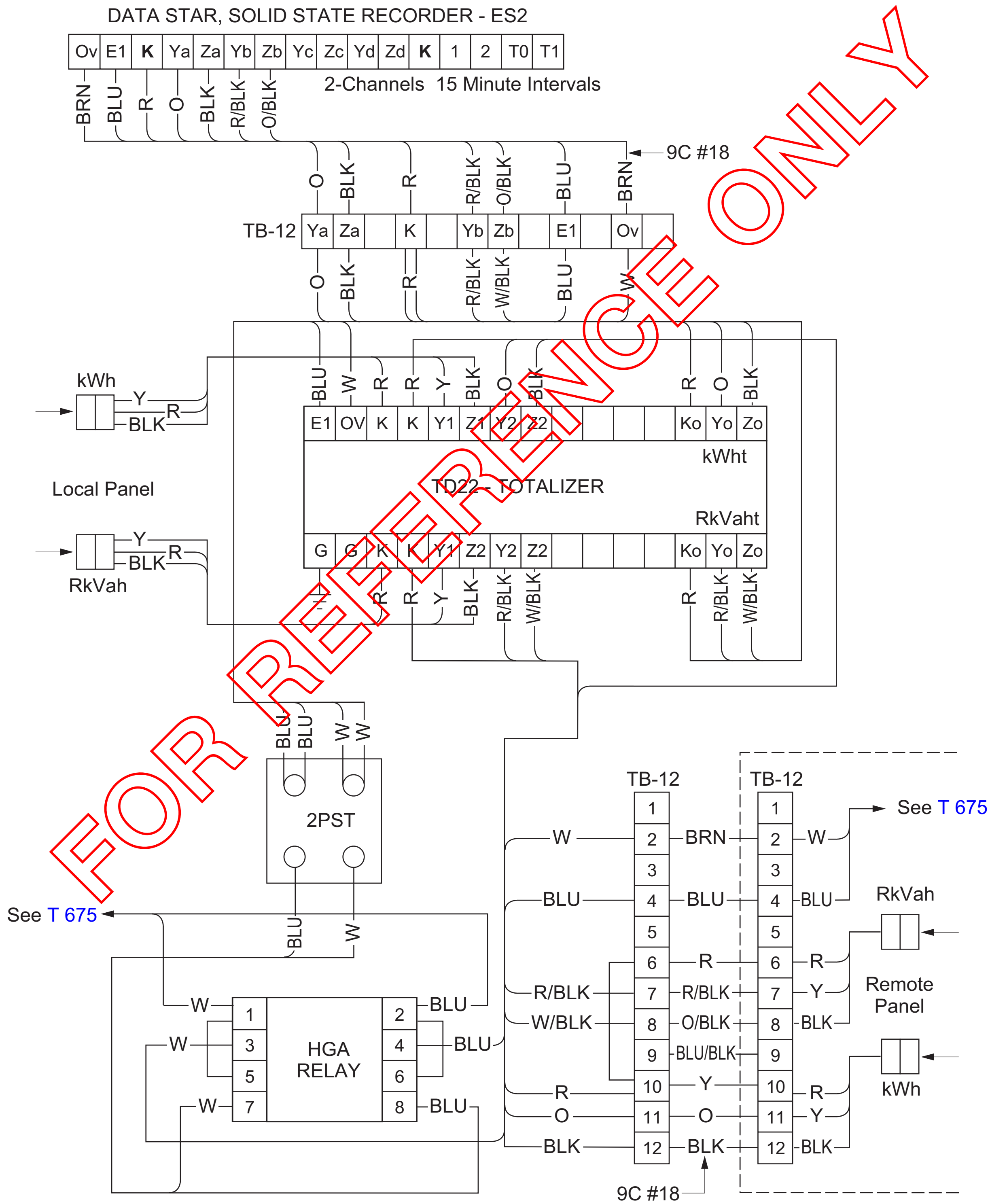
Scope T 654.1 Two-Circuit Using Data Star Recorder and TD22 (FRO)

Figure T 654–1: Two-Circuit Using Data Star Recorder and TD22 (FRO)



Scope T 654.2 Two-Circuit Using Data Star Recorder and TD22

Figure T 654–2: Two-Circuit Using Data Star Recorder and TD22



Metering Using Pulse Initiators — Wiring Diagrams

What's Changed?

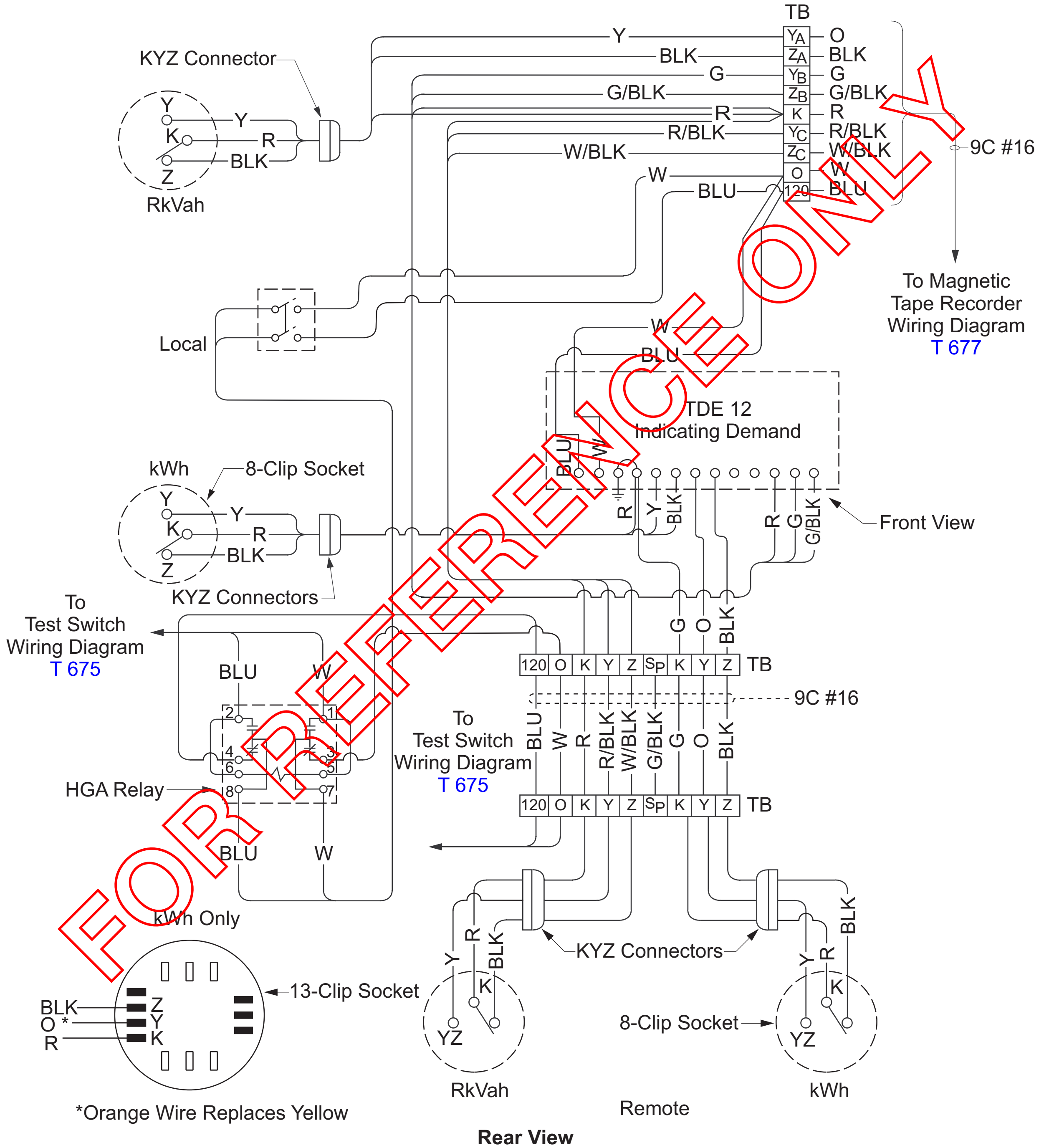
Approved by:

Effective Date: 07-27-2007

T 655 Metering Using Pulse Initiators — Wiring Diagrams

Scope T 655.1 Typical Two Circuit Tape Recorder and TDE-12 Indicating Demand (Wiring Diagram)

Figure T 655–1: Two Circuit Using Tape Recorder and TDE-12 Indicating Demand (Wiring Diagram)



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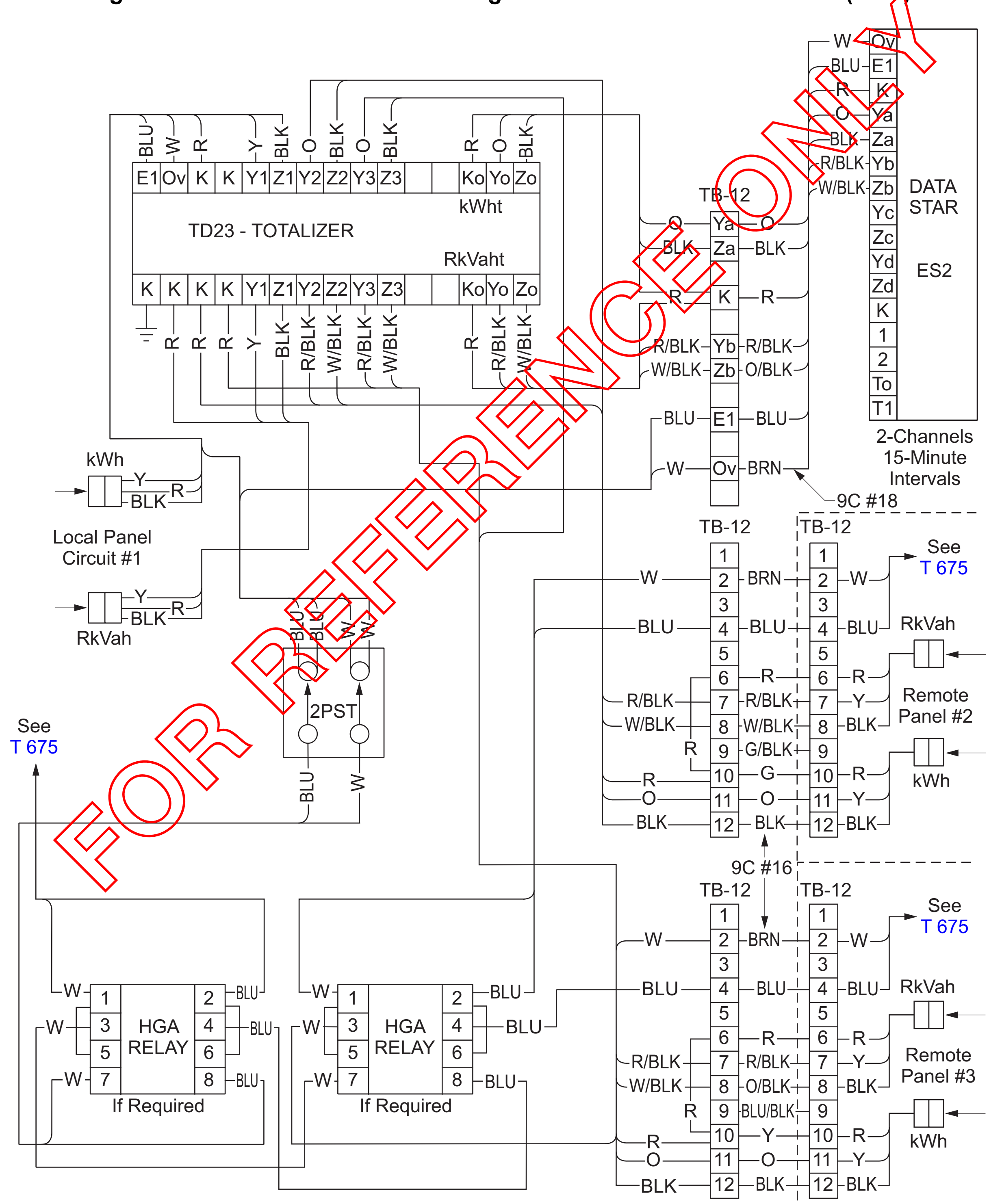
T 658 Metering Using Pulse Initiators — Wiring Diagrams

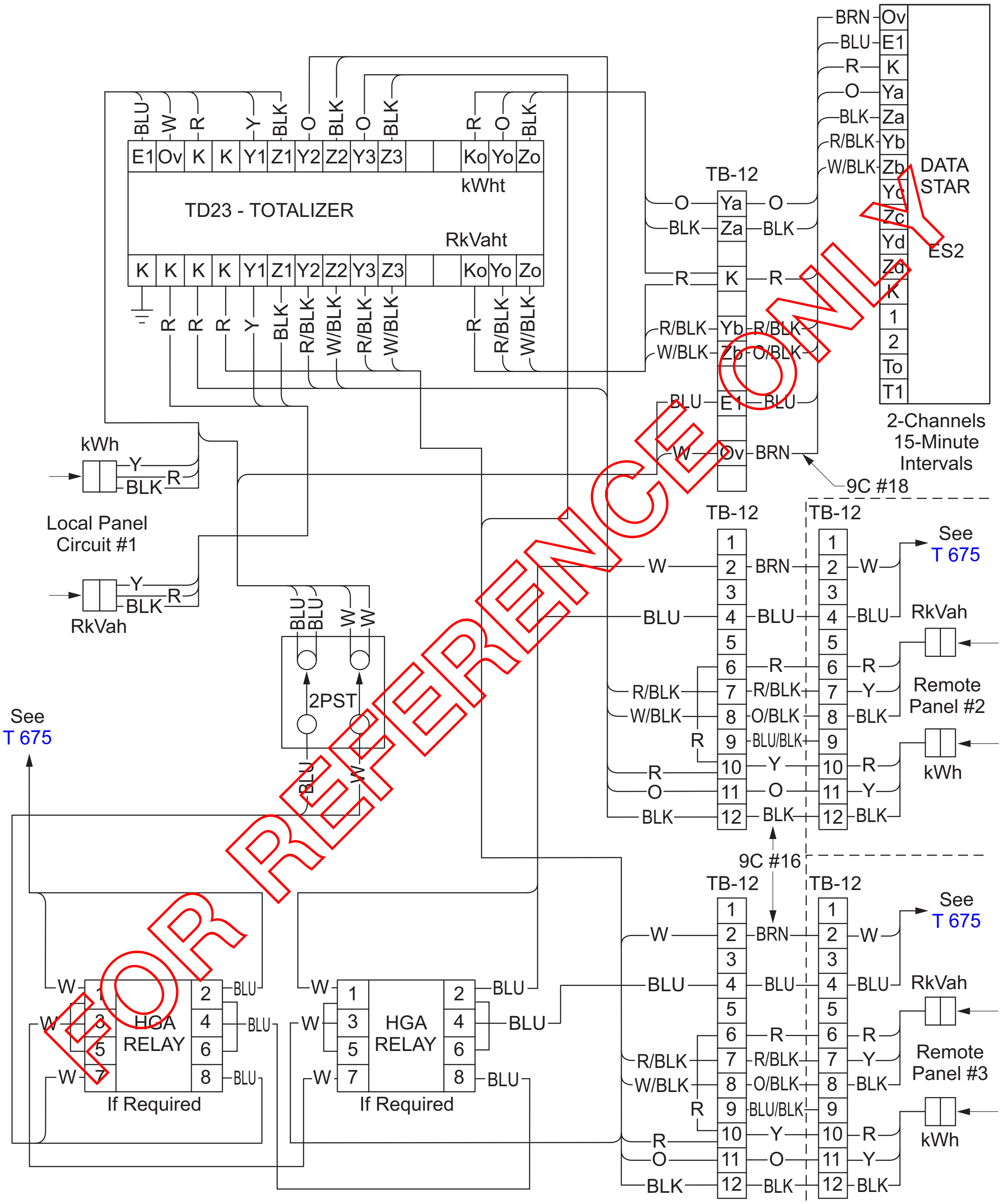
Scope T 658.1 Three Circuits Using Data Star Recorder and TD23 (FRO)

Figure T 658–1: Three Circuits Using Data Star Recorder and TD23 (FRO)



Scope T 658.2 Three Circuits Using Data Star Recorder and TD23

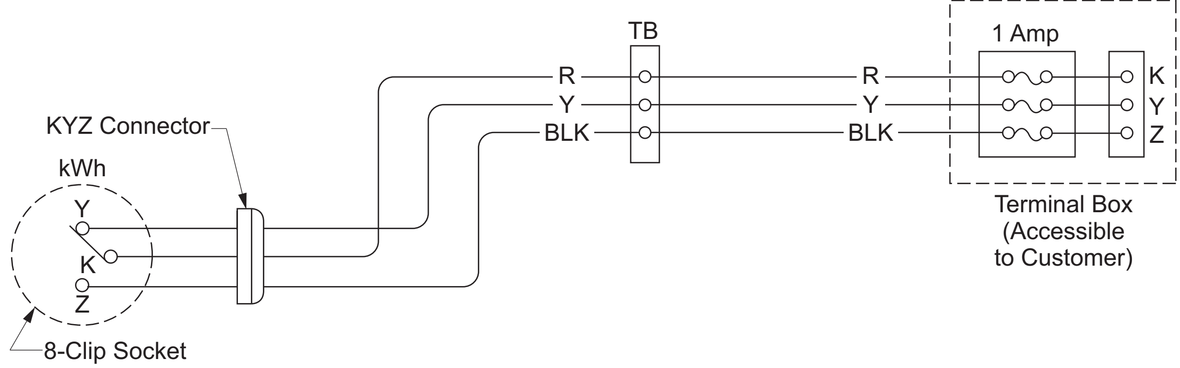
Figure T 658–2: Three Circuits Using Data Star Recorder and TD23

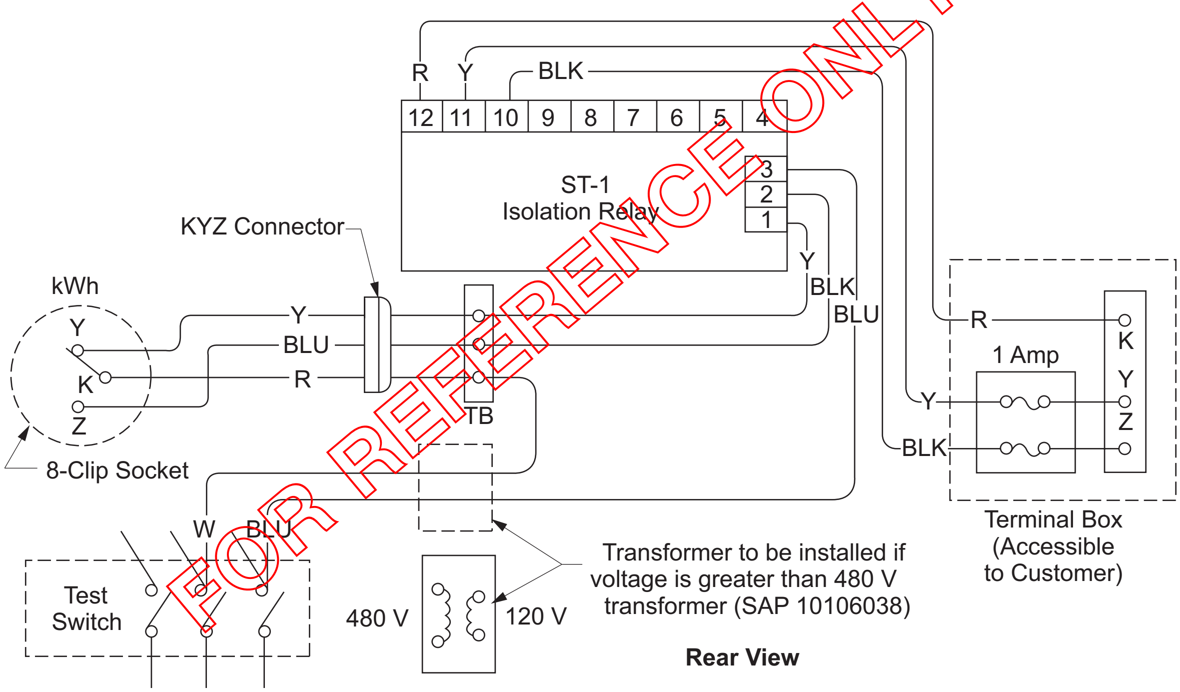


T 670 Metering Using Pulse Initiators — Wiring Diagrams

Scope T 670.1 Customer Pulse Metering (3-Wire, No Tape or Printing Demand)

Figure T 670–1: Customer Pulse Metering (3-Wire, No Tape or Printing Demand)





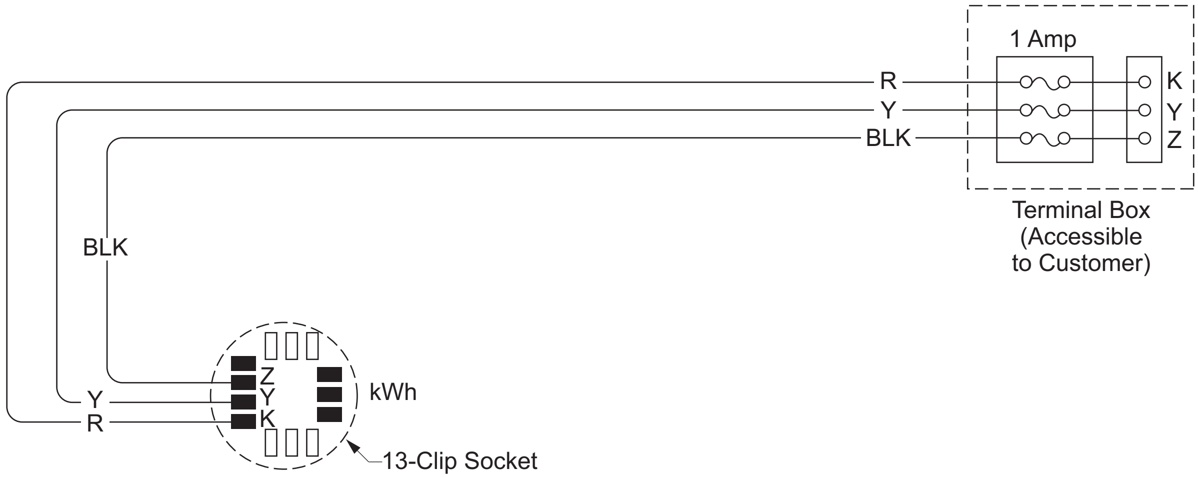
Rear View

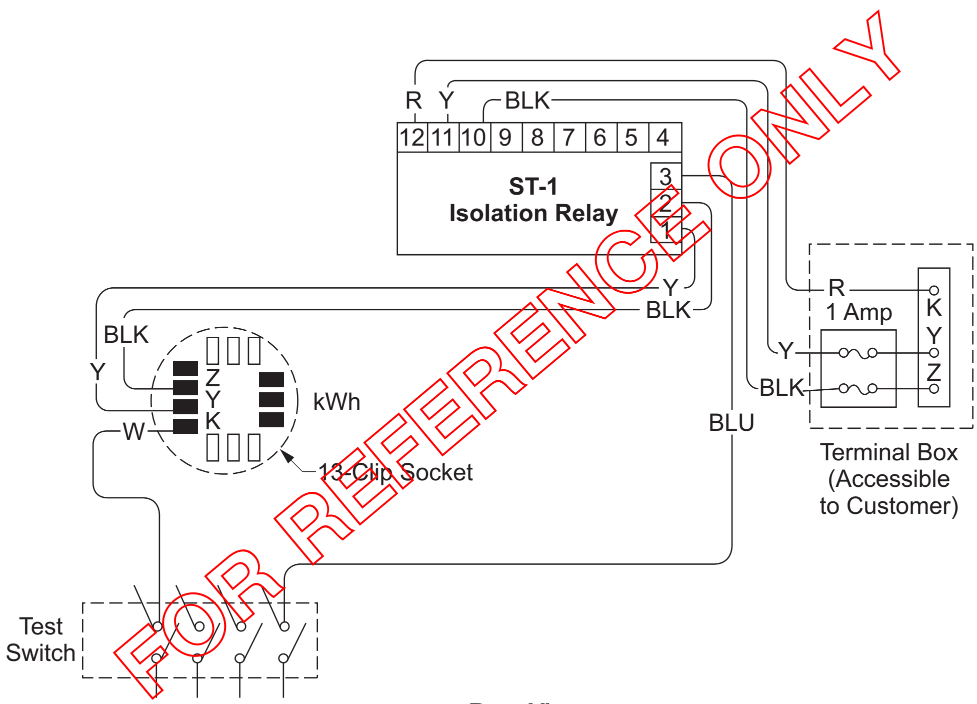
Note(s):

1. All wiring and equipment to be under “seal” except terminal box.
2. Customer contacts (KYZ) are isolated mercury wetted form “C.”

