SOUTHERN CALIFORNIA EDISON
TRANSMISSION AND DISTRIBUTION

Distribution Overhead Construction Standards (DOH)

2026 — THIRD QUARTER ISSUE
July 31, 2026

Note: *Printed and downloaded versions of this document are uncontrolled. In the case of a conflict between printed/downloaded and electronic versions of this document, the controlled version published on the Company portal prevails.*

►SCE Internal◄

Copyright © 2026 Southern California Edison. All rights reserved.

No part of this document may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, without the prior written permission of Southern California Edison.

Direct technical questions/comments to:
Distribution Standards
Email: Standards.Engineering@sce.com

Published by:
Southern California Edison
Standards Publications, 1 Innovation Way, Pomona, California 91768-2560

Distribution Overhead Construction Standards (DOH)

Revision Summary

2026 — Third Quarter Issue

Effective Date: July 31, 2026

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 section provides contact information.

Table 1: Revisions

Division Standard	Page/Sheet	Description	Type
CC 100	3, 4	Changed from “Pilot” to “For Planning Use Only”.	Admin
CC 110	4	Changed from “Pilot” to “For Planning Use Only”.	Admin
CC 122	1	Changed from “Pilot” to “For Planning Use Only”.	Admin
CC 123	1	Changed from “Pilot” to “For Planning Use Only”.	Admin
CC 150	4	Changed from “Pilot” to “For Planning Use Only”.	Admin
	5	Updated Section 3.0 for Jumpers/Taps.	Admin
	8-9	Updated Figure CC 150-8 & CC-150-9. Updated Section 6.5 from to “Termination”	Admin
	10-11	Updated Section 6.6.	Admin
	17	New pilot Section 6.10.	Pilot
CC 190	2-3	Changed from “Pilot” to “For Planning Use Only”.	Admin
CO 106	3	Added Table CO 106-6 for Protected Ground Wire (PGW) data.	Admin
CO 143	ALL	Changed from “Pilot” to “For Planning Use Only”.	Admin
CO 149	ALL	Changed from “Pilot” to “For Planning Use Only”.	Admin
CO 153	ALL	Changed from “Pilot” to “For Planning Use Only”.	Admin
CO 161	ALL	Changed from “Pilot” to “For Planning Use Only”.	Admin
CO 168	Throughout	Changed from “Pilot” to “For Planning Use Only”.	Admin
CO 300	4	Added Table CO 106-6 for Protected Ground Wire (PGW) data.	Admin
CO 305	4	Updated Table 305-4.	Admin
CO 420	4	Changed from “Pilot” to “For Planning Use Only”.	Admin
DC 500	1	Updated Figure DC 500-1, added Note 6, and made “For Reference Only”.	Admin

Table 1: Revisions *(Continued)*

Division Standard	Page/Sheet	Description	Type
DC 535	20	Added PGW SAP 10224292 to Table DC 535-1 and updated connector cover photos.	Admin
GR 205	4-5	Updated scope and sections to include “Aluminum”.	Admin
	8-9	Added new Scope GR 205.6.	Admin
PO 100	2	Added Note F in reference to APM Rule 209 for working in elevated positions.	Admin
PO 112	1	Added reference to APM Rule 209 for working in elevated positions.	Admin
PO 148	1	Added reference to APM Rule 209 for working in elevated positions.	Admin
	13-15	Updated FR wrap installation of pole ground in PO 148.2 to align with FR wrap SOP.	Admin
PO 150	1	Updated pole top extension and updated Figure PO 150-1	Admin
PO 310	9	Updated Note 6.	Admin
PO 320	3	Updated 350 and 500 copper conductor wire tension at Dead-End.	Admin
SL 335	3	Added new Table SL-335-5.	Admin
SL 343	1-7	Added Corn Cob LED replacement lamp equivalency tables.	Admin
Cover	Revision Summary	Added GO95 compliance.	Admin

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 require a standards manager approval. They may include updates to SAP numbers, 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 SPMT approval.
New	Refers to a new standard. New technical standards require SPMT 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.
For Reference Only	A FOR REFERENCE ONLY watermark is used when the standard is provided solely for informational purposes. It may be used to guide understanding, planning or decision-making, but it is **not authorized** for direct application in official process, construction, or implementation. Users should not rely on this standard as a basis for action or compliance, as it may be subject to change or may not reflect current requirements.
For Planning Use Only	A FOR PLANNING USE ONLY watermark is used when the standard is intended exclusively for use by Design and Field Asset Services (DFAS) for planning purposes and by Distribution Engineering for scoping purposes. It is not authorized for us in construction processes at this time. Guidance will be provided in the body of the standard for anticipated constructed start date whenever this watermark is used.

Regulatory Compliance Requirements

The statutory minimum compliance requirements established by the CPUC (e.g., GO 95, GO 128, GO 165, GO 166, GO 167, and GO 174) form the basis of this engineering standard. For this reason, these standards should be followed at all times. When existing standards are not suitable the Standards Deviations Process must be applied, see Standards Process Manual - DP-3: Deviation Process.

Getting Help

Technical Revisions

If you have any comments, corrections, questions, or suggestions concerning manual revisions, please click to send an email:

- Standards.Engineering@sce.com



Fernando Garcia
Director | Asset Management Program

This page intentionally left blank.

DI — Division Index

Section **Tab**

DI: Division Index . . . . . Division Index
AC: Aerial Cable . . . . . AC
CC: Covered Conductor CC
CO: Conductors and Splices . . . . . CO
DC: Distribution Construction . . . . . DC
GR: Grounding Bonds and Insulators . . . . . GR
PO: Poles and Guying . . . . . PO
PR: Protection (Fusing) . . . . . PR
SC: Spacer Cable . . . . . SC
SL: Street Lighting . . . . . SL
T: Testing and Metering . . . . . T
ISGD: Irvine Smart Grid Demonstration . . . . . ISGD
DESI: Distribution Energy Storage Integration . . . . . DESI
IGP: Integrated Grid Project . . . . . IGP
EVSE: Electrical Vehicle Service Equipment . . . . . EVSE

This page intentionally left blank.

DOH–AC: Aerial Cable

TABLE OF CONTENTS

STANDARD	TITLE
AC 100	General
AC 100.1	Aerial Cable General
AC 110	Cable Data
AC 110.1	Aerial Bundled Cable (ABC)
AC 110.2	Cross-Linked Polyethylene Insulated Aluminum
AC 110.3	Current Carrying Capacities Self-Supporting Shielded Aerial Cable
AC 120	Clearances
AC 120.1	Above-Below-Right Angles (Line/Buck Arm)
AC 120.2	Above-Below-Parallel (Line Arms)
AC 130	Surge Arresters
AC 130.1	Application of Surge Arresters
AC 140	Grounding
AC 140.1	Flexible Ground Connections on Free-Swing Tree-Mounting
AC 140.2	Grounding Messenger for 4 kV, 12 kV, and 16 kV
AC 200	Operating Instructions — Spinner
AC 200.1	Operating Instructions for Model K Neale Spinner
AC 200.2	Typical Operating Instructions — Spinner
AC 210	Terminating Lashing Wires
AC 210.1	Terminating Lashing Wires
AC 215	Aerial Cable Installation Equipment
AC 215.1	Aerial Cable Pulling Socks and Rollers
AC 220	Messenger Tensions
AC 220.1	Messenger Tensions
AC 220.2	Messenger Tensions
AC 230	Insulating the Aerial Cable Messenger
AC 230.1	Insulating the Aerial Cable Messenger
AC 290	Aerial Cable Angle Construction Requirements
AC 290.1	Angle Construction Requirements
AC 300	Aerial Cable Tree Guard
AC 300.1	Aerial Cable Tree Guard

STANDARD	TITLE
AC 310	Tree-Mounted Aerial Cable Free Swing
AC 310.1	Tree-Mounted Aerial Cable Free Swing
AC 320	Aerial Cable Tree-Mounted Corner
AC 320.1	Aerial Cable Tree-Mounted Corner
AC 330	Typical Aerial Cable Free Swing
AC 330.1	Typical Aerial Cable Free Swing
AC 340	Aerial Cable Flying Dead-End Corner
AC 340.1	Typical Aerial Cable Flying Dead-End Corner
AC 345	Pole-Mounted Double Dead-End
AC 345.1	Typical Pole-Mounted Double Dead-End
AC 350	Aerial Cable Dead-End with Anchor Guy
AC 350.1	Aerial Cable Dead-End with Anchor Guy
AC 360	Pole-Mounted Corner
AC 360.1	Typical Pole-Mounted Corner
AC 370	Anchor Guy — Zone of Proximity
AC 370.1	Anchor Guy — Zone of Proximity
AC 380	Voltage Designation Sign
AC 380.1	Voltage Designation Sign
AC 400	2.4/4/12/16 kV Aerial Cable Connection to Transformer
AC 400.1	2.4/4/12/16 kV Aerial Jacketed Cable Connection to Transformer
AC 400.2	2.4 kV 1/C Aerial Cable Connection to Transformer Dead-End Construction
AC 400.3	2.4 kV 1/C Aerial Cable Connection to Transformer
AC 410	4/12/16 kV Aerial Cable Connected to 3-1Ø Transformer Bank
AC 410.1	4/12/16 kV Aerial Cable Connected to 3-1Ø Transformer Bank
AC 410.2	4 kV Aerial Cable Connected to 3Ø Transformer Bank
AC 420	2.4/4/12/16 kV Aerial Cable Disconnect Switches
AC 420.1	2.4/4/12/16 kV Aerial Cable Disconnect Switches
AC 425	2.4/4 kV Aerial Cable Tap Connected to Open Wire
AC 425.1	2.4/4 kV Aerial Cable Tap Connected to Open Wire
AC 430	4/12/16 kV Aerial Cable Connected to Open Wire
AC 430.1	4 kV Aerial Cable Connected to Open Wire
AC 430.2	4/12/16 kV Aerial Jacketed Cable Connected to Open Wire

STANDARD	TITLE
AC 450	Termination of Old-Style Cable Rubber Insulated with Copper Tape Shielding
AC 450.1	Typical Single Conductor — 5 kV — Shielded Rubber-Like Cable
AC 455	Splicing Old-Style Cable Rubber Insulated with Copper Tape Shielding
AC 455.1	Single Conductor — 5 kV — Shielded Rubber-Like Aerial Cable
AC 460	Y-Splice for Old Style Cable Rubber Insulated with Copper Tape Shielding
AC 460.1	Typical Single Conductor — 5 kV — Shielded Rubber-Like Aerial Cable
AC 465	350 kcmil T-Tap Using Polyethylene Insulated Primary Cable
AC 465.1	Tee Splice — 1/C 5–16 kV Polyethylene — Insulated Cables 350 kcmil to #2-220 mil
AC 470	Sag Charts and Tension Stringing Tables for Aerial Bundled Cable
AC 470.1	Directions for Use
AC 470.2	Sag Charts and Tension Stringing Tables for 3 Conductor 1/0 Aerial Bundled Cable for Light Loading Areas
AC 470.3	Sag Charts and Tension Stringing Tables for 3 Conductor 1/0 Aerial Bundled Cable for Heavy Loading Areas
AC 470.4	Sag Charts and Tension Stringing Tables for 3 Conductor 350 kcmil Aerial Bundled Cable for Light Loading Areas
AC 470.5	Sag Charts and Tension Stringing Tables for 3 Conductor 350 kcmil Aerial Bundled Cable for Heavy Loading Areas
AC 470.6	Sag Charts and Tension Stringing Tables for 2 Conductor 1/0 Aerial Bundled Cable for Light Loading Areas
AC 470.7	Sag Charts and Tension Stringing Tables for 2 Conductor 1/0 Aerial Bundled Cable for Heavy Loading Areas
AC 470.8	Sag Charts and Tension Stringing Tables for 1 Conductor 1/0 Aerial Bundled Cable for Light Loading Areas
AC 470.9	Sag Charts and Tension Stringing Tables for 1 Conductor 1/0 Aerial Bundled Cable for Heavy Loading Areas
AC 472	Reduced Tension Sag Charts and Tension Stringing for Aerial Bundled Cable
AC 472.1	Directions for Use

This page intentionally left blank.

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.

This page intentionally left blank.

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	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%

FOR REFERENCE ONLY

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):

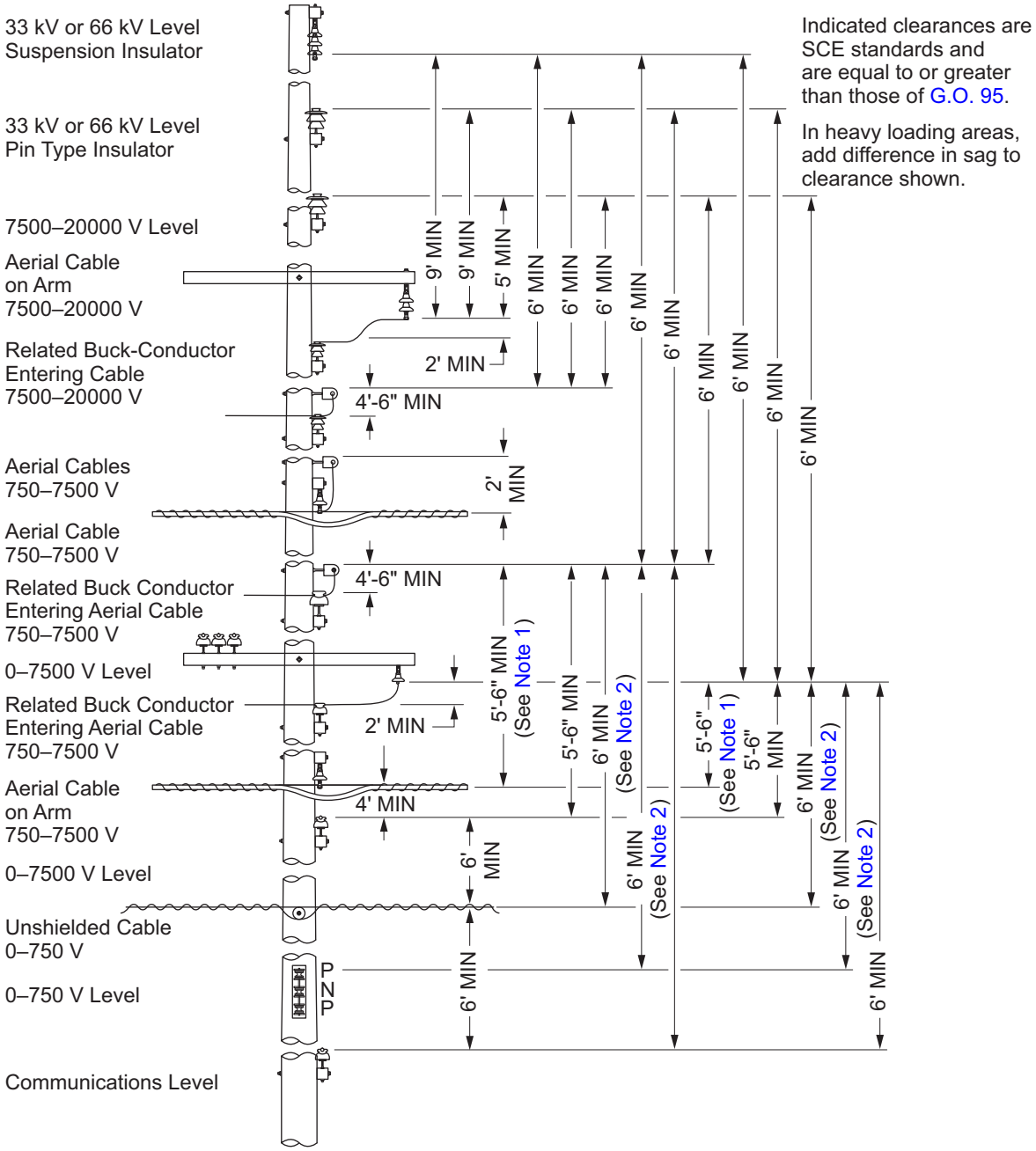
1. Conductor temperature
   a. 75°C for 90 mil
   b. 70°C for 220 mil
2. Ambient temperature 40°C
3. Load factor 100%

FOR REFERENCE ONLY

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)

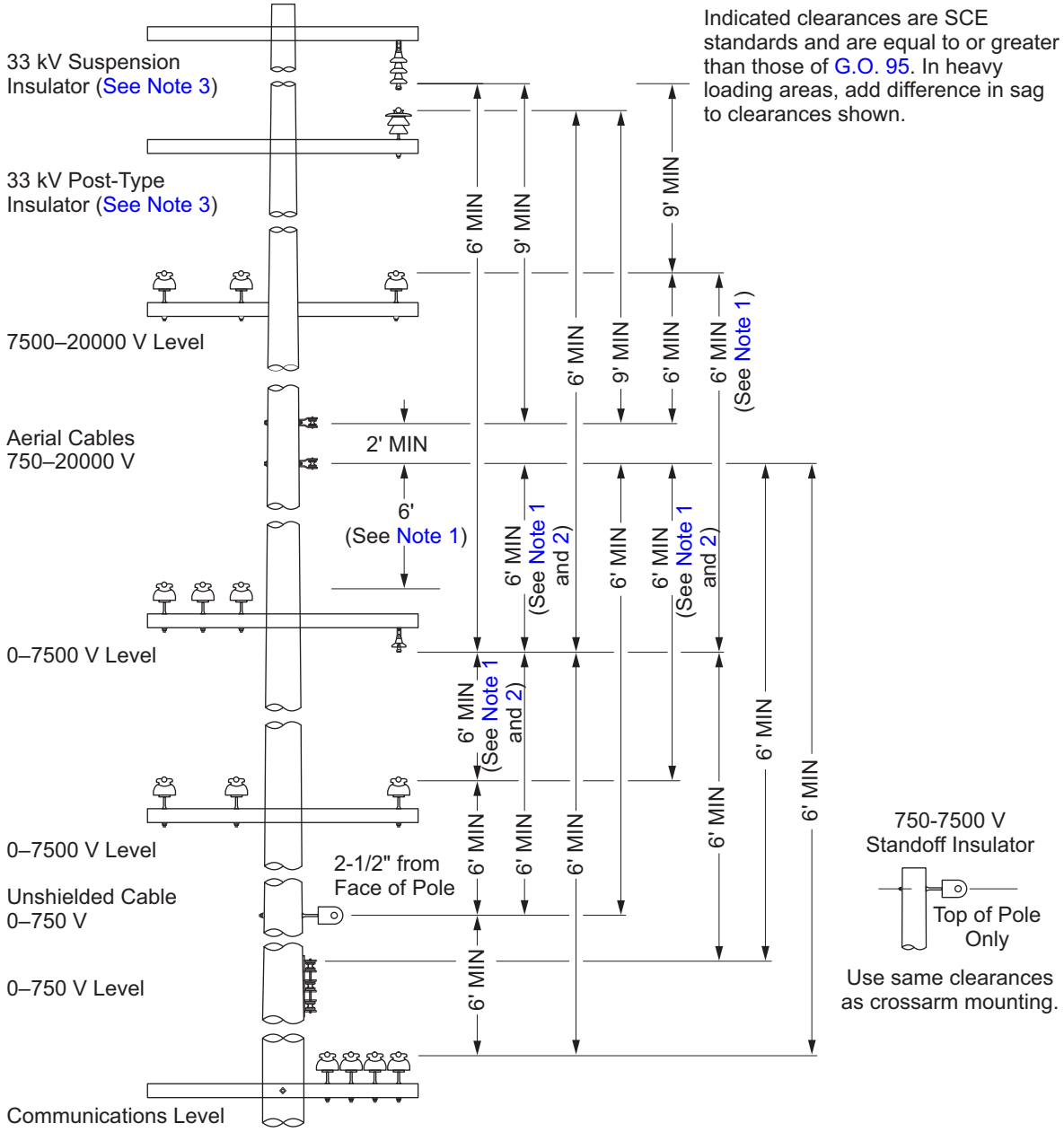


Note(s):

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).

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).

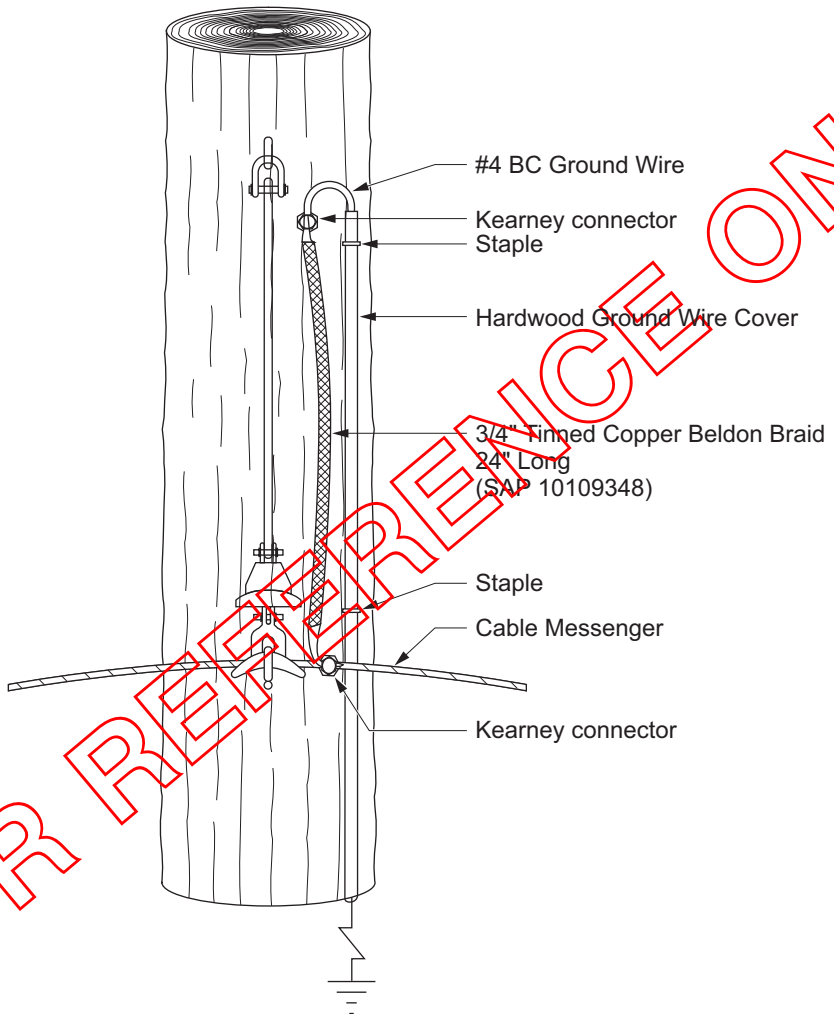
Arresters should be located as close as practical to the cable being protected.

This page intentionally left blank.

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



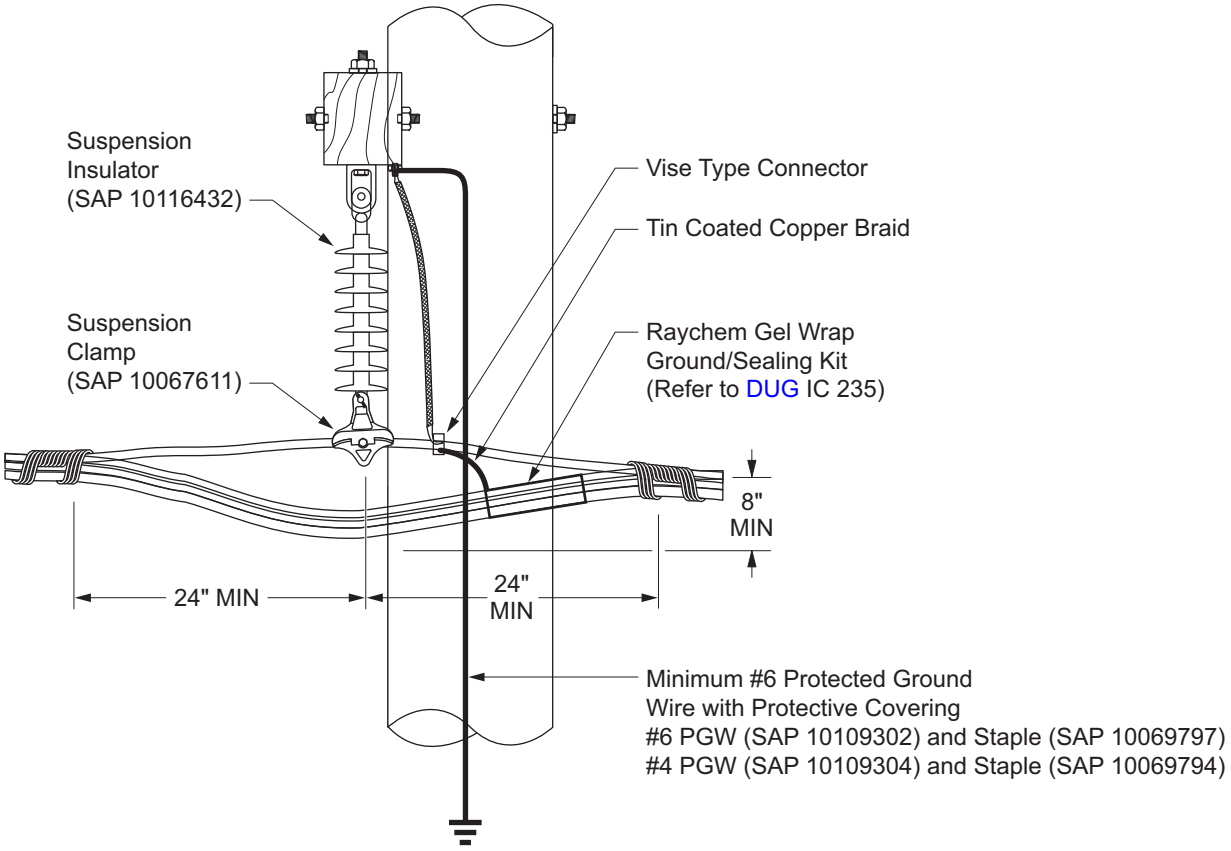
FOR REFERENCE ONLY

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.

FOR REFERENCE ONLY

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

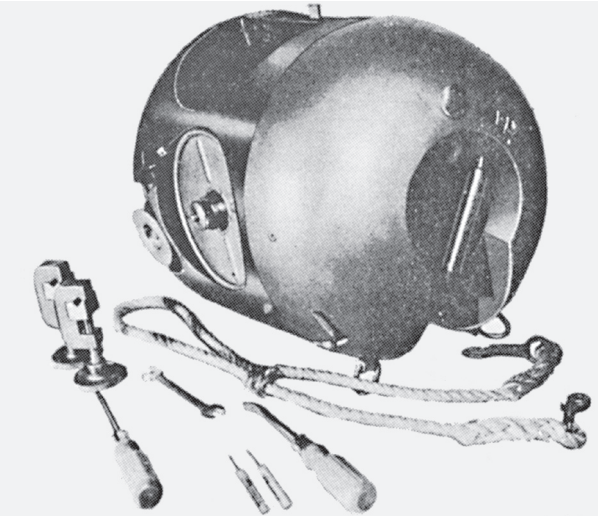


Figure AC 200–1.5: Neale Model K Pull Tyle Spinner
(SAP 843-25505)

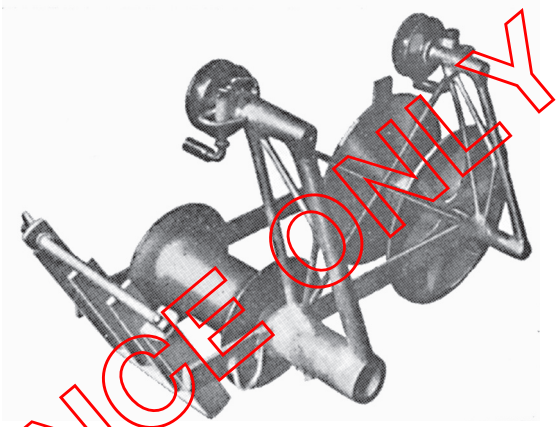


Figure AC 200–1.6: Cable Pulling Dolly
(SAP PENDING)

FOR REFERENCE ONLY

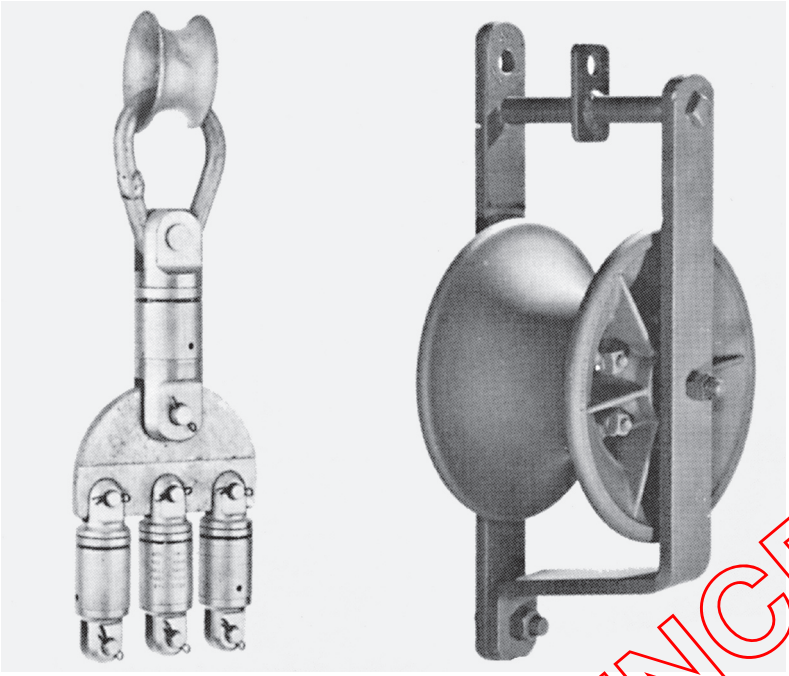


Figure AC 200–1.7: Cable Running Board
(SAP PENDING)

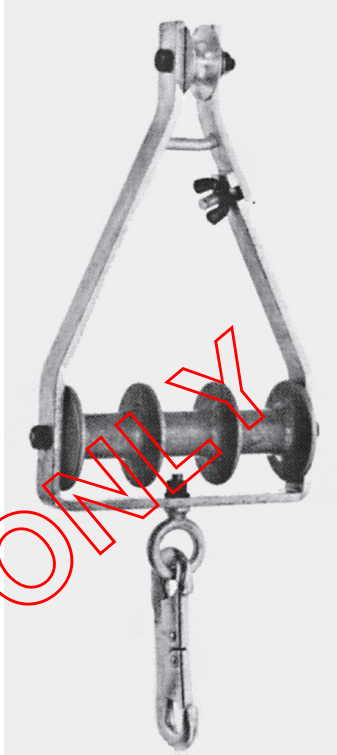


Figure AC 200–1.8: Cable Pulling Ring
(SAP PENDING)

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.

FOR REFERENCE ONLY

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

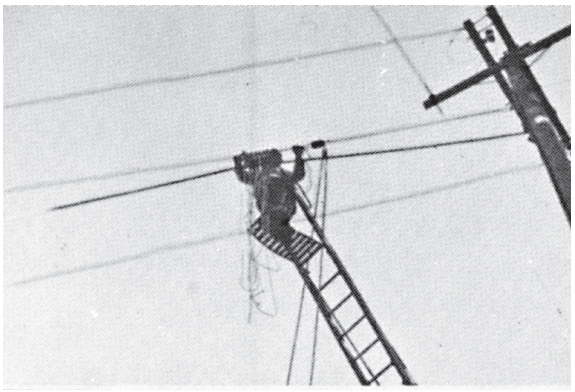


Figure AC 200–2.9

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.

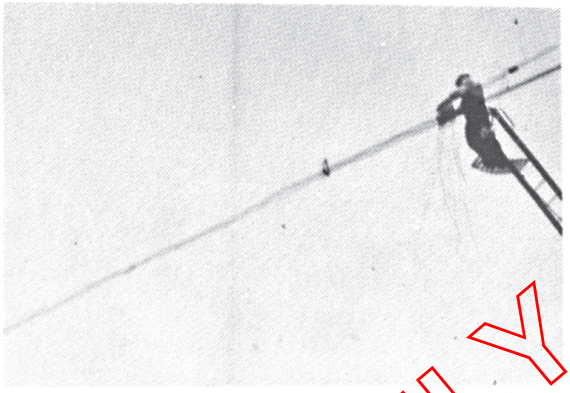


Figure AC 200–2.10

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.

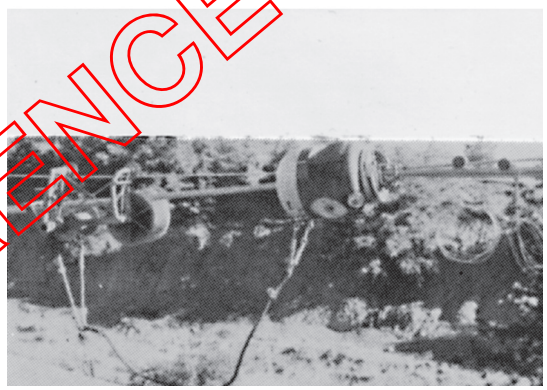


Figure AC 200–2.12

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.

FOR REFERENCE ONLY

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

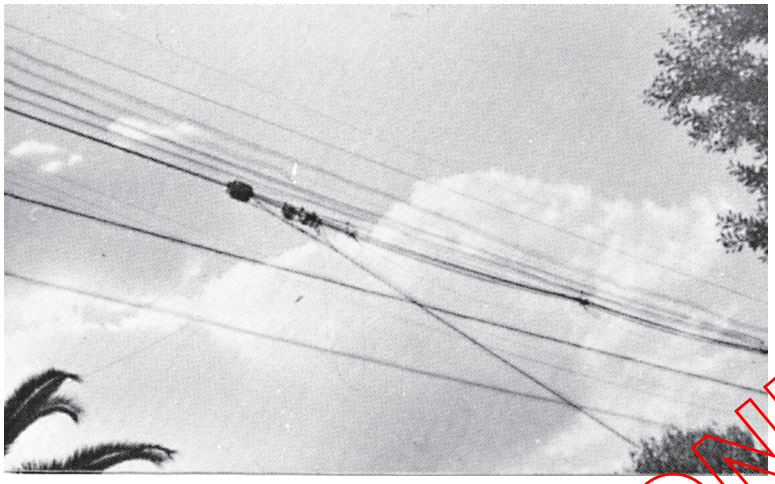


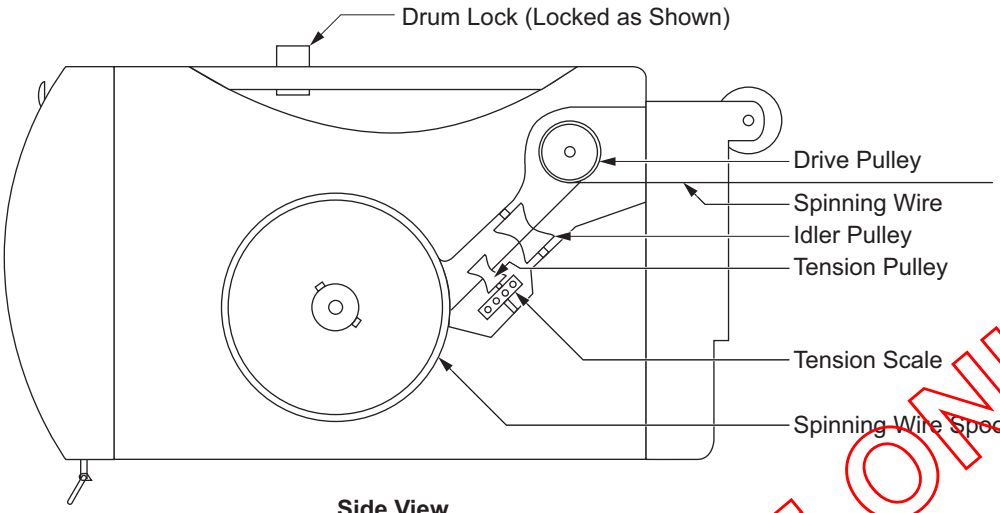
Figure AC 200–2.13

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.)

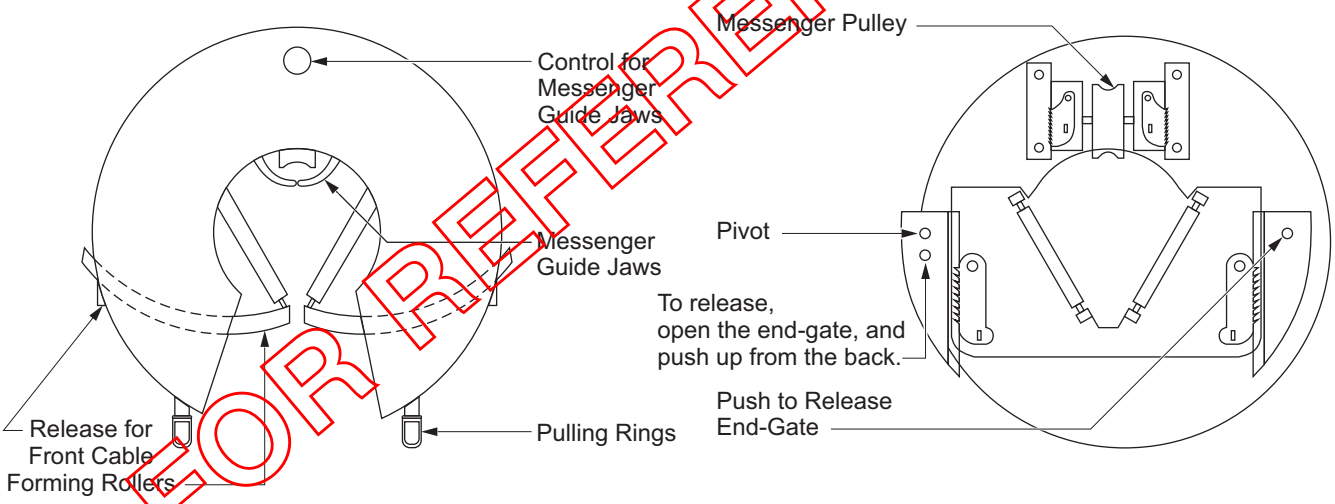
FOR REFERENCE ONLY

Scope AC 200.2 Typical Operating Instructions — Spinner

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



Side View



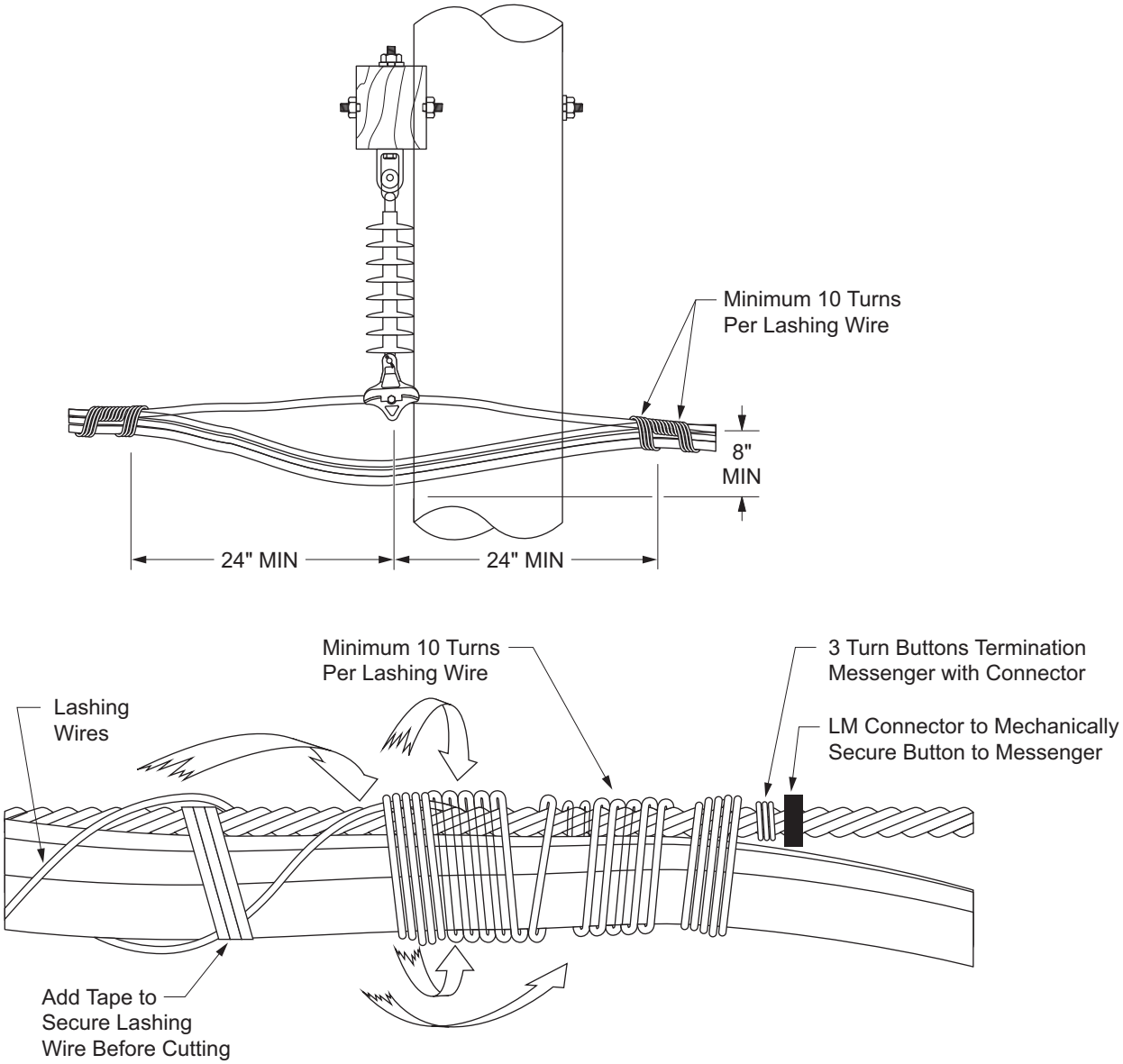
Front View **Rear View**

FOR REFERENCE ONLY

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

This page intentionally left blank.

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

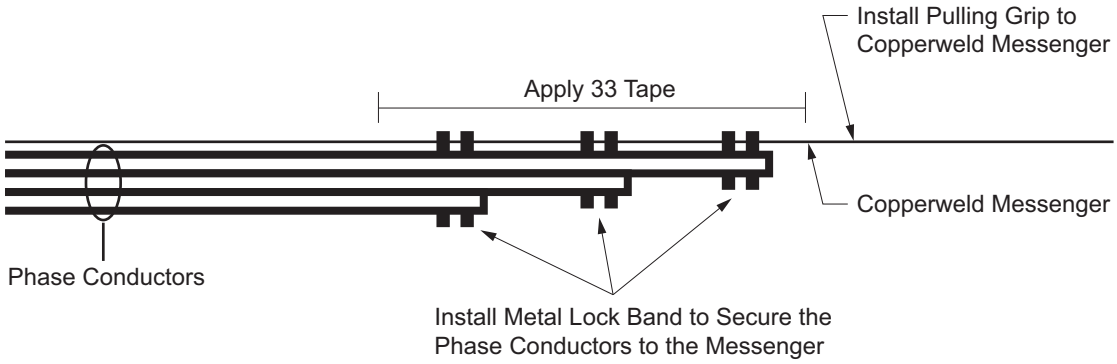


Table AC 215–2: Aerial Cable Rollers



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.

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.

FOR REFERENCE ONLY

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

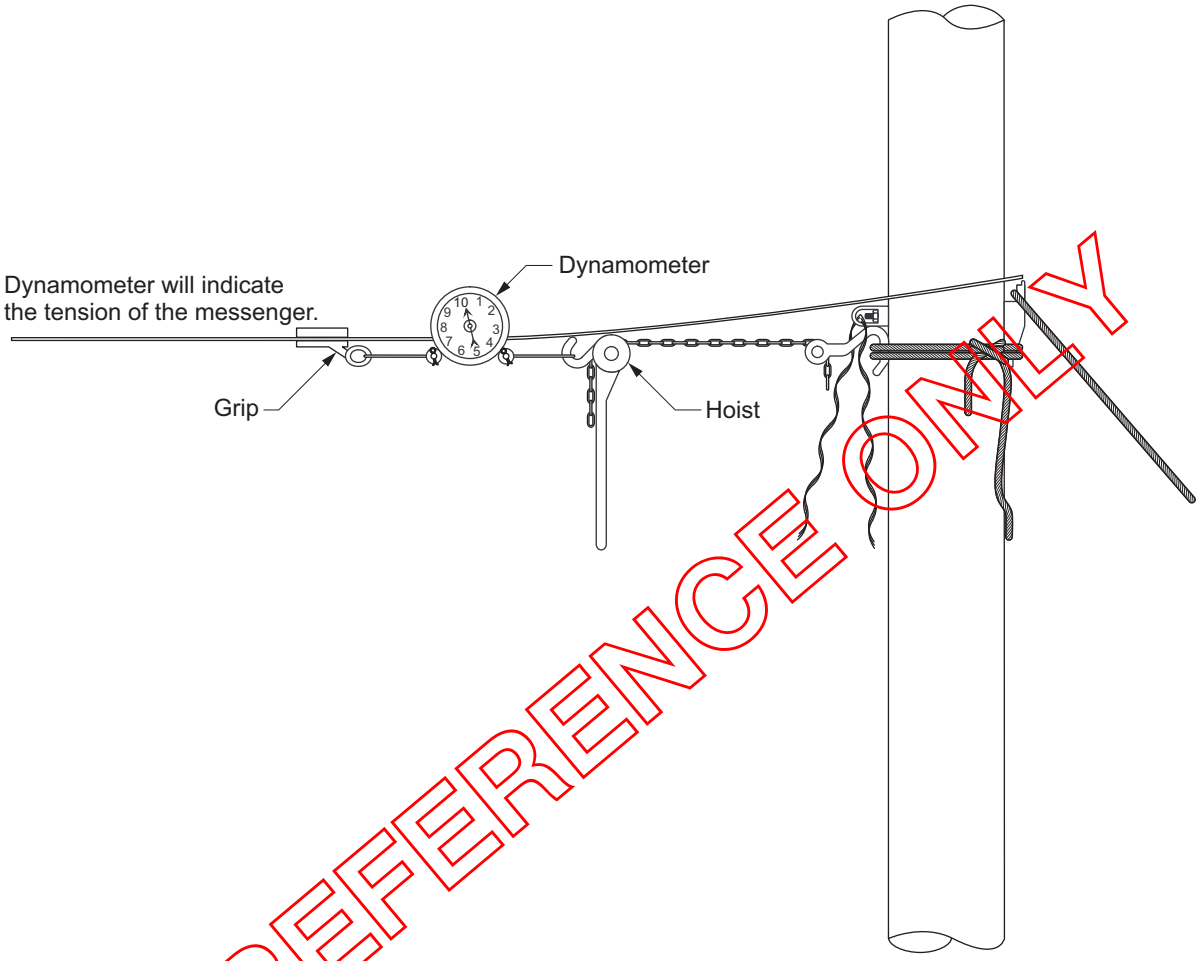
Note(s):

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

FOR REFERENCE ONLY

Scope AC 220.2 Messenger Tensions

Figure AC 220–1: Messenger Tensions



FOR REFERENCE ONLY

This page intentionally left blank.

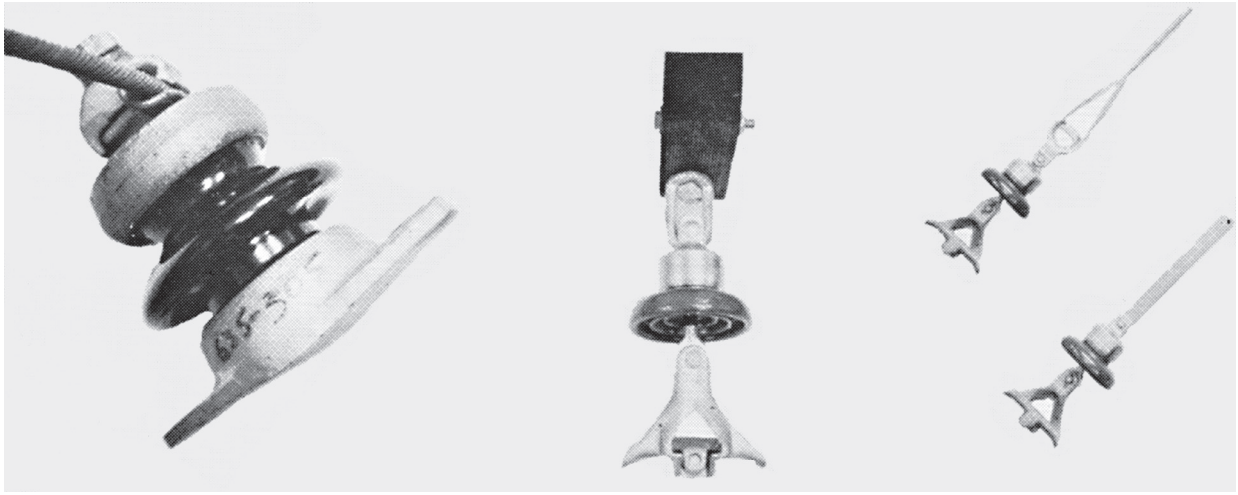
AC 230 Insulating the Aerial Cable Messenger

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	

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)	

This page intentionally left blank.

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

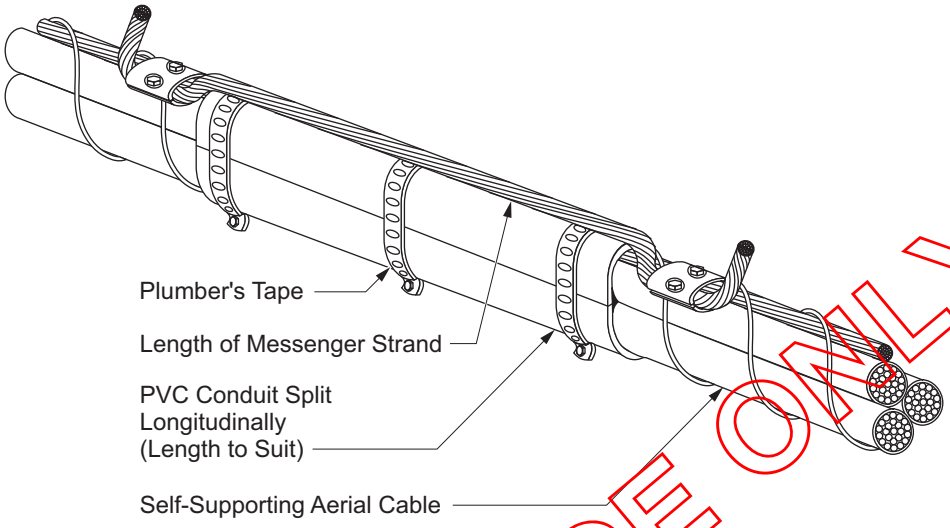
Construction Type	Limiting Angle	Standard Reference
Free Swing	30°	AC 330
Pole-Mounted Double Dead-End	60°	AC 345
Pole Mounted Corner	90°	AC 360

This page intentionally left blank.

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.

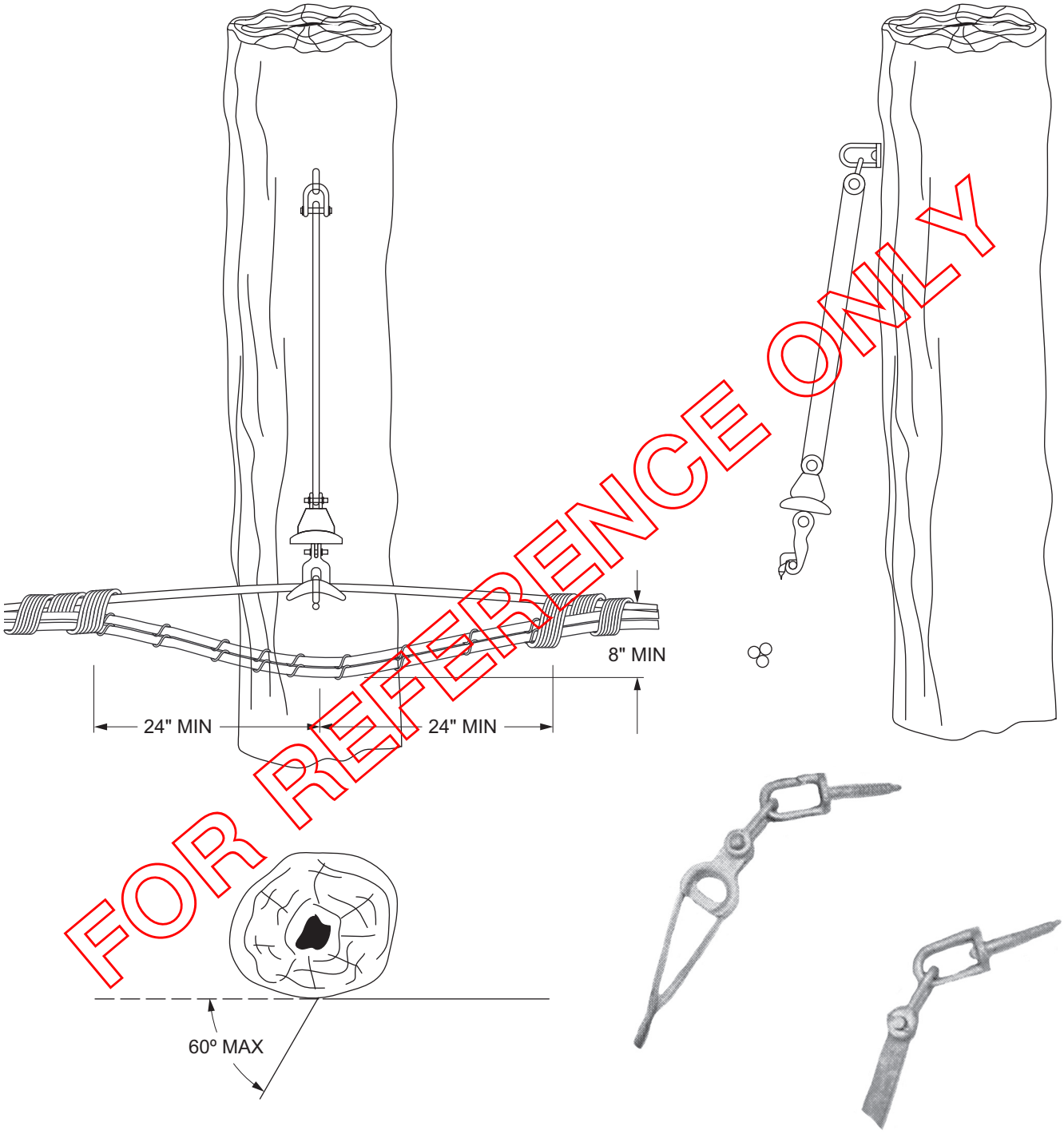
FOR REFERENCE ONLY

This page intentionally left blank.

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



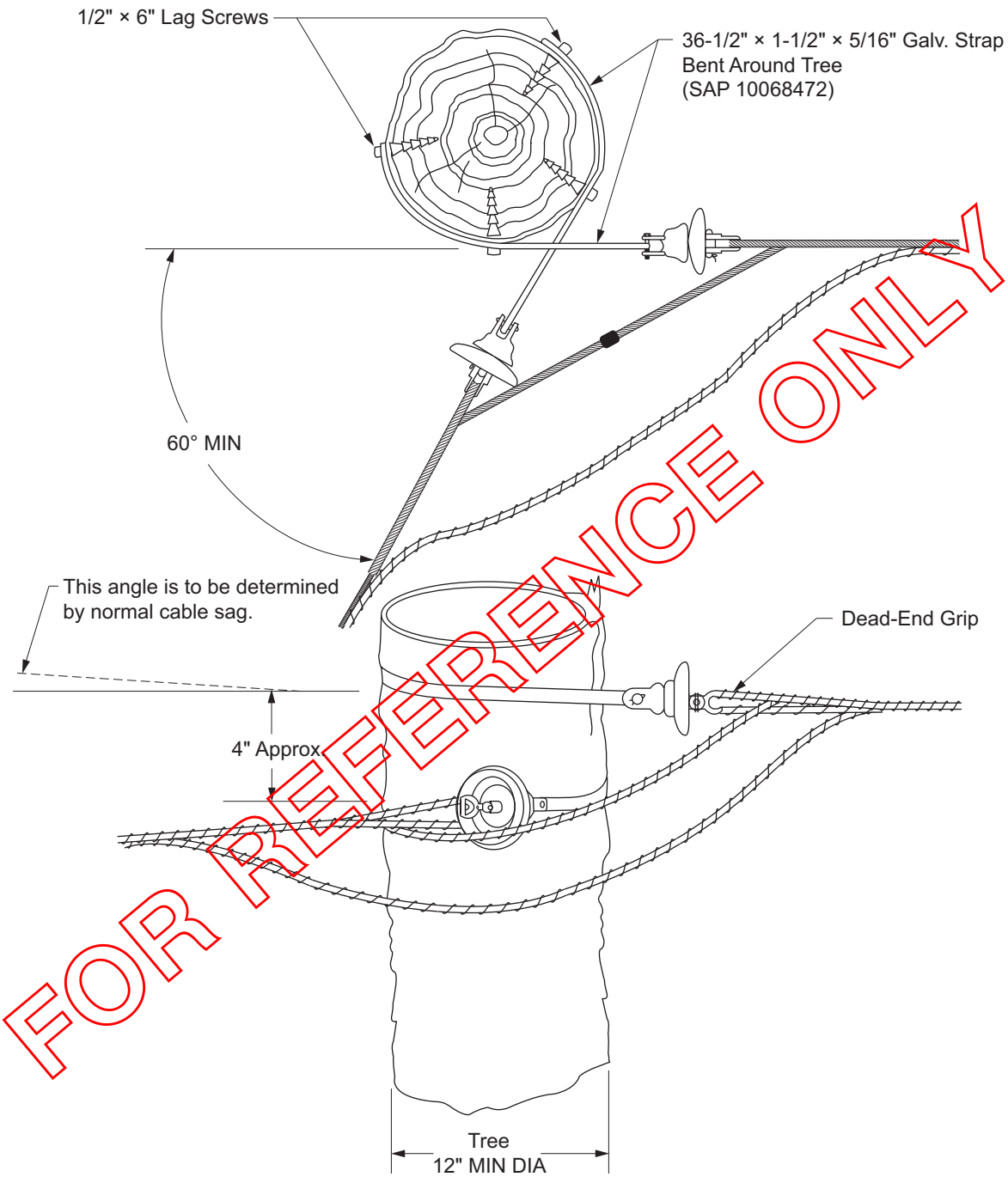
FOR REFERENCE ONLY

This page intentionally left blank.

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



FOR REFERENCE ONLY

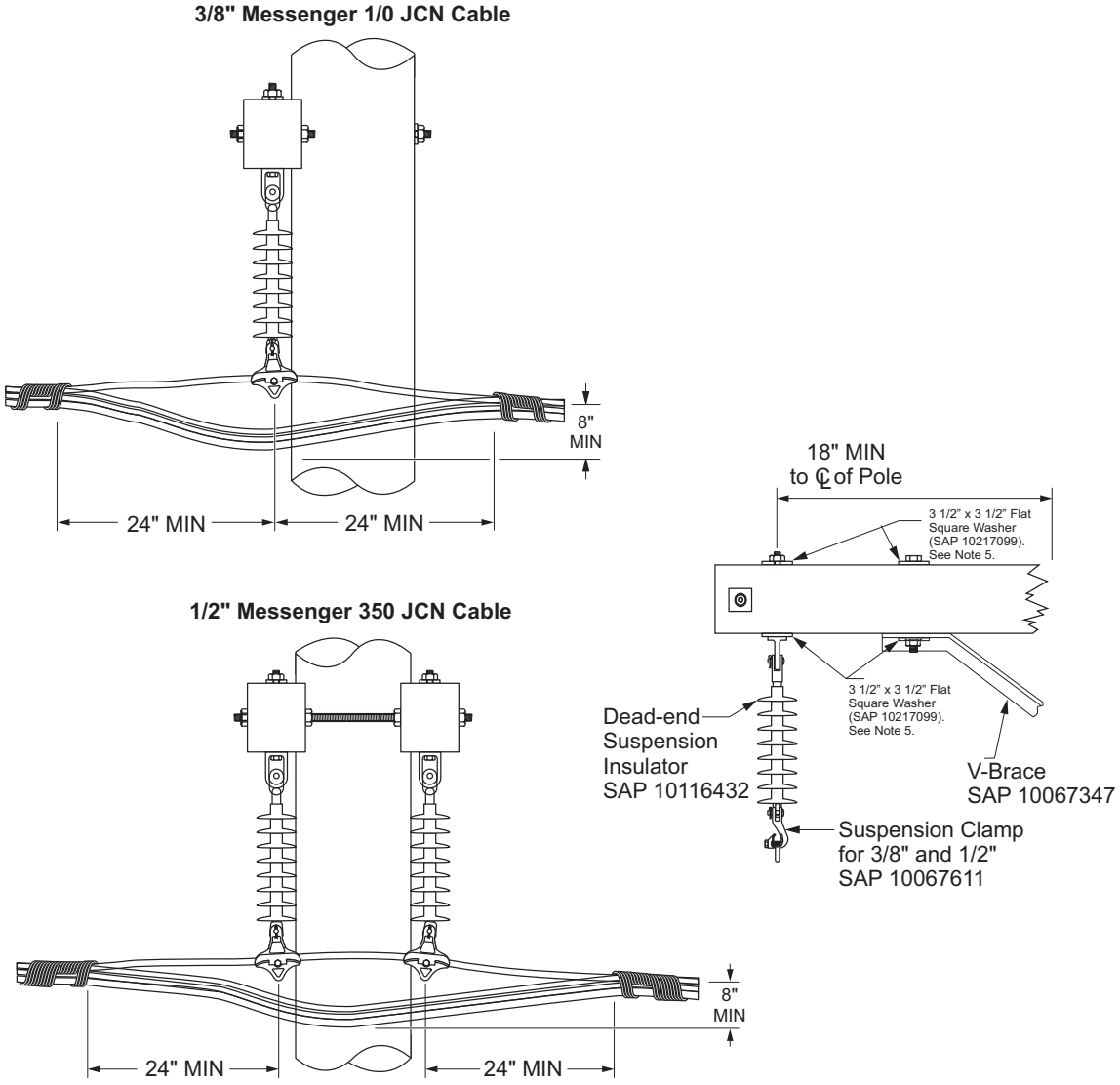
This construction is to be used for angles of deviation in excess of 60°.

This page intentionally left blank.

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.
5. For composite crossarms length 10’ and below, use 3-1/2” x 3-1/2” washers (SAP 10217099). For composite crossarm lengths 12’ and above, use 4” x 4” washers (SAP 10071859).

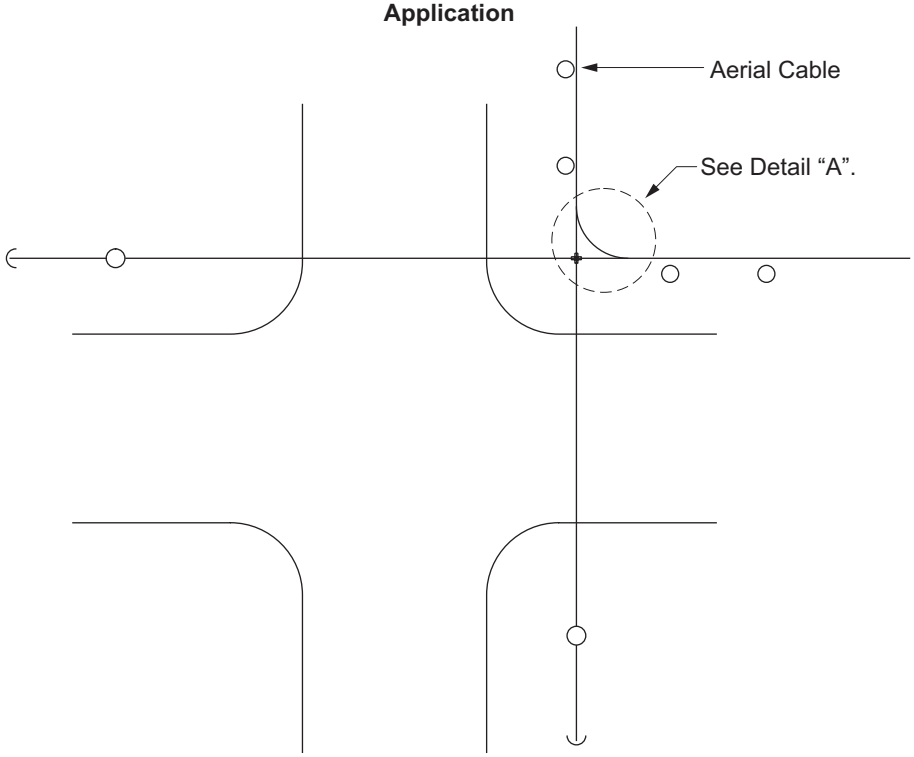
This page intentionally left blank.