Scope T 670.2 Customer Pulse Metering (4-Wire, No Tape or Printing Demand)

Figure T 670–2: Customer Pulse Metering (4-Wire, No Tape or Printing Demand)





Rear View

Note(s):

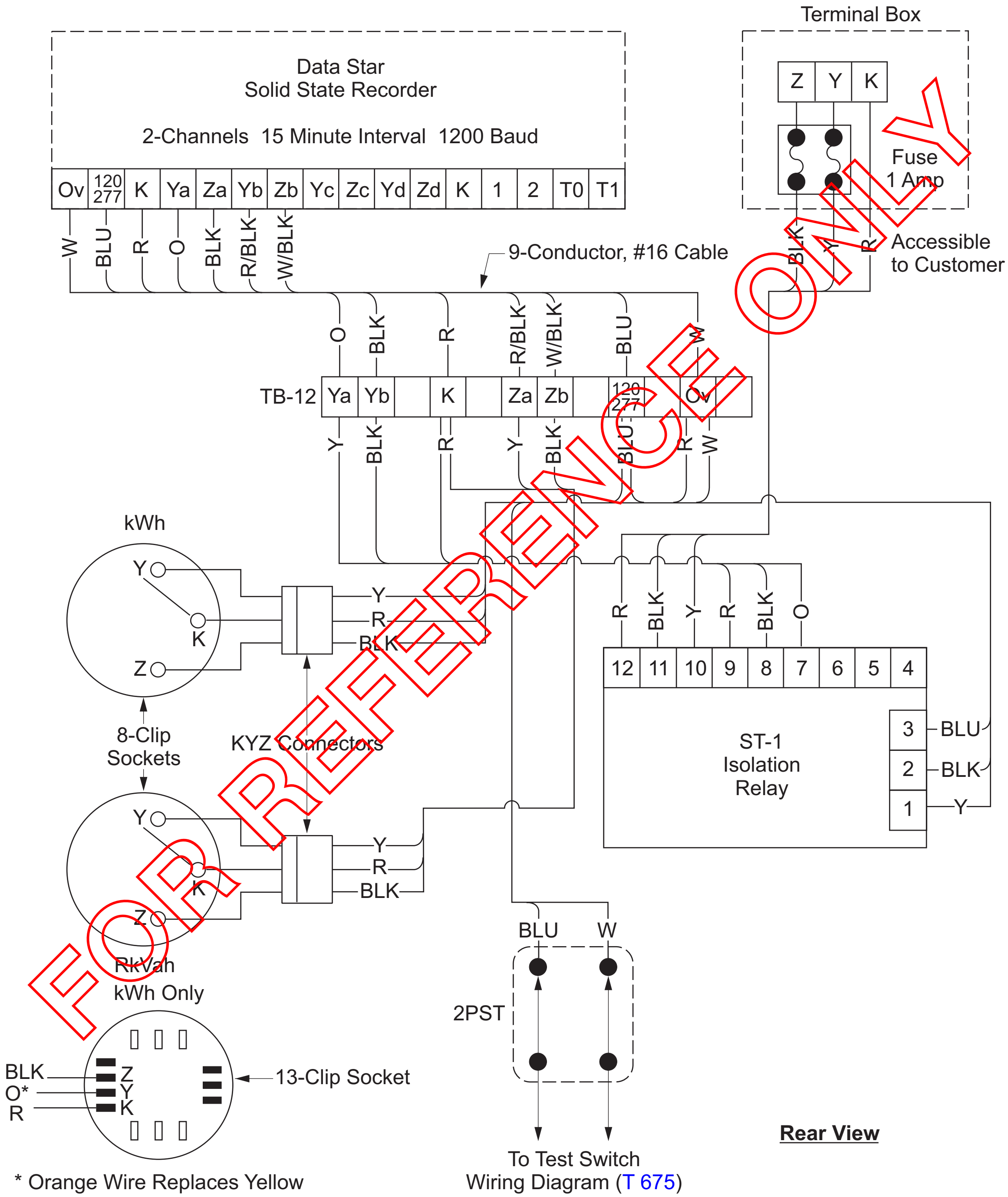
1. All wiring and equipment to be under “seal” except terminal box.
2. Customer contacts (KYZ) are isolated mercury wetted form “C.”

What’s Changed? New figures for customer pulse metering for both 3- and 4-wire have been added to reflect current design criteria. The older figures are retained for reference only.

T 672 Metering Using Pulse Initiators — Wiring Diagrams

Scope T 672.1 Customer Pulse Metering with Recorder (FRO)

Figure T 672–1: Customer Pulse Metering with Recorder (FRO)

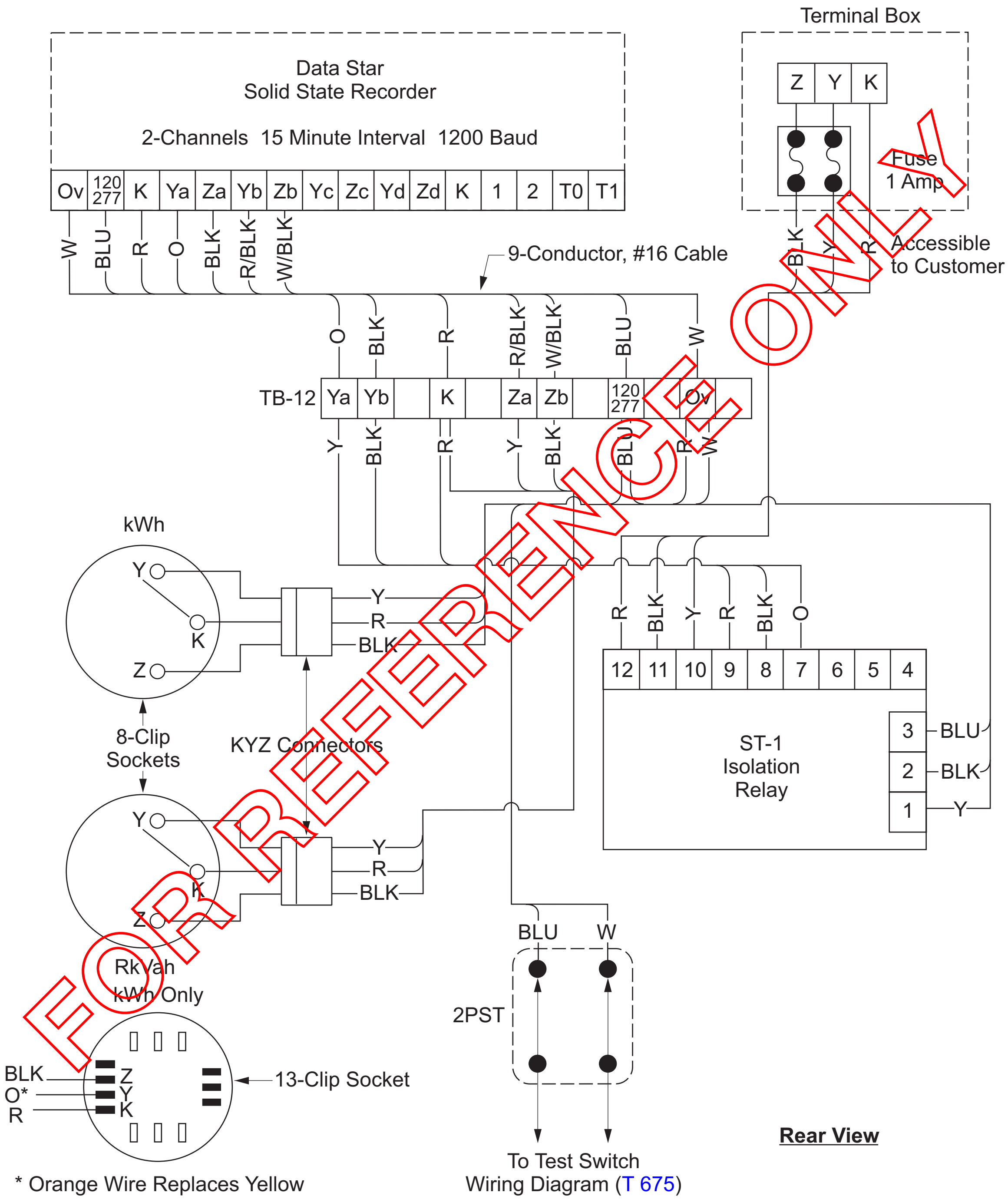


Note(s):

1. All wiring and equipment to be under "seal" except terminal box.

T 672.2 Customer Pulse Metering with Recorder

Figure T 672–2: Customer Pulse Metering with Recorder



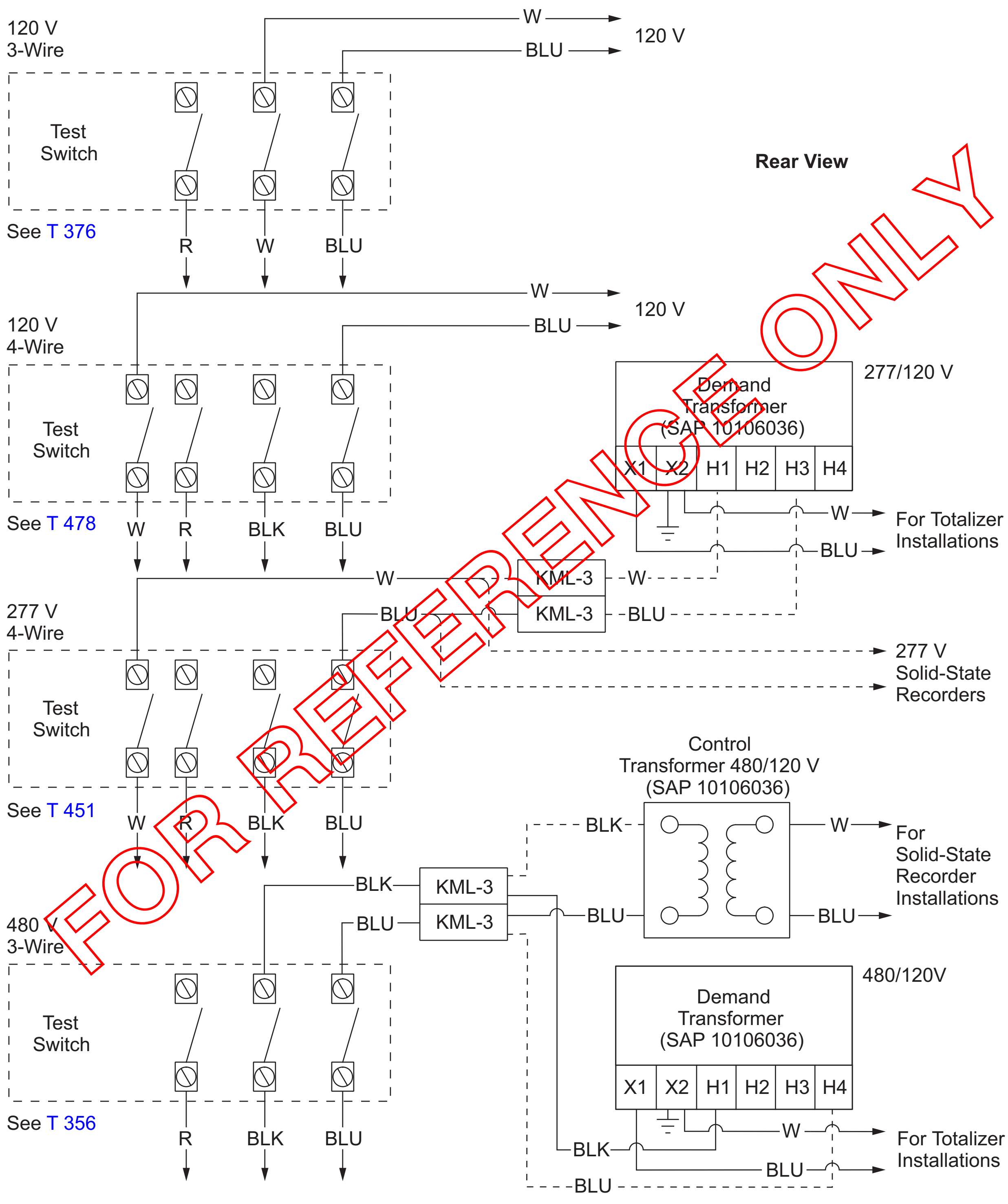
Note(s):

1. All wiring and equipment to be under “seal” except terminal box.

T 675 Metering Using Pulse Initiators — Peripheral Equipment

Scope T 675.1 Pulse Wiring Diagram for TOU-8 Rate Test Switch Wiring Diagrams

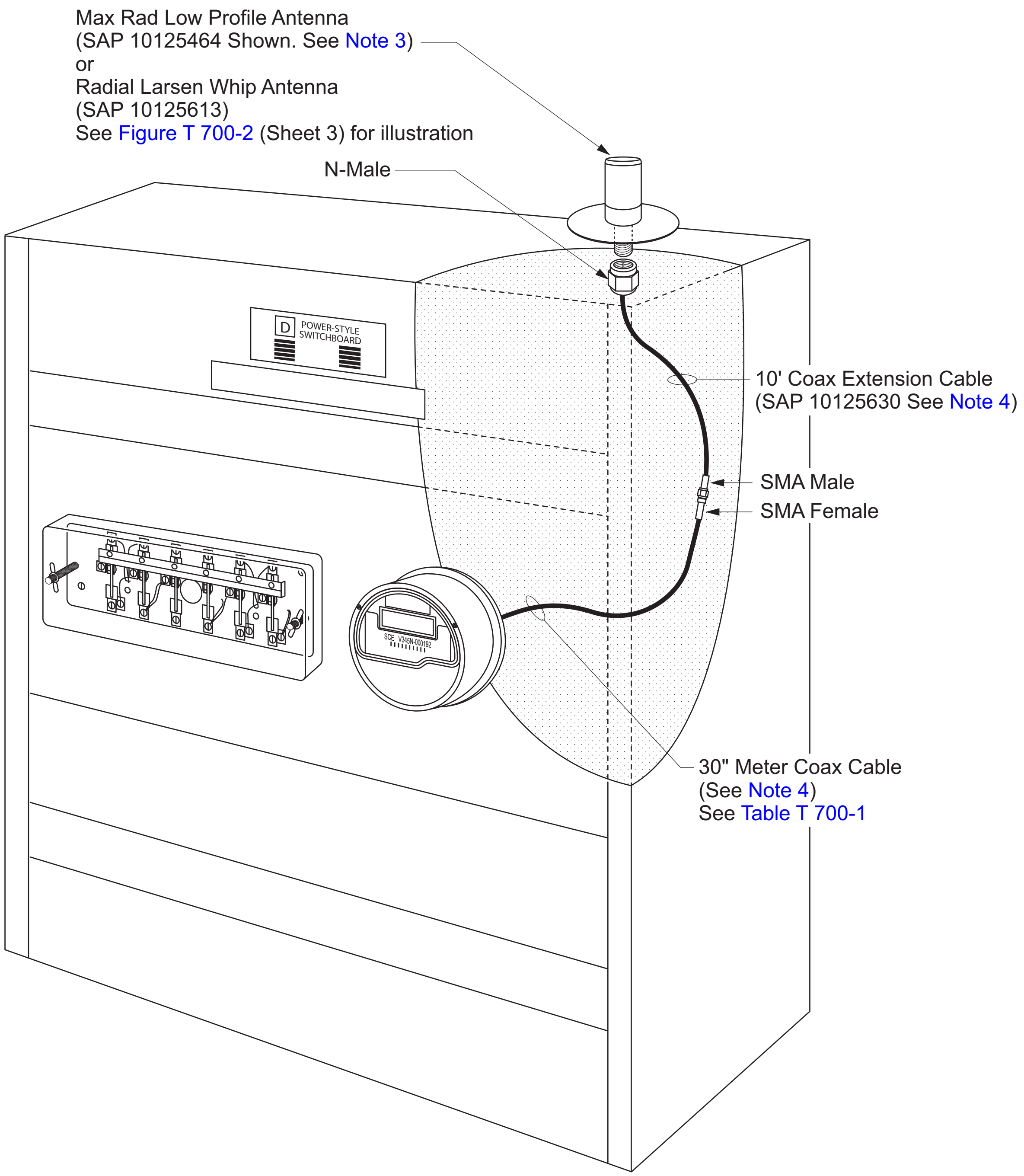
Figure T 675–1: Pulse Wiring Diagram for TOU-8 Rate Test Switch Wiring Diagrams



T 700 Externally Mounted Metering Antenna Installations

Scope T 700.1 Installation Diagram for Mounting Metering Antennas to the Top of the Metering Cabinet using L+G S4e Radio Under Glass (RUG) Meters

Figure T 700–1: Typical Installation Diagram for Mounting Metering Antennas to the Top of the Metering Cabinet (shown using a Low Profile Antenna type)



CAUTION

When drilling holes into a panel, switchboard, or cabinet, care is to be exercised to minimize the amount and possible effects of the resultant metal filings. Preventing contamination of the inside components is necessary so as to not create an "electrical hazard."

Table T 700–1: Meter Coax Cable Data

SAP[a/]	Description
10185337	Landis + Gyr (L+G) high voltage isolation antenna, 6+dB loss. Must be used on all L+G Form 2S, 3S, 5S, 9S, 12S, and 16S Radio Under Glass (RUG) meters [L+G RUG (ANSI)].
10125596	Landis + Gyr (L+G) high voltage isolation antenna, 6+ dBd loss. Must be used on all L+G Form 2S, 3S, 5S, all L+G Form 2S, 3S, 5S, 9S, 12S, and 16S Radio Under Glass (RUG) meters [L+G RUG (DG COM)].
10125631	Direct Connect, 0.5 dBd loss. Only use on L+G Forms 9S and 16S RUG (DG COM) meters.

[a/] Type used is dependent upon meter Form and manufacturer

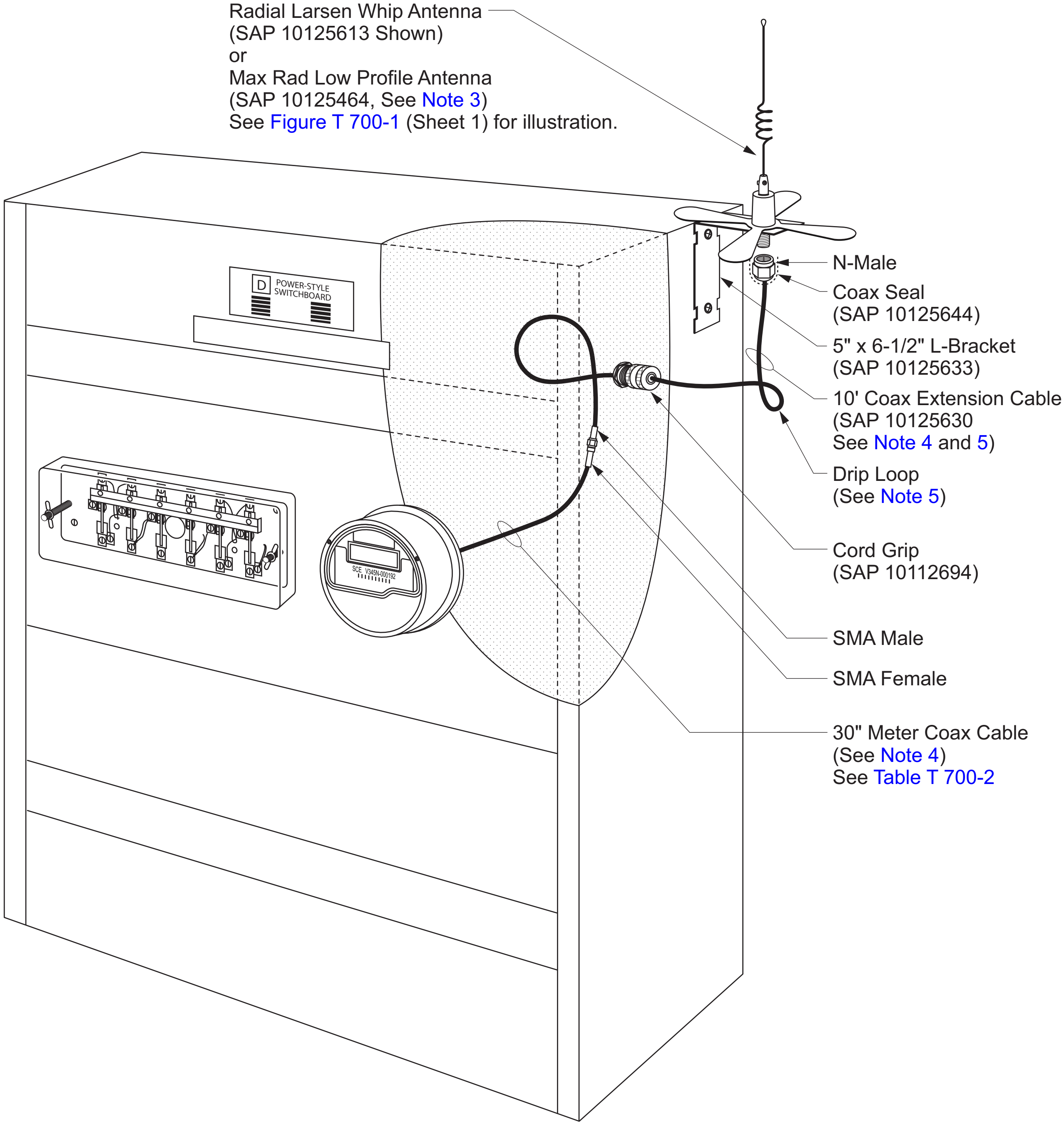
For Reference Only

Note(s):

1. For a complete listing of the available L+G RUG metering antenna kits only (see Table T 700–4).
2. All RF connectors are designated as male, having internal threads; female, having external threads.
3. The Max Rad Low Profile antenna includes a 4-1/2-inch diameter brass ground plane. The use of this ground plane **is optional** when installing this antenna type on top of a metal Metering Cabinet.
4. Installation of coax cable requires observing a minimum bend radius (see Table T 700–5).

Scope T 700.2 Installation Diagram for Mounting Metering Antennas to the Side of the Metering Cabinet

Figure T 700–2: Typical Installation Diagram for Mounting Metering Antennas to the Side of the Metering Cabinet (shown using a Whip Antenna type)



CAUTION **When drilling holes into a panel, switchboard, or cabinet, care is to be exercised to minimize the amount and possible effects of the resultant metal filings. Preventing contamination of the inside components is necessary so as to not create an "electrical hazard."**

Table T 700–2: Meter Coax Cable Data for Side Mount Installation

SAP[a/]	Description
10185337	Landis + Gyr (L+G) high voltage isolation antenna, 6+dB loss. Must be used on all L+G Form 2S, 3S, 5S, 9S, 12S, and 16S Radio Under Glass (RUG) meters [L+G RUG (ANSI)].
10125596	L+G high voltage isolation antenna, 6+ dBd loss. Must be used on all L+G Form 2S, 3S, 5S, and all L+G Form 2S, 3S, 5S, 9S, 12S, and 16S RUG meters [L+G RUG (DG COM)].
10125631	Direct Connect, 0.5 dBd loss. Only use on Form 3S, 9S, and 16S RUG (DG COM) meters.

[a/] Type used is dependent upon meter Form and manufacturer

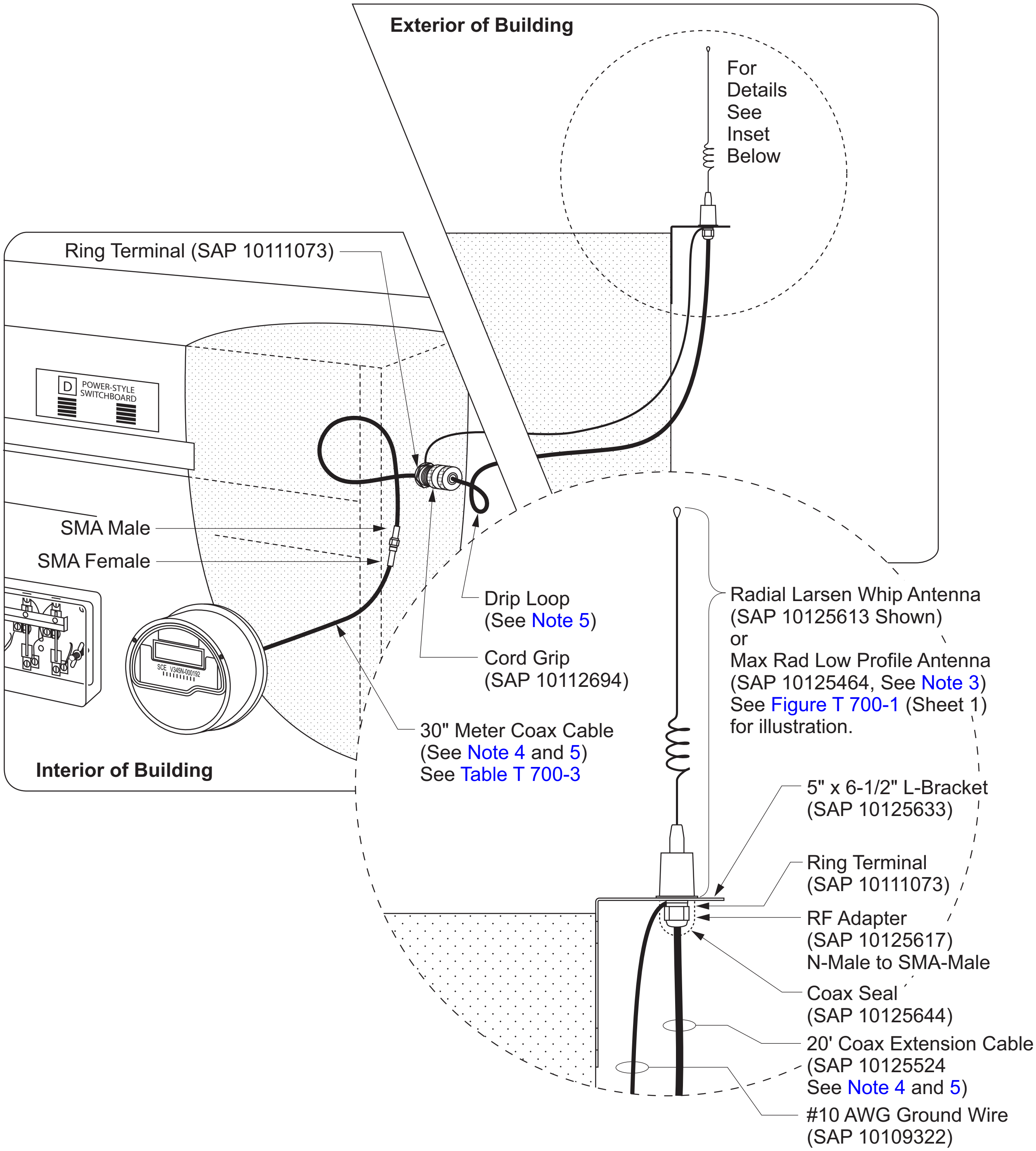
For Reference Only

Note(s):

1. For a complete listing of the available L+G RUG metering antenna kits only (see Table T 700–4).
2. All RF connectors are designated as male, having internal threads; female, having external threads.
3. The Max Rad Low Profile antenna includes a 4-1/2-inch diameter brass ground plane. This ground plane **must be used** when installing this antenna type.
4. Installation of coax cable requires observing a minimum bend radius (see Table T 700–5).
5. Metering antennas mounted to the side of the metering cabinets shall have a drip loop on the antenna cable.