AC 340 Aerial Cable Flying Dead-End Corner

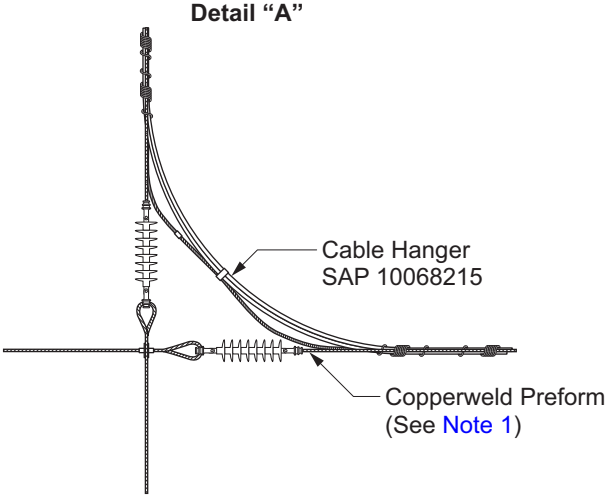
Scope AC 340.1 Typical Aerial Cable Flying Dead-End Corner

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

Application



Detail “A”



Note(s):

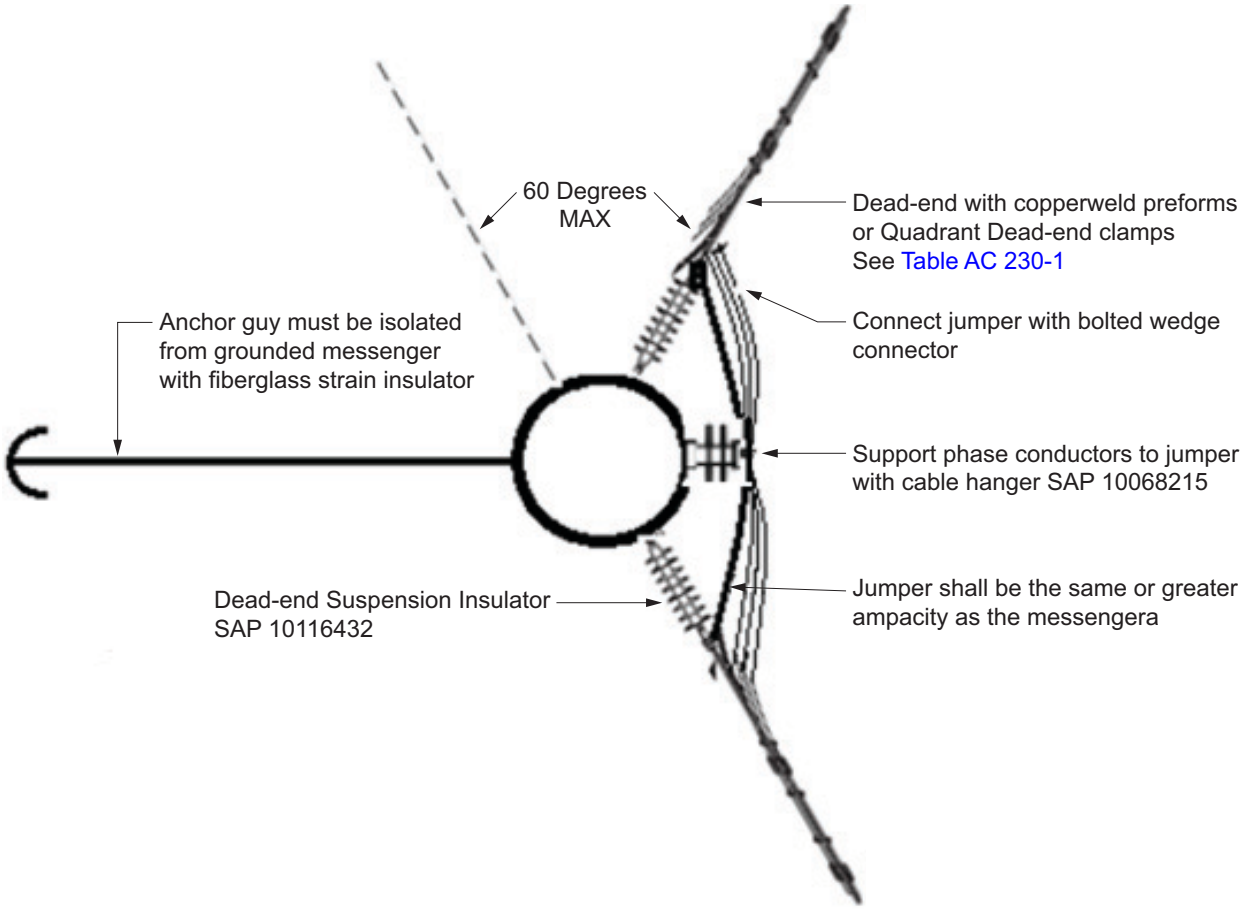
1. Guy strain insulator is an alternative insulator for 2.4/4.16 kV systems.

This page intentionally left blank.

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.

This page intentionally left blank.

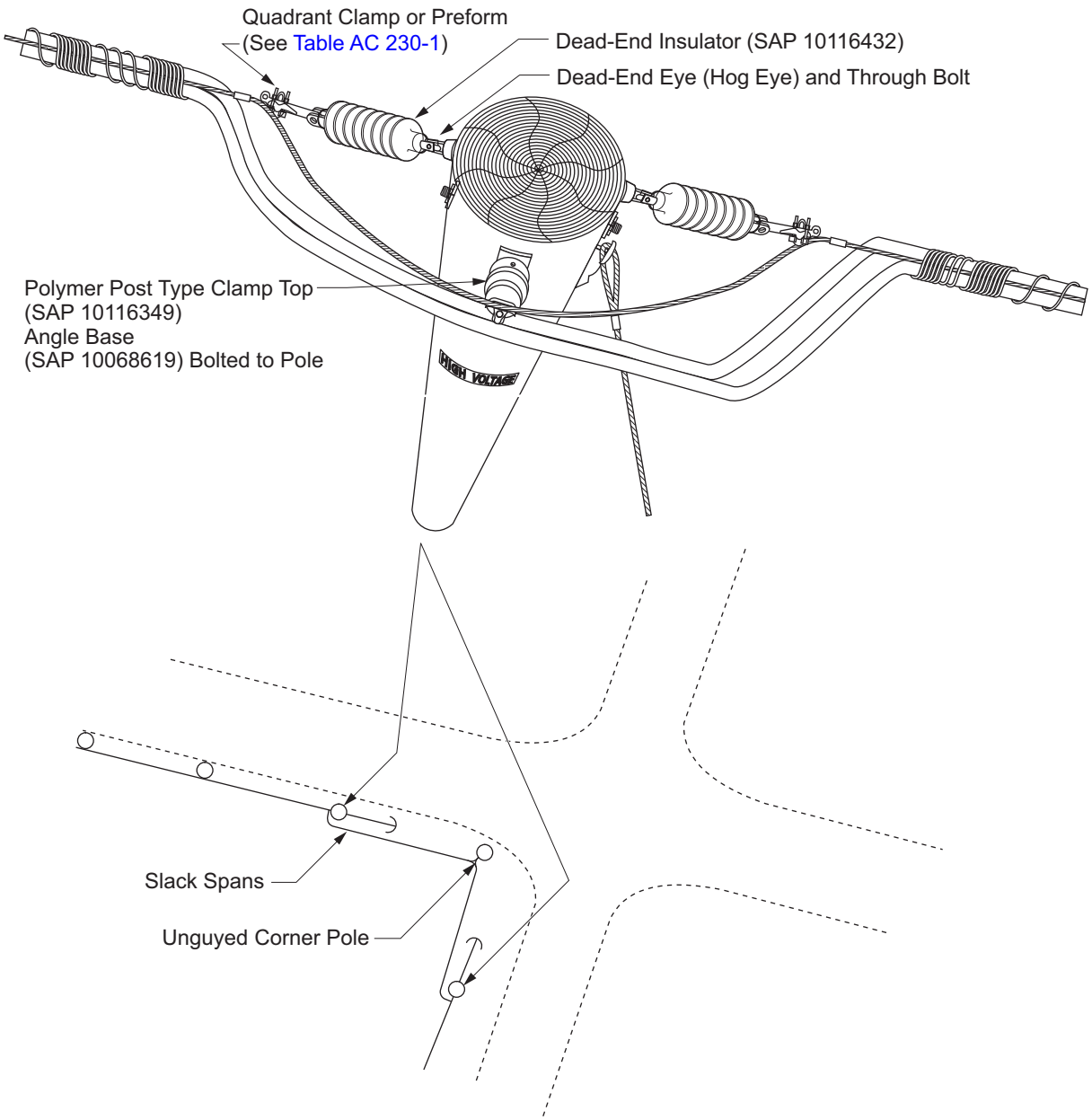
AC 350 Aerial Cable Dead-End with Anchor Guy

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

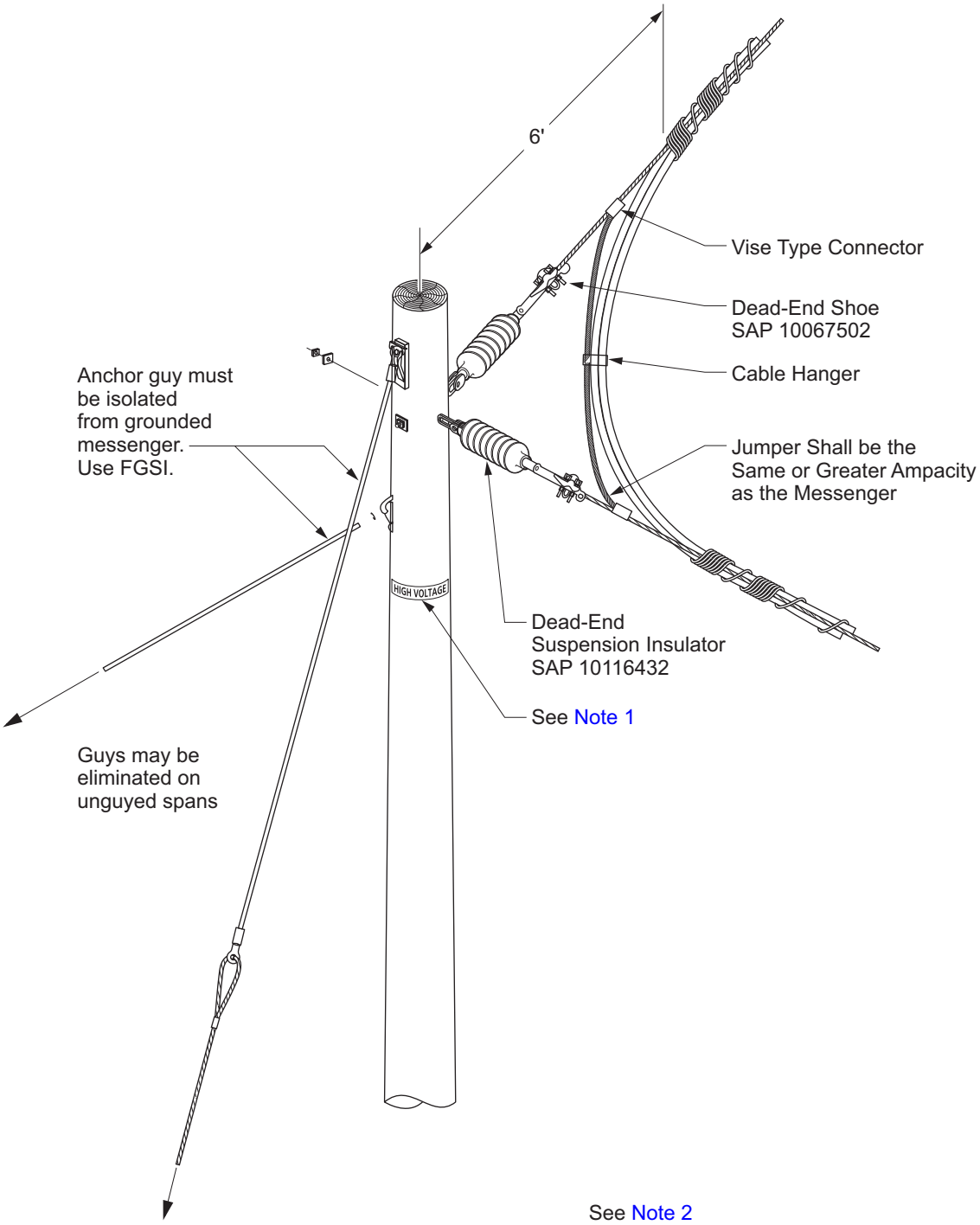


This page intentionally left blank.

AC 360 Pole-Mounted Corner

Scope AC 360.1 Typical Pole-Mounted Corner

Figure AC 360–1: Typical Pole-Mounted Corner



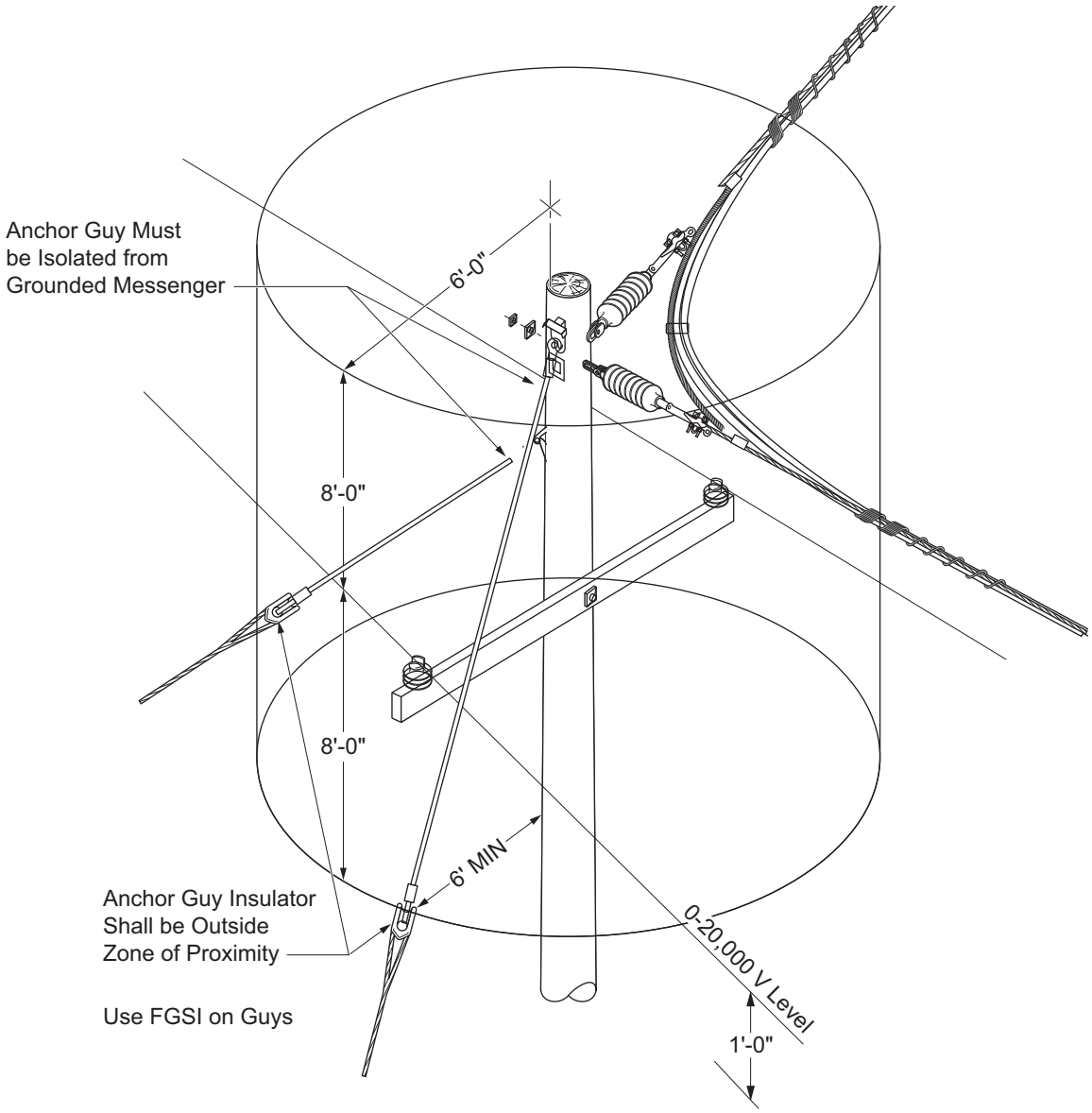
Note(s):

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):

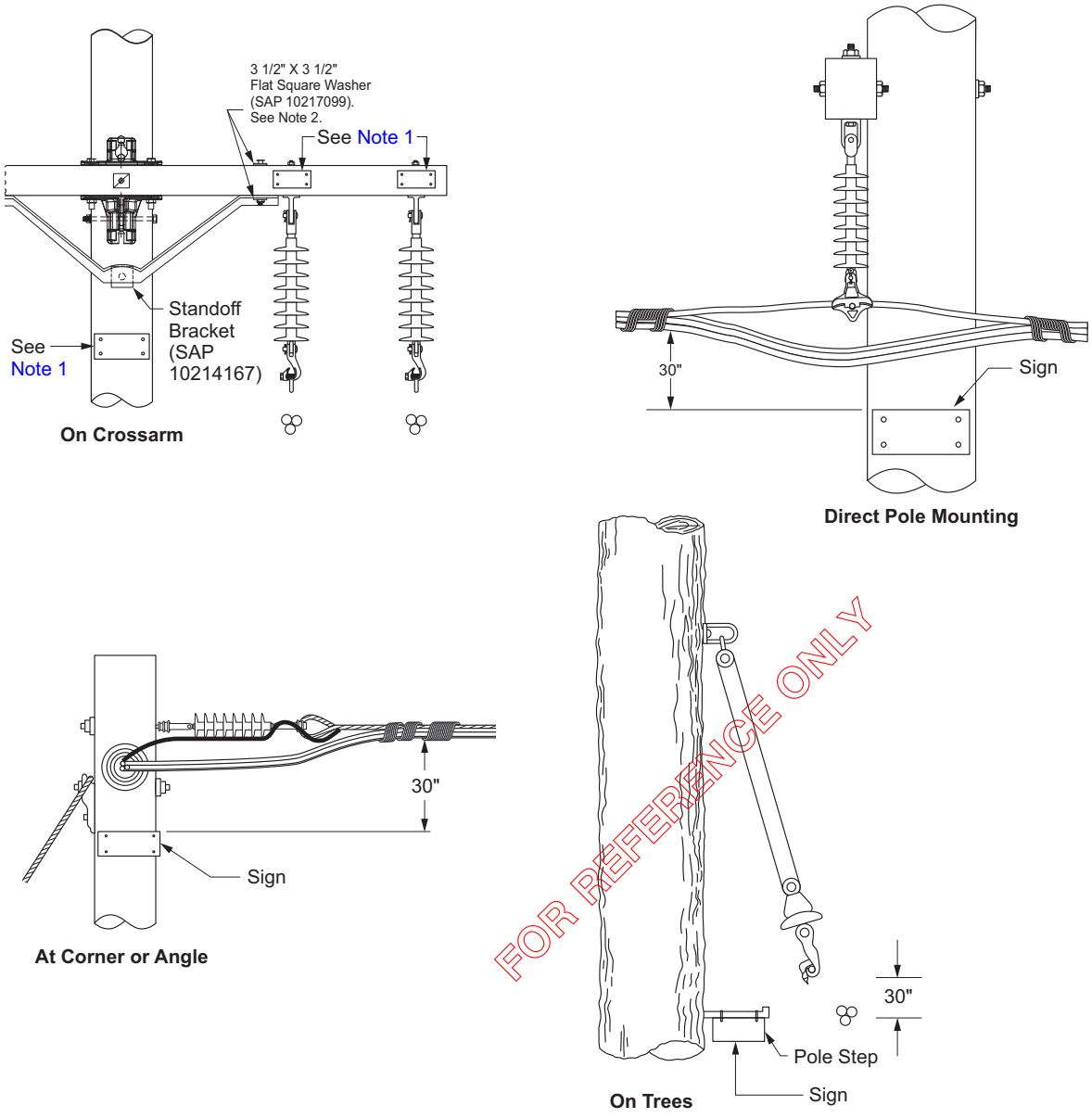
1. See AC 340 for guying details.

This page intentionally left blank.

AC 380 Voltage Designation Sign

Scope AC 380.1 Voltage Designation Sign

Figure AC 380–1: Voltage Designation Sign



FOR REFERENCE ONLY

Note(s):

1. See PO 120 for High Voltage sign installation requirements.
2. For composite crossarms length 10' and below, use 3-1/2" x 3-1/2" washers (SAP 10217099). For composite crossarms length 12' and above, use 4" x 4" washers (SAP 10071859).

This page intentionally left blank.

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)

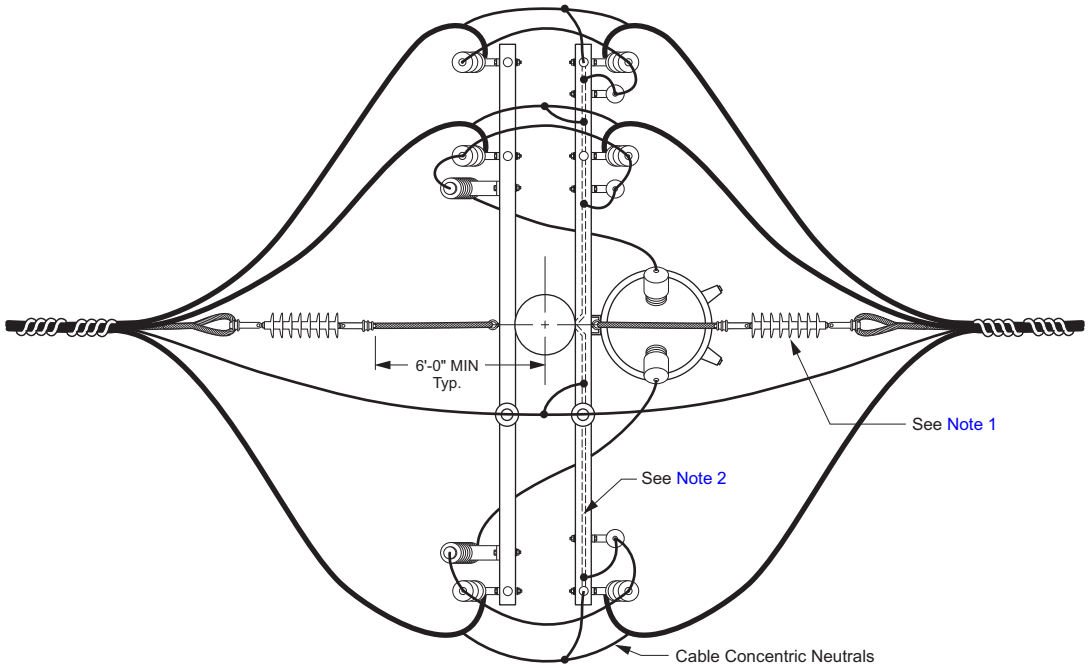
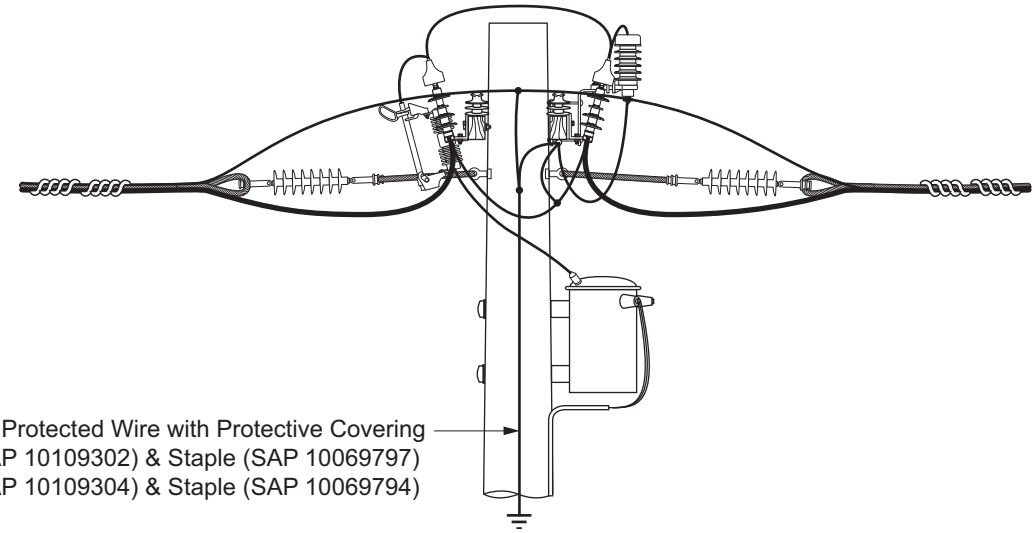


Figure AC 400–2: 4/12/16 kV Aerial Cable Connection to Transformer (Side View)

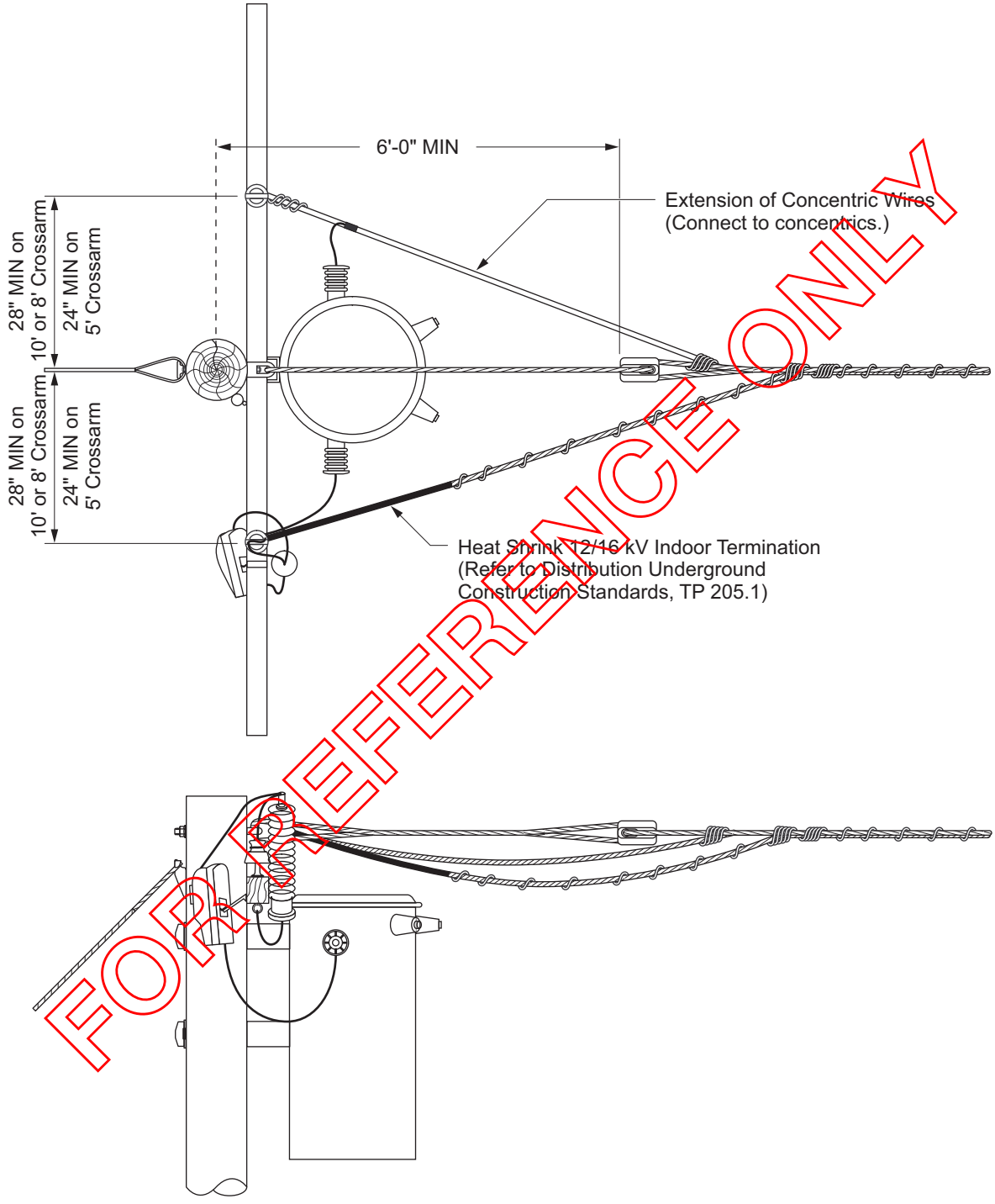


Note(s):

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

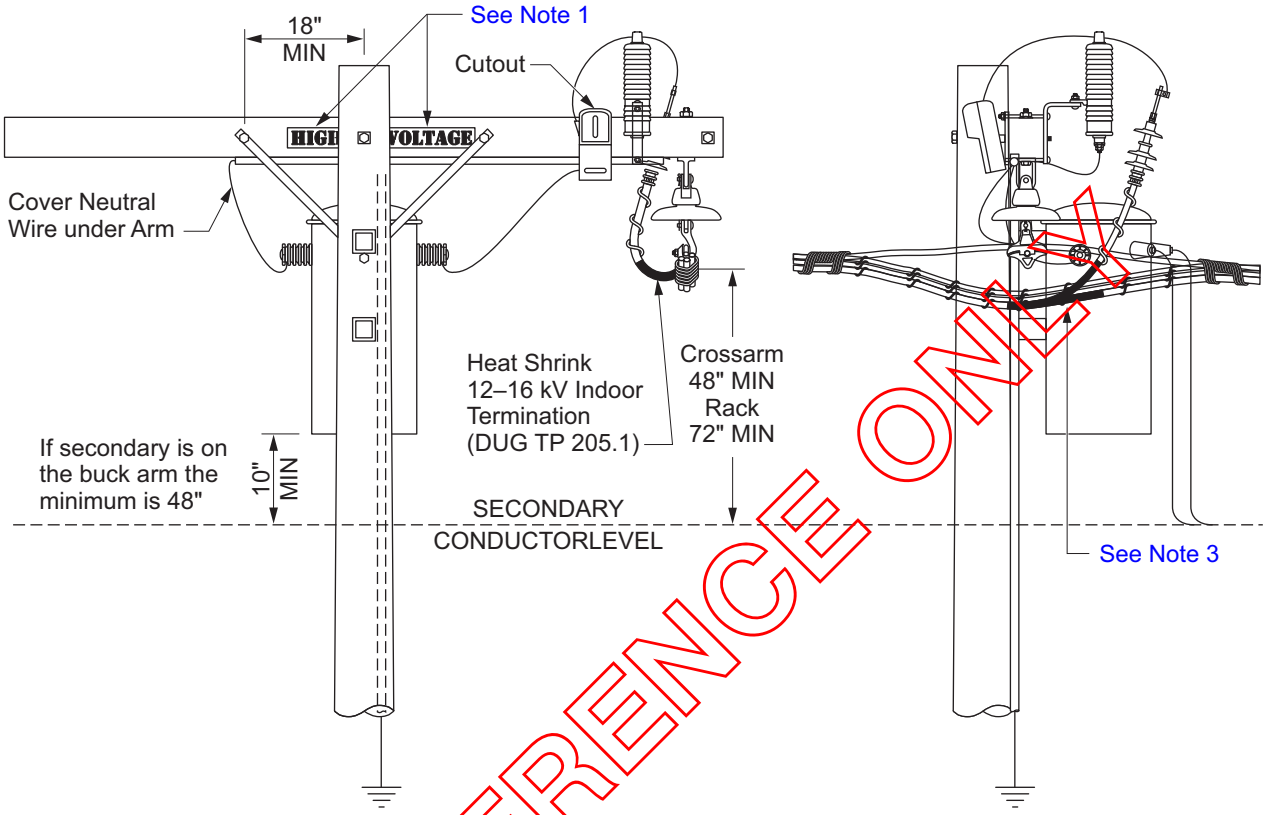
Figure AC 400–3: 2.4 kV 1/C Aerial Cable Connection to Transformer Dead-End Construction



FOR REFERENCE ONLY

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

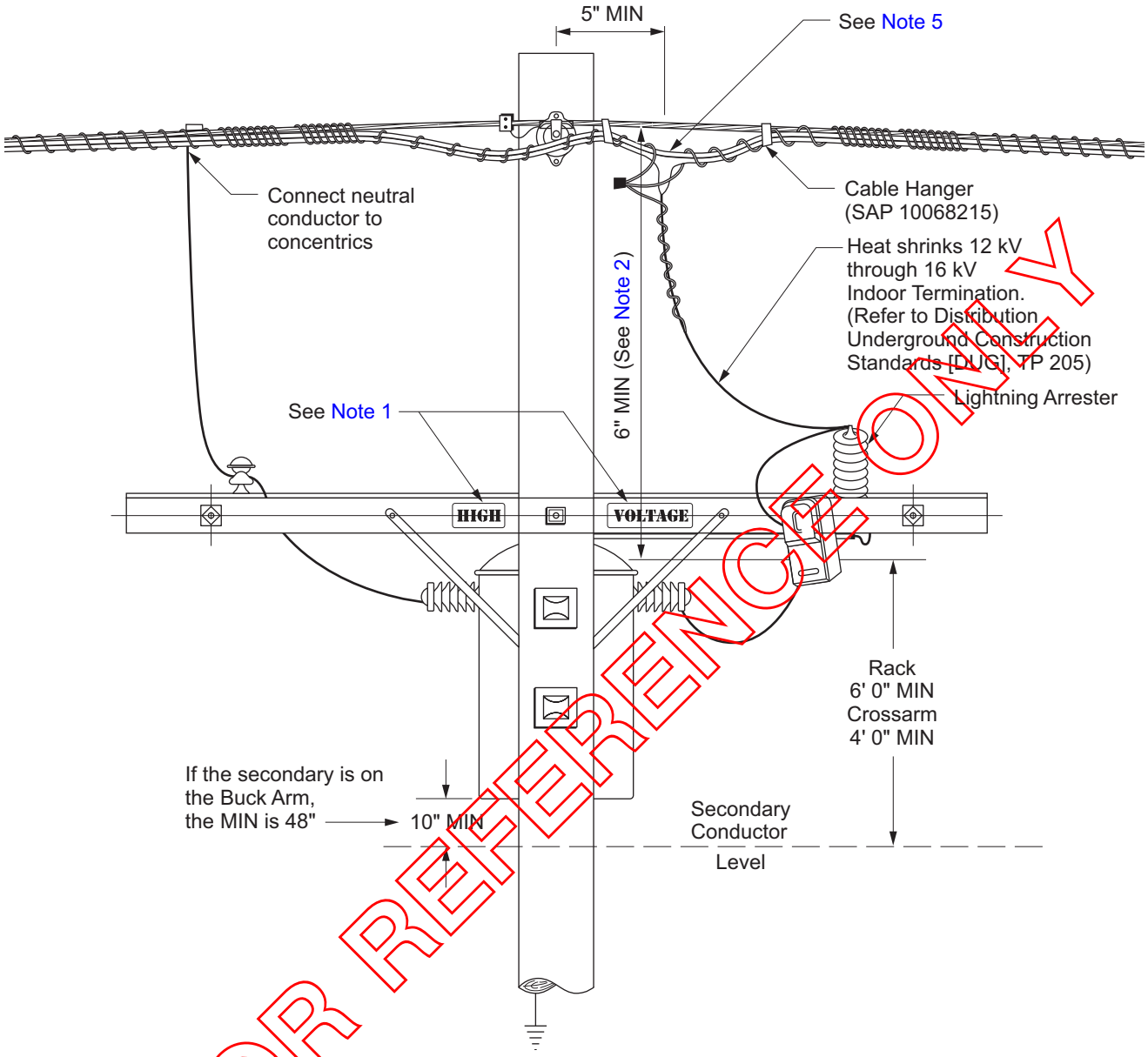


FOR REFERENCE ONLY

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



FOR REFERENCE ONLY

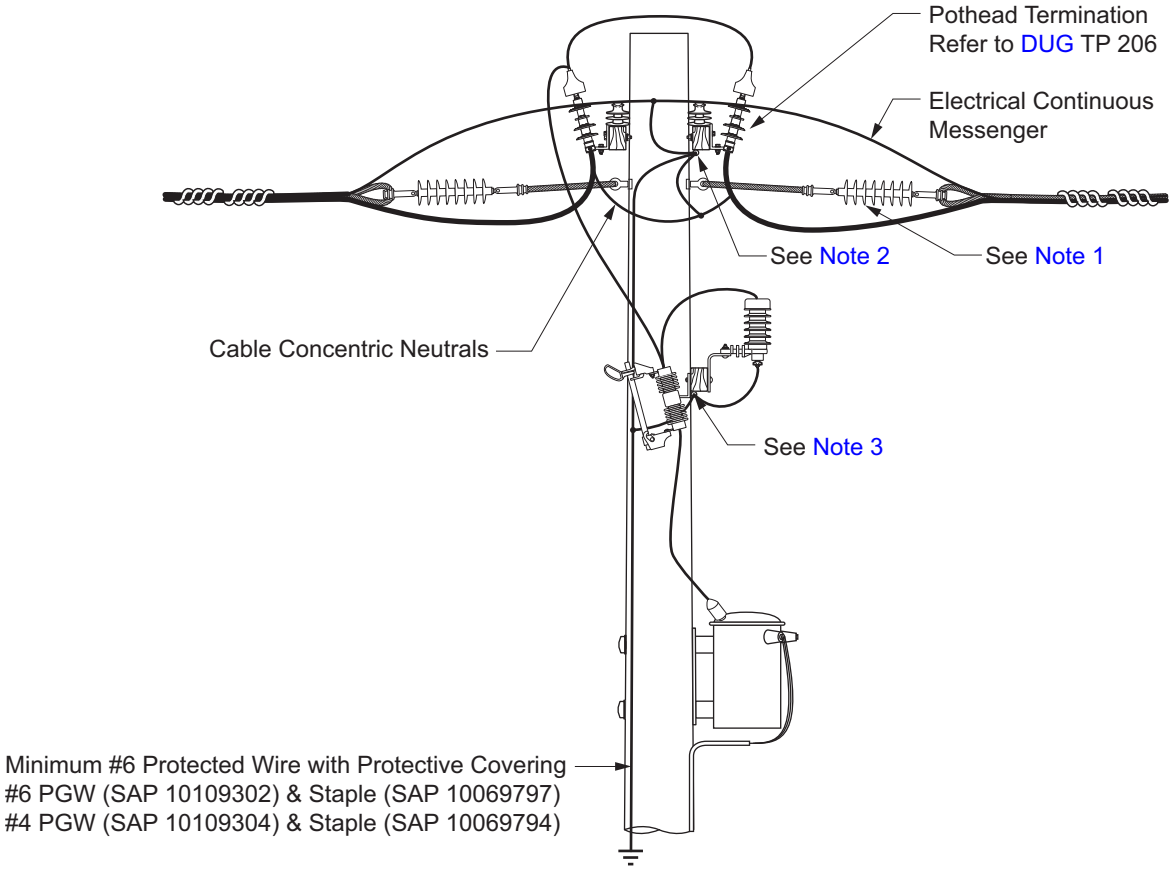
Note(s):

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)

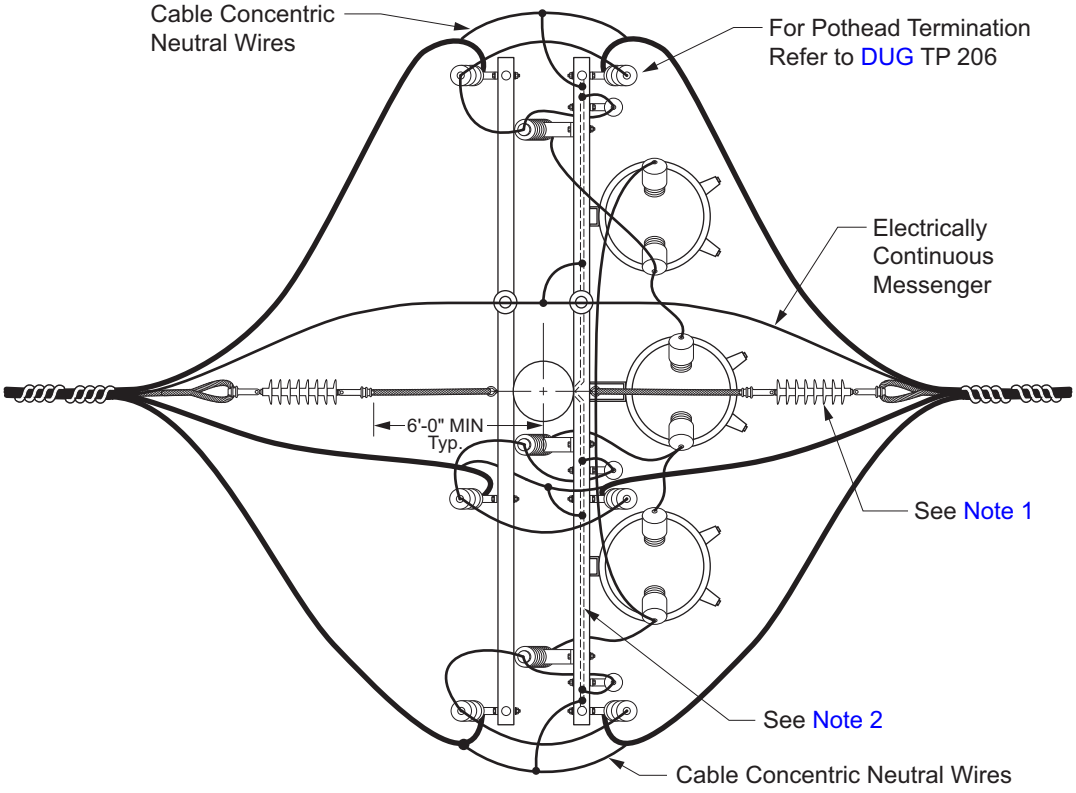


Side View

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)



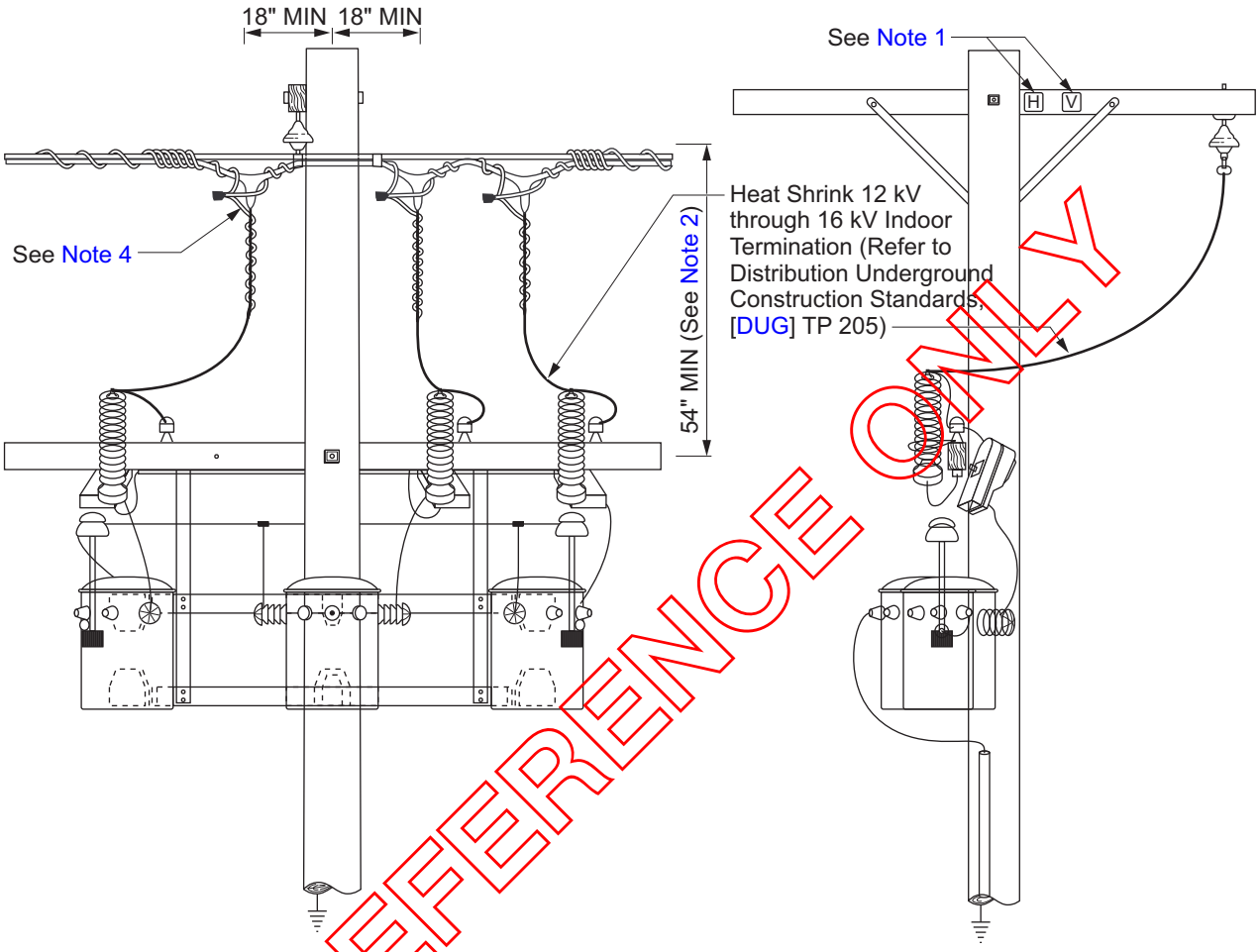
Top View

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



FOR REFERENCE ONLY

Note(s):

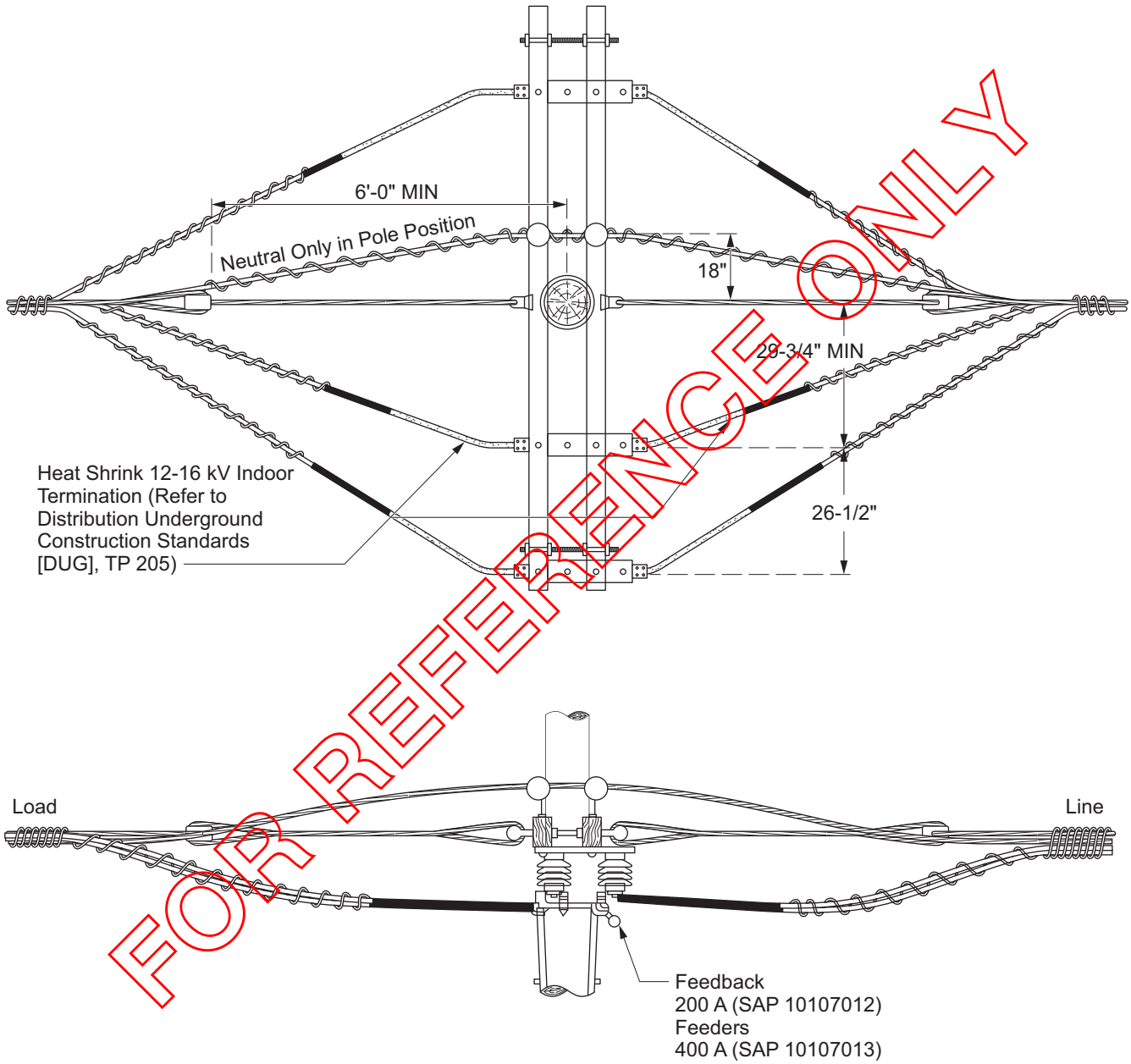
1. See PO 120 for High Voltage sign installation requirements.
2. If cable is at top of pole, cable may be mounted directly to pole with horizontal post insulator with 6-foot vertical clearance to transformer.
3. Concentric wires should be interconnected at Y-splices.
4. Y-Splice #2 and 1/0 JJ 650.1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

This page intentionally left blank.

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



FOR REFERENCE ONLY

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)

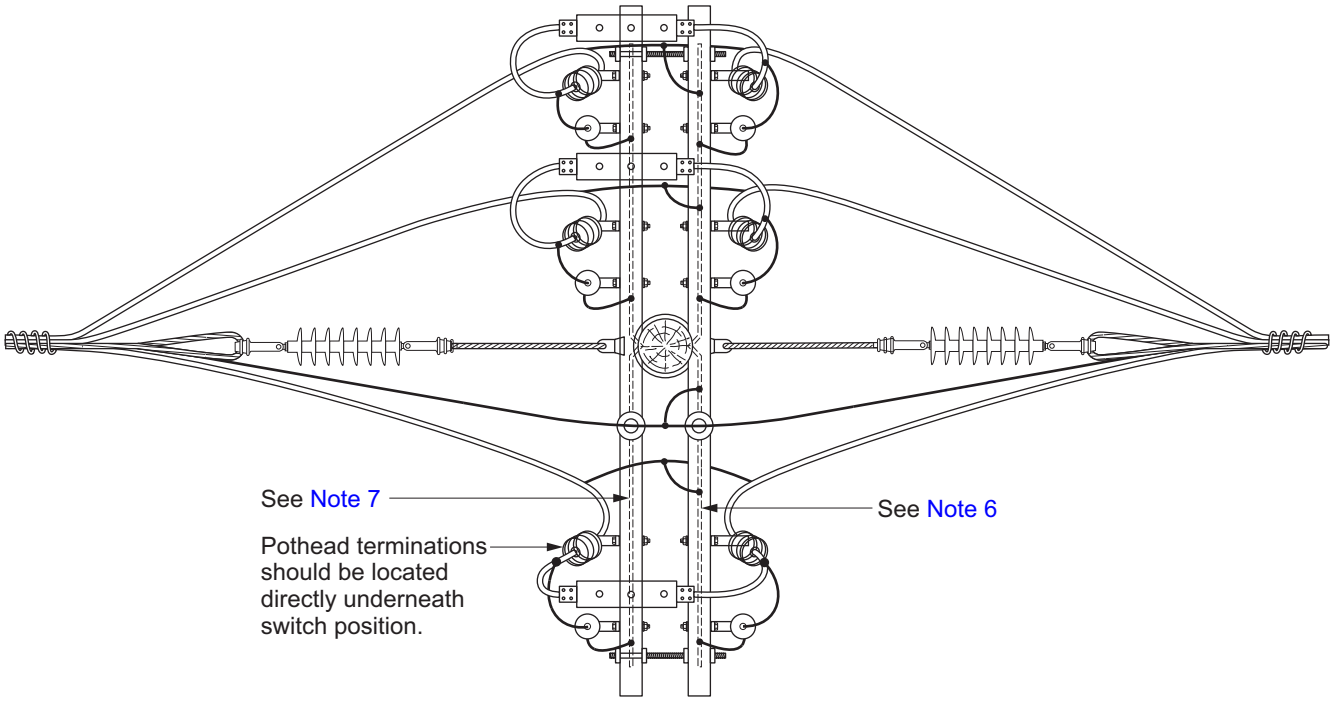
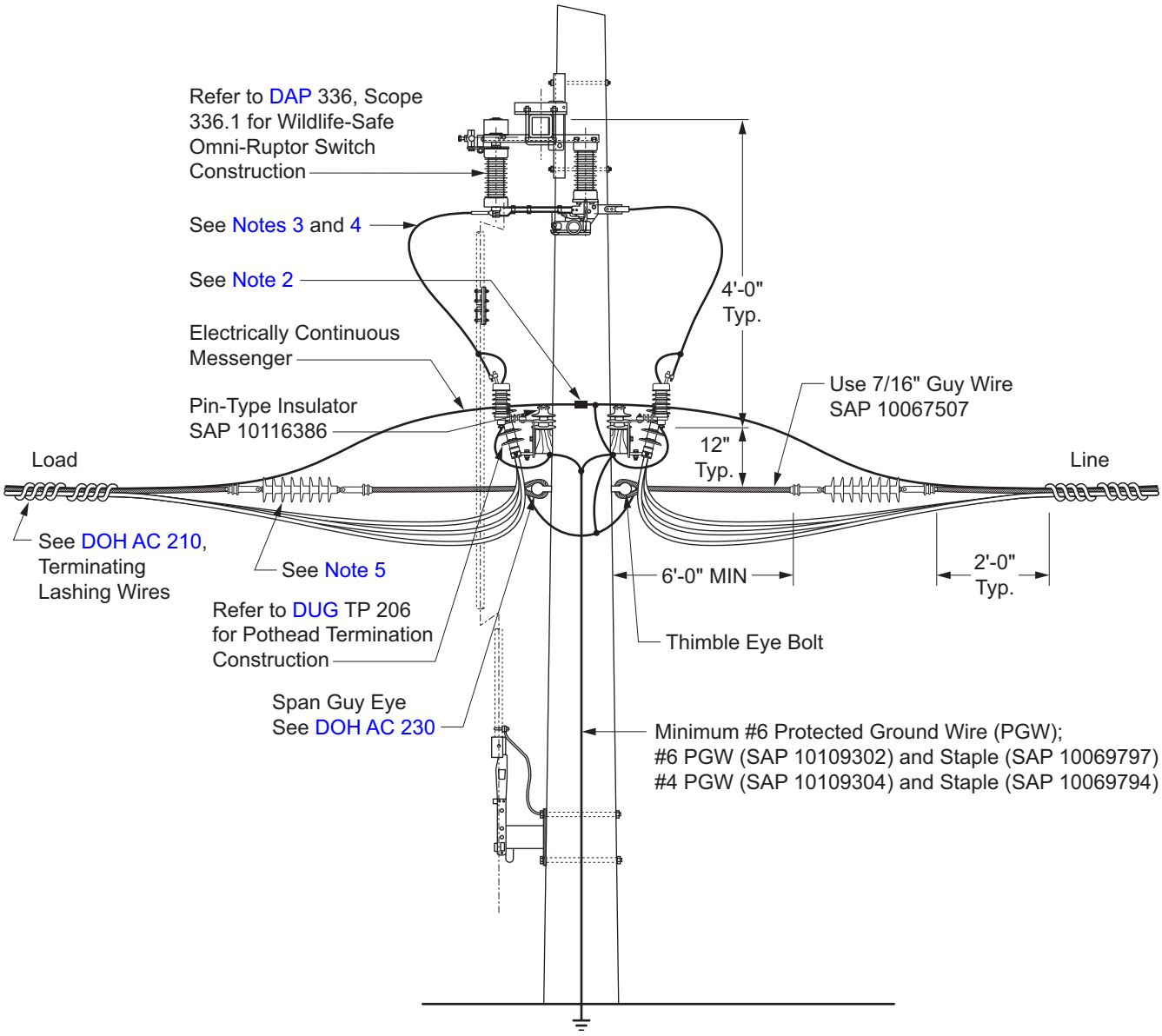


Figure AC 420–3: 2.4/4/12/16 kV Aerial Cable Disconnect Switches (Side View)



Note(s):

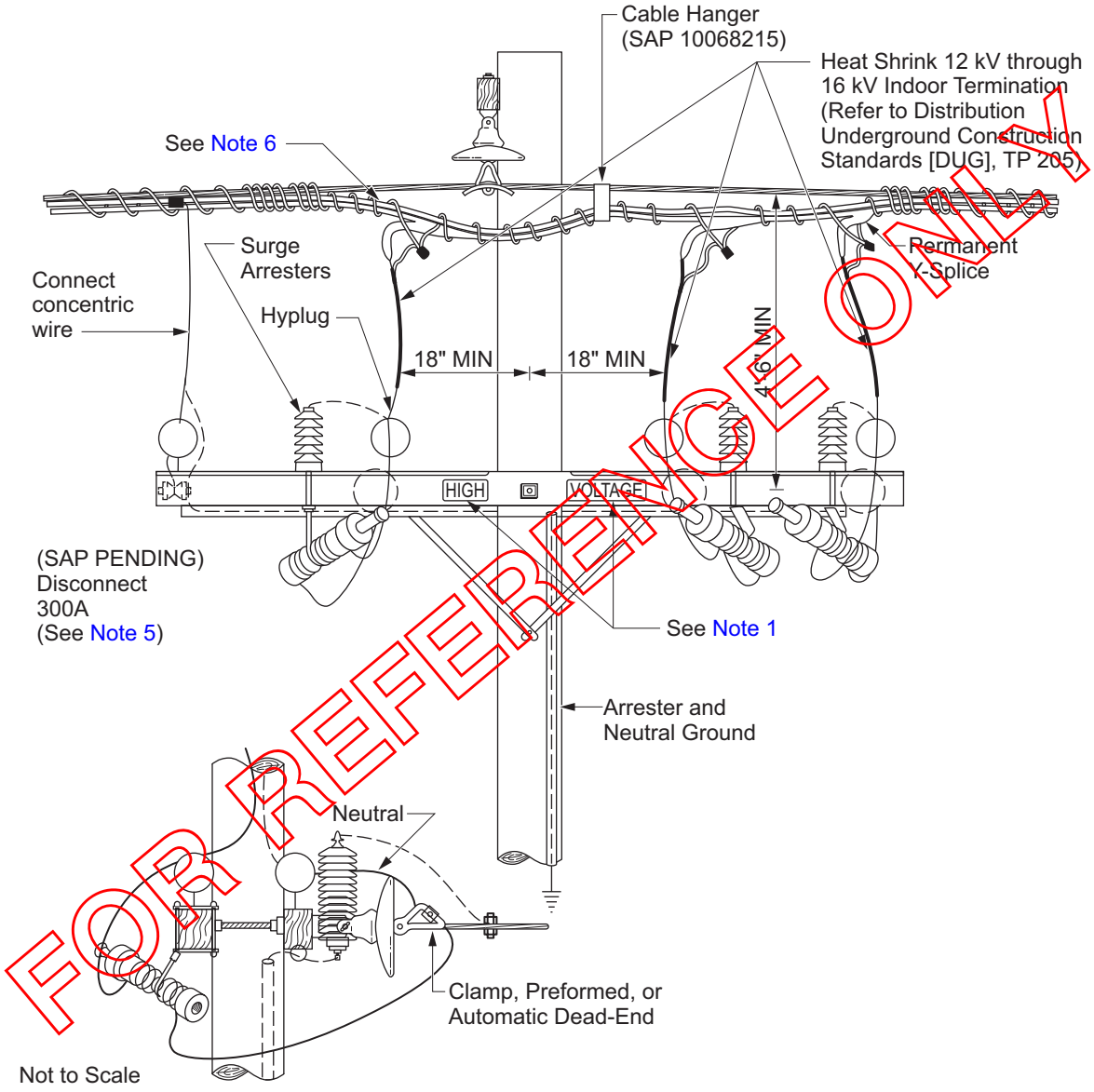
1. Install V-brace for all messenger sizes, SAP 10067347.
2. Connect Copperweld messenger using a 2 Bolt Parallel Groove Copper Clamp, SAP 10111580.
3. Jumper shall have an equivalent or greater ampacity than Aerial Cable.
4. Cover the wire per DC 535 Wildlife Protection.
5. Guy strain insulator is an 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.

This page intentionally left blank.

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



FOR REFERENCE ONLY

Note(s):

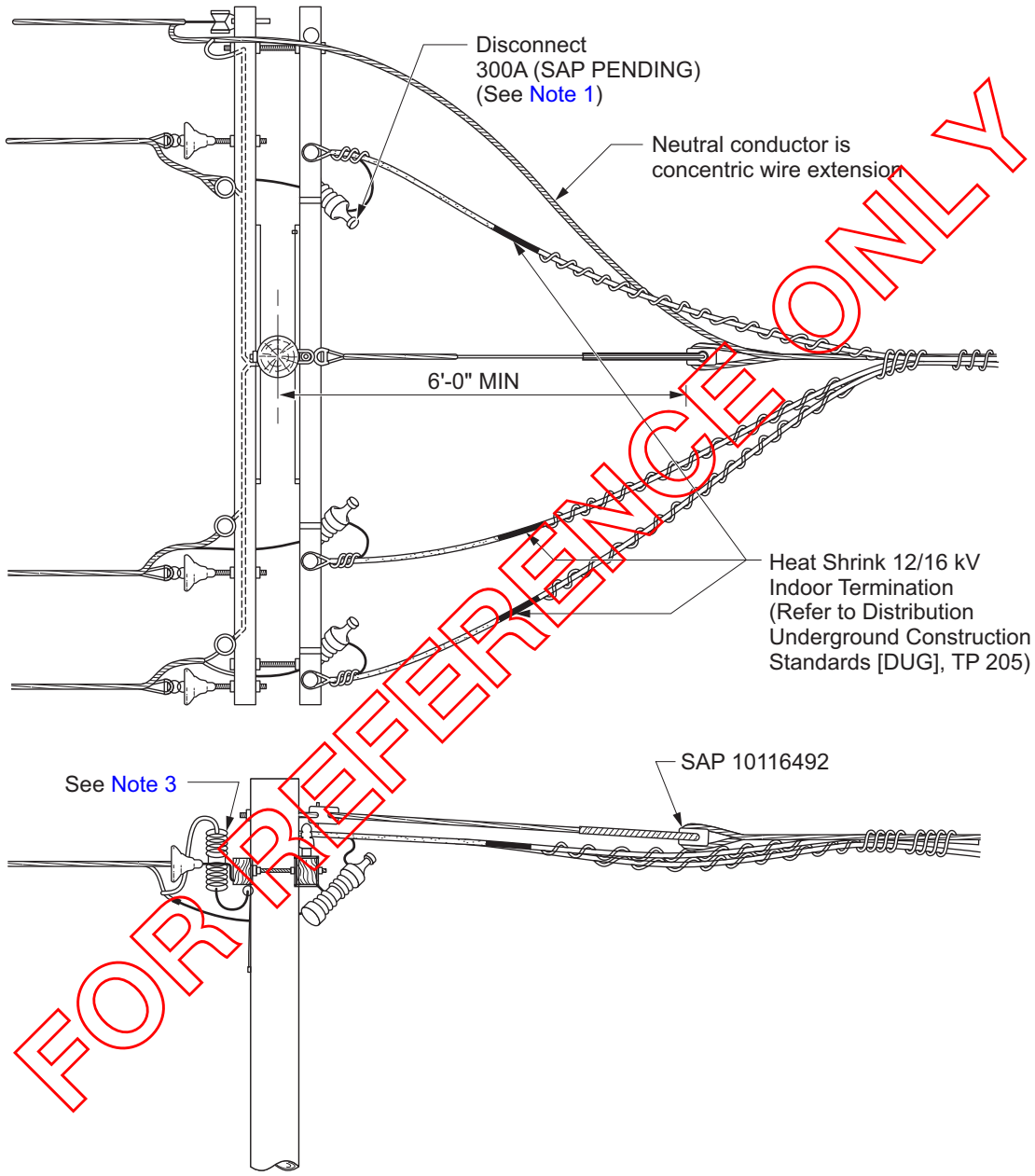
1. See PO 120 for High Voltage sign installation requirements.
2. Omit disconnects if less than 100-kVA transformer capacity is connected to open wire, and open wire cannot be transferred to another circuit.
3. Use cutout, Positect disconnect type (SAP PENDING) for open wire cable installation.
4. Disconnects 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.

FOR REFERENCE ONLY

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



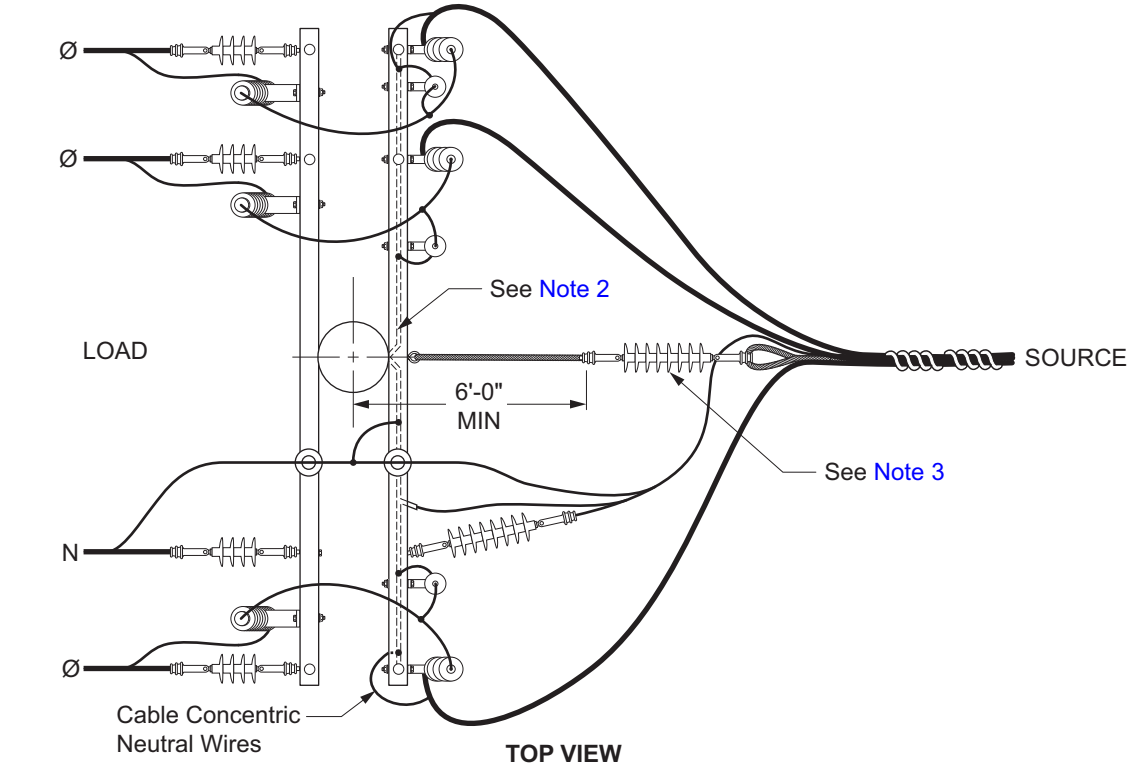
FOR REFERENCE ONLY

Note(s):

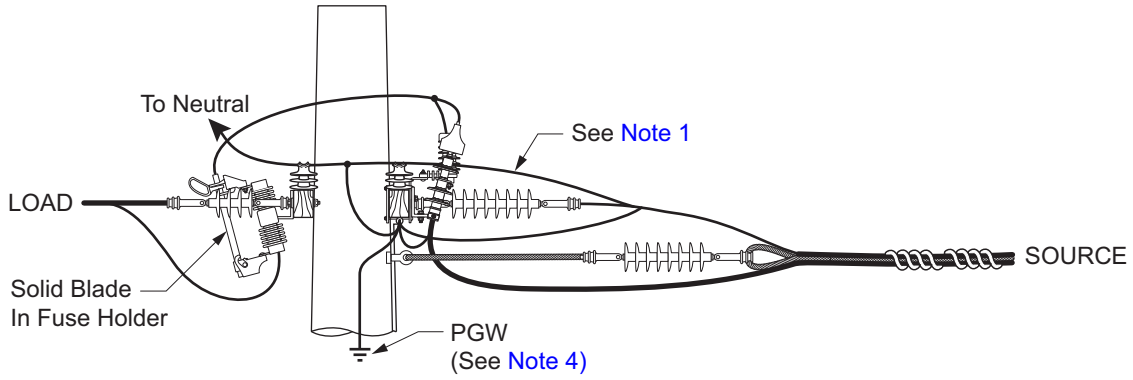
1. Omit disconnects if less than 100 kVA transformer capacity is connected to open wire and open wire cannot be transferred to another circuit.
2. Connect neutral ground to surge arrester ground.
3. Surge Arrester — For applications, see AC 400.