Scope T 700.3 **Installation Diagram for Mounting Metering Antennas away (remote) from the Metering Cabinet**

Figure T 700–3: Typical Installation Diagram for Mounting Metering Antennas away (remote) from the Metering Cabinet (shown using a Whip Antenna type mounted outside, at roof top)



CAUTION

When drilling holes into a panel, switchboard, or cabinet, care is to be exercised to minimize the amount and possible effects of the resultant metal filings. Preventing contamination of the inside components is necessary so as to not create an "electrical hazard."

Table T 700–3: Meter Coax Cable Data for Remote Installation

SAP[a/]	Description
10185337	Landis + Gyr (L+G) high voltage isolation antenna, 6+dB loss. Must be used on all L+G Form 2S, 3S, 5S, 9S, 12S, and 16S Radio Under Glass (RUG) meters [L+G RUG (ANSI)].
10125596	L+G high voltage isolation antenna, 6+ dBd loss. Must be used on all L+G Form 2S, 3S, 5S, and L+G Form 2S, 3S, 5S, 9S, 12S, and 16S RUG meters [L+G RUG (DG COM)].
10125631	Direct Connect, 0.5 dBd loss. Only use on L+G Forms 9S and 16S RUG (DG COM) meters.

[a/] Type used is dependent upon meter Form and manufacturer

= For Reference Only

Note(s):

1. For a complete listing of the available L+G RUG metering antenna kits only (see Table T 700–1).
2. All RF connectors are designated as male, having internal threads; female, having external threads.
3. The Max Rad Low Profile antenna includes a 4-1/2-inch diameter brass ground plane. This ground plane **must be used** when installing this antenna type on an Antenna mounting bracket.
4. Installation of coax cable requires observing a minimum bend radius (see Table T 700–2).
5. Metering antennas mounted away (remote) from the metering cabinet shall have a drip loop on the antenna cable.

Table T 700–4: Externally Mounted Metering Antenna Kits

Manufacturer (meter type)	Antenna Kit Type: Low Profile	
	RUG Meter	
	w/ Grounded Meter Voltage (Forms: 9 & 16)	w/ Ungrounded Meter Voltage (Forms: 2, 3, 5, & 12)
L+G (S4) — ANSI	10200805	10200805
L+G (S4) — DG COM	10125636[a/]	

Manufacturer (meter type)	Antenna Kit Type: Whip	
	RUG Meter	
	w/ Grounded Meter Voltage (Forms: 9 & 16)	w/ Ungrounded Meter Voltage (Forms: 2, 3, 5, & 12)
L+G (S4) — ANSI	10200806	10200806
L+G (S4) — DG COM	10125640[a/]	

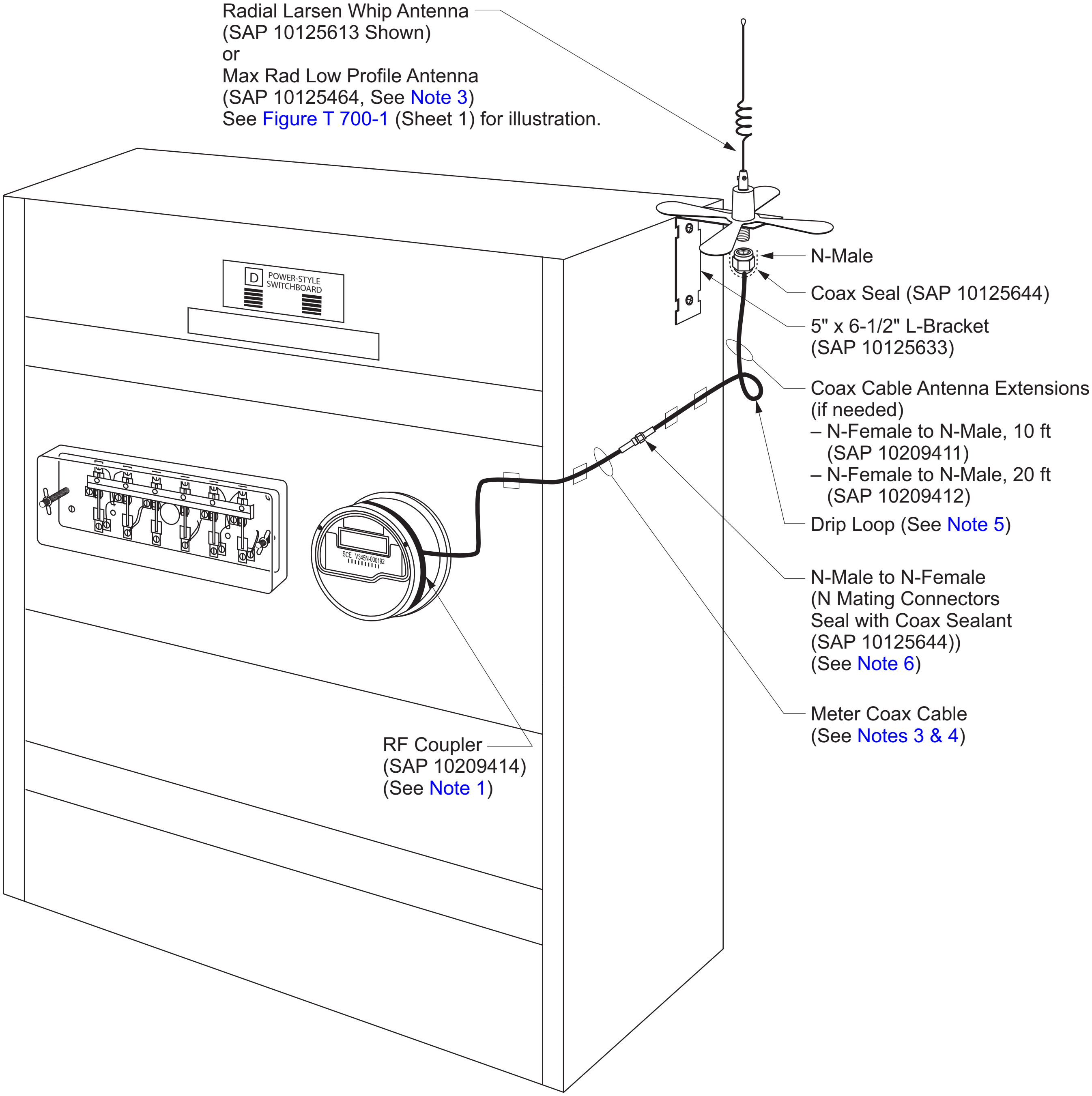
[a/] For existing installations only.

Table T 700–5: Coax Cable Minimum Bending Radii Requirements

Table of Coax Cable Minimum Bending Radii			
T-Print Part Designation	Part Name or Description	SAP	Minimum Bending Radius of Coax Cable
B or D	Antenna Extension Cable	10125630	2"
C or F	30" Coax Meter Cable w/ Isolation Circuit	10125631	2"
		10125596	1"
		10125523	1-1/2"
		10125653	1-1/2"

Scope T 700.4 Installation Diagram for Mounting Metering Antennas with L+G RUG Meters (Series4 Radio) on Metering Cabinets

Figure T 700–4: Typical Installation Diagram for Mounting Metering Antennas to the "Side" of the Metering Cabinet (shown using a Whip Antenna Type)

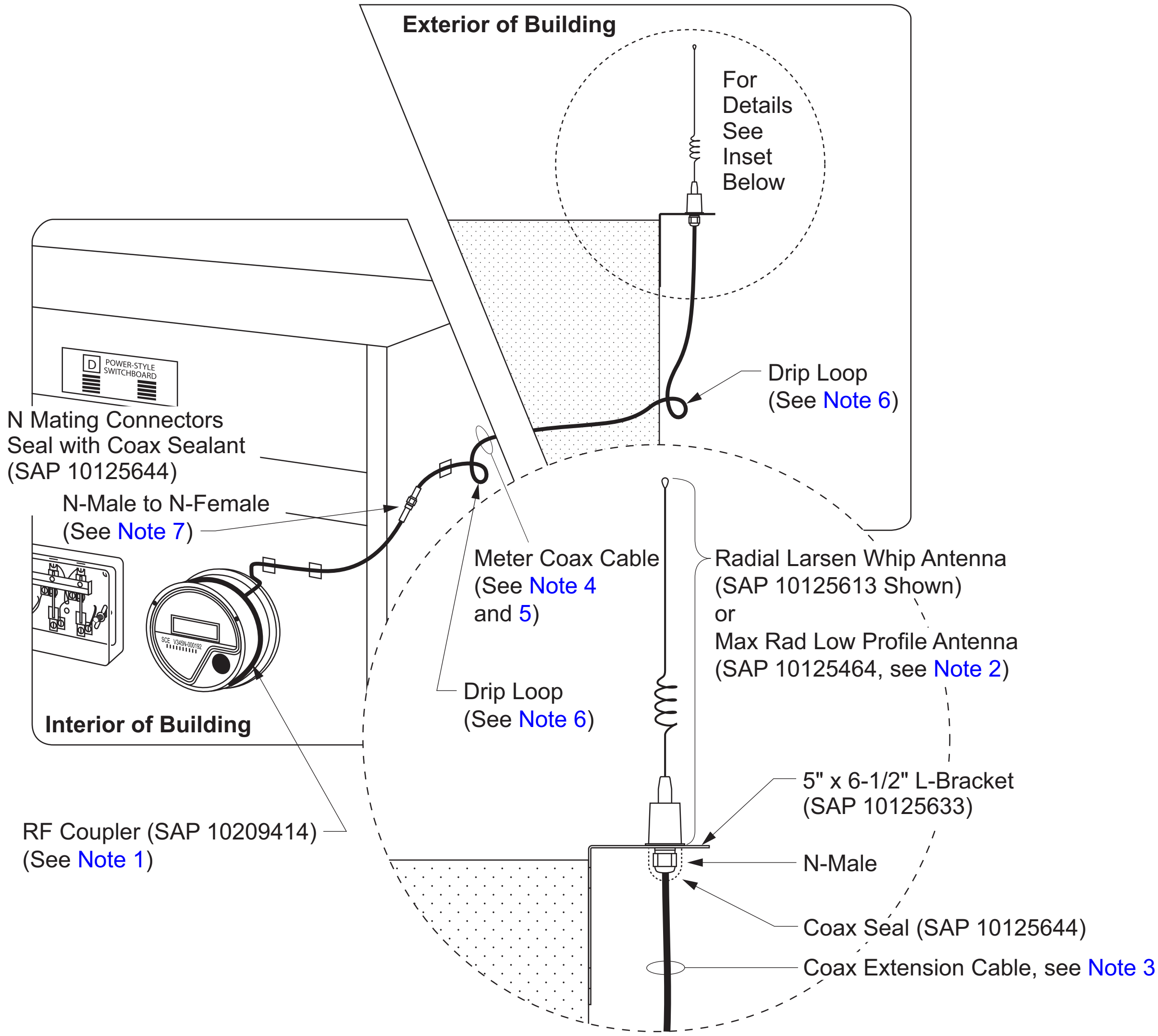


Note(s):

1. RF coupler (SAP 10209414) placement position on the meter cover can vary. Final position is per best connectivity to NetCom. Secure the RF coupler with the tie-wrap that is included. For RF coupler installation instructions, refer to Job Aid: “L+G Series4 RF Coupler Installation Job Aid”.
2. The Max Rad Low Profile antenna includes a 4-1/2 inch diameter brass ground plane. This ground plane must be used when installing this antenna type.
3. Use cable mounts and tie-wraps to secure the cable to the sides of the cabinet.
4. Installation of coax cable requires observing a minimum bend radius (see Table T 700–5).
5. Metering antennas mounted to the side of the metering cabinets shall have a drip loop on the antenna cable.
6. For a hinge side meter panel, disconnect the N-Male to N-Female connection to allow access.

Scope T 700.5 Installation Diagram for Mounting Metering Antennas with L+G RUG Meters (Series4 Radio) on Metering Cabinets

Figure T 700–5: Typical Installation Diagram for Mounting Metering Antennas Away (Remote) from the Metering Cabinet (Shown using a Whip Antenna Type Mounted External, at Roof Top)



Note(s):

1. RF coupler (SAP 10209414) placement position on the meter cover can vary. Final position is per best connectivity to NetCom. Secure the RF coupler with the tie-wrap that is included. For RF coupler installation instructions, refer to Job Aid: "L+G Series4 RF Coupler Installation Job Aid".
2. The Max Rad Low Profile antenna includes a 4-1/2-inch diameter brass ground plane. This ground plane must be used when installing this antenna type.
3. Some installations can be made using SAP 10209411 (10-ft w/N-Female to N-Male) or SAP 10209412 (20-feet w/N-Female to N-Male) extension. Installations requiring coax extension cables greater than 20 feet, use LMR-400 coax extension cable (Contractor to provide materials, mounting hardware/fasteners, and fabrication).

4. Use cable mounts and tie-wraps to secure the cable to the sides of the cabinet.
5. Installation of coax cable requires observing a minimum bend radius (see Table T 700–5).
6. Metering antennas mounted remotely shall have a drip loop on the antenna cable.
7. For installation of L+G RUG Meters (Series4 radio) into a pre-exisiting, hard-to-replace L+G RUG Meter (Series3 radio) coaxial cable, use N-Female to SMA-Female connector adapter (SAP 10209586).

Scope T 700.6 Installation Diagram for Mounting Metering Antennas with Edison SmartConnect (ESC) Meters on Pedestal Metering Cabinets

Figure T 700–6: Typical Installation Diagram for Mounting Metering Antenna to the “Top” of the Pedestal Metering Cabinet using Low Profile Antenna

Note(s):

1. See Table T 700–6 for antenna material items mounted to the top of the pedestal metering cabinet.

Figure T 700–7: Radiall Larsen Low Profile Antenna Detail — SAP 10178544

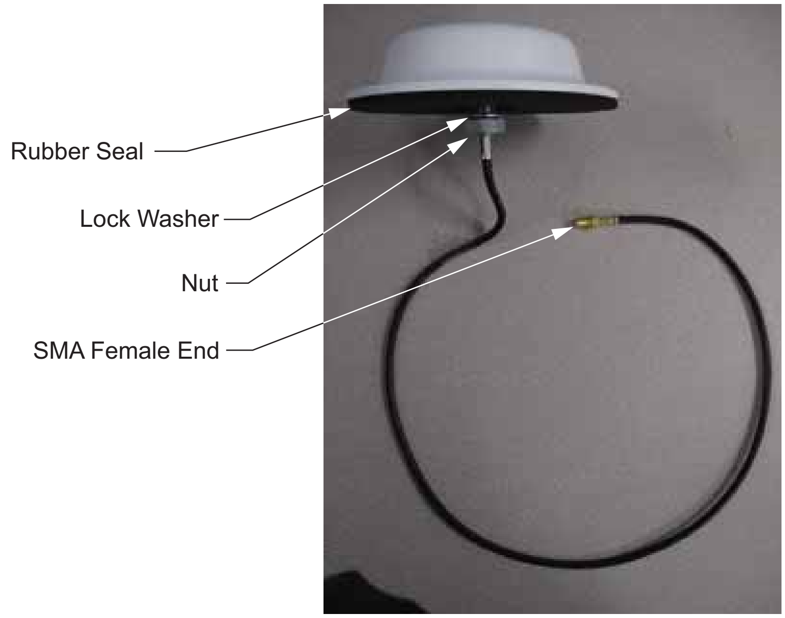
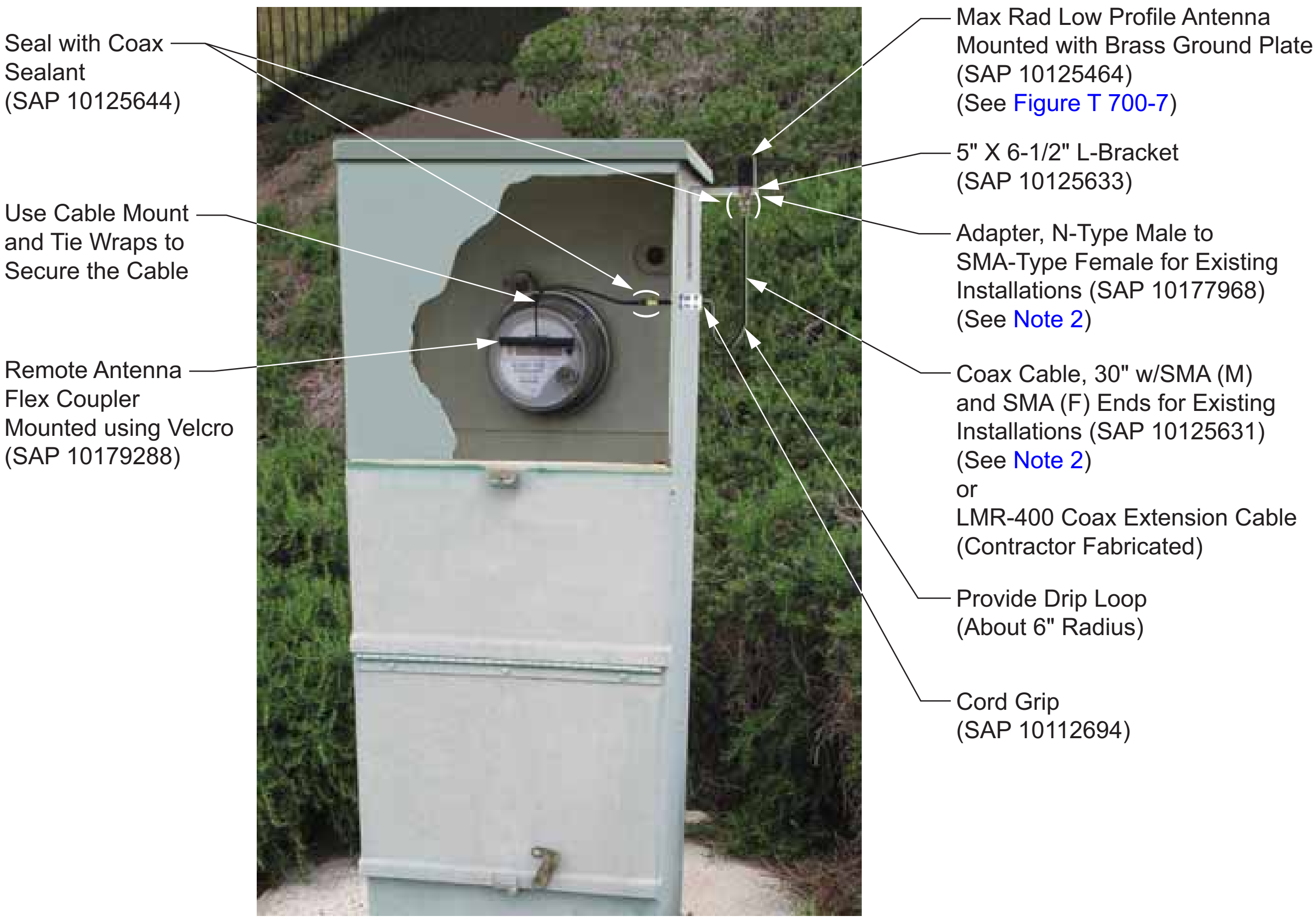


Table T 700–6: Materials for Externally Mounted Antenna Component for "Top" Mounting onto Pedestal Metering Cabinet

Item	Description	SAP
1	Antenna, 890–960 MHz, Flex Coupler with Velcro® Type: Remote antenna flex coupler with Velcro® option (for installation and removal of antenna from meter cover) and 18-inch cable with SMA male connector.	10179288
2	Sealant, Coax Cable Type: Coax seal 1/2" × 10" strip in pre-packed envelope with connectors to seal out moisture.	10125644
3	Cable, Coax 30-inches long with SMA-M & SMA-F Connectors: Terminations are right angle SMA-Male and straight SMA-Female Connectors — As needed.	10125631
4	Antenna, 806–960 MHz, Low Profile Kind: Radial Larsen Low Profile Antenna ("White" Hockey Puck Type), 3-inch coax cable with SMA-Female connector, use in areas of high vandalism.	10178544

Scope T 700.7 Installation Diagram for Mounting Metering Antennas with Edison SmartConnect (ESC) Meters on Pedestal Metering Cabinets

Figure T 700–8: Typical Installation Diagram for Mounting Metering Antenna to the "Side" of the Pedestal Metering Cabinet using a Max Rad Low Profile Antenna



Note(s):

1. See Table T 700–7 for antenna material items mounted to the side of the pedestal metering cabinet.
2. For new installations use SAP 10205805.

Figure T 700–9: Max Rad Low Profile Antenna Detail — SAP 10125464

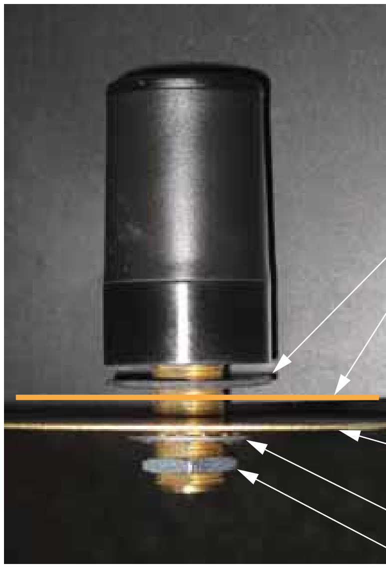
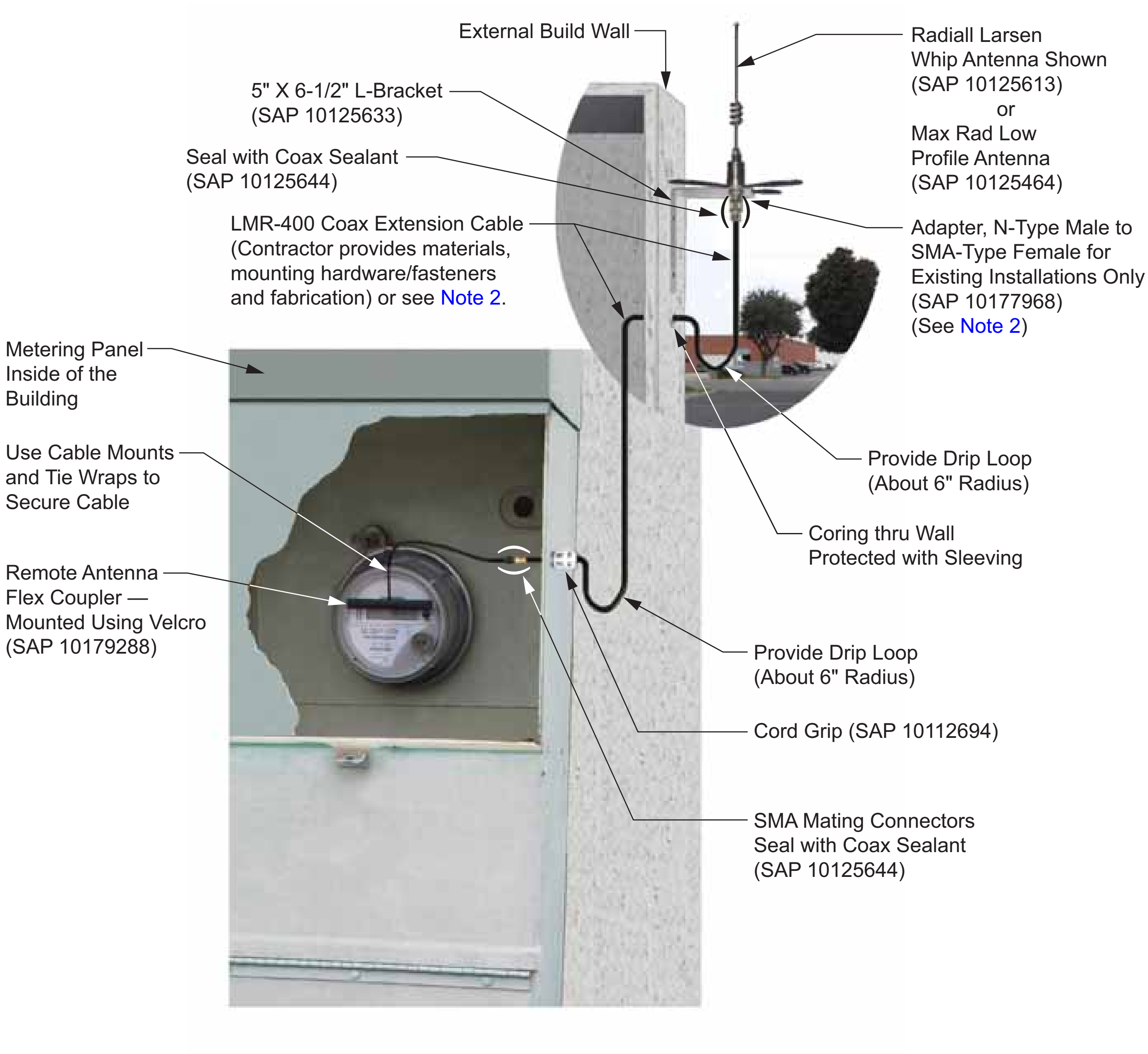


Table T 700–7: Materials for Externally Mounted Antenna Component for “Side” Mounting onto Pedestal Metering Cabinet

Item	Description	SAP
1	Antenna, 890–960 MHz, Flex Coupler with Velcro® Type: Remote antenna flex coupler with Velcro® option (for installation and removal of antenna from meter cover) and 18-inch cable with SMA male connector (for SmartConnect meters only).	10179288
2	Sealant, Coax Cable Type: Coax seal 1/2" × 10" strip in pre-packed envelope with connectors to seal out moisture.	10125644
3a	Existing Installations: Cable, Coax 30-inches long with SMA-M & SMA-F Connectors, Terminations are right angle SMA-Male and straight SMA-Female Connectors.	10125631
3b	New Installations: Cable, Coax 30-inches long with N-Male to SMA-F straight connectors.	10205805
4	Connector, Conduit Type: Cord Grip, Hubbell Cord Connector, 1/2-inch hub size, NPT male connection, aluminum.	10112694
5	Bracket: L-Bracket, 5" × 6-1/2", L-Shaped steel antenna mounting bracket for Whip or Low Profile Antennas.	10125633
6	Existing Installations: Adapter, N-Type Male to SMA-Type Female kind, Steel material, for use with high gain Whip and Low Profile Antennas.	10177968
7	Antenna, 806–960 MHz, Low Profile Type: Max Rad Low Profile Antenna, “N” connector stud, used in areas of high Vandalism, or used as a replacement antenna for the 3 dB gain antenna.	10125464

Scope T 700.8 Installation Diagram for Mounting Metering Antennas with Edison SmartConnect (ESC) Meters on Pedestal Metering Cabinets

Figure T 700–10: Typical Installation Diagram for Mounting Metering Antenna Remotely from the Pedestal Metering Cabinet using Whip Antenna Type Mounted Externally at Rooftop



Note(s):

1. See Table T 700–8 for antenna material items installed remotely from pedestal metering cabinet.
2. Some installations can be made using SAP 10204762 (10 feet with SMA-F to N-M) or SAP 10204805 (20 feet with SMA-F to N-M) extension. When additional extensions are required use SAP 10205732 (20 feet with SMA-M to SMA-F straight connector) extension(s), as needed.

Figure T 700–11: Radiall Larsen Whip Antenna Detail — SAP 10125613

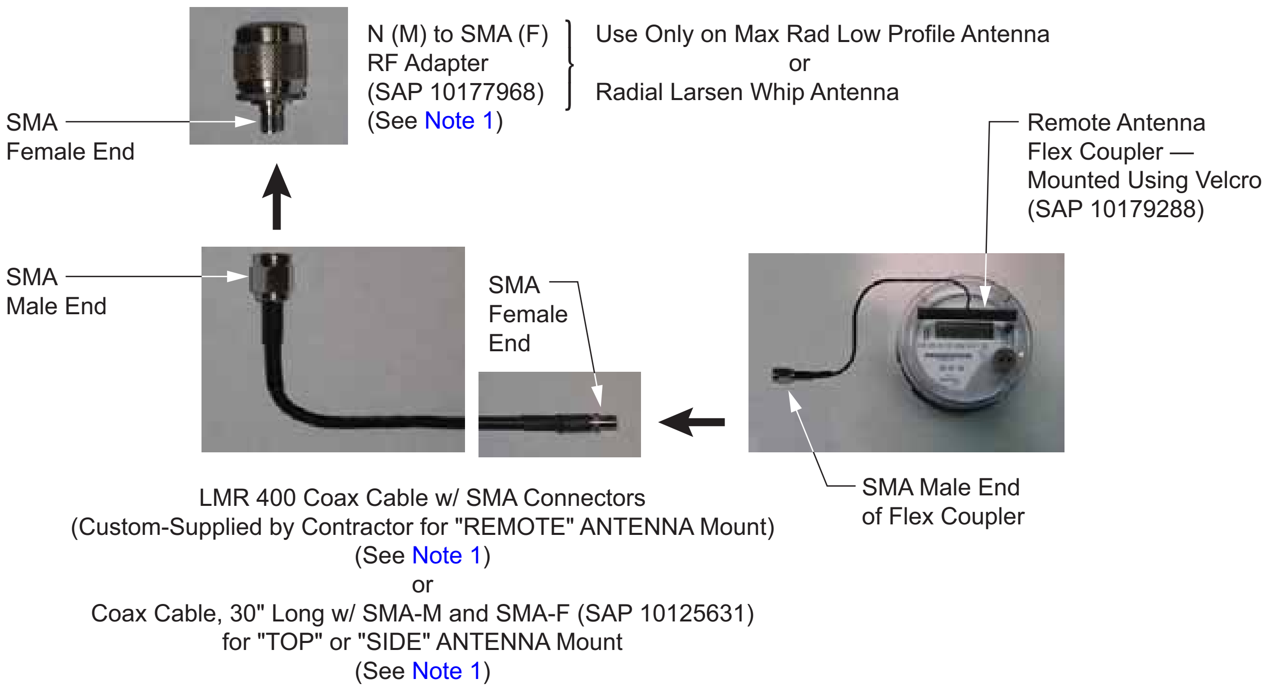
Table T 700–8: Materials for Externally Mounted Antenna Component for "Remote" Mounting onto Pedestal Metering Cabinet

Item	Description	SAP
1	Antenna, 890–960 MHz, Flex Coupler with Velcro® Type: Remote antenna flex coupler with Velcro® option (for installation and removal of antenna from meter cover) and 18-inch cable with SMA male connector.	10179288
2	Sealant, Coax Cable Type: Coax seal 1/2" × 10" strip in pre-packed envelope with connectors to seal out moisture.	10125644
3a or 3b 3c 3d	Cable Coax LMR-400 Coax extension cable with SMA-M & SMA-F Connectors (Contractor to provide). Cable, Coax 10 feet long with N-M to SMA-F straight connectors. Cable, Coax 20 feet long with N-M to SMA-F straight connectors. Cable, Coax 20 feet long with SMA-M to SMA-F straight connectors.	— 10204762 10204805 10205732
4	Connector, Conduit Type: Cord Grip, Hubbell Cord Connector, 1/2-inch hub size, NPT male connection, aluminum.	10112694
5	Bracket, Netcomm Radio/Pager Type: L-Bracket, 5" × 6-1/2", L-Shaped steel antenna mounting bracket for Whip or Low Profile Antennas.	10125633

Table T 700–8: Materials for Externally Mounted Antenna Component for “Remote” Mounting onto Pedestal Metering Cabinet *(Continued)*

6	Adapter, N-Type Male to SMA-Type Female kind: Steel material, for use with high gain Whip and Low Profile Antennas.	10177968
7a or 7b	Antenna, 890–960 MHz, High Gain Whip Antenna: Radial Larsen Whip Antenna, 3.2 dB gain, with mounting hardware. Antenna, 806–960 MHz, Low Profile Type: Max Rad Low Profile Antenna, “N” connector stud, used in areas of high Vandalism, or used as a replacement antenna for the 3 dB gain antenna.	10125613 10125464

Figure T 700–12: Edison SmartConnect (ESC) Meter Connection Detail

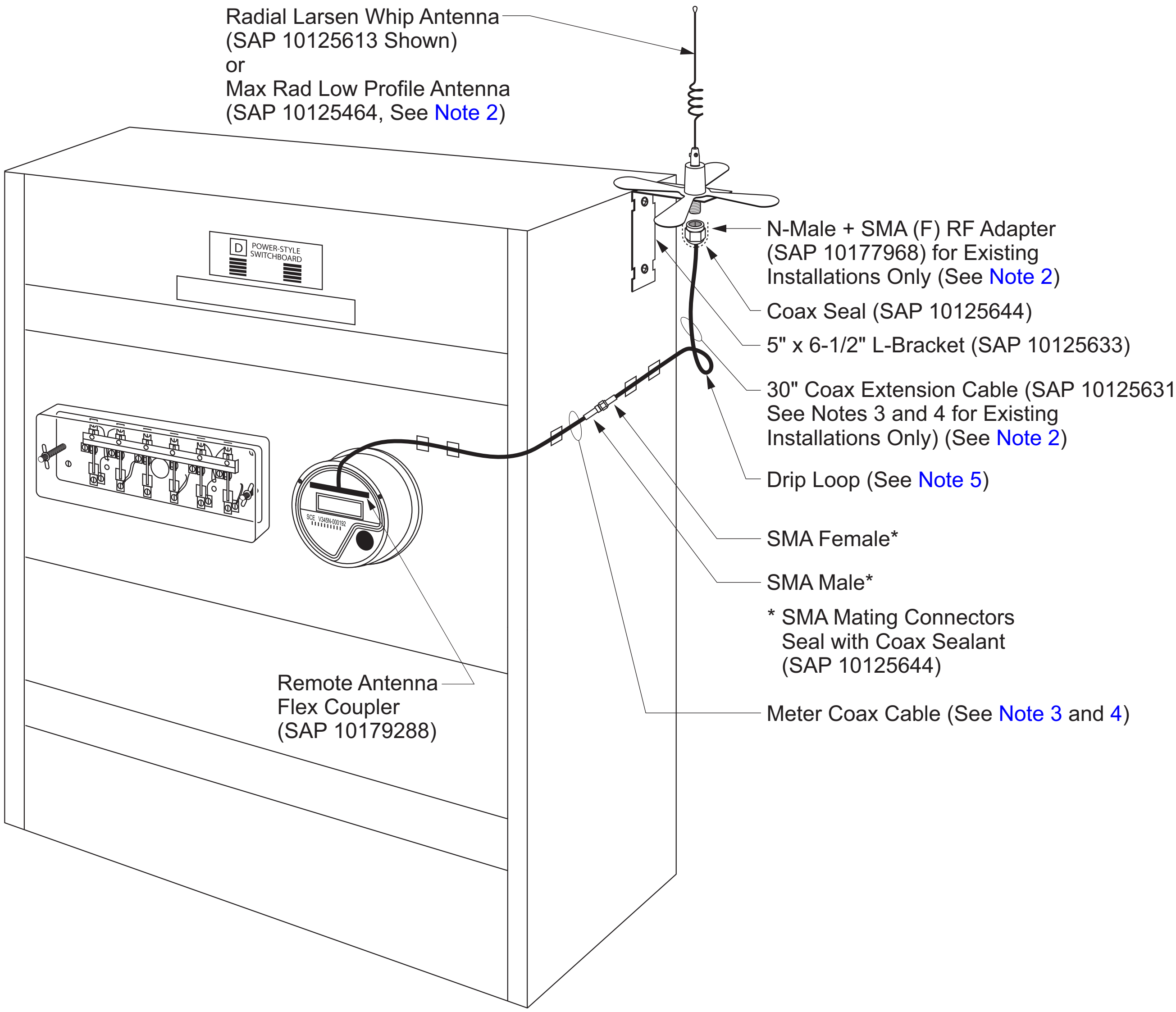


Note(s):

1. The components shown are for existing installations or installations completed by a contractor. For installations by Meter Technicians utilize the following:
   SAP 10204762: Cable,Coax 10 feet long with N-M to SMA-F straight connectors
   SAP 10204805: Cable,Coax 20 feet long with N-M to SMA-F straight connectors
   SAP 10205732: Cable, Coax 20 feet long with SMA-M to SMA-F straight connectors

Scope T 700.9 Installation Diagram for Mounting Metering Antennas with Edison SmartConnect (ESC) Meters on Metering Cabinets

Figure T 700–13: Typical Installation Diagram for Mounting Metering Antennas to the “Side” of the Metering Cabinet (shown using a Whip Antenna Type)



Note(s):

1. See Table T 700–9 for antenna material items installed on the side of a metering cabinet.\
2. Components shown are for existing installations. For new installations use the following:
   SAP 10205805: Cable, Coax 30-inches long with N-M to SMA-F straight connectors
   SAP 10204762: Cable, Coax 10-feet long with N-M to SMA-F straight connectors
   SAP 10204805: Cable, Coax 20-feet long with N-M to SMA-F straight connectors
3. Use Cable Mounts and tie-wraps to secure the cable to the sides of the cabinet.
4. Installation of coax cable requires observing a minimum bend radius (see Table T 700–5).
5. Metering antennas mounted to the side of the metering cabinets shall have a drip loop on the antenna cable.

Table T 700–9: Materials for Externally Mounted Antenna Attached to the Side of the Metering Cabinet

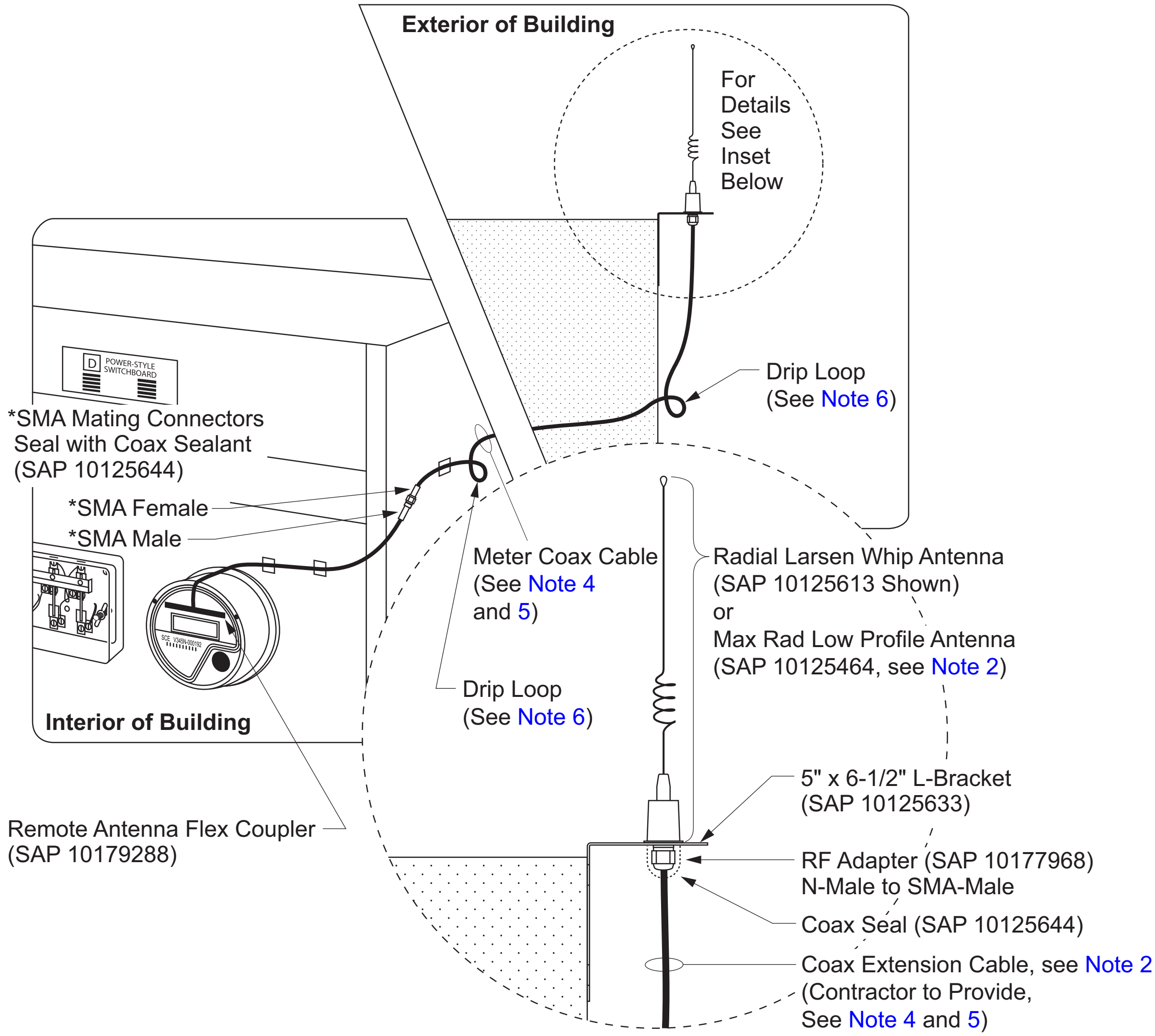
Item	Description	SAP
1	Antenna, 890–960 MHz, Flex Coupler with Velcro® Type: Remote antenna flex coupler with Velcro® option (for installation and removal of antenna from meter cover) and 18-inch cable with SMA male connector.	10179288
2	Sealant, Coax Cable Type: Coax seal 1/2" × 10" strip in pre-packed envelope with connectors to seal out moisture.	10125644
3a or	Cable, Coax 30-inches long with SMA-M & SMA-F Connectors: Terminations are right angle SMA-Male and straight SMA female Connectors.	10125631
3b	Cable, Coax 30-inches long with N-M to SMA-F straight connectors.	10205805
3c	Cable, Coax 10-feet long with N-M to SMA-F straight connectors.	10204762
3d	Cable, Coax 20-feet long with N-M to SMA-F straight connectors.	10204805
4	Adapter, N-Type Male to SMA-Type Female Kind: Steel material, for use with high gain Whip and Low Profile Antennas.	10177968
5	Bracket, Netcomm Radio/Pager Type: L-Bracket, 5" × 6-1/2", L-shaped steel antenna mounting bracket for Whip or Low Profile Antennas.	10125633
6a or	Antenna, 890–960 MHz, High Gain Whip Antenna: Radial Larsen Whip Antenna, 3.2 dB gain, with mounting hardware.	10125613
6b	Antenna, 806–960 MHz, Low Profile Type: Max Rad Low Profile Antenna, “N” connector stud, used in areas of high vandalism, or used as a replacement antenna for the 3 dB gain antenna.	10125464
7	Adapter, SMA-F to SMA-F.	10200966
8	Adapter, SMA-M to SMA-M.	10204866
9	20 foot long Coax antenna Cable; SMA-M and SMA-F straight connectors.	10205732

Note(s):

1. All RF connectors are designated as — male (with internal threads); female (with external threads).
2. The Max Rad Low Profile antenna includes a 4-1/2-inch diameter brass ground plane. This ground plane must be used when installing this antenna type.
3. Use Cable Mounts and tie-wraps to secure the cable to the sides of the cabinet.
4. Installation of coax cable requires observing a minimum bend radius (see Table T 700–5).
5. Metering antennas mounted to the side of the metering cabinets shall have a drip loop on the antenna cable.

Scope T 700.10 Installation Diagram for Mounting Metering Antennas with Edison SmartConnect (ESC) Meters on Metering Cabinets

Figure T 700–14: Typical Installation Diagram for Mounting Metering Antennas Away (Remote) from the Metering Cabinet (Shown using a Whip Antenna Type Mounted External, at Roof Top)



Note(s):

1. See Table T 700–10 for antenna material items installed remotely from the metering cabinet.
2. The Max Rad Low Profile antenna includes a 4-1/2-inch diameter brass ground plane. This ground plane must be used when installing this antenna type.
3. Some installations can be made using SAP 10204762 (10-feet with SMA-F to SMA-N) or SAP 10204805 (20 feet with SMA-F to N-M) extension. When additional extension(s) are required use SAP 10205732 (20-feet with SMA-M to SMA-F straight connectors), as needed.
4. Use Cable Mounts and tie-wraps to secure the cable to the sides of the cabinet.
5. Installation of coax cable requires observing a minimum bend radius (see Table T 700–5).
6. Metering antennas mounted to the side of the metering cabinets shall have a drip loop on the antenna cable.

Table T 700–10: Materials for Externally Mounted Antenna Attached Remotely from the Metering Cabinet

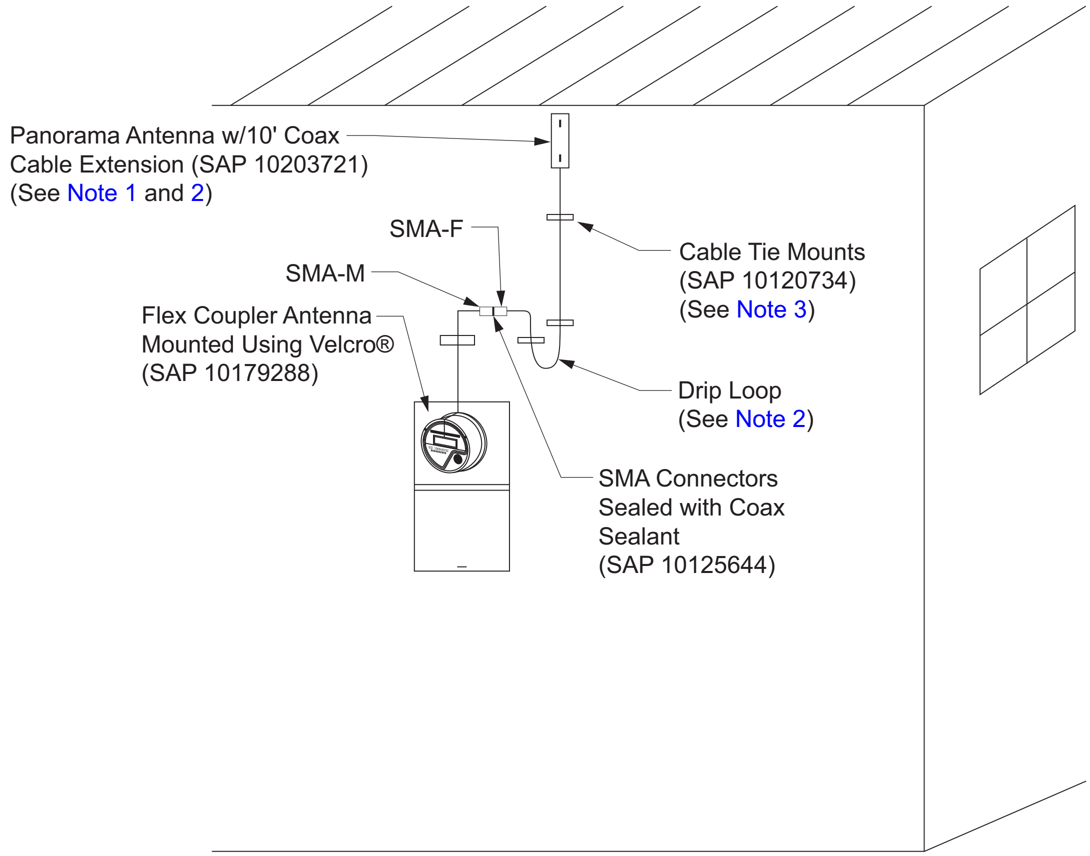
Item	Description	SAP
1	Antenna, 890–960 MHz, Flex Coupler with Velcro® Type: Remote antenna flex coupler with Velcro® option (for installation and removal of antenna from meter cover) and 18-inch cable with SMA male connector.	10179288
2	Sealant, Coax Cable Type: Coax seal 1/2" × 10" strip in pre-packed envelope with connectors to seal out moisture.	10125644
3a	Cable, Coax LMR-400 Coax extension cable with SMA-M & SMA-F Connectors (Contractor to provide).	—
or		
3b	Cable, Coax 30-inches long with N-M to SMA-F straight connectors	10205805
3c	Cable, Coax 10-feet long with N-M to SMA-F straight connectors.	10204762
3d	Cable, Coax 20-feet long with N-M to SMA-F straight connectors.	10204805
4	Adapter, N-Type Male to SMA-Type Female kind: Steel material, for use with high gain Whip and Low Profile Antennas.	10177968
5	Bracket, Netcomm Radio/Pager Type: L-Bracket, 5" × 6-1/2", L-Shaped steel antenna mounting bracket for Whip or Low Profile Antennas.	10125633
6a	Antenna, 890–960 MHz, High Gain Whip Antenna: Radial Larsen Whip Antenna, 3.2 dB gain, with mounting hardware.	10125613
or		
6b	Antenna, 806–960 MHz, Low Profile Type: Max Rad Low Profile Antenna, "N" connector stud, used in areas of high Vandalism, or used as a replacement antenna for the 3 dB gain antenna.	10125464
7	Adapter, SMA-F to SMA-F.	10200966
8	Adapter, SMA-M to SMA-M.	10204866
9	20-foot long Coax antenna Cable; SMA-M and SMA-F straight connectors.	10205732

Note(s):

1. All RF connectors are designated as — male (with internal threads); female (with external threads).
2. The Max Rad Low Profile antenna includes a 4-1/2-inch diameter brass ground plane. This ground plane must be used when installing this antenna type.
3. Use Cable Mounts and tie-wraps to secure the cable to the sides of the cabinet.
4. Installation of coax cable requires observing a minimum bend radius (see Table T 700–5).
5. Metering antennas mounted to the side of the metering cabinets or remotely, shall have a drip loop on the antenna cable at all exterior walls and at the metering cabinet.

Scope T 700.11 **Diagram Illustrating the Various Types of Externally Mounted Metering Antenna Installation using SmartConnect Meters**

Figure T 700–15: Typical Installation Diagram for Mounting External Antenna at Residential Customer Installations (Installation shown using an Itron SmartConnect Meter)



Note(s):

1. Install the Panorama antenna as high as possible onto the structure. Ensure good and consistent Receive Signal Strength Indicator (RSSI) values of Grid Services Advanced Metering Operations (AMO) reads [Reference: EMS-04-096, “Using the Portable RFLAN Range Extender (PRRE), Section 5.6].
2. Metering antennas mounted away from the meter shall have a drip loop on the antenna cable.
3. Using tie wraps, secure the antenna cable to the cable tie mounts. Attach the Panorama antenna and cable tie mounts to the wall using a silicone adhesive (SAP 10204638).