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

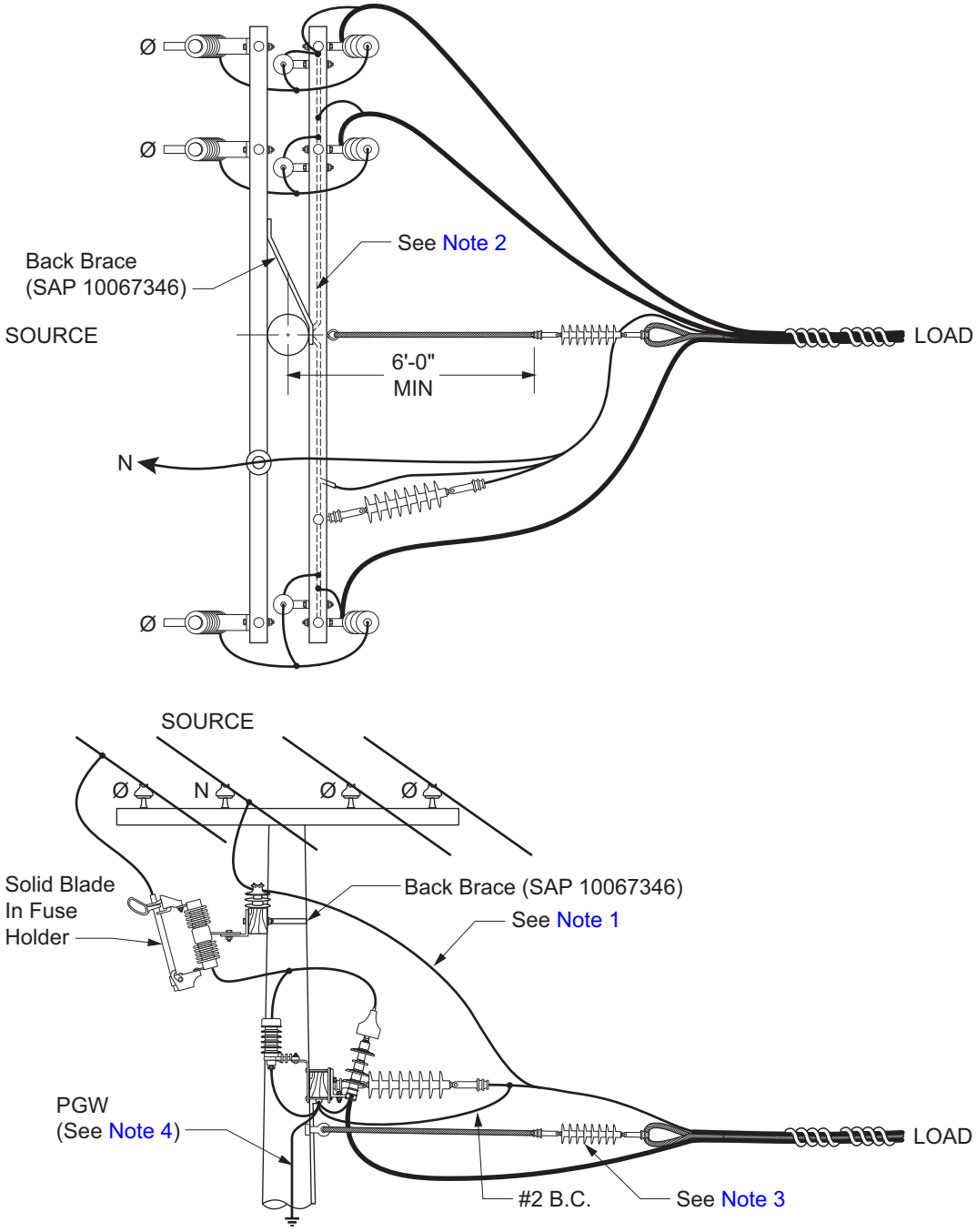


SIDE VIEW

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):

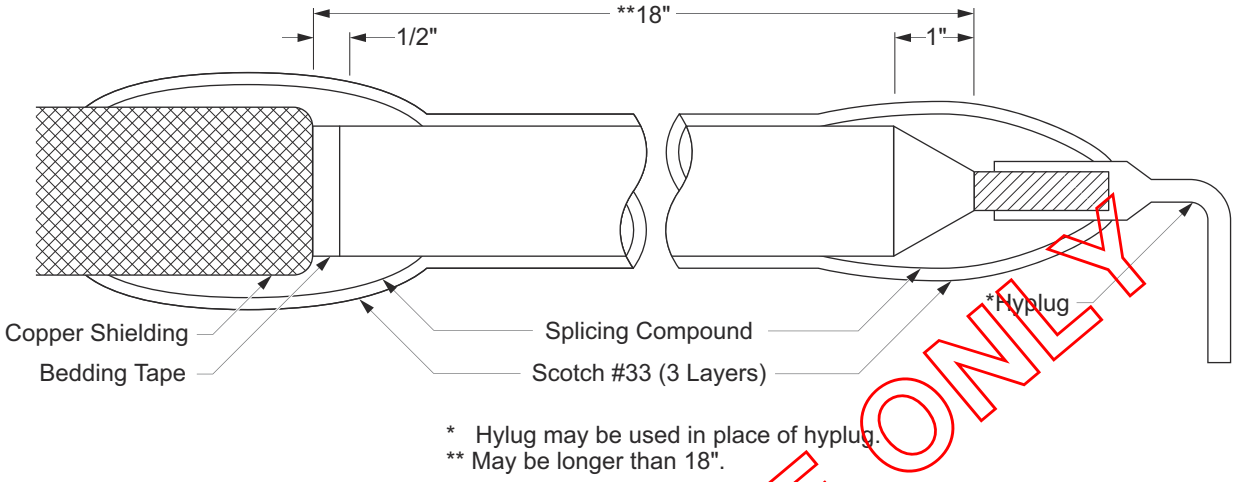
1. Use #2 B.C. neutral for 1/0 3-Phase Aerial Cable and 4/0 B.C. for 350 3-Phase Aerial Cable.
2. Connect surge arrester, concentric neutrals and messenger to #2 B.C. in PVC under arm. Connect #6 MIN ground wire to #2 B.C. in PVC under arm.

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



Note(s):

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

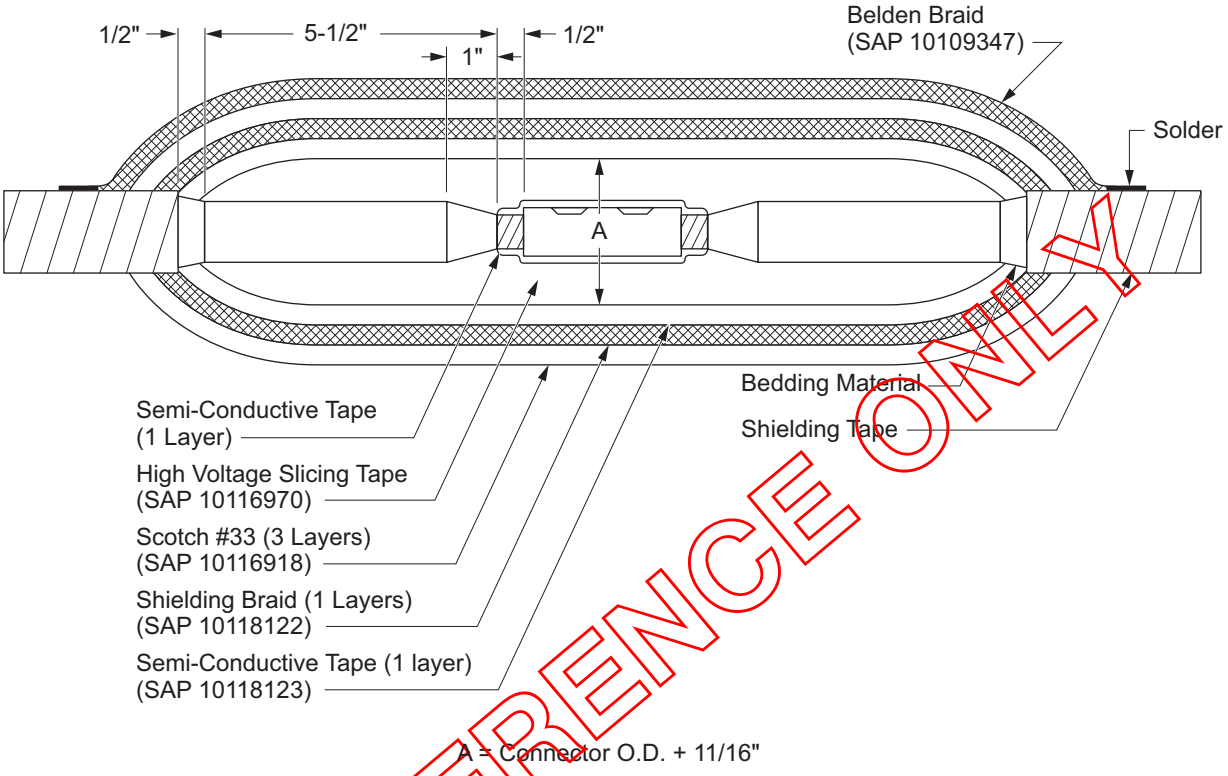
FOR REFERENCE ONLY

This page intentionally left blank.

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



FOR REFERENCE ONLY

Note(s):

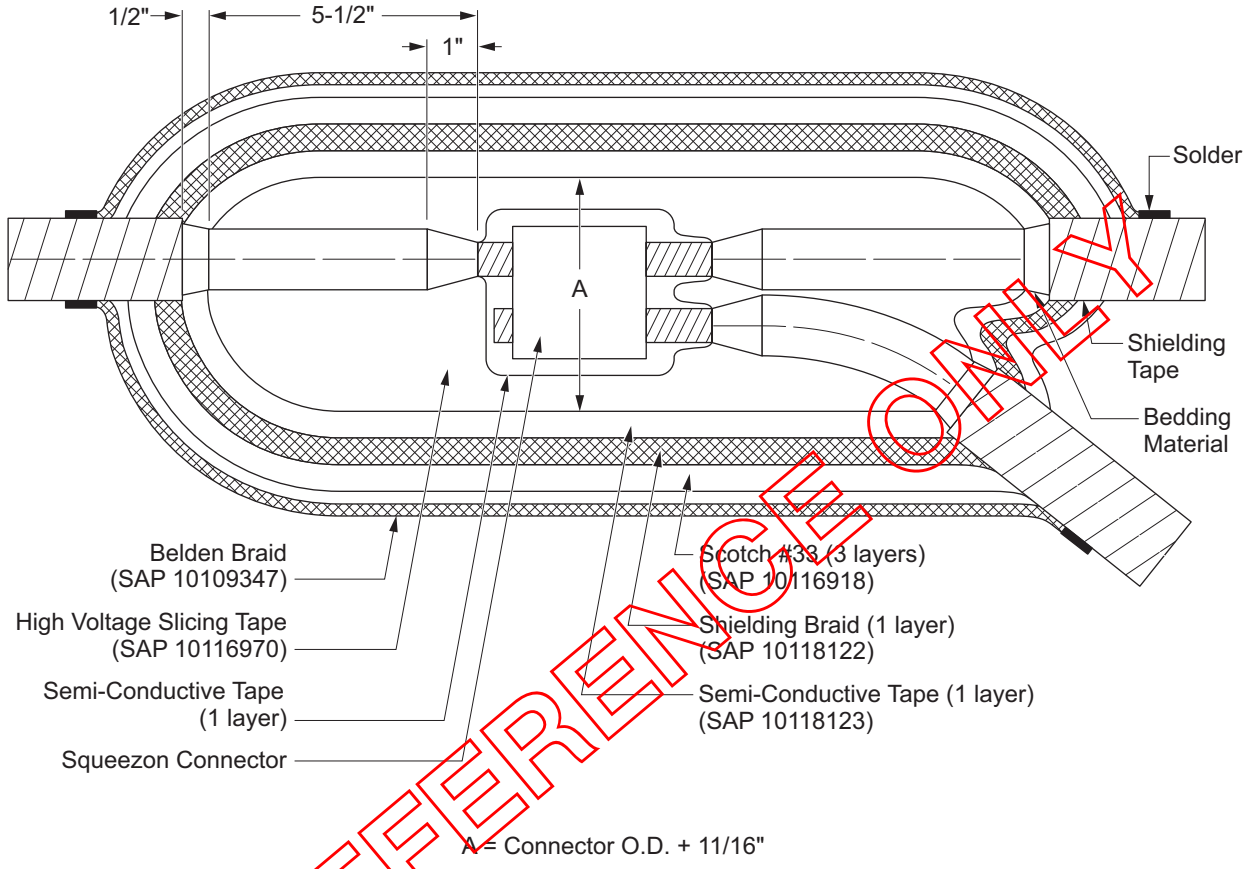
1. To select proper connector and for proper compression tool, refer to Distribution Underground Construction Standards (DUG), JJ 110 and JJ 116.

This page intentionally left blank.

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



FOR REFERENCE ONLY

Note(s):

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

This page intentionally left blank.

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.

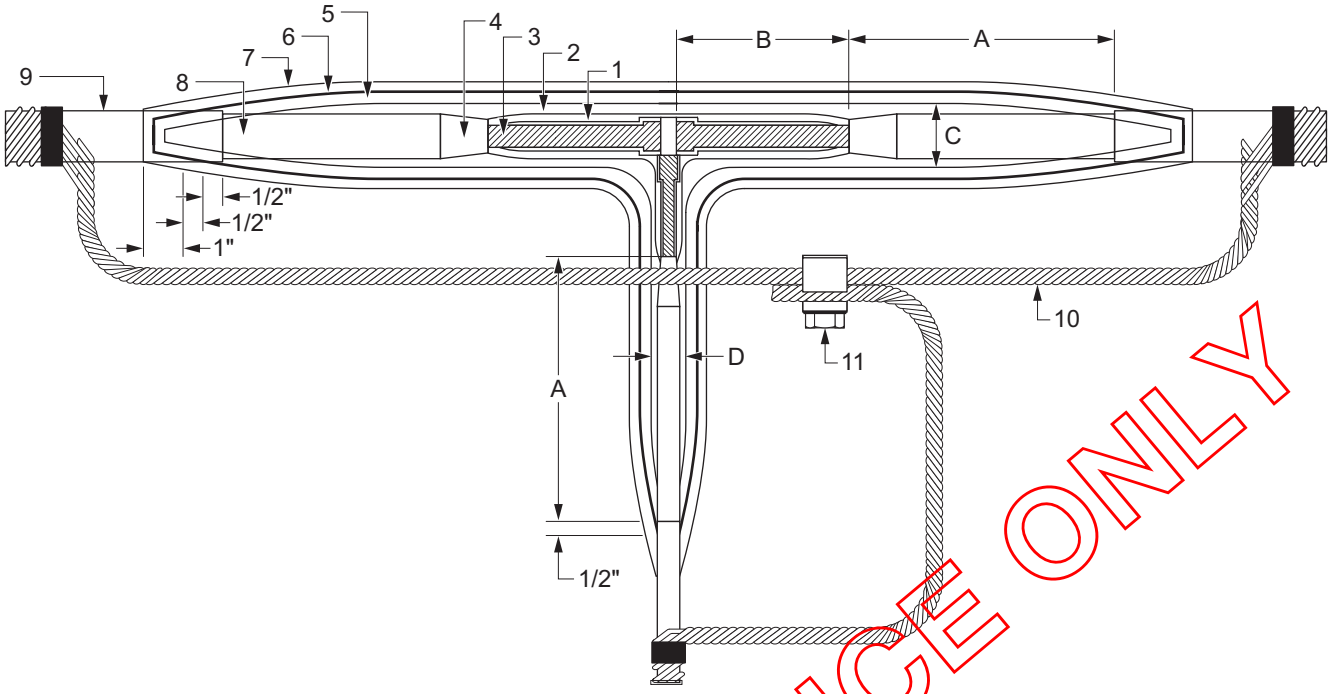
1.8 Apply half-lapped layers of high-voltage insulating tape to Diameters “C” and “D,” forming gradual slopes at each end, extending tape to edge of semi-conducting insulation shielding. Two diameters are given, since the connector barrels may be of different diameters. **Do not overlap the semi-conducting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

FOR REFERENCE ONLY

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



FOR REFERENCE ONLY

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	3,827	3,587	3,345	3,103	3,473	2,634
60	3,782	3,547	3,313	3,079	3,430	2,636
80	3,721	3,495	3,270	3,050	3,375	2,638
100	3,648	3,433	3,222	3,016	3,312	2,640
120	3,568	3,366	3,170	2,982	3,246	2,641
140	3,484	3,298	3,119	2,948	3,181	2,643
160	3,401	3,231	3,069	2,916	3,120	2,645
180	3,321	3,168	3,023	2,886	3,064	2,646
200	3,247	3,110	2,981	2,860	3,014	2,647
220	3,180	3,059	2,944	2,837	2,971	2,648

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

	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'-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

	Tension (lb)					
	Initial Stringing Tension				Final Tension	
Span (ft)	50°F	70°F	90°F	110°F	70°F	130°F
40	3,283	3,040	2,798	2,558	2,838	2,035
60	2,958	2,729	2,506	2,290	2,504	1,825
80	2,564	2,367	2,182	2,009	2,147	1,648
100	2,188	2,040	1,905	1,784	1,863	1,529
120	1,904	1,804	1,713	1,631	1,676	1,455
140	1,718	1,651	1,589	1,533	1,561	1,408
160	1,599	1,553	1,510	1,469	1,487	1,376
180	1,521	1,488	1,456	1,426	1,439	1,354
200	1,468	1,443	1,418	1,395	1,405	1,339
220	1,431	1,411	1,391	1,373	1,380	1,327

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	4,446	4,069	3,700	3,340	3,936	2,751
60	4,387	4,040	3,706	3,388	3,916	2,898
80	4,317	4,006	3,713	3,438	3,895	3,032
100	4,245	3,973	3,719	3,485	3,875	3,147
120	4,176	3,942	3,725	3,525	3,857	3,242
140	4,115	3,916	3,731	3,560	3,842	3,320
160	4,063	3,893	3,735	3,588	3,829	3,384
180	4,019	3,874	3,738	3,612	3,819	3,437
200	3,982	3,858	3,741	3,632	3,811	3,481
220	3,952	3,845	3,744	3,649	3,804	3,517

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

	Sag					
	Initial Stringing Sag				Final Sag	
Span (ft)	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

	Tension (lb)					
	Initial Stringing Tension				Final Sag	
Span (ft)	50°F	70°F	90°F	110°F	70°F	130°F
40	3,562	3,208	2,870	2,554	2,980	2,006
60	3,152	2,872	2,619	2,392	2,675	2,018
80	2,791	2,600	2,429	2,278	2,454	2,025
100	2,547	2,421	2,308	2,205	2,319	2,029
120	2,395	2,310	2,232	2,160	2,237	2,032
140	2,299	2,239	2,183	2,130	2,186	2,034
160	2,237	2,192	2,150	2,110	2,152	2,035
180	2,194	2,160	2,127	2,095	2,128	2,036
200	2,164	2,136	2,110	2,085	2,111	2,037
220	2,141	2,119	2,098	2,077	2,098	2,037

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	2,709	2,464	2,220	1,980	2,375	1,571
60	2,670	2,434	2,203	1,980	2,347	1,615
80	2,620	2,398	2,183	1,980	2,312	1,661
100	2,563	2,357	2,162	1,980	2,275	1,702
120	2,502	2,315	2,141	1,979	2,238	1,739
140	2,442	2,275	2,121	1,979	2,204	1,771
160	2,386	2,238	2,103	1,979	2,174	1,798
180	2,335	2,205	2,087	1,979	2,148	1,821
200	2,289	2,177	2,073	1,979	2,125	1,841
220	2,250	2,152	2,062	1,979	2,106	1,857

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	2,164	1,925	1,694	1,473	1,768	1,069
60	1,880	1,673	1,482	1,311	1,517	1,020
80	1,585	1,432	1,298	1,183	1,307	989
100	1,360	1,262	1,176	1,101	1,175	971
120	1,220	1,157	1,101	1,051	1,098	960
140	1,136	1,093	1,055	1,019	1,051	953
160	1,083	1,053	1,025	999	1,022	948
180	1,048	1,026	1,004	984	1,002	945
200	1,024	1,007	990	974	988	942
220	1,007	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	1,565	1,330	1,107	902	1,247	610
60	1,541	1,325	1,125	950	1,250	717
80	1,513	1,318	1,145	996	1,253	804
100	1,483	1,312	1,163	1,035	1,256	874
120	1,454	1,306	1,178	1,069	1,258	932
140	1,428	1,301	1,192	1,098	1,260	979
160	1,405	1,297	1,203	1,121	1,262	1,019
180	1,386	1,294	1,212	1,141	1,264	1,051
200	1,370	1,291	1,220	1,158	1,265	1,079
220	1,357	1,288	1,227	1,172	1,266	1,102
240	1,346	1,286	1,232	1,184	1,266	1,121
260	1,336	1,284	1,237	1,194	1,267	1,138
280	1,329	1,283	1,241	1,202	1,268	1,152
300	1,322	1,282	1,244	1,209	1,268	1,164

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	1,060	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 50–110°F	Final Sag 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) 50–110°F	Final Tension (lb) 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 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"
	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 50–110°F	Final Sag 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 50–110°F	Final Sag 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 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 472–14: Stringing Tension Table for New Reduced Tension Unguyed 1/0 — 350 Aerial Bundled Cable for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Tension 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 472–15: 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.

This page intentionally left blank.

DOH–CC: Covered Conductor

TABLE OF CONTENTS

STANDARD	TITLE
CC 100	Covered Conductor
CC 100.1	Covered Conductor 1.0 General
CC 100.2	Covered Conductor Exposed End Protection - Sealing/Moisture Proofing Method for Covered Conductor Ends
CC 110	Cable Data
CC 110.1	15 kV Covered Conductors — 75°C Rated
CC 110.2	17 kV Covered Conductors 1.0 — 90°C Rated
CC 110.3	35 kV Covered Conductors 1.0 — 90°C Rated
CC 110.4	17 kV ACSR/AW Grey Covered Conductor for 2.0 (AWCC)—90°C Rated
CC 110.5	17 kV HDCU Grey Covered Conductor for 2.0 (CCCU)—90°C Rated
CC 110.6	35 kV ACSR/AW Grey Covered Conductor for 2.0 (AWCC)—90°C Rated
CC 110.7	35 kV HDCU Grey Covered Conductor for 2.0 (CCCU)—90°C Rated
CC 120	Sagging and Clearances
CC 120.1	Sagging Covered Conductors
CC 120.2	Directions for Use of Sag Charts
CC 120.3	Sag Chart and Clearances for 1/0 ACSR Covered Conductor
CC 120.4	Sag Charts and Clearances 336.4 ACSR Covered Conductor
CC 120.5	Sag Charts and Clearances 653.9 ACSR Covered Conductor
CC 120.6	Sag Charts and Clearances #2 Copper Covered Conductor
CC 121	Reduce Tension Span Sag Charts for Covered Conductors
CC 121.1	Directions for Use of Sag Charts
CC 121.2	Reduced Tension Sag Charts for Light-Loading Areas
CC 121.3	Reduced Tension Sag Charts for Heavy-Loading Areas
CC 122	High Strength Covered Conductor Application and Construction Requirements
CC 122	High Strength Covered Conductor Application and Construction Requirements
CC 123	CC 2.0 in Heavy Loading Areas
CC 123.1	CC 2.0 in Heavy Loading Area
CC 130	Surge Arresters
CC 130.1	Application of Surge Arresters for Covered Conductors
CC 131	4/12/16 kV OH Branch Line Fusing for Covered Conductor
CC 131	4/12/16 kV OH Branch Line Fusing for Covered Conductor
CC 140	Neutrals in Covered Conductor Systems
CC 140.1	Covered Conductor Neutrals
CC 150	Covered Conductor Installation Materials and Equipment
CC 150.1	Covered Conductor Insulator

STANDARD	TITLE
CC 150.2	Dead-Ending Covered Conductors
CC 150.3	Covered Conductor Tap Connections
CC 150.4	Insulated Cover Requirements
CC 170	Splicing Covered Conductors
CC 170.1	Compression Splices and Splice Covering Kit
CC 170.2	Cable Preparation, Splicing, and Installation of Splice Covering
CC 180	Transitioning to Bare Wire
CC 180.1	Transitioning from Covered Conductor to Bare Wire
CC 190	Vibration Dampers Requirements in Covered Conductor Systems
CC 190.1	Applications for Vibration Dampers in Covered Conductor Systems
CC 190.2	Installation of Spiral Vibration Dampers in Covered Conductor Systems
CC 190.3	Installation of Stockbridge Dampers in Covered Conductor Systems
CC 200	Personal Protection Grounding for Covered Conductor Systems
CC 200.1	Grounding Points Procedure for Personal Protection

CC 100 Covered Conductor

Scope CC 100.1 Covered Conductor 1.0 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).

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.

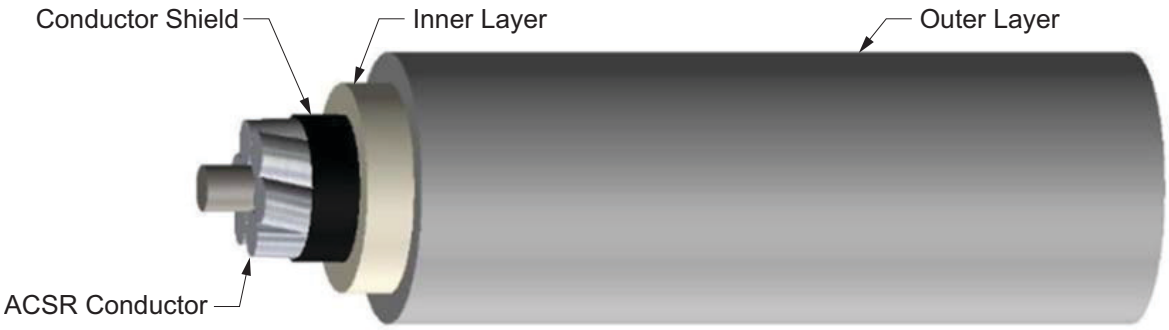
The outer layer is Crosslinked High Density Polyethylene (XL-HDPE), which is an insulating material as well. It has the same insulating function as the inner layer. However, due to being high density, it is also a tougher layer, making it abrasion and impact resistant. The outer layer is also track resistant, 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 1.0 (ATW/CTW)



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:

☐ Insulators shall be used based on the applications listed in the GR section.
☐ Splices, dead-ends, equipment bushing, fuses, and lightning arresters shall be covered
☐ Outer covering must be stripped before making any connections
☐ Surge Arresters (see CC 130)

NOTE The Sentient MM3 Remote Fault Indicator (RFI) (see DAP AP 604) shall not be used on Covered Conductor. The gripping teeth in the clamping mechanism of the Sentient MM3 RFI can cause damage to the sheath of the covered conductor.

Scope CC 100.2 Covered Conductor Exposed End Protection - Sealing/Moisture Proofing Method for Covered Conductor Ends

1.0 General

All covered conductors shall not be left exposed other than during the time work is being performed on the covered conductor. Partial reels of covered conductor that are stored in company warehouses, district/contractor yards, or contractor project stores shall have protection installed on the covered conductor ends. Exposed covered conductors shall be protected from moisture and contaminants in the following manner:

- Apply Aqua-Seal SAP 10116816/10116813 over exposed covered conductor end, extending at least one inch over the jacket.
- Follow this by wrapping two layers of half wrap Electrical tap (33 tape) SAP 10116970 over the Aqua-Seal.

Scope CC 100.3 Covered Conductor 2.0 Overview

1.0 General CC

Note: ***CC 2.0 is currently deployed For Planning Use Only and is not authorized for construction without engineering approval at this time. New work orders with operational dates in 2027 or beyond shall use the CC 2.0 Standard.***

Covered Conductor 2.0 (CC 2.0) aims to improve on SCE's previous generation of covered conductor. While the main goal of the first-gen covered conductor was for wildfire mitigation, CC2.0 shifts towards public safety and reduced customer interruptions as being the primary focus in non-high fire risk areas (non-HFRA's). This is realized by improving on the existing design of covered conductor and it's associated components, namely wildlife covers.

CC 2.0 is designed with similar components as it's predecessor: the conductor, a conductor shield, an inner layer (Crosslinked Low Density Polyethylene or XL-LDPE), and an outer layer (Crosslinked High Density Polyethylene or XL-HDPE). Where CC2.0 is different is as follows:

- Reduced insulation thicknesses to reduce total weight (lb/ft.) which can aid in reduced pole replacements
- Compact stranding to further reduce weight as compared to the previous generation's equivalent size.
- Moisture block between conductor strands to prevent moisture ingress and the potential for strand corrosion, particularly in coastal environments.
- Embossed printing on the outer layer for easier identification of conductor data as the conductor is exposed to various elements.

The conductor types can be Aluminum Conductor Aluminum-Clad Steel Reinforced (ACSR/AW - **AWCC**) or Hard/Medium Drawn Copper (HDCU-CCCU).

Similar to the first generation of covered conductor, CC 2.0 shall be treated and worked on as a bare conductor and does not exempt tree trimming requirements.

FOR PLANNING USE ONLY

2.0 Application

Two conductor designs are available for CC 2.0: 17kV and 35kV designed conductors.

- 17kV covered conductors may be used on 4, 12, and 16kV single- or three-phase circuits, laterals, or feeders. Neutral conductors (when applicable) shall be covered.
- 35kV covered conductors may be used on 25kV or 34.5kV single- or three-phase circuits, laterals, or feeders. Neutral conductors (when applicable) shall be covered.

Installing covered conductor is the same as installing bare conductor except the following:

- Insulator application shall be followed per the GR section
- Covering must be fully removed for making up dead-ends, jumper/tap connections, and splices
- All exposed bare conductor (when making up dead-ends, tap connections, or splices) shall be fully covered (that is, no exposed metal) AND sealed at the ends of the wildlife covers that are applied.
- Surge arresters must be applied per DOH CC 130

IMPORTANT: CC 2.0 should not be mixed with first-generation covered conductor and vice versa in a given span and should not be spliced together due to different overall conductor diameters. If CC2.0 is introduced in a circuit with mixed conductor types, it should only be utilized at the nearest dead-end structure where a clean transition can be made.

CC 2.0 will be deployed for planned work such as 4kV cutovers, Overhead Conductor Program (OCP), Distribution System Planning (DSP), and Wildfire Covered Conductor Program (WCCP) with operational dates in 2027. First-gen covered conductor will continue to be utilized for maintenance work on existing covered conductor systems and for planned work through 2026. Once first-gen covered conductor is depleted, CC2.0 will be required for all program, planned, and maintenance work moving forward.

Figure CC 100–2: Covered Conductor 2.0 (AWCC/CCCU)



1. Conductor: Compact stranded short lay ACSR/AW with Water Blocking Tape or/and Yarns.
2. Stand Shield: Semi-conducting cross linked polymer.
3. Inner Layer: Low-Density Crosslinked Polyethylene (LDXLPE).
4. Outer Layer: Track-Resistant High-Density Crosslinked Polyethylene (HDTRXLPE).

FOR PLANNING USE ONLY

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 (ATW)

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 1.0 — 90°C Rated

Table CC 110–2: 17 kV Cable Data — 90°C Rated ACSR Covered Conductor 1.0 (ATW)

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 1.0 (CTW)

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

Scope CC 110.3 35 kV Covered Conductors 1.0 — 90°C Rated

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

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.

Scope CC 110.4 17 kV ACSR/AW Grey Covered Conductor for 2.0 (AWCC)—90°C Rated

SAP	Conductor Size (AWG)	Conductor Type (Stranding)	Cover Type	Weight (lb/ft)	Conductor Diameter (in)	Overall Diameter (in)	Ampacity per Conductor (amps)[a/]
10222704	101.8	ACSR/AW (12/7)	XLPE (135 mils)	0.366	0.723	0.732	295
10222702	1/0	ACSR/AW (6/1)	XLPE (135 mils)	0.267	0.398	0.635	271
10222792	336.4	ACSR/AW (18/1)	XLPE (135 mils)	0.545	0.684	0.898	550
10222793	336.4[b/]	ACSR/AW (30/7)	XLPE (135 mils)	0.689	0.741	0.96	550
10222796 PILOT	653.9	ACSR (18/3)	XLPE (135 mils)	0.928	0.952	1.17	838

Note(s): Conductor size 653.9 (SAP 10222796) from Scope 110.4 is in pilot.

Scope CC 110.5 17 kV HDCU Grey Covered Conductor for 2.0 (CCCU)—90°C Rated

SAP	Conductor Size (AWG)	Conductor Type (Stranding)	Cover Type	Weight (lb/ft)	Conductor Diameter (in)	Overall Diameter (in)	Ampacity per Conductor (amps)[a/]
10222798	#2	HDCU (7)	XLPE (135 mils)	0.305	0.292	0.562	270
10222799	2/0	HDCU (7)	XLPE (135 mils)	0.541	0.414	0.684	367
10222800	4/0	HDCU (7)	XLPE (135 mils)	0.812	0.522	0.792	488
10222801	350	HDCU (19)	XLPE (135 mils)	1.271	0.679	0.989	660
10222802 PILOT	500	HDCU (19)	XLPE (135 mils)	1.767	0.813	1.123	820

Scope CC 110.6 35 kV ACSR/AW Grey Covered Conductor for 2.0 (AWCC)—90°C Rated

SAP	Conductor Size (AWG)	Conductor Type (Stranding)	Cover Type	Weight (lb/ft)	Conductor Diameter (in)	Overall Diameter (in)	Ampacity per Conductor (amps)[a/]
10222705	401.8	ACSR/AW (12/7)	XLPE (250 mils)	0.489	0.365	0.952	275
10222702	1/0	ACSR/AW (6/1)	XLPE (250 mils)	0.380	0.398	0.855	255
10222794	336.4	ACSR/AW (18/1)	XLPE (250 mils)	0.695	0.684	1.12	518
10222795	336.4[b/]	ACSR/AW (30/7)	XLPE (250 mils)	0.848	0.741	1.18	518
10222797 PILOT	653.9	ACSR/AW (18/3)	XLPE (250 mils)	1.115	0.952	1.38	784

Scope CC 110.7 35 kV HDCU Grey Covered Conductor for 2.0 (CCCU)—90°C Rated

SAP	Conductor Size (AWG)	Conductor Type (Stranding)	Cover Type	Weight (lb/ft)	Conductor Diameter (in)	Overall Diameter (in)	Ampacity per Conductor (amps)[a/]
10220186	#2	HDCU (7)	XLPE (250 mils)	0.412	0.295	0.782	225
10220187	2/0	HDCU (7)	XLPE (250 mils)	0.663	0.414	0.904	345
10220188	4/0	HDCU (7)	XLPE (250 mils)	0.946	0.522	1.012	450
10222803	350	HDCU (19)	XLPE (250 mils)	1.433	0.679	1.209	635
10222804 PILOT	500	HDCU (19)	XLPE (250 mils)	1.494	0.813	1.209	775

Note(s): Conductor size 500 (SAP 10222802) from Scope 110.5 is in pilot.
Conductor size 653.9 (SAP 10222797) from Scope 110.6 is in pilot.
Conductor size 500 (SAP 10222804) from Scope 110.7 is in pilot.

FOR PLANNING USE ONLY

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.

This page intentionally left blank.

CC 122 High Strength Covered Conductor Application and Construction Requirements

Scope CC 122.1 High Strength 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, 350 HDCS CC, and 500 HDCU CC.

The 336 (30/7) ACSR Covered Conductor, 350 HDCS Covered Conductor, and 500 HDCU Covered Conductor are high strength conductor typically used in heavy loading areas. If it needs to be installed in light loading areas to provide ground clearance, contact Transmission Engineering. 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 these high strength conductors will be 5,000 pounds. Limiting the tension to 5,000 pounds 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 pounds 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.

FOR PLANNING USE ONLY

This page intentionally left blank.

CC 123 CC 2.0 in Heavy Loading Areas

Scope CC 123.1 CC 2.0 in Heavy Loading Area

Heavy loading areas will continue to utilize high strength conductors to ensure that ground clearances are met with G.O. 95 heavy loading design constraints. 336.4 (30/7) “Oriole” will continue to be an option with CC2.0 for instances where greater conductor strength is needed and higher mainline circuit loading is expected

A new size of high strength covered conductor, 101.8 (12/7) “Petrel”, has been approved for the similar purposes as 336.4 (30/7). The “Petrel” conductor will be an option where portions of circuits in heavy loading areas do not require higher ampacity requirements. Being that this conductor is significantly lighter than the “Oriole” size, ground clearances can be achieved at lower tensions and, in most cases, shorter poles.

Transmission/Structures Engineering shall be contacted for engineered long spans that may require the use of these conductor sizes. H-frames or 3-pole structures shall be considered. Refer to DOH DC 630 for construction requirements.

In all cases, quadrant dead-end clamps shall be used for dead-end connections.

FOR PLANNING USE ONLY

This page intentionally left blank.

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.

Cal-Fire Exempt Surge Arresters are to be used in High Fire Risk Areas (HFRA) for covered conductors (DAP AP 415). Use standard distribution arresters (DAP AP 410) in non-HFRAs.

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

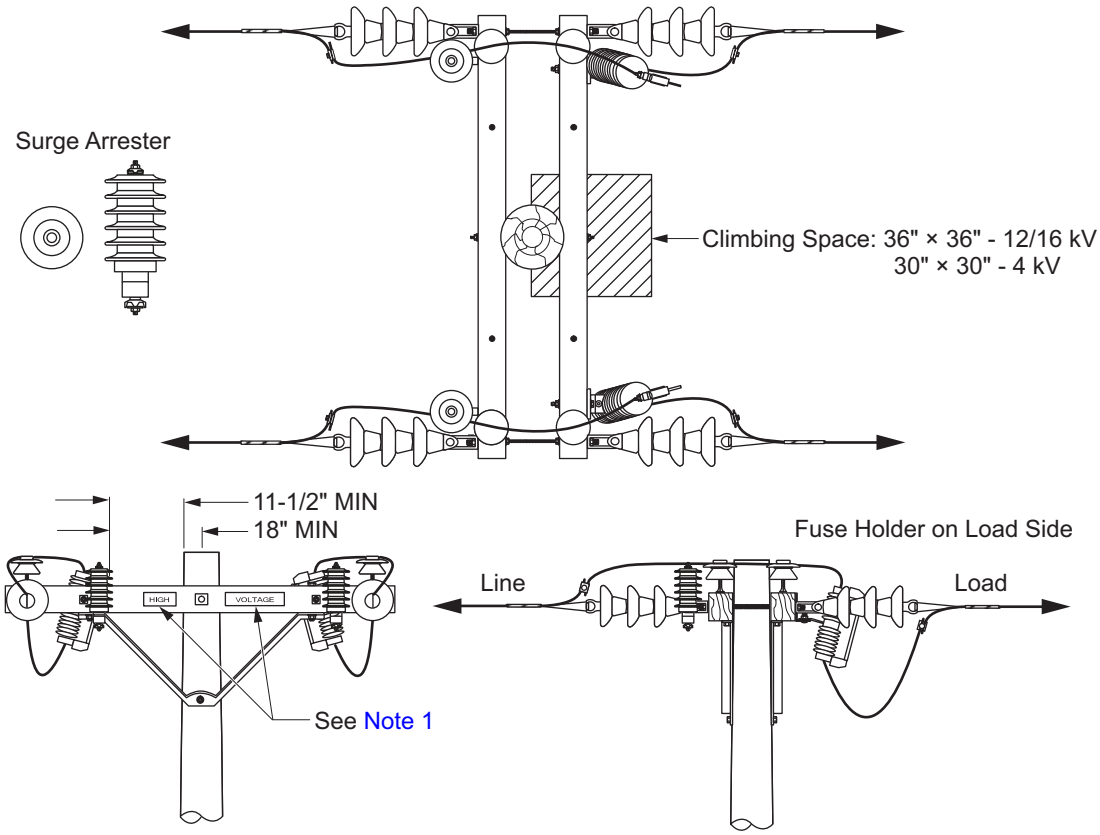
- Remote Automatic Reclosers (RARs)
- Remote Sectionalizing Reclosers (RSRs)
- Capacitors
- Line Voltage Regulators
- Potential Transformers (PTs) associated with Remote Control Switches (RCSs)
- PTs associated with Overhead Preferred Emergency (PE) Equipment
- Overhead Transformers (All installations)
- Branch Line Fusing Installations on Covered Conductor (see CC 131)
- All underground dips from overhead lines must have arresters installed.

This page intentionally left blank.

CC 131 4/12/16 kV OH Branch Line Fusing for Covered Conductor

Scope CC 131.1 Typical Branch Fuse Construction for 1Ø Double Dead-End Straight Line Pole

Figure CC 131–1: 5/8/10-Foot Single or Double Arm Construction

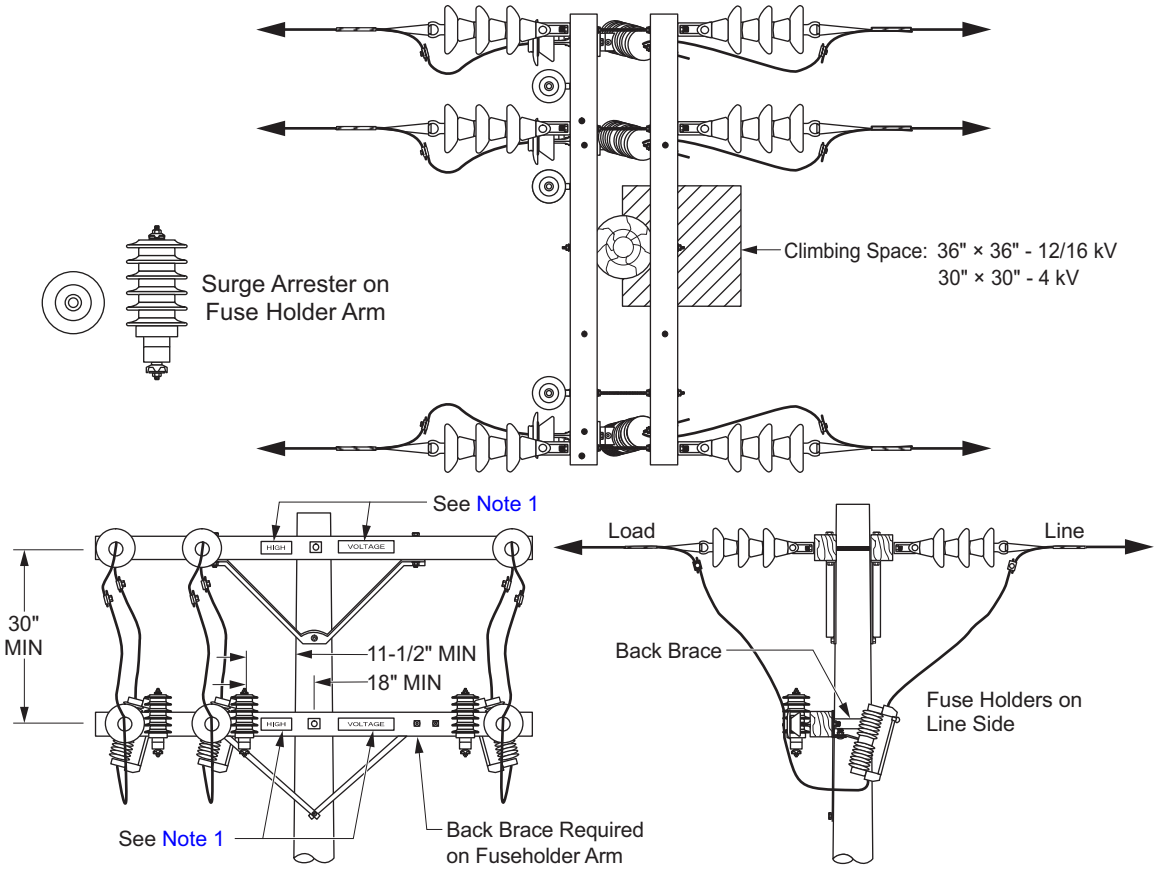


Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Maintain minimum climbing/working space clearances.
   - Centerline of pole to fuse holder/surge arrester — 18 inches MIN 12/16 kV
   - Face of pole to fuse holder/surge arrester — 11-1/2 inches MIN 12/16 kV
   - Centerline of pole to fuse holder/surge arrester — 15 inches MIN 4 kV
   - Face of pole to fuse holder/surge arrester — 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).
9. For double dead-end construction where the fuse holder is on the line arm, fuse holders shall only be installed on the load side.

Scope CC 131.2 Typical Branch Fuse Construction for 3Ø Double Dead-End Straight Line Pole Construction

Figure CC 131–2: 10-Foot Single or Double Crossarm Construction

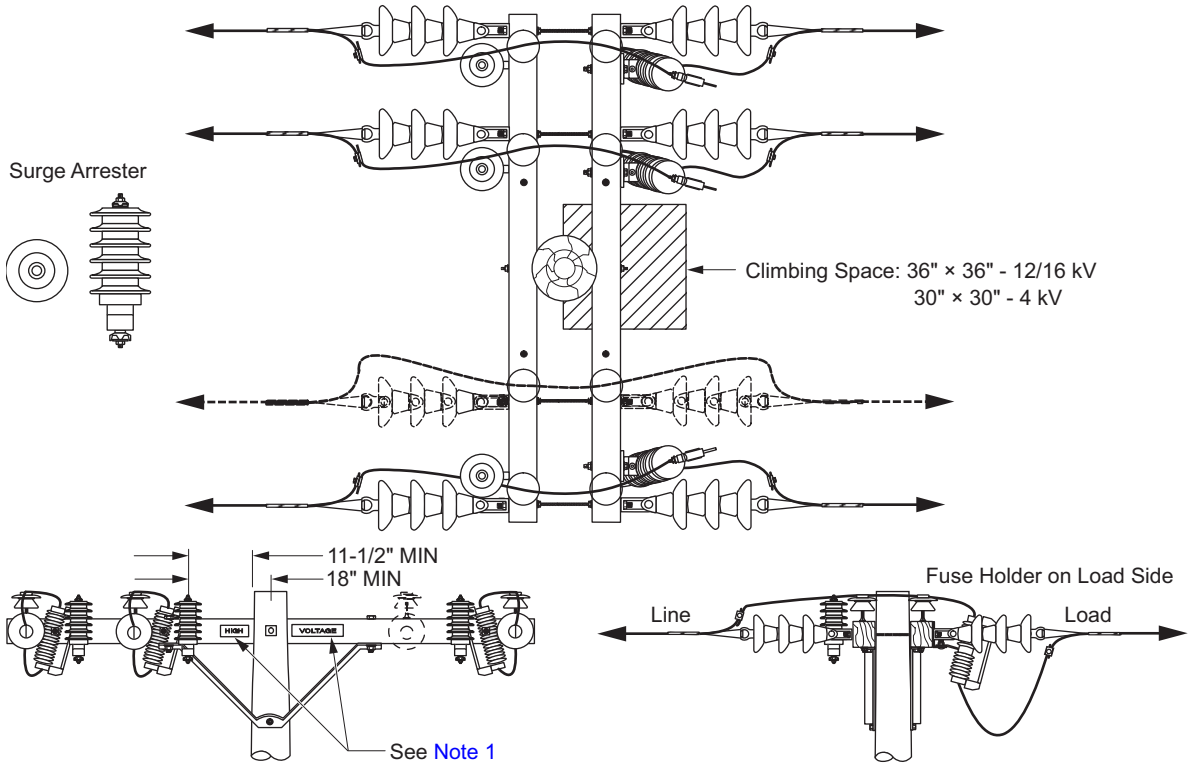


Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Maintain minimum climbing/working space clearances.
   - Centerline of pole to fuse holder/surge arrester — 18 inches MIN 12/16 kV
   - Face of pole to fuse holder/surge arrester — 11-1/2 inches MIN 12/16 kV
   - Centerline of pole to fuse holder/surge arrester — 15 inches MIN 4 kV
   - Face of pole to fuse holder/surge arrester — 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).
9. Surge Arrester shall be installed inside of tap-over pin.
10. For double dead-end construction where the fuse holder is on the separate fuse holder arm, fuse holders shall only be installed on the line side.

Scope CC 131.3 Typical Branch Fuse Construction for 3Ø 3/4 Wire Double Dead-End Straight Line Pole Construction

Figure CC 131–3: 12-Foot Single or Double Crossarm Construction

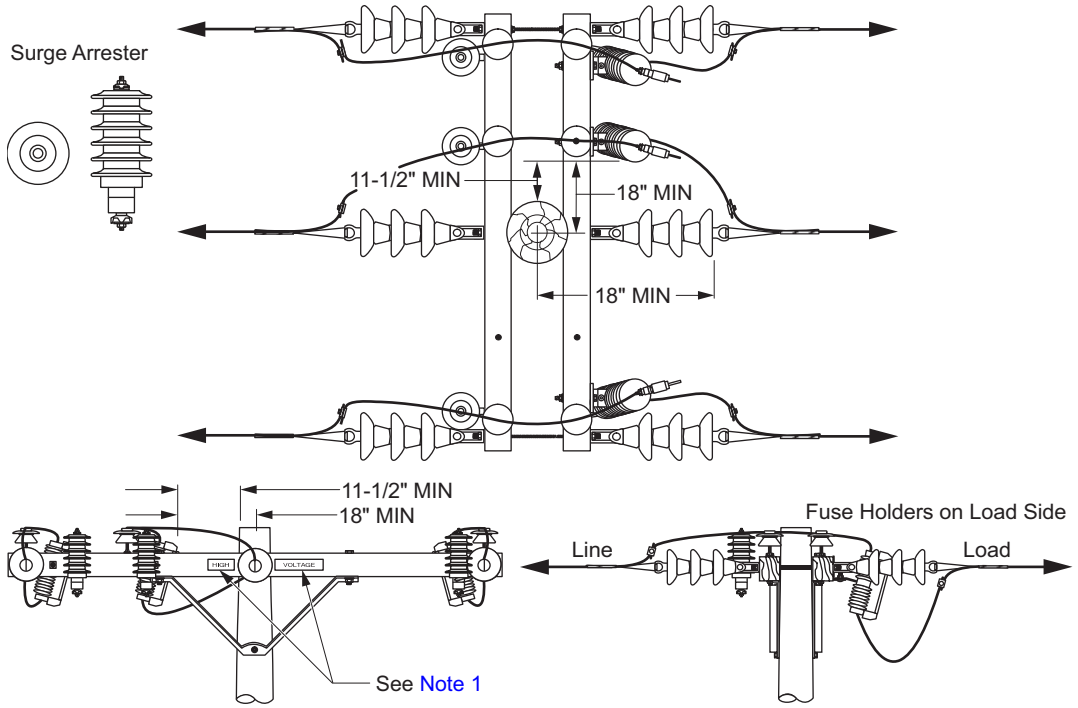


Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Maintain minimum climbing/working space clearances.
   - Centerline of pole to fuse holder/surge arrester — 18 inches MIN 12/16 kV
   - Face of pole to fuse holder/surge arrester — 11-1/2 inches MIN 12/16 kV
   - Centerline of pole to fuse holder/surge arrester — 15 inches MIN 4 kV
   - Face of pole to fuse holder/surge arrester — 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 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).
11. For double dead-end construction where the fuse holder is on the line arm, fuse holders shall only be installed on the load side.

Scope CC 131.4 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 CC 131–4: 10-Foot Single or Double Arm Construction

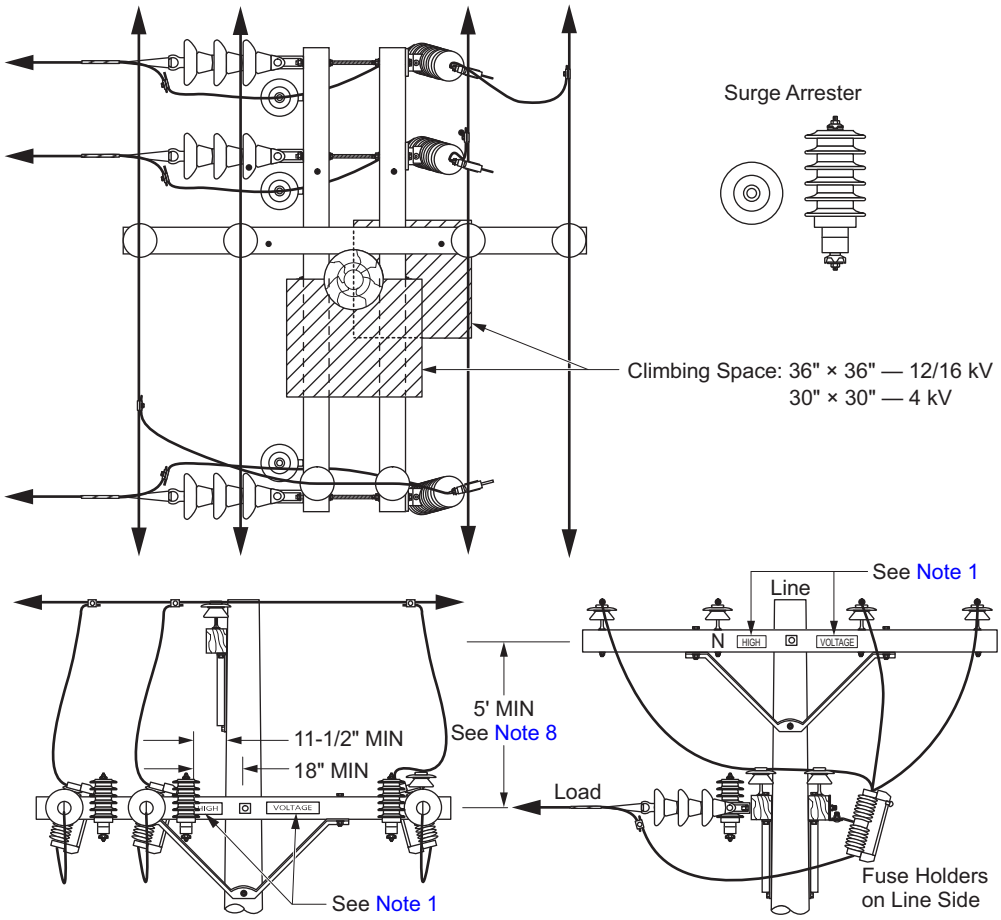


Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Maintain minimum climbing/working space clearances.
   - Centerline of pole to fuse holder/surge arrester — 18 inches MIN 12/16 kV
   - Face of pole to fuse holder/surge arrester — 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).
12. For double dead-end construction where the fuse holder is on the line arm, fuse holders shall only be installed on the load side.

Scope CC 131.5 Typical Branch Fuse Construction for 1Ø /3Ø Break-Off Pole

Figure CC 131–5: 10-Foot Single or Double Arm Construction

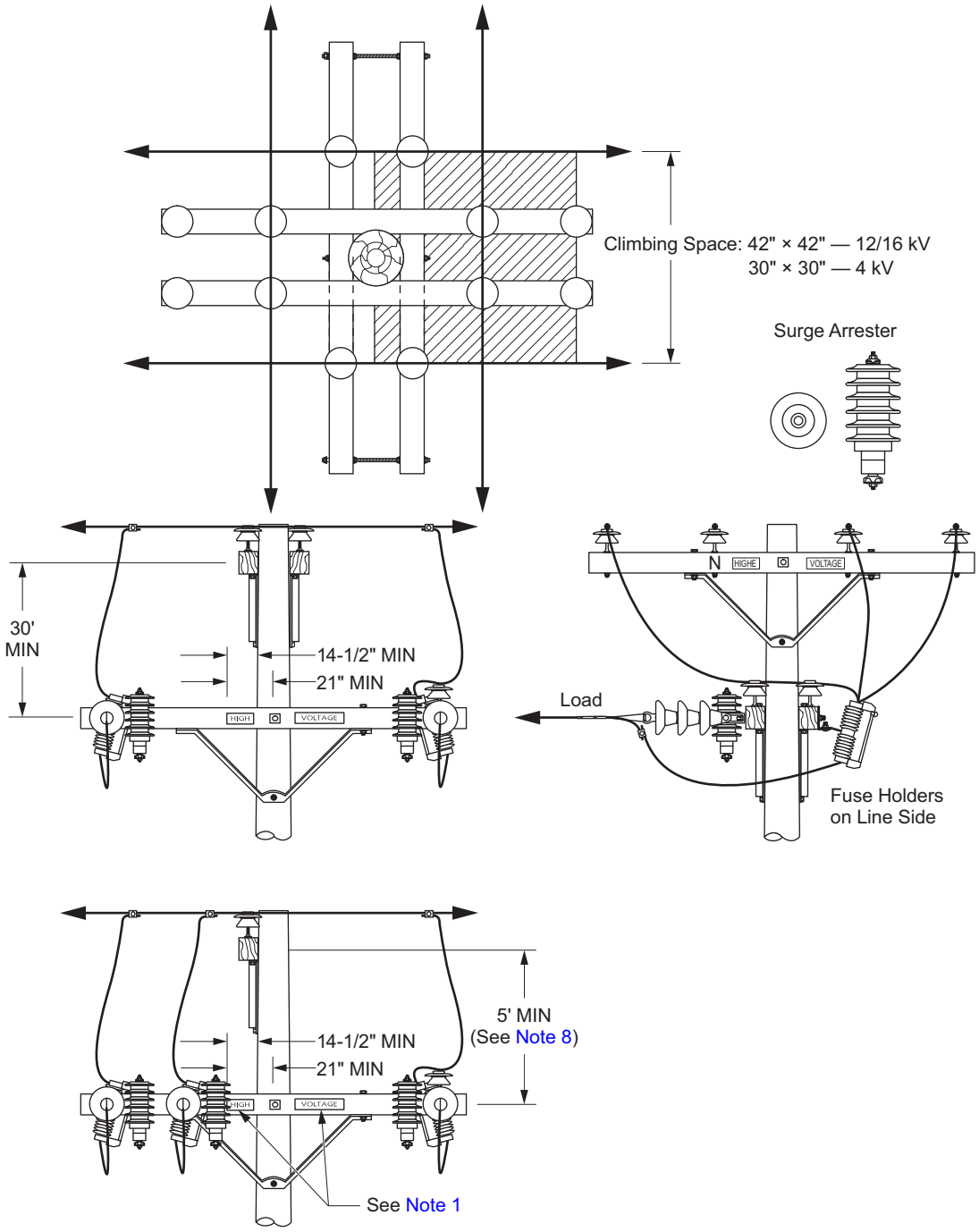


Note(s):

1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Maintain minimum climbing/working space clearances.
   - Centerline of pole to fuse holder/surge arrester — 18 inches MIN 12/16 kV
   - Face of pole to fuse holder/surge arrester — 11-1/2 inches MIN 12/16 kV
   - Centerline of pole to fuse holder/surge arrester — 15 inches MIN 4 kV
   - Face of pole to fuse holder/surge arrester — 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).
10. Fuse holders shall be installed on the DA bolts on the line side of Dead-End Buck Arm.

Scope CC 131.6 Typical Branch Fuse Construction for 1Ø /3Ø Break-Off Pole — Top of Pole Only

Figure CC 131–6: 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.
   - Centerline of pole to fuse holder/surge arrester — 21 inches MIN 12/16 kV
   - Face of pole to fuse holder/surge arrester — 14-1/2 inches MIN 12/16 kV
   - Centerline of pole to fuse holder/surge arrester — 15 inches MIN 4 kV
   - Face of pole to fuse holder/surge arrester — 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).
10. Fuse holders shall be installed on the DA bolts on the line side of Dead-End Buck Arm.

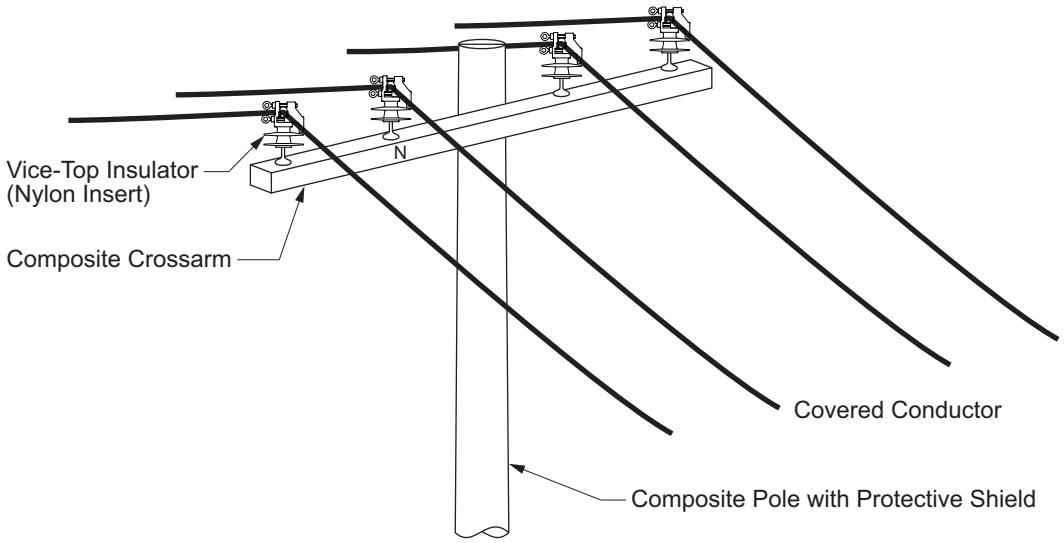
This page intentionally left blank.

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.

This page intentionally left blank.

CC 150 Covered Conductor Installation Materials and Equipment

Scope CC 150.1 Covered Conductor Insulator

1.0 General Information

- Do not strip the covering when installing the covered conductor in the insulator clamping mechanism.
- Covered conductor systems do not require wildlife hoods on the insulator when the covering is intact.
- Refer to DOH GR 200 and DOH GR 205 for SAP numbers and applications.

2.0 Application

Table CC 150–1: Covered Conductor Insulator Application

Contamination Area (DOH GR 215)	Application/Construction	Post Insulators (Universal and Trunnion Type)	Pin Insulators (Nylon Inserts Only)
A	High Contamination Areas (DOH GR 215)	X	
ABC	Angle Deviations (DOH DC 520 or 575)	X	
ABC	Heavy Loading Above 5000ft (DOH DC 520)	X	
ABC	Incline/Decline Terrain (Trunnion Clamp)	X	
ABC	Uplift Support	X	
BC	Over the Arm, Vertical, and Other Jumper Supports	X	X
BC	Tangent/Straight Through	X	X
ABC	Transformer Delta Bracket & Switch Jumpers		X

Note(s):

1. Trunnion clamps shall be selected based on conductor diameters per DOH CO 510.
2. For suspension construction, refer to DOH DC 530 for additional details. Contact Apparatus Engineering for additional details.
3. For chart additions/recommendations, contact Apparatus Engineering.

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 when there are material shortages and with Engineering approval.

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. Dead-end clamps, along with the connectors used on dead-end tails (when applicable), shall be covered as detailed in the wildlife cover section of the Wildlife Section (150.4 Section 6.1 and 6.2). 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 CC 150.4 and Table DC 535–1 for the Dead-end Clamp).

Figure CC 150–1: 4-Wire Covered Conductor Dead-end Construction

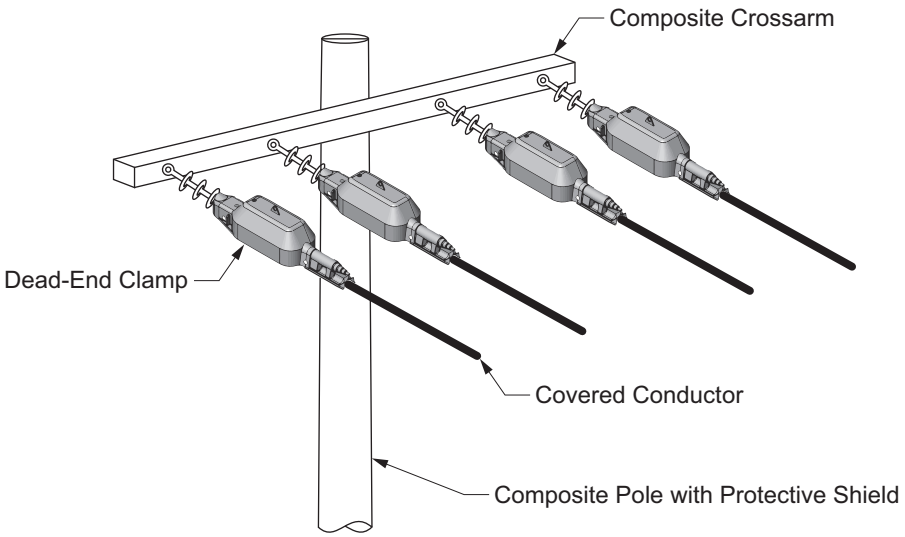
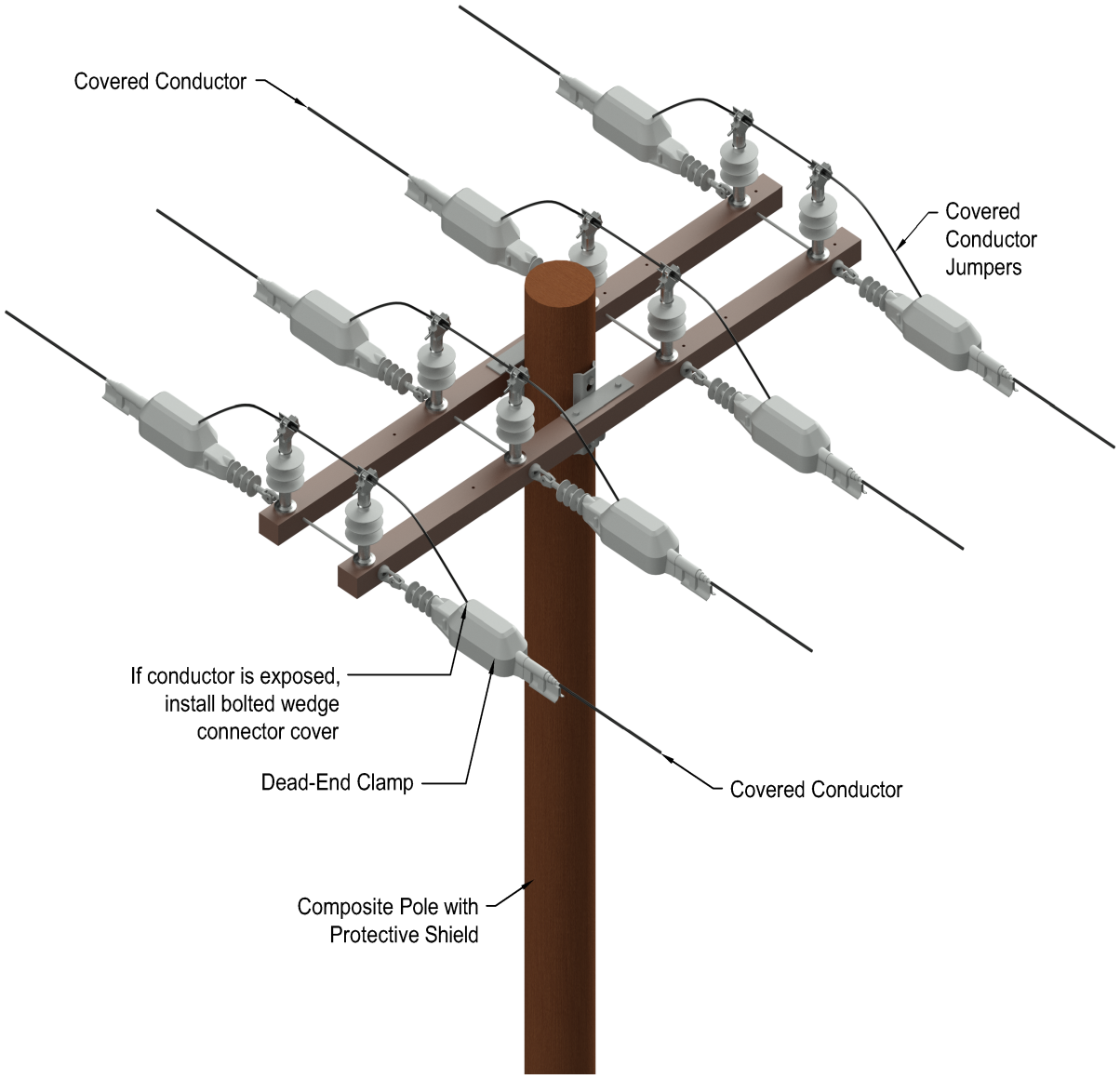


Figure CC 150–2: 4-Wire Covered Conductor Double Dead-end Construction



Scope CC 150.3 Covered Conductor Tap Connections

Bolted wedge connectors are the preferred mainline-to-mainline or tapline connectors in covered conductor systems (CC 1.0 and 2.0). This includes connections to mainline devices such as reclosers, voltage regulators, and overhead switches. See CO 100 for alternate connector options if installation of the bolted wedge connector is not practical.

Connectors shall be covered with an appropriately sized connector cover (see CC 150.4 and DC 535).

FOR PLANNING USE ONLY

1.0 Covered Conductor 2.0

The following sections (section 3.1 to 3.5) should be referenced when making up connections within CC2.0 systems. Additional guidelines and application criteria can be found in DOH CO 100, CO 300, CO 305, and CO 420. If there are no specifics listed here for any other styles of connectors, their respective sections should be referred to.

Figure CC 150–3: Connector Cover Installed at Dead-End Tap



Scope CC 150.4 Insulated Cover Requirements

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 Connectors

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

Connector covers shall be installed on all primary connections. Secondary connectors are required to be taped in covered conductor systems and/or in HFRA.

3.0 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, including connections to terminations/potheads. However, PGW must 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.

4.0 Equipment

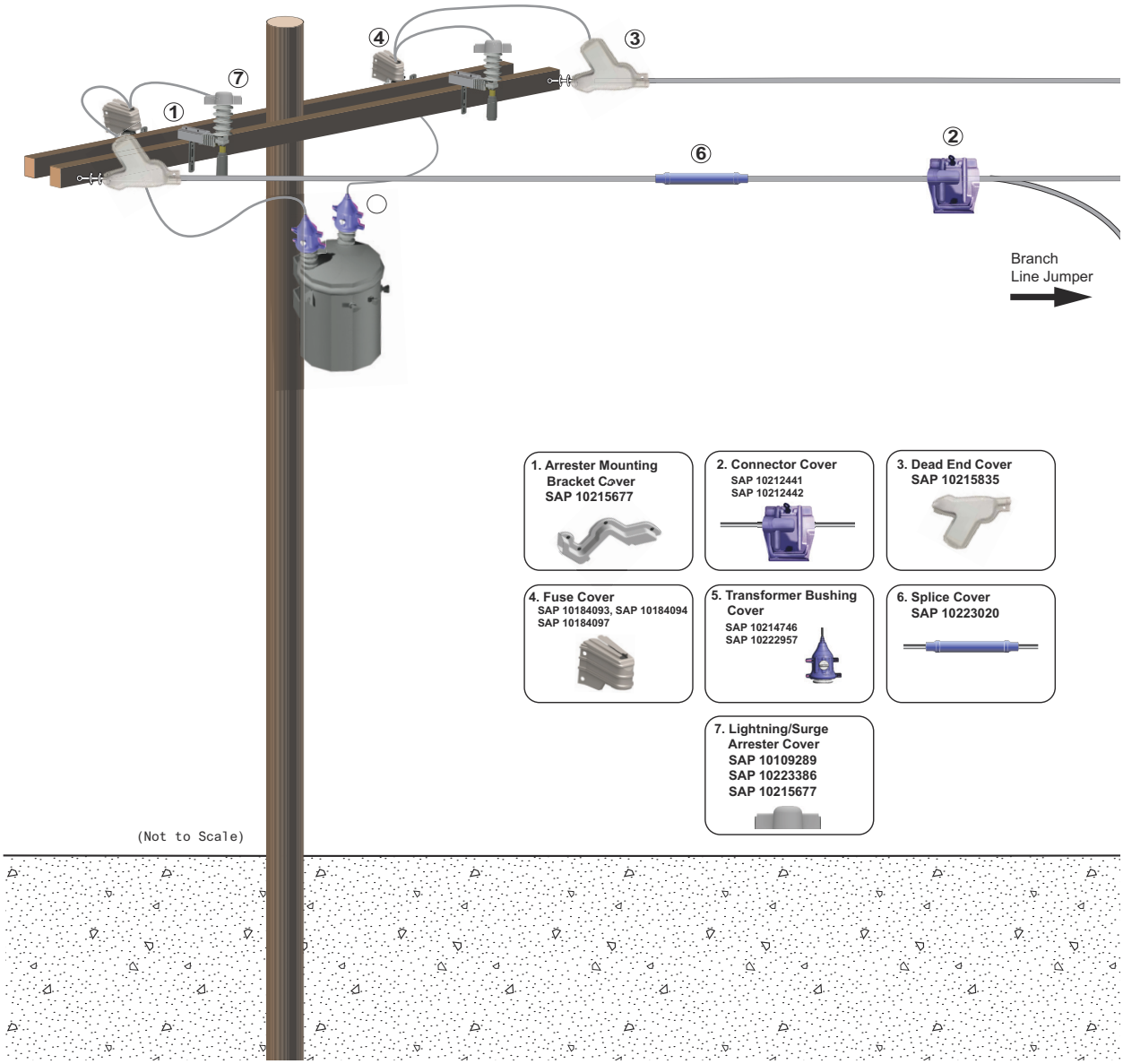
All overhead equipment shall utilize appropriate wildlife covers.

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.

5.0 Cover Conductor System Configuration

Figure CC 150–4: Cover Conductor System Configuration Drawing



6.0 Insulated Cover Construction

6.1 Straight Clamp Dead-End Insulated Cover

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 quadrant dead-ends shall be covered.

Ensure covers are secured and locking mechanism is secure.

Install dead-end cover only on the first skirt of the dead end (the skirt closest to the dead-end shoe). Installing the dead-end cover beyond the first skirt will reduce the creepage distance, which could potentially lead to equipment failure due to tracking.

SAP	Covered Conductor	Figure References
10211487	All Primary Voltage	Figure CC 150-5

Figure CC 150–5: Straight Clamp Dead-End Insulated Cover



6.2 Quadrant Clamp Dead-End Insulated Cover

Dead-ends using quadrant clamps shall be covered with quadrant 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 quadrant dead-ends shall be covered.

Ensure covers are secured and locking mechanism is secure.

Install quardant dead-end cover only on the first skirt of the dead-end (the skirt closest to the dead-end shoe). Installing the quadrant dead-end cover beyond the first skirt will reduce the creepage distance, which could potentially lead to equipment failiure due to tracking.

SAP	Covered Conductor	Figure References
10215385	336.4 kcmil 30/7 (Al), 639.9 kcmil (Al)	Figure CC 150-6
10215386	#6 Sol. To 4/0 (Cu), #4 and 1-0 ACSR (Al)	Figure CC 150-7

Figure CC 150–6: Quadrant Clamp Dead-End Insulated Cover (Large)



Figure CC 150–7: Quadrant Clamp Dead-End Insulated Cover (Small)



6.3 Connector Cover

Connectors shall be covered with connector covers. Covering connectors will ensure that any exposed or stripped portions at the tap point are protected from incidental contact that could result in phase-to-phase or phase-to-ground faults.

All exposed conductors at the connection shall be covered.

Ensure covers are secured and locking mechanism is secure.

SAP	Conductor to Conductor Connection	Figure References
10212441	653 to 653 ACSR	Figure CC 150-8
10212442	Conductor connections of all sizes except 653 to 653 ACSR	Figure CC 150-9

Figure CC 150–8: Connector Cover (Large)

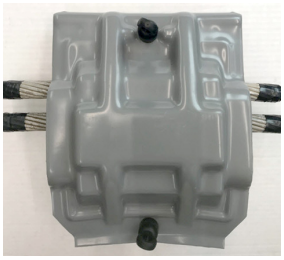


Figure CC 150–9: Connector Cover (Small)



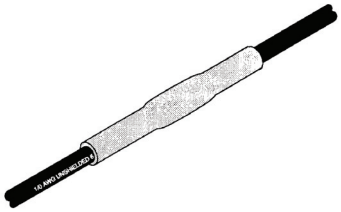
6.4 Splice Cover

Splices shall be covered with splice covers. Covering splices will ensure that any exposed or stripped portions of the conductor at the splice point are protected from incidental contact that could result in phase-to-phase or phase-to-ground faults.

All exposed conductors at the splice shall be covered.

SAP	Covered Conductor	Figure References
See CC 170	See CC 170	See Figure CC 150-10

Figure CC 150–10: Splice Cover



6.5 Termination/Pothead Cover

Terminations (potheads) shall be covered with termination (pothead) covers. Covering potheads will ensure that any exposed or stripped portions of the covered conductor at the termination point are protected from contact that could result in phase-to-phase or phase-to-ground faults.

All exposed energized parts of the conductor and pothead shall be covered.

Install pothead cover only on the first skirt of the pothead (the skirt closest to the overhead connection point). Installing the pothead cover beyond the first skirt will reduce the creepage distance, which could potentially lead to equipment failure due to tracking.

Mounting bracket covers shall be used to cover the brackets supporting the terminations/potheads. See Section 6.7 for mounting bracket information.

Description	SAP	Covered Conductor	Connectors	Figure References
Universal Termination/Pothead Cover **Small/Medium** (Beer Can)	10222957	Applicable to all primary covered conductor sizes	For up to 336 Connectors	Figure CC 150-11
Universal Termination/Pothead Cover **Large** (Beer Can)	10222956	Applicable to all primary covered conductor sizes	For up to 653 Connectors	Figure CC 150-12

Figure CC 150–11: Termination Pothead Cover (Small/Medium)

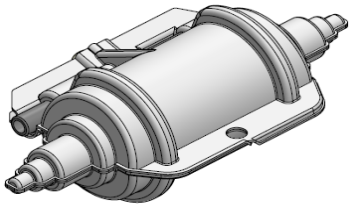
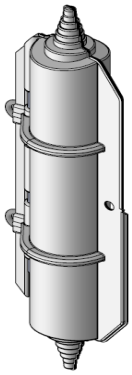


Figure CC 150–12: Termination Pothead Cover (Large)



Note(s): Should be taped at newly installed/replaced de-energized potheads. All exposed bare conductor/connector (when making up dead-ends, tap connections, or splices) shall be fully covered (that is, no exposed metal) AND sealed at the ends of the wildlife covers that are applied.

6.6 Transformer Bushing Cover

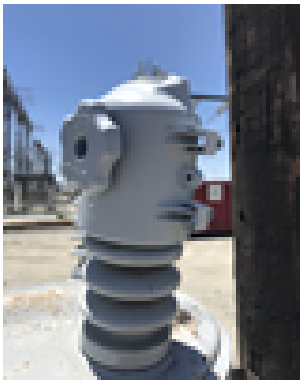
Transformer bushings shall be covered with transformer bushings covers. Covering transformer bushings will ensure that any exposed or stripper portions at the bushing interface are protected from contact that could result in phase-to-phase or phase-to-ground faults.

All exposed conductor at the transformer bushing shall be covered.

Install transformer bushing cover only on the first skirt of the bushing (the skirt closest to the conductor connection point). Installing the transformer bushing cover beyond the first skirt will reduce the creepage distance, which could potentially lead to equipment failure due to tracking.

Description	SAP	Figure References
Bushing Cover Note: Bushing cover is the same as Termination/Pothead Cover Small/Medium (Beer Can)	10222957	Figure CC 150-11
Wildlife Bushing Cover with Handwheel	10214746	Figure CC 150-13

Figure CC 150–13: Transformer Bushing Cover



6.7 Lightning/Surge Arrester Cover

Lightning/Surge arrester shall be covered with lightning/surge arrester covers. Covering lightning/surge arresters will ensure that any exposed/energized parts are protected from contact that could result in phase-to-phase or phase-to-ground faults.

Soft tap with hammer on top of cover to ensure tight fitting.

Mounting bracket covers shall be used to cover the brackets supporting lightning/surge arresters.

SAP	Description	Figure References
10223386	Standard Arrester	Figure CC 150-14
10109289	Cal Fire Exempted Arrester	Figure CC 150-15
10215677	Mounting Bracket Cover	Figure CC 150-116
10215676	Mounting Bracket Cover (for double arm)	Figure DC 535-14

Figure CC 150–14: Standard Arrester Cover



Figure CC 150–15: Cal Fire Exempted Arrester Cover



Figure CC 150–16: Mounting Bracket Cover



6.8 Fuse Cover

Fuses shall be covered with fuse covers. Covering the fuse will ensure that any exposed/energized parts are protected from contact that could result in phase-to-phase or phase-to-ground faults.

SAP	Fuse Cover	Fuse Type	Figure References
10184097	Wildlife Cutover Cover, Large, XLPE Material, Grey	For 150 kV BIL Universal and SMD Porcelain Cutouts (12 and 16 kV)	Figure CC 150-17
10184093	Wildlife Cutover Cover, XLPE Material, Grey, Equipped with Securing Pin	For 110/150 kV BIL Universal Porcelain and Polymer Cutouts (4, 12, and 16 kV)	Figure CC 150-18
10184094	Wildlife Cutover Cover, Equipped with Securing Pin	For 110/150/200 kV VIL SMD Style Porcelain Cutouts (4, 12, 16, and 33 kV)	Figure CC 150-19
10223839	Universal Top Wildlife Guard Cutout Cover	For 110/150/200 kV VIL SMD Style Porcelain/Polymer Cutouts (4, 12, 16, and 35 kV)	Figure CC 150-20
10223840	Universal Bottom Wildlife Guard Cutout Cover	For 110/150/200 kV VIL SMD Style Porcelain/Polymer Cutouts (4, 12, 16, and 35 kV)	Figure CC 150-20

Figure CC 150–17: Wildlife Cutover Cover, Large, XLPE Material, Grey



Figure CC 150–18: Wildlife Cutover Cover, XLPE Material, Grey, Equipped with Securing Pin



Figure CC 150–19: Wildlife Cutover Cover, XLPE Material, Grey, Equipped with Securing Pin

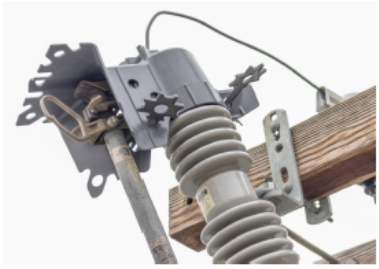


Figure CC 150–20: Top, Bottom Wildlife Guard Cutover Cover



6.9 Grounding Point Covers

Covering grounding points will ensure that stripped portions of the covered conductor will be protected from contact that could lead to phase-to-phase or phase-to-ground faults.

All exposed conductor shall be covered.

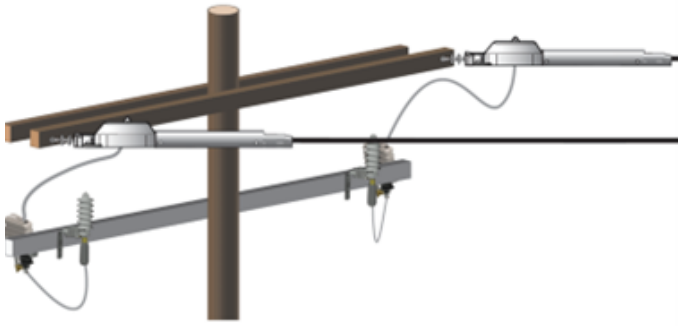
A. Grounding Points on Dead-Ends

Grounding Points shall be covered by securely attaching the dead-end extension to the dead-end clamp or quadrant clamp dead-end cover as illustrated in Figure CC 150-17.

Ensure covers and locking mechanism is secure.

SAP	Description	Covered Conductor	Figure References
10211487	Dead End Clamp, HDPE Material, Grey Color	All primary voltage	Figure CC 150-21
10215385	Quadrant Clamp Dead-end Cover, Large Size, Grey Color	All primary voltages	Figure CC 150-6
10215386	Quadrant Clamp Dead-end Cover, Small Size, Grey Color	All primary voltages	Figure CC 150-7
10214588	Dead-End Extension Cover, 31.5” Long, Grey Color	All primary voltages	Figure CC 150-21

Figure CC 150–21: Dead End Grounding Cover





B. Grounding Point

Grounding points on tangent structures shall be covered with either insulated covers listed in the following table.

Ensure covers and locking mechanism is secure.

SAP	Description	Covered Conductor	Figure References
10211426	Wildlife Termination/Pothead Cover, 4-1/2” X 16” Outside Dimensions, HDPE Material, Grey Color	All primary voltages	Figure CC 150-22
10214588	Dead-End Extension Cover/Mid Span Cover, 31.5” Long, Grey Color	All primary voltages	Figure CC 150-23

Figure CC 150–22: Tangent Grounding Cover

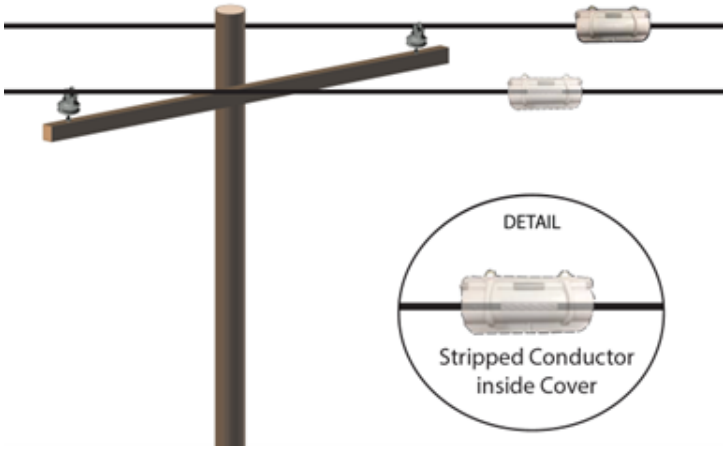


Figure CC 150–23: Mid-Span Cover



6.10 Modulated Straight Dead-End Assembly Cover

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

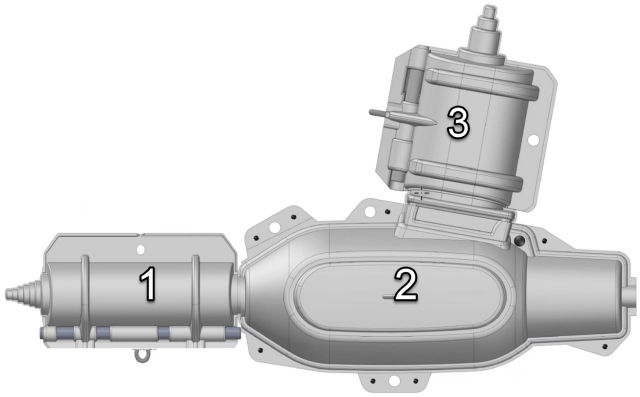
All exposed conductor shall be covered.

Installed Modulated Straight Dead-End Assembly cover only on the first skirt of the straight dead-end (the skirt closest to the dead-end shoe).

Note: ***Installing the modulated straight dead-end assembly cover beyond the first skirt will reduce the creepage distance, which could potentially lead to equipment failure due to tracking.***

Figure CC 150–24: Modulated Straight Dead-End Assembly Cover

PILOT



Number	Description	SAP	Covered Conductor	Figure References
1	Modulated Universal Grounding Cover (Beer Can) See Note 1	10222957	Applicable to all primary covered conductor sizes	Figure CC 150-11
2	Modulated Dead-End Cover (Small/Medium) See Note 2	10223843	336 and below	Figure CC 150-26
3	Modulated Universal Connector Cover See Note 2	10223018	1/0 through 350	Figure CC 150-56

Note(s):

1. Grounding Cover is the same as Termination/Pothead Cover, which can be ordered.
2. Modulated Dead-End Cover and Modulated Universal Connector Cover (#2 and #3) are in pilot status.
3. If the covering needs to be stripped beyond 12”, then use SAP 10222956 (Large Beer Can) to cover the bare conductor.

This page intentionally left blank.

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

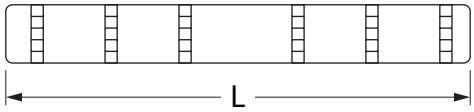


Figure CC 170–2: Cable Preparation

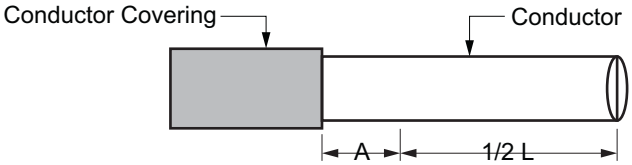


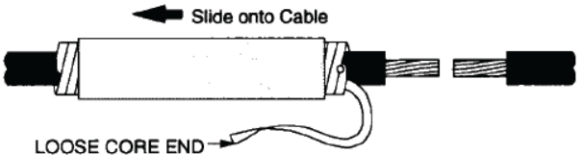
Table CC 170–5: Cable Prep Dimension “A”

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

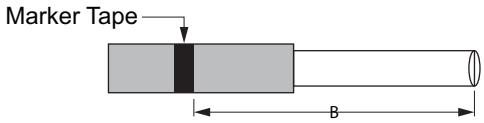
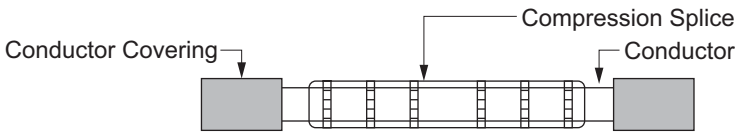


Table CC 170–6: Cable Prep Dimension “B”

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

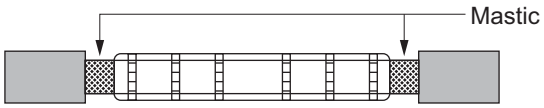
1.5 Slide ends of conductor all the way into the connector body and crimp using Table CC 170–1 as a reference for the number of crimps and the tool and die set. Keep connector as straight as possible.



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.

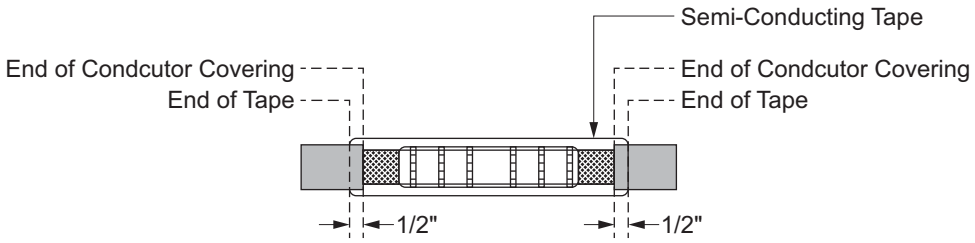
Figure CC 170–5: Mastic Application



2.2 Semi-conducting Tape

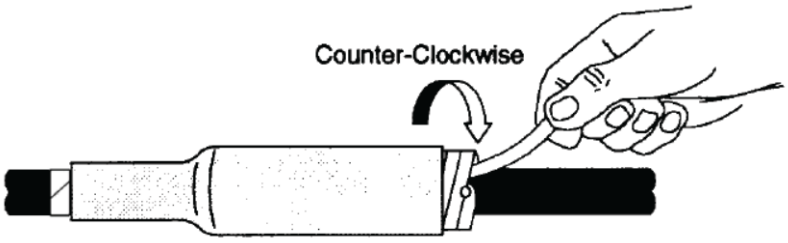
Beginning 1/2 inch over the cable insulation, apply a half-lapped layer of Semi-Conducting Tape across the connector to 1/2 inch over the insulation on the other side of the splice.

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.

This page intentionally left blank.

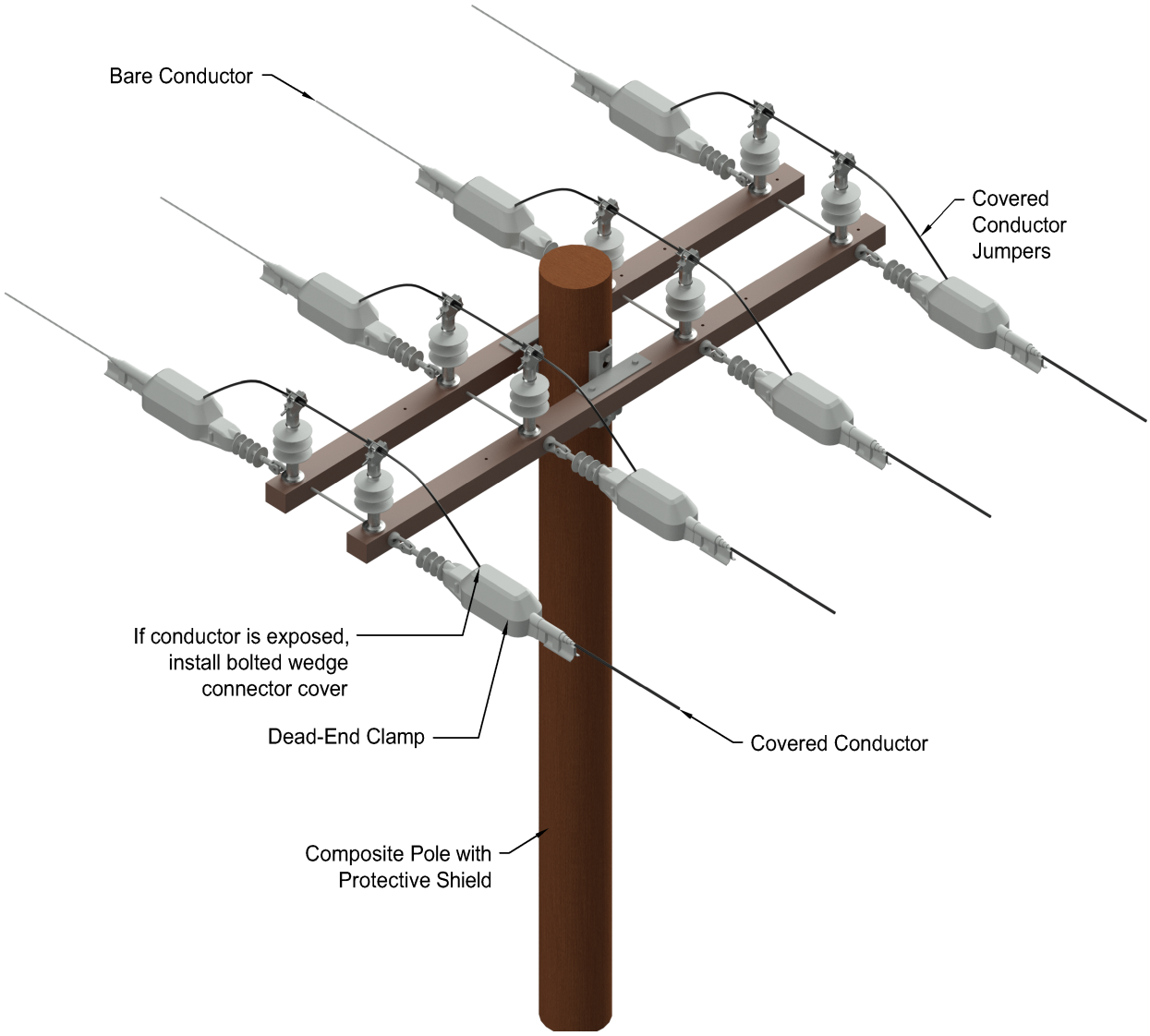
CC 180 Transitioning to Bare Wire

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



This page intentionally left blank.

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.

Figure CC 190–1: Spiral Vibration Damper



Figure CC 190–2: Stockbridge Damper



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. See Table CC 190–1 for Damper Application Requirements. Vibration dampers are only required on full tension spans and will not be required on reduced tension spans. See Figure CC 190–3 for vibration damper installation in reduced tension span configurations.

Figure CC 190–3: Vibration Damper Placement in Full Tension Spans

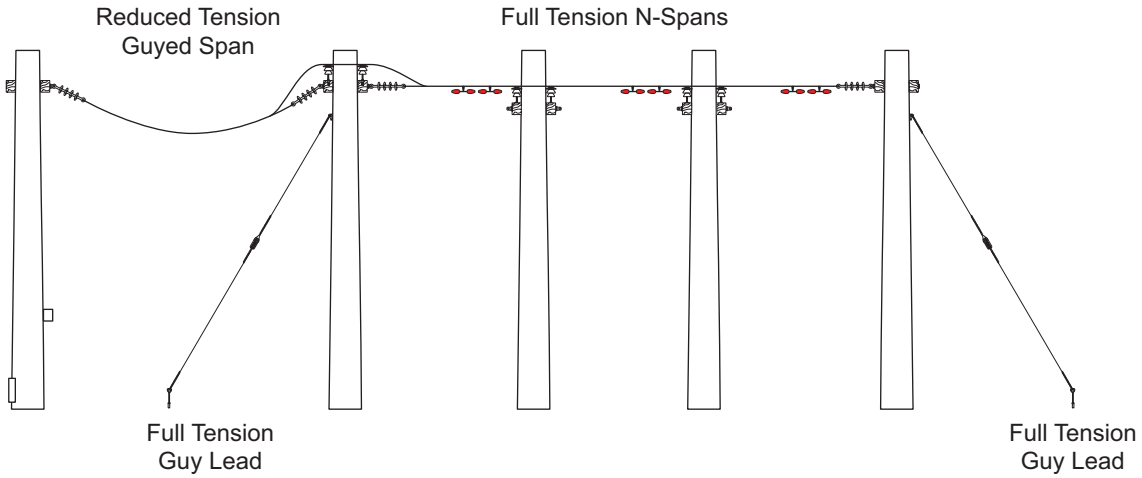


Table CC 190–1: Damper Information and Requirements

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 17 kv 101.8 ACSR and ACSR/AW	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
10223965	17 kV 350 Copper	Stockbridge Damper	Every span in light loading areas and heavy loading areas	Span < 500 ft: 2 Dampers
10223967	17 kV 350 Copper	Stockbridge Damper	Every span in light loading areas	Span < 500 ft: 2 Dampers
10214495	17 kV 653 ACSR	Stockbridge Damper	Every span in light loading areas	Span < 500 ft: 2 Dampers
10223968	17 kV 653 ACSR/AW	Stockbridge Damper	Every span in light loading areas	Span < 655 ft: 2 Dampers
10214496	35 kV 1/0 ACSR	Stockbridge Damper	Every span in light loading areas	Span < 655 ft: 2 Dampers
10223964	35 kV 336 (18/1) ACSR	Stockbridge Damper	Every span in light loading areas	Span < 655 ft: 2 Dampers

FOR PLANNING USE ONLY
FOR PLANNING USE ONLY
FOR PLANNING USE ONLY
FOR PLANNING USE ONLY

SAP	Covered Conductor	Damper Type	Required Application	Dampers Required Per Phase[a/]
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
10223966	35 kV 350 Copper	Stockbridge Damper	Every span in light loading areas and heavy loading areas	Span < 500 ft: 2 Dampers
10223968	35 kV 350 Copper	Stockbridge Damper	Every span in light loading areas and heavy loading areas	Span < 755 ft: 2 Dampers
10223968	35 kV 653 ACSR/AW	Stockbridge Damper	Every span in light loading areas and heavy loading areas	Span < 755 ft: 2 Dampers
10214499	35 kV 653 ACSR	Stockbridge Damper	Every span in light loading areas	Span < 755 ft: 2 Dampers

FOR PLANNING USE ONLY
FOR PLANNING USE ONLY
FOR PLANNING USE ONLY

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

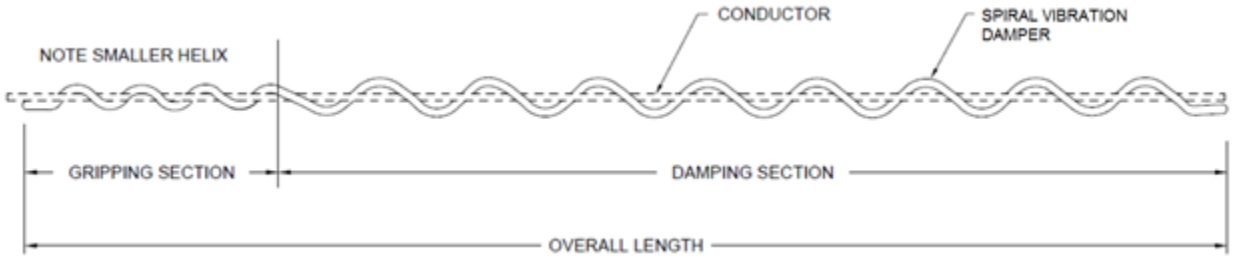
b/ A maximum of 2 dampers can be interlaced for Spiral Vibration Damper SAP 10214215.

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.

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

1.0 Spiral Vibration Damper Installation

Figure CC 190–4: 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 3 to 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. See Figure CC 190–6.

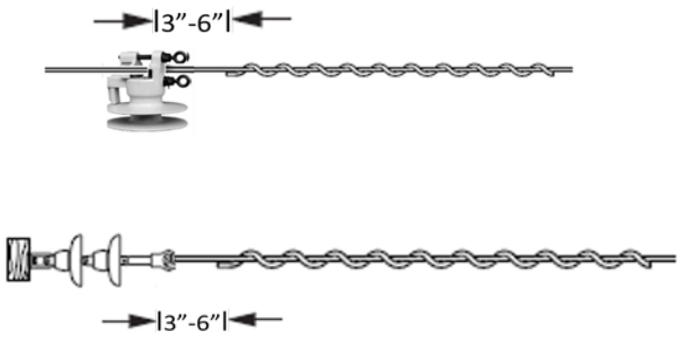
STEP 4. Wrap the gripping section in a counter-clockwise fashion.

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

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



Figure CC 190–6: Installation of Spiral Vibration Dampers on Covered Conductor



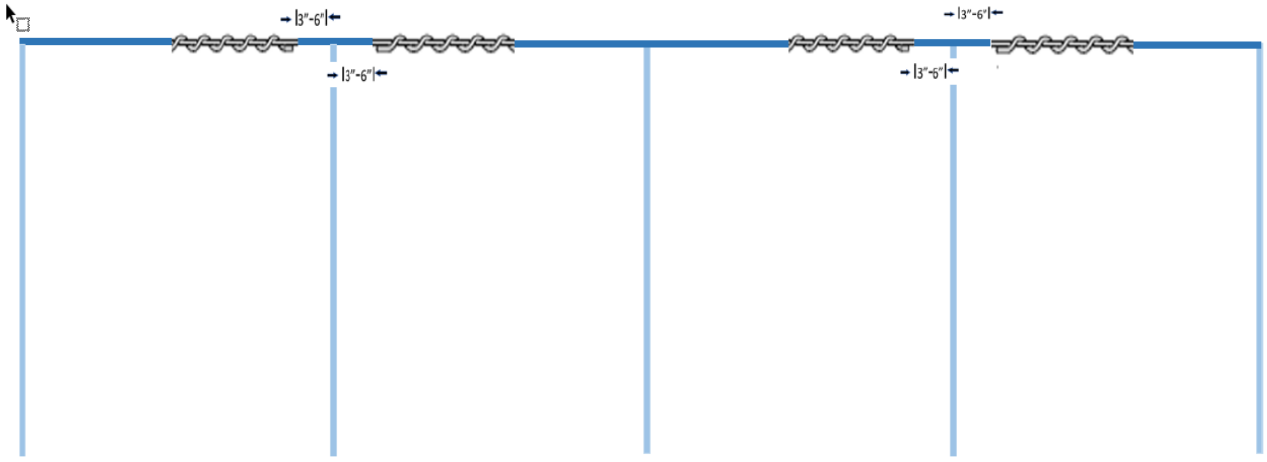
Note(s):

1. Clearances between the spiral vibration damper and conductor attachments that are less than 6-inches do not impact the damper's performance and are not required to be adjusted for in-service dampers if the spiral vibration dampers only contact the conductor and do not interfere with any hardware.

Figure CC 190–7: Spiral Vibration Damper Subset



Figure CC 190–8: Examples of Spiral Vibration Damper Placement



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.

Figure CC 190–9: Stockbridge Dampers



2.0 Stockbridge Damper Installation

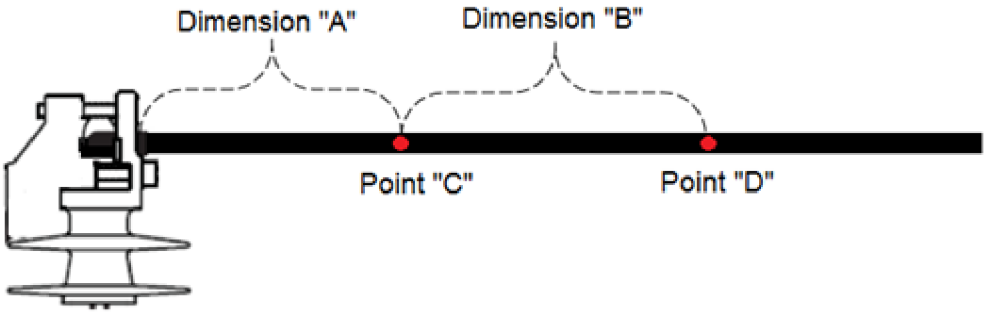
2.1 Spiral Rod Stockbridge Damper Installation

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 190–10.

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 190–10.

Figure CC 190–10: 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 190–10.

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 190–11.

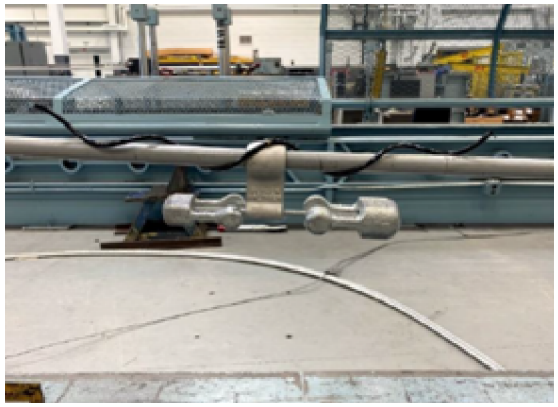
Table CC 190–2: Stockbridge Damper Dimension Requirements

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 190–11: First Attachment Rod Placement



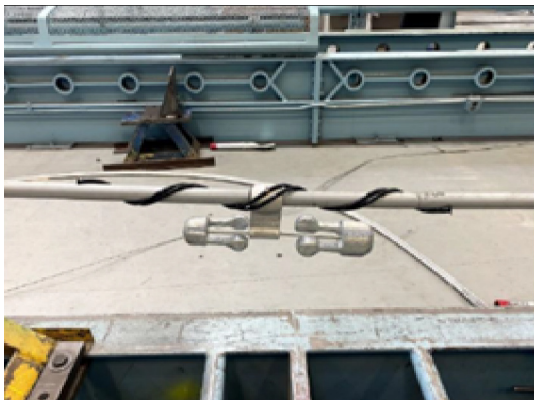


STEP 5. Fully install the first attachment rod, ensuring that both rod ends are fully snapped in.

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 190–12).

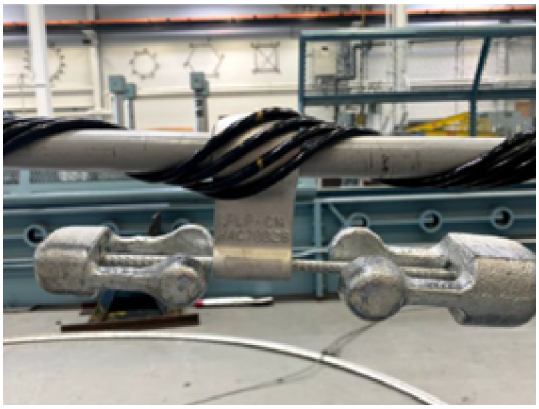
Figure CC 190–12: Second Attachment Rod Placement

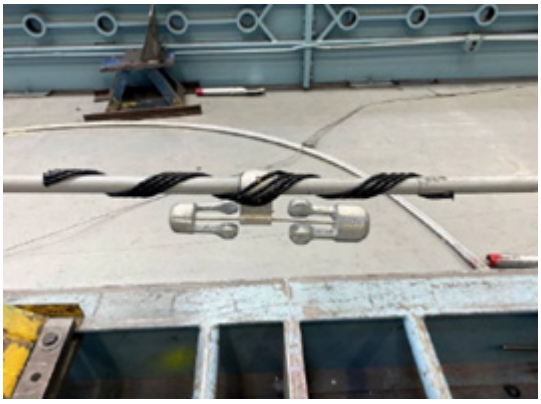




STEP 7. Repeat STEP 6 (Sheet 8) for the remaining two rods, for a total of (4) attachment rods per damper, ensuring that the color codes line up and that the rods are pushed against each other as much as possible. Due to the profile of the clamp there may be gaps between the rods at the clamp; this is acceptable. Ensure that all rod ends are fully snapped in (see Figure CC 190–13).

Figure CC 190–13: Completed Attachment Rod Placement





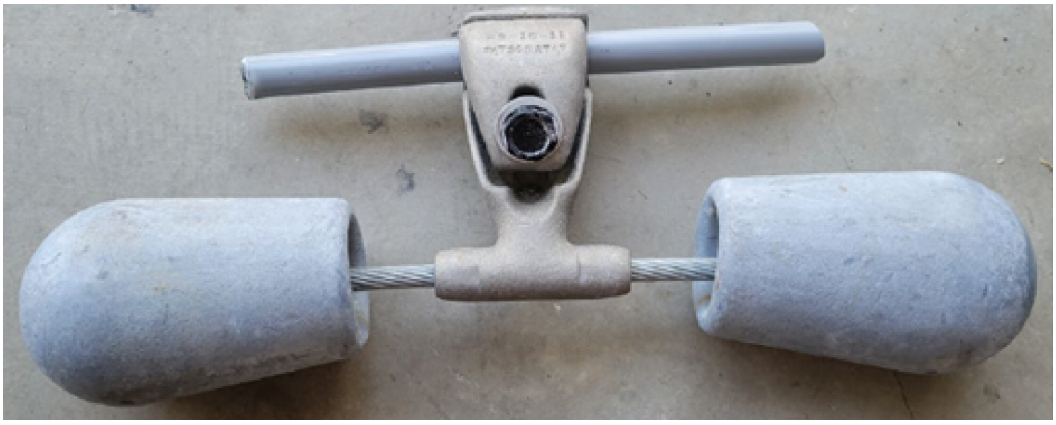
STEP 8. Repeat STEPS 3 (Sheet 7) to 7 (Sheet 8) for the second damper. The second damper will be placed on Point “D” as shown in Figure CC 190–10.

Figure CC 190–14: Installed Spiral Rod Stockbridge Damper



2.2 Shear Bolt Stockbridge Installation

Figure CC 190–15: 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 190–10.

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 190–10.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 190–10.

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.

Figure CC 190–16: Examples of Stockbridge Damper Placement

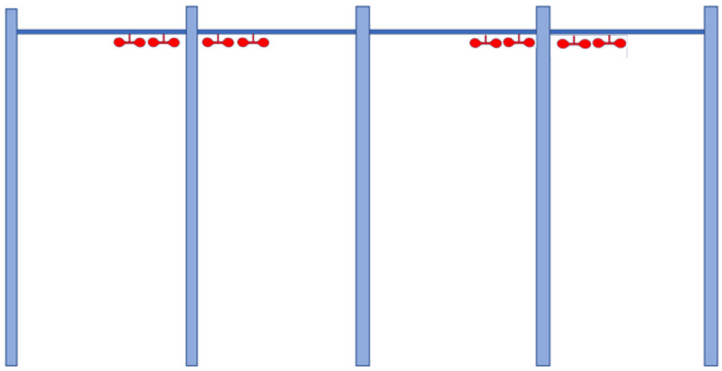


Figure CC 190–16.1: Stockbridge Damper Placement Example 1

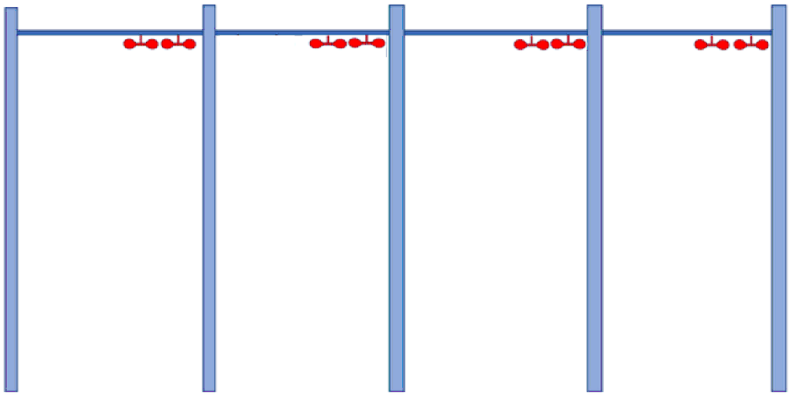


Figure CC 190–16.2: Stockbridge Damper Placement Example 2

This page intentionally left blank.

CC 200 Personal Protection Grounding for Covered Conductor Systems

Scope CC 200.1 Grounding Points Procedure for Personal Protection

Grounding points shall be incorporated into covered conductor systems for better/easier access in the future when grounding is required during maintenance work. All grounding procedures shall be followed per the Overhead Grounding Manual (OGM) in conjunction with the recommendations of this standard.

Grounding procedures will require removal of conductor covering to expose the bare wire in order to apply grounds. The exposed conductor shall be re-covered with the grounding cover.

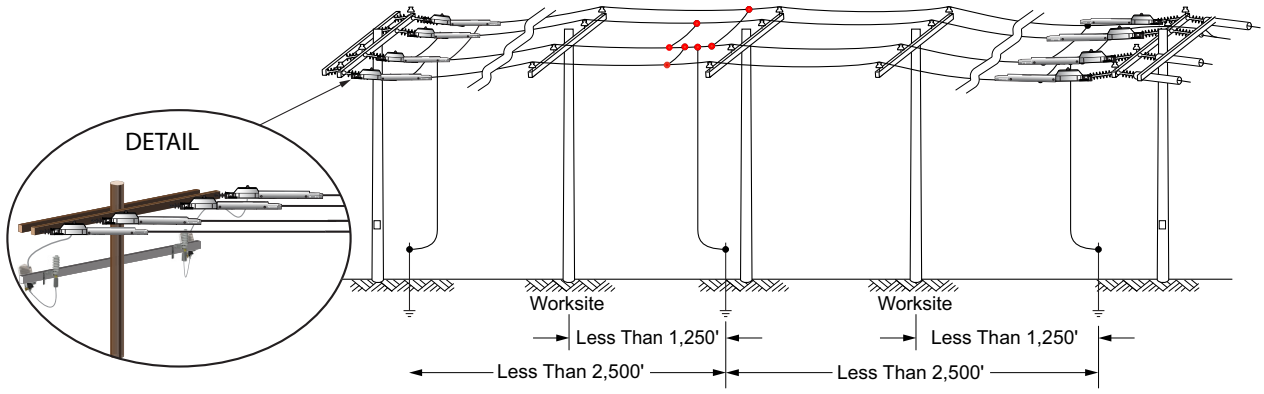
1.0 1.0 Grounding Location for New Installations

For new installation grounding points must be installed no more than 2,500 feet apart. Grounding points can be created by removing the covering at dead-end or tangent poles. Grounding points must be covered with a grounding cover per Section CC 150.4.

These grounding points for personal protection grounding and will allow personnel to be within 1,250 feet of a grounding point at any time. Refer to T&D Overhead Grounding Manual.

In areas with overbuild or underbuild crossings, install dead-ends on either side of the crossing.

Figure CC 200–1: Grounding Point System Diagram



2.0 Grounding Location for Existing Installations

For existing installations where dead ends are more than 2,500 feet apart or no existing stripped grounding point is available within 1,250 feet, grounding points must be installed. A grounding point can be installed by:

- — Removing the covering for grounding point. Exposed conductor must be covered when grounding point is not in use. Refer to Section CC150.4.
- — Installing dead-ends with a grounding point. Dead-ends will allow for sectionalizing and help reduce customer impact.
- — Installing isolation points where bucket truck accessible in conjunction with a grounding point to allow for sectionalizing and reducing customer impact. Isolation points shall only be installed if a dead-end cannot be installed.

3.0 Grounding Point Installations

The following figures depict grounding point installations at dead-end poles and tangent poles.

Figure CC 200–2: Grounding Point at Dead-End for CC 2.0

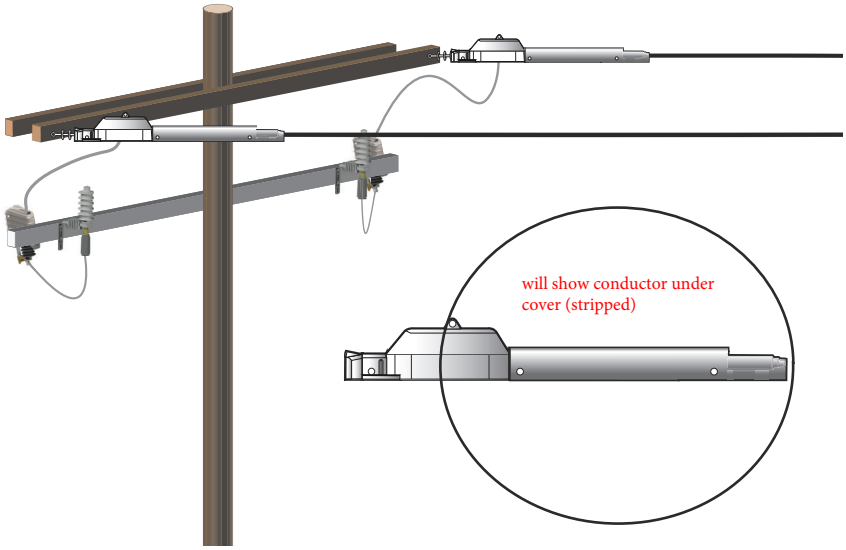
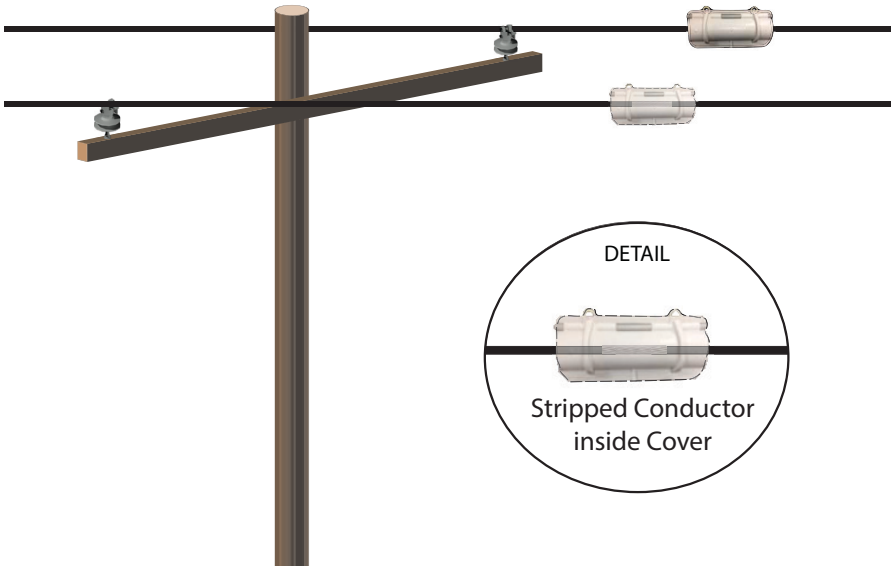


Figure CC 200–3: Grounding Point at Tangent for CC 1.0 and CC 2.0



DOH–CO: Conductors and Splices

TABLE OF CONTENTS

STANDARD	TITLE
CO 100	Installation of Conductors and Connectors
CO 100.1	Installation of Conductors and Connectors
CO 104	Distribution Conductors General Information
CO 104.1	General Information for Copper and Aluminum Overhead Conductors
CO 106	Characteristics of Overhead Aluminum Conductor
CO 106.1	Overhead Aluminum Conductor Physical and Electrical Properties
CO 106.2	Overhead Copper Conductor Physical and Electrical Properties
CO 107	Curves for Short-Time Loadability
CO 107.1	Short-Time Loadability for ACSR Conductors
CO 107.2	Short-Time Loadability for Copper Conductors
CO 108	Triplex/Quadruplex Secondary — General Requirements
CO 108.1	General Information for Installation of Triplex and Quadruplex Secondary Conductors
CO 109	Minimum Size Wire to X-Ray Services
CO 109.1	Minimum Size Wire to X-Ray Services
CO 110	Stringing Tensions — Table
CO 110.1	ACSR and Copper Stringing Tensions
CO 120	Sag Charts — Directions for Use
CO 120.1	Directions for Use of Sag Charts
CO 132	Sag Chart #4 Aluminum Duplex ACSR Messenger
CO 132	Sag Chart #4 Aluminum Duplex ACSR Messenger
CO 134	Sag Charts #4 and #2 Aluminum Triplex
CO 134.1	Sag — Temperature Stringing Table #4 and #2 Aluminum Triplex for Light-Loading Areas
CO 136	Sag Charts 1/0 and 4/0 Aluminum Triplex
CO 136.1	Sag — Temperature Stringing Table 1/0 and 4/0 Aluminum Triplex for Light-Loading Areas
CO 138	Sag Charts 1/0 and 4/0 Aluminum Quadruplex
CO 138.1	Sag — Temperature Stringing Table 1/0 and 4/0 Aluminum Quadruplex for Light-Loading Areas
CO 140	Sag Chart #4—336 ACSR
CO 140.1	Sag — Temperature Stringing Table #4 — 336 ACSR for Light-Loading Areas
CO 142	Sag Chart 653 ACSR
CO 142.1	Sag — Temperature Stringing Table 653 ACSR for Light-Loading Areas
CO 142.2	Sag — Temperature Stringing Table 653 ACSR Covered Conductor for Light-Loading Areas
CO 143	Sag —Temperature Stringing Table 1/0—653 ACSR/AW (Oriole) for Covered Conductor 2.0
CO 143.1	Sag —Temperature Stringing Table 1/0—653 ACSR/AW (Oriole) for Covered Conductor 2.0

STANDARD	TITLE
CO 146	Sag Chart #8 Copper Duplex
CO 146.1	Sag — Temperature Stringing Table #8 M.H.D. Copper Wire Duplex with Polyethylene Insulation for Light-Loading Areas
CO 148	Sag Chart #6 — 4/0 Copper
CO 148.1	Sag — Temperature Stringing Table #6 — 4/0 Copper for Light Loading Areas
CO 148.2	Sag — Temperature Stringing Table #2 Copper Covered Conductor for Light-Loading Areas
CO 148.3	Sag — Temperature Stringing Table 2/0 Copper Covered Conductor for Light-Loading Areas
CO 148.4	Sag — Temperature Stringing Table 4/0 Copper Covered Conductor for Light-Loading Areas
CO 149	Sag —Temperature Chart #2 — 500 kcmil Copper for Covered Conductor 2.0
CO 149.1	Sag —Temperature Chart #2 — 500 kcmil Copper for Covered Conductor 2.0
CO 150	Sag Chart #4 Copper and #4 ACSR
CO 150.1	Sag — Temperature Stringing Table #4 Copper and #4 ACSR for Heavy-Loading Areas
CO 153	Sag —Temperature Chart #2 — 500 kcmil Copper for Covered Conductor 2.0
CO 153.1	Sag —Temperature Chart #2 — 500 kcmil Copper for Covered Conductor 2.0
CO 152	Sag Chart #2 Copper
CO 152.1	Sag — Temperature Stringing Table #2 Copper for Heavy-Loading Areas
CO 154	Sag Chart #4 Aluminum Duplex
CO 154.1	Sag — Temperature Stringing Table Streetlight Secondary 120 V #4 Aluminum Duplex for Heavy-Loading Areas
CO 155	Sag Charts #4 and #2 Aluminum Triplex
CO 155.1	Sag — Temperature Stringing Table #4 and #2 Aluminum Triplex for Heavy-Loading Areas
CO 156	Sag Charts 1/0 and 4/0 Triplex
CO 156.1	Sag — Temperature Stringing Table 1/0 and 4/0 Triplex for Heavy-Loading Areas
CO 158	Sag Charts 1/0 and 4/0 Quadruplex
CO 158.1	Sag — Temperature Stringing Table 1/0 and 4/0 Quadruplex for Heavy-Loading Areas
CO 160	Sag Chart 2/0 and 4/0 Copper
CO 160.1	Sag — Temperature Stringing Table 2/0 and 4/0 Copper for Heavy-Loading Areas
CO 161	Sag —Temperature Stringing Table 17 kV 1/0 ACSR/AW — 653 ACSR/AW (Oriole) for Covered Conductor 2.0
CO 160.1	Sag — Temperature Stringing Table 2/0 and 4/0 Copper for Heavy-Loading Areas
CO 162	Sag Chart 1/0 ACSR
CO 162.1	Sag — Temperature Stringing Table 1/0 ACSR for Heavy-Loading Areas
CO 164	Sag Chart 336 ACSR
CO 164.1	Sag — Temperature Stringing Area 336 ACSR for Heavy-Loading Areas
CO 166	Sag Chart 654 ACSR
CO 166.1	Sag — Temperature Stringing Table 654 ACSR for Heavy-Loading Areas
CO 168	Reduce Tension Span Sag Charts — Directions for Use
CO 168.1	Directions for Use of Sag Charts

STANDARD	TITLE
CO 168.2	Sag Chart for New and Existing Reduced Tension Guyed Primary #4 — 653 ACSR for Light-Loading Areas
CO 168.3	Sag Chart for New and Existing Reduced Tension Guyed Primary 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas
CO 168.4	Sag Chart for New and Existing Reduced Tension Guyed Primary #6 — 4/0 Copper for Light-Loading Areas
CO 168.5	Sag Chart for New and Existing Reduced Tension Guyed Primary #2 — 4/0 Copper Covered Conductor for Light Loading Areas
CO 168.6	Sag Chart for New and Existing Reduced Tension Guyed #6 — 1/0 Aluminum Duplex and Triplex for Light-Loading Areas
CO 168.7	Sag Chart for New and Existing Reduced Tension Guyed #4 — 4/0 Aluminum Quadruplex for Light-Loading Areas
CO 168.8	Sag Chart for New Reduced Tension Unguyed #4 — 653 ACSR for Light-Loading Areas
CO 168.9	Sag Chart for New Reduced Tension Unguyed 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas
CO 168.10	Sag Chart for New Reduced Tension Unguyed #6 — 4/0 Copper for Light-Loading Areas
CO 168.11	Sag Chart for New Reduced Tension Unguyed #2 — 4/0 Copper Covered Conductor for Light-Loading Areas
CO 168.12	Sag Chart for New Reduced Tension Unguyed #6 — 1/0 Aluminum Duplex and Triplex for Light-Loading Areas
CO 168.13	Sag Chart for New Reduced Tension Unguyed #4 — 4/0 Aluminum Quadruplex for Light-Loading Areas
CO 168.14	Sag Chart for Existing and Rebuild Reduced Tension Unguyed #4 — 653 ACSR for Light-Loading Areas
CO 168.15	Sag Chart for Existing and Rebuild Reduced Tension Unguyed 1/0 — 653 ACSR Covered Conductor for Light-Loading Areas
CO 168.16	Sag Chart for Existing and Rebuild Reduced Tension Unguyed #6 — 4/0 Copper for Light-Loading Areas
CO 168.17	Sag Chart for Existing and Rebuild Reduced Tension Unguyed #2 — 4/0 Copper Covered Conductor for Light-Loading Areas
CO 168.18	Sag Chart for Existing and Rebuild Reduced Tension Unguyed #6 — 4/0 Aluminum Duplex and Triplex for Light-Loading Areas
CO 168.19	Sag Chart for New and Existing Reduced Tension Guyed #4 — 653 ACSR for Heavy-Loading Areas
CO 168.20	Sag Chart for New and Existing Reduced Tension Guyed 1/0— 653 ACSR Covered Conductor for Heavy-Loading Areas
CO 168.21	Sag Chart for New and Existing Reduced Tension Guyed #6 — 4/0 Copper for Heavy-Loading Areas
CO 168.22	Sag Chart for New and Existing Reduced Tension Guyed #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas
CO 168.23	Sag Chart for New and Existing Reduced Tension Guyed #6 — 4/0 Aluminum Duplex and Triplex for Heavy-Loading Areas

STANDARD	TITLE
CO 168.24	Sag Chart for New and Existing Reduced Tension Guyed #4 — 4/0 Aluminum Quadruplex for Heavy-Loading Area
CO 168.25	Sag Chart for New Reduced Tension Unguyed #4 — 653 ACSR for Heavy-Loading Areas
CO 168.26	Sag Chart for New Reduced Tension Unguyed 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas
CO 168.27	Sag Chart for New Reduced Tension Unguyed #6 — 4/0 Copper for Heavy-Loading Areas
CO 168.28	Sag Chart for New Reduced Tension Unguyed #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas
CO 168.29	Sag Chart for New Reduced Tension Unguyed #6 — 4/0 Aluminum Duplex and Triplex for Heavy-Loading Areas
CO 168.30	Sag Chart for New Reduced Tension Unguyed #4 — 4/0 Aluminum Quadruplex for Heavy-Loading Areas
CO 168.31	Sag Chart for Existing and Rebuild Reduced Tension Unguyed #4 — 653 ACSR for Heavy-Loading Areas
CO 168.32	Sag Chart for Existing and Rebuild Reduced Tension Unguyed 1/0 — 653 ACSR Covered Conductor for Heavy-Loading Areas
CO 168.33	Sag Chart for Existing and Rebuild Reduced Tension Unguyed #6 — 4/0 Copper for Heavy-Loading Areas
CO 168.34	Sag Chart for Existing and Rebuild Reduced Tension Unguyed #2 — 4/0 Copper Covered Conductor for Heavy-Loading Areas
CO 168.35	Sag Chart for Existing and Rebuild Reduced Tension Unguyed #6 — 4/0 Aluminum Duplex and Triplex for Heavy-Loading Areas
CO 200	Dead-Ending Tables
CO 200.1	Crossarm Requirements for Dead-Ending All Sizes of Copper and ACSR Conductors
CO 201	Composite Arm Dead-Ending Tables
CO 201.1	Composite Crossarm Requirements for Dead-Ending All Sizes of Copper and ACSR Conductors
CO 205	Dead-Ending — All Aluminum and ACSR
CO 205.1	Dead-Ending Method for All Aluminum and ACSR Conductors
CO 207	Dead-Ending — Aluminum and Copper
CO 207.1	Dead-Ending Methods
CO 207.2	Automatic Wedge Straight Line Clamp
CO 209	Dead-Ending — ACSR and Copper
CO 209.1	Typical Dead-Ending Methods to Prevent Radio Interference
CO 211	Dead-Ending — Wood Crossarm Construction
CO 211.1	Wood Crossarm Construction Requirements for Dead-Ending Conductors
CO 212	Dead-Ending — Composite Crossarm Construction
CO 212.1	Composite Crossarm Construction Requirements for Dead-Ending Conductors
CO 215	Dead-Ending — Copper Conductors
CO 215.1	Typical Dead-Ending for Copper Conductors

STANDARD	TITLE
CO 217	Dead-ending Method—Sectionalizer Links (Isolators)
CO 217.1	Typical Construction for Sectionalizer Links/Isolators
CO 300	Copper-to-Copper Connectors
CO 300.1	Copper-to-Copper Connectors
CO 300.2	Connectors - Copper Compression Lugs
CO 305	Connectors — Copper-to-Aluminum and Aluminum-to-Aluminum
CO 305.1	Connectors — Copper-to-Aluminum and Aluminum-to-Aluminum
CO 310P	600V Insulation Piercing Connectors
CO 310P.1	Insulation Piercing Connectors (IPCs)
CO 310P.2	Construction and Application
CO 400	Splices — Full Tension — Copper #8 — 250 kcmil
CO 400.1	Full Tension Splice Information for Copper #8 — 250 kcmil Automatic Splices
CO 400.2	Full Tension Splice Information for #4 — 336.4 ACSR Automatic Splice
CO 410	Compression Splices
CO 410.1	Tool and Die List for Full Tension Compression Splices
CO 410.2	Tool and Die List for Full and Partial Tension Compression and Repair Splices
CO 410.3	Instructions for Installing Full Tension, Double-Sleeve, Compression Splices for ACSR Conductors
CO 410.4	ACSR Repair Splice for #4, 1/0, and 336.4 ACSR
CO 420	Bolted Wedge Connector
CO 420.1	ACSR - ACSR, ACSR - CU and CU - CU Bolted Wedge Connectors
CO 450	Insulated Overhead Wire Spacers
CO 450.1	Insulated Overhead Wire Spacers for 4 kV, 12 kV, 16 kV, and 34.5 kV Systems
CO 460	Bare Wire System Installation Procedures for Spiral Vibration Dampers
CO 460.1	Bare Wire System Installation Procedures for Spiral Vibration Dampers
CO 470	ClampStar® Splice Shunt
CO 470.1	Installation Procedures for ClampStar® Splice Shunt
CO 480	Torque Recommendations for Bolted Connectors and Bolted Connections
CO 480.1	Torque Recommendations for Bolted Connectors
CO 480.2	Bolted Connections Using Compression Lugs
CO 500	Insulator Ties Copper and Aluminum
CO 500.1	Wire Length and Method of Securing the Conductor to the Insulator
CO 500.2	Insulator Ties Copper and Aluminum
CO 505	Insulator Ties Using Weather-Resistant Copper Conductor 0–5 kV
CO 505.1	Typical Insulator Ties Using Weather-Resistant Copper Conductor 0–5 kV
CO 510	Insulator Conductor Clamps
CO 510.1	Applications and SAP Numbers for Insulator Conductor Clamps

STANDARD	TITLE
CO 515	Universal Conductor Clamps — Angle Pins
CO 515.1	Typical Universal Conductor Clamps — Angle Pins
CO 520	Grip-Type Conductor Clamps
CO 520.1	Typical Grip-Type Conductor Clamps
CO 600	Terminating Large Copper and Aluminum Services
CO 600.1	Method of Dead-Ending All-Aluminum and Copper Conductors
CO 700	Span Lengths, Minimum Conductor Spacing, Composite and Wood Crossarm Pre-Drilled Holes
CO 700.1	Span Lengths and Minimum Conductor Spacing
CO 700.2	Composite Crossarm Pre-Drilled Holes
CO 700.3	8' and 10' Composite Crossarm Mounting Bracket Details
CO 700.4	12' and 20' Composite Crossarm Mounting Bracket Details
CO 700.5	Wood Crossarm Pre-Drilled Holes

CO 100 Installation of Conductors and Connectors

Scope CO 100.1 Installation of Conductors and Connectors

1.0 Exposed End Protection for Conductors with insulation or Protective Jacketing

All conductors with insulation or protective jacketing shall not be left exposed other than during the time work is being performed on the conductor. Partial reels of conductor that are stored in company warehouses, district/contractor yards, contractor project stores shall have protection installed on the conductor ends. Exposed conductors shall be protected from moisture and contaminants in the following manner:

Apply Aqua-Seal SAP 10116816/10116813 over exposed conductor end, extending at least one inch over the jacket. Follow this by wrapping two layers of half wrap Electrical Tape (33 tape) SAP 10116970 over the Aqua-Seal.