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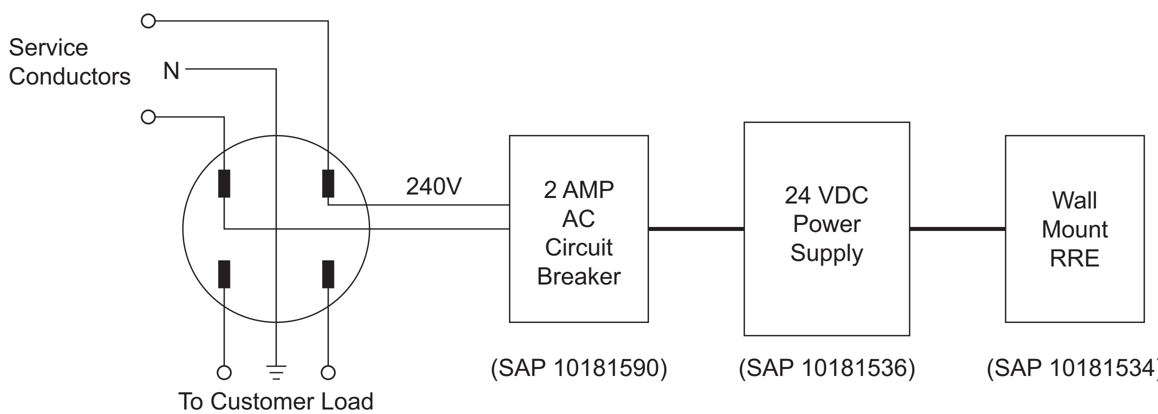
T 720 24 VDC Wall-Mounted RFLAN Range Extender (WMRRE) Installations

Scope T 720.1 24 VDC Wall-Mounted RFLAN Range Extender (WMRRE) Installations

Figure T 720–1: WMRRE Installation using Meter Socket Adapters

Meter Socket Adapter
2S (SAP 10181833)



or
Meter Socket Adapter
12S (SAP 10181899)

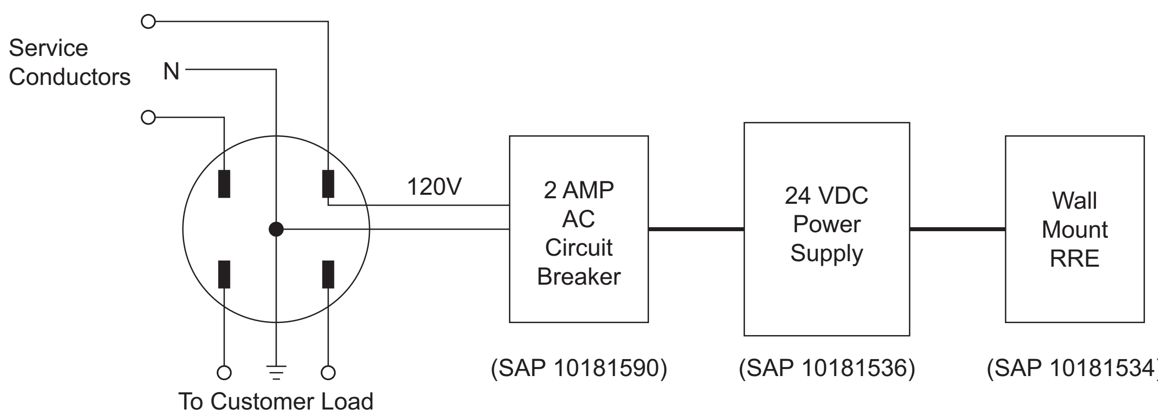


Figure T 720–2: WMRRE Installation for 277/480 Services

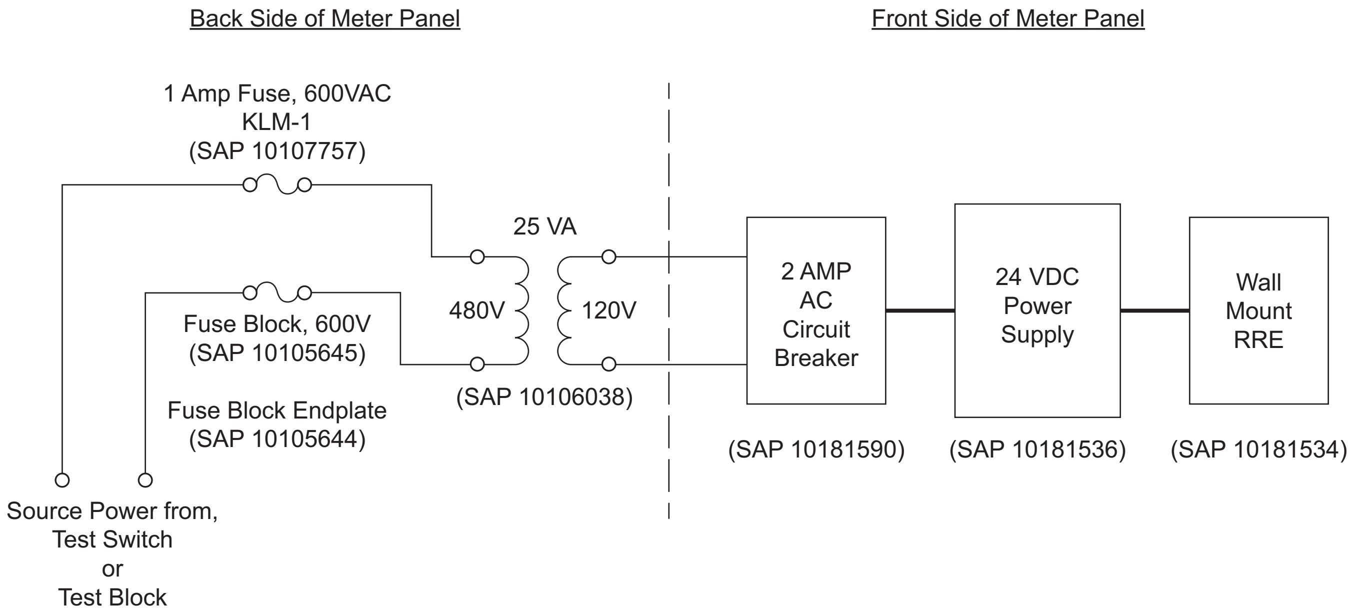


Figure T 720–3: WMRRE Installation for 120/208/240 V Services

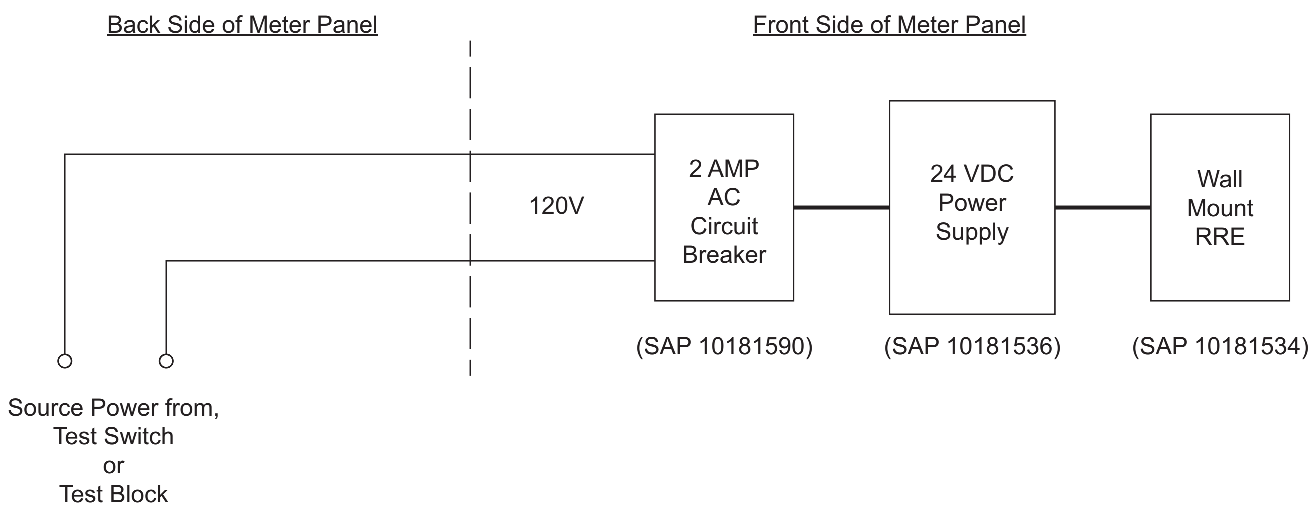
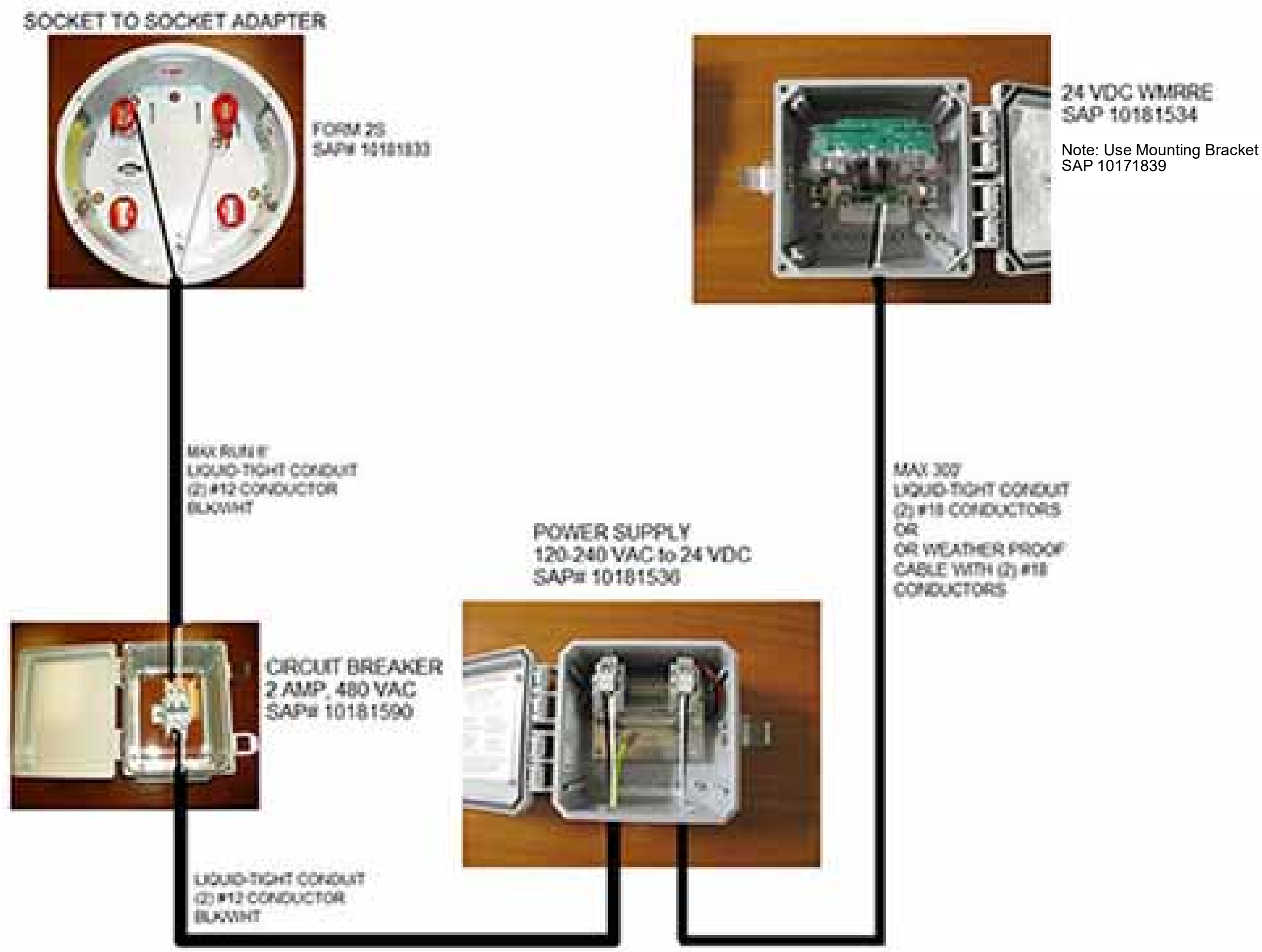


Figure T 720–4: WMRRE Using a Meter Socket to Socket Adapter



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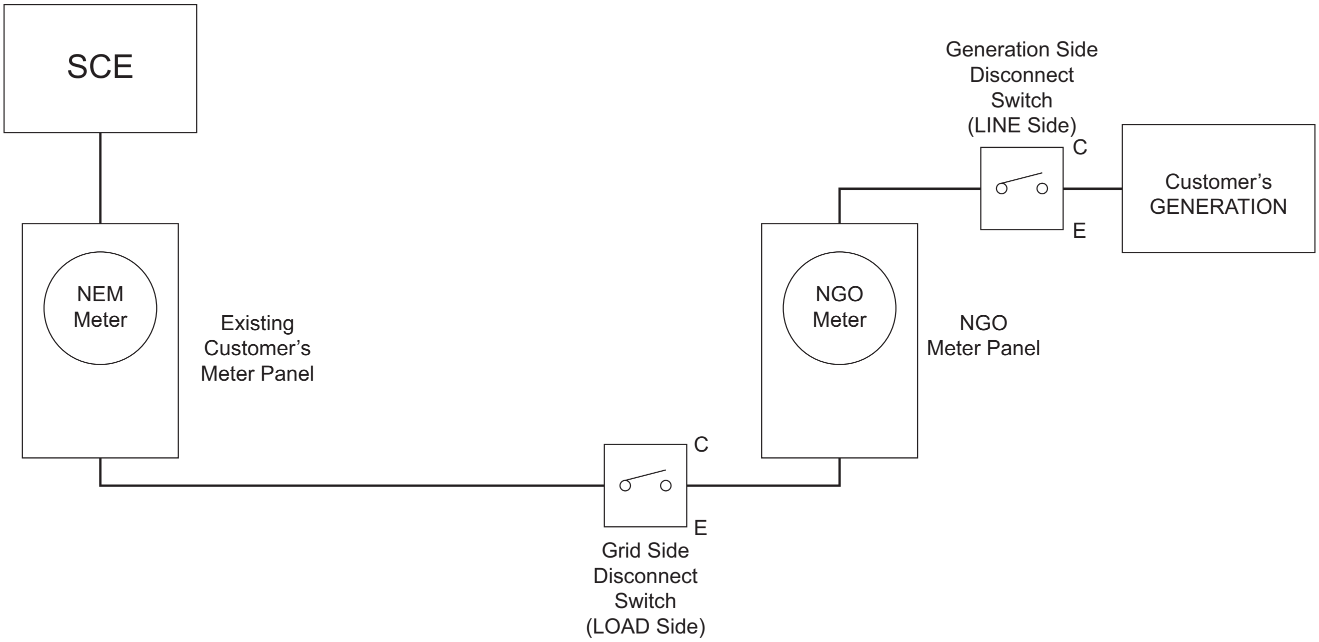
T 725 NET Generation Output Meter (NGOM)

Scope T 725.1 NET Generation Output Meter (NGOM) used in Paired Storage, NEM-ST, NEM-MT-ST, and NEM-A Applications

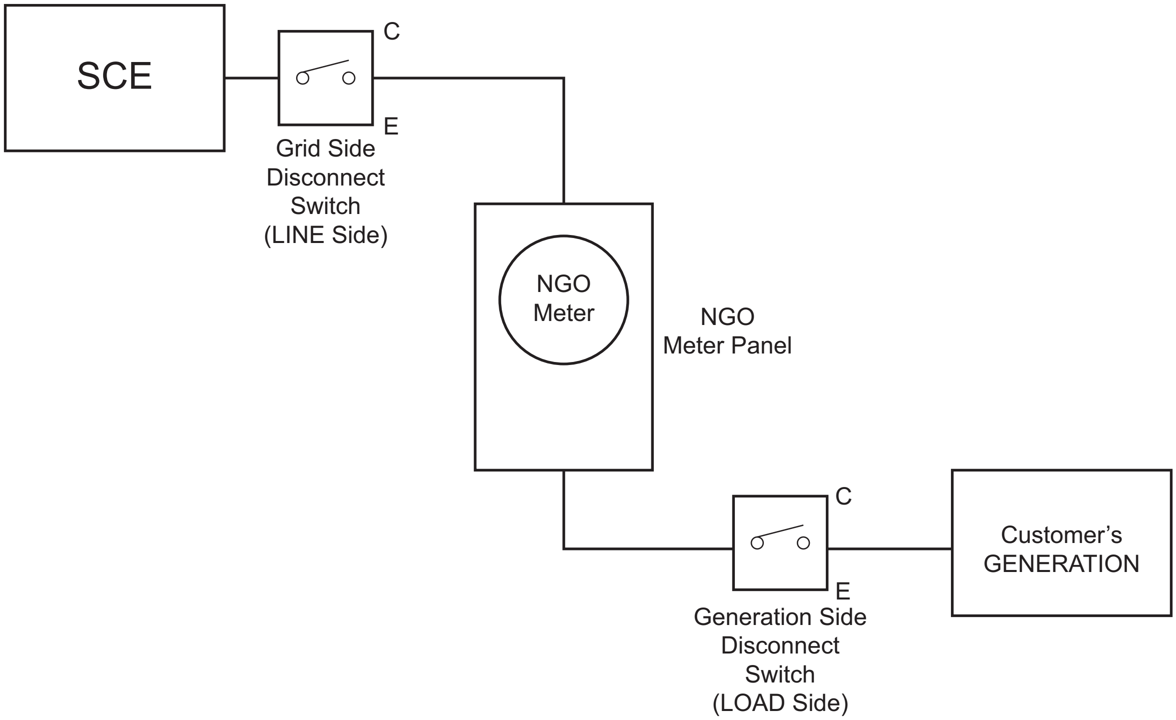
Figure T 725–1: NGOM used in Paired Storage, NEM-ST, NEM-MT-ST, and NEM-A Applications



Note(s):
1. NGOM shall have "Generation Side" and "Grid Side" Disconnect switches visible.
2. Refer to latest version of NEM HANDBOOK for additional requirements.

Scope T 725.2 **NET Generation Output Meter (NGOM) used in MASH, V-NEM, NEM-V, NEM-V-ST, or SOMAH Application**

Figure T 725–2: NGOM used in MASH, V-NEM, NEM-V, NEM-V-ST, or SOMAH Application



Note(s):

1. NGOM shall have "Generation Side" and "Grid Side" Disconnect switches visible.
2. NGOM will require NEM "bi-directional" program.
3. Refer to latest version of NEM HANDBOOK for additional requirements.

DOH–ISGD: ISGD Irvine Smart Grid Demonstration

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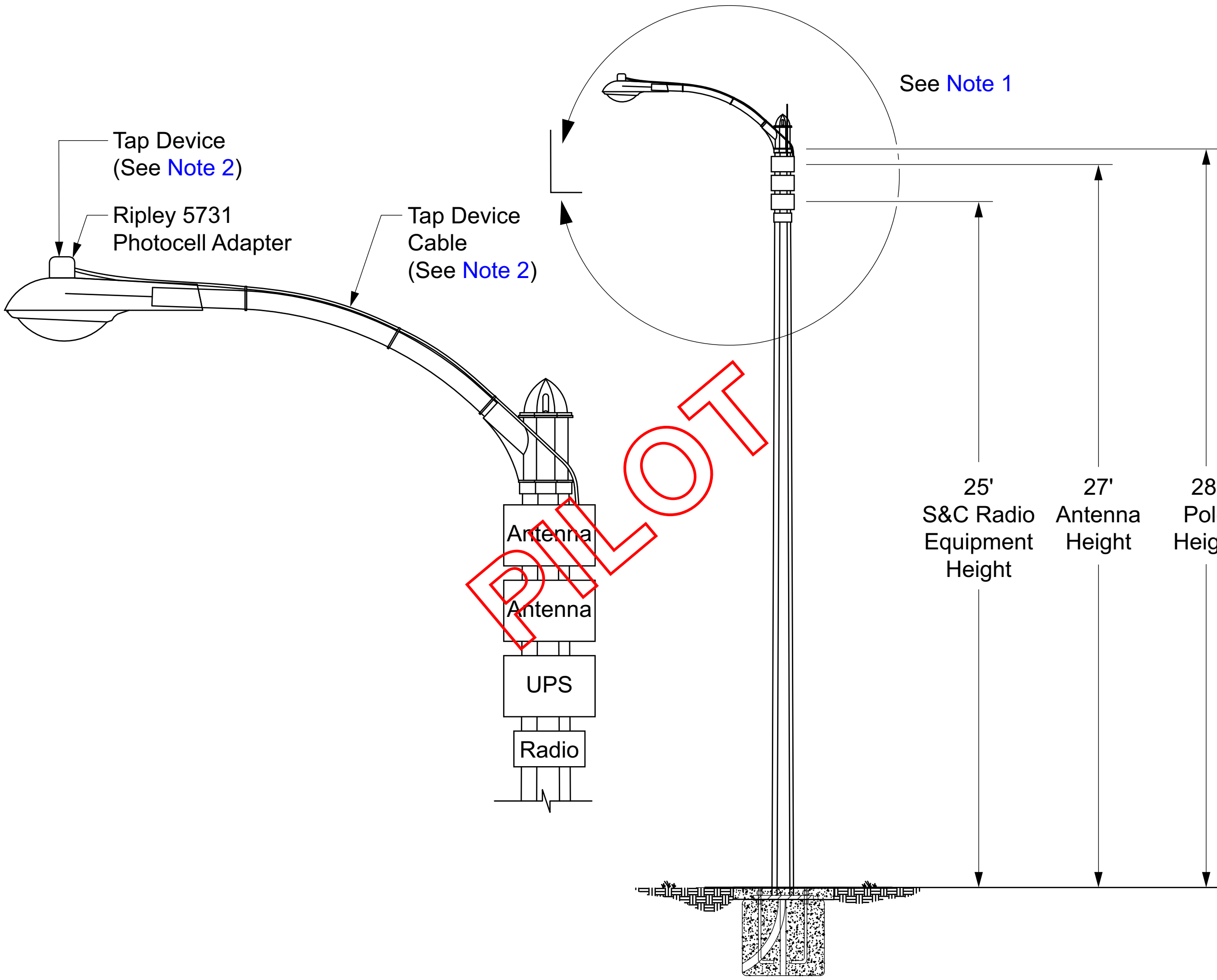
ISGD 100P S&C IntelliComm Repeater Radio Mounted on SCE LS-1 Marbelites (Underground Fed Only)

Scope ISGD 100P.1 S&C IntelliComm Repeater Radio Mounted on SCE LS-1 Marbelites (Underground Fed Only)

Figure ISGD 100P–1: S&C IntelliComm Repeater Radio Mounted on SCE LS-1 Marbelites (Underground Fed Only)



Note(s):

1. S&C IntelliComm Antenna, Uninterruptible Power Supply (UPS) and Radio.
2. One Time Auxiliary Power (TAP) device is allowed per light fixture. The TAP device cable shall be secured to the mast arm with not less than five evenly spaced 1/2-inch steel bands. The TAP device cable transitioning from the mast arm to the equipment shall be secured to the pole with not less than two evenly spaced 1/2-inch steel band.
3. The antennas and radio shall be secured using steel bands. The UPS shall be mounted using a unistrut.
4. Equipment must be installed opposite vehicular traffic space and shall not interfere with the intended illumination pattern.
5. A maximum of one hundred twenty five (125) watts or less rated consumption attached to any one streetlight secondary circuit connected to SCE's transformer.
6. For emergency situations (for example, pole has been struck by a car), contact decal number shall be provided on the radio equipment.

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DOH–DESI: Distribution Energy Storage Integration

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DESI 100P Distribution Energy Storage Integration 1 (DESI) Pilot

Scope DESI 100P.1 Distribution Energy Storage Integration Monitoring Node

1.0 General Information

These instructions cover the Distribution Energy Storage Integration 1 project (DESI 1) Monitoring Node installation. The system is to be connected to the Scarlet 12 kV out of Orange Substation (5086875). The Monitoring Node utilizes an SEL-735 meter and 4G radio to collect and transmit circuit information to support the operation of the DESI system.

Contact Advanced Technology (Energy Storage Hotline — (909) 469-0224) for more information/questions.

2.0 Operation Procedures for DESI 1 Pole Monitoring point (Scarlet Circuit Feeder Head)

Notify the Switching Center before performing any operations on DESI 1 Pole Monitoring point. Perform switching after confirming the assigned line device number, circuit name, source substation, and the equipment type with the Switching Center.

2.1 Procedure for Removing Pole Monitoring from Service

STEP 1. Close the bypass switch.

STEP 2. Open the load (L) disconnects.

STEP 3. Open the source (S) disconnects.

2.2 Procedure for Returning Pole Monitoring to Service

With the Bypass switch closed

STEP 1. Close the source (S) disconnects.

STEP 2. Close the load (L) disconnects.

STEP 3. Verify current distribution through the CT's by interrogating the SEL relay:

Navigate through the Menu Keypad in conjunction with the LCD to view and verify current readings IA, IB, and IC within present loading constraints (at least 10 percent)

STEP 4. Open the bypass switch.