2.0 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.

3.0 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.

4.0 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.

5.0 Connectors

Applications for each connector type are listed below. See CO 300 and CO 305 for SAP numbers.

5.1 Bolted Wedge (see CO 420)

- Preferred connector when practical (See Note in Section 4.5) for:
  - — Overhead mainline to mainline (including tap line and/or branch line connections)
  - — Apparatus connections/taps such as voltage regulators, overhead switches, and automatic reclosers

5.2 GA9000 Series (Vise or Fargo) Connector

- Preferred connector for (Al-Al or Al-Cu Only):
  - — Apparatus connections/taps such as transformers (in HFRA) or capacitor banks
- Alternative primary connector for (Al-Al or Al-Cu only):
  - — Overhead mainline to mainline (including tap line and/or branch line connections)



NOTE If rubber/leather gloves can be used or if the line is de-energized upon installation, the appropriate bolted wedge connector shall be used. If use of a hot-stick is deemed necessary due to field constraints, then the GA9000 Series (Fargo) or Parallel Groove connector is an acceptable alternative.

5.3 Parallel Groove (Aluminum or Copper)

- Shall only be used when bolted wedge or GA9000 Series (Fargo) connectors are unavailable (Al-Al or Al-Cu).
- Alternative primary connector to bronze bolted wedge for copper-to-copper connections in HFRA.
- "Secondary Voltage System: Preferred connector for secondary voltage connections (Al-Al, Al-Cu, or Cu-Cu).

5.4 Vise-Type (also known as “LM,”Copper-to-Copper Only)

- Alternative copper-to-copper secondary voltage connections in non-HFRA

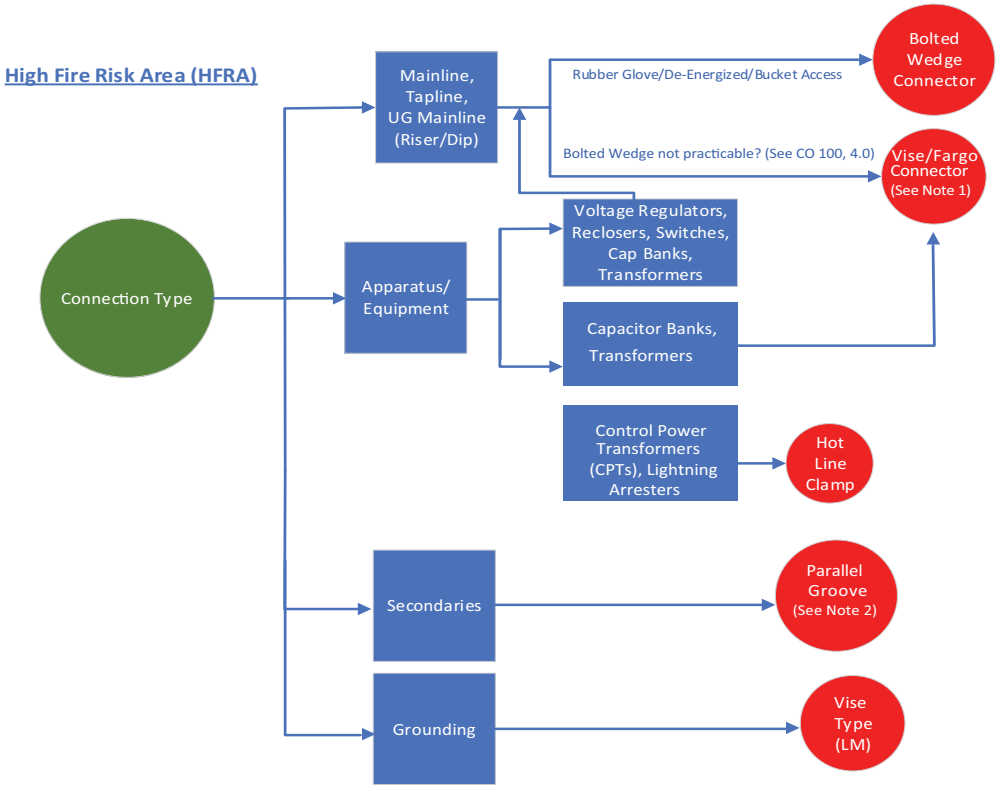
- Alternative primary voltage connector in non-HFRA
- Grounding connections for lightning arresters and potheads

5.5 Hot Line Clamp

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

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

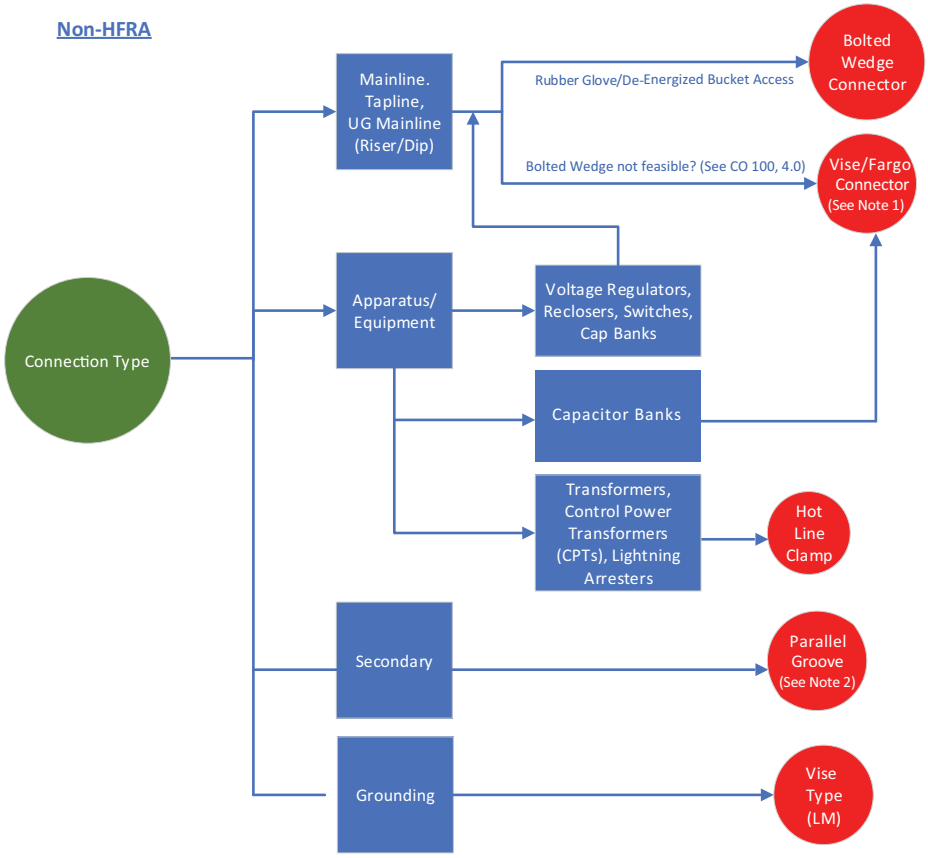
Figure CO 100–1: Decision Tree for Appropriate Connector Type in High Fire Risk Area (HFRA)



Note(s):

1. GA9000/Fargo Connectors shall only be used for Al-Al or Al-Cu. Bronze parallel grooves shall be installed as an immediate alternate to bronze bolted wedge connectors for Cu-Cu.
2. Parallel Groove connectors may be used as alternates when bolted wedge or GA9000/Fargo connectors are unavailable.
3. See DOH CO 300 and CO 305 for SAP codes.

Figure CO 100–2: Decision Tree for Appropriate Connector Type in Non-HFRA



Note(s):

1. Vise/Fargo Connectors shall only be used for Al-Al or Al-Cu. Bronze parallel grooves should be installed as an alternate to bronze bolted wedge connectors for Cu-Cu.
2. Parallel Groove connectors may be used as alternates when bolted wedge or GA9000/ Fargo connectors are unavailable.
3. See DOH CO 300 and CO 305 for SAP codes.

6.0 Taping Over Connectors

Taping over connectors is required in the following applications in HFRA:

- At the load end of services and secondary conductors and connectors (phase connections only).
- On triplex phase connections at spreader bars.

The 3M 33 tape (SAP 10116921) shall be used exclusively. Preinsulated compression connectors require no additional taping. Taping is NOT required on bare open wire secondary systems or grounding/neutral connections.

6.1 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.

7.0 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.

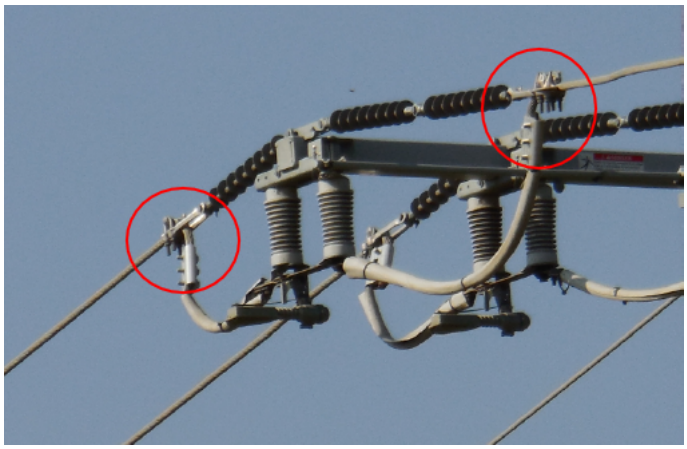
Automatic splices, so as long as they do not exceed the appropriate number of splices per span, may be retrofitted with the Clampstar Splice Shunt (see CO 470). Non-compression (not including automatic splices) splices shall be replaced whenever work activities allow for their removal.

8.0 Dead-Ending

Dead-ending of aluminum or ACSR conductors shall be performed as shown later in CO 200 through CO 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 100–3).

Figure CO 100–3: 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.

9.0 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.

10.0 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 types and sizes of both copper and aluminum conductors are in general use by the Company for overhead distribution lines.

Due to the corrosive environment in the coastal areas within ONE MILE of the ocean, SCE has historically used bare copper and greased aluminum conductors to improve service life of conductors in coastal areas. In 2018, the DDS was updated to expand the use of covered conductor (tree wire). Refer to DDS-10 for the present design requirements for the application of overhead conductor.

Inform Field Engineering of any specific area that experiences accelerated corrosion because of unique circumstances 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)

E. Covered Conductor - Material Standard Specification No. 511

1. Aluminum Covered Conductor: 1/0, 336 (18/1), 336 (30/7), and 653 kcmil stranded
2. Hard Drawn Copper Covered Conductor: #2, 2/0, and 4/0 stranded

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).

Conductors with voltage classification between 750V-7500V and voltage classification between 0-750V shall not be installed adjacent to each other on the same end of a crossarm. However, the conductors for each of the voltage classifications may be used on opposite ends of the same crossarm, and the two classifications are separated by 30 inches. The minimum spacing for barewire is 20 inches for spans up to 205 feet. (Exception: Spacing of less than 20 inches may be used in special cases.)

= FOR REFERENCE ONLY

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.

This page intentionally left blank.

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
2	66.36	211	1	0.258	0.110	0.478	252	1,330.6	3.968	0.1826

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

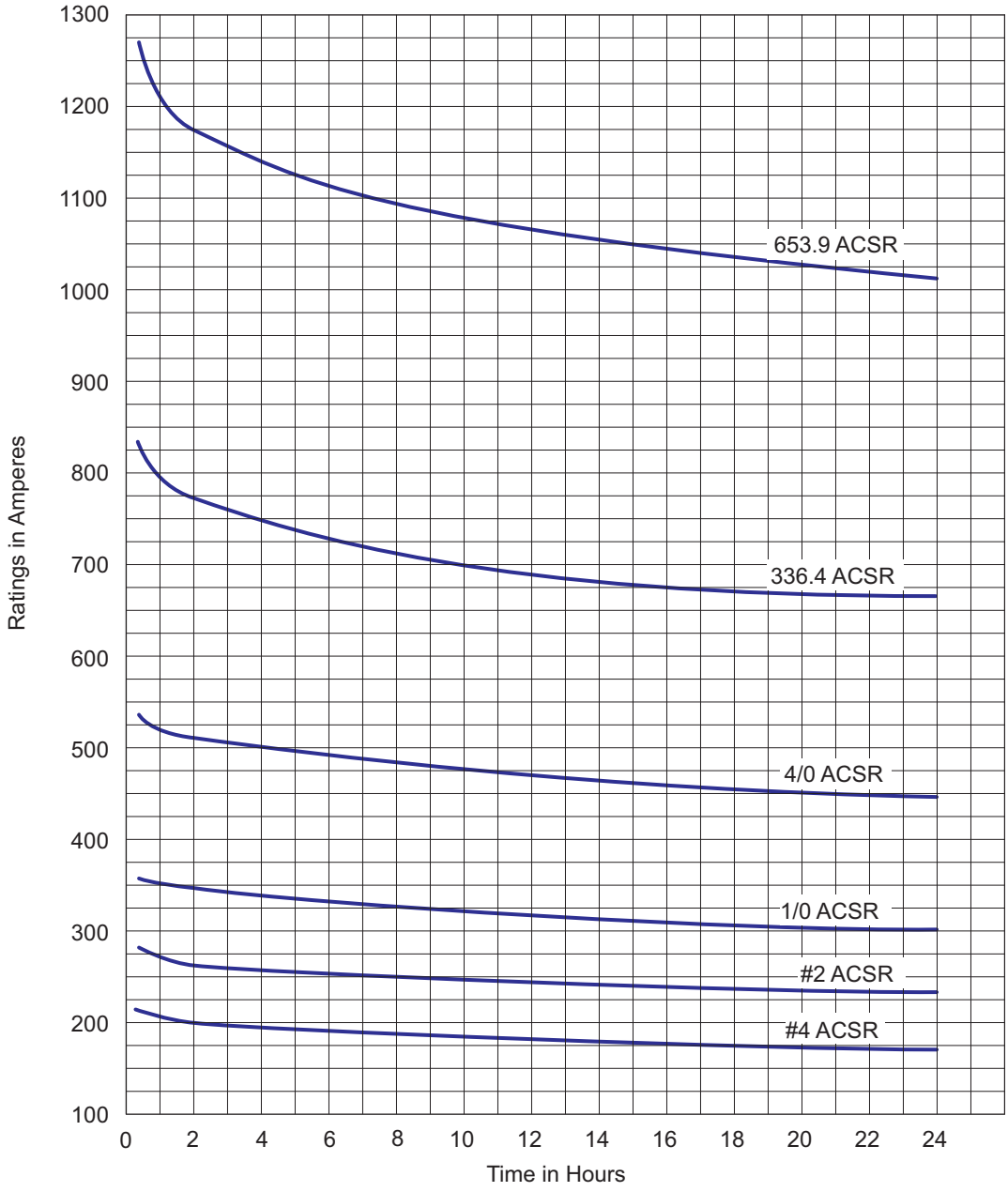
Note(s):

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

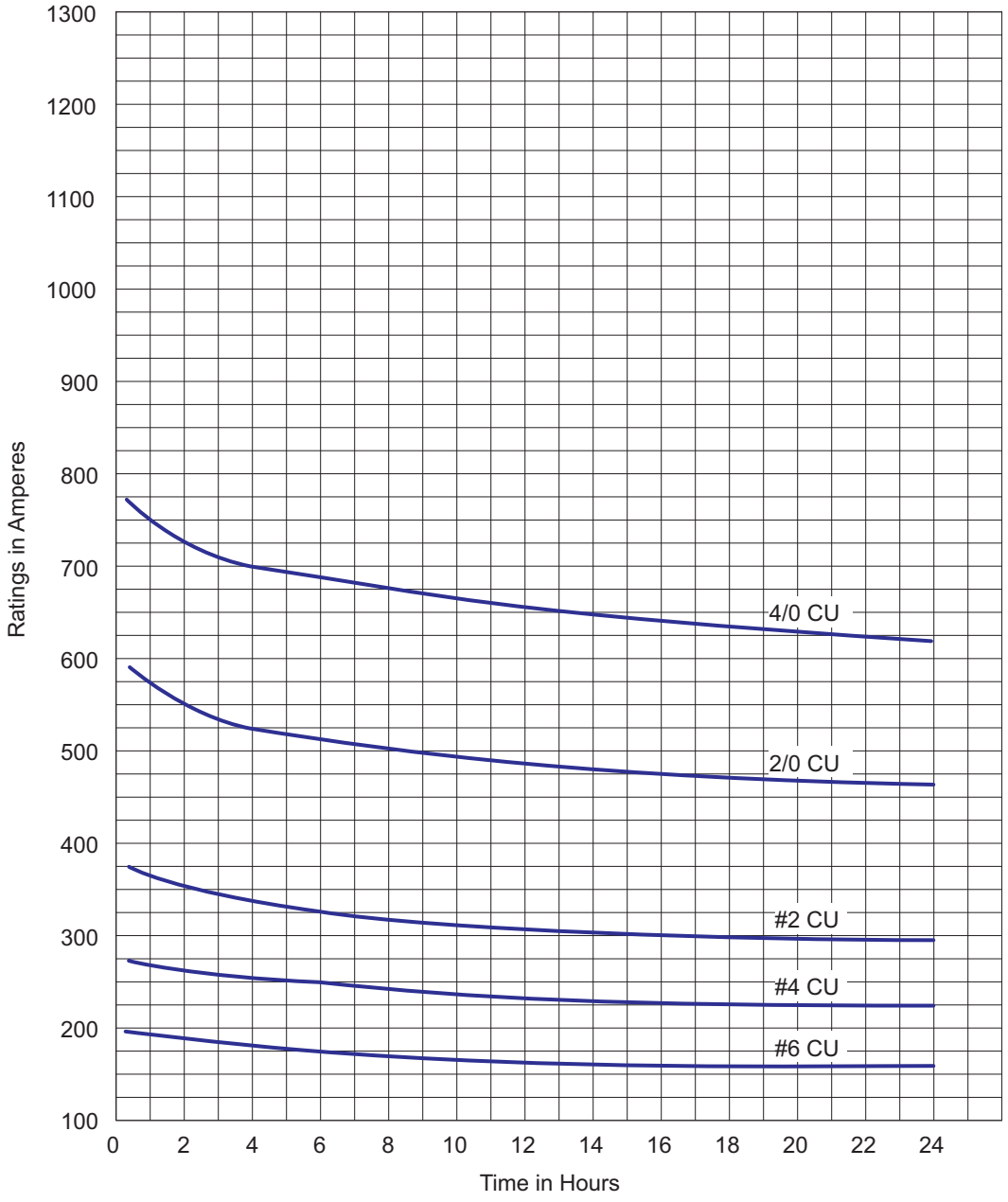


Note(s):

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.

This page intentionally left blank.

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.**

This page intentionally left blank.

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.

This page intentionally left blank.

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.

This page intentionally left blank.

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.

This page intentionally left blank.

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.

This page intentionally left blank.

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 quadruplex is 1,415 lb.

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

2.0 Ground Clearance

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

This page intentionally left blank.

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

	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-3"	0'-3"	0'-4"	0'-4"	0'-4"	0'-5"	0'-5"	0'-5"	1'-0"
120	0'-5"	0'-5"	0'-5"	0'-6"	0'-6"	0'-7"	0'-8"	0'-7"	1'-4"
140	0'-6"	0'-7"	0'-7"	0'-8"	0'-9"	0'-9"	0'-10"	0'-10"	1'-8"
160	0'-8"	0'-9"	0'-10"	0'-11"	0'-11"	1'-0"	1'-2"	1'-1"	2'-0"
180	0'-11"	1'-0"	1'-1"	1'-2"	1'-3"	1'-4"	1'-6"	1'-5"	2'-5"
200	1'-2"	1'-3"	1'-4"	1'-5"	1'-7"	1'-8"	1'-10"	1'-9"	2'-11"
220	1'-5"	1'-6"	1'-8"	1'-9"	1'-11"	2'-1"	2'-3"	2'-2"	3'-5"
240	1'-9"	1'-11"	2'-0"	2'-2"	2'-4"	2'-6"	2'-9"	2'-7"	3'-11"
260	2'-2"	2'-3"	2'-5"	2'-7"	2'-10"	3'-0"	3'-3"	3'-0"	4'-6"
280	2'-7"	2'-9"	2'-11"	3'-1"	3'-4"	3'-6"	3'-9"	3'-6"	5'-1"
300	3'-0"	3'-2"	3'-5"	3'-7"	3'-10"	4'-1"	4'-4"	4'-1"	5'-8"
320	3'-6"	3'-9"	4'-0"	4'-2"	4'-5"	4'-8"	4'-11"	4'-8"	6'-4"
340	4'-1"	4'-4"	4'-7"	4'-10"	5'-1"	5'-4"	5'-7"	5'-4"	7'-0"
360	4'-8"	4'-11"	5'-3"	5'-6"	5'-9"	6'-0"	6'-4"	6'-0"	7'-9"
380	5'-4"	5'-8"	5'-11"	6'-2"	6'-6"	6'-9"	7'-1"	6'-9"	8'-6"
400	6'-1"	6'-4"	6'-8"	6'-11"	7'-3"	7'-6"	7'-10"	7'-6"	9'-4"
420	6'-10"	7'-2"	7'-5"	7'-9"	8'-0"	8'-4"	8'-8"	8'-4"	10'-2"
440	7'-8"	7'-11"	8'-3"	8'-7"	8'-11"	9'-2"	9'-6"	9'-2"	11'-1"
460	8'-6"	8'-10"	9'-2"	9'-6"	9'-9"	10'-1"	10'-5"	10'-1"	12'-0"
480	9'-5"	9'-9"	10'-1"	10'-5"	10'-9"	11'-0"	11'-4"	11'-0"	12'-11"
500	10'-4"	10'-8"	11'-0"	11'-4"	11'-8"	12'-0"	12'-4"	11'-11"	13'-11"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1338	1252	1165	1075	984	894	803	840	351
120	1313	1227	1142	1055	966	877	791	831	381
140	1289	1205	1119	1033	947	864	780	822	409
160	1261	1177	1093	1011	929	849	771	814	434
180	1229	1149	1066	986	907	832	760	804	456
200	1197	1117	1040	962	889	817	751	795	476
220	1163	1086	1011	939	869	803	741	786	493
240	1130	1056	985	916	851	791	735	779	509
260	1097	1028	960	896	836	780	729	772	524
280	1065	1001	937	877	822	771	724	766	537
300	1037	974	917	861	811	764	721	760	549
320	1006	949	895	845	798	756	716	754	559
340	981	928	878	832	789	750	715	750	569
360	956	907	861	819	781	745	712	745	578
380	933	888	847	808	773	740	710	741	586
400	913	871	833	798	766	735	708	737	593
420	894	856	822	789	760	732	706	734	599
440	878	843	811	782	754	729	705	732	606
460	862	831	801	774	749	726	703	728	611
480	849	821	794	769	745	724	703	726	616
500	836	810	786	762	741	721	702	724	620

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-5"	0'-6"	0'-6"	0'-6"	0'-7"	0'-8"	0'-8"	0'-8"	1'-3"
120	0'-8"	0'-8"	0'-9"	0'-9"	0'-10"	0'-11"	1'-0"	1'-0"	1'-8"
140	0'-11"	0'-11"	1'-0"	1'-1"	1'-2"	1'-3"	1'-5"	1'-4"	2'-1"
160	1'-3"	1'-3"	1'-5"	1'-6"	1'-7"	1'-8"	1'-10"	1'-9"	2'-7"
180	1'-7"	1'-8"	1'-10"	1'-11"	2'-1"	2'-2"	2'-4"	2'-3"	3'-2"
200	2'-0"	2'-2"	2'-3"	2'-5"	2'-7"	2'-9"	2'-11"	2'-9"	3'-9"
220	2'-7"	2'-8"	2'-10"	3'-0"	3'-2"	3'-4"	3'-6"	3'-4"	4'-5"
240	3'-2"	3'-3"	3'-6"	3'-8"	3'-10"	4'-0"	4'-2"	4'-0"	5'-2"
260	3'-9"	4'-0"	4'-2"	4'-4"	4'-6"	4'-9"	4'-11"	4'-9"	5'-11"
280	4'-6"	4'-8"	4'-11"	5'-1"	5'-4"	5'-6"	5'-8"	5'-6"	6'-9"
300	5'-4"	5'-6"	5'-9"	5'-11"	6'-2"	6'-4"	6'-6"	6'-4"	7'-7"
320	6'-2"	6'-5"	6'-7"	6'-10"	7'-0"	7'-3"	7'-5"	7'-3"	8'-7"
340	7'-1"	7'-4"	7'-6"	7'-9"	8'-0"	8'-2"	8'-5"	8'-2"	9'-6"
360	8'-1"	8'-4"	8'-6"	8'-9"	9'-0"	9'-3"	9'-5"	9'-3"	10'-7"
380	9'-2"	9'-5"	9'-7"	9'-10"	10'-1"	10'-4"	10'-6"	10'-4"	11'-8"
400	10'-3"	10'-6"	10'-9"	11'-0"	11'-3"	11'-5"	11'-8"	11'-5"	12'-10"
420	11'-6"	11'-8"	11'-11"	12'-2"	12'-5"	12'-8"	12'-11"	12'-8"	14'-1"
440	12'-9"	12'-11"	13'-2"	13'-5"	13'-8"	13'-11"	14'-2"	13'-11"	15'-4"
460	14'-0"	14'-3"	14'-6"	14'-9"	15'-0"	15'-3"	15'-6"	15'-3"	16'-8"
480	15'-5"	15'-8"	15'-11"	16'-2"	16'-5"	16'-8"	16'-10"	16'-7"	18'-1"
500	16'-10"	17'-1"	17'-4"	17'-7"	17'-10"	18'-1"	18'-4"	18'-1"	19'-6"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1295	1212	1128	1043	960	878	800	838	445
120	1256	1175	1095	1014	937	862	790	830	482
140	1214	1137	1061	985	914	846	783	822	514
160	1173	1100	1029	960	895	834	777	816	541
180	1130	1063	998	935	876	822	773	810	565
200	1091	1029	971	914	862	814	770	805	586
220	1053	997	945	894	848	806	767	800	603
240	1019	970	923	878	837	800	765	796	619
260	989	945	903	863	828	794	764	792	632
280	963	924	887	852	820	791	763	789	644
300	941	906	873	842	814	787	763	786	655
320	920	890	861	833	808	784	762	784	664
340	903	876	850	825	802	781	761	781	672
360	889	864	842	819	798	779	761	780	679
380	875	854	833	813	794	777	760	778	686
400	864	845	826	808	791	775	760	776	691
420	854	837	820	803	788	773	760	774	696
440	845	830	814	799	785	772	759	773	700
460	838	823	809	795	783	770	759	771	704
480	831	818	805	792	780	769	758	770	707
500	824	812	801	789	778	768	757	768	710

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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 and Tensions — 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	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-3"	0'-4"	0'-4"	0'-5"	0'-5"	0'-6"	0'-8"	0'-6"	1'-4"
120	0'-5"	0'-5"	0'-6"	0'-7"	0'-8"	0'-9"	0'-11"	0'-9"	1'-8"
140	0'-6"	0'-7"	0'-8"	0'-9"	0'-10"	1'-0"	1'-2"	0'-11"	2'-0"
160	0'-9"	0'-9"	0'-11"	1'-0"	1'-1"	1'-3"	1'-6"	1'-3"	2'-5"
180	0'-11"	1'-0"	1'-1"	1'-3"	1'-5"	1'-7"	1'-9"	1'-6"	2'-10"
200	1'-2"	1'-3"	1'-5"	1'-6"	1'-9"	1'-11"	2'-2"	1'-10"	3'-3"
220	1'-5"	1'-6"	1'-8"	1'-10"	2'-1"	2'-3"	2'-6"	2'-3"	3'-9"
240	1'-8"	1'-10"	2'-0"	2'-3"	2'-5"	2'-8"	2'-11"	2'-7"	4'-2"
260	2'-0"	2'-2"	2'-4"	2'-7"	2'-10"	3'-1"	3'-5"	3'-0"	4'-9"
280	2'-4"	2'-6"	2'-9"	3'-0"	3'-3"	3'-7"	3'-10"	3'-6"	5'-3"
300	2'-8"	2'-11"	3'-2"	3'-6"	3'-9"	4'-0"	4'-4"	3'-11"	5'-9"
320	3'-1"	3'-4"	3'-8"	3'-11"	4'-3"	4'-6"	4'-10"	4'-5"	6'-4"
340	3'-7"	3'-10"	4'-2"	4'-5"	4'-9"	5'-1"	5'-5"	5'-0"	7'-0"
360	4'-0"	4'-4"	4'-8"	5'-0"	5'-4"	5'-8"	6'-0"	5'-7"	7'-7"
380	4'-7"	4'-11"	5'-3"	5'-7"	5'-11"	6'-3"	6'-7"	6'-2"	8'-3"
400	5'-1"	5'-5"	5'-10"	6'-2"	6'-6"	6'-11"	7'-3"	6'-9"	9'-0"
420	5'-8"	6'-1"	6'-5"	6'-10"	7'-2"	7'-7"	7'-11"	7'-5"	9'-8"
440	6'-4"	6'-8"	7'-1"	7'-6"	7'-10"	8'-3"	8'-7"	8'-1"	10'-5"
460	7'-0"	7'-4"	7'-9"	8'-2"	8'-7"	8'-11"	9'-4"	8'-10"	11'-2"
480	7'-8"	8'-1"	8'-6"	8'-11"	9'-3"	9'-8"	10'-1"	9'-7"	12'-0"
500	8'-5"	8'-10"	9'-3"	9'-8"	10'-1"	10'-6"	10'-11"	10'-4"	12'-9"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	2614	2355	2096	1832	1573	1327	1104	1408	533
120	2600	2344	2088	1836	1589	1360	1154	1435	612
140	2582	2329	2080	1836	1605	1388	1201	1459	683
160	2556	2311	2073	1836	1617	1416	1245	1481	749
180	2531	2296	2061	1840	1632	1445	1285	1503	811
200	2506	2274	2054	1840	1646	1473	1322	1525	868
220	2480	2259	2042	1844	1660	1499	1357	1548	922
240	2448	2236	2031	1843	1672	1521	1387	1565	971
260	2422	2218	2023	1845	1683	1542	1419	1585	1018
280	2389	2193	2012	1843	1695	1560	1444	1600	1061
300	2360	2176	2004	1845	1705	1580	1469	1616	1102
320	2330	2157	1994	1847	1714	1598	1493	1630	1140
340	2299	2135	1981	1843	1720	1610	1512	1642	1174
360	2273	2116	1975	1845	1728	1625	1533	1654	1208
380	2245	2099	1965	1842	1734	1637	1549	1664	1238
400	2219	2080	1955	1842	1739	1648	1565	1673	1266
420	2193	2064	1946	1840	1744	1657	1580	1682	1293
440	2170	2049	1940	1840	1750	1668	1595	1690	1320
460	2149	2038	1934	1840	1754	1678	1607	1698	1343
480	2129	2024	1926	1839	1758	1686	1618	1705	1366
500	2110	2010	1920	1836	1761	1691	1629	1711	1386

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-5"	0'-5"	0'-6"	0'-6"	0'-7"	0'-8"	0'-10"	1'-5"	0'-8"
120	0'-7"	0'-7"	0'-8"	0'-9"	0'-10"	1'-0"	1'-1"	1'-10"	0'-11"
140	0'-9"	0'-10"	0'-11"	1'-0"	1'-2"	1'-4"	1'-5"	2'-3"	1'-3"
160	1'-0"	1'-1"	1'-3"	1'-4"	1'-6"	1'-8"	1'-10"	2'-8"	1'-7"
180	1'-3"	1'-5"	1'-6"	1'-8"	1'-10"	2'-0"	2'-3"	3'-2"	2'-0"
200	1'-7"	1'-9"	1'-11"	2'-1"	2'-3"	2'-6"	2'-8"	3'-8"	2'-5"
220	2'-0"	2'-2"	2'-4"	2'-6"	2'-9"	2'-11"	3'-2"	4'-3"	2'-11"
240	2'-5"	2'-7"	2'-9"	3'-0"	3'-3"	3'-5"	3'-8"	4'-10"	3'-5"
260	2'-10"	3'-1"	3'-3"	3'-6"	3'-9"	4'-0"	4'-3"	5'-5"	3'-11"
280	3'-4"	3'-7"	3'-10"	4'-1"	4'-4"	4'-7"	4'-10"	6'-1"	4'-6"
300	3'-11"	4'-2"	4'-5"	4'-8"	4'-11"	5'-3"	5'-6"	6'-9"	5'-2"
320	4'-6"	4'-9"	5'-0"	5'-4"	5'-7"	5'-10"	6'-2"	7'-6"	5'-10"
340	5'-2"	5'-5"	5'-9"	6'-0"	6'-3"	6'-7"	6'-10"	8'-3"	6'-6"
360	5'-10"	6'-1"	6'-5"	6'-9"	7'-0"	7'-4"	7'-7"	9'-0"	7'-3"
380	6'-7"	6'-10"	7'-2"	7'-6"	7'-10"	8'-1"	8'-5"	9'-10"	8'-1"
400	7'-4"	7'-8"	8'-0"	8'-4"	8'-7"	8'-11"	9'-3"	10'-9"	8'-10"
420	8'-2"	8'-6"	8'-10"	9'-2"	9'-6"	9'-10"	10'-1"	11'-8"	9'-9"
440	9'-0"	9'-5"	9'-9"	10'-1"	10'-5"	10'-9"	11'-0"	12'-7"	10'-8"
460	10'-0"	10'-4"	10'-8"	11'-0"	11'-4"	11'-8"	12'-0"	13'-7"	11'-7"
480	10'-11"	11'-3"	11'-8"	12'-0"	12'-4"	12'-8"	13'-0"	14'-7"	12'-7"
500	11'-11"	12'-3"	12'-8"	13'-0"	13'-4"	13'-8"	14'-0"	15'-8"	13'-8"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	2605	2355	2101	1855	1620	1404	1213	1469	683
120	2578	2336	2094	1862	1645	1448	1275	1506	776
140	2547	2314	2084	1867	1667	1488	1331	1538	859
160	2514	2292	2075	1873	1689	1525	1382	1569	935
180	2484	2273	2069	1883	1713	1562	1431	1601	1005
200	2450	2251	2061	1888	1732	1594	1472	1628	1069
220	2411	2225	2048	1889	1747	1619	1507	1650	1126
240	2375	2202	2039	1893	1762	1644	1541	1672	1179
260	2340	2180	2029	1894	1774	1666	1570	1690	1227
280	2305	2157	2018	1895	1784	1684	1595	1706	1270
300	2274	2138	2010	1897	1795	1702	1619	1722	1311
320	2244	2119	2001	1897	1803	1718	1640	1736	1348
340	2217	2102	1994	1898	1810	1731	1659	1748	1382
360	2192	2086	1987	1898	1818	1744	1676	1759	1414
380	2168	2071	1979	1898	1823	1754	1691	1768	1443
400	2148	2058	1974	1898	1828	1764	1705	1777	1469
420	2128	2046	1967	1897	1833	1773	1717	1785	1494
440	2110	2034	1961	1896	1836	1780	1728	1791	1516
460	2094	2024	1957	1896	1840	1788	1739	1798	1537
480	2079	2014	1952	1895	1843	1794	1748	1803	1556
500	2065	2005	1947	1895	1845	1799	1756	1808	1573

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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.

Table CO 140–10: Sag — Temperature Stringing Table 17 kV 336 (30/7) ACSR Covered Conductor for Light-Loading Areas

	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-4"	0'-4"	0'-5"	0'-5"	0'-6"	0'-7"	0'-9"	0'-7"	1'-4"
120	0'-5"	0'-6"	0'-7"	0'-8"	0'-9"	0'-10"	1'-0"	0'-9"	1'-8"
140	0'-7"	0'-8"	0'-9"	0'-10"	1'-0"	1'-1"	1'-3"	1'-1"	2'-0"
160	0'-10"	0'-11"	1'-0"	1'-1"	1'-3"	1'-5"	1'-7"	1'-4"	2'-5"
180	1'-0"	1'-2"	1'-3"	1'-5"	1'-7"	1'-9"	1'-11"	1'-8"	2'-10"
200	1'-3"	1'-5"	1'-7"	1'-9"	1'-11"	2'-1"	2'-3"	2'-0"	3'-3"
220	1'-7"	1'-9"	1'-11"	2'-1"	2'-3"	2'-5"	2'-8"	2'-4"	3'-8"
240	1'-11"	2'-1"	2'-3"	2'-5"	2'-8"	2'-10"	3'-1"	2'-9"	4'-2"
260	2'-3"	2'-5"	2'-7"	2'-10"	3'-1"	3'-3"	3'-6"	3'-2"	4'-8"
280	2'-7"	2'-10"	3'-0"	3'-3"	3'-6"	3'-9"	4'-0"	3'-8"	5'-3"
300	3'-0"	3'-3"	3'-6"	3'-9"	4'-0"	4'-3"	4'-6"	4'-2"	5'-9"
320	3'-6"	3'-9"	4'-0"	4'-3"	4'-6"	4'-9"	5'-0"	4'-8"	6'-4"
340	3'-11"	4'-3"	4'-6"	4'-9"	5'-0"	5'-4"	5'-7"	5'-3"	6'-11"
360	4'-6"	4'-9"	5'-0"	5'-4"	5'-7"	5'-11"	6'-2"	5'-10"	7'-7"
380	5'-0"	5'-4"	5'-7"	5'-11"	6'-2"	6'-6"	6'-10"	6'-5"	8'-3"
400	5'-7"	5'-11"	6'-2"	6'-6"	6'-10"	7'-2"	7'-5"	7'-1"	8'-11"
420	6'-3"	6'-6"	6'-10"	7'-2"	7'-6"	7'-10"	8'-1"	7'-9"	9'-8"
440	6'-10"	7'-2"	7'-6"	7'-10"	8'-2"	8'-6"	8'-10"	8'-5"	10'-5"
460	7'-7"	7'-11"	8'-3"	8'-7"	8'-11"	9'-3"	9'-7"	9'-2"	11'-2"
480	8'-3"	8'-7"	9'-0"	9'-4"	9'-8"	10'-0"	10'-4"	9'-11"	12'-0"
500	9'-0"	9'-4"	9'-9"	10'-1"	10'-5"	10'-9"	11'-2"	10'-8"	12'-10"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

1.0 Guying

Conductor tensions for guying 336 (30/7) Covered Conductor is 3,267 lb.

2.0 Ground Clearance

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

Table CO 140–11: Tension — Temperature Stringing Table 17 kV 336 (30/7) ACSR Covered Conductor for Light-Loading Areas

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	2935	2636	2336	2046	1771	1518	1292	1629	699
120	2925	2636	2346	2072	1813	1577	1374	1679	802
140	2910	2631	2357	2093	1850	1633	1444	1724	896
160	2895	2626	2362	2114	1890	1689	1512	1768	983
180	2874	2615	2367	2134	1924	1735	1571	1806	1063
200	2854	2608	2372	2155	1959	1783	1631	1846	1137
220	2834	2597	2377	2171	1988	1823	1679	1880	1206
240	2819	2592	2382	2192	2019	1865	1730	1915	1271
260	2793	2584	2387	2207	2045	1899	1773	1945	1331
280	2768	2569	2382	2215	2064	1929	1810	1969	1386
300	2742	2556	2384	2228	2085	1958	1845	1995	1438
320	2722	2545	2384	2238	2105	1987	1880	2018	1487
340	2702	2535	2384	2248	2124	2010	1909	2039	1532
360	2679	2522	2381	2253	2137	2031	1935	2057	1573
380	2658	2512	2381	2261	2149	2050	1959	2075	1612
400	2640	2506	2381	2268	2165	2071	1984	2092	1650
420	2620	2495	2378	2272	2175	2086	2004	2106	1683
440	2602	2485	2376	2276	2186	2101	2024	2119	1715
460	2586	2476	2375	2281	2194	2115	2041	2132	1745
480	2573	2469	2373	2286	2203	2128	2058	2144	1774
500	2558	2461	2371	2288	2211	2139	2072	2154	1800

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

Table CO 140–12: Sag — Temperature Stringing Table 35 kV 336 (30/7) ACSR Covered Conductor for Light-Loading Areas

Span (Ft)	Sag								
	Initial Stringing Sag							Final Sag	
	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-5"	0'-6"	0'-6"	0'-7"	0'-8"	0'-9"	0'-10"	0'-9"	1'-5"
120	0'-7"	0'-8"	0'-9"	0'-10"	0'-11"	1'-0"	1'-2"	1'-0"	1'-9"
140	0'-10"	0'-11"	1'-0"	1'-1"	1'-3"	1'-4"	1'-6"	1'-4"	2'-2"
160	1'-1"	1'-2"	1'-4"	1'-5"	1'-7"	1'-9"	1'-10"	1'-8"	2'-8"
180	1'-5"	1'-6"	1'-8"	1'-9"	1'-11"	2'-1"	2'-3"	2'-1"	3'-1"
200	1'-9"	1'-10"	2'-0"	2'-2"	2'-4"	2'-6"	2'-9"	2'-6"	3'-7"
220	2'-1"	2'-3"	2'-5"	2'-7"	2'-10"	3'-0"	3'-2"	2'-11"	4'-2"
240	2'-6"	2'-9"	2'-11"	3'-1"	3'-4"	3'-6"	3'-9"	3'-5"	4'-9"
260	3'-0"	3'-2"	3'-5"	3'-7"	3'-10"	4'-0"	4'-3"	4'-0"	5'-4"
280	3'-6"	3'-9"	3'-11"	4'-2"	4'-5"	4'-7"	4'-10"	4'-7"	5'-11"
300	4'-1"	4'-4"	4'-6"	4'-9"	5'-0"	5'-3"	5'-6"	5'-2"	6'-7"
320	4'-8"	4'-11"	5'-2"	5'-5"	5'-8"	5'-11"	6'-2"	5'-10"	7'-4"
340	5'-4"	5'-7"	5'-10"	6'-1"	6'-4"	6'-7"	6'-10"	6'-6"	8'-1"
360	6'-0"	6'-3"	6'-7"	6'-10"	7'-1"	7'-4"	7'-7"	7'-3"	8'-10"
380	6'-9"	7'-0"	7'-4"	7'-7"	7'-10"	8'-1"	8'-4"	8'-1"	9'-8"
400	7'-6"	7'-10"	8'-1"	8'-5"	8'-8"	8'-11"	9'-2"	8'-10"	10'-6"
420	8'-4"	8'-8"	8'-11"	9'-3"	9'-6"	9'-9"	10'-1"	9'-9"	11'-5"
440	9'-3"	9'-6"	9'-10"	10'-1"	10'-5"	10'-8"	11'-0"	10'-8"	12'-4"
460	10'-2"	10'-5"	10'-9"	11'-1"	11'-4"	11'-7"	11'-11"	11'-7"	13'-4"
480	11'-1"	11'-5"	11'-9"	12'-0"	12'-4"	12'-7"	12'-11"	12'-7"	14'-4"
500	12'-1"	12'-5"	12'-9"	13'-0"	13'-4"	13'-7"	13'-11"	13'-7"	15'-4"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

Table CO 140–13: Tension — Temperature Stringing Table 35 kV 336 (30/7) ACSR Covered Conductor for Light-Loading Areas

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	2926	2641	2357	2089	1839	1614	1419	1709	858
120	2903	2631	2363	2115	1887	1683	1506	1765	974
140	2889	2631	2380	2150	1941	1754	1592	1824	1081
160	2863	2620	2387	2175	1983	1813	1664	1873	1177
180	2837	2610	2393	2198	2023	1866	1729	1917	1264
200	2811	2600	2399	2220	2059	1915	1787	1958	1344
220	2780	2584	2400	2235	2087	1955	1837	1993	1416
240	2752	2571	2402	2251	2114	1992	1882	2025	1482
260	2724	2558	2402	2264	2138	2025	1923	2054	1542
280	2697	2545	2402	2274	2159	2054	1959	2080	1597
300	2672	2532	2400	2283	2176	2079	1991	2102	1647
320	2650	2521	2400	2292	2193	2103	2020	2124	1694
340	2627	2510	2398	2298	2207	2123	2046	2141	1736
360	2608	2500	2397	2305	2220	2142	2070	2159	1776
380	2589	2490	2395	2309	2231	2158	2090	2173	1811
400	2570	2479	2391	2312	2239	2171	2107	2185	1843
420	2555	2471	2389	2316	2248	2184	2125	2197	1874
440	2540	2463	2387	2319	2255	2196	2140	2207	1902
460	2526	2455	2384	2321	2261	2205	2153	2216	1927
480	2516	2449	2383	2324	2268	2216	2166	2225	1951
500	2504	2442	2381	2326	2273	2224	2177	2232	1973

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

This page intentionally left blank.

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

	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-6"	0'-7"	0'-8"	0'-10"	1'-0"	1'-1"	1'-3"	1'-1"	1'-10"
120	0'-8"	0'-10"	0'-11"	1'-1"	1'-3"	1'-5"	1'-7"	1'-5"	2'-4"
140	0'-11"	1'-1"	1'-3"	1'-5"	1'-7"	1'-9"	1'-11"	1'-9"	2'-9"
160	1'-2"	1'-4"	1'-7"	1'-9"	1'-11"	2'-2"	2'-4"	2'-2"	3'-3"
180	1'-6"	1'-8"	1'-11"	2'-1"	2'-4"	2'-7"	2'-9"	2'-7"	3'-10"
200	1'-11"	2'-1"	2'-4"	2'-7"	2'-9"	3'-0"	3'-3"	3'-1"	4'-5"
220	2'-4"	2'-6"	2'-9"	3'-0"	3'-3"	3'-6"	3'-9"	3'-8"	5'-0"
240	2'-9"	3'-0"	3'-3"	3'-6"	3'-9"	4'-0"	4'-3"	4'-3"	5'-8"
260	3'-3"	3'-7"	3'-10"	4'-1"	4'-4"	4'-7"	4'-11"	4'-10"	6'-4"
280	3'-10"	4'-2"	4'-5"	4'-8"	5'-0"	5'-3"	5'-6"	5'-6"	7'-0"
300	4'-6"	4'-9"	5'-1"	5'-4"	5'-8"	5'-11"	6'-2"	6'-2"	7'-9"
320	5'-2"	5'-5"	5'-9"	6'-1"	6'-4"	6'-8"	6'-11"	6'-11"	8'-7"
340	5'-10"	6'-2"	6'-6"	6'-10"	7'-1"	7'-5"	7'-8"	7'-8"	9'-5"
360	6'-8"	6'-11"	7'-3"	7'-7"	7'-11"	8'-3"	8'-6"	8'-6"	10'-3"
380	7'-5"	7'-9"	8'-1"	8'-5"	8'-9"	9'-1"	9'-4"	9'-5"	11'-2"
400	8'-4"	8'-8"	9'-0"	9'-4"	9'-8"	10'-0"	10'-3"	10'-4"	12'-1"
420	9'-3"	9'-7"	9'-11"	10'-3"	10'-7"	10'-11"	11'-3"	11'-3"	13'-1"
440	10'-3"	10'-7"	10'-11"	11'-3"	11'-7"	11'-11"	12'-3"	12'-3"	14'-2"
460	11'-3"	11'-7"	11'-11"	12'-3"	12'-7"	12'-11"	13'-3"	13'-4"	15'-3"
480	12'-4"	12'-8"	13'-0"	13'-4"	13'-8"	14'-0"	14'-4"	14'-5"	16'-4"
500	13'-5"	13'-9"	14'-2"	14'-6"	14'-10"	15'-2"	15'-6"	15'-7"	17'-6"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	2503	2113	1764	1481	1262	1097	972	1146	651
120	2561	2197	1874	1611	1402	1239	1113	1257	758
140	2588	2251	1953	1711	1515	1359	1234	1349	856
160	2601	2291	2018	1794	1611	1462	1340	1433	948
180	2602	2317	2068	1862	1692	1551	1433	1505	1032
200	2582	2324	2098	1910	1753	1621	1510	1564	1109
220	2564	2330	2125	1954	1808	1685	1579	1619	1181
240	2537	2327	2141	1985	1852	1737	1637	1667	1246
260	2511	2322	2154	2012	1889	1782	1688	1709	1306
280	2486	2316	2164	2034	1921	1821	1734	1747	1362
300	2456	2304	2167	2049	1945	1853	1771	1778	1412
320	2433	2295	2171	2063	1967	1882	1805	1808	1459
340	2407	2283	2170	2072	1984	1904	1833	1832	1501
360	2384	2273	2170	2080	1999	1925	1858	1855	1541
380	2365	2264	2170	2087	2012	1944	1881	1876	1577
400	2345	2254	2168	2092	2022	1959	1900	1893	1610
420	2328	2245	2166	2096	2032	1972	1917	1909	1640
440	2312	2236	2163	2099	2039	1984	1932	1924	1668
460	2296	2227	2160	2101	2045	1993	1945	1936	1693
480	2282	2219	2157	2102	2050	2002	1957	1947	1717
500	2271	2212	2155	2104	2056	2010	1968	1958	1739

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-7"	0'-8"	0'-9"	0'-10"	0'-11"	1'-1"	1'-2"	1'-1"	1'-10"
120	0'-10"	1'-0"	1'-1"	1'-2"	1'-3"	1'-5"	1'-6"	1'-6"	2'-3"
140	1'-2"	1'-3"	1'-5"	1'-6"	1'-8"	1'-10"	1'-11"	1'-11"	2'-9"
160	1'-6"	1'-8"	1'-10"	2'-0"	2'-1"	2'-3"	2'-5"	2'-5"	3'-4"
180	2'-0"	2'-1"	2'-3"	2'-5"	2'-7"	2'-9"	2'-11"	2'-11"	3'-11"
200	2'-5"	2'-7"	2'-9"	3'-0"	3'-2"	3'-4"	3'-6"	3'-6"	4'-7"
220	3'-0"	3'-2"	3'-5"	3'-7"	3'-9"	3'-11"	4'-1"	4'-2"	5'-3"
240	3'-7"	3'-10"	4'-0"	4'-3"	4'-5"	4'-7"	4'-10"	4'-10"	6'-0"
260	4'-4"	4'-6"	4'-9"	4'-11"	5'-1"	5'-4"	5'-6"	5'-7"	6'-9"
280	5'-0"	5'-3"	5'-6"	5'-8"	5'-11"	6'-1"	6'-4"	6'-5"	7'-7"
300	5'-10"	6'-1"	6'-3"	6'-6"	6'-9"	6'-11"	7'-2"	7'-3"	8'-6"
320	6'-9"	6'-11"	7'-2"	7'-5"	7'-8"	7'-10"	8'-1"	8'-2"	9'-6"
340	7'-8"	7'-11"	8'-1"	8'-4"	8'-7"	8'-10"	9'-0"	9'-2"	10'-6"
360	8'-8"	8'-11"	9'-1"	9'-4"	9'-7"	9'-10"	10'-1"	10'-2"	11'-6"
380	9'-8"	9'-11"	10'-2"	10'-5"	10'-8"	10'-11"	11'-2"	11'-3"	12'-8"
400	10'-10"	11'-1"	11'-4"	11'-7"	11'-10"	12'-1"	12'-3"	12'-5"	13'-10"
420	12'-0"	12'-3"	12'-6"	12'-9"	13'-0"	13'-3"	13'-6"	13'-7"	15'-0"
440	13'-3"	13'-6"	13'-9"	14'-0"	14'-3"	14'-6"	14'-9"	14'-10"	16'-4"
460	14'-7"	14'-10"	15'-1"	15'-4"	15'-7"	15'-10"	16'-1"	16'-2"	17'-8"
480	15'-11"	16'-2"	16'-5"	16'-8"	16'-11"	17'-2"	17'-5"	17'-7"	19'-1"
500	17'-4"	17'-7"	17'-11"	18'-2"	18'-5"	18'-8"	18'-11"	19'-0"	20'-6"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	2540	2279	2039	1823	1633	1471	1334	1399	857
120	2573	2332	2111	1914	1741	1591	1462	1502	982
140	2581	2360	2160	1981	1823	1685	1566	1588	1092
160	2570	2370	2189	2028	1885	1759	1649	1657	1190
180	2549	2369	2207	2062	1934	1819	1718	1717	1278
200	2528	2367	2221	2091	1975	1870	1777	1769	1357
220	2495	2352	2223	2106	2002	1907	1822	1810	1426
240	2467	2340	2224	2120	2026	1940	1862	1846	1489
260	2440	2327	2224	2131	2045	1967	1896	1877	1544
280	2414	2314	2222	2137	2060	1989	1924	1904	1594
300	2391	2301	2219	2143	2073	2008	1948	1928	1639
320	2366	2286	2212	2144	2080	2021	1966	1946	1677
340	2346	2275	2208	2146	2088	2034	1984	1964	1713
360	2328	2264	2203	2147	2094	2045	1998	1979	1745
380	2311	2253	2198	2147	2099	2053	2010	1991	1773
400	2295	2243	2193	2147	2102	2060	2020	2003	1798
420	2281	2234	2189	2146	2105	2066	2029	2012	1821
440	2269	2225	2184	2145	2107	2071	2037	2020	1841
460	2258	2218	2180	2144	2109	2076	2044	2028	1860
480	2247	2211	2176	2142	2110	2079	2049	2034	1877
500	2237	2204	2171	2140	2111	2082	2054	2040	1892

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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.

This page intentionally left blank.

CO 143 Sag —Temperature Stringing Table 1/0—653 ACSR/AW (Oriole) for Covered Conductor 2.0

Scope CO 143.1 Sag —Temperature Stringing Table 1/0—653 ACSR/AW (Oriole) for Covered Conductor 2.0

Table CO 143–1: Sag—Temperature Stringing 17kV 1/0 ACSR/AW (Raven) Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 17 kV 1/0 ACSR/AW Raven for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'3"	0'3"	0'3"	0'3"	0'3"	0'3"	0'4"	0'4"	0'10"
120	0'4"	0'4"	0'4"	0'4"	0'5"	0'5"	0'6"	0'6"	1'2"
140	0'5"	0'6"	0'6"	0'6"	0'7"	0'7"	0'8"	0'9"	1'6"
160	0'7"	0'7"	0'8"	0'8"	0'9"	0'9"	0'10"	0'11"	1'10"
180	0'9"	0'9"	0'10"	0'11"	0'11"	1'0"	1'1"	1'3"	2'3"
200	0'11"	1'0"	1'1"	1'1"	1'2"	1'3"	1'4"	1'6"	2'7"
220	1'2"	1'3"	1'4"	1'5"	1'6"	1'7"	1'8"	1'10"	3'1"
240	1'5"	1'6"	1'7"	1'8"	1'10"	1'11"	2'1"	2'3"	3'6"
260	1'9"	1'10"	1'11"	2'0"	2'2"	2'4"	2'6"	2'7"	4'0"
280	2'0"	2'2"	2'3"	2'5"	2'7"	2'9"	2'11"	3'1"	4'7"
300	2'5"	2'6"	2'8"	2'10"	3'0"	3'2"	3'5"	3'7"	5'2"
320	2'9"	2'11"	3'1"	3'3"	3'6"	3'8"	3'11"	4'1"	5'9"
340	3'3"	3'5"	3'7"	3'10"	4'0"	4'3"	4'6"	4'8"	6'4"
360	3'9"	3'11"	4'1"	4'4"	4'7"	4'10"	5'1"	5'3"	7'0"
380	4'3"	4'6"	4'8"	4'11"	5'2"	5'5"	5'9"	5'10"	7'8"
400	4'10"	5'1"	5'4"	5'7"	5'10"	6'1"	6'5"	6'6"	8'5"
420	5'5"	5'8"	6'0"	6'3"	6'6"	6'10"	7'1"	7'3"	9'2"
440	6'1"	6'5"	6'8"	7'0"	7'3"	7'7"	7'10"	8'0"	10'0"
460	6'10"	7'1"	7'5"	7'9"	8'0"	8'4"	8'8"	8'9"	10'10"
480	7'7"	7'11"	8'2"	8'6"	8'10"	9'2"	9'6"	9'7"	11'8"
500	8'4"	8'8"	9'0"	9'4"	9'8"	10'0"	10'4"	10'5"	12'6"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 143–2: Tension — Temperature Stringing 17 kV 1/0 ACSR/AW CC (Raven) Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 17 kV 1/0 ACSR/AW Raven for Light-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1471	1399	1326	1251	1174	1096	1016	884	370
120	1453	1380	1307	1233	1156	1079	1000	877	398
140	1430	1359	1285	1212	1136	1060	983	870	423
160	1407	1336	1262	1189	1114	1040	964	861	447
180	1382	1310	1239	1166	1092	1019	947	854	468
200	1353	1284	1213	1141	1069	998	928	845	487
220	1323	1254	1184	1114	1045	976	910	837	504
240	1293	1225	1156	1089	1021	956	892	829	520
260	1262	1196	1130	1063	999	936	876	823	535
280	1230	1165	1101	1037	977	917	860	815	547
300	1199	1136	1075	1014	956	900	847	809	560
320	1170	1109	1049	992	937	885	835	802	571
340	1140	1081	1025	971	918	870	824	796	580
360	1111	1055	1002	951	902	857	815	791	589
380	1083	1030	981	933	888	845	806	787	598
400	1059	1009	962	917	875	836	799	783	606
420	1033	987	943	901	863	826	792	779	613
440	1010	967	926	887	851	817	786	775	619
460	989	948	911	875	841	810	780	771	625
480	970	933	897	864	832	803	776	768	631
500	953	918	885	854	825	797	772	765	636

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 143–3: Sag — Temperature Stringing Table 35 kV 1/0 ACSR/AW (Raven) Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 35 kV 1/0 ACSR/AW for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'4"	0'4"	0'4"	0'4"	0'5"	0'5"	0'6"	0'6"	1'1"
120	0'6"	0'6"	0'6"	0'7"	0'7"	0'7"	0'8"	0'9"	1'5"
140	0'8"	0'8"	0'9"	0'9"	0'10"	0'10"	0'11"	1'0"	1'10"
160	0'10"	0'11"	1'0"	1'0"	1'1"	1'2"	1'3"	1'4"	2'3"
180	1'2"	1'2"	1'3"	1'4"	1'5"	1'6"	1'7"	1'9"	2'9"
200	1'5"	1'6"	1'7"	1'8"	1'10"	1'11"	2'1"	2'2"	3'3"
220	1'10"	1'11"	2'0"	2'1"	2'3"	2'5"	2'6"	2'8"	3'10"
240	2'3"	2'4"	2'6"	2'7"	2'9"	2'11"	3'1"	3'2"	4'5"
260	2'8"	2'10"	3'0"	3'2"	3'4"	3'6"	3'8"	3'9"	5'1"
280	3'3"	3'5"	3'7"	3'9"	3'11"	4'1"	4'3"	4'5"	5'9"
300	3'10"	4'0"	4'2"	4'4"	4'7"	4'9"	5'0"	5'1"	6'6"
320	4'6"	4'8"	4'10"	5'1"	5'3"	5'6"	5'9"	5'10"	7'3"
340	5'2"	5'5"	5'7"	5'10"	6'1"	6'3"	6'6"	6'7"	8'1"
360	5'11"	6'2"	6'5"	6'8"	6'10"	7'1"	7'4"	7'5"	9'0"
380	6'9"	7'0"	7'3"	7'6"	7'9"	8'0"	8'3"	8'4"	9'11"
400	7'8"	7'11"	8'2"	8'5"	8'8"	8'11"	9'2"	9'3"	10'10"
420	8'7"	8'10"	9'2"	9'5"	9'8"	9'11"	10'2"	10'3"	11'10"
440	9'7"	9'11"	10'2"	10'5"	10'8"	10'11"	11'2"	11'3"	12'11"
460	10'8"	10'11"	11'3"	11'6"	11'9"	12'0"	12'3"	12'4"	14'0"
480	11'9"	12'1"	12'4"	12'7"	12'11"	13'2"	13'5"	13'6"	15'2"
500	12'11"	13'3"	13'6"	13'9"	14'1"	14'4"	14'7"	14'8"	16'5"

Note(s): 1. Listed temperatures refers to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 143–4: Tension — Temperature Stringing Table 35 kV 1/0 ACSR/AW (Raven) Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 35 kV 1/0 ACSR/AW for Light-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1440	1367	1295	1220	1145	1069	992	876	430
120	1409	1337	1266	1193	1119	1044	971	867	462
140	1372	1302	1231	1160	1088	1017	947	857	491
160	1335	1266	1196	1127	1058	990	923	849	516
180	1296	1230	1163	1095	1030	965	903	841	539
200	1255	1190	1125	1062	1000	940	883	831	558
220	1215	1154	1092	1032	974	919	866	824	576
240	1177	1118	1059	1005	952	900	853	818	592
260	1138	1083	1029	977	928	882	839	811	605
280	1102	1051	1001	954	909	868	828	806	617
300	1069	1022	976	934	893	855	820	801	628
320	1038	995	954	914	878	844	812	796	638
340	1011	972	934	898	865	834	805	792	647
360	986	950	916	884	854	825	799	788	654
380	965	932	901	872	845	819	795	786	662
400	945	915	887	861	836	812	790	783	668
420	927	900	875	851	828	806	786	780	674
440	912	887	864	842	821	802	783	778	679
460	897	875	854	834	815	797	780	775	683
480	885	865	845	827	809	793	777	773	687
500	874	856	838	821	805	790	775	772	691

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

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.

Table CO 143–5: Sag — Temperature Stringing 17 kV 101.8 ACSR/AW Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 17 kV 101.8 ACSR/AW Petrel for Light-Loading

	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'2"	0'2"	0'2"	0'3"	0'3"	0'3"	0'3"	0'2"	0'4"
120	0'3"	0'3"	0'3"	0'4"	0'4"	0'4"	0'5"	0'3"	0'6"
140	0'4"	0'4"	0'5"	0'5"	0'5"	0'6"	0'6"	0'5"	0'8"
160	0'5"	0'6"	0'6"	0'7"	0'7"	0'8"	0'8"	0'6"	0'10"
180	0'7"	0'7"	0'8"	0'8"	0'9"	0'10"	0'10"	0'8"	1'1"
200	0'9"	0'9"	0'10"	0'10"	0'11"	1'0"	1'1"	0'10"	1'4"
220	0'10"	0'11"	1'0"	1'0"	1'1"	1'2"	1'3"	1'0"	1'7"
240	1'0"	1'1"	1'2"	1'3"	1'4"	1'5"	1'6"	1'2"	1'11"
260	1'3"	1'4"	1'5"	1'6"	1'7"	1'8"	1'10"	1'5"	2'2"
280	1'5"	1'6"	1'7"	1'9"	1'10"	1'11"	2'1"	1'7"	2'6"
300	1'8"	1'9"	1'10"	2'0"	2'1"	2'3"	2'5"	1'10"	2'10"
320	1'11"	2'0"	2'1"	2'3"	2'5"	2'7"	2'9"	2'2"	3'3"
340	2'2"	2'3"	2'5"	2'7"	2'9"	2'11"	3'1"	2'5"	3'7"
360	2'5"	2'7"	2'9"	2'11"	3'1"	3'3"	3'5"	2'9"	4'0"
380	2'9"	2'11"	3'0"	3'3"	3'5"	3'7"	3'10"	3'1"	4'5"
400	3'1"	3'3"	3'5"	3'7"	3'9"	4'0"	4'3"	3'5"	4'10"
420	3'5"	3'7"	3'9"	4'0"	4'2"	4'5"	4'8"	3'9"	5'4"
440	3'9"	3'11"	4'2"	4'4"	4'7"	4'10"	5'1"	4'2"	5'9"
460	4'2"	4'4"	4'7"	4'10"	5'1"	5'4"	5'7"	4'7"	6'3"
480	4'7"	4'9"	5'0"	5'3"	5'6"	5'9"	6'1"	5'0"	6'9"
500	5'0"	5'2"	5'6"	5'9"	6'0"	6'3"	6'7"	5'6"	7'4"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 143–6: Tension — Temperature Stringing 17 kV 101.8 ACSR/AW Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 17 kV 101.8 ACSR/AW Petrel for Light-Loading

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	2489	2348	2206	2062	1916	1772	1626	2187	1246
120	2481	2345	2200	2059	1916	1772	1629	2184	1258
140	2476	2337	2195	2054	1913	1772	1629	2179	1274
160	2465	2329	2189	2048	1908	1769	1632	2171	1286
180	2454	2320	2181	2042	1905	1769	1632	2165	1299
200	2443	2309	2173	2037	1899	1766	1635	2154	1315
220	2433	2298	2164	2028	1896	1766	1638	2146	1328
240	2419	2287	2153	2023	1891	1763	1640	2138	1344
260	2405	2274	2145	2014	1888	1763	1643	2131	1357
280	2392	2263	2134	2006	1882	1760	1643	2120	1372
300	2373	2246	2123	1997	1876	1757	1646	2106	1384
320	2359	2235	2111	1989	1871	1757	1646	2095	1396
340	2343	2221	2100	1981	1865	1754	1650	2087	1410
360	2326	2205	2089	1972	1862	1754	1651	2077	1422
380	2307	2188	2075	1962	1854	1751	1653	2063	1432
400	2291	2177	2064	1955	1851	1751	1657	2052	1445
420	2274	2163	2053	1947	1845	1748	1658	2041	1456
440	2255	2146	2039	1938	1839	1747	1659	2030	1465
460	2239	2133	2028	1930	1835	1745	1661	2019	1475
480	2217	2116	2015	1918	1828	1742	1661	2006	1484
500	2200	2102	2005	1913	1825	1741	1662	1996	1492

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 143–7: Sag — Temperature Stringing 35 kV 101.8 ACSR/AW Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 35 kV 101.8 ACSR/AW Petrel for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'3"	0'3"	0'3"	0'3"	0'4"	0'4"	0'4"	0'3"	0'6"
120	0'4"	0'4"	0'5"	0'5"	0'5"	0'6"	0'6"	0'5"	0'8"
140	0'6"	0'6"	0'6"	0'7"	0'7"	0'8"	0'8"	0'6"	0'11"
160	0'7"	0'8"	0'8"	0'9"	0'9"	0'10"	0'11"	0'8"	1'2"
180	0'9"	0'10"	0'11"	0'11"	1'0"	1'1"	1'2"	0'11"	1'5"
200	1'0"	1'0"	1'1"	1'2"	1'3"	1'4"	1'5"	1'1"	1'9"
220	1'2"	1'3"	1'4"	1'5"	1'6"	1'7"	1'9"	1'4"	2'0"
240	1'5"	1'6"	1'7"	1'8"	1'9"	1'11"	2'0"	1'7"	2'5"
260	1'8"	1'9"	1'11"	2'0"	2'1"	2'3"	2'5"	1'11"	2'9"
280	2'0"	2'1"	2'2"	2'4"	2'6"	2'7"	2'9"	2'3"	3'2"
300	2'3"	2'5"	2'6"	2'8"	2'10"	3'0"	3'2"	2'7"	3'7"
320	2'8"	2'9"	2'11"	3'1"	3'3"	3'5"	3'7"	2'11"	4'1"
340	3'0"	3'2"	3'4"	3'6"	3'8"	3'10"	4'1"	3'4"	4'7"
360	3'5"	3'7"	3'9"	3'11"	4'1"	4'4"	4'6"	3'9"	5'1"
380	3'10"	4'0"	4'2"	4'5"	4'7"	4'10"	5'1"	4'3"	5'7"
400	4'3"	4'6"	4'8"	4'11"	5'1"	5'4"	5'7"	4'8"	6'2"
420	4'9"	5'0"	5'2"	5'5"	5'8"	5'11"	6'2"	5'3"	6'9"
440	5'3"	5'6"	5'9"	6'0"	6'3"	6'6"	6'9"	5'9"	7'4"
460	5'10"	6'1"	6'4"	6'7"	6'10"	7'1"	7'4"	6'4"	8'0"
480	6'5"	6'8"	6'11"	7'2"	7'6"	7'9"	8'0"	6'11"	8'8"
500	7'0"	7'3"	7'7"	7'10"	8'1"	8'5"	8'8"	7'7"	9'4"

Note(s): Listed temperature refer to conductor temperatures, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 143–8: Tension — Temperature Stringing 35 kV 101.8 ACSR/AW Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 35 kV 101.8 ACSR/AW Petrel for Light-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	2476	2339	2198	2056	1913	1772	1629	2179	1267
120	2468	2329	2192	2051	1910	1772	1632	2174	1289
140	2452	2318	2178	2042	1905	1766	1635	2160	1305
160	2438	2307	2170	2034	1899	1769	1640	2155	1327
180	2422	2290	2156	2025	1893	1766	1643	2141	1346
200	2403	2271	2142	2014	1888	1763	1643	2128	1363
220	2384	2257	2128	2003	1882	1763	1649	2114	1382
240	2365	2238	2114	1995	1876	1760	1651	2101	1401
260	2343	2221	2100	1983	1871	1760	1656	2090	1418
280	2321	2202	2086	1972	1862	1757	1657	2074	1434
300	2299	2185	2072	1964	1856	1757	1662	2060	1450
320	2274	2164	2056	1952	1851	1755	1665	2047	1464
340	2252	2146	2042	1941	1845	1754	1668	2030	1479
360	2226	2124	2022	1927	1836	1748	1668	2014	1489
380	2203	2105	2008	1916	1829	1747	1669	2001	1501
400	2182	2088	1995	1907	1825	1746	1673	1987	1513
420	2161	2070	1983	1900	1821	1746	1676	1976	1524
440	2139	2053	1970	1890	1815	1745	1677	1962	1535
460	2120	2038	1957	1881	1810	1743	1680	1952	1543
480	2099	2021	1945	1873	1805	1742	1681	1939	1552
500	2081	2004	1933	1866	1800	1740	1682	1928	1559

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

3.0 Guying

Conductor tensions for guying 101.8 Covered Conductor is 2,846 lb.

4.0 Ground Clearance

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

Table CO 143–9: Sag — Temperature Stringing 17 kV 336 (18/1) ACSR/AW Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 17 kV 336 (18/1) ACSR/AW Merlin for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'3"	0'3"	0'3"	0'3"	0'4"	0'4"	0'5"	0'6"	1'3"
120	0'4"	0'4"	0'4"	0'5"	0'5"	0'6"	0'7"	0'8"	1'7"
140	0'5"	0'6"	0'6"	0'7"	0'7"	0'8"	0'9"	0'11"	1'11"
160	0'7"	0'7"	0'8"	0'9"	0'9"	0'11"	1'0"	1'2"	2'4"
180	0'9"	0'9"	0'10"	0'11"	1'0"	1'1"	1'3"	1'5"	2'9"
200	0'11"	1'0"	1'0"	1'2"	1'3"	1'4"	1'6"	1'9"	3'2"
220	1'1"	1'2"	1'3"	1'4"	1'6"	1'8"	1'10"	2'1"	3'7"
240	1'4"	1'5"	1'6"	1'8"	1'10"	2'0"	2'2"	2'5"	4'0"
260	1'7"	1'8"	1'9"	1'11"	2'1"	2'4"	2'6"	2'10"	4'6"
280	1'10"	1'11"	2'1"	2'3"	2'6"	2'8"	2'11"	3'3"	5'0"
300	2'1"	2'3"	2'5"	2'7"	2'10"	3'1"	3'4"	3'8"	5'6"
320	2'5"	2'7"	2'9"	3'0"	3'3"	3'6"	3'9"	4'2"	6'1"
340	2'9"	3'0"	3'2"	3'5"	3'8"	4'0"	4'3"	4'7"	6'8"
360	3'2"	3'4"	3'7"	3'10"	4'2"	4'5"	4'9"	5'2"	7'3"
380	3'7"	3'9"	4'1"	4'4"	4'8"	4'11"	5'3"	5'8"	7'10"
400	4'0"	4'3"	4'6"	4'10"	5'2"	5'6"	5'10"	6'3"	8'6"
420	4'5"	4'9"	5'0"	5'4"	5'9"	6'1"	6'5"	6'10"	9'2"
440	5'0"	5'3"	5'7"	5'11"	6'3"	6'8"	7'0"	7'6"	9'10"
460	5'6"	5'10"	6'2"	6'6"	6'11"	7'3"	7'8"	8'2"	10'7"
480	6'1"	6'5"	6'9"	7'2"	7'6"	7'11"	8'4"	8'10"	11'4"
500	6'8"	7'0"	7'5"	7'10"	8'3"	8'8"	9'0"	9'7"	12'1"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 143–10: Tension — Temperature Stringing Table 17 kV 336 (18/1) ACSR/AW Merlin Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 17 kV 336 (18/1) ACSR/AW Merlin for Light-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	3095	2875	2649	2413	2172	1929	1679	1448	523
120	3083	2865	2639	2407	2169	1928	1690	1469	600
140	3068	2853	2629	2400	2169	1936	1705	1490	671
160	3053	2837	2619	2393	2169	1943	1723	1513	737
180	3029	2815	2600	2380	2158	1943	1734	1532	796
200	3008	2797	2584	2370	2155	1946	1745	1555	854
220	2983	2778	2568	2356	2148	1950	1759	1576	907
240	2956	2752	2548	2343	2141	1949	1770	1593	956
260	2925	2724	2525	2326	2134	1949	1779	1612	1002
280	2898	2699	2505	2312	2127	1953	1790	1630	1047
300	2864	2673	2482	2295	2120	1953	1799	1645	1088
320	2829	2641	2456	2278	2109	1953	1806	1660	1126
340	2792	2610	2433	2261	2102	1951	1813	1672	1162
360	2759	2583	2411	2248	2095	1952	1821	1687	1197
380	2723	2551	2386	2231	2084	1950	1826	1697	1229
400	2685	2520	2363	2213	2076	1947	1831	1708	1259
420	2650	2490	2339	2200	2067	1947	1836	1718	1287
440	2611	2462	2317	2182	2060	1945	1840	1728	1314
460	2579	2434	2297	2170	2052	1943	1843	1736	1340
480	2543	2406	2275	2155	2044	1941	1847	1745	1363
500	2509	2378	2255	2141	2036	1939	1849	1752	1386

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 143–11: Sag — Temperature Stringing Table 35 kV 336 (18/1) ACSR/AW Merlin Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 35 kV 336 (18/1) ACSR/AW Merlin for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'3"	0'4"	0'4"	0'4"	0'5"	0'5"	0'6"	0'7"	1'4"
120	0'5"	0'5"	0'6"	0'6"	0'7"	0'8"	0'9"	0'10"	1'9"
140	0'7"	0'7"	0'8"	0'8"	0'9"	0'10"	1'0"	1'1"	2'1"
160	0'9"	0'9"	0'10"	0'11"	1'0"	1'1"	1'3"	1'5"	2'6"
180	0'11"	1'0"	1'1"	1'2"	1'3"	1'5"	1'7"	1'9"	3'0"
200	1'2"	1'3"	1'4"	1'5"	1'7"	1'9"	1'11"	2'1"	3'5"
220	1'5"	1'6"	1'8"	1'9"	1'11"	2'1"	2'3"	2'6"	3'11"
240	1'9"	1'10"	2'0"	2'1"	2'4"	2'6"	2'8"	3'0"	4'5"
260	2'0"	2'2"	2'4"	2'6"	2'9"	2'11"	3'2"	3'5"	5'0"
280	2'5"	2'7"	2'9"	2'11"	3'2"	3'5"	3'8"	3'11"	5'7"
300	2'9"	3'0"	3'2"	3'5"	3'8"	3'11"	4'2"	4'6"	6'2"
320	3'3"	3'5"	3'8"	3'11"	4'2"	4'5"	4'9"	5'1"	6'10"
340	3'9"	3'11"	4'2"	4'5"	4'9"	5'0"	5'4"	5'8"	7'6"
360	4'3"	4'6"	4'9"	5'0"	5'4"	5'7"	5'11"	6'4"	8'3"
380	4'9"	5'1"	5'4"	5'8"	6'0"	6'3"	6'7"	7'0"	8'11"
400	5'5"	5'8"	6'0"	6'4"	6'8"	7'0"	7'3"	7'8"	9'9"
420	6'0"	6'4"	6'8"	7'0"	7'4"	7'8"	8'0"	8'5"	10'6"
440	6'9"	7'1"	7'5"	7'9"	8'1"	8'5"	8'9"	9'3"	11'4"
460	7'6"	7'10"	8'2"	8'6"	8'11"	9'3"	9'7"	10'1"	12'2"
480	8'3"	8'7"	9'0"	9'4"	9'8"	10'1"	10'5"	10'11"	13'1"
500	9'1"	9'5"	9'10"	10'2"	10'7"	10'11"	11'4"	11'9"	14'0"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 143–12: Tension — Temperature Stringing Table 35 kV 336 (18/1) ACSR/AW Merlin Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 35 kV 336 (18/1) ACSR/AW Merlin for Light-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	3080	2862	2639	2407	2172	1936	1698	1475	627
120	3065	2850	2629	2403	2175	1946	1723	1509	714
140	3038	2825	2610	2390	2169	1950	1738	1536	793
160	3014	2806	2594	2376	2165	1957	1758	1563	865
180	2986	2781	2571	2363	2158	1962	1776	1591	932
200	2953	2752	2548	2349	2154	1967	1792	1616	993
220	2913	2718	2522	2329	2144	1967	1803	1637	1050
240	2873	2683	2492	2309	2133	1967	1814	1658	1101
260	2829	2647	2466	2289	2123	1968	1824	1676	1150
280	2789	2612	2436	2271	2116	1970	1835	1695	1196
300	2742	2573	2406	2251	2104	1966	1842	1709	1237
320	2700	2536	2379	2232	2095	1966	1851	1725	1276
340	2653	2498	2351	2213	2084	1964	1856	1736	1311
360	2611	2464	2326	2194	2073	1964	1861	1750	1344
380	2566	2427	2299	2177	2064	1960	1866	1760	1375
400	2524	2394	2273	2159	2055	1958	1870	1769	1403
420	2486	2364	2251	2145	2047	1956	1873	1778	1430
440	2450	2337	2230	2131	2039	1955	1877	1786	1455
460	2414	2307	2208	2116	2030	1952	1878	1793	1478
480	2382	2282	2190	2103	2024	1950	1881	1800	1500
500	2352	2259	2173	2093	2017	1948	1883	1806	1520

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

5.0 Guying

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

6.0 Ground Clearance

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

Table CO 143–13: Sag — Temperature Stringing Cable 17 kV 336 (30/7) ACSR/AW Oriole ACSR Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 17 kV 336 (30/7) ACSR/AW Oriole for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'3"	0'3"	0'4"	0'4"	0'5"	0'5"	0'6"	0'6"	1'0"
120	0'5"	0'5"	0'6"	0'6"	0'7"	0'8"	0'9"	0'8"	1'4"
140	0'6"	0'7"	0'8"	0'8"	0'9"	0'10"	1'0"	0'11"	1'9"
160	0'8"	0'9"	0'10"	0'11"	1'0"	1'1"	1'3"	1'2"	2'1"
180	0'11"	1'0"	1'1"	1'2"	1'3"	1'5"	1'6"	1'6"	2'6"
200	1'1"	1'2"	1'3"	1'5"	1'6"	1'8"	1'10"	1'9"	2'11"
220	1'4"	1'5"	1'7"	1'8"	1'10"	2'0"	2'2"	2'2"	3'5"
240	1'7"	1'9"	1'10"	2'0"	2'2"	2'4"	2'6"	2'6"	3'10"
260	1'11"	2'1"	2'2"	2'4"	2'7"	2'9"	2'11"	2'11"	4'4"
280	2'3"	2'5"	2'7"	2'9"	2'11"	3'2"	3'4"	3'4"	4'10"
300	2'7"	2'9"	2'11"	3'2"	3'4"	3'7"	3'10"	3'9"	5'4"
320	3'0"	3'2"	3'4"	3'7"	3'10"	4'1"	4'3"	4'3"	5'11"
340	3'4"	3'7"	3'10"	4'0"	4'3"	4'6"	4'9"	4'9"	6'6"
360	3'10"	4'1"	4'3"	4'6"	4'9"	5'1"	5'4"	5'3"	7'1"
380	4'3"	4'6"	4'9"	5'1"	5'4"	5'7"	5'10"	5'10"	7'8"
400	4'10"	5'1"	5'4"	5'7"	5'11"	6'2"	6'6"	6'5"	8'4"
420	5'4"	5'7"	5'11"	6'2"	6'6"	6'9"	7'1"	7'0"	9'0"
440	5'11"	6'3"	6'6"	6'10"	7'1"	7'5"	7'9"	7'8"	9'8"
460	6'6"	6'10"	7'2"	7'5"	7'9"	8'1"	8'4"	8'4"	10'5"
480	7'2"	7'6"	7'9"	8'1"	8'5"	8'9"	9'1"	9'1"	11'2"
500	7'10"	8'2"	8'6"	8'10"	9'2"	9'6"	9'9"	9'9"	11'11"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 143–14: Tension — Temperature Stringing Table 17 kV 336 (30/7) ACSR/AW Oriole Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 17 kV 336 (30/7) ACSR/AW Oriole for Light-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	3149	2888	2628	2372	2122	1877	1644	1726	828
120	3136	2878	2624	2376	2132	1900	1684	1756	903
140	3122	2874	2623	2381	2151	1931	1727	1795	973
160	3108	2860	2623	2390	2170	1962	1768	1828	1039
180	3094	2855	2623	2404	2188	1995	1811	1865	1101
200	3075	2841	2619	2404	2203	2019	1849	1892	1159
220	3052	2831	2614	2411	2221	2043	1882	1922	1214
240	3033	2817	2609	2418	2235	2069	1918	1952	1266
260	3006	2796	2599	2413	2245	2087	1944	1975	1315
280	2982	2782	2595	2418	2259	2109	1974	2001	1369
300	2959	2768	2590	2422	2268	2127	2000	2023	1421
320	2926	2747	2576	2418	2273	2142	2022	2043	1468
340	2903	2733	2571	2422	2284	2160	2045	2064	1513
360	2875	2714	2561	2420	2291	2172	2064	2079	1554
380	2849	2695	2552	2419	2296	2186	2083	2096	1593
400	2823	2676	2542	2417	2303	2195	2099	2111	1630
420	2800	2662	2535	2417	2307	2207	2116	2126	1664
440	2774	2643	2523	2412	2309	2215	2127	2136	1696
460	2753	2629	2516	2412	2314	2224	2141	2149	1727
480	2729	2614	2506	2407	2316	2230	2152	2158	1755
500	2710	2603	2501	2406	2321	2239	2164	2169	1782

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 143–15: Sag — Temperature Stringing Table 35 kV 336 (30/7) ACSR/AW Oriole Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 35kV 336 30/7) ACSR/AW Oriole for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'4"	0'4"	0'5"	0'5"	0'6"	0'7"	0'7"	0'7"	1'2"
120	0'6"	0'6"	0'7"	0'8"	0'8"	0'9"	0'10"	0'10"	1'6"
140	0'8"	0'9"	0'9"	0'10"	0'11"	1'0"	1'2"	1'1"	1'11"
160	0'10"	0'11"	1'0"	1'1"	1'3"	1'4"	1'5"	1'5"	2'4"
180	1'1"	1'2"	1'3"	1'5"	1'6"	1'8"	1'9"	1'9"	2'9"
200	1'4"	1'6"	1'7"	1'9"	1'10"	2'0"	2'2"	2'1"	3'3"
220	1'8"	1'10"	1'11"	2'1"	2'3"	2'5"	2'7"	2'6"	3'9"
240	2'0"	2'2"	2'4"	2'6"	2'8"	2'10"	3'0"	3'0"	4'3"
260	2'5"	2'7"	2'9"	2'11"	3'1"	3'3"	3'6"	3'5"	4'9"
280	2'10"	3'0"	3'2"	3'4"	3'7"	3'9"	4'0"	3'11"	5'4"
300	3'3"	3'6"	3'8"	3'10"	4'1"	4'3"	4'6"	4'6"	6'0"
320	3'9"	4'0"	4'2"	4'5"	4'7"	4'10"	5'1"	5'1"	6'7"
340	4'3"	4'6"	4'9"	5'0"	5'2"	5'5"	5'8"	5'8"	7'3"
360	4'10"	5'1"	5'4"	5'7"	5'10"	6'1"	6'4"	6'4"	7'11"
380	5'6"	5'9"	6'0"	6'3"	6'6"	6'9"	7'0"	7'0"	8'8"
400	6'1"	6'4"	6'8"	6'11"	7'2"	7'5"	7'8"	7'8"	9'5"
420	6'9"	7'1"	7'4"	7'7"	7'11"	8'2"	8'5"	8'5"	10'2"
440	7'6"	7'10"	8'1"	8'4"	8'8"	8'11"	9'3"	9'2"	11'0"
460	8'3"	8'7"	8'10"	9'2"	9'5"	9'9"	10'0"	10'0"	11'10"
480	9'1"	9'5"	9'8"	10'0"	10'3"	10'7"	10'10"	10'10"	12'9"
500	9'11"	10'3"	10'6"	10'10"	11'2"	11'5"	11'9"	11'9"	13'8"

Note(s): Listed temperatures refer to conductor temperatures, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 143–16: Tension — Temperature Stringing Table 35 kV 336 (30/7) ACSR/AW Oriole Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 35kV 336 30/7) ACSR/AW Oriole for Light-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	3136	2878	2628	2381	2141	1910	1691	1765	914
120	3117	2874	2628	2390	2160	1943	1744	1808	999
140	3103	2864	2628	2400	2184	1983	1796	1850	1078
160	3085	2850	2628	2409	2207	2019	1846	1892	1151
180	3057	2831	2618	2413	2226	2047	1889	1928	1219
200	3033	2820	2616	2423	2245	2080	1932	1962	1282
220	3001	2796	2604	2423	2257	2104	1965	1992	1346
240	2968	2780	2597	2427	2273	2127	1998	2022	1410
260	2936	2756	2585	2427	2282	2149	2026	2046	1470
280	2901	2733	2571	2424	2289	2165	2052	2069	1522
300	2870	2711	2564	2427	2301	2184	2078	2091	1574
320	2842	2693	2554	2426	2308	2198	2099	2111	1621
340	2812	2674	2544	2424	2314	2212	2119	2129	1664
360	2781	2652	2532	2421	2319	2223	2137	2144	1703
380	2753	2633	2523	2419	2322	2234	2151	2159	1741
400	2729	2617	2513	2416	2325	2243	2166	2172	1774
420	2706	2602	2503	2413	2330	2252	2180	2184	1806
440	2684	2586	2496	2412	2333	2260	2191	2196	1836
460	2663	2571	2487	2408	2335	2267	2201	2204	1863
480	2643	2558	2479	2405	2336	2272	2211	2213	1889
500	2625	2545	2471	2402	2338	2277	2220	2222	1912

FOR PLANNING USE ONLY

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

7.0 Guying

Conductor tensions for guying 336 (30/7) Covered Conductor is 3,260 lb.

8.0 Ground Clearance

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

Table CO 143–17: Sag — Temperature Stringing Table 17 kV ACSR/AW Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 17 kV 653 ACSR-AW for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'6"	0'7"	0'8"	0'10"	0'11"	1'1"	1'3"	1'0"	1'10"
120	0'8"	0'9"	0'11"	1'1"	1'3"	1'5"	1'7"	1'4"	2'3"
140	0'10"	1'0"	1'2"	1'4"	1'6"	1'8"	1'11"	1'8"	2'9"
160	1'1"	1'3"	1'6"	1'8"	1'10"	2'1"	2'3"	2'1"	3'3"
180	1'5"	1'7"	1'10"	2'0"	2'3"	2'5"	2'8"	2'6"	3'9"
200	1'9"	1'11"	2'2"	2'5"	2'8"	2'11"	3'1"	3'0"	4'3"
220	2'1"	2'4"	2'7"	2'10"	3'1"	3'4"	3'7"	3'6"	4'10"
240	2'6"	2'9"	3'1"	3'4"	3'7"	3'10"	4'1"	4'0"	5'6"
260	3'0"	3'3"	3'7"	3'10"	4'1"	4'5"	4'8"	4'7"	6'1"
280	3'6"	3'10"	4'1"	4'5"	4'8"	5'0"	5'3"	5'2"	6'9"
300	4'1"	4'5"	4'8"	5'0"	5'3"	5'7"	5'10"	5'10"	7'6"
320	4'8"	5'0"	5'4"	5'8"	5'11"	6'3"	6'7"	6'6"	8'3"
340	5'4"	5'8"	6'0"	6'4"	6'8"	6'11"	7'3"	7'3"	9'0"
360	6'1"	6'5"	6'9"	7'1"	7'5"	7'8"	8'0"	8'0"	9'10"
380	6'10"	7'2"	7'6"	7'10"	8'2"	8'6"	8'10"	8'10"	10'8"
400	7'7"	7'11"	8'4"	8'8"	9'0"	9'4"	9'8"	9'8"	11'7"
420	8'5"	8'10"	9'2"	9'6"	9'10"	10'2"	10'6"	10'7"	12'6"
440	9'4"	9'8"	10'1"	10'5"	10'9"	11'1"	11'5"	11'6"	13'6"
460	10'3"	10'8"	11'0"	11'4"	11'9"	12'1"	12'5"	12'6"	14'6"
480	11'3"	11'8"	12'0"	12'4"	12'9"	13'1"	13'5"	13'6"	15'6"
500	12'3"	12'8"	13'0"	13'5"	13'9"	14'1"	14'6"	14'7"	16'8"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 143–18: Tension — Temperature Stringing Table 17 kV 653 ACSR/AW Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 17 kV 653 ACSR-AW for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'6"	0'7"	0'8"	0'10"	0'11"	1'1"	1'3"	1'0"	1'10"
120	0'8"	0'9"	0'11"	1'1"	1'3"	1'5"	1'7"	1'4"	2'3"
140	0'10"	1'0"	1'2"	1'4"	1'6"	1'8"	1'11"	1'8"	2'9"
160	1'1"	1'3"	1'6"	1'8"	1'10"	2'1"	2'3"	2'1"	3'3"
180	1'5"	1'7"	1'10"	2'0"	2'3"	2'5"	2'8"	2'6"	3'9"
200	1'9"	1'11"	2'2"	2'5"	2'8"	2'11"	3'1"	3'0"	4'3"
220	2'1"	2'4"	2'7"	2'10"	3'1"	3'4"	3'7"	3'6"	4'10"
240	2'6"	2'9"	3'1"	3'4"	3'7"	3'10"	4'1"	4'0"	5'6"
260	3'0"	3'3"	3'7"	3'10"	4'1"	4'5"	4'8"	4'7"	6'1"
280	3'6"	3'10"	4'1"	4'5"	4'8"	5'0"	5'3"	5'2"	6'9"
300	4'1"	4'5"	4'8"	5'0"	5'3"	5'7"	5'10"	5'10"	7'6"
320	4'8"	5'0"	5'4"	5'8"	5'11"	6'3"	6'7"	6'6"	8'3"
340	5'4"	5'8"	6'0"	6'4"	6'8"	6'11"	7'3"	7'3"	9'0"
360	6'1"	6'5"	6'9"	7'1"	7'5"	7'8"	8'0"	8'0"	9'10"
380	6'10"	7'2"	7'6"	7'10"	8'2"	8'6"	8'10"	8'10"	10'8"
400	7'7"	7'11"	8'4"	8'8"	9'0"	9'4"	9'8"	9'8"	11'7"
420	8'5"	8'10"	9'2"	9'6"	9'10"	10'2"	10'6"	10'7"	12'6"
440	9'4"	9'8"	10'1"	10'5"	10'9"	11'1"	11'5"	11'6"	13'6"
460	10'3"	10'8"	11'0"	11'4"	11'9"	12'1"	12'5"	12'6"	14'6"
480	11'3"	11'8"	12'0"	12'4"	12'9"	13'1"	13'5"	13'6"	15'6"
500	12'3"	12'8"	13'0"	13'5"	13'9"	14'1"	14'6"	14'7"	16'8"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 143–19: Sag — Temperature Stringing Table 35 kV 653 ACSR/AW Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 35 kV 653 ACSR-AW for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'7"	0'7"	0'8"	0'9"	0'11"	1'0"	1'1"	1'0"	1'9"
120	0'9"	0'10"	1'0"	1'1"	1'2"	1'4"	1'5"	1'5"	2'3"
140	1'0"	1'2"	1'3"	1'5"	1'6"	1'8"	1'10"	1'9"	2'8"
160	1'4"	1'6"	1'7"	1'9"	1'11"	2'1"	2'3"	2'3"	3'2"
180	1'9"	1'10"	2'0"	2'2"	2'4"	2'6"	2'8"	2'8"	3'9"
200	2'2"	2'4"	2'6"	2'8"	2'10"	3'0"	3'2"	3'2"	4'4"
220	2'7"	2'9"	3'0"	3'2"	3'4"	3'7"	3'9"	3'9"	5'0"
240	3'2"	3'4"	3'6"	3'9"	3'11"	4'2"	4'4"	4'5"	5'8"
260	3'9"	3'11"	4'2"	4'4"	4'7"	4'9"	5'0"	5'1"	6'4"
280	4'4"	4'7"	4'10"	5'0"	5'3"	5'6"	5'9"	5'9"	7'1"
300	5'0"	5'3"	5'6"	5'9"	6'0"	6'3"	6'6"	6'6"	7'11"
320	5'9"	6'0"	6'3"	6'6"	6'9"	7'0"	7'3"	7'4"	8'9"
340	6'7"	6'10"	7'1"	7'4"	7'7"	7'10"	8'1"	8'2"	9'8"
360	7'5"	7'9"	8'0"	8'3"	8'6"	8'9"	9'0"	9'1"	10'7"
380	8'4"	8'8"	8'11"	9'2"	9'5"	9'8"	9'11"	10'1"	11'7"
400	9'4"	9'7"	9'11"	10'2"	10'5"	10'8"	11'0"	11'1"	12'7"
420	10'4"	10'8"	10'11"	11'2"	11'6"	11'9"	12'0"	12'1"	13'8"
440	11'5"	11'9"	12'0"	12'3"	12'7"	12'10"	13'1"	13'3"	14'10"
460	12'7"	12'10"	13'2"	13'5"	13'9"	14'0"	14'3"	14'5"	16'0"
480	13'9"	14'1"	14'4"	14'8"	14'11"	15'2"	15'6"	15'7"	17'3"
500	15'0"	15'4"	15'7"	15'11"	16'2"	16'6"	16'9"	16'10"	18'6"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Tension — Temperature Stringing Table 35 kV 653 ACSR/AW Covered Conductor 2.0 for Light-Loading Areas

Table CO 143–20: Tension — Temperature Stringing Table 35 kV 653 ACSR/AW Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 35 kV 653 ACSR-AW for Light-Loading

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	2515	2241	1991	1760	1561	1391	1248	1334	780
120	2558	2304	2068	1856	1669	1511	1377	1432	897
140	2577	2342	2121	1928	1757	1611	1483	1519	1004
160	2592	2370	2168	1990	1832	1695	1575	1595	1103
180	2587	2385	2199	2036	1891	1764	1653	1662	1191
200	2572	2387	2221	2072	1939	1821	1718	1716	1270
220	2552	2384	2230	2095	1975	1867	1770	1762	1341
240	2528	2377	2239	2114	2005	1905	1815	1804	1406
260	2504	2367	2243	2131	2029	1938	1855	1840	1466
280	2477	2354	2241	2140	2047	1963	1887	1870	1517
300	2455	2344	2242	2149	2065	1988	1916	1897	1566
320	2431	2332	2239	2155	2077	2006	1940	1921	1609
340	2409	2318	2235	2158	2087	2021	1960	1941	1648
360	2391	2309	2232	2162	2097	2036	1980	1960	1685
380	2372	2297	2228	2164	2104	2047	1995	1976	1717
400	2356	2287	2224	2165	2109	2057	2008	1990	1746
420	2341	2278	2220	2165	2115	2066	2020	2003	1773
440	2326	2270	2216	2166	2118	2073	2031	2013	1797
460	2313	2260	2211	2165	2121	2079	2039	2022	1819
480	2300	2252	2207	2164	2123	2085	2047	2031	1839
500	2290	2245	2203	2163	2125	2089	2054	2039	1857

FOR PLANNING USE ONLY

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

9.0 Guying

Conductor tensions for guying 653 Covered Conductor is 2,846 lb.

10.0 Ground Clearance

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

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.

This page intentionally left blank.

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

	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-6"	0'-7"	0'-8"	0'-9"	0'-9"	0'-10"	0'-11"	0'-8"	1'-2"
120	0'-9"	0'-10"	0'-11"	1'-0"	1'-1"	1'-3"	1'-4"	0'-11"	1'-7"
140	1'-1"	1'-2"	1'-3"	1'-5"	1'-6"	1'-7"	1'-9"	1'-4"	2'-0"
160	1'-6"	1'-7"	1'-8"	1'-10"	1'-11"	2'-1"	2'-2"	1'-8"	2'-6"
180	1'-11"	2'-0"	2'-2"	2'-3"	2'-5"	2'-7"	2'-9"	2'-2"	3'-0"
200	2'-5"	2'-6"	2'-8"	2'-10"	3'-0"	3'-2"	3'-3"	2'-8"	3'-8"
220	2'-11"	3'-1"	3'-3"	3'-5"	3'-7"	3'-9"	3'-11"	3'-3"	4'-3"
240	3'-7"	3'-9"	3'-11"	4'-1"	4'-3"	4'-5"	4'-7"	3'-11"	4'-11"
260	4'-3"	4'-5"	4'-7"	4'-9"	4'-11"	5'-1"	5'-4"	4'-7"	5'-8"
280	5'-0"	5'-2"	5'-4"	5'-6"	5'-9"	5'-11"	6'-1"	5'-4"	6'-6"
300	5'-9"	5'-11"	6'-2"	6'-4"	6'-6"	6'-9"	6'-11"	6'-2"	7'-4"
320	6'-7"	6'-10"	7'-0"	7'-3"	7'-5"	7'-7"	7'-10"	7'-0"	8'-3"
340	7'-6"	7'-9"	7'-11"	8'-2"	8'-4"	8'-7"	8'-9"	7'-11"	9'-2"
360	8'-6"	8'-9"	8'-11"	9'-2"	9'-4"	9'-6"	9'-9"	8'-11"	10'-2"
380	9'-6"	9'-9"	10'-0"	10'-2"	10'-5"	10'-7"	10'-10"	10'-0"	11'-3"
400	10'-7"	10'-10"	11'-1"	11'-3"	11'-6"	11'-9"	11'-11"	11'-1"	12'-4"
420	11'-9"	12'-0"	12'-3"	12'-5"	12'-8"	12'-11"	13'-1"	12'-3"	13'-6"
440	13'-0"	13'-3"	13'-5"	13'-8"	13'-11"	14'-1"	14'-4"	13'-5"	14'-9"
460	14'-3"	14'-6"	14'-9"	14'-11"	15'-2"	15'-5"	15'-7"	14'-9"	16'-1"
480	15'-7"	15'-10"	16'-1"	16'-3"	16'-6"	16'-9"	16'-11"	16'-1"	17'-5"
500	17'-0"	17'-3"	17'-6"	17'-8"	17'-11"	18'-2"	18'-4"	17'-6"	18'-10"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	710	650	592	538	488	443	403	585	322
120	696	641	587	539	495	455	419	582	349
140	682	631	583	540	501	465	434	579	372
160	668	623	580	541	506	475	447	576	391
180	655	614	576	542	511	483	458	573	408
200	643	606	572	542	515	490	468	570	423
220	632	600	570	543	518	496	476	568	436
240	622	594	567	543	521	501	483	565	446
260	614	589	565	544	524	506	489	564	456
280	607	584	563	544	526	510	495	562	465
300	600	580	561	544	528	513	499	560	472
320	594	577	559	544	530	516	503	559	478
340	590	574	558	544	531	519	507	557	484
360	585	571	557	544	532	521	510	556	489
380	581	568	556	544	533	523	513	555	493
400	578	566	554	544	534	524	515	554	497
420	575	564	553	544	534	526	517	553	500
440	572	563	553	544	535	527	519	552	503
460	570	561	551	543	535	528	520	551	506
480	567	559	551	543	536	529	522	550	508
500	565	558	550	543	536	529	523	549	510

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-6"	0'-6"	0'-7"	0'-8"	0'-9"	0'-9"	0'-10"	0'-7"	1'-1"
120	0'-8"	0'-9"	0'-10"	0'-11"	1'-0"	1'-1"	1'-2"	0'-10"	1'-6"
140	0'-11"	1'-0"	1'-1"	1'-3"	1'-4"	1'-5"	1'-6"	1'-1"	1'-10"
160	1'-3"	1'-4"	1'-5"	1'-7"	1'-8"	1'-10"	1'-11"	1'-5"	2'-3"
180	1'-7"	1'-8"	1'-10"	1'-11"	2'-1"	2'-3"	2'-4"	1'-10"	2'-9"
200	1'-11"	2'-1"	2'-3"	2'-4"	2'-6"	2'-8"	2'-10"	2'-3"	3'-2"
220	2'-4"	2'-6"	2'-8"	2'-10"	3'-0"	3'-2"	3'-4"	2'-8"	3'-9"
240	2'-10"	3'-0"	3'-2"	3'-4"	3'-6"	3'-8"	3'-10"	3'-2"	4'-3"
260	3'-4"	3'-6"	3'-8"	3'-11"	4'-1"	4'-3"	4'-5"	3'-9"	4'-10"
280	3'-10"	4'-1"	4'-3"	4'-6"	4'-8"	4'-10"	5'-0"	4'-3"	5'-6"
300	4'-6"	4'-8"	4'-10"	5'-1"	5'-3"	5'-6"	5'-8"	4'-11"	6'-2"
320	5'-1"	5'-4"	5'-6"	5'-9"	5'-11"	6'-2"	6'-5"	5'-6"	6'-10"
340	5'-9"	6'-0"	6'-3"	6'-5"	6'-8"	6'-11"	7'-1"	6'-3"	7'-7"
360	6'-6"	6'-9"	6'-11"	7'-2"	7'-5"	7'-8"	7'-10"	7'-0"	8'-4"
380	7'-3"	7'-6"	7'-9"	7'-11"	8'-2"	8'-5"	8'-8"	7'-9"	9'-2"
400	8'-0"	8'-3"	8'-6"	8'-9"	9'-0"	9'-3"	9'-6"	8'-7"	10'-0"
420	8'-10"	9'-2"	9'-5"	9'-8"	9'-11"	10'-2"	10'-5"	9'-5"	10'-11"
440	9'-9"	10'-0"	10'-3"	10'-6"	10'-9"	11'-1"	11'-3"	10'-4"	11'-10"
460	10'-8"	10'-11"	11'-3"	11'-6"	11'-9"	12'-0"	12'-3"	11'-3"	12'-9"
480	11'-8"	11'-11"	12'-3"	12'-6"	12'-9"	13'-0"	13'-3"	12'-3"	13'-10"
500	12'-8"	12'-11"	13'-3"	13'-6"	13'-9"	14'-0"	14'-3"	13'-3"	14'-10"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1433	1309	1186	1073	967	870	784	1172	610
120	1429	1311	1196	1091	994	906	828	1184	670
140	1421	1311	1204	1107	1019	939	867	1194	723
160	1417	1313	1214	1125	1043	970	904	1205	771
180	1412	1316	1224	1142	1067	999	938	1216	815
200	1404	1315	1231	1155	1086	1023	967	1224	853
220	1397	1315	1237	1167	1104	1046	993	1231	888
240	1392	1316	1244	1180	1121	1067	1018	1239	920
260	1387	1317	1251	1191	1137	1087	1041	1246	949
280	1383	1318	1257	1202	1151	1104	1061	1253	975
300	1379	1319	1262	1211	1164	1120	1080	1259	999
320	1374	1319	1266	1219	1175	1134	1097	1263	1021
340	1371	1320	1271	1227	1186	1148	1112	1268	1041
360	1367	1320	1274	1233	1195	1159	1126	1272	1059
380	1365	1321	1278	1240	1204	1171	1139	1276	1076
400	1361	1321	1281	1245	1212	1180	1151	1279	1091
420	1358	1321	1283	1250	1219	1189	1161	1282	1105
440	1356	1321	1286	1255	1225	1197	1171	1284	1118
460	1354	1321	1289	1259	1232	1205	1180	1287	1130
480	1351	1320	1290	1262	1236	1211	1188	1288	1140
500	1349	1321	1292	1266	1241	1218	1195	1291	1151

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-6"	0'-6"	0'-7"	0'-7"	0'-8"	0'-9"	0'-10"	0'-7"	1'-1"
120	0'-8"	0'-9"	0'-10"	0'-11"	1'-0"	1'-1"	1'-2"	0'-10"	1'-5"
140	0'-11"	1'-0"	1'-1"	1'-2"	1'-3"	1'-5"	1'-6"	1'-1"	1'-10"
160	1'-2"	1'-3"	1'-5"	1'-6"	1'-7"	1'-9"	1'-11"	1'-5"	2'-3"
180	1'-6"	1'-7"	1'-9"	1'-10"	2'-0"	2'-2"	2'-3"	1'-9"	2'-8"
200	1'-10"	2'-0"	2'-1"	2'-3"	2'-5"	2'-7"	2'-9"	2'-1"	3'-1"
220	2'-3"	2'-4"	2'-6"	2'-8"	2'-10"	3'-0"	3'-2"	2'-6"	3'-7"
240	2'-8"	2'-9"	3'-0"	3'-2"	3'-4"	3'-6"	3'-8"	3'-0"	4'-1"
260	3'-1"	3'-3"	3'-5"	3'-8"	3'-10"	4'-0"	4'-2"	3'-6"	4'-8"
280	3'-7"	3'-9"	4'-0"	4'-2"	4'-4"	4'-7"	4'-9"	4'-0"	5'-3"
300	4'-1"	4'-4"	4'-6"	4'-9"	4'-11"	5'-2"	5'-4"	4'-6"	5'-10"
320	4'-8"	4'-10"	5'-1"	5'-4"	5'-6"	5'-9"	6'-0"	5'-1"	6'-6"
340	5'-3"	5'-6"	5'-9"	5'-11"	6'-2"	6'-5"	6'-7"	5'-9"	7'-2"
360	5'-11"	6'-1"	6'-4"	6'-7"	6'-10"	7'-1"	7'-4"	6'-5"	7'-10"
380	6'-7"	6'-10"	7'-1"	7'-4"	7'-7"	7'-9"	8'-0"	7'-1"	8'-7"
400	7'-3"	7'-6"	7'-9"	8'-0"	8'-3"	8'-6"	8'-9"	7'-9"	9'-4"
420	8'-0"	8'-3"	8'-6"	8'-10"	9'-1"	9'-4"	9'-7"	8'-7"	10'-2"
440	8'-9"	9'-1"	9'-4"	9'-7"	9'-10"	10'-2"	10'-5"	9'-4"	10'-11"
460	9'-7"	9'-10"	10'-2"	10'-5"	10'-8"	11'-0"	11'-3"	10'-2"	11'-10"
480	10'-5"	10'-9"	11'-0"	11'-4"	11'-7"	11'-10"	12'-2"	11'-0"	12'-9"
500	11'-4"	11'-8"	11'-11"	12'-3"	12'-6"	12'-9"	13'-1"	11'-11"	13'-8"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	2225	2026	1830	1648	1479	1326	1190	1808	919
120	2227	2037	1853	1684	1528	1388	1264	1833	1015
140	2231	2052	1880	1723	1579	1449	1334	1862	1103
160	2232	2064	1902	1756	1624	1504	1397	1887	1182
180	2237	2079	1928	1792	1668	1557	1457	1915	1255
200	2238	2090	1949	1823	1708	1604	1510	1937	1321
220	2241	2103	1971	1853	1746	1649	1560	1961	1382
240	2241	2112	1989	1880	1779	1688	1605	1980	1437
260	2244	2123	2008	1906	1812	1726	1647	2000	1489
280	2245	2132	2025	1929	1841	1760	1686	2017	1536
300	2247	2142	2041	1951	1868	1792	1722	2034	1580
320	2249	2151	2056	1972	1894	1822	1755	2050	1621
340	2252	2160	2071	1992	1918	1850	1787	2066	1659
360	2254	2167	2084	2009	1940	1875	1815	2079	1694
380	2253	2173	2094	2024	1958	1897	1840	2090	1725
400	2255	2179	2105	2039	1977	1919	1865	2102	1755
420	2256	2185	2115	2053	1994	1939	1888	2113	1784
440	2257	2190	2125	2066	2010	1958	1909	2122	1809
460	2258	2195	2133	2077	2024	1975	1928	2131	1833
480	2258	2198	2139	2087	2037	1990	1945	2138	1855
500	2259	2203	2147	2097	2049	2004	1962	2145	1876

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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.

This page intentionally left blank.

CO 149 Sag —Temperature Chart #2 — 500 kcmil Copper for Covered Conductor 2.0

Scope CO 149.1 Sag —Temperature Chart #2 — 500 kcmil Copper for Covered Conductor 2.0

Table CO 149–1: Sag—Temperature Chart 17 kV #2 Copper Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 17 kV #2 Copper for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'6"	0'7"	0'7"	0'8"	0'9"	0'10"	0'11"	0'7"	1'2"
120	0'9"	0'10"	0'11"	1'0"	1'1"	1'2"	1'3"	0'11"	1'6"
140	1'0"	1'1"	1'3"	1'4"	1'5"	1'6"	1'8"	1'3"	1'11"
160	1'4"	1'6"	1'7"	1'8"	1'10"	1'11"	2'1"	1'7"	2'5"
180	1'9"	1'11"	2'0"	2'2"	2'3"	2'5"	2'7"	2'0"	2'11"
200	2'3"	2'4"	2'6"	2'8"	2'10"	2'11"	3'1"	2'6"	3'6"
220	2'9"	2'10"	3'0"	3'2"	3'4"	3'6"	3'8"	3'0"	4'1"
240	3'3"	3'5"	3'7"	3'9"	4'0"	4'2"	4'4"	3'7"	4'8"
260	3'11"	4'1"	4'3"	4'5"	4'7"	4'10"	5'0"	4'3"	5'5"
280	4'7"	4'9"	4'11"	5'2"	5'4"	5'6"	5'9"	5'0"	6'2"
300	5'3"	5'6"	5'8"	5'11"	6'1"	6'3"	6'6"	5'8"	6'11"
320	6'1"	6'3"	6'6"	6'8"	6'11"	7'1"	7'4"	6'6"	7'9"
340	6'11"	7'2"	7'4"	7'7"	7'9"	8'0"	8'2"	7'4"	8'8"
360	7'10"	8'0"	8'3"	8'6"	8'8"	8'11"	9'1"	8'3"	9'7"
380	8'9"	9'0"	9'2"	9'5"	9'8"	9'10"	10'1"	9'3"	10'6"
400	9'9"	10'0"	10'3"	10'5"	10'8"	10'11"	11'1"	10'3"	11'7"
420	10'10"	11'1"	11'3"	11'6"	11'9"	12'0"	12'2"	11'3"	12'8"
440	11'11"	12'2"	12'5"	12'8"	12'10"	13'1"	13'4"	12'5"	13'10"
460	13'1"	13'4"	13'7"	13'10"	14'0"	14'3"	14'6"	13'7"	15'0"
480	14'4"	14'7"	14'10"	15'0"	15'3"	15'6"	15'9"	14'10"	16'3"
500	15'7"	15'10"	16'1"	16'4"	16'7"	16'10"	17'0"	16'1"	17'6"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 149–2: Tension — Temperature Stringing Table 17 kV #2 Copper Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 17 kV #2 Copper for Light-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	719	658	598	543	491	444	402	592	317
120	707	651	596	545	499	457	420	590	345
140	695	642	592	547	505	468	435	587	368
160	683	635	590	549	512	479	448	586	388
180	672	628	588	552	518	488	461	585	406
200	661	621	585	553	522	495	471	583	422
220	651	615	583	554	527	502	480	582	435
240	643	611	582	556	531	509	488	580	448
260	634	606	580	556	534	514	495	579	458
280	627	602	578	557	537	519	501	577	467
300	621	598	577	558	539	523	507	576	476
320	615	595	576	558	542	526	512	575	483
340	611	592	575	559	543	529	516	574	490
360	606	590	574	559	545	532	520	574	495
380	603	587	573	559	547	535	523	573	501
400	599	585	572	560	548	537	526	572	505
420	596	583	571	560	549	539	529	571	509
440	593	581	570	560	550	540	531	570	513
460	591	580	570	560	551	542	533	569	516
480	588	578	569	560	551	543	535	569	519
500	586	577	568	560	552	544	536	568	522

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 149–3: Sag — Temperature Stringing Table 35 kV #2 Copper Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 35kV #2 Copper CC for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'8"	0'9"	0'10"	0'11"	1'0"	1'1"	1'2"	0'10"	1'4"
120	1'0"	1'1"	1'2"	1'3"	1'5"	1'6"	1'7"	1'3"	1'10"
140	1'5"	1'7"	1'8"	1'9"	1'10"	2'0"	2'1"	1'8"	2'4"
160	1'11"	2'1"	2'2"	2'3"	2'5"	2'6"	2'8"	2'2"	2'11"
180	2'6"	2'8"	2'9"	2'11"	3'0"	3'2"	3'3"	2'9"	3'7"
200	3'2"	3'3"	3'5"	3'7"	3'8"	3'10"	4'0"	3'5"	4'3"
220	3'10"	4'0"	4'2"	4'4"	4'6"	4'7"	4'9"	4'2"	5'1"
240	4'8"	4'10"	5'0"	5'2"	5'3"	5'5"	5'7"	5'0"	5'11"
260	5'6"	5'8"	5'10"	6'0"	6'2"	6'4"	6'6"	5'10"	6'10"
280	6'6"	6'8"	6'10"	7'0"	7'2"	7'4"	7'6"	6'10"	7'10"
300	7'6"	7'8"	7'10"	8'0"	8'2"	8'4"	8'6"	7'10"	8'10"
320	8'7"	8'9"	9'0"	9'2"	9'4"	9'6"	9'8"	9'0"	10'0"
340	9'9"	10'0"	10'2"	10'4"	10'6"	10'8"	10'10"	10'2"	11'2"
360	11'0"	11'3"	11'5"	11'7"	11'9"	11'11"	12'1"	11'5"	12'5"
380	12'4"	12'6"	12'9"	12'11"	13'1"	13'3"	13'5"	12'9"	13'9"
400	13'9"	13'11"	14'1"	14'4"	14'6"	14'8"	14'10"	14'1"	15'2"
420	15'3"	15'5"	15'7"	15'9"	16'0"	16'2"	16'4"	15'7"	16'8"
440	16'9"	17'0"	17'2"	17'4"	17'6"	17'8"	17'11"	17'2"	18'3"
460	18'5"	18'7"	18'9"	19'0"	19'2"	19'4"	19'6"	18'9"	19'11"
480	20'1"	20'4"	20'6"	20'8"	20'10"	21'1"	21'3"	20'6"	21'7"
500	21'11"	22'1"	22'3"	22'6"	22'8"	22'10"	23'0"	22'3"	23'5"

FOR PLANNING USE ONLY

Note(s): Listed temperatures refers to conductor temperature, not ambient temperature.

Table CO 149–4: Tension — Temperature Stringing Table 35 kV #2 Copper Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 35kV #2 Copper CC for Light-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	693	638	587	542	498	460	426	583	358
120	675	628	584	543	506	474	444	580	386
140	658	617	579	544	513	484	459	577	408
160	643	608	575	546	518	493	471	573	427
180	630	599	571	546	522	501	481	570	442
200	620	593	570	547	527	508	490	568	456
220	610	588	566	547	529	513	497	566	467
240	602	583	565	548	532	517	503	564	476
260	595	579	563	547	534	520	508	562	484
280	590	575	561	548	535	524	512	561	490
300	585	572	559	548	536	526	516	559	496
320	580	569	558	547	537	528	519	558	501
340	577	567	557	547	538	530	521	557	505
360	574	564	556	547	539	531	524	556	509
380	571	563	555	547	539	532	525	554	512
400	568	561	553	546	540	533	527	553	514
420	566	559	552	546	540	534	528	552	517
440	564	557	551	546	540	534	529	551	518
460	561	556	550	545	540	535	530	550	520
480	560	554	549	544	540	535	530	549	521
500	558	553	549	544	539	535	531	548	522

FOR PLANNING USE ONLY

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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.

Table CO 149–5: Sag — Temperature Stringing 17 kV 2/0 Copper Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 17 kV 2/0 Copper for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'6"	0'6"	0'7"	0'7"	0'8"	0'9"	0'10"	0'7"	1'1"
120	0'8"	0'9"	0'9"	0'10"	0'11"	1'1"	1'2"	0'10"	1'5"
140	0'11"	1'0"	1'1"	1'2"	1'3"	1'5"	1'6"	1'1"	1'10"
160	1'2"	1'3"	1'5"	1'6"	1'7"	1'9"	1'11"	1'5"	2'3"
180	1'6"	1'7"	1'9"	1'10"	2'0"	2'2"	2'3"	1'9"	2'8"
200	1'10"	2'0"	2'2"	2'3"	2'5"	2'7"	2'9"	2'2"	3'1"
220	2'3"	2'5"	2'7"	2'9"	2'11"	3'1"	3'3"	2'7"	3'7"
240	2'8"	2'10"	3'0"	3'2"	3'4"	3'7"	3'9"	3'0"	4'2"
260	3'2"	3'4"	3'6"	3'9"	3'11"	4'1"	4'3"	3'6"	4'9"
280	3'8"	3'10"	4'1"	4'3"	4'6"	4'8"	4'10"	4'1"	5'4"
300	4'3"	4'5"	4'8"	4'10"	5'1"	5'3"	5'6"	4'8"	6'0"
320	4'10"	5'0"	5'3"	5'6"	5'8"	5'11"	6'2"	5'3"	6'7"
340	5'6"	5'8"	5'11"	6'2"	6'4"	6'7"	6'10"	5'11"	7'4"
360	6'2"	6'5"	6'7"	6'10"	7'1"	7'4"	7'7"	6'7"	8'1"
380	6'10"	7'1"	7'4"	7'7"	7'10"	8'1"	8'4"	7'4"	8'10"
400	7'7"	7'10"	8'1"	8'4"	8'7"	8'10"	9'1"	8'1"	9'8"
420	8'5"	8'8"	8'11"	9'2"	9'5"	9'8"	9'11"	8'11"	10'6"
440	9'3"	9'6"	9'9"	10'0"	10'4"	10'7"	10'10"	9'9"	11'4"
460	10'1"	10'5"	10'8"	10'11"	11'2"	11'6"	11'9"	10'8"	12'3"
480	11'0"	11'4"	11'7"	11'10"	12'2"	12'5"	12'8"	11'7"	13'3"
500	12'0"	12'3"	12'7"	12'10"	13'1"	13'5"	13'8"	12'7"	14'3"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 149–6: Tension — Temperature Stringing 17 kV 2/0 Copper Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 17 kV 2/0 Copper for Light-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1433	1309	1187	1072	963	864	771	1172	599
120	1433	1314	1199	1091	992	902	821	1184	659
140	1429	1316	1208	1110	1018	935	860	1198	712
160	1424	1317	1218	1126	1042	965	897	1208	760
180	1419	1321	1227	1143	1064	994	931	1219	803
200	1414	1323	1237	1157	1086	1020	962	1229	843
220	1411	1325	1245	1171	1105	1044	989	1240	879
240	1407	1327	1253	1185	1124	1067	1015	1248	912
260	1403	1329	1260	1197	1140	1087	1039	1257	942
280	1401	1332	1268	1209	1156	1106	1060	1264	969
300	1397	1333	1274	1220	1169	1123	1080	1271	994
320	1394	1335	1280	1229	1182	1139	1098	1277	1017
340	1391	1336	1284	1237	1193	1153	1115	1282	1038
360	1388	1337	1289	1245	1204	1165	1130	1287	1058
380	1386	1337	1294	1252	1213	1177	1143	1292	1075
400	1383	1339	1297	1259	1222	1188	1156	1296	1092
420	1381	1340	1301	1264	1230	1198	1168	1300	1107
440	1379	1340	1304	1269	1237	1207	1178	1302	1121
460	1377	1341	1306	1274	1244	1215	1188	1305	1133
480	1374	1341	1309	1278	1250	1222	1197	1308	1145
500	1372	1341	1311	1282	1255	1230	1205	1310	1156

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 149–7: Sag — Temperature Stringing 35 kV 2/0 Copper Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 35kV 2/0 Copper for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'7"	0'7"	0'8"	0'9"	0'10"	0'11"	1'0"	0'8"	1'3"
120	0'10"	0'11"	1'0"	1'0"	1'2"	1'3"	1'4"	1'0"	1'7"
140	1'1"	1'2"	1'4"	1'5"	1'6"	1'7"	1'9"	1'4"	2'0"
160	1'6"	1'7"	1'8"	1'10"	1'11"	2'0"	2'2"	1'8"	2'6"
180	1'10"	2'0"	2'1"	2'3"	2'5"	2'6"	2'8"	2'1"	3'0"
200	2'4"	2'6"	2'7"	2'9"	2'11"	3'0"	3'2"	2'7"	3'6"
220	2'10"	3'0"	3'2"	3'3"	3'5"	3'7"	3'9"	3'2"	4'2"
240	3'4"	3'6"	3'8"	3'10"	4'0"	4'3"	4'5"	3'9"	4'9"
260	4'0"	4'2"	4'4"	4'6"	4'8"	4'10"	5'0"	4'4"	5'5"
280	4'8"	4'10"	5'0"	5'2"	5'4"	5'7"	5'9"	5'0"	6'2"
300	5'4"	5'6"	5'9"	5'11"	6'1"	6'4"	6'6"	5'9"	6'11"
320	6'1"	6'3"	6'6"	6'8"	6'11"	7'1"	7'3"	6'6"	7'9"
340	6'11"	7'1"	7'4"	7'6"	7'9"	7'11"	8'2"	7'4"	8'7"
360	7'9"	8'0"	8'2"	8'5"	8'7"	8'10"	9'0"	8'2"	9'6"
380	8'8"	8'11"	9'1"	9'4"	9'6"	9'9"	10'0"	9'1"	10'5"
400	9'7"	9'10"	10'1"	10'4"	10'6"	10'9"	11'0"	10'1"	11'5"
420	10'8"	10'10"	11'1"	11'4"	11'7"	11'9"	12'0"	11'1"	12'6"
440	11'8"	11'11"	12'2"	12'5"	12'7"	12'10"	13'1"	12'2"	13'7"
460	12'10"	13'0"	13'3"	13'6"	13'9"	14'0"	14'3"	13'3"	14'8"
480	14'0"	14'3"	14'5"	14'8"	14'11"	15'2"	15'5"	14'5"	15'11"
500	15'2"	15'5"	15'8"	15'11"	16'2"	16'5"	16'8"	15'8"	17'2"

Note(s): Listed temperature refer to conductor temperatures, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 149–8: Tension — Temperature Stringing 35 kV 2/0 Copper Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 35kV 2/0 Copper for Light-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1423	1306	1191	1085	988	899	820	1179	660
120	1416	1306	1201	1105	1017	937	866	1190	723
140	1406	1306	1210	1123	1043	971	907	1201	777
160	1399	1307	1220	1142	1069	1004	945	1214	826
180	1392	1307	1228	1156	1090	1031	977	1222	869
200	1382	1304	1233	1169	1109	1055	1005	1229	906
220	1375	1304	1240	1181	1126	1077	1031	1236	939
240	1369	1306	1247	1192	1143	1097	1055	1244	970
260	1363	1305	1251	1203	1157	1115	1076	1249	998
280	1358	1306	1256	1211	1170	1130	1094	1254	1022
300	1353	1305	1261	1219	1181	1144	1111	1259	1044
320	1348	1305	1264	1226	1190	1157	1126	1262	1063
340	1345	1305	1267	1232	1199	1168	1139	1266	1081
360	1341	1304	1270	1237	1207	1178	1151	1269	1096
380	1337	1304	1272	1242	1213	1187	1161	1271	1111
400	1334	1304	1274	1246	1220	1195	1171	1273	1124
420	1331	1302	1275	1250	1225	1202	1179	1275	1135
440	1328	1302	1277	1253	1230	1208	1187	1277	1145
460	1325	1301	1278	1255	1234	1214	1194	1277	1155
480	1323	1301	1279	1258	1238	1219	1200	1279	1164
500	1321	1300	1279	1260	1241	1223	1206	1279	1171

FOR PLANNING USE ONLY

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

3.0 Guying

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

4.0 Ground Clearance

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

Table CO 149–9: Sag — Temperature Stringing 17 kV 4//0 Copper Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 17 kV 4/0 Copper for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'5"	0'6"	0'6"	0'7"	0'8"	0'9"	0'10"	0'7"	1'1"
120	0'8"	0'8"	0'9"	0'10"	0'11"	1'0"	1'2"	0'9"	1'5"
140	0'10"	0'11"	1'0"	1'2"	1'3"	1'4"	1'6"	1'1"	1'9"
160	1'2"	1'3"	1'4"	1'5"	1'7"	1'8"	1'10"	1'4"	2'2"
180	1'5"	1'7"	1'8"	1'10"	1'11"	2'1"	2'3"	1'8"	2'7"
200	1'9"	1'11"	2'0"	2'2"	2'4"	2'6"	2'8"	2'1"	3'0"
220	2'2"	2'3"	2'5"	2'7"	2'9"	2'11"	3'1"	2'5"	3'6"
240	2'6"	2'8"	2'10"	3'0"	3'3"	3'5"	3'7"	2'11"	4'0"
260	3'0"	3'2"	3'4"	3'6"	3'9"	3'11"	4'1"	3'4"	4'7"
280	3'5"	3'8"	3'10"	4'0"	4'3"	4'5"	4'8"	3'10"	5'1"
300	4'0"	4'2"	4'4"	4'7"	4'9"	5'0"	5'3"	4'5"	5'8"
320	4'6"	4'9"	4'11"	5'2"	5'4"	5'7"	5'10"	4'11"	6'4"
340	5'1"	5'3"	5'6"	5'9"	6'0"	6'3"	6'5"	5'6"	7'0"
360	5'8"	5'11"	6'2"	6'5"	6'8"	6'10"	7'1"	6'2"	7'8"
380	6'4"	6'7"	6'10"	7'1"	7'4"	7'7"	7'10"	6'10"	8'4"
400	7'0"	7'3"	7'6"	7'9"	8'0"	8'3"	8'6"	7'6"	9'1"
420	7'9"	8'0"	8'3"	8'6"	8'9"	9'0"	9'3"	8'3"	9'10"
440	8'6"	8'9"	9'0"	9'3"	9'7"	9'10"	10'1"	9'0"	10'8"
460	9'3"	9'6"	9'10"	10'1"	10'4"	10'8"	10'11"	9'10"	11'6"
480	10'1"	10'4"	10'8"	10'11"	11'2"	11'6"	11'9"	10'8"	12'4"
500	10'11"	11'2"	11'6"	11'9"	12'1"	12'4"	12'8"	11'6"	13'3"

FOR PLANNING USE ONLY

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

Table CO 149–10: Tension — Temperature Stringing Table 17 kV 4/0 Copper Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 17 kV 4/0 Copper for Light-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	2227	2022	1831	1647	1474	1318	1180	1807	905
120	2231	2041	1857	1685	1525	1381	1256	1835	1001
140	2234	2052	1880	1719	1573	1442	1322	1863	1088
160	2238	2067	1903	1755	1618	1495	1387	1887	1167
180	2242	2080	1929	1791	1664	1548	1446	1915	1240
200	2245	2095	1953	1823	1706	1598	1501	1941	1307
220	2249	2108	1976	1855	1744	1643	1552	1965	1368
240	2252	2119	1995	1882	1778	1683	1598	1985	1423
260	2256	2132	2015	1910	1812	1723	1641	2009	1477
280	2260	2143	2034	1934	1842	1759	1681	2026	1526
300	2261	2152	2049	1957	1870	1791	1717	2044	1570
320	2263	2160	2066	1977	1896	1821	1751	2060	1611
340	2266	2171	2081	1997	1921	1849	1783	2076	1649
360	2268	2178	2094	2015	1942	1875	1812	2089	1685
380	2272	2185	2107	2033	1964	1900	1839	2103	1719
400	2273	2193	2119	2048	1983	1922	1866	2115	1750
420	2275	2200	2129	2062	2001	1943	1888	2125	1778
440	2276	2204	2138	2075	2017	1961	1910	2135	1805
460	2277	2210	2147	2088	2032	1979	1930	2145	1830
480	2279	2216	2156	2100	2046	1997	1949	2153	1854
500	2280	2219	2163	2110	2059	2011	1966	2161	1875

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Sag — Temperature Stringing Table 35 kV 4/0 Copper Covered Conductor 2.0 for Light-Loading Areas

Table CO 149–11: Sag — Temperature Stringing Table 35 kV 4/0 Copper Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 35kV 4/0 Copper for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'11"	1'0"	1'1"	1'2"	1'3"	1'4"	1'5"	1'1"	1'8"
120	1'3"	1'4"	1'6"	1'7"	1'8"	1'9"	1'11"	1'6"	2'2"
140	1'8"	1'10"	1'11"	2'0"	2'2"	2'3"	2'5"	1'11"	2'8"
160	2'2"	2'4"	2'5"	2'7"	2'8"	2'10"	2'11"	2'5"	3'3"
180	2'9"	2'10"	3'0"	3'2"	3'3"	3'5"	3'7"	3'0"	3'10"
200	3'4"	3'6"	3'8"	3'9"	3'11"	4'1"	4'3"	3'8"	4'6"
220	4'0"	4'2"	4'4"	4'6"	4'8"	4'10"	4'11"	4'4"	5'3"
240	4'9"	4'11"	5'1"	5'3"	5'5"	5'7"	5'9"	5'1"	6'1"
260	5'7"	5'9"	5'11"	6'1"	6'3"	6'5"	6'7"	5'11"	6'11"
280	6'5"	6'7"	6'10"	7'0"	7'2"	7'4"	7'6"	6'10"	7'10"
300	7'5"	7'7"	7'9"	7'11"	8'1"	8'3"	8'5"	7'9"	8'9"
320	8'5"	8'7"	8'9"	8'11"	9'1"	9'3"	9'6"	8'9"	9'10"
340	9'5"	9'8"	9'10"	10'0"	10'2"	10'4"	10'7"	9'10"	10'11"
360	10'7"	10'9"	11'0"	11'2"	11'4"	11'6"	11'8"	11'0"	12'1"
380	11'9"	12'0"	12'2"	12'4"	12'6"	12'9"	12'11"	12'2"	13'3"
400	13'0"	13'3"	13'5"	13'8"	13'10"	14'0"	14'2"	13'5"	14'7"
420	14'5"	14'7"	14'9"	15'0"	15'2"	15'4"	15'6"	14'9"	15'11"
440	15'9"	16'0"	16'2"	16'4"	16'7"	16'9"	16'11"	16'2"	17'4"
460	17'3"	17'5"	17'8"	17'10"	18'0"	18'3"	18'5"	17'8"	18'10"
480	18'9"	19'0"	19'2"	19'5"	19'7"	19'9"	20'0"	19'2"	20'4"
500	20'5"	20'7"	20'9"	21'0"	21'2"	21'5"	21'7"	20'10"	22'0"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 149–12: Tension — Temperature Stringing Table 35kV Copper Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 35kV 4/0 Copper for Light-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1316	1193	1089	998	920	855	799	1082	698
120	1333	1229	1138	1058	990	930	878	1134	782
140	1350	1259	1179	1109	1047	993	945	1177	856
160	1363	1284	1215	1153	1097	1047	1002	1212	919
180	1376	1307	1246	1189	1139	1094	1052	1243	974
200	1385	1325	1270	1220	1175	1133	1095	1268	1023
220	1393	1339	1291	1245	1205	1166	1131	1289	1065
240	1398	1351	1307	1267	1229	1195	1162	1306	1101
260	1403	1361	1322	1285	1252	1220	1191	1322	1133
280	1407	1370	1334	1301	1270	1241	1214	1334	1161
300	1412	1378	1346	1316	1287	1261	1235	1345	1186
320	1414	1384	1355	1328	1301	1277	1253	1354	1208
340	1416	1389	1362	1337	1313	1291	1269	1362	1227
360	1418	1393	1369	1346	1324	1303	1283	1369	1244
380	1420	1397	1374	1353	1333	1314	1295	1374	1258
400	1420	1399	1379	1360	1341	1323	1306	1379	1272
420	1421	1402	1383	1365	1347	1331	1315	1382	1283
440	1422	1404	1387	1370	1354	1338	1323	1386	1294
460	1422	1405	1389	1374	1359	1345	1331	1389	1303
480	1421	1406	1391	1377	1363	1350	1337	1391	1311
500	1421	1407	1394	1380	1367	1355	1342	1393	1318

FOR PLANNING USE ONLY

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

5.0 Guying

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

6.0 Ground Clearance

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

Table CO 149–13: Sag — Temperature Stringing Cable 17 kV 350 kcmil Copper Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 17 kV 350 HDCU for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'8"	0'9"	0'10"	0'11"	1'0"	1'1"	1'3"	0'10"	1'5"
120	0'11"	1'0"	1'1"	1'3"	1'4"	1'6"	1'7"	1'1"	1'10"
140	1'3"	1'4"	1'5"	1'7"	1'9"	1'10"	2'0"	1'6"	2'3"
160	1'7"	1'8"	1'10"	2'0"	2'1"	2'3"	2'5"	1'10"	2'9"
180	2'0"	2'1"	2'3"	2'5"	2'7"	2'9"	2'10"	2'3"	3'3"
200	2'5"	2'7"	2'9"	2'11"	3'1"	3'3"	3'4"	2'9"	3'9"
220	2'10"	3'0"	3'3"	3'5"	3'7"	3'9"	3'11"	3'3"	4'3"
240	3'5"	3'7"	3'9"	3'11"	4'2"	4'4"	4'6"	3'9"	4'11"
260	3'11"	4'2"	4'4"	4'6"	4'9"	4'11"	5'1"	4'4"	5'6"
280	4'6"	4'9"	4'11"	5'2"	5'4"	5'7"	5'9"	5'0"	6'2"
300	5'2"	5'5"	5'7"	5'10"	6'0"	6'3"	6'5"	5'7"	6'11"
320	5'10"	6'1"	6'4"	6'6"	6'9"	7'0"	7'2"	6'4"	7'7"
340	6'7"	6'10"	7'1"	7'3"	7'6"	7'9"	7'11"	7'1"	8'5"
360	7'4"	7'7"	7'10"	8'1"	8'3"	8'6"	8'9"	7'10"	9'3"
380	8'2"	8'5"	8'8"	8'11"	9'2"	9'4"	9'7"	8'8"	10'1"
400	9'0"	9'3"	9'6"	9'9"	10'0"	10'3"	10'6"	9'6"	11'0"
420	9'11"	10'2"	10'5"	10'8"	10'11"	11'2"	11'5"	10'5"	11'11"
440	10'10"	11'1"	11'5"	11'8"	11'11"	12'2"	12'5"	11'5"	12'11"
460	11'10"	12'1"	12'4"	12'7"	12'11"	13'2"	13'5"	12'4"	13'11"
480	12'11"	13'2"	13'5"	13'8"	13'11"	14'2"	14'5"	13'5"	15'0"
500	13'11"	14'3"	14'6"	14'9"	15'0"	15'3"	15'6"	14'6"	16'1"

FOR PLANNING USE ONLY

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

Table CO 149–14: Tension — Temperature Stringing Table 17 kV 350 kcmil Copper Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 17 kV 350 HDCU for Light-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	2433	2170	1935	1731	1556	1413	1292	1915	1078
120	2471	2236	2019	1838	1678	1544	1429	2006	1223
140	2515	2295	2104	1935	1788	1663	1554	2091	1353
160	2549	2352	2176	2020	1885	1766	1663	2166	1471
180	2577	2396	2236	2095	1970	1859	1760	2227	1576
200	2609	2442	2295	2164	2048	1943	1851	2289	1674
220	2633	2483	2347	2226	2117	2018	1929	2340	1763
240	2658	2517	2394	2281	2179	2087	2003	2389	1843
260	2677	2550	2436	2329	2236	2148	2069	2430	1916
280	2695	2578	2472	2373	2286	2203	2128	2467	1983
300	2712	2604	2504	2414	2331	2253	2183	2503	2044
320	2724	2626	2532	2448	2370	2296	2229	2530	2099
340	2738	2647	2562	2482	2407	2338	2275	2558	2151
360	2750	2666	2585	2511	2441	2377	2317	2583	2198
380	2761	2679	2606	2536	2471	2410	2352	2605	2240
400	2770	2696	2626	2561	2499	2442	2386	2625	2280
420	2778	2710	2644	2582	2525	2470	2418	2642	2317
440	2784	2719	2658	2600	2546	2495	2445	2657	2349
460	2791	2731	2674	2619	2568	2519	2473	2673	2381
480	2795	2739	2685	2634	2586	2539	2495	2684	2408
500	2802	2748	2698	2650	2604	2560	2517	2697	2434

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 149–15: Sag — Temperature Stringing Table 35 kV 350 HDCU for Light-Loading Areas

Sag — Temperature Stringing Table 35 kV 350 HDCU for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'9"	0'9"	0'11"	1'0"	1'1"	1'2"	1'3"	0'11"	1'6"
120	1'0"	1'1"	1'3"	1'4"	1'5"	1'7"	1'8"	1'3"	1'11"
140	1'4"	1'6"	1'7"	1'9"	1'10"	2'0"	2'1"	1'7"	2'4"
160	1'9"	1'11"	2'0"	2'2"	2'3"	2'5"	2'7"	2'0"	2'10"
180	2'2"	2'4"	2'6"	2'8"	2'9"	2'11"	3'1"	2'6"	3'5"
200	2'8"	2'10"	3'0"	3'2"	3'4"	3'6"	3'8"	3'0"	4'0"
220	3'3"	3'5"	3'7"	3'9"	3'11"	4'1"	4'3"	3'7"	4'7"
240	3'10"	4'0"	4'2"	4'4"	4'6"	4'8"	4'10"	4'2"	5'3"
260	4'5"	4'7"	4'10"	5'0"	5'2"	5'4"	5'6"	4'10"	5'11"
280	5'1"	5'4"	5'6"	5'8"	5'11"	6'1"	6'3"	5'6"	6'8"
300	5'10"	6'1"	6'3"	6'5"	6'8"	6'10"	7'0"	6'3"	7'5"
320	6'7"	6'10"	7'0"	7'3"	7'5"	7'8"	7'10"	7'0"	8'3"
340	7'5"	7'8"	7'10"	8'1"	8'4"	8'6"	8'8"	7'11"	9'2"
360	8'4"	8'6"	8'9"	9'0"	9'2"	9'5"	9'7"	8'9"	10'1"
380	9'3"	9'6"	9'8"	9'11"	10'2"	10'4"	10'7"	9'8"	11'0"
400	10'3"	10'5"	10'8"	10'11"	11'2"	11'4"	11'7"	10'8"	12'0"
420	11'3"	11'6"	11'9"	11'11"	12'2"	12'5"	12'7"	11'9"	13'1"
440	12'4"	12'7"	12'10"	13'0"	13'3"	13'6"	13'9"	12'10"	14'2"
460	13'5"	13'8"	13'11"	14'2"	14'5"	14'8"	14'10"	13'11"	15'4"
480	14'8"	14'10"	15'1"	15'4"	15'7"	15'10"	16'1"	15'1"	16'6"
500	15'10"	16'1"	16'4"	16'7"	16'10"	17'1"	17'4"	16'4"	17'9"

FOR PLANNING USE ONLY

Note(s): Listed temperatures refer to conductor temperatures, not ambient temperature.