2.3 Procedure for Replacing Metering Cabinet

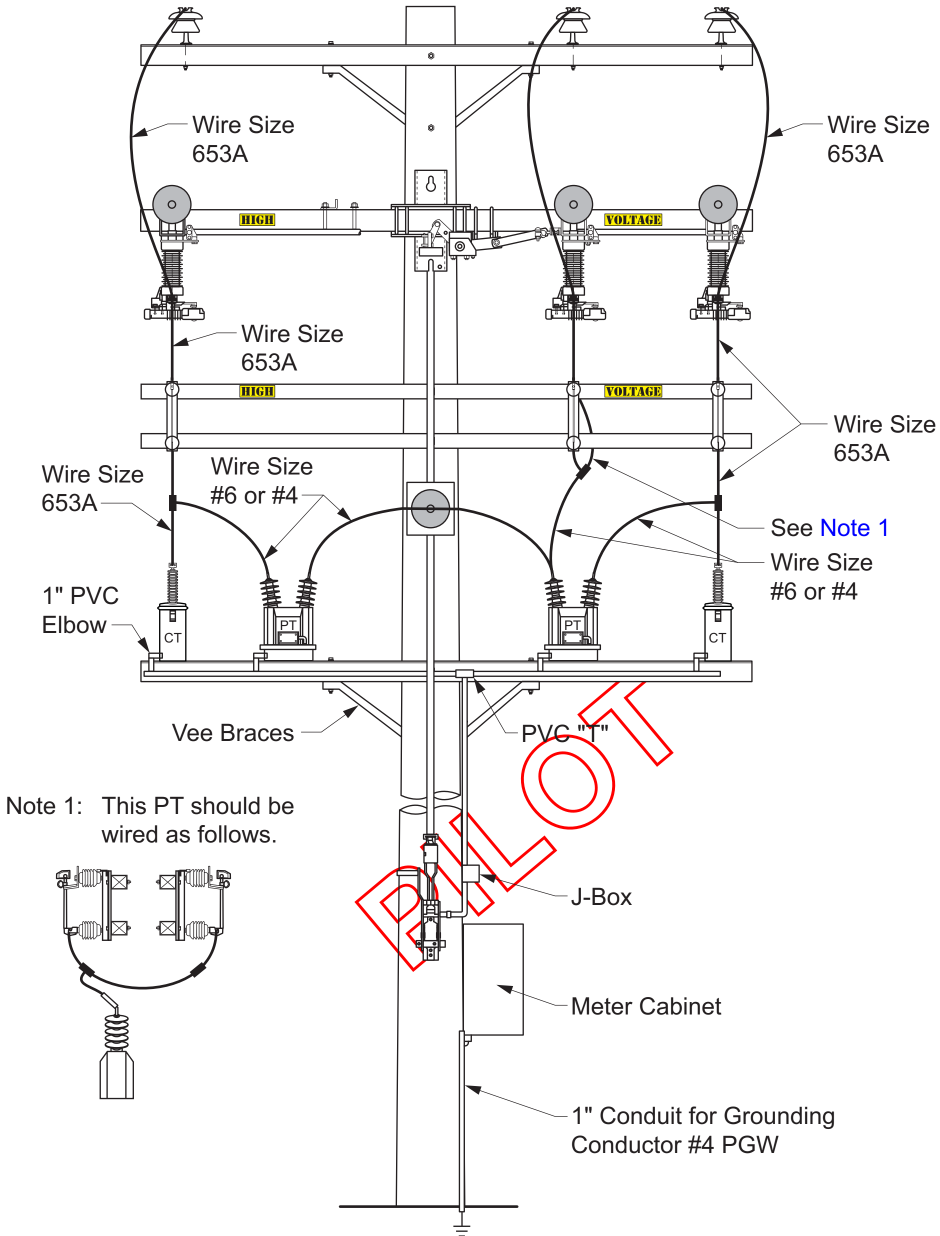
In order to replace the metering cabinet, the PTs and CTs shall be bypassed and de-energized in order to avoid open circuiting the CTs secondaries and allow removal of the voltage wiring.

STEP 1. Follow Part A above "Procedure for Removing Pole Monitoring from Service".

STEP 2. Replace cabinet and connect wires from cabinet to the Junction Box.

STEP 3. Follow part B above "Procedure for Returning Pole Monitoring to Service".

Figure 100P–1: DESI Monitoring Node (Front View)



Note(s):

1. See Note 1 in the drawing for wiring of one of the PTs.
2. See PO 120 for High Voltage sign installation requirements.
3. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
4. Refer to DAP, AP 336.2 for Omni-Rupter installation details.
5. See T 399.2 for 12/16 kV, 3Ø, 3-Wire Pole Top Metering Installation.
6. Use #12 stranded wire for monitoring box inputs.

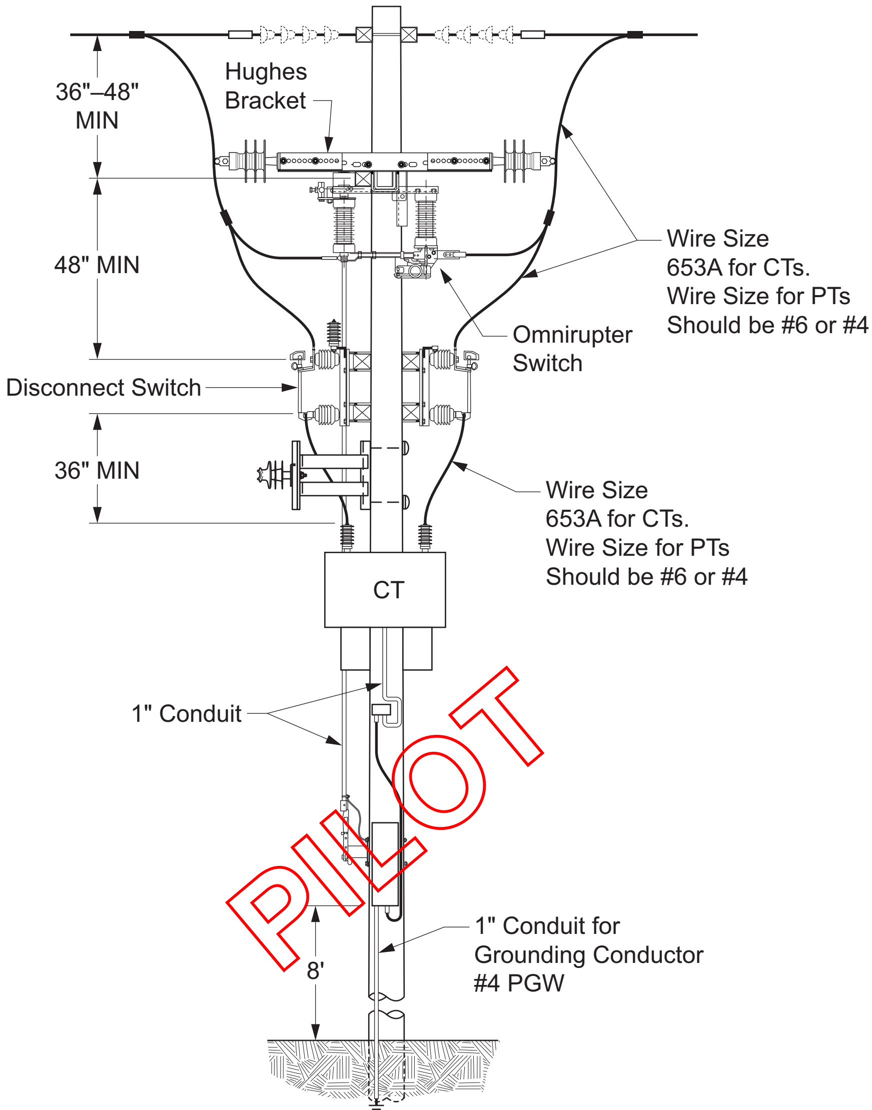
Distribution Energy Storage Integration 1 (DESI) Pilot

What's Changed? Figure DESI 100P-1 was updated for clarity and to reflect the field installation. Changed “Avian” to “Wildlife”.

Approved by:

Effective Date: 04-29-2016

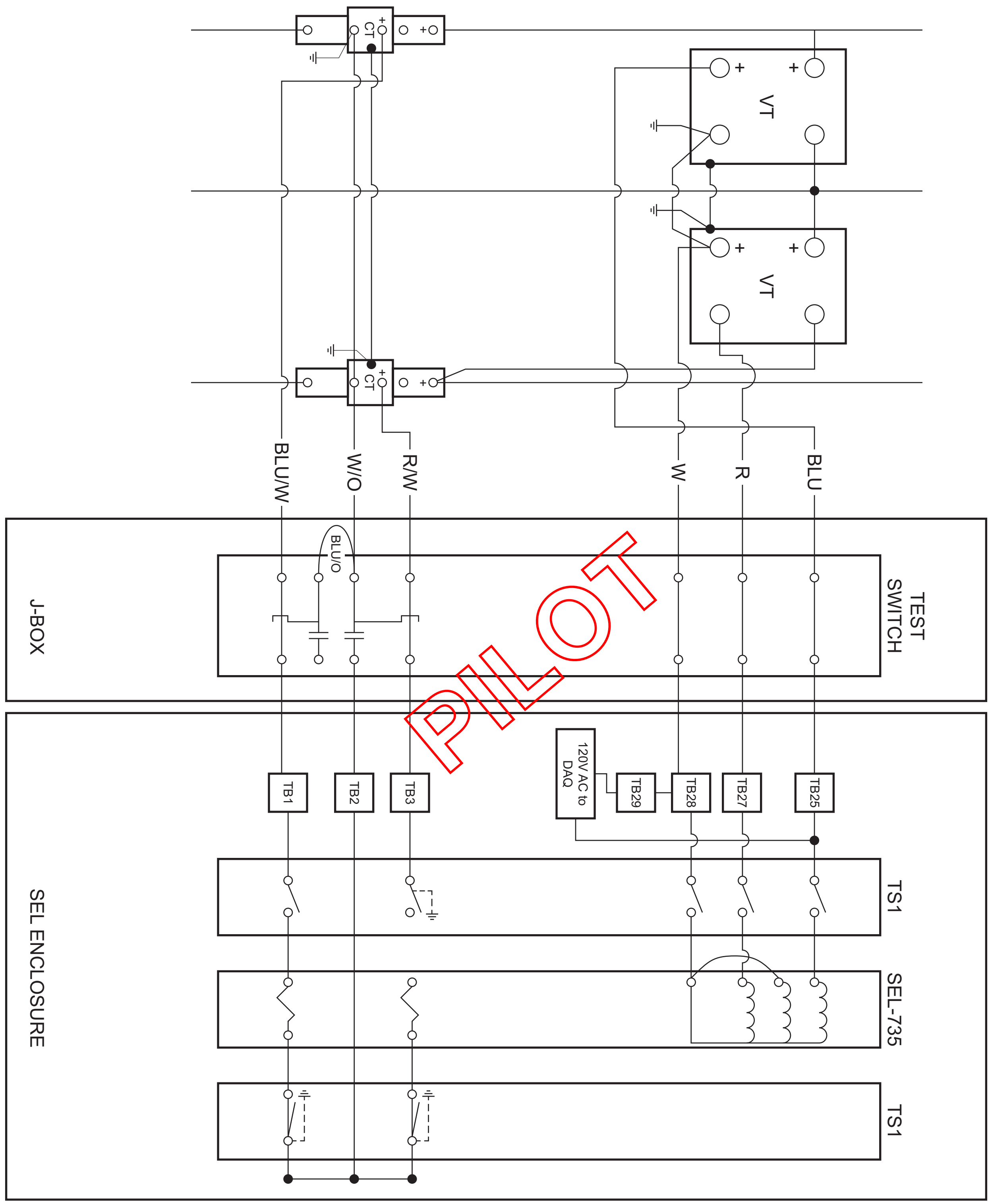
Figure 100P–2: DESI Monitoring Node (Side View)



SIDE VIEW

Approved by:	Distribution Energy Storage Integration 1 (DESI) Pilot	DESI 100P
Effective Date: 04-29-2016	**What's Changed?** Figure DESI 100P-2 was updated for clarity and to reflect the field installation.	Sheet 3 of 4 DOH

Figure 100P–3: Monitoring Box Wiring Diagram



Distribution Energy Storage Integration 1 (DESI) Pilot

What's Changed?

Approved by:

Effective Date:
04-29-2016

DOH–IGP: Intergrated Grid Project

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STANDARD **TITLE**

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IGP 100P Three Phase Overhead Remote Integrated Switch (RIS)

Scope IGP 100P.1 Remote Integrated Switch (RIS) Installation Details

1.0 General Information

The G&W 27 kV Viper-S RIS can be applied on the 12 kV, and 16 kV systems. The G&W Viper-S RIS has a continuous current rating of 630 amps and an interrupting rating of 12.5 kA symmetrical.

2.0 Control Power Transformer (CPT) Fusing

The following fusing practices shall be implemented for the CPT:

2.1 CPT located on the same pole

A primary current-limiting device (CLD) and secondary fuse shall be used for protection with the solid dielectric transformers. The secondary fuse is supplied with the CPT. The clearance between the bypass switch crossarm and upper buck arm shall be four feet minimum when CLDs are used.

3.0 Installation Details

All new RIS installations shall be automated with the installation of a NetComm radio.

Install wildlife guards (SAP 10067758 or SAP 10067753) on all RIS bushings. To provide a location for grounding at the disconnect switch terminals; leave six-inches of uncovered conductor on the leads that terminate on the Viper-S.

Install the wildlife-safe current limiting (CL) fuse cover (SAP 10067793) on CPT's with CLD fusing. Protective ground wire (PGW) (SAP 10109302) may be used for taps for the CPT. Wire covers shall be installed on all bare conductor leads. Use wire cover (SAP 10117061) for #2 AWG bare copper. Use wire cover (SAP 10117062) for 2/0 and 4/0 copper.

The CPT (SAP 10105102) has secondary taps for use on either 12 kV or 16 kV applications. One leg of the secondary shall be grounded. For 12 kV applications, X3 shall be grounded. For 16 kV applications, X2 shall be grounded. DO NOT ground the primary neutral at the RIS installation location.

Surge arresters are required for protection of the RIS and CPT. Arresters shall be installed on the line and load sides of the RIS (refer to DAP, Table AP 410–1). Mount arresters directly on frame of Viper-S (see Figure IGP 100P–1).

To increase the space for maintenance of the RIS, 12-foot crossarms and the use of the outer insulator pin positions are recommended for primary underbuild applications.

Underbuild circuits shall have a minimum four-foot clearance between the conductors and the bottom of the RIS frame. Communication conductors shall have a minimum four-foot clearance to the bottom of the RIS frame. See DC 200 for clearances between conductors and communication levels.

Hard drawn copper wire is required for RIS taps for mechanical strength and to prevent interactions of aluminum with the RIS copper alloy terminals. The RIS tap requirements are detailed in Table IGP 100P–1. The standard RIS terminals will accept conductor range between #2-500MCM. For larger wire sizes NEMA style terminals can be attached to the RIS terminals.

Figure IGP 100P–1: Surge Arrester Mounting Detail

Note(s):

1. Use additional NEMA arrester bracket (SAP 10067357) and T-Bolt connector (SAP 10110829) to mount arresters to Viper-S frame. Attach arrester ground lead to T-Bolt connector.
2. Use 3/8-inch round washers (SAP 10072002), 3/8" × 2" bolts (SAP 10070382), 3/8-inch helical spring washers (SAP 10072344), and 3/8-inch hex nuts (SAP 10069734) to assemble NEMA brackets.

Table IGP 100P–1: RIS Tap Requirement Chart

Item	RIS Conductor Requirements	Aluminum Span Conductor			Copper Span Conductor	
		#4 through #2 ACSR	1/0 through 4/0 ACSR	336.4 ACSR	#4 through 2/0 Cu	4/0 Cu
1	Leads between the span conductors and disconnect switches	#2 Cu Hard Drawn SAP 10109330	2/0 Cu Hard Drawn SAP 10109331	4/0 Cu Hard Drawn SAP 10109332	2/0 Cu Hard Drawn SAP 10109331	4/0 Cu Hard Drawn SAP 10109332
2	Leads between the disconnect switches and the RIS terminals	2/0 Cu Hard Drawn SAP 10109331	4/0 Cu Hard Drawn SAP 10109332	4/0 Cu Hard Drawn SAP 10109332	4/0 Cu Hard Drawn SAP 10109332	4/0 Cu Hard Drawn SAP 10109332
3	Maximum Loading (amps)[a/]	160-210	280-415	540	195-405	540

[a/] Loading can be limited by the RIS ratings, tap sizes, and span wire sizes. The values in the chart assume an RIS continuous rating of 630-amps, the range is based on the available range of the span conductors.

4.0 Remote Integrated Switch prior to Commissioning after Construction

After the installation of the RIS, the equipment needs to be commissioned by Distribution Apparatus Test. The construction crew shall configure the equipment for Distribution Apparatus Test as follows:

- Line and Load disconnects connected to both the source and the RIS.
- Line and Load disconnects in the OPEN position.
- RIS breaker in the OPEN position.
- By-pass switch in CLOSED position, unless otherwise indicated on the Work Order.
- PT tapped to the primary circuit (see Figure IGP 100P–3 for secondary connection details):
  — If the circuit is energized, check for 120 V at the controller and connect the controller battery.
  — If the circuit is not energized, controller battery shall not be connected.
- Release to substation jurisdiction that RIS has been installed and is NOT READY FOR SERVICE, Follow the procedure stated in System Operating Bulletin #25.

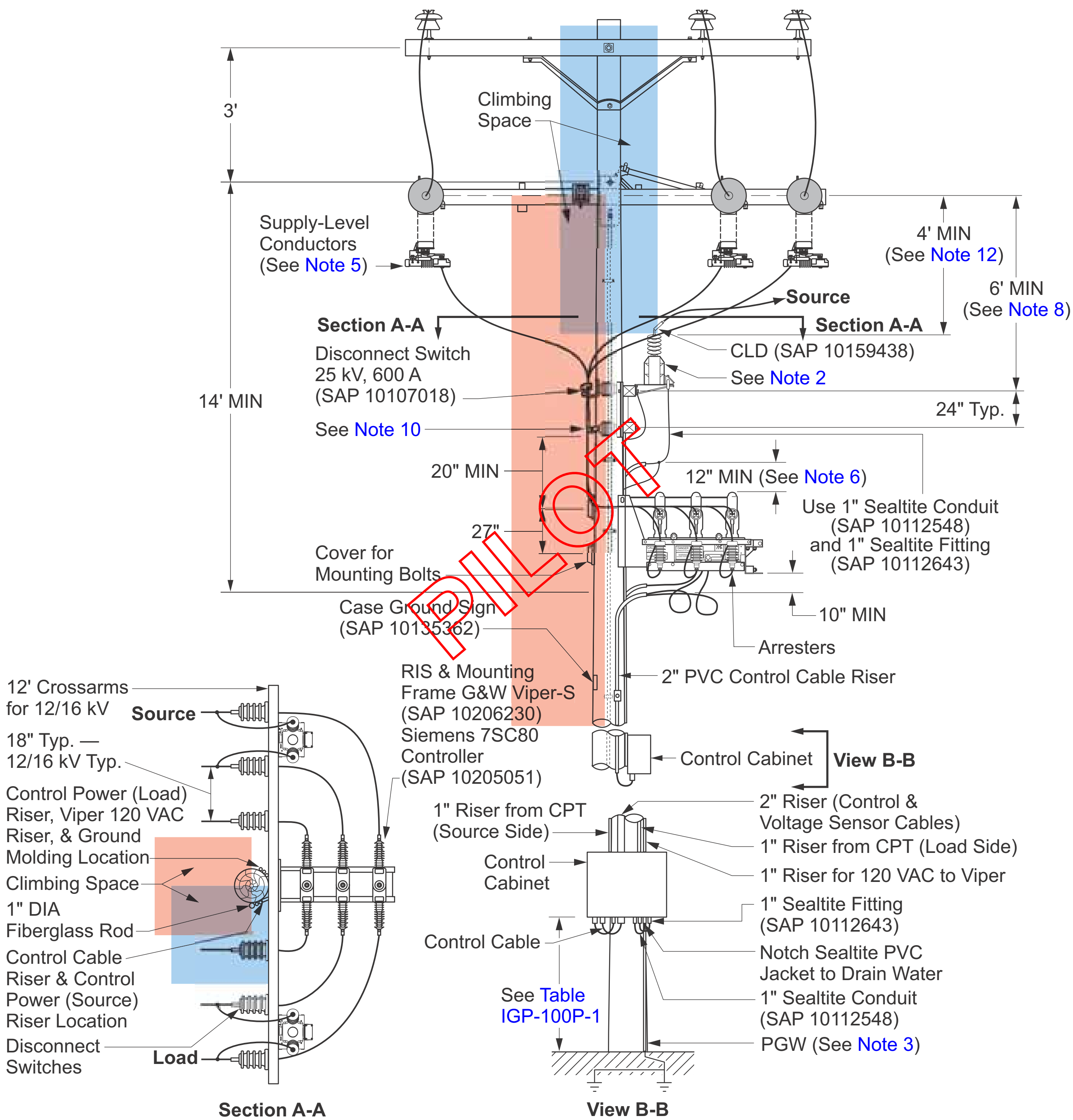
5.0 Controller Mounting Height Requirements

Table IGP 100P–2: RIS Controller Mounting Height Requirements

Preferred	**8 Feet Above Ground**
Lower (4–8 feet)	All the following conditions shall be met (Usually in Rural Areas): ● Away from obstacles — fences and walls ● Away from parking area ● Away from traffic signals ● Away from traffic — Vehicle and pedestrian OR in SCE Substation and locked fence areas
Higher than 8 feet	At a specified height, as determined by the planner, after contacting the responsible Apparatus Foreman due to the following conditions: ● Ability to work over fence with bucket truck ● Bus Stop ● Communications obstacles ● Fences and walls ● Parking area ● Slopes ● Traffic — Vehicle and pedestrian ● Trees and shrubs Examples: ● 6 feet below communication cable (usually 12'–15' above ground) ● 4 feet below communication cable with no junction box (usually 14'–17' above ground) ● 13'-6" above ground level to clear truck traffic Note: Contact the responsible Apparatus Foreman if the control is planned to be mounted above 8 feet.

Scope IGP 100P.2 Remote Integrated Switch (RIS) for 12/16 kV Installations

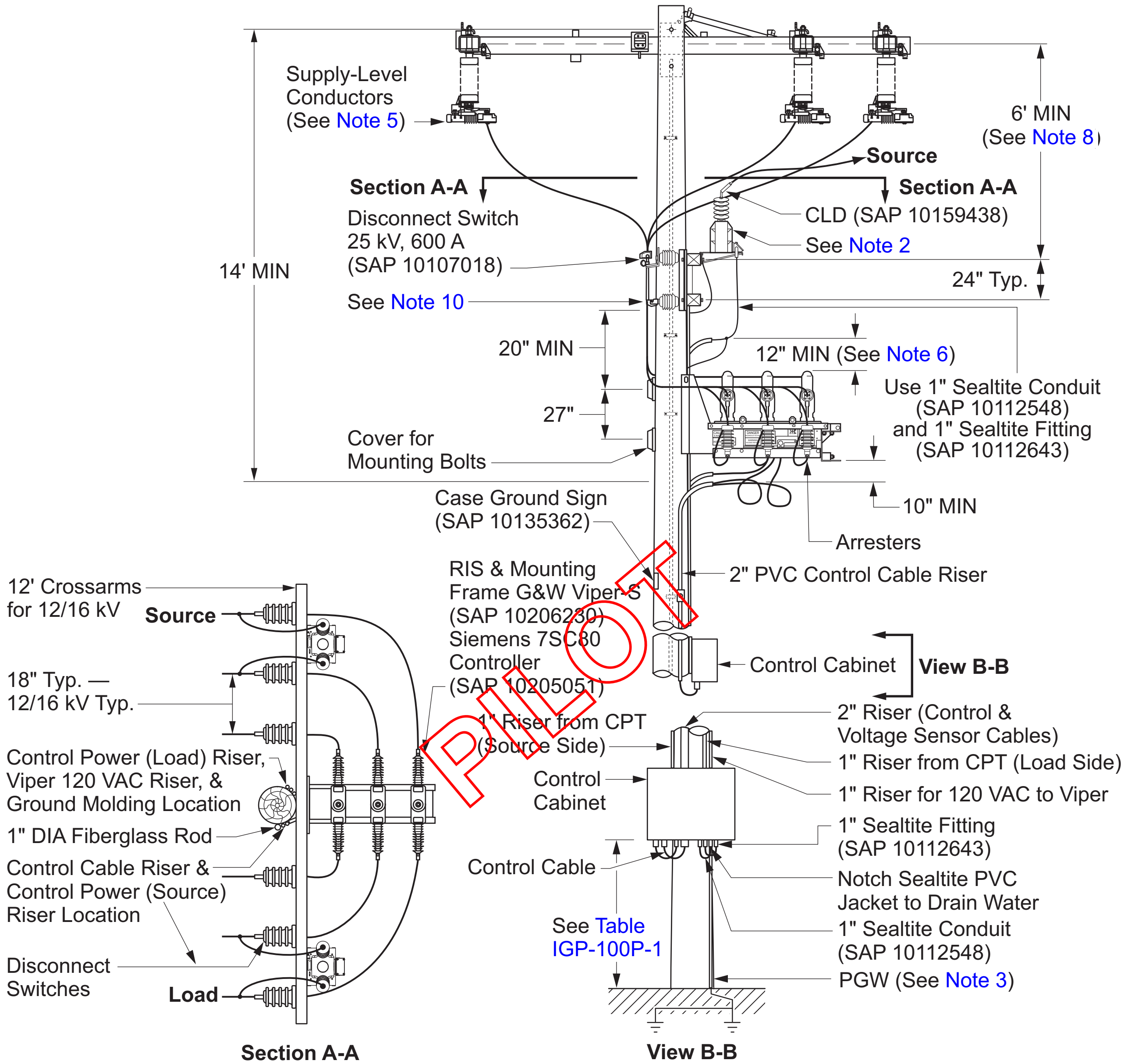
Figure IGP 100P–2: Typical G&W Viper-S Electronic RIS for 12/16 kV Dual CPTs (Alternate Mehod Using Hughes Adapter)



Note(s):

1. The CPTs shall serve no load other than the RIS and RIS controls.
2. CPTs to be rated 980 VA solid dielectric with 120 V fused secondary. CPT (SAP 10105102); CPT bracket (SAP 10104923). Do not ground the CPT brackets.
3. See Scope IGP 100P.3 for RIS, control, and CPT grounding. See GR 105 for ground conductor and connection requirements.
4. Refer to DAP, AP 336 for installation requirements for Omni-Rupter bypass switch, the supply conductors shall be dead-ended to the switch crossarm.
5. Maintain 12-inch minimum separation between high voltage bushings and the CPT mounting brackets, and all secondary leads.
6. Refer to DAP, AP 410 and GR 107 for surge arrester installation requirements.
7. Maintain 18-inch minimum (radial) separation between CPT or arrester leads/bushings and the switch blades.
8. To provide a location for grounding at the disconnect switch terminals, leave 6-inches of uncovered conductor on the leads that terminate on the RIS.
9. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
10. Use two T-Bolt connectors (2/0 AWG - 350 kcmil SAP 10110830; #6 AWG - 2/0 AWG SAP 10110829) per terminal pad to make connections at disconnect switches.
11. See PO 120 for High Voltage sign installation requirements.
12. Taps from the Hughes adapters to disconnect switches shall be formed so as not to obstruct the required climbing space. When possible, the inside (closest to the pole) and middle disconnects should be tapped to the Omni-rupter phases furthest from the climbing space.
13. Climbing Space required — 36" × 36".

Figure IGP 100P–3: Typical G&W Viper-S Electronic RIS for 12/16 kV Dual CPTs

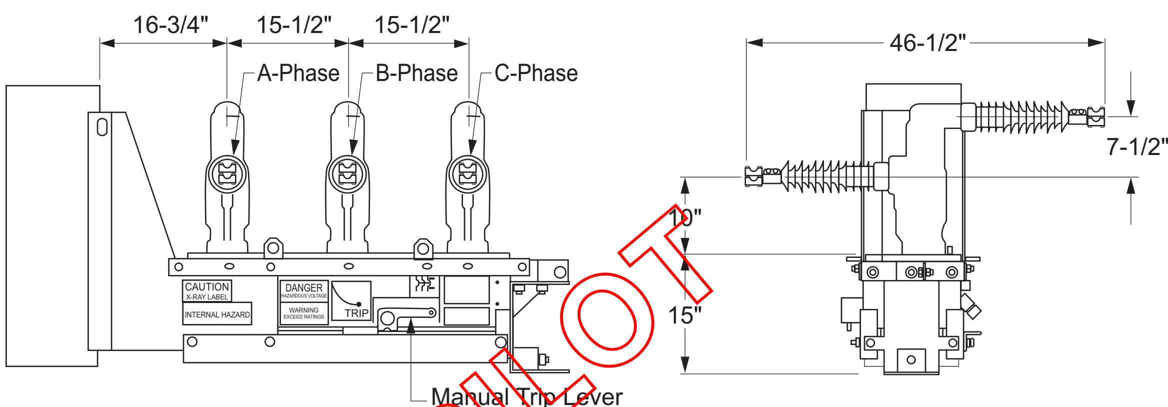


Note(s):

1. The CPTs shall serve no load other than the RIS and RIS controls.
2. CPTs to be rated 980 VA solid dielectric with 120 V fused secondary. CPT (SAP 10105102); CPT bracket (SAP 10104923). Do not ground the CPT brackets.
3. See Scope IGP 100P.3 for RIS, control, and CPT grounding. See GR 105 for ground conductor and connection requirements.
4. Refer to DAP, AP 336 for installation requirements for Omni-Rupter bypass switch, the supply conductors shall be dead-ended to the switch crossarm.

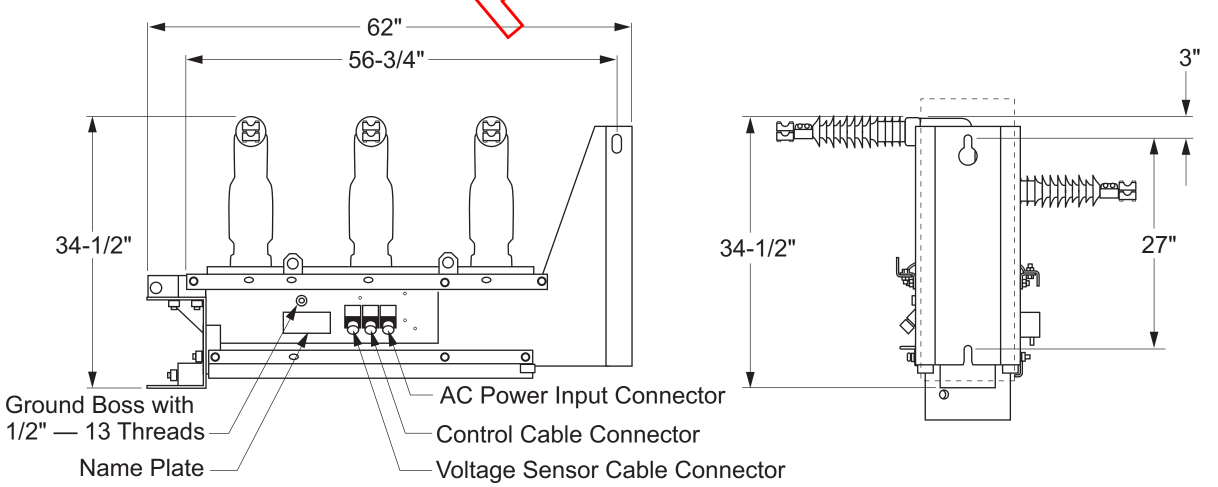
5. Maintain 12-inch minimum separation between high voltage bushings and the CPT mounting brackets, and all secondary leads.
6. Refer to DAP, AP 410 and GR 107 for surge arrester installation requirements.
7. Maintain 18-inch minimum (radial) separation between CPT or arrester leads/bushings and the switch blades.
8. To provide a location for grounding at the disconnect switch terminals, leave 6-inches of uncovered conductor on the leads that terminate on the RIS.
9. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
10. Use two T-Bolt connectors (2/0 AWG - 350 kcmil SAP 10110830; #6 AWG - 2/0 AWG SAP 10110829) per terminal pad to make connections at disconnect switches.
11. See PO 120 for High Voltage sign installation requirements.

Figure IGP 100P–4: G&W Viper-S



LEFT VIEW

FRONT VIEW

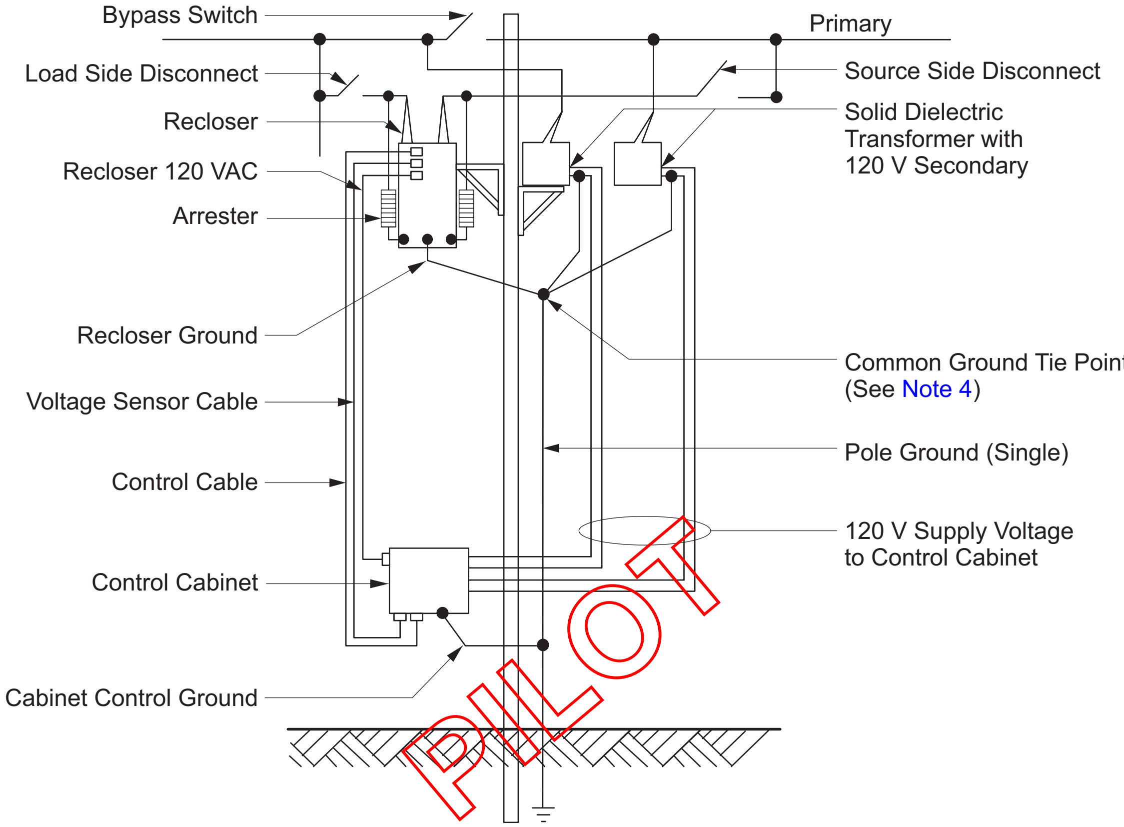


RIGHT VIEW

BACK VIEW

Scope IGP 100P.3 Typical RIS Connections with the Dual CPT Located on the Same Pole

Figure IGP 100P–5: Typical Connections for G&W Viper-S with Dual CPT Located on the Same Pole



Note(s):

1. The CPT shall serve no load other than the RIS and RIS control.
2. Control cable shielding shall be grounded to the RIS head and to the control cabinet.
3. RIS primary bushings are denoted “line” and “load”. Either side can be used for source or load with Viper RISs.
4. Surge arresters, transformer tank discharge gap, secondary neutral, RIS tank and frame, and control cabinet shall be connected to the same ground to minimize any potential ground differences between equipment.
5. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.

IGP 105P DNP Router Cabinet for Remote Integrated Switch

Scope IGP 105P.1 Typical Installation DNP Router Cabinet for Remote Integrated Switch (RIS)

1.0 General Information

One DNP Router is required for each RIS Operational Group. The DNP Router shall be installed on a Distribution or Transmission pole and shall not share the pole with any other distribution or Transmission equipment. The DNP Router can be applied on the 12 kV and 16 kV systems. Information Technology shall support selection of the optimal pole for the RIS Operational Group.

2.0 Control Power Transformer (CPT) Fusing

The following fusing practices shall be implemented for the CPT:

- A primary current-limiting device (CLD) and secondary fuse shall be used for protection with the solid dielectric transformer. The secondary fuse is supplied with the CPT.
- CPT shall be located on the same pole as the DNP Router.
- CPT shall serve no other load than DNP Router.

3.0 Installation Details

All new DNP Router installations shall be automated with the installation of two NetComm radios.

Install the wildlife-safe current limiting (CL) fuse cover (SAP 10067793) on CPT with CLD fusing. Protective ground wire (PGW) (SAP 10109302) may be used for taps for the CPT.

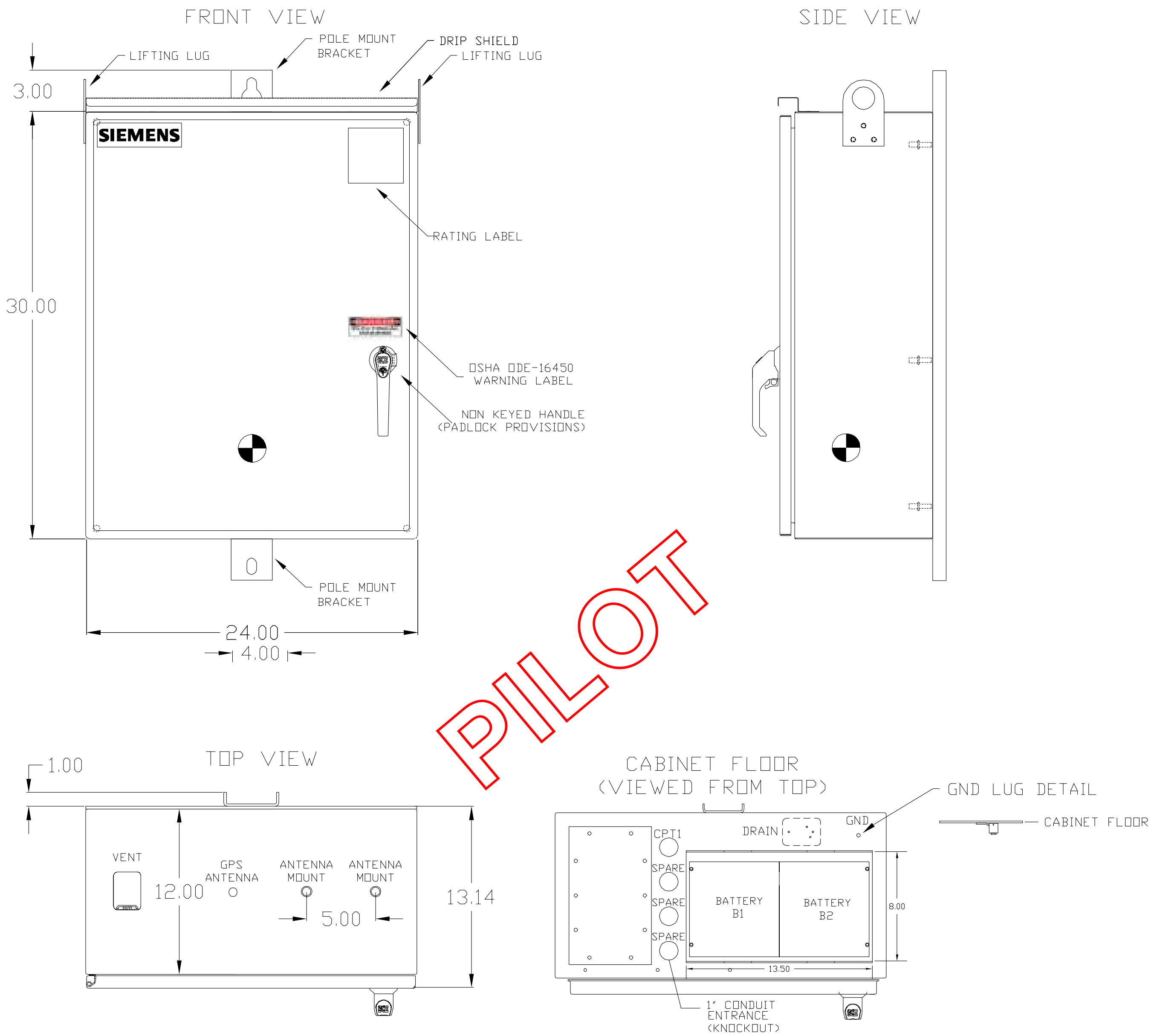
The CPT (SAP 10105102) has secondary taps for use on either 12 kV or 16 kV applications. One leg of the secondary shall be grounded. For 12 kV applications, X3 shall be grounded. For 16 kV applications, X2 shall be grounded.

Surge arresters are required for protection of the DNP Router and CPT. Refer to DAP, AP 410 for surge arrester installation. Refer to AP 400 for surge arrester applications. Refer to DAP, Table AP 410–1 for surge arrester selection.

See DC 200 for clearances between conductors and communication levels.

PILOT

Figure IGP 105P–1: Typical DNP Router Cabinet for Remote Integrated Switch



Note(s):

1. Control panel weight = 140 lb, Each Lifting Lug Capacity = 1,100 lb, Safety Factor = 15.7.
2. Center of Mass is located 10.5-inches from bottom, 4-inches from front, 12-inches from left side (looking at front).

4.0 DNP Router prior to Commissioning after Construction

After the installation of the DNP Router, the equipment needs to be commissioned by Distribution Apparatus Test. The construction crew shall configure the equipment for Distribution Apparatus Test as follows:

- PT tapped to the primary circuit (see Figure IGP 105P–3 for secondary connection details):
  — If the circuit is energized, check for 120 V at the controller and connect the controller battery.
  — If the circuit is not energized, controller battery shall not be connected.
- Release to substation jurisdiction that DNP Router has been installed and is NOT READY FOR SERVICE, Follow the procedure stated in System Operating Bulletin #25.

5.0 Controller Mounting Height Requirements

Table IGP 105P–1: DNP Router Mounting Height Requirements

Preferred	**8 Feet Above Ground**
Lower (4–8 feet)	All the following conditions shall be met (Usually in Rural Areas): • Away from obstacles — fences and walls • Away from parking area • Away from traffic signals • Away from traffic — vehicle and pedestrian OR in SCE Substation and locked fence areas
Higher than 8 feet	At a specified height, as determined by the planner, after contacting the responsible Apparatus Foreman due to the following conditions: • Ability to work over fence with bucket truck • Bus Stop • Communications obstacles • Fences and walls • Parking area • Slopes • Traffic — vehicle and pedestrian • Trees and shrubs Examples: • 6 feet below communication cable (usually 12'–15' above ground) • 4 feet below communication cable with no junction box (usually 14'–17' above ground) • 13'-6" above ground level to clear truck traffic **Note:** Contact the responsible Apparatus Foreman if the control is planned to be mounted above 8 feet.

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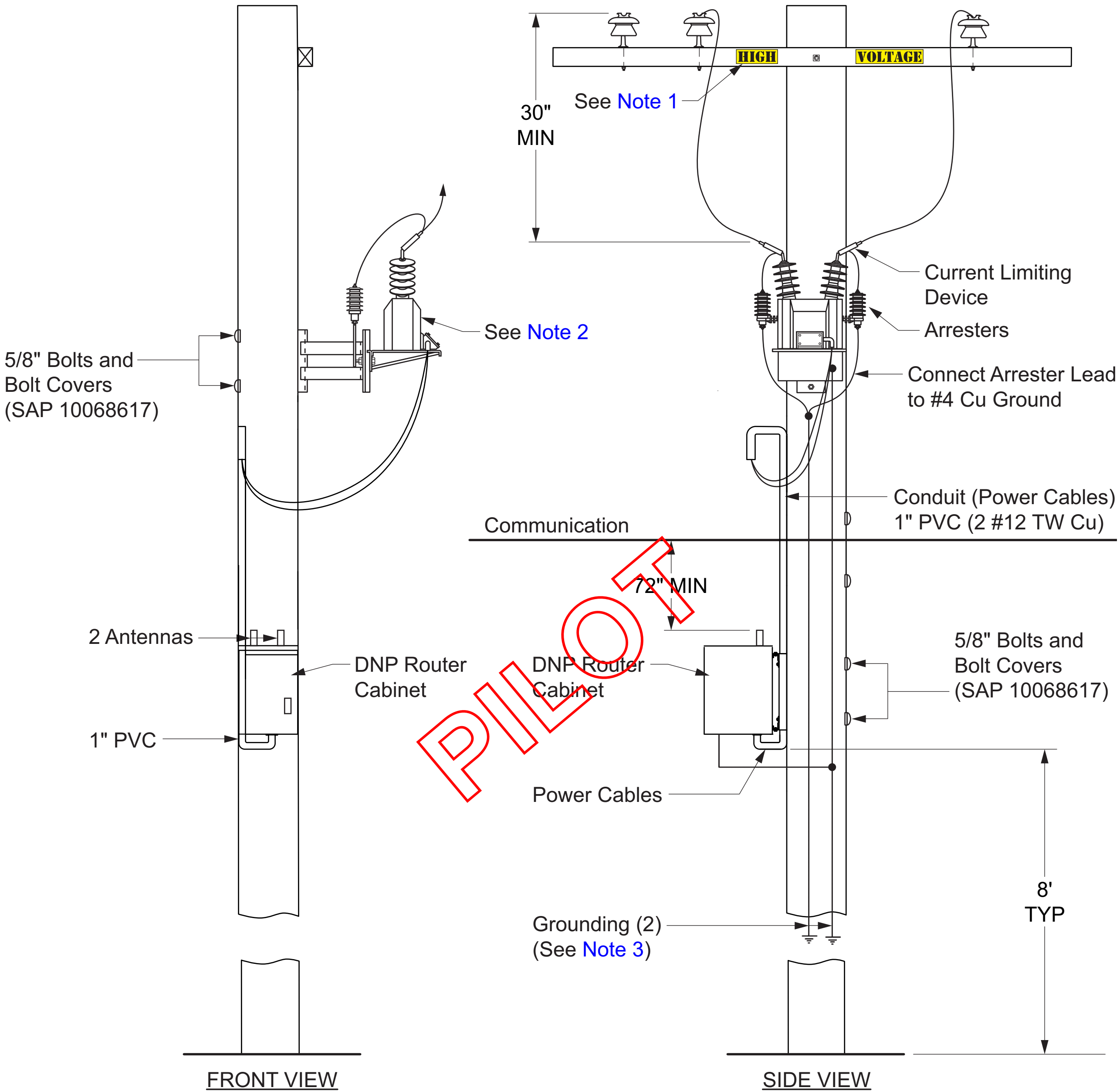
Figure IGP 105P–2: Typical Installation DNP Router Cabinet for Remote Integrated Switch

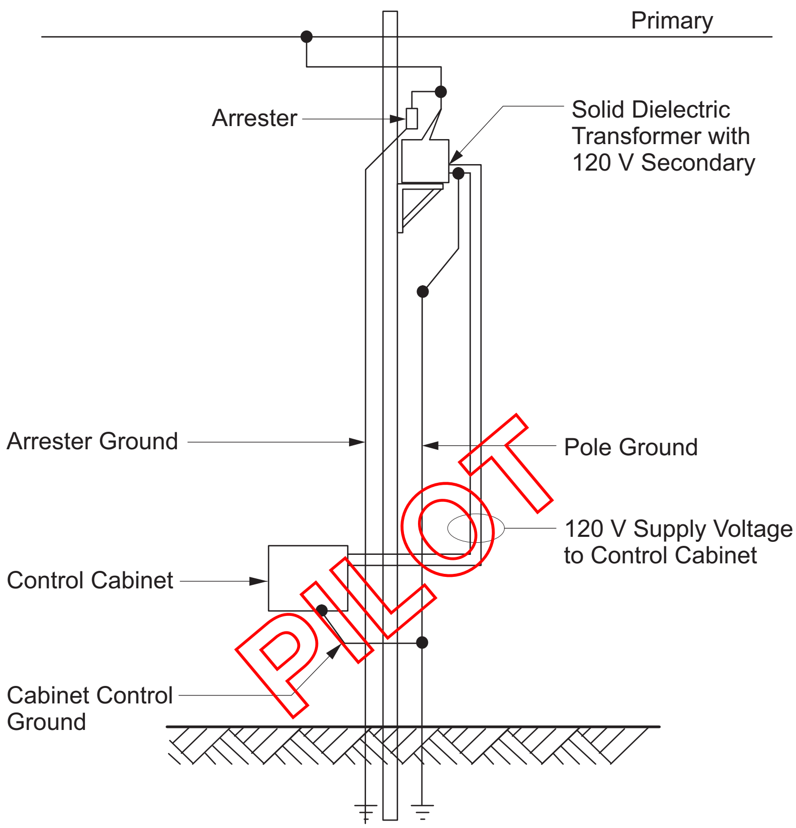


Note(s):

1. See PO 120 for High Voltage sign installation requirements.
2. CPT to be rated 980 VA solid dielectric with 120 V fused secondary. CPT (SAP 10105102); CPT Bracket (SAP 10104923), and transformer extension bracket (SAP 10067312). Do not ground CPT bracket. (refer to DAP, Figure AP 363–1 for details).
3. Potential transformers secondary neutral, and DNP router enclosure shall be connected to a common ground to minimize any differences of potential between the equipment (see GR 105). Surge arresters shall be grounded using its own separate ground.

4. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
5. Distribution equipment shall not exist on the pole with the DNP router cabinet.
6. When installed near vehicular traffic the equipment shall be installed on the opposite side of the pole.

Figure IGP 105P–3: Typical Connections for G&W Viper-S with Dual CPT Located on the Same Pole



Note(s):

1. Surge arrester shall be grounded using its own separate ground.

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IGP 110PField Area Network (FAN) Radio Integration Pilot

Scope IGP 110P.1 FAN Integration Pilot General Information

1.0 Definitions

CGR 1120: Connected Grid Router 1120 — Cisco's indoor rated, 900 MHz, rack-mountable FAD. If mounted outdoors, it requires a NEMA enclosure, and external omnidirectional antenna.

CGR 1240: Connected Grid Router 1240 — Cisco's outdoor rated, 900 MHz, pipe-mountable FAD. It comes with a direct mounted, low profile, omnidirectional antenna. Additionally, a variety of larger omnidirectional antennas are available that require a short run of coaxial cable to an external mounting solution.

6430-C: ABB's outdoor rated, 900 MHz/2.4 GHz/5 GHz, pipe mountable FAD.

FAD: FAN Aggregation Device — Headend radios that are most often going to be located at a substation or service center on a tower or monopole. Additionally, FAD's come optional as an indoor unit or an outdoor unit.

FAN: Field Area Network — SCE's future radio network (currently NetComm).

IGP: Integrated Grid Project — SCE's production pilot/demonstration scheduled for summer 2017, which will include testing of the FAN in the Orange County area.

WAN: Wide Area Network — Generic term describing a network that generally spans a wide geographical area. In the case of this project, the WAN is the FAN or vice versa.

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2.0 General Information

The Integrated Grid Project (IGP) project is designed to test controls and equipment that will inform the deployment of SCE's Grid Modernization program.

SCE has traditionally used NetComm as the two-way communication link for distribution monitoring and control. The IGP and Grid Modernization require the use of new FAN radios to provide next level grid operation capabilities including the control of Distributed Energy Resources (DER).

The FAN radios are being tested as a part of the IGP. The FAN radios will be used to control select capacitor controllers, photovoltaic installations, and IGP energy storage devices. FAN radios will also be installed in a test network, not connected to any other equipment, to provide real world simulations on an ad-hoc basis.