Table CO 149–16: Tension — Temperature Stringing Table 35 kV 350 kcmil Copper Covered Conductor for Light-Loading Areas

Tension — Temperature Stringing Table 35 kV 350 HDCU for Light-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	2452	2204	1982	1791	1628	1491	1373	1964	1164
120	2487	2264	2069	1897	1750	1622	1513	2056	1314
140	2524	2323	2151	1994	1860	1741	1638	2141	1448
160	2558	2380	2220	2079	1955	1846	1749	2212	1568
180	2586	2427	2283	2154	2038	1937	1846	2275	1674
200	2611	2467	2336	2218	2114	2018	1932	2330	1768
220	2636	2505	2384	2276	2179	2090	2009	2380	1855
240	2655	2536	2426	2326	2235	2154	2078	2421	1932
260	2671	2562	2463	2371	2288	2210	2139	2460	2002
280	2685	2587	2494	2410	2332	2260	2193	2492	2064
300	2699	2607	2524	2446	2372	2305	2243	2521	2121
320	2711	2628	2550	2477	2410	2347	2288	2548	2173
340	2721	2645	2573	2505	2442	2383	2328	2570	2220
360	2730	2659	2593	2531	2471	2416	2364	2592	2262
380	2736	2671	2610	2552	2497	2445	2396	2608	2300
400	2744	2683	2626	2572	2520	2471	2426	2625	2334
420	2748	2692	2639	2588	2540	2494	2451	2638	2365
440	2754	2701	2652	2605	2560	2516	2475	2652	2394
460	2758	2710	2663	2619	2576	2536	2497	2662	2420
480	2762	2717	2673	2632	2591	2553	2517	2673	2444
500	2764	2721	2681	2642	2605	2569	2534	2681	2465

FOR PLANNING USE ONLY

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

7.0 Guying

Conductor tensions for guying 4/0 copper covered conductor is 3,260 lb.

8.0 Ground Clearance

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

Table CO 149–17: Sag — Temperature Stringing Table 17 kV 500 kcmil Copper Covered Conductor 2.0 for Light-Loading Areas

Sag — Temperature Stringing Table 17 kV 500 HDCU for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'11"	1'0"	1'1"	1'2"	1'4"	1'5"	1'6"	1'1"	1'8"
120	1'3"	1'4"	1'6"	1'7"	1'9"	1'10"	1'11"	1'6"	2'2"
140	1'8"	1'9"	1'11"	2'0"	2'2"	2'3"	2'5"	1'11"	2'8"
160	2'2"	2'3"	2'5"	2'6"	2'8"	2'10"	2'11"	2'5"	3'3"
180	2'8"	2'9"	2'11"	3'1"	3'3"	3'5"	3'6"	2'11"	3'10"
200	3'3"	3'5"	3'6"	3'8"	3'10"	4'0"	4'2"	3'6"	4'5"
220	3'10"	4'0"	4'2"	4'4"	4'6"	4'8"	4'10"	4'2"	5'2"
240	4'6"	4'9"	4'11"	5'1"	5'3"	5'5"	5'7"	4'11"	5'11"
260	5'3"	5'6"	5'8"	5'10"	6'0"	6'2"	6'4"	5'8"	6'8"
280	6'1"	6'3"	6'5"	6'8"	6'10"	7'0"	7'2"	6'5"	7'6"
300	6'11"	7'2"	7'4"	7'6"	7'8"	7'10"	8'1"	7'4"	8'5"
320	7'10"	8'1"	8'3"	8'5"	8'7"	8'10"	9'0"	8'3"	9'4"
340	8'10"	9'0"	9'3"	9'5"	9'7"	9'10"	10'0"	9'3"	10'5"
360	9'10"	10'1"	10'3"	10'6"	10'8"	10'10"	11'1"	10'3"	11'5"
380	11'0"	11'2"	11'4"	11'7"	11'9"	12'0"	12'2"	11'5"	12'7"
400	12'1"	12'4"	12'6"	12'9"	12'11"	13'2"	13'4"	12'6"	13'9"
420	13'4"	13'6"	13'9"	14'0"	14'2"	14'4"	14'7"	13'9"	15'0"
440	14'7"	14'10"	15'0"	15'3"	15'5"	15'8"	15'10"	15'0"	16'3"
460	15'11"	16'2"	16'5"	16'7"	16'10"	17'0"	17'3"	16'5"	17'8"
480	17'4"	17'7"	17'9"	18'0"	18'2"	18'5"	18'7"	17'9"	19'0"
500	18'10"	19'0"	19'3"	19'6"	19'8"	19'11"	20'1"	19'3"	20'6"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 149–18: Tension — Temperature Stringing Table 17 kV 500 kcmil Copper Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 17 kV 500 HDCU for Light-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	2435	2196	1996	1826	1685	1563	1460	1986	1284
120	2511	2306	2127	1973	1841	1727	1629	2119	1456
140	2575	2395	2235	2097	1976	1871	1777	2227	1607
160	2629	2469	2326	2201	2091	1993	1905	2322	1742
180	2670	2531	2403	2290	2187	2096	2014	2398	1859
200	2714	2585	2471	2367	2274	2189	2111	2468	1965
220	2745	2630	2529	2433	2347	2268	2196	2525	2058
240	2770	2670	2574	2489	2410	2337	2269	2572	2139
260	2793	2703	2617	2539	2465	2397	2334	2614	2212
280	2816	2732	2655	2583	2516	2453	2393	2653	2279
300	2831	2757	2685	2619	2557	2499	2443	2684	2336
320	2846	2778	2712	2651	2594	2540	2488	2711	2388
340	2858	2795	2736	2679	2626	2576	2528	2735	2434
360	2868	2811	2756	2704	2655	2608	2563	2755	2475
380	2877	2824	2774	2725	2680	2636	2594	2773	2512
400	2886	2836	2791	2746	2703	2662	2623	2789	2546
420	2892	2847	2804	2763	2723	2684	2648	2803	2575
440	2897	2854	2814	2776	2739	2703	2669	2814	2601
460	2901	2862	2825	2789	2754	2721	2689	2825	2625
480	2905	2869	2835	2801	2769	2737	2707	2834	2646
500	2907	2874	2841	2810	2780	2750	2722	2841	2665

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 149–19: Sag — Temperature Stringing Table 35 kV 500 kcmil Copper Covered Conductor 2.0 for Light-Loading Areas

FOR PLANNING USE ONLY

Sag — Temperature Stringing Table 35 kV 500 HDCU for Light-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1'0"	1'1"	1'2"	1'3"	1'4"	1'6"	1'7"	1'2"	1'9"
120	1'4"	1'6"	1'7"	1'8"	1'10"	1'11"	2'0"	1'7"	2'3"
140	1'10"	1'11"	2'1"	2'2"	2'4"	2'5"	2'6"	2'1"	2'9"
160	2'4"	2'5"	2'7"	2'9"	2'10"	3'0"	3'1"	2'7"	3'4"
180	2'11"	3'0"	3'2"	3'4"	3'5"	3'7"	3'9"	3'2"	4'0"
200	3'6"	3'8"	3'10"	4'0"	4'1"	4'3"	4'5"	3'10"	4'8"
220	4'3"	4'5"	4'6"	4'8"	4'10"	5'0"	5'2"	4'7"	5'5"
240	5'0"	5'2"	5'4"	5'6"	5'8"	5'9"	5'11"	5'4"	6'3"
260	5'10"	6'0"	6'2"	6'4"	6'6"	6'8"	6'10"	6'2"	7'1"
280	6'8"	6'10"	7'1"	7'3"	7'5"	7'7"	7'9"	7'1"	8'1"
300	7'8"	7'10"	8'0"	8'2"	8'4"	8'6"	8'8"	8'0"	9'0"
320	8'8"	8'10"	9'0"	9'3"	9'5"	9'7"	9'9"	9'0"	10'1"
340	9'9"	9'11"	10'2"	10'4"	10'6"	10'8"	10'10"	10'2"	11'2"
360	10'11"	11'1"	11'4"	11'6"	11'8"	11'10"	12'0"	11'4"	12'5"
380	12'2"	12'4"	12'6"	12'9"	12'11"	13'1"	13'3"	12'6"	13'8"
400	13'5"	13'7"	13'10"	14'0"	14'2"	14'5"	14'7"	13'10"	14'11"
420	14'9"	15'0"	15'2"	15'4"	15'7"	15'9"	15'11"	15'2"	16'4"
440	16'3"	16'5"	16'7"	16'10"	17'0"	17'2"	17'4"	16'7"	17'9"
460	17'9"	17'11"	18'1"	18'4"	18'6"	18'8"	18'10"	18'1"	19'3"
480	19'3"	19'6"	19'8"	19'10"	20'1"	20'3"	20'5"	19'8"	20'10"
500	20'11"	21'1"	21'4"	21'6"	21'8"	21'11"	22'1"	21'4"	22'6"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

Table CO 149–20: Tension — Temperature Stringing Table 35 kV 500 kcmil Copper Covered Conductor 2.0 for Light-Loading Areas

Tension — Temperature Stringing Table 35 kV 500 HDCU for Light-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	2463	2241	2053	1895	1758	1643	1543	2045	1369
120	2535	2346	2180	2037	1914	1807	1713	2173	1542
140	2595	2431	2286	2158	2046	1945	1857	2279	1695
160	2645	2501	2373	2260	2156	2065	1982	2368	1827
180	2686	2559	2447	2343	2250	2166	2089	2442	1944
200	2719	2608	2507	2413	2329	2251	2179	2503	2044
220	2744	2647	2556	2473	2395	2325	2258	2553	2131
240	2769	2683	2600	2524	2455	2389	2328	2599	2210
260	2790	2711	2637	2569	2504	2445	2387	2635	2278
280	2807	2737	2670	2607	2548	2492	2440	2668	2338
300	2819	2755	2695	2638	2584	2532	2484	2693	2389
320	2832	2774	2719	2667	2617	2569	2525	2718	2437
340	2841	2788	2738	2691	2645	2601	2559	2737	2478
360	2849	2801	2754	2710	2668	2628	2589	2754	2513
380	2855	2811	2769	2729	2690	2652	2616	2769	2545
400	2860	2820	2781	2744	2708	2673	2640	2781	2574
420	2865	2828	2792	2757	2724	2692	2660	2791	2599
440	2868	2833	2801	2769	2738	2708	2679	2800	2621
460	2870	2838	2808	2778	2749	2721	2694	2808	2641
480	2872	2843	2815	2787	2760	2734	2709	2814	2658
500	2873	2846	2819	2794	2769	2744	2721	2820	2673

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

9.0 Guying

Conductor tensions for guying 4/0 Covered Conductor is 3,260 lb.

10.0 Ground Clearance

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

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.

This page intentionally left blank.

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

	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1'-4"	1'-5"	1'-6"	1'-7"	1'-8"	1'-9"	1'-10"	1'-6"	2'-0"
120	2'-1"	2'-2"	2'-3"	2'-4"	2'-5"	2'-6"	2'-7"	2'-3"	2'-10"
140	3'-0"	3'-1"	3'-2"	3'-3"	3'-4"	3'-5"	3'-7"	3'-2"	3'-9"
160	4'-0"	4'-1"	4'-3"	4'-4"	4'-5"	4'-6"	4'-7"	4'-3"	4'-9"
180	5'-3"	5'-4"	5'-5"	5'-6"	5'-8"	5'-9"	5'-10"	5'-5"	6'-0"
200	6'-7"	6'-8"	6'-9"	6'-11"	7'-0"	7'-1"	7'-2"	6'-9"	7'-4"
220	8'-1"	8'-2"	8'-3"	8'-5"	8'-6"	8'-7"	8'-8"	8'-3"	8'-10"
240	9'-9"	9'-10"	9'-11"	10'-0"	10'-2"	10'-3"	10'-4"	9'-11"	10'-6"
260	11'-6"	11'-8"	11'-9"	11'-10"	11'-11"	12'-1"	12'-2"	11'-9"	12'-4"
280	13'-6"	13'-7"	13'-9"	13'-10"	13'-11"	14'-0"	14'-1"	13'-9"	14'-4"
300	15'-8"	15'-9"	15'-10"	15'-11"	16'-1"	16'-2"	16'-3"	15'-10"	16'-5"
320	17'-11"	18'-0"	18'-2"	18'-3"	18'-4"	18'-5"	18'-6"	18'-2"	18'-9"
340	20'-5"	20'-6"	20'-7"	20'-9"	20'-10"	20'-11"	21'-0"	20'-7"	21'-2"
360	23'-0"	23'-2"	23'-3"	23'-4"	23'-5"	23'-6"	23'-8"	23'-3"	23'-10"
380	25'-10"	25'-11"	26'-1"	26'-2"	26'-3"	26'-4"	26'-5"	26'-1"	26'-8"
400	28'-10"	28'-11"	29'-1"	29'-2"	29'-3"	29'-4"	29'-5"	29'-1"	29'-8"
420	32'-0"	32'-1"	32'-3"	32'-4"	32'-5"	32'-6"	32'-8"	32'-3"	32'-10"
440	35'-5"	35'-6"	35'-7"	35'-9"	35'-10"	35'-11"	36'-0"	35'-7"	36'-2"
460	39'-0"	39'-1"	39'-3"	39'-4"	39'-5"	39'-6"	39'-7"	39'-3"	39'-9"
480	42'-9"	42'-10"	43'-0"	43'-1"	43'-2"	43'-3"	43'-4"	43'-0"	43'-7"
500	46'-9"	46'-11"	47'-0"	47'-1"	47'-2"	47'-4"	47'-5"	47'-0"	47'-7"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	293	274	256	242	229	218	208	255	190
120	268	256	244	235	226	218	210	244	197
140	254	245	237	230	224	218	212	237	202
160	244	238	232	227	222	218	213	232	205
180	238	234	229	225	221	217	214	229	207
200	234	230	226	223	220	217	214	226	209
220	230	227	224	222	219	217	214	224	210
240	227	225	223	220	218	216	214	223	210
260	225	223	221	219	217	216	214	221	211
280	223	222	220	218	217	215	214	220	211
300	221	220	218	217	216	214	213	218	211
320	220	219	217	216	215	214	213	217	210
340	218	217	216	215	214	213	212	216	210
360	217	216	215	214	213	212	211	215	210
380	216	215	214	213	212	211	211	214	209
400	214	214	213	212	211	211	210	213	208
420	213	212	211	211	210	209	209	211	208
440	212	211	210	210	209	208	208	210	207
460	210	210	209	208	208	207	207	209	206
480	209	208	208	207	207	206	206	208	205
500	207	207	206	206	205	205	205	206	204

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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.

This page intentionally left blank.

CO 153 Sag —Temperature Chart #2 — 500 kcmil Copper for Covered Conductor 2.0

Scope CO 153.1 Sag —Temperature Chart #2 — 500 kcmil Copper for Covered Conductor 2.0

Table CO 153–1: Sag—Temperature Chart 17 kV #2 Copper Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 2 Copper for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1'3"	1'4"	1'5"	1'6"	1'7"	1'8"	1'9"	1'5"	1'11"
120	1'11"	2'0"	2'2"	2'3"	2'4"	2'5"	2'6"	2'2"	2'8"
140	2'9"	2'11"	3'0"	3'1"	3'2"	3'3"	3'5"	3'0"	3'7"
160	3'9"	3'11"	4'0"	4'1"	4'3"	4'4"	4'5"	4'0"	4'7"
180	4'11"	5'0"	5'2"	5'3"	5'4"	5'5"	5'7"	5'2"	5'9"
200	6'3"	6'4"	6'5"	6'6"	6'8"	6'9"	6'10"	6'5"	7'1"
220	7'8"	7'9"	7'10"	8'0"	8'1"	8'2"	8'3"	7'10"	8'6"
240	9'3"	9'4"	9'5"	9'7"	9'8"	9'9"	9'10"	9'5"	10'1"
260	11'0"	11'1"	11'2"	11'3"	11'4"	11'6"	11'7"	11'2"	11'9"
280	12'10"	12'11"	13'0"	13'2"	13'3"	13'4"	13'5"	13'0"	13'8"
300	14'10"	14'11"	15'1"	15'2"	15'3"	15'4"	15'6"	15'1"	15'8"
320	17'0"	17'1"	17'3"	17'4"	17'5"	17'7"	17'8"	17'3"	17'10"
340	19'4"	19'6"	19'7"	19'8"	19'9"	19'11"	20'0"	19'7"	20'2"
360	21'10"	22'0"	22'1"	22'2"	22'3"	22'5"	22'6"	22'1"	22'8"
380	24'6"	24'8"	24'9"	24'10"	24'11"	25'1"	25'2"	24'9"	25'4"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.
Contact Transmission Engineering for span lengths above 380'.

FOR PLANNING USE ONLY

Table CO 153–2: Tension — Temperature Stringing Table 17 kV #2 Copper Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 2 Copper for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	301	279	260	244	230	217	207	260	187
120	273	259	247	236	226	217	209	247	195
140	257	248	239	231	224	217	211	239	200
160	247	240	234	228	222	217	212	234	203
180	240	235	230	225	221	217	213	230	206
200	235	231	227	224	220	217	214	227	208
220	231	228	225	222	219	216	214	225	209
240	228	226	223	221	218	216	214	223	210
260	226	224	222	219	217	216	214	222	210
280	224	222	220	218	217	215	213	220	210
300	222	220	219	217	216	214	213	219	210
320	220	219	218	216	215	214	213	218	210
340	219	218	217	215	214	213	212	217	210
360	217	217	215	214	213	212	212	215	210
380	216	215	214	213	213	212	211	214	209

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.
Contact Transmission Engineering for span lengths above 380’.

FOR PLANNING USE ONLY

Table CO 153–3: Sag — Temperature Stringing Table 35 kV #2 Copper Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 35kV #2 Copper CC for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1'8"	1'9"	1'10"	1'11"	2'0"	2'1"	2'1"	1'10"	2'3"
120	2'6"	2'7"	2'8"	2'9"	2'10"	2'11"	3'0"	2'8"	3'2"
140	3'7"	3'8"	3'9"	3'10"	3'11"	4'0"	4'1"	3'9"	4'3"
160	4'10"	4'11"	5'0"	5'1"	5'2"	5'3"	5'4"	5'0"	5'6"
180	6'2"	6'3"	6'4"	6'5"	6'6"	6'7"	6'8"	6'4"	6'10"
200	7'9"	7'10"	7'11"	8'0"	8'1"	8'2"	8'3"	7'11"	8'5"
220	9'6"	9'7"	9'8"	9'9"	9'10"	9'11"	10'0"	9'8"	10'2"
240	11'5"	11'6"	11'7"	11'8"	11'9"	11'10"	11'11"	11'7"	12'1"
260	13'6"	13'8"	13'9"	13'10"	13'11"	14'0"	14'1"	13'9"	14'3"
280	15'10"	15'11"	16'0"	16'1"	16'2"	16'3"	16'4"	16'0"	16'6"
300	18'4"	18'5"	18'6"	18'7"	18'8"	18'9"	18'10"	18'6"	19'0"
320	21'0"	21'1"	21'2"	21'3"	21'4"	21'5"	21'6"	21'2"	21'9"
340	23'11"	24'0"	24'1"	24'2"	24'3"	24'4"	24'5"	24'1"	24'7"
360	27'0"	27'1"	27'2"	27'3"	27'5"	27'6"	27'7"	27'3"	27'9"
380	30'4"	30'5"	30'7"	30'8"	30'9"	30'10"	30'11"	30'6"	31'1"

Note(s): Listed temperatures refers to conductor temperature, not ambient temperature.
Contact Transmission Engineering for span lengths above 380'.

FOR PLANNING USE ONLY

Table CO 153–4: Tension — Temperature Stringing Table 35 kV #2 Copper Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 35kV #2 Copper CC for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	296	282	269	257	247	238	230	268	214
120	278	269	260	253	246	239	233	260	221
140	267	261	255	249	244	239	234	255	226
160	260	256	251	247	243	239	235	251	228
180	255	252	249	245	242	239	236	248	230
200	252	249	246	244	241	239	236	246	232
220	249	247	244	242	240	238	236	244	232
240	246	245	243	241	239	237	236	243	233
260	244	243	241	240	238	237	235	241	233
280	242	241	240	238	237	236	235	240	232
300	241	239	238	237	236	235	234	238	232
320	239	238	237	236	235	234	233	237	231
340	237	236	235	235	234	233	232	236	231
360	235	235	234	233	233	232	231	234	230
380	234	233	232	232	231	231	230	232	229

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.
Contact Transmission Engineering for span lengths above 380'.

FOR PLANNING USE ONLY

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.

Table CO 153–5: Sag — Temperature Stringing Table 17 kV 2/0 Copper Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 2/0 Copper for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'9"	0'10"	0'11"	1'0"	1'2"	1'3"	1'4"	0'11"	1'7"
120	1'2"	1'3"	1'5"	1'6"	1'7"	1'9"	1'10"	1'5"	2'1"
140	1'8"	1'9"	1'11"	2'1"	2'2"	2'3"	2'5"	1'11"	2'8"
160	2'3"	2'5"	2'7"	2'8"	2'10"	2'11"	3'1"	2'7"	3'4"
180	3'0"	3'1"	3'3"	3'5"	3'6"	3'8"	3'10"	3'3"	4'1"
200	3'9"	3'11"	4'1"	4'3"	4'4"	4'6"	4'7"	4'1"	4'11"
220	4'8"	4'10"	4'11"	5'1"	5'3"	5'5"	5'6"	4'11"	5'10"
240	5'7"	5'9"	5'11"	6'1"	6'3"	6'4"	6'6"	5'11"	6'10"
260	6'8"	6'10"	7'0"	7'2"	7'4"	7'5"	7'7"	7'0"	7'11"
280	7'10"	8'0"	8'2"	8'4"	8'5"	8'7"	8'9"	8'2"	9'1"
300	9'1"	9'3"	9'5"	9'6"	9'8"	9'10"	10'0"	9'5"	10'4"
320	10'5"	10'7"	10'9"	10'11"	11'0"	11'2"	11'4"	10'9"	11'8"
340	11'10"	12'0"	12'2"	12'4"	12'6"	12'7"	12'9"	12'2"	13'1"
360	13'4"	13'6"	13'8"	13'10"	14'0"	14'2"	14'3"	13'8"	14'7"
380	14'11"	15'1"	15'3"	15'5"	15'7"	15'9"	15'11"	15'3"	16'3"
400	16'8"	16'10"	17'0"	17'2"	17'3"	17'5"	17'7"	17'0"	17'11"
420	18'5"	18'7"	18'9"	18'11"	19'1"	19'3"	19'5"	18'9"	19'9"
440	20'4"	20'6"	20'8"	20'10"	21'0"	21'2"	21'3"	20'8"	21'7"
460	22'4"	22'6"	22'8"	22'9"	22'11"	23'1"	23'3"	22'8"	23'7"
480	24'5"	24'6"	24'9"	24'10"	25'0"	25'2"	25'4"	24'8"	25'8"
500	26'7"	26'9"	26'11"	27'1"	27'3"	27'4"	27'6"	26'11"	27'10"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 153–6: Tension — Temperature Stringing Table 17 kV 2/0 Copper Covered Conductor 2.0 for Heavy-Loading Areas

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	866	778	701	636	579	533	493	696	422
120	813	745	684	632	588	550	517	681	457
140	772	719	671	630	594	563	535	670	484
160	741	699	661	629	599	573	550	661	506
180	718	684	654	627	603	584	561	653	523
200	699	673	648	626	605	587	569	648	537
220	686	664	644	625	608	591	576	643	548
240	675	656	640	624	609	595	582	639	557
260	666	651	636	623	610	597	586	636	564
280	659	646	634	622	611	600	590	634	570
300	653	642	631	621	611	601	592	631	575
320	648	638	629	620	611	603	595	629	579
340	644	635	627	619	611	603	596	627	582
360	640	632	625	618	611	604	598	625	585
380	637	630	623	617	611	604	599	623	587
400	634	627	622	616	610	605	599	622	589
420	631	625	620	615	610	605	600	620	590
440	628	623	618	614	609	604	600	618	591
460	626	621	617	612	608	604	600	617	592
480	624	619	615	611	607	603	600	615	593
500	621	617	614	610	606	603	599	614	592

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Sag — Temperature Stringing Table 35 kV 2/0 Copper Covered Conductor 2.0 for Heavy-Loading Areas

Table CO 153–7: Sag — Temperature Stringing Table 35 kV 2/0 Copper Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 35kV 2/0 Copper for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1'0"	1'1"	1'2"	1'3"	1'4"	1'5"	1'6"	1'2"	1'9"
120	1'6"	1'7"	1'8"	1'9"	1'11"	2'0"	2'1"	1'8"	2'4"
140	2'1"	2'3"	2'4"	2'5"	2'7"	2'8"	2'9"	2'4"	3'0"
160	2'10"	2'11"	3'1"	3'2"	3'4"	3'5"	3'6"	3'1"	3'9"
180	3'8"	3'9"	3'11"	4'0"	4'2"	4'3"	4'5"	3'11"	4'8"
200	4'7"	4'9"	4'10"	5'0"	5'1"	5'3"	5'4"	4'10"	5'7"
220	5'8"	5'9"	5'11"	6'1"	6'2"	6'4"	6'5"	5'11"	6'8"
240	6'10"	6'11"	7'1"	7'3"	7'4"	7'6"	7'7"	7'1"	7'10"
260	8'1"	8'3"	8'4"	8'6"	8'7"	8'9"	8'10"	8'4"	9'1"
280	9'5"	9'7"	9'9"	9'10"	10'0"	10'1"	10'3"	9'9"	10'6"
300	10'11"	11'1"	11'2"	11'4"	11'6"	11'7"	11'9"	11'2"	12'0"
320	12'6"	12'8"	12'9"	12'11"	13'1"	13'2"	13'4"	12'9"	13'7"
340	14'2"	14'4"	14'6"	14'7"	14'9"	14'11"	15'0"	14'6"	15'3"
360	16'0"	16'2"	16'3"	16'5"	16'6"	16'8"	16'10"	16'3"	17'1"
380	17'11"	18'1"	18'2"	18'4"	18'6"	18'7"	18'9"	18'2"	19'0"
400	19'11"	20'1"	20'3"	20'4"	20'6"	20'8"	20'9"	20'3"	21'0"
420	22'1"	22'3"	22'4"	22'6"	22'8"	22'9"	22'11"	22'4"	23'2"
440	24'4"	24'6"	24'7"	24'9"	24'11"	25'0"	25'2"	24'8"	25'5"

Note(s): Listed temperature refer to conductor temperatures, not ambient temperature.
Contact Transmission Engineering for span lengths above 440'.

FOR PLANNING USE ONLY

Table CO 153–8: Tension — Temperature Stringing Table 35 kV 2/0 Copper Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 35kV 2/0 Copper for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	831	761	699	646	600	561	528	696	466
120	786	733	687	646	610	579	551	684	500
140	752	712	677	645	617	591	568	676	526
160	728	697	670	644	622	601	581	669	545
180	710	686	663	643	625	607	591	663	560
200	697	677	660	643	627	613	599	659	572
220	686	671	656	642	629	616	604	656	582
240	678	665	653	641	630	619	609	653	589
260	672	661	650	640	630	621	612	650	595
280	666	657	648	639	631	622	615	648	599
300	662	654	646	638	631	623	617	646	603
320	658	651	644	637	630	624	618	644	606
340	654	648	642	636	630	624	619	642	608
360	651	645	640	635	629	624	619	640	610
380	648	643	638	633	629	624	620	638	611
400	645	641	636	632	628	624	620	636	612
420	642	638	634	631	627	623	619	634	612
440	640	636	633	629	626	622	619	632	612

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.
Contact Transmission Engineering for span lengths above 440'.

FOR PLANNING USE ONLY

3.0 Guying

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

4.0 Ground Clearance

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

Table CO 153–9: Sag — Temperature Stringing Table 17 kV 4/0 Copper Covered Conductor 2.0 for Heavy-Loading Area

Tension — Temperature Stringing Table 17 kV 4/0 Copper for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'8"	0'9"	0'10"	0'11"	1'0"	1'2"	1'3"	0'10"	1'6"
120	1'0"	1'1"	1'2"	1'4"	1'5"	1'6"	1'8"	1'3"	1'11"
140	1'5"	1'6"	1'8"	1'9"	1'11"	2'0"	2'2"	1'8"	2'5"
160	1'10"	2'0"	2'2"	2'3"	2'5"	2'6"	2'8"	2'2"	3'0"
180	2'5"	2'6"	2'8"	2'10"	3'0"	3'2"	3'3"	2'8"	3'7"
200	3'0"	3'2"	3'4"	3'6"	3'8"	3'9"	3'11"	3'4"	4'3"
220	3'8"	3'10"	4'0"	4'2"	4'4"	4'6"	4'8"	4'0"	5'0"
240	4'5"	4'7"	4'9"	4'11"	5'2"	5'3"	5'5"	4'9"	5'9"
260	5'3"	5'5"	5'7"	5'9"	6'0"	6'2"	6'4"	5'7"	6'8"
280	6'2"	6'4"	6'6"	6'8"	6'10"	7'1"	7'3"	6'6"	7'7"
300	7'1"	7'4"	7'6"	7'8"	7'10"	8'0"	8'2"	7'6"	8'7"
320	8'2"	8'4"	8'6"	8'8"	8'11"	9'1"	9'3"	8'6"	9'7"
340	9'3"	9'5"	9'7"	9'10"	10'0"	10'2"	10'4"	9'7"	10'9"
360	10'5"	10'7"	10'9"	11'0"	11'2"	11'4"	11'6"	10'9"	11'11"
380	11'8"	11'10"	12'0"	12'3"	12'5"	12'7"	12'10"	12'0"	13'2"
400	12'11"	13'2"	13'4"	13'6"	13'9"	13'11"	14'1"	13'4"	14'6"
420	14'4"	14'6"	14'9"	14'11"	15'1"	15'4"	15'6"	14'9"	15'11"
440	15'9"	16'0"	16'2"	16'5"	16'7"	16'9"	17'0"	16'2"	17'4"
460	17'3"	17'6"	17'8"	17'11"	18'1"	18'3"	18'6"	17'8"	18'11"
480	18'11"	19'1"	19'4"	19'6"	19'8"	19'11"	20'1"	19'4"	20'6"
500	20'7"	20'9"	21'0"	21'2"	21'4"	21'7"	21'9"	21'0"	22'2"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 153–10: Tension — Temperature Stringing Table 17 kV 4/0 Copper Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 4/0 Copper for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1489	1332	1191	1072	968	881	808	1182	678
120	1449	1315	1195	1093	1004	929	865	1187	749
140	1411	1297	1197	1110	1034	969	913	1191	808
160	1377	1281	1197	1123	1059	1001	950	1193	857
180	1348	1268	1196	1133	1077	1027	982	1194	898
200	1326	1258	1197	1142	1093	1049	1009	1195	934
220	1308	1251	1199	1151	1108	1069	1032	1197	964
240	1292	1243	1197	1156	1117	1083	1050	1196	989
260	1280	1238	1198	1161	1128	1096	1067	1197	1011
280	1269	1232	1197	1165	1135	1107	1080	1197	1030
300	1260	1227	1196	1168	1141	1115	1091	1196	1045
320	1252	1223	1196	1171	1146	1123	1101	1196	1060
340	1246	1220	1196	1173	1151	1130	1110	1195	1072
360	1240	1217	1195	1174	1154	1135	1117	1195	1082
380	1235	1214	1194	1175	1157	1140	1123	1194	1091
400	1230	1211	1193	1176	1159	1144	1128	1193	1098
420	1226	1209	1192	1177	1161	1147	1133	1192	1105
440	1222	1206	1191	1177	1163	1150	1136	1191	1111
460	1218	1204	1190	1177	1164	1152	1140	1190	1116
480	1214	1202	1189	1177	1165	1153	1142	1189	1120
500	1211	1199	1188	1176	1166	1155	1145	1188	1124

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 153–11: Sag — Temperature Stringing Table 35 kV 4/0 Copper Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 35kV 4/0 Copper for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1'6"	1'7"	1'9"	1'10"	1'11"	2'0"	2'0"	1'9"	2'2"
120	2'2"	2'3"	2'5"	2'6"	2'7"	2'8"	2'9"	2'5"	2'11"
140	3'0"	3'1"	3'2"	3'3"	3'4"	3'5"	3'6"	3'2"	3'9"
160	3'10"	4'0"	4'1"	4'2"	4'3"	4'4"	4'5"	4'1"	4'8"
180	4'10"	5'0"	5'1"	5'2"	5'3"	5'5"	5'6"	5'1"	5'8"
200	6'0"	6'1"	6'3"	6'4"	6'5"	6'6"	6'8"	6'3"	6'10"
220	7'3"	7'4"	7'6"	7'7"	7'8"	7'10"	7'11"	7'6"	8'1"
240	8'8"	8'9"	8'10"	9'0"	9'1"	9'2"	9'4"	8'10"	9'6"
260	10'2"	10'3"	10'5"	10'6"	10'7"	10'9"	10'10"	10'5"	11'1"
280	11'10"	11'11"	12'0"	12'2"	12'3"	12'4"	12'6"	12'0"	12'8"
300	13'7"	13'8"	13'10"	13'11"	14'0"	14'2"	14'3"	13'10"	14'6"
320	15'6"	15'7"	15'8"	15'10"	15'11"	16'0"	16'2"	15'8"	16'4"
340	17'6"	17'7"	17'9"	17'10"	18'0"	18'1"	18'2"	17'9"	18'5"
360	19'8"	19'9"	19'11"	20'0"	20'2"	20'3"	20'4"	19'11"	20'7"
380	22'0"	22'1"	22'3"	22'4"	22'5"	22'7"	22'8"	22'3"	22'11"
400	24'5"	24'7"	24'8"	24'9"	24'11"	25'0"	25'2"	24'8"	25'4"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.
Contact Transmission Engineering for span lengths above 400'.

FOR PLANNING USE ONLY

Table CO 153–12: Tension — Temperature Stringing Table 35 kV 4/0 Copper Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 35kV 4/0 Copper for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	756	713	677	644	615	589	567	676	525
120	763	730	701	675	651	629	609	701	573
140	767	741	718	696	676	658	641	717	609
160	769	749	730	712	695	680	665	729	637
180	771	754	738	723	709	696	683	738	660
200	772	758	745	732	720	709	698	745	677
220	772	760	749	738	728	718	709	749	690
240	771	762	752	743	734	725	717	752	701
260	771	762	754	746	738	731	724	754	709
280	770	763	756	749	742	736	729	756	717
300	769	763	756	750	744	738	733	756	722
320	768	762	757	751	746	741	736	757	726
340	766	761	756	751	747	742	738	757	729
360	765	761	756	752	748	743	739	756	731
380	763	759	755	751	747	744	740	755	732
400	761	757	754	750	747	744	740	754	734

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.
Contact Transmission Engineering for span lengths above 400'.

FOR PLANNING USE ONLY

5.0 Guying

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

6.0 Ground Clearance

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

Table CO 153–13: Sag — Temperature Stringing Table 17 kV 350 kcmil Copper Covered Conductor 2.0 for Heavy-Loading Area

Tension — Temperature Stringing Table 17 kV 350 HDCU for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1'0"	1'1"	1'3"	1'4"	1'5"	1'6"	1'7"	1'3"	1'10"
120	1'5"	1'6"	1'8"	1'9"	1'11"	2'0"	2'1"	1'8"	2'4"
140	1'11"	2'0"	2'2"	2'3"	2'5"	2'6"	2'8"	2'2"	2'10"
160	2'6"	2'7"	2'9"	2'10"	3'0"	3'1"	3'3"	2'9"	3'6"
180	3'1"	3'3"	3'4"	3'6"	3'8"	3'9"	3'11"	3'5"	4'2"
200	3'9"	3'11"	4'1"	4'3"	4'5"	4'6"	4'8"	4'1"	4'11"
220	4'7"	4'9"	4'10"	5'0"	5'2"	5'4"	5'5"	4'10"	5'9"
240	5'5"	5'7"	5'9"	5'10"	6'0"	6'2"	6'4"	5'9"	6'8"
260	6'4"	6'6"	6'8"	6'10"	7'0"	7'1"	7'3"	6'8"	7'7"
280	7'4"	7'6"	7'8"	7'10"	8'0"	8'2"	8'3"	7'8"	8'7"
300	8'5"	8'6"	8'9"	8'11"	9'1"	9'3"	9'4"	8'9"	9'8"
320	9'6"	9'8"	9'10"	10'0"	10'2"	10'4"	10'6"	9'10"	10'10"
340	10'9"	10'11"	11'1"	11'3"	11'5"	11'7"	11'9"	11'1"	12'1"
360	12'0"	12'2"	12'5"	12'7"	12'9"	12'11"	13'1"	12'5"	13'5"
380	13'5"	13'7"	13'9"	13'11"	14'1"	14'3"	14'5"	13'9"	14'9"
400	14'10"	15'0"	15'2"	15'5"	15'7"	15'9"	15'11"	15'3"	16'3"
420	16'4"	16'7"	16'9"	16'11"	17'1"	17'3"	17'5"	16'9"	17'9"
440	18'0"	18'2"	18'4"	18'6"	18'8"	18'10"	19'0"	18'4"	19'5"
460	19'8"	19'10"	20'0"	20'2"	20'5"	20'7"	20'9"	20'0"	21'1"
480	21'5"	21'7"	21'9"	22'0"	22'2"	22'4"	22'6"	21'9"	22'10"
500	23'3"	23'6"	23'8"	23'10"	24'0"	24'2"	24'4"	23'8"	24'9"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 153–14: Tension — Temperature Stringing Table 17 kV 350 kcmil Copper Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 350 HDCU for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1556	1413	1292	1190	1106	1034	972	1286	866
120	1584	1464	1362	1273	1198	1133	1075	1359	973
140	1609	1508	1419	1342	1274	1214	1161	1417	1065
160	1627	1542	1464	1397	1336	1282	1233	1463	1143
180	1641	1567	1501	1441	1387	1338	1293	1499	1210
200	1652	1587	1529	1477	1428	1384	1343	1528	1267
220	1661	1605	1555	1507	1464	1424	1387	1553	1316
240	1668	1618	1574	1532	1493	1457	1422	1573	1358
260	1672	1630	1589	1553	1517	1484	1453	1589	1393
280	1677	1639	1603	1570	1538	1508	1480	1603	1425
300	1679	1646	1614	1584	1555	1528	1502	1614	1451
320	1683	1653	1624	1596	1570	1545	1521	1623	1475
340	1684	1657	1631	1606	1583	1560	1538	1631	1495
360	1685	1661	1637	1615	1593	1572	1552	1637	1513
380	1686	1664	1642	1622	1602	1583	1564	1642	1528
400	1686	1666	1646	1627	1609	1591	1574	1646	1541
420	1686	1668	1650	1632	1616	1599	1583	1650	1552
440	1686	1669	1652	1637	1621	1606	1591	1652	1562
460	1685	1670	1654	1640	1625	1611	1598	1654	1571
480	1684	1670	1656	1642	1629	1616	1603	1656	1578
500	1682	1669	1656	1644	1631	1619	1608	1656	1584

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 153–15: Sag — Temperature Stringing Table 35 kV 350 kcmil Copper Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 35 kV 350 HDCU for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1'1"	1'3"	1'4"	1'5"	1'6"	1'7"	1'8"	1'4"	1'11"
120	1'7"	1'8"	1'10"	1'11"	2'0"	2'1"	2'3"	1'10"	2'5"
140	2'1"	2'3"	2'4"	2'6"	2'7"	2'9"	2'10"	2'4"	3'0"
160	2'9"	2'11"	3'0"	3'2"	3'3"	3'4"	3'6"	3'0"	3'9"
180	3'6"	3'7"	3'9"	3'10"	4'0"	4'1"	4'3"	3'9"	4'6"
200	4'3"	4'5"	4'6"	4'8"	4'9"	4'11"	5'1"	4'6"	5'4"
220	5'1"	5'3"	5'5"	5'6"	5'8"	5'10"	5'11"	5'5"	6'3"
240	6'1"	6'3"	6'4"	6'6"	6'8"	6'9"	6'11"	6'4"	7'3"
260	7'1"	7'3"	7'5"	7'7"	7'8"	7'10"	8'0"	7'5"	8'3"
280	8'3"	8'5"	8'6"	8'8"	8'10"	9'0"	9'1"	8'6"	9'5"
300	9'5"	9'7"	9'9"	9'11"	10'1"	10'2"	10'4"	9'9"	10'8"
320	10'9"	10'11"	11'1"	11'2"	11'4"	11'6"	11'8"	11'1"	12'0"
340	12'1"	12'3"	12'5"	12'7"	12'9"	12'11"	13'1"	12'5"	13'4"
360	13'7"	13'9"	13'11"	14'1"	14'3"	14'4"	14'6"	13'11"	14'10"
380	15'2"	15'4"	15'6"	15'8"	15'9"	15'11"	16'1"	15'6"	16'5"
400	16'9"	16'11"	17'1"	17'3"	17'5"	17'7"	17'9"	17'1"	18'1"
420	18'6"	18'8"	18'10"	19'0"	19'2"	19'4"	19'6"	18'10"	19'10"
440	20'4"	20'6"	20'8"	20'10"	21'0"	21'2"	21'4"	20'8"	21'8"
460	22'3"	22'5"	22'7"	22'9"	22'11"	23'1"	23'3"	22'7"	23'7"
480	24'3"	24'6"	24'7"	24'9"	24'11"	25'1"	25'3"	24'8"	25'7"

FOR PLANNING USE ONLY

Note(s): Listed temperatures refer to conductor temperatures, not ambient temperature.

Table CO 153–16: Tension — Temperature Stringing Table 35 kV 350 kcmil Copper Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 35 kV 350 HDCU for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1569	1439	1331	1239	1160	1093	1034	1327	931
120	1595	1491	1399	1320	1250	1190	1136	1396	1039
140	1616	1529	1452	1384	1322	1268	1219	1449	1129
160	1632	1559	1492	1433	1379	1331	1286	1491	1204
180	1643	1581	1524	1473	1426	1382	1342	1523	1267
200	1653	1598	1551	1505	1463	1424	1388	1549	1320
220	1658	1613	1570	1531	1494	1459	1427	1569	1364
240	1663	1624	1586	1551	1518	1487	1458	1586	1402
260	1667	1632	1599	1568	1539	1511	1484	1599	1433
280	1669	1640	1610	1582	1556	1531	1507	1610	1460
300	1672	1645	1619	1594	1570	1547	1526	1619	1483
320	1672	1649	1626	1603	1582	1561	1541	1625	1503
340	1673	1652	1631	1611	1591	1572	1554	1631	1519
360	1674	1654	1635	1617	1599	1582	1566	1635	1533
380	1673	1655	1638	1622	1606	1590	1575	1638	1545
400	1673	1657	1641	1626	1611	1597	1583	1641	1556
420	1671	1657	1643	1629	1616	1603	1589	1643	1565
440	1670	1656	1644	1631	1619	1606	1594	1644	1571
460	1668	1656	1644	1632	1621	1610	1599	1644	1578
480	1667	1655	1644	1634	1623	1613	1603	1644	1583
500	1664	1654	1644	1634	1624	1614	1605	1644	1587

FOR PLANNING USE ONLY

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

7.0 Guying

Conductor tensions for guying 4/0 copper covered conductor is 3,260 lb.

8.0 Ground Clearance

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

Table CO 153–17: Sag — Temperature Stringing Table 17 kV 500 kcmil Copper Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 500 HDCU for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1'4"	1'5"	1'7"	1'8"	1'9"	1'10"	1'11"	1'7"	2'1"
120	1'11"	2'0"	2'1"	2'2"	2'3"	2'5"	2'6"	2'1"	2'8"
140	2'6"	2'7"	2'9"	2'10"	2'11"	3'0"	3'2"	2'9"	3'4"
160	3'2"	3'3"	3'5"	3'6"	3'8"	3'9"	3'10"	3'5"	4'1"
180	3'11"	4'1"	4'2"	4'4"	4'5"	4'7"	4'8"	4'2"	4'11"
200	4'10"	4'11"	5'1"	5'3"	5'4"	5'6"	5'7"	5'1"	5'10"
220	5'9"	5'11"	6'1"	6'2"	6'4"	6'5"	6'7"	6'1"	6'10"
240	6'10"	7'0"	7'1"	7'3"	7'4"	7'6"	7'8"	7'1"	7'11"
260	8'0"	8'1"	8'3"	8'5"	8'6"	8'8"	8'9"	8'3"	9'1"
280	9'3"	9'4"	9'6"	9'8"	9'9"	9'11"	10'0"	9'6"	10'4"
300	10'7"	10'8"	10'10"	11'0"	11'1"	11'3"	11'5"	10'10"	11'8"
320	12'0"	12'2"	12'3"	12'5"	12'7"	12'8"	12'10"	12'3"	13'1"
340	13'6"	13'8"	13'10"	13'11"	14'1"	14'3"	14'4"	13'10"	14'8"
360	15'2"	15'3"	15'5"	15'7"	15'9"	15'10"	16'0"	15'5"	16'3"
380	16'10"	17'0"	17'2"	17'3"	17'5"	17'7"	17'9"	17'2"	18'0"
400	18'8"	18'10"	19'0"	19'1"	19'3"	19'5"	19'7"	19'0"	19'10"
420	20'7"	20'9"	20'11"	21'0"	21'2"	21'4"	21'6"	20'11"	21'9"
440	22'7"	22'9"	22'11"	23'1"	23'3"	23'4"	23'6"	22'11"	23'9"
460	24'9"	24'11"	25'1"	25'2"	25'4"	25'6"	25'8"	25'0"	25'11"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.
Contact Transmission Engineering for span lengths above 460'.

FOR PLANNING USE ONLY

Tension — Temperature Stringing Table 17 kV 653 ACSR/AW Covered Conductor 2.0 for Light-Loading Areas

Table CO 153–18: Tension — Temperature Stringing Table 17 kV 500 kcmil Copper Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 500 HDCU for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1609	1502	1407	1328	1259	1198	1145	1406	1052
120	1676	1585	1504	1435	1372	1316	1266	1504	1177
140	1726	1648	1579	1518	1462	1412	1366	1578	1282
160	1761	1697	1637	1583	1534	1488	1447	1637	1369
180	1789	1735	1683	1636	1592	1551	1513	1683	1442
200	1811	1763	1718	1677	1638	1601	1567	1718	1503
220	1827	1787	1747	1711	1676	1643	1612	1747	1553
240	1841	1805	1771	1738	1707	1678	1650	1770	1596
260	1851	1819	1789	1760	1732	1706	1680	1788	1632
280	1858	1831	1803	1778	1753	1729	1706	1803	1662
300	1864	1839	1815	1792	1770	1748	1728	1815	1688
320	1868	1846	1825	1804	1784	1764	1745	1825	1709
340	1871	1851	1832	1814	1796	1778	1761	1832	1727
360	1874	1856	1838	1822	1805	1789	1773	1838	1742
380	1875	1858	1843	1827	1813	1798	1783	1842	1756
400	1875	1860	1847	1833	1818	1805	1792	1846	1767
420	1875	1862	1848	1836	1823	1811	1799	1849	1775
440	1875	1863	1851	1839	1828	1816	1805	1850	1783
460	1873	1863	1851	1840	1830	1819	1809	1851	1789

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.
Contact Transmission Engineering for span lengths above 460'.

FOR PLANNING USE ONLY

Table CO 153–19: Sag — Temperature Stringing Table 35 kV 500 kcmil Copper Covered Conductor 23.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 35 kV 500 HDCU for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1'6"	1'7"	1'8"	1'9"	1'10"	1'11"	2'0"	1'8"	2'2"
120	2'0"	2'2"	2'3"	2'4"	2'5"	2'6"	2'7"	2'3"	2'10"
140	2'9"	2'10"	2'11"	3'0"	3'2"	3'3"	3'4"	2'11"	3'6"
160	3'6"	3'7"	3'8"	3'10"	3'11"	4'0"	4'1"	3'8"	4'4"
180	4'4"	4'6"	4'7"	4'8"	4'10"	4'11"	5'0"	4'7"	5'3"
200	5'4"	5'5"	5'7"	5'8"	5'9"	5'11"	6'0"	5'7"	6'3"
220	6'4"	6'6"	6'7"	6'9"	6'10"	7'0"	7'1"	6'7"	7'4"
240	7'6"	7'8"	7'9"	7'11"	8'0"	8'2"	8'3"	7'10"	8'6"
260	8'10"	8'11"	9'1"	9'3"	9'4"	9'5"	9'7"	9'1"	9'10"
280	10'2"	10'4"	10'6"	10'7"	10'9"	10'10"	11'0"	10'6"	11'3"
300	11'8"	11'10"	11'11"	12'1"	12'3"	12'4"	12'6"	11'11"	12'9"
320	13'3"	13'5"	13'7"	13'8"	13'10"	13'11"	14'1"	13'7"	14'4"
340	15'0"	15'2"	15'3"	15'5"	15'6"	15'8"	15'9"	15'3"	16'0"
360	16'10"	16'11"	17'1"	17'3"	17'4"	17'6"	17'7"	17'1"	17'10"
380	18'9"	18'11"	19'0"	19'2"	19'3"	19'5"	19'6"	19'0"	19'9"
400	20'9"	20'11"	21'1"	21'2"	21'4"	21'5"	21'7"	21'0"	21'10"
420	22'11"	23'1"	23'3"	23'4"	23'6"	23'7"	23'9"	23'3"	24'0"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.
Contact Transmission Engineering for span lengths above 460'.

FOR PLANNING USE ONLY

Table CO 153–20: Tension — Temperature Stringing Table 35 kV 500 kcmil Copper Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 35 kV 500 HDCU for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1632	1535	1449	1376	1310	1253	1202	1449	1112
120	1693	1612	1540	1476	1419	1367	1320	1539	1236
140	1738	1669	1609	1554	1503	1457	1415	1608	1337
160	1768	1711	1660	1613	1568	1527	1490	1659	1418
180	1792	1745	1700	1659	1620	1584	1550	1700	1486
200	1809	1769	1730	1695	1661	1629	1598	1730	1541
220	1823	1788	1755	1724	1694	1666	1638	1755	1587
240	1833	1803	1774	1746	1720	1695	1671	1774	1624
260	1840	1813	1788	1764	1740	1718	1696	1788	1654
280	1845	1822	1800	1778	1758	1738	1718	1800	1681
300	1849	1829	1809	1790	1771	1753	1736	1809	1702
320	1852	1834	1816	1799	1782	1766	1750	1816	1719
340	1853	1837	1822	1806	1791	1776	1762	1821	1734
360	1854	1839	1825	1811	1798	1784	1771	1825	1746
380	1853	1840	1827	1815	1803	1791	1779	1827	1756
400	1852	1841	1829	1818	1807	1796	1785	1830	1764
420	1851	1840	1830	1819	1809	1799	1789	1830	1770

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.
Contact Transmission Engineering for span lengths above 460'.

FOR PLANNING USE ONLY

9.0 Guying

Conductor tensions for guying 4/0 copper covered conductor is 3,260 lb.

10.0 Ground Clearance

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

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.

This page intentionally left blank.

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.

This page intentionally left blank.

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.

This page intentionally left blank.

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.

This page intentionally left blank.

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

	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-10"	0'-11"	1'-0"	1'-1"	1'-2"	1'-3"	1'-4"	1'-0"	1'-7"
120	1'-3"	1'-4"	1'-5"	1'-7"	1'-8"	1'-9"	1'-11"	1'-6"	2'-1"
140	1'-9"	1'-11"	2'-0"	2'-2"	2'-3"	2'-4"	2'-6"	2'-0"	2'-9"
160	2'-5"	2'-6"	2'-8"	2'-9"	2'-11"	3'-1"	3'-2"	2'-8"	3'-5"
180	3'-2"	3'-3"	3'-5"	3'-6"	3'-8"	3'-10"	3'-11"	3'-5"	4'-2"
200	3'-11"	4'-1"	4'-3"	4'-5"	4'-6"	4'-8"	4'-9"	4'-3"	5'-1"
220	4'-10"	5'-0"	5'-2"	5'-4"	5'-6"	5'-7"	5'-9"	5'-2"	6'-0"
240	5'-11"	6'-0"	6'-2"	6'-4"	6'-6"	6'-8"	6'-9"	6'-2"	7'-1"
260	7'-0"	7'-2"	7'-4"	7'-6"	7'-7"	7'-9"	7'-11"	7'-4"	8'-2"
280	8'-2"	8'-4"	8'-6"	8'-8"	8'-10"	8'-11"	9'-1"	8'-6"	9'-5"
300	9'-6"	9'-8"	9'-10"	10'-0"	10'-1"	10'-3"	10'-5"	9'-10"	10'-8"
320	10'-11"	11'-0"	11'-3"	11'-4"	11'-6"	11'-8"	11'-10"	11'-3"	12'-1"
340	12'-4"	12'-6"	12'-8"	12'-10"	13'-0"	13'-2"	13'-3"	12'-8"	13'-7"
360	13'-11"	14'-1"	14'-3"	14'-5"	14'-7"	14'-9"	14'-11"	14'-3"	15'-2"
380	15'-8"	15'-9"	16'-0"	16'-1"	16'-3"	16'-5"	16'-7"	16'-0"	16'-10"
400	17'-5"	17'-7"	17'-9"	17'-11"	18'-0"	18'-2"	18'-4"	17'-9"	18'-8"
420	19'-3"	19'-5"	19'-7"	19'-9"	19'-11"	20'-1"	20'-3"	19'-7"	20'-6"
440	21'-3"	21'-5"	21'-7"	21'-9"	21'-11"	22'-0"	22'-2"	21'-7"	22'-6"
460	23'-4"	23'-6"	23'-8"	23'-10"	24'-0"	24'-1"	24'-3"	23'-8"	24'-7"
480	25'-6"	25'-8"	25'-10"	26'-0"	26'-2"	26'-3"	26'-5"	25'-10"	26'-9"
500	27'-9"	27'-11"	28'-1"	28'-3"	28'-5"	28'-7"	28'-9"	28'-1"	29'-0"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	855	771	697	634	581	536	498	692	430
120	801	736	679	630	588	552	521	675	463
140	761	711	666	628	594	565	538	664	490
160	730	692	656	626	599	574	552	655	511
180	708	678	649	625	602	581	562	648	527
200	691	667	644	623	604	587	571	643	540
220	679	659	640	622	606	591	577	639	551
240	668	652	635	621	607	594	582	635	559
260	660	646	632	620	608	597	586	632	565
280	654	642	630	619	609	599	589	629	571
300	648	638	627	618	609	600	592	627	575
320	643	634	625	617	609	601	594	625	579
340	639	632	623	616	609	602	595	623	582
360	636	629	621	615	608	602	596	621	584
380	633	626	620	614	608	602	597	619	586
400	630	624	618	613	607	602	598	618	588
420	627	622	616	611	607	602	598	616	589
440	624	620	615	610	606	602	598	615	590
460	622	618	613	609	605	601	598	613	590
480	620	616	611	608	604	601	597	611	590
500	617	614	610	606	603	600	597	610	590

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-8"	0'-9"	0'-10"	1'-0"	1'-1"	1'-2"	1'-3"	0'-10"	1'-6"
120	1'-0"	1'-2"	1'-3"	1'-4"	1'-6"	1'-7"	1'-8"	1'-3"	1'-11"
140	1'-5"	1'-7"	1'-8"	1'-10"	1'-11"	2'-1"	2'-2"	1'-8"	2'-6"
160	1'-11"	2'-1"	2'-2"	2'-4"	2'-6"	2'-7"	2'-9"	2'-3"	3'-0"
180	2'-6"	2'-8"	2'-9"	2'-11"	3'-1"	3'-3"	3'-4"	2'-9"	3'-8"
200	3'-1"	3'-3"	3'-5"	3'-7"	3'-9"	3'-11"	4'-1"	3'-5"	4'-4"
220	3'-10"	4'-0"	4'-2"	4'-4"	4'-6"	4'-8"	4'-10"	4'-2"	5'-1"
240	4'-7"	4'-9"	5'-0"	5'-1"	5'-3"	5'-5"	5'-7"	5'-0"	5'-11"
260	5'-6"	5'-8"	5'-10"	6'-0"	6'-2"	6'-4"	6'-6"	5'-10"	6'-10"
280	6'-5"	6'-7"	6'-9"	6'-11"	7'-1"	7'-3"	7'-5"	6'-9"	7'-9"
300	7'-5"	7'-7"	7'-9"	7'-11"	8'-1"	8'-3"	8'-6"	7'-9"	8'-10"
320	8'-5"	8'-8"	8'-10"	9'-0"	9'-2"	9'-4"	9'-6"	8'-10"	9'-11"
340	9'-7"	9'-9"	10'-0"	10'-2"	10'-4"	10'-6"	10'-8"	10'-0"	11'-1"
360	10'-10"	11'-0"	11'-2"	11'-5"	11'-7"	11'-9"	11'-11"	11'-2"	12'-3"
380	12'-1"	12'-3"	12'-6"	12'-8"	12'-10"	13'-0"	13'-3"	12'-6"	13'-7"
400	13'-5"	13'-8"	13'-10"	14'-0"	14'-3"	14'-5"	14'-7"	13'-10"	15'-0"
420	14'-11"	15'-1"	15'-3"	15'-6"	15'-8"	15'-10"	16'-0"	15'-3"	16'-5"
440	16'-5"	16'-7"	16'-9"	17'-0"	17'-2"	17'-4"	17'-7"	16'-10"	17'-11"
460	18'-0"	18'-2"	18'-5"	18'-7"	18'-9"	18'-11"	19'-2"	18'-5"	19'-6"
480	19'-8"	19'-10"	20'-0"	20'-3"	20'-5"	20'-7"	20'-9"	20'-0"	21'-2"
500	21'-4"	21'-7"	21'-9"	22'-0"	22'-2"	22'-4"	22'-6"	21'-9"	22'-11"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1480	1326	1188	1071	970	886	815	1178	689
120	1437	1307	1191	1092	1007	935	872	1184	759
140	1394	1286	1189	1106	1034	972	917	1184	816
160	1363	1272	1191	1121	1059	1004	955	1187	865
180	1336	1260	1191	1131	1077	1030	986	1188	906
200	1314	1250	1191	1140	1093	1051	1013	1189	940
220	1295	1241	1191	1146	1105	1068	1034	1189	969
240	1280	1234	1190	1151	1116	1083	1052	1189	993
260	1268	1228	1190	1156	1124	1094	1067	1189	1014
280	1258	1224	1190	1160	1131	1105	1080	1189	1032
300	1249	1219	1189	1162	1137	1113	1091	1188	1047
320	1242	1215	1188	1164	1142	1120	1100	1188	1060
340	1236	1212	1188	1166	1146	1126	1108	1187	1072
360	1229	1208	1187	1167	1149	1131	1114	1186	1081
380	1225	1205	1186	1168	1151	1135	1120	1186	1089
400	1220	1203	1185	1169	1153	1139	1124	1185	1096
420	1216	1200	1184	1169	1155	1142	1128	1184	1103
440	1212	1198	1183	1169	1156	1144	1132	1182	1108
460	1208	1195	1181	1169	1157	1146	1134	1181	1112
480	1205	1193	1180	1169	1158	1147	1137	1180	1116
500	1201	1191	1179	1168	1158	1148	1139	1179	1120

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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.