The FAN network will be installed in the Santa Ana and Saddleback Districts and will include:

- Repeaters for new Field Area Network (FAN)
- FAN radio/antenna incorporated into SCE and 3rd party DERs
  - — Capacitor controller
  - — IGP Energy Storage Devices (DOS)
  - — PV (Photovoltaic) Inverters
  - — RCS+ with LineScope sensors for Microgrid monitoring point

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Table IGP 110P–1: Details for Field Installations: FAN IGP and Simulated Networks

Unit Model	Unit Type	Freq. Band	Power Required	IGP Net	Sim. Net	Mount Type	Antenna Mount	Location
			Cisco					
CGR 1240	FAD	900 MHz	120/240 VAC	Yes	Yes	Tower	Integrated	Johanna/COCDO
CGR 1120	FAD	900 MHz	120/240 VAC/ 10.6-52 VDC	Yes	No	Rack	External	Camden
IR510	FD	900 MHz	VAC/VDC?	Yes	Yes	DIN	External	Solar/PCC
IR530	Range Extender	900 MHz	120/240 VAC	Yes	Yes	Pole	Integrated	Mastarm/ Streetlight Arm
IW3702	AP/Range Extender	2.4/5.8 GHz (4×4 MIMO)	12-48 VDC/PoE	No	Yes	Tower/Pole	Integrated	COCDO/Sim Field
IR829	FD	2.4/5.8 GHz	9-32 VDC	No	Yes	DIN	External	Solar
			ABB					
6430-C	FAD/WID/Range Extender	900 MHz/ 2.4/5.8 GHz	12-48 VDC ((PoE) LAN Port)/ 120/240 VAC w/battery	Yes	Yes	Tower Pole	Integrated	All 3 subs/ Sim Field/IGP Field
2410	FD	2.4 GHz	12 VDC	No	Yes	DIN	External	Solar
DA Gateway	FD	900 MHz	? VDC	Yes	Yes	DIN	External	Solar/PCC

Scope IGP 110P.2 FAN Device Installation Procedures

1.0 Installation Procedures

1.1 Programmable Capacitor Controller Installation

The FAN radios will come pre-installed and configured in each Programmable Capacitor Controller unit. The final installation will include plugging the capacitor controller into its socket and a performing a final end-point test. The Apparatus crew shall contact the Distribution Automation Hotline when installing, relocating, or removing automated equipment at 714-285-4325. Hours: Mon–Fri 7 a.m.–4 p.m. Available after hours/weekends upon request.

Figure IGP 110P–1: Capacitor Controller Manufacturer Radio

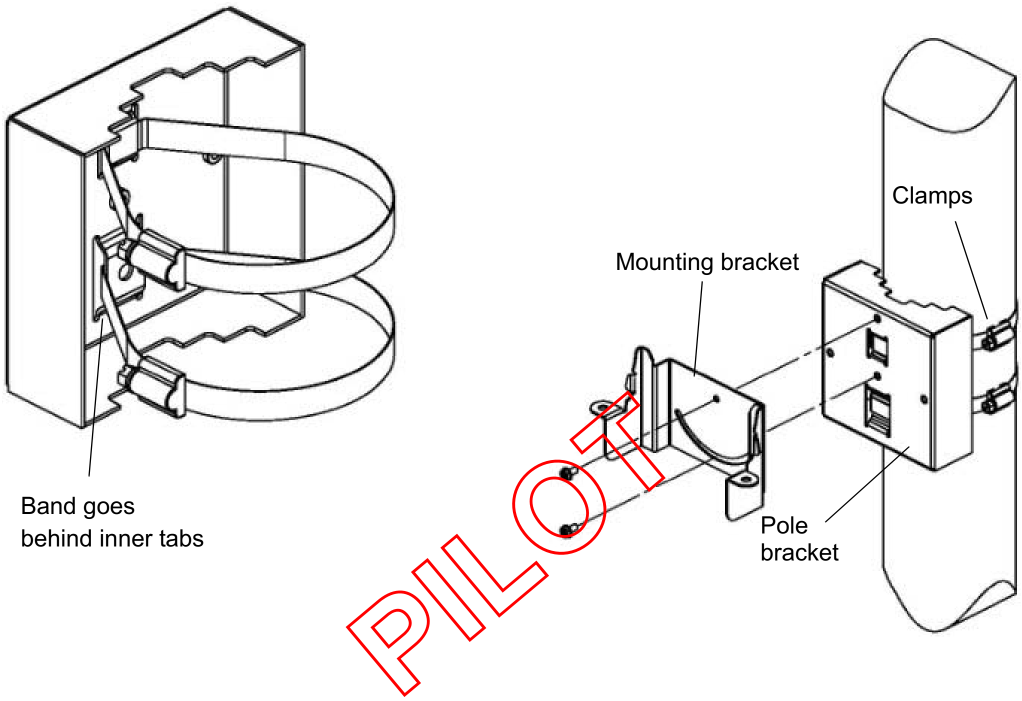
1.2 Pad-Mounted Programmable Capacitor Controller Installations

A new Programmable Capacitor Controller with a FAN radio will be swapped with the existing one. The existing antenna may need to be replaced with the antenna recommended by the vendor. No additional drilling will be required.

1.3 ABB FAN Radio Mounting Assembly

The mounting assembly contains two clamps to secure the router to the mast arm. Figure IGP 110P–2 depicts the use of the clamps. The clamps must be toured through slots in the mast arm bracket, then attached to the pole and tightened. The bracket should be leveled before final tightening.

Figure IGP 110P–2: ABB FAN Radio Mounting Assembly

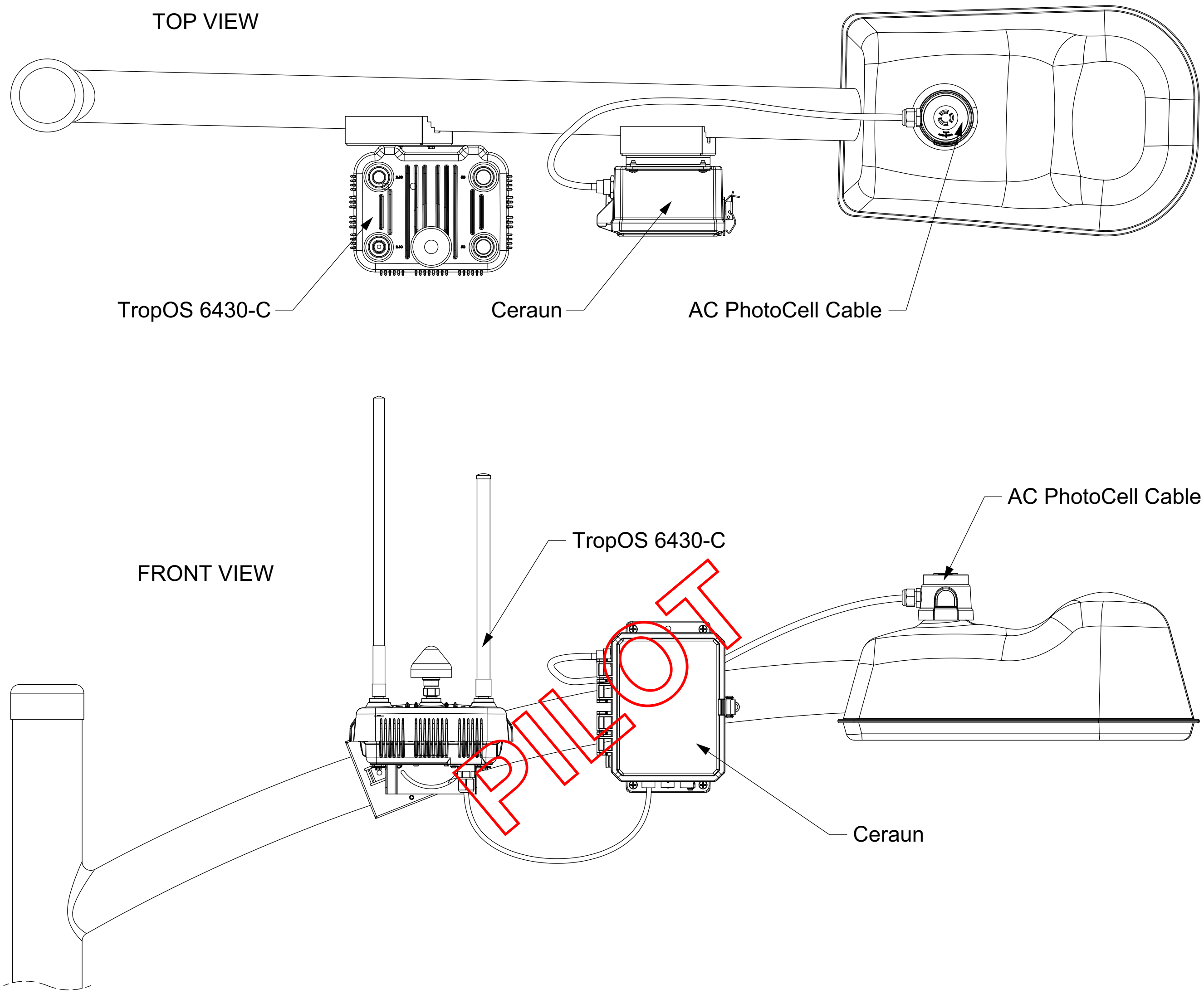


1.4 ABB FAN Radio Repeater Streetlight Installation

See Figure IGP 110P–3 for typical installation.

STEP 1. Attach mounting bracket to radio.
STEP 2. Install antennas onto radio.
STEP 3. Attach radio battery pack unit to mounting bracket. Do not over-tighten.
STEP 4. Mount radio battery pack unit on streetlight arm using steel bands.
STEP 5. Mount pole bracket on streetlight arm using steel bands.
STEP 6. Install radio onto pole bracket. Do not over-tighten.
STEP 7. Wire devices using photocell adapter and included cable.

Figure IGP 110P–3: ABB FAN Radio Repeater — Streetlight Installation

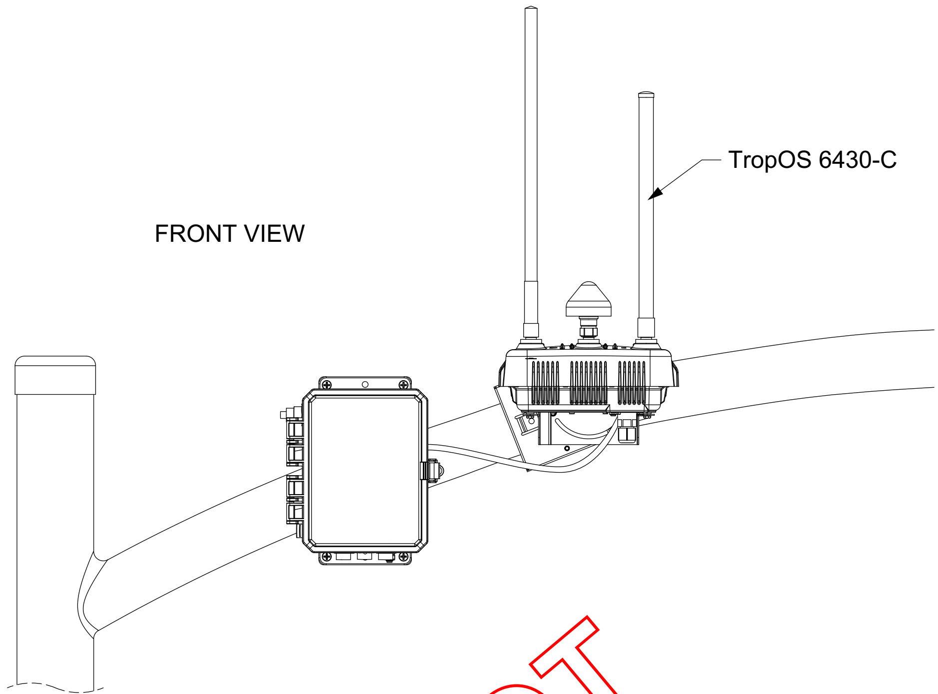


1.5 ABB FAN Radio Repeater Mast Arm Installation

See Figure IGP 110P–3 for typical installation.

STEP 1. Attach mounting bracket to radio.
STEP 2. Install antennas onto radio (hand-tight).
STEP 3. Attach radio battery pack unit to mounting bracket. Do not over-tighten.
STEP 4. Mount radio battery pack unit on mast arm using steel bands.
STEP 5. Mount pole bracket on mast arm using steel bands.
STEP 6. Install radio onto pole bracket. Do not over-tighten.
STEP 7. Wire devices using included power cable.

Figure IGP 110P–4: ABB FAN Radio Repeater — Mast Arm Installation

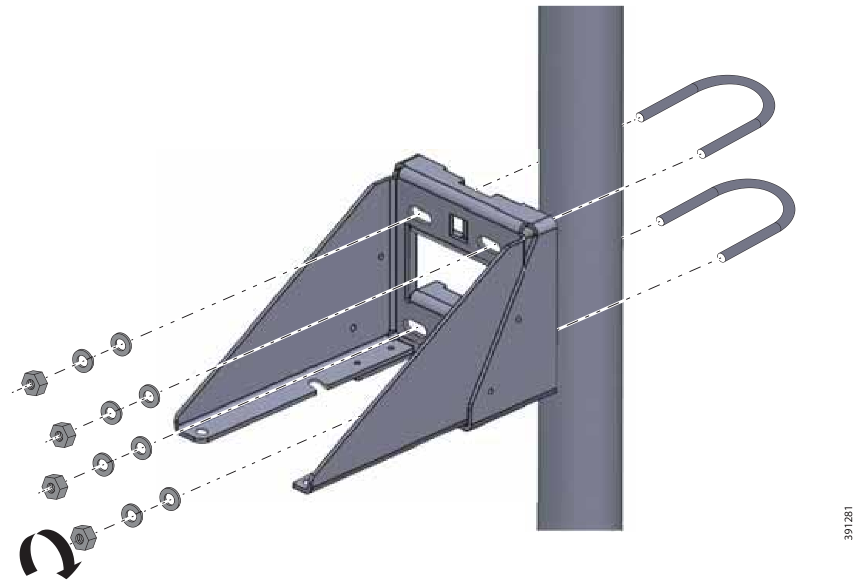


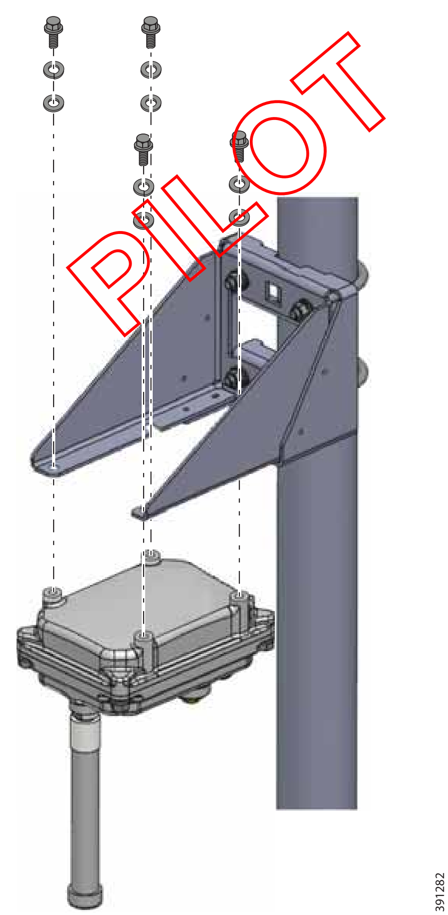
1.6 Cisco FAN Radio Repeater Mast Arm Installation

See Figure IGP 110P–5 for typical installation.

STEP 1. Attach mounting bracket to mast arm using U-bolts.
STEP 2. Install antenna on radio (hand-tight).
STEP 3. Attach radio to mounting bracket.
STEP 4. Wire radio using included power cable.

Figure IGP 110P–5: Cisco FAN Radio Repeater — Mast Arm Installation





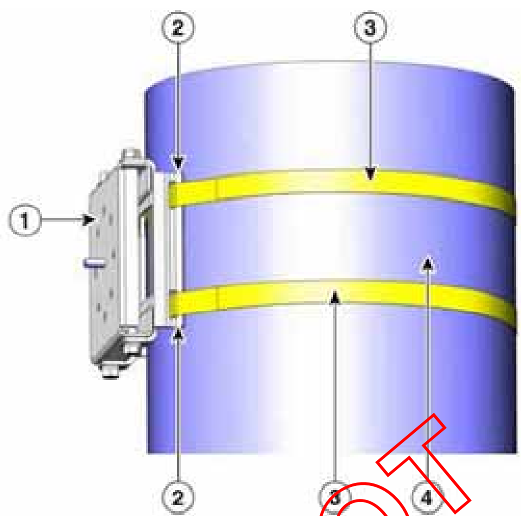
1.7 Cisco FAN Radio Repeater Pole Installation

See Figure IGP 110P–6 for typical installation.

STEP 1. Assemble pole clamp bracket.

STEP 2. Attach mounting bracket to pole using steel bands.

Figure IGP 110P–6: Cisco FAN Radio Repeater — Pole Installation — Attach Mounting Bracket



1	Pole clamp bracket	3	Metal mounting strap
2	Strap slot in strap bracket	4	Pole

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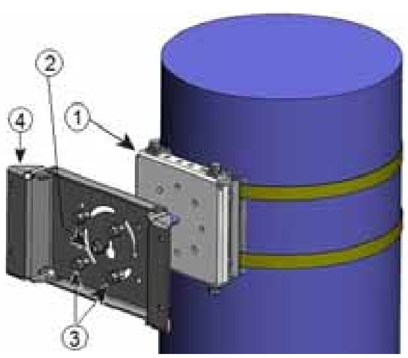
STEP 3. Attach radio to mounting bracket.

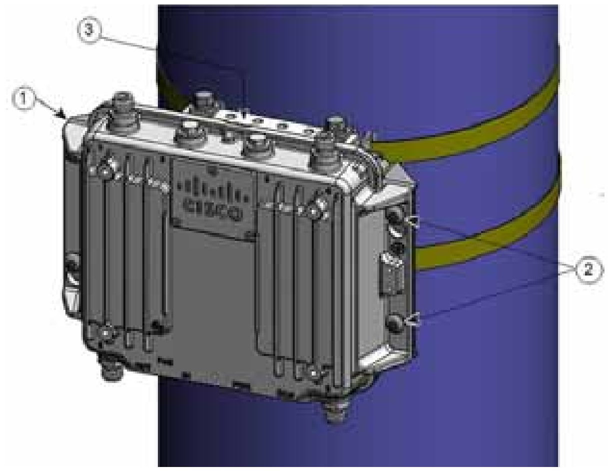
Figure IGP 110P–7: Cisco FAN Radio Repeater — Pole Installation — Attach Radio



1	Pole clamp bracket assembly	3	Bolt holes
2	Access point support bolt	4	Mounting bracket

STEP 4. Install antennas on radio (hand-tight).

Figure IGP 110P–8: Cisco FAN Radio Repeater — Pole Installation — Install Antennas



1	Access point
2	M6 bolts and washers
3	Pole mounting bracket

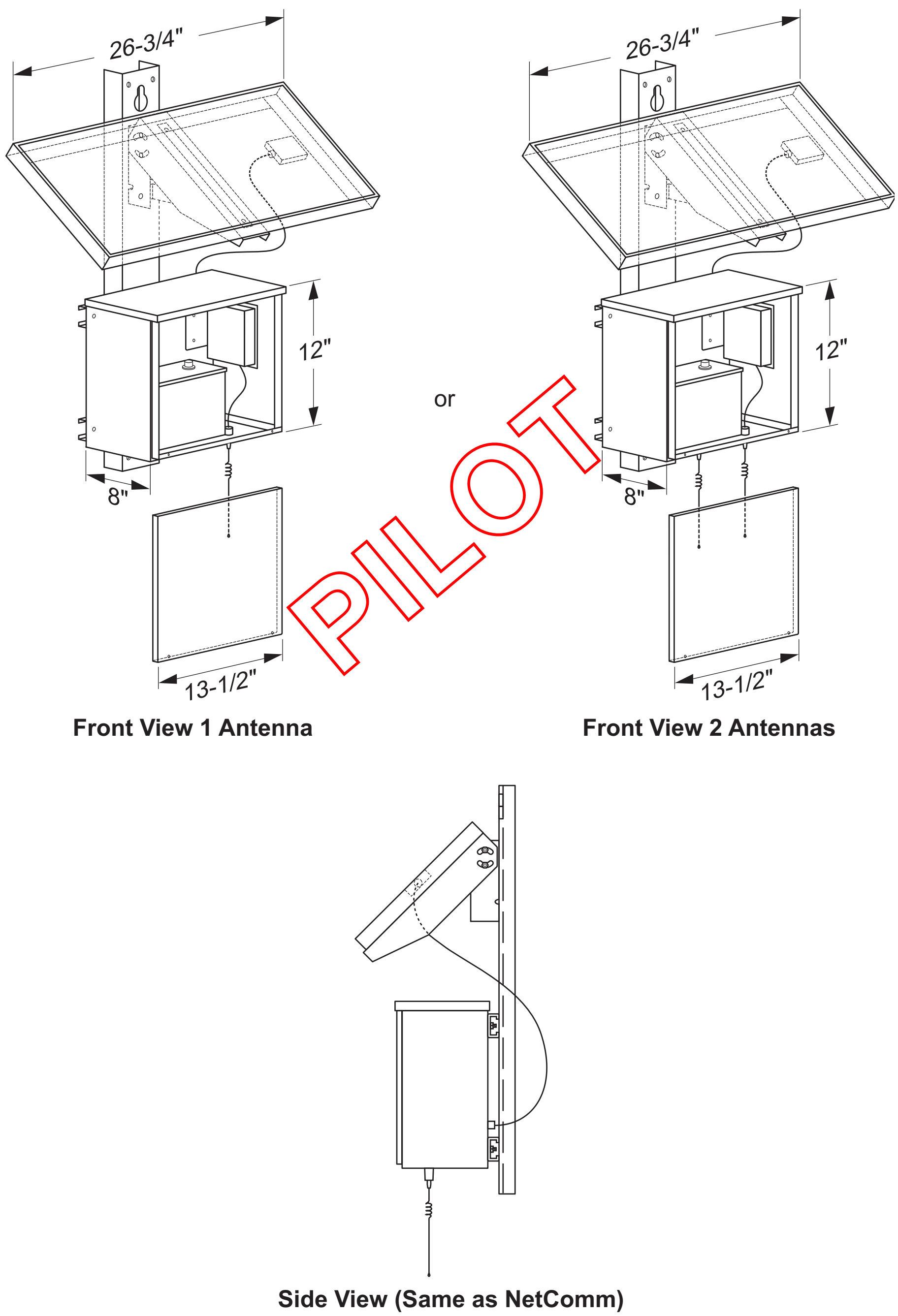
STEP 5. Wire radio using included power cable.

Scope IGP 110P.3 Simulated Network Installations

2.0 Simulated Network Installations

The simulated network FAN radios will be installed utilizing the same equipment as the Solar Power Supply for Power to NETCOMM Radios where no AC Power Exists (refer to DAP, Scope AP 700.5).

Figure IGP 110P–9: Solar Unit for Simulated Network



2.1 ABB Device

ABB 6430 Range Extender

- Integrated antennas
- Operates on 2.4 GHz, 5.8 GHz, 900 MHz bands
- Built-in GPS
- Pipe, Mast-arm or streetlight mount

Figure IGP 110P–10: ABB Radio

2.2 Cisco Devices

Cisco IR530 WPAN Range Extender

- Integrated antennas
- Operates on 900 MHz band
- Built-in GPS

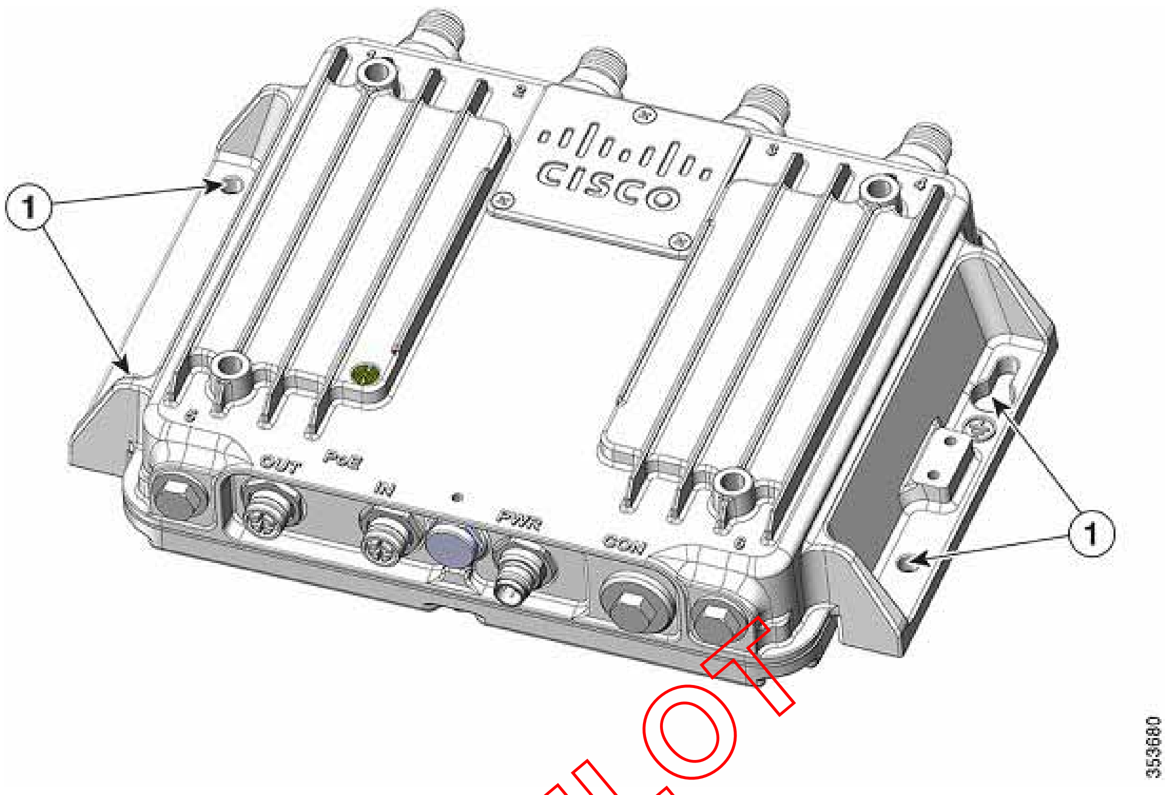
- Pipe, Mast-arm or streetlight mount

Figure IGP 110P–11: Cisco Radio

Cisco IW3702 Access Point

- Integrated antennas
- Operates on 2.4 GHz, 5 GHz bands
- Built-in GPS
- Pipe, Mast-arm or streetlight mount

Figure IGP 110P–12: Cisco Access Point



1	0.28 in (7.12 mm) mounting holes

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