This page intentionally left blank.

CO 161 Sag —Temperature Stringing Table 17 kV 1/0 ACSR/AW — 653 ACSR/AW (Oriole) for Covered Conductor 2.0

Scope CO 161.1 Sag —Temperature Stringing Table 17 kV 1/0 ACSR/AW — 653 ACSR/AW (Oriole) for Covered Conductor 2.0

Table CO 161–1: Sag—Temperature Stringing 17kV 1/0 ACSR/AW (Raven) Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 1/0 ACSR/AW Raven for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'5"	0'5"	0'6"	0'7"	0'8"	0'9"	0'10"	0'9"	1'6"
120	0'8"	0'9"	0'10"	0'11"	1'0"	1'2"	1'3"	1'1"	1'11"
140	1'0"	1'2"	1'3"	1'5"	1'7"	1'8"	1'10"	1'7"	2'6"
160	1'7"	1'9"	1'10"	2'0"	2'2"	2'4"	2'6"	2'3"	3'2"
180	2'3"	2'5"	2'7"	2'9"	2'11"	3'1"	3'3"	2'11"	3'11"
200	3'1"	3'3"	3'5"	3'7"	3'9"	3'11"	4'1"	3'9"	4'9"
220	4'0"	4'2"	4'4"	4'6"	4'9"	4'11"	5'1"	4'9"	5'9"
240	5'0"	5'2"	5'5"	5'7"	5'9"	5'11"	6'1"	5'9"	6'9"
260	6'2"	6'4"	6'6"	6'8"	6'10"	7'0"	7'3"	6'10"	7'11"
280	7'4"	7'7"	7'9"	7'11"	8'1"	8'3"	8'5"	8'1"	9'1"
300	8'8"	8'10"	9'1"	9'3"	9'5"	9'7"	9'9"	9'5"	10'5"
320	10'1"	10'3"	10'6"	10'8"	10'10"	11'0"	11'2"	10'10"	11'10"
340	11'7"	11'10"	12'0"	12'2"	12'4"	12'6"	12'8"	12'4"	13'4"
360	13'3"	13'5"	13'7"	13'9"	13'11"	14'1"	14'3"	13'11"	15'0"
380	14'11"	15'1"	15'4"	15'6"	15'8"	15'10"	16'0"	15'7"	16'8"
400	16'9"	16'11"	17'1"	17'3"	17'5"	17'7"	17'9"	17'5"	18'6"
420	18'8"	18'10"	19'0"	19'2"	19'4"	19'6"	19'8"	19'4"	20'5"
440	20'8"	20'10"	21'0"	21'2"	21'4"	21'6"	21'8"	21'4"	22'5"
460	22'9"	23'0"	23'1"	23'4"	23'6"	23'8"	23'10"	23'5"	24'6"
480	25'0"	25'2"	25'4"	25'6"	25'8"	25'10"	26'0"	25'8"	26'9"
500	27'4"	27'6"	27'8"	27'10"	28'0"	28'2"	28'4"	28'0"	29'0"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 161–2: Tension — Temperature Stringing 17 kV 1/0 ACSR/AW CC (Raven) Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 1/0 ACSR/AW Raven for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	793	715	639	565	496	434	380	439	218
120	698	627	560	498	443	396	356	411	235
140	604	544	490	443	402	367	338	386	248
160	521	477	436	402	373	348	326	365	256
180	461	428	400	375	353	334	317	350	262
200	417	394	373	355	338	324	311	337	267
220	387	370	355	341	328	316	306	328	270
240	366	353	341	330	320	311	302	320	272
260	351	341	331	322	314	306	299	315	273
280	339	331	323	316	309	303	297	310	275
300	330	324	317	311	305	300	295	306	275
320	323	318	312	307	302	297	293	303	276
340	318	313	308	304	299	295	291	300	276
360	313	309	305	301	297	293	290	297	277
380	309	305	302	298	295	292	289	295	277
400	305	302	299	296	293	290	287	294	277
420	302	299	297	294	291	289	286	292	277
440	300	297	294	292	290	287	285	290	277
460	297	295	293	290	288	286	284	289	276
480	295	293	291	289	287	285	283	287	276
500	293	291	289	287	286	284	282	286	276

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 161–3: Sag — Temperature Stringing Table 35 kV 1/0 ACSR/AW (Raven) Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 1/0 ACSR/AW for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'8"	0'8"	0'9"	0'10"	0'11"	1'1"	1'2"	1'0"	1'8"
120	1'1"	1'2"	1'3"	1'4"	1'6"	1'7"	1'9"	1'7"	2'3"
140	1'8"	1'9"	1'11"	2'0"	2'2"	2'3"	2'5"	2'3"	3'0"
160	2'5"	2'6"	2'8"	2'10"	3'0"	3'1"	3'3"	3'0"	3'9"
180	3'3"	3'5"	3'7"	3'9"	3'10"	4'0"	4'2"	3'11"	4'9"
200	4'4"	4'6"	4'7"	4'9"	4'11"	5'0"	5'2"	4'11"	5'9"
220	5'5"	5'7"	5'9"	5'11"	6'0"	6'2"	6'4"	6'1"	6'11"
240	6'9"	6'10"	7'0"	7'2"	7'3"	7'5"	7'7"	7'4"	8'2"
260	8'1"	8'3"	8'4"	8'6"	8'8"	8'10"	8'11"	8'8"	9'6"
280	9'7"	9'9"	9'10"	10'0"	10'2"	10'3"	10'5"	10'2"	11'0"
300	11'2"	11'4"	11'6"	11'7"	11'9"	11'11"	12'0"	11'9"	12'7"
320	12'11"	13'1"	13'2"	13'4"	13'6"	13'7"	13'9"	13'6"	14'4"
340	14'9"	14'11"	15'0"	15'2"	15'4"	15'6"	15'7"	15'4"	16'2"
360	16'9"	16'10"	17'0"	17'2"	17'3"	17'5"	17'7"	17'3"	18'2"
380	18'10"	18'11"	19'1"	19'3"	19'4"	19'6"	19'8"	19'4"	20'3"
400	21'0"	21'2"	21'4"	21'5"	21'7"	21'9"	21'10"	21'7"	22'5"
420	23'4"	23'6"	23'8"	23'10"	23'11"	24'1"	24'3"	23'11"	24'10"
440	25'10"	26'0"	26'1"	26'3"	26'5"	26'6"	26'8"	26'5"	27'3"
460	28'5"	28'7"	28'9"	28'10"	29'0"	29'2"	29'3"	29'0"	29'11"
480	31'2"	31'4"	31'6"	31'7"	31'9"	31'11"	32'0"	31'9"	32'7"
500	34'1"	34'2"	34'4"	34'6"	34'8"	34'9"	34'11"	34'8"	35'6"

FOR PLANNING USE ONLY

Note(s): Listed temperatures refers to conductor temperature, not ambient temperature.

Tension — Temperature Stringing Table 35 kV 1/0 ACSR/AW (Raven) Covered Conductor 2.0 for Heavy-Loading Areas

Table CO 161–4: Tension — Temperature Stringing Table 35 kV 1/0 ACSR/AW (Raven) Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 1/0 ACSR/AW for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	717	650	586	528	477	431	393	441	268
120	617	565	517	474	437	405	377	418	286
140	539	501	467	437	411	388	367	400	298
160	483	456	432	411	392	375	360	386	306
180	445	427	409	394	379	367	355	376	311
200	420	406	393	381	370	360	350	368	315
220	402	391	381	372	363	355	347	362	318
240	389	381	373	365	358	351	345	357	320
260	379	372	366	360	354	348	343	353	322
280	371	366	360	355	350	345	341	350	323
300	365	360	356	352	347	343	339	347	323
320	360	356	352	348	345	341	338	344	324
340	356	352	349	346	342	339	336	342	324
360	352	349	346	343	340	338	335	340	324
380	349	346	343	341	339	336	334	338	324
400	346	343	341	339	337	335	332	337	324
420	343	341	339	337	335	333	331	335	323
440	341	339	337	335	333	332	330	334	323
460	338	337	335	333	332	330	329	332	322
480	336	335	333	332	330	329	328	330	322
500	334	333	331	330	329	327	326	329	321

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

1.0 Guying

Conductor tensions for guying 101.8 Covered Conductor is 1,415 lb.

2.0 Ground Clearance

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

Table CO 161–5: Sag — Temperature Stringing 17 kV 101.8 ACSR/AW Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 101.8 ACSR/AW Petrel for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'2"	0'2"	0'3"	0'3"	0'3"	0'3"	0'4"	0'3"	0'5"
120	0'3"	0'3"	0'4"	0'4"	0'4"	0'5"	0'5"	0'4"	0'7"
140	0'5"	0'5"	0'5"	0'6"	0'6"	0'7"	0'7"	0'5"	0'10"
160	0'6"	0'7"	0'7"	0'8"	0'8"	0'9"	0'10"	0'7"	1'1"
180	0'8"	0'9"	0'9"	0'10"	0'11"	1'0"	1'1"	0'9"	1'5"
200	0'11"	0'11"	1'0"	1'1"	1'2"	1'4"	1'5"	1'0"	1'9"
220	1'1"	1'2"	1'3"	1'5"	1'6"	1'8"	1'9"	1'4"	2'2"
240	1'5"	1'6"	1'7"	1'9"	1'11"	2'1"	2'3"	1'8"	2'8"
260	1'9"	1'10"	2'0"	2'2"	2'4"	2'6"	2'8"	2'0"	3'2"
280	2'2"	2'3"	2'6"	2'8"	2'10"	3'0"	3'3"	2'6"	3'9"
300	2'7"	2'9"	3'0"	3'2"	3'5"	3'7"	3'10"	3'0"	4'4"
320	3'2"	3'4"	3'7"	3'9"	4'0"	4'3"	4'6"	3'7"	5'0"
340	3'9"	4'0"	4'3"	4'5"	4'8"	4'11"	5'2"	4'3"	5'9"
360	4'5"	4'8"	4'11"	5'2"	5'5"	5'8"	5'11"	4'11"	6'6"
380	5'2"	5'5"	5'8"	6'0"	6'3"	6'6"	6'9"	5'8"	7'4"
400	6'0"	6'3"	6'6"	6'9"	7'1"	7'4"	7'7"	6'6"	8'2"
420	6'10"	7'1"	7'5"	7'8"	7'11"	8'3"	8'6"	7'5"	9'1"
440	7'9"	8'0"	8'4"	8'7"	8'11"	9'2"	9'5"	8'4"	10'0"
460	8'9"	9'0"	9'4"	9'7"	9'11"	10'2"	10'5"	9'4"	11'0"
480	9'9"	10'1"	10'4"	10'8"	10'11"	11'3"	11'6"	10'4"	12'1"
500	10'10"	11'2"	11'5"	11'9"	12'0"	12'4"	12'7"	11'6"	13'2"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 161–6: Tension — Temperature Stringing 17 kV 101.8 ACSR/AW Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 101.8 ACSR/AW Petrel for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	2340	2200	2056	1911	1764	1619	1477	2039	1110
120	2286	2144	2003	1860	1716	1574	1434	1986	1087
140	2223	2081	1942	1801	1660	1523	1386	1926	1062
160	2149	2011	1872	1734	1598	1464	1335	1857	1035
180	2069	1933	1796	1664	1533	1404	1285	1785	1011
200	1983	1850	1718	1587	1465	1345	1233	1707	987
220	1892	1760	1636	1514	1396	1286	1184	1623	966
240	1797	1671	1552	1438	1330	1230	1139	1543	948
260	1699	1582	1470	1366	1268	1179	1097	1462	931
280	1604	1497	1394	1300	1211	1133	1060	1387	915
300	1512	1415	1322	1238	1161	1092	1029	1317	903
320	1429	1341	1259	1186	1119	1057	1001	1256	892
340	1352	1275	1203	1138	1079	1026	978	1199	881
360	1284	1217	1155	1097	1047	1000	957	1152	872
380	1223	1165	1110	1061	1017	976	939	1109	864
400	1173	1123	1075	1033	993	957	924	1074	857
420	1129	1084	1043	1006	971	939	910	1042	850
440	1092	1054	1017	984	954	925	899	1016	845
460	1060	1026	994	965	937	912	888	992	840
480	1032	1002	974	948	923	900	879	973	835
500	1008	981	956	933	911	890	871	955	831

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 161–7: Sag — Temperature Stringing 35 kV 101.8 ACSR/AW Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 35 kV 101.8 ACSR/AW Petrel for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'3"	0'3"	0'3"	0'4"	0'4"	0'4"	0'5"	0'3"	0'6"
120	0'5"	0'5"	0'5"	0'6"	0'6"	0'7"	0'7"	0'5"	0'9"
140	0'6"	0'7"	0'7"	0'8"	0'9"	0'9"	0'10"	0'7"	1'1"
160	0'9"	0'9"	0'10"	0'11"	1'0"	1'1"	1'2"	0'10"	1'5"
180	1'0"	1'0"	1'1"	1'3"	1'4"	1'5"	1'6"	1'2"	1'10"
200	1'3"	1'4"	1'6"	1'7"	1'8"	1'10"	1'11"	1'6"	2'4"
220	1'8"	1'9"	1'10"	2'0"	2'2"	2'3"	2'5"	1'11"	2'10"
240	2'1"	2'3"	2'4"	2'6"	2'8"	2'10"	3'0"	2'4"	3'5"
260	2'7"	2'9"	2'11"	3'1"	3'3"	3'5"	3'8"	2'11"	4'1"
280	3'2"	3'4"	3'6"	3'9"	3'11"	4'1"	4'4"	3'7"	4'9"
300	3'10"	4'0"	4'3"	4'5"	4'8"	4'10"	5'1"	4'3"	5'6"
320	4'7"	4'10"	5'0"	5'3"	5'5"	5'8"	5'10"	5'0"	6'4"
340	5'5"	5'8"	5'10"	6'1"	6'4"	6'6"	6'9"	5'10"	7'3"
360	6'4"	6'6"	6'9"	7'0"	7'3"	7'5"	7'8"	6'9"	8'2"
380	7'3"	7'6"	7'9"	8'0"	8'2"	8'5"	8'8"	7'9"	9'1"
400	8'3"	8'6"	8'9"	9'0"	9'3"	9'5"	9'8"	8'9"	10'2"
420	9'4"	9'7"	9'10"	10'1"	10'4"	10'6"	10'9"	9'10"	11'3"
440	10'6"	10'9"	11'0"	11'3"	11'5"	11'8"	11'11"	11'0"	12'5"
460	11'8"	11'11"	12'2"	12'5"	12'8"	12'11"	13'1"	12'2"	13'7"
480	13'0"	13'2"	13'5"	13'8"	13'11"	14'2"	14'4"	13'5"	14'11"
500	14'3"	14'6"	14'9"	15'0"	15'3"	15'6"	15'8"	14'9"	16'3"

Note(s): Listed temperature refer to conductor temperatures, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 161–8: Tension — Temperature Stringing 35 kV 101.8 ACSR/AW Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 35 kV 101.8 ACSR/AW Petrel for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	2291	2153	2012	1869	1727	1585	1448	1995	1110
120	2220	2081	1942	1801	1665	1529	1397	1926	1086
140	2135	2000	1864	1728	1598	1469	1347	1848	1065
160	2041	1908	1777	1649	1524	1404	1293	1765	1045
180	1939	1811	1687	1568	1451	1342	1242	1677	1027
200	1833	1715	1597	1486	1383	1286	1196	1587	1010
220	1727	1617	1510	1410	1318	1232	1154	1501	994
240	1624	1523	1428	1339	1259	1184	1117	1422	981
260	1528	1440	1356	1280	1210	1145	1088	1351	969
280	1441	1364	1293	1226	1166	1111	1061	1289	960
300	1368	1300	1239	1181	1130	1082	1039	1236	951
320	1301	1244	1191	1143	1098	1057	1019	1188	943
340	1247	1198	1152	1111	1072	1037	1003	1151	936
360	1200	1159	1119	1083	1050	1018	989	1117	930
380	1162	1125	1092	1060	1031	1003	977	1090	925
400	1129	1098	1068	1041	1015	990	967	1067	920
420	1101	1074	1048	1023	1000	979	958	1047	916
440	1078	1054	1030	1009	988	969	950	1030	912
460	1057	1036	1015	996	977	960	943	1015	908
480	1039	1020	1002	984	968	952	937	1001	905
500	1024	1006	990	974	959	945	931	989	902

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

3.0 Guying

Conductor tensions for guying 101.8 Covered Conductor is 3,126 lb.

4.0 Ground Clearance

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

Table CO 161–9: Sag — Temperature Stringing 17 kV 336 (18/1) ACSR/AW Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 336 (18/1) ACSR/AW Merlin for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'5"	0'6"	0'7"	0'8"	0'10"	1'0"	1'2"	0'11"	1'9"
120	0'8"	0'9"	0'10"	1'0"	1'2"	1'4"	1'6"	1'3"	2'2"
140	0'11"	1'1"	1'3"	1'5"	1'7"	1'9"	1'11"	1'8"	2'8"
160	1'3"	1'5"	1'8"	1'10"	2'0"	2'3"	2'5"	2'1"	3'3"
180	1'8"	1'11"	2'1"	2'4"	2'7"	2'9"	3'0"	2'8"	3'10"
200	2'2"	2'5"	2'8"	2'11"	3'2"	3'4"	3'7"	3'3"	4'6"
220	2'9"	3'0"	3'3"	3'6"	3'9"	4'0"	4'3"	3'10"	5'2"
240	3'5"	3'8"	3'11"	4'3"	4'5"	4'8"	4'11"	4'7"	5'11"
260	4'2"	4'5"	4'8"	4'11"	5'3"	5'5"	5'8"	5'4"	6'8"
280	4'11"	5'3"	5'6"	5'9"	6'0"	6'3"	6'6"	6'2"	7'6"
300	5'10"	6'1"	6'4"	6'8"	6'11"	7'2"	7'5"	7'0"	8'5"
320	6'9"	7'0"	7'3"	7'7"	7'10"	8'1"	8'4"	7'11"	9'5"
340	7'9"	8'0"	8'3"	8'7"	8'10"	9'1"	9'4"	8'11"	10'5"
360	8'9"	9'0"	9'4"	9'7"	9'11"	10'2"	10'5"	10'0"	11'6"
380	9'10"	10'2"	10'5"	10'9"	11'0"	11'3"	11'6"	11'1"	12'8"
400	11'0"	11'4"	11'7"	11'11"	12'2"	12'5"	12'9"	12'4"	13'10"
420	12'3"	12'7"	12'10"	13'2"	13'5"	13'8"	14'0"	13'6"	15'1"
440	13'7"	13'11"	14'2"	14'6"	14'9"	15'0"	15'3"	14'10"	16'5"
460	15'0"	15'3"	15'6"	15'10"	16'1"	16'5"	16'8"	16'3"	17'10"
480	16'5"	16'8"	17'0"	17'3"	17'6"	17'10"	18'1"	17'8"	19'3"
500	17'11"	18'2"	18'6"	18'9"	19'0"	19'4"	19'7"	19'2"	20'9"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 161–10: Tension — Temperature Stringing Table 17 kV 336 (18/1) ACSR/AW Merlin Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 336 (18/1) ACSR/AW Merlin for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1626	1390	1164	967	806	685	593	748	387
120	1538	1322	1123	957	822	718	639	773	442
140	1446	1252	1085	945	832	744	675	792	489
160	1360	1194	1053	937	842	767	705	808	531
180	1285	1144	1028	931	850	785	730	821	568
200	1218	1102	1006	925	856	799	750	830	601
220	1165	1069	988	919	861	811	767	839	629
240	1123	1044	975	916	866	821	783	846	654
260	1088	1021	964	913	869	830	795	852	676
280	1060	1004	954	910	871	837	805	856	696
300	1038	990	947	909	874	842	814	861	713
320	1019	978	941	906	875	847	822	863	728
340	1004	968	934	905	877	852	828	866	741
360	991	959	930	903	878	855	833	868	753
380	979	951	925	901	879	858	838	870	764
400	970	945	922	900	879	860	842	871	773
420	961	939	918	898	880	862	845	872	781
440	954	934	915	897	880	864	848	873	789
460	947	929	912	896	880	865	851	874	795
480	942	925	909	894	880	866	853	874	801
500	937	921	907	893	880	867	855	875	806

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 161–11: Sag — Temperature Stringing Table 35 kV 336 (18/1) ACSR/AW Merlin Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 35 336 (18/1) ACSR/AW Merlin for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'6"	0'7"	0'9"	0'10"	1'0"	1'1"	1'3"	1'1"	1'10"
120	0'10"	0'11"	1'1"	1'3"	1'4"	1'6"	1'8"	1'6"	2'4"
140	1'2"	1'4"	1'6"	1'8"	1'10"	2'0"	2'2"	1'11"	2'10"
160	1'8"	1'10"	2'0"	2'2"	2'4"	2'7"	2'9"	2'6"	3'6"
180	2'2"	2'5"	2'7"	2'9"	3'0"	3'2"	3'4"	3'1"	4'2"
200	2'10"	3'0"	3'3"	3'5"	3'8"	3'10"	4'0"	3'9"	4'11"
220	3'6"	3'9"	4'0"	4'2"	4'5"	4'7"	4'10"	4'6"	5'8"
240	4'4"	4'6"	4'9"	5'0"	5'2"	5'5"	5'7"	5'4"	6'6"
260	5'2"	5'5"	5'8"	5'10"	6'1"	6'4"	6'6"	6'3"	7'5"
280	6'1"	6'4"	6'7"	6'10"	7'1"	7'3"	7'6"	7'2"	8'5"
300	7'2"	7'4"	7'7"	7'10"	8'1"	8'4"	8'6"	8'3"	9'6"
320	8'3"	8'6"	8'9"	8'11"	9'2"	9'5"	9'8"	9'4"	10'7"
340	9'5"	9'8"	9'11"	10'1"	10'4"	10'7"	10'10"	10'6"	11'10"
360	10'8"	10'11"	11'2"	11'4"	11'7"	11'10"	12'1"	11'9"	13'1"
380	11'11"	12'2"	12'5"	12'8"	12'11"	13'2"	13'5"	13'1"	14'5"
400	13'4"	13'7"	13'10"	14'1"	14'4"	14'7"	14'9"	14'6"	15'10"
420	14'10"	15'1"	15'4"	15'7"	15'10"	16'0"	16'3"	15'11"	17'4"
440	16'4"	16'7"	16'10"	17'1"	17'4"	17'7"	17'10"	17'6"	18'11"
460	18'0"	18'3"	18'6"	18'9"	19'0"	19'2"	19'5"	19'1"	20'6"
480	19'8"	19'11"	20'2"	20'5"	20'8"	20'11"	21'2"	20'10"	22'3"
500	21'6"	21'9"	22'0"	22'2"	22'5"	22'8"	22'11"	22'7"	24'0"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 161–12: Tension — Temperature Stringing Table 35 kV 336 (18/1) ACSR/AW Merlin Covered Conductor 2.0 for Heavy-Loading Areas

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1597	1380	1183	1014	875	767	682	812	468
120	1505	1314	1149	1010	896	804	731	840	529
140	1414	1255	1117	1004	911	833	769	863	581
160	1332	1200	1090	997	919	854	798	879	626
180	1267	1161	1071	995	929	873	824	893	665
200	1214	1128	1053	990	934	885	843	904	698
220	1172	1101	1040	986	939	896	859	913	727
240	1140	1082	1030	984	943	906	873	920	752
260	1114	1065	1021	982	946	913	884	925	773
280	1092	1051	1013	979	948	919	892	930	792
300	1075	1040	1007	977	949	924	900	933	808
320	1061	1030	1002	975	951	928	907	937	822
340	1049	1022	997	974	952	931	912	939	834
360	1039	1015	993	972	952	934	916	941	844
380	1030	1009	989	970	953	936	920	942	854
400	1022	1003	986	969	953	937	923	943	862
420	1015	998	982	967	952	938	925	944	869
440	1009	994	980	966	952	940	927	945	875
460	1004	990	977	964	952	940	929	945	880
480	999	986	974	963	951	941	930	945	885
500	994	983	972	961	951	940	931	945	889

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

5.0 Guying

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

6.0 Ground Clearance

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

Sag — Temperature Stringing Cable 17 kV 336 (30/7) ACSR/AW Oriole ACSR Covered Conductor 2.0 for Heavy-Loading Areas

Table CO 161–13: Sag — Temperature Stringing Cable 17 kV 336 (30/7) ACSR/AW Oriole ACSR Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 336 (30/7) ACSR/AW Oriole for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'6"	0'7"	0'8"	0'9"	0'10"	1'0"	1'1"	0'10"	1'6"
120	0'9"	0'10"	1'0"	1'1"	1'2"	1'4"	1'6"	1'2"	2'0"
140	1'1"	1'2"	1'4"	1'5"	1'7"	1'9"	1'11"	1'7"	2'6"
160	1'5"	1'7"	1'9"	1'11"	2'0"	2'2"	2'4"	2'0"	3'0"
180	1'11"	2'0"	2'3"	2'5"	2'7"	2'9"	2'10"	2'7"	3'7"
200	2'5"	2'7"	2'9"	2'11"	3'1"	3'3"	3'5"	3'1"	4'2"
220	3'0"	3'2"	3'4"	3'6"	3'9"	3'11"	4'1"	3'9"	4'10"
240	3'7"	3'10"	4'0"	4'2"	4'5"	4'7"	4'9"	4'5"	5'7"
260	4'4"	4'6"	4'9"	4'11"	5'1"	5'4"	5'6"	5'1"	6'4"
280	5'1"	5'3"	5'6"	5'8"	5'11"	6'1"	6'3"	5'11"	7'2"
300	5'11"	6'1"	6'4"	6'6"	6'9"	6'11"	7'2"	6'9"	8'0"
320	6'9"	7'0"	7'3"	7'5"	7'8"	7'10"	8'1"	7'8"	8'11"
340	7'9"	8'0"	8'2"	8'5"	8'7"	8'10"	9'0"	8'7"	9'11"
360	8'9"	9'0"	9'2"	9'5"	9'7"	9'10"	10'0"	9'7"	10'11"
380	9'10"	10'0"	10'3"	10'6"	10'8"	10'11"	11'1"	10'8"	12'0"
400	10'11"	11'2"	11'5"	11'7"	11'10"	12'1"	12'3"	11'10"	13'2"
420	12'1"	12'4"	12'7"	12'10"	13'0"	13'3"	13'5"	13'0"	14'5"
440	13'5"	13'7"	13'10"	14'1"	14'3"	14'6"	14'9"	14'3"	15'8"
460	14'8"	14'11"	15'2"	15'4"	15'7"	15'10"	16'0"	15'7"	17'0"
480	16'1"	16'3"	16'6"	16'9"	17'0"	17'2"	17'5"	17'0"	18'4"
500	17'6"	17'9"	17'11"	18'2"	18'5"	18'8"	18'10"	18'5"	19'10"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 161–14: Tension — Temperature Stringing Table 17 kV 336 (30/7) ACSR/AW Oriole Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 336 (30/7) ACSR/AW Oriole for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1704	1488	1293	1123	984	869	779	981	557
120	1637	1447	1276	1132	1014	916	836	1015	621
140	1572	1408	1263	1142	1040	956	884	1040	677
160	1512	1372	1251	1148	1061	987	923	1061	725
180	1459	1343	1240	1153	1077	1012	956	1077	770
200	1416	1317	1231	1156	1091	1034	983	1092	812
220	1381	1298	1224	1159	1102	1052	1006	1103	848
240	1352	1281	1218	1162	1112	1066	1025	1113	880
260	1329	1267	1213	1164	1120	1079	1042	1121	908
280	1309	1257	1209	1166	1126	1090	1056	1127	933
300	1292	1247	1205	1167	1131	1099	1068	1132	954
320	1280	1240	1202	1168	1136	1106	1079	1137	974
340	1267	1232	1199	1168	1139	1113	1088	1140	990
360	1257	1226	1196	1168	1143	1118	1095	1143	1005
380	1248	1221	1194	1169	1145	1123	1101	1146	1018
400	1241	1216	1192	1169	1148	1127	1107	1148	1030
420	1235	1212	1190	1169	1150	1130	1113	1150	1040
440	1228	1207	1187	1168	1150	1133	1116	1151	1049
460	1222	1204	1185	1168	1151	1135	1120	1152	1058
480	1218	1201	1184	1168	1152	1138	1123	1153	1065
500	1213	1197	1182	1168	1153	1140	1126	1154	1071

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Sag — Temperature Stringing Table 35 kV 336 (30/7) ACSR/AW Oriole Covered Conductor 2.0 for Heavy-Loading Areas

Table CO 161–15: Sag — Temperature Stringing Table 35 kV 336 (30/7) ACSR/AW Oriole Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 35kV 336 (30/7) ACSR/AW Oriole for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'7"	0'8"	0'9"	0'11"	1'0"	1'1"	1'3"	1'0"	1'8"
120	0'11"	1'0"	1'2"	1'3"	1'5"	1'6"	1'8"	1'5"	2'2"
140	1'4"	1'5"	1'7"	1'9"	1'10"	2'0"	2'1"	1'10"	2'8"
160	1'9"	1'11"	2'1"	2'3"	2'4"	2'6"	2'8"	2'4"	3'3"
180	2'4"	2'6"	2'8"	2'10"	2'11"	3'1"	3'3"	3'0"	3'11"
200	2'11"	3'1"	3'3"	3'5"	3'7"	3'9"	3'11"	3'7"	4'7"
220	3'8"	3'10"	4'0"	4'2"	4'4"	4'6"	4'8"	4'4"	5'4"
240	4'5"	4'7"	4'9"	4'11"	5'1"	5'3"	5'5"	5'1"	6'2"
260	5'3"	5'5"	5'7"	5'9"	5'11"	6'1"	6'3"	5'11"	7'0"
280	6'1"	6'4"	6'6"	6'8"	6'10"	7'0"	7'2"	6'10"	8'0"
300	7'1"	7'3"	7'6"	7'8"	7'10"	8'0"	8'2"	7'10"	9'0"
320	8'1"	8'4"	8'6"	8'8"	8'11"	9'1"	9'3"	8'11"	10'0"
340	9'3"	9'5"	9'7"	9'10"	10'0"	10'2"	10'4"	10'0"	11'2"
360	10'5"	10'7"	10'10"	11'0"	11'2"	11'4"	11'7"	11'2"	12'4"
380	11'8"	11'10"	12'1"	12'3"	12'5"	12'7"	12'10"	12'5"	13'8"
400	13'0"	13'2"	13'5"	13'7"	13'9"	14'0"	14'2"	13'9"	15'0"
420	14'5"	14'7"	14'9"	15'0"	15'2"	15'4"	15'6"	15'2"	16'5"
440	15'10"	16'1"	16'3"	16'5"	16'8"	16'10"	17'0"	16'8"	17'10"
460	17'5"	17'7"	17'9"	18'0"	18'2"	18'4"	18'7"	18'2"	19'5"
480	19'0"	19'2"	19'5"	19'7"	19'9"	20'0"	20'2"	19'10"	21'0"
500	20'8"	20'11"	21'1"	21'3"	21'6"	21'8"	21'10"	21'6"	22'9"

Note(s): Listed temperatures refer to conductor temperatures, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 161–16: Tension — Temperature Stringing Table 35 kV 336 (30/7) ACSR/AW Oriole Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 35kV 336 (30/7) ACSR/AW Oriole for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1676	1481	1312	1166	1045	945	862	1039	637
120	1603	1442	1300	1181	1079	993	921	1073	706
140	1541	1406	1290	1190	1105	1032	969	1101	764
160	1492	1380	1285	1200	1128	1064	1009	1124	820
180	1449	1357	1277	1207	1145	1089	1040	1141	869
200	1417	1340	1273	1213	1159	1111	1068	1155	911
220	1390	1326	1269	1217	1171	1128	1089	1168	947
240	1368	1314	1265	1220	1180	1142	1108	1177	978
260	1350	1304	1261	1222	1187	1154	1123	1184	1004
280	1336	1296	1259	1225	1193	1163	1135	1191	1027
300	1324	1290	1257	1227	1199	1172	1147	1196	1047
320	1314	1283	1255	1228	1203	1178	1156	1201	1064
340	1305	1278	1253	1229	1206	1185	1164	1204	1080
360	1297	1273	1250	1229	1208	1189	1170	1207	1093
380	1291	1270	1249	1229	1211	1193	1176	1210	1105
400	1284	1265	1247	1229	1212	1196	1180	1211	1114
420	1279	1262	1245	1229	1214	1199	1184	1213	1123
440	1274	1258	1243	1228	1214	1200	1187	1213	1131
460	1270	1255	1241	1228	1215	1202	1190	1214	1138
480	1266	1253	1240	1227	1215	1203	1192	1214	1144
500	1261	1250	1238	1226	1215	1204	1194	1214	1148

FOR PLANNING USE ONLY

Note(s): Listed temperatures refer to conductor temperature, not ambient tem/perature.

7.0 Guying

Conductor tensions for guying 336 (30/7) Covered Conductor is 3,260 lb.

8.0 Ground Clearance

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

Table CO 161–17: Sag — Temperature Stringing Table 17 kV ACSR/AW Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 653 ACSR-AW for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'11"	1'1"	1'3"	1'5"	1'6"	1'8"	1'9"	1'5"	2'2"
120	1'4"	1'6"	1'8"	1'9"	1'11"	2'1"	2'3"	1'11"	2'8"
140	1'9"	1'11"	2'1"	2'3"	2'5"	2'7"	2'9"	2'5"	3'3"
160	2'3"	2'5"	2'7"	2'9"	3'0"	3'2"	3'3"	2'11"	3'11"
180	2'9"	3'0"	3'2"	3'5"	3'7"	3'9"	3'11"	3'7"	4'7"
200	3'5"	3'8"	3'10"	4'0"	4'3"	4'5"	4'7"	4'3"	5'4"
220	4'2"	4'4"	4'7"	4'9"	5'0"	5'2"	5'4"	5'0"	6'2"
240	4'11"	5'2"	5'4"	5'7"	5'9"	6'0"	6'2"	5'10"	7'0"
260	5'9"	6'0"	6'3"	6'5"	6'8"	6'10"	7'1"	6'8"	7'11"
280	6'8"	6'11"	7'2"	7'4"	7'7"	7'9"	8'0"	7'8"	8'11"
300	7'8"	7'11"	8'2"	8'4"	8'7"	8'10"	9'0"	8'8"	9'11"
320	8'9"	9'0"	9'3"	9'5"	9'8"	9'11"	10'1"	9'9"	11'1"
340	9'11"	10'1"	10'4"	10'7"	10'10"	11'0"	11'3"	10'11"	12'3"
360	11'1"	11'4"	11'7"	11'10"	12'0"	12'3"	12'6"	12'2"	13'6"
380	12'5"	12'7"	12'10"	13'1"	13'4"	13'7"	13'9"	13'5"	14'9"
400	13'9"	14'0"	14'3"	14'6"	14'8"	14'11"	15'2"	14'9"	16'2"
420	15'2"	15'5"	15'8"	15'11"	16'2"	16'4"	16'7"	16'3"	17'8"
440	16'8"	16'11"	17'2"	17'5"	17'8"	17'11"	18'1"	17'9"	19'2"
460	18'3"	18'6"	18'9"	19'0"	19'3"	19'6"	19'8"	19'4"	20'9"
480	19'11"	20'2"	20'5"	20'8"	20'11"	21'2"	21'4"	21'0"	22'5"
500	21'8"	21'11"	22'2"	22'5"	22'7"	22'10"	23'1"	22'9"	24'2"

FOR PLANNING USE ONLY

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

Table CO 161–18: Tension — Temperature Stringing Table 17 kV 653 ACSR/AW Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 17 kV 653 ACSR-AW for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1211	1047	924	831	758	700	652	789	531
120	1265	1121	1011	922	852	794	745	871	612
140	1298	1176	1075	995	929	873	824	938	685
160	1319	1214	1126	1053	991	938	892	994	751
180	1331	1240	1163	1098	1041	991	948	1039	808
200	1338	1260	1193	1134	1082	1037	996	1077	859
220	1342	1275	1215	1163	1116	1074	1036	1108	905
240	1344	1285	1233	1186	1144	1105	1070	1135	945
260	1345	1293	1247	1204	1166	1131	1098	1157	980
280	1344	1299	1258	1220	1185	1153	1123	1175	1011
300	1343	1303	1266	1232	1200	1171	1143	1191	1038
320	1342	1306	1273	1243	1214	1187	1162	1204	1063
340	1341	1309	1279	1251	1225	1200	1177	1216	1084
360	1339	1311	1284	1259	1235	1212	1190	1226	1103
380	1338	1312	1288	1265	1242	1222	1201	1234	1120
400	1336	1313	1290	1269	1249	1230	1211	1241	1135
420	1334	1313	1292	1273	1255	1237	1220	1247	1148
440	1332	1312	1294	1276	1259	1242	1226	1252	1160
460	1330	1313	1295	1279	1263	1247	1233	1256	1170
480	1328	1312	1296	1281	1266	1252	1238	1259	1179
500	1326	1311	1297	1282	1269	1256	1243	1262	1188

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 161–19: Sag — Temperature Stringing Table 35 kV 653 ACSR/AW Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 35 kV 653 ACSR-AW for Heavy-Loading									
	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'11"	1'0"	1'2"	1'3"	1'5"	1'6"	1'7"	1'5"	2'0"
120	1'4"	1'6"	1'7"	1'9"	1'10"	2'0"	2'1"	1'11"	2'7"
140	1'10"	2'0"	2'2"	2'3"	2'5"	2'6"	2'8"	2'6"	3'3"
160	2'5"	2'7"	2'9"	2'10"	3'0"	3'2"	3'4"	3'1"	3'11"
180	3'1"	3'3"	3'5"	3'7"	3'8"	3'10"	4'0"	3'9"	4'8"
200	3'9"	4'0"	4'2"	4'4"	4'6"	4'7"	4'9"	4'7"	5'6"
220	4'7"	4'9"	5'0"	5'2"	5'4"	5'6"	5'7"	5'5"	6'4"
240	5'6"	5'8"	5'10"	6'0"	6'3"	6'5"	6'7"	6'4"	7'4"
260	6'6"	6'8"	6'10"	7'0"	7'3"	7'5"	7'7"	7'4"	8'4"
280	7'7"	7'9"	7'11"	8'1"	8'3"	8'6"	8'8"	8'5"	9'5"
300	8'8"	8'11"	9'1"	9'3"	9'5"	9'8"	9'10"	9'7"	10'8"
320	9'11"	10'1"	10'4"	10'6"	10'8"	10'10"	11'1"	10'10"	11'11"
340	11'3"	11'5"	11'8"	11'10"	12'0"	12'2"	12'5"	12'2"	13'3"
360	12'8"	12'10"	13'0"	13'3"	13'5"	13'7"	13'10"	13'7"	14'8"
380	14'2"	14'4"	14'6"	14'9"	14'11"	15'1"	15'3"	15'1"	16'2"
400	15'8"	15'11"	16'1"	16'3"	16'6"	16'8"	16'10"	16'8"	17'9"	
420	17'4"	17'7"	17'9"	18'0"	18'2"	18'4"	18'6"	18'3"	19'5"
440	19'1"	19'4"	19'6"	19'9"	19'11"	20'1"	20'3"	20'1"	21'2"
460	20'11"	21'2"	21'4"	21'6"	21'9"	21'11"	22'2"	21'11"	23'0"
480	22'10"	23'1"	23'3"	23'6"	23'8"	23'10"	24'1"	23'10"	25'0"
500	24'11"	25'1"	25'3"	25'6"	25'8"	25'10"	26'1"	25'10"	27'0"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 161–20: Tension — Temperature Stringing Table 35 kV 653 ACSR/AW Covered Conductor 2.0 for Heavy-Loading Areas

Tension — Temperature Stringing Table 35 kV 653 ACSR-AW for Heavy-Loading									
	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1488	1330	1197	1088	998	923	861	986	673
120	1471	1343	1234	1143	1065	999	942	1047	759
140	1459	1352	1263	1184	1117	1059	1006	1096	833
160	1457	1370	1292	1225	1165	1112	1065	1142	898
180	1456	1380	1314	1256	1203	1157	1114	1179	956
200	1451	1388	1331	1280	1234	1191	1152	1209	1005
220	1444	1391	1342	1297	1256	1219	1183	1233	1047
240	1439	1393	1350	1311	1274	1241	1210	1253	1084
260	1434	1394	1357	1322	1289	1259	1230	1269	1115
280	1428	1394	1361	1330	1301	1274	1248	1283	1142
300	1423	1393	1364	1337	1311	1286	1263	1294	1165
320	1419	1392	1366	1342	1318	1296	1275	1302	1185
340	1414	1390	1367	1345	1324	1304	1285	1310	1202
360	1410	1389	1368	1348	1329	1311	1293	1316	1216
380	1406	1387	1368	1350	1333	1316	1300	1321	1230
400	1403	1385	1368	1352	1336	1321	1306	1325	1241
420	1399	1383	1368	1353	1338	1324	1311	1328	1251
440	1395	1381	1367	1353	1340	1327	1315	1330	1259
460	1391	1378	1366	1353	1341	1329	1317	1332	1266
480	1388	1376	1364	1353	1342	1331	1320	1333	1272
500	1385	1374	1363	1353	1342	1332	1322	1334	1277

FOR PLANNING USE ONLY

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

9.0 Guying

Conductor tensions for guying 653 Covered Conductor is 2,846 lb.

10.0 Ground Clearance

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

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

	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-6"	0'-7"	0'-8"	0'-9"	0'-11"	1'-0"	1'-1"	0'-10"	1'-7"
120	0'-10"	1'-0"	1'-1"	1'-3"	1'-4"	1'-6"	1'-8"	1'-4"	2'-2"
140	1'-4"	1'-6"	1'-8"	1'-10"	2'-0"	2'-1"	2'-3"	1'-11"	2'-9"
160	2'-0"	2'-2"	2'-4"	2'-6"	2'-8"	2'-10"	3'-0"	2'-7"	3'-6"
180	2'-10"	3'-0"	3'-2"	3'-4"	3'-6"	3'-8"	3'-9"	3'-5"	4'-4"
200	3'-9"	3'-11"	4'-1"	4'-3"	4'-5"	4'-7"	4'-9"	4'-4"	5'-3"
220	4'-9"	4'-11"	5'-1"	5'-3"	5'-5"	5'-7"	5'-9"	5'-4"	6'-3"
240	5'-10"	6'-0"	6'-2"	6'-4"	6'-6"	6'-8"	6'-10"	6'-5"	7'-4"
260	7'-1"	7'-3"	7'-5"	7'-7"	7'-9"	7'-11"	8'-1"	7'-8"	8'-7"
280	8'-5"	8'-7"	8'-9"	8'-11"	9'-1"	9'-3"	9'-5"	8'-11"	9'-11"
300	9'-10"	10'-0"	10'-2"	10'-4"	10'-6"	10'-8"	10'-9"	10'-4"	11'-4"
320	11'-4"	11'-6"	11'-8"	11'-10"	12'-0"	12'-2"	12'-4"	11'-11"	12'-10"
340	12'-11"	13'-1"	13'-3"	13'-6"	13'-7"	13'-9"	13'-11"	13'-6"	14'-6"
360	14'-8"	14'-10"	15'-0"	15'-2"	15'-4"	15'-6"	15'-8"	15'-3"	16'-2"
380	16'-6"	16'-8"	16'-10"	17'-0"	17'-2"	17'-4"	17'-6"	17'-1"	18'-0"
400	18'-6"	18'-8"	18'-9"	19'-0"	19'-2"	19'-4"	19'-6"	19'-0"	20'-0"
420	20'-6"	20'-8"	20'-10"	21'-0"	21'-2"	21'-4"	21'-6"	21'-1"	22'-0"
440	22'-8"	22'-10"	23'-0"	23'-2"	23'-4"	23'-6"	23'-8"	23'-3"	24'-2"
460	25'-0"	25'-2"	25'-3"	25'-6"	25'-8"	25'-10"	25'-11"	25'-6"	26'-6"
480	27'-4"	27'-6"	27'-8"	27'-10"	28'-0"	28'-2"	28'-4"	27'-11"	28'-10"
500	29'-10"	30'-0"	30'-2"	30'-5"	30'-6"	30'-8"	30'-10"	30'-5"	31'-5"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	674	593	518	450	393	346	308	398	216
120	576	511	453	404	364	331	303	374	233
140	493	446	406	372	344	320	300	354	245
160	436	403	375	351	331	313	297	340	254
180	398	375	355	337	322	308	295	330	260
200	372	355	340	327	315	304	294	322	265
220	354	342	330	319	310	301	293	316	268
240	341	331	322	313	306	298	291	311	271
260	331	324	316	309	302	296	290	307	273
280	324	318	311	305	300	295	290	304	274
300	318	313	308	302	298	293	289	301	275
320	313	309	304	300	296	292	288	299	276
340	309	306	302	298	294	291	287	297	277
360	306	303	299	296	293	290	287	295	277
380	303	300	297	294	291	289	286	293	278
400	301	298	295	293	290	288	285	292	278
420	298	296	294	291	289	287	284	290	278
440	296	294	292	290	288	286	284	289	278
460	294	293	291	288	287	285	283	288	277
480	293	291	289	287	286	284	282	287	277
500	291	289	288	286	285	283	282	286	277

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-11"	1'-0"	1'-1"	1'-3"	1'-4"	1'-5"	1'-6"	1'-4"	1'-11"
120	1'-6"	1'-8"	1'-9"	1'-10"	2'-0"	2'-1"	2'-3"	2'-0"	2'-7"
140	2'-3"	2'-5"	2'-6"	2'-8"	2'-9"	2'-11"	3'-0"	2'-9"	3'-5"
160	3'-2"	3'-4"	3'-5"	3'-7"	3'-8"	3'-10"	3'-11"	3'-8"	4'-4"
180	4'-3"	4'-4"	4'-6"	4'-7"	4'-9"	4'-10"	5'-0"	4'-8"	5'-5"
200	5'-5"	5'-6"	5'-8"	5'-9"	5'-11"	6'-0"	6'-2"	5'-10"	6'-7"
220	6'-8"	6'-10"	7'-0"	7'-1"	7'-3"	7'-4"	7'-6"	7'-2"	7'-11"
240	8'-2"	8'-3"	8'-5"	8'-6"	8'-8"	8'-9"	8'-11"	8'-7"	9'-4"
260	9'-8"	9'-10"	9'-11"	10'-1"	10'-3"	10'-4"	10'-6"	10'-2"	10'-11"
280	11'-5"	11'-6"	11'-8"	11'-9"	11'-11"	12'-0"	12'-2"	11'-10"	12'-7"
300	13'-3"	13'-4"	13'-6"	13'-8"	13'-9"	13'-11"	14'-0"	13'-8"	14'-5"
320	15'-2"	15'-4"	15'-5"	15'-7"	15'-9"	15'-10"	16'-0"	15'-8"	16'-5"
340	17'-4"	17'-5"	17'-7"	17'-9"	17'-10"	18'-0"	18'-1"	17'-9"	18'-6"
360	19'-7"	19'-8"	19'-10"	20'-0"	20'-1"	20'-3"	20'-4"	20'-0"	20'-9"
380	22'-0"	22'-1"	22'-3"	22'-4"	22'-6"	22'-7"	22'-9"	22'-5"	23'-2"
400	24'-6"	24'-8"	24'-9"	24'-11"	25'-1"	25'-2"	25'-4"	25'-0"	25'-9"
420	27'-3"	27'-4"	27'-6"	27'-8"	27'-9"	27'-11"	28'-0"	27'-8"	28'-5"
440	30'-1"	30'-3"	30'-4"	30'-6"	30'-7"	30'-9"	30'-10"	30'-7"	31'-3"
460	33'-1"	33'-3"	33'-4"	33'-6"	33'-8"	33'-9"	33'-11"	33'-7"	34'-4"
480	36'-3"	36'-5"	36'-6"	36'-8"	36'-10"	36'-11"	37'-1"	36'-9"	37'-6"
500	39'-8"	39'-9"	39'-11"	40'-1"	40'-2"	40'-3"	40'-5"	40'-1"	40'-10"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	597	543	495	453	418	388	362	422	289
120	523	487	455	426	402	381	362	407	306
140	476	451	429	409	392	376	362	397	318
160	445	428	412	397	384	372	361	389	326
180	425	413	401	389	379	370	361	383	332
200	411	402	392	383	375	368	361	379	337
220	401	394	386	379	372	366	360	375	340
240	393	387	381	375	370	365	360	372	343
260	387	382	377	372	368	363	359	370	344
280	382	378	374	369	366	362	358	367	345
300	378	375	371	367	364	361	357	365	346
320	375	372	369	365	362	359	357	364	347
340	371	369	366	363	361	358	356	362	347
360	369	366	364	361	359	357	355	360	347
380	366	364	362	359	357	355	354	358	347
400	364	362	360	358	356	354	352	357	346
420	361	360	358	356	354	353	351	355	346
440	359	358	356	354	353	351	350	354	345
460	357	356	354	353	351	350	349	352	344
480	355	354	352	351	350	348	347	350	343
500	353	352	350	349	348	347	346	348	342

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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.

This page intentionally left blank.

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 17kV 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’-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

	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-6"	0'-8"	0'-9"	0'-11"	1'-1"	1'-3"	1'-4"	1'-0"	1'-9"
120	0'-10"	0'-11"	1'-1"	1'-3"	1'-5"	1'-7"	1'-9"	1'-4"	2'-3"
140	1'-2"	1'-4"	1'-6"	1'-9"	1'-11"	2'-1"	2'-3"	1'-9"	2'-9"
160	1'-7"	1'-9"	2'-0"	2'-2"	2'-5"	2'-7"	2'-9"	2'-3"	3'-4"
180	2'-1"	2'-4"	2'-6"	2'-9"	2'-11"	3'-2"	3'-4"	2'-10"	4'-0"
200	2'-8"	2'-11"	3'-2"	3'-4"	3'-7"	3'-9"	4'-0"	3'-6"	4'-8"
220	3'-4"	3'-7"	3'-10"	4'-0"	4'-3"	4'-6"	4'-8"	4'-2"	5'-4"
240	4'-1"	4'-4"	4'-7"	4'-9"	5'-0"	5'-3"	5'-5"	4'-11"	6'-2"
260	4'-10"	5'-1"	5'-4"	5'-7"	5'-10"	6'-1"	6'-3"	5'-8"	7'-0"
280	5'-8"	6'-0"	6'-3"	6'-6"	6'-8"	6'-11"	7'-2"	6'-7"	7'-11"
300	6'-8"	6'-11"	7'-2"	7'-5"	7'-8"	7'-11"	8'-1"	7'-6"	8'-11"
320	7'-7"	7'-11"	8'-2"	8'-5"	8'-8"	8'-11"	9'-1"	8'-6"	9'-11"
340	8'-8"	8'-11"	9'-3"	9'-6"	9'-9"	10'-0"	10'-2"	9'-7"	11'-0"
360	9'-10"	10'-1"	10'-4"	10'-7"	10'-10"	11'-1"	11'-4"	10'-9"	12'-2"
380	11'-0"	11'-3"	11'-7"	11'-10"	12'-1"	12'-4"	12'-7"	11'-11"	13'-4"
400	12'-3"	12'-6"	12'-10"	13'-1"	13'-4"	13'-7"	13'-10"	13'-2"	14'-8"
420	13'-7"	13'-10"	14'-2"	14'-5"	14'-8"	14'-11"	15'-2"	14'-6"	16'-0"
440	15'-0"	15'-3"	15'-6"	15'-10"	16'-1"	16'-4"	16'-7"	15'-11"	17'-5"
460	16'-6"	16'-9"	17'-0"	17'-3"	17'-6"	17'-9"	18'-0"	17'-5"	18'-11"
480	18'-0"	18'-3"	18'-7"	18'-10"	19'-1"	19'-4"	19'-7"	18'-11"	20'-5"
500	19'-7"	19'-10"	20'-2"	20'-5"	20'-8"	20'-11"	21'-2"	20'-6"	22'-1"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1331	1111	923	778	669	587	526	728	397
120	1256	1070	916	797	705	633	577	755	452
140	1194	1039	912	813	735	672	621	778	500
160	1138	1012	908	825	758	703	656	795	542
180	1094	991	905	835	777	728	686	809	579
200	1057	973	902	842	792	748	710	819	611
220	1029	960	899	848	804	765	731	828	638
240	1007	949	897	853	814	780	749	836	663
260	989	940	895	857	822	791	763	841	684
280	975	933	894	860	829	801	776	846	702
300	962	926	892	862	834	809	786	849	718
320	952	921	890	864	839	816	795	853	732
340	944	916	889	865	843	823	803	856	745
360	937	912	888	866	846	828	810	858	756
380	930	908	887	867	849	832	816	859	765
400	925	905	886	868	851	836	821	861	774
420	920	902	884	868	853	839	825	862	782
440	916	900	883	869	855	841	829	862	788
460	912	897	882	869	856	843	832	863	794
480	908	895	881	869	857	845	834	863	799
500	905	893	880	868	857	847	837	864	804

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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

Span (Ft)	Sag								
	Initial Stringing Sag							Final Sag	
	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-9"	0'-10"	1'-0"	1'-1"	1'-3"	1'-5"	1'-6"	1'-2"	1'-11"
120	1'-2"	1'-3"	1'-5"	1'-7"	1'-9"	1'-10"	2'-0"	1'-8"	2'-5"
140	1'-7"	1'-9"	1'-11"	2'-1"	2'-3"	2'-5"	2'-7"	2'-2"	3'-1"
160	2'-2"	2'-4"	2'-6"	2'-8"	2'-10"	3'-0"	3'-2"	2'-9"	3'-9"
180	2'-10"	3'-0"	3'-2"	3'-4"	3'-7"	3'-9"	3'-11"	3'-6"	4'-5"
200	3'-7"	3'-9"	3'-11"	4'-2"	4'-4"	4'-6"	4'-8"	4'-3"	5'-3"
220	4'-4"	4'-7"	4'-9"	5'-0"	5'-2"	5'-4"	5'-6"	5'-1"	6'-2"
240	5'-3"	5'-6"	5'-8"	5'-11"	6'-1"	6'-3"	6'-5"	6'-0"	7'-1"
260	6'-3"	6'-6"	6'-8"	6'-11"	7'-1"	7'-3"	7'-6"	7'-0"	8'-1"
280	7'-4"	7'-6"	7'-9"	8'-0"	8'-2"	8'-4"	8'-7"	8'-1"	9'-3"
300	8'-6"	8'-8"	8'-11"	9'-1"	9'-4"	9'-6"	9'-9"	9'-3"	10'-5"
320	9'-9"	9'-11"	10'-2"	10'-4"	10'-7"	10'-9"	11'-0"	10'-6"	11'-8"
340	11'-0"	11'-3"	11'-6"	11'-8"	11'-11"	12'-1"	12'-4"	11'-10"	13'-0"
360	12'-5"	12'-8"	12'-11"	13'-1"	13'-4"	13'-6"	13'-9"	13'-3"	14'-5"
380	13'-11"	14'-2"	14'-5"	14'-7"	14'-10"	15'-0"	15'-3"	14'-9"	15'-11"
400	15'-6"	15'-9"	16'-0"	16'-2"	16'-5"	16'-7"	16'-9"	16'-4"	17'-6"
420	17'-2"	17'-5"	17'-8"	17'-10"	18'-1"	18'-3"	18'-6"	18'-0"	19'-2"
440	18'-11"	19'-2"	19'-5"	19'-7"	19'-10"	20'-0"	20'-3"	19'-9"	20'-11"
460	20'-9"	21'-0"	21'-3"	21'-5"	21'-8"	21'-10"	22'-1"	21'-7"	22'-9"
480	22'-8"	22'-11"	23'-2"	23'-4"	23'-7"	23'-9"	24'-0"	23'-6"	24'-9"
500	24'-8"	24'-11"	25'-2"	25'-5"	25'-7"	25'-10"	26'-0"	25'-6"	26'-9"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1325	1148	999	881	788	714	654	829	515
120	1260	1119	1000	905	828	764	711	861	578
140	1208	1096	1001	923	858	803	756	885	632
160	1169	1080	1002	938	882	834	793	905	678
180	1135	1064	1001	947	900	858	821	919	717
200	1112	1053	1000	955	914	878	845	931	750
220	1093	1045	1000	961	926	894	865	940	778
240	1078	1037	999	966	935	907	881	947	801
260	1065	1031	998	969	942	917	894	953	821
280	1055	1026	997	971	948	925	905	957	839
300	1047	1021	996	973	952	932	914	961	853
320	1039	1017	995	975	956	938	921	963	866
340	1033	1013	993	976	959	943	927	965	877
360	1028	1010	992	976	961	947	933	967	886
380	1023	1007	991	977	963	950	937	969	895
400	1018	1004	990	977	964	952	940	969	901
420	1014	1002	988	976	965	954	943	970	907
440	1011	999	987	976	966	956	946	970	912
460	1007	997	985	976	966	957	948	970	917
480	1004	994	984	975	966	957	949	969	920
500	1000	992	982	974	966	958	950	969	923

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-7"	0'-9"	0'-10"	0'-11"	1'-1"	1'-3"	1'-4"	1'-0"	1'-9"
120	0'-11"	1'-0"	1'-2"	1'-4"	1'-6"	1'-7"	1'-9"	1'-5"	2'-2"
140	1'-3"	1'-5"	1'-7"	1'-9"	1'-11"	2'-0"	2'-2"	1'-10"	2'-8"
160	1'-8"	1'-10"	2'-0"	2'-3"	2'-5"	2'-6"	2'-8"	2'-3"	3'-3"
180	2'-2"	2'-5"	2'-7"	2'-9"	2'-11"	3'-1"	3'-3"	2'-10"	3'-10"
200	2'-9"	3'-0"	3'-2"	3'-4"	3'-6"	3'-9"	3'-11"	3'-5"	4'-6"
220	3'-5"	3'-7"	3'-10"	4'-0"	4'-2"	4'-5"	4'-7"	4'-1"	5'-2"
240	4'-1"	4'-4"	4'-6"	4'-9"	4'-11"	5'-1"	5'-4"	4'-10"	5'-11"
260	4'-10"	5'-1"	5'-3"	5'-6"	5'-8"	5'-11"	6'-1"	5'-7"	6'-9"
280	5'-8"	5'-11"	6'-2"	6'-4"	6'-7"	6'-9"	6'-11"	6'-5"	7'-8"
300	6'-7"	6'-10"	7'-0"	7'-3"	7'-5"	7'-8"	7'-10"	7'-4"	8'-7"
320	7'-6"	7'-9"	8'-0"	8'-3"	8'-5"	8'-8"	8'-10"	8'-4"	9'-7"
340	8'-7"	8'-9"	9'-0"	9'-3"	9'-5"	9'-8"	9'-10"	9'-4"	10'-7"
360	9'-8"	9'-10"	10'-1"	10'-4"	10'-7"	10'-9"	11'-0"	10'-5"	11'-9"
380	10'-9"	11'-0"	11'-3"	11'-6"	11'-9"	11'-11"	12'-2"	11'-7"	12'-11"
400	12'-0"	12'-3"	12'-6"	12'-9"	12'-11"	13'-2"	13'-4"	12'-10"	14'-2"
420	13'-3"	13'-6"	13'-9"	14'-0"	14'-3"	14'-5"	14'-8"	14'-1"	15'-5"
440	14'-8"	14'-10"	15'-1"	15'-4"	15'-7"	15'-9"	16'-0"	15'-6"	16'-10"
460	16'-0"	16'-3"	16'-6"	16'-9"	17'-0"	17'-3"	17'-5"	16'-11"	18'-3"
480	17'-6"	17'-9"	18'-0"	18'-3"	18'-6"	18'-8"	18'-11"	18'-4"	19'-9"
500	19'-1"	19'-4"	19'-7"	19'-9"	20'-0"	20'-3"	20'-6"	19'-11"	21'-3"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1516	1298	1113	967	853	764	694	915	535
120	1471	1287	1132	1009	911	831	766	962	609
140	1430	1276	1147	1042	956	885	825	1000	673
160	1391	1264	1156	1067	992	928	874	1029	729
180	1360	1255	1163	1086	1021	964	915	1053	778
200	1337	1248	1169	1103	1045	994	949	1073	822
220	1316	1241	1173	1116	1065	1019	978	1089	859
240	1298	1235	1176	1126	1080	1039	1002	1102	892
260	1285	1230	1179	1134	1094	1057	1023	1113	920
280	1272	1225	1180	1140	1104	1071	1040	1121	945
300	1263	1221	1181	1146	1114	1083	1055	1129	967
320	1255	1218	1183	1151	1122	1094	1069	1135	987
340	1248	1215	1183	1155	1128	1103	1080	1141	1004
360	1241	1212	1183	1158	1133	1111	1089	1145	1019
380	1235	1209	1183	1160	1138	1117	1097	1148	1032
400	1230	1206	1183	1162	1142	1122	1104	1151	1043
420	1226	1204	1183	1163	1145	1127	1110	1153	1054
440	1221	1202	1182	1165	1148	1131	1115	1155	1063
460	1218	1200	1182	1166	1150	1135	1120	1157	1071
480	1214	1198	1181	1166	1152	1138	1124	1158	1078
500	1211	1196	1180	1166	1153	1140	1127	1159	1084

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

1.0 Guying

Conductor tensions for guying 336.4 (30/7) Covered Conductor is 3,260 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	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	0'-9"	0'-11"	1'-0"	1'-2"	1'-3"	1'-4"	1'-6"	1'-2"	1'-10"
120	1'-2"	1'-4"	1'-5"	1'-7"	1'-8"	1'-10"	1'-11"	1'-8"	2'-4"
140	1'-8"	1'-9"	1'-11"	2'-1"	2'-2"	2'-4"	2'-6"	2'-2"	2'-11"
160	2'-2"	2'-4"	2'-6"	2'-8"	2'-9"	2'-11"	3'-1"	2'-9"	3'-7"
180	2'-10"	3'-0"	3'-2"	3'-3"	3'-5"	3'-7"	3'-9"	3'-5"	4'-3"
200	3'-6"	3'-8"	3'-10"	4'-0"	4'-2"	4'-4"	4'-6"	4'-1"	5'-0"
220	4'-3"	4'-6"	4'-8"	4'-10"	5'-0"	5'-2"	5'-3"	4'-11"	5'-10"
240	5'-2"	5'-4"	5'-6"	5'-8"	5'-10"	6'-0"	6'-2"	5'-9"	6'-9"
260	6'-1"	6'-3"	6'-5"	6'-8"	6'-10"	7'-0"	7'-2"	6'-9"	7'-9"
280	7'-1"	7'-3"	7'-6"	7'-8"	7'-10"	8'-0"	8'-2"	7'-9"	8'-10"
300	8'-2"	8'-5"	8'-7"	8'-9"	8'-11"	9'-1"	9'-3"	8'-10"	9'-11"
320	9'-4"	9'-7"	9'-9"	9'-11"	10'-1"	10'-4"	10'-6"	10'-1"	11'-1"
340	10'-7"	10'-10"	11'-0"	11'-2"	11'-5"	11'-7"	11'-9"	11'-4"	12'-5"
360	12'-0"	12'-2"	12'-4"	12'-6"	12'-9"	12'-11"	13'-1"	12'-8"	13'-9"
380	13'-4"	13'-7"	13'-9"	14'-0"	14'-2"	14'-4"	14'-6"	14'-1"	15'-2"
400	14'-10"	15'-1"	15'-3"	15'-6"	15'-8"	15'-10"	16'-0"	15'-7"	16'-8"
420	16'-5"	16'-8"	16'-10"	17'-0"	17'-3"	17'-5"	17'-7"	17'-2"	18'-3"
440	18'-1"	18'-4"	18'-6"	18'-8"	18'-11"	19'-1"	19'-3"	18'-10"	19'-11"
460	19'-10"	20'-0"	20'-3"	20'-5"	20'-8"	20'-10"	21'-0"	20'-7"	21'-8"
480	21'-8"	21'-10"	22'-1"	22'-3"	22'-6"	22'-8"	22'-10"	22'-5"	23'-6"
500	23'-7"	23'-9"	24'-0"	24'-2"	24'-4"	24'-7"	24'-9"	24'-4"	25'-5"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1530	1351	1198	1076	976	894	827	1021	659
120	1490	1345	1221	1119	1034	963	902	1071	741
140	1454	1337	1235	1151	1078	1016	962	1108	811
160	1426	1331	1247	1176	1114	1059	1010	1139	870
180	1404	1326	1255	1195	1141	1093	1050	1162	920
200	1385	1320	1261	1209	1162	1120	1081	1180	963
220	1370	1316	1265	1220	1179	1142	1108	1195	999
240	1358	1312	1268	1229	1194	1160	1129	1207	1031
260	1348	1308	1270	1236	1205	1175	1147	1216	1057
280	1339	1304	1271	1241	1213	1187	1162	1223	1079
300	1332	1302	1272	1246	1221	1197	1175	1230	1099
320	1326	1299	1273	1249	1227	1206	1185	1235	1116
340	1320	1297	1273	1252	1232	1212	1194	1239	1131
360	1315	1294	1273	1254	1236	1218	1201	1242	1143
380	1310	1292	1273	1255	1239	1223	1207	1245	1154
400	1306	1289	1272	1256	1241	1227	1212	1247	1163
420	1302	1287	1271	1257	1243	1230	1217	1248	1171
440	1298	1285	1270	1257	1244	1232	1220	1249	1178
460	1295	1282	1269	1257	1245	1234	1223	1249	1184
480	1291	1280	1267	1256	1246	1235	1225	1250	1189
500	1288	1278	1266	1256	1246	1236	1227	1250	1193

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

1.0 Guying

Conductor tensions for guying 336.4 (30/7) Covered Conductor is 3,260 lb.

2.0 Ground Clearance

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

This page intentionally left blank.

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

	Sag					
	Initial Stringing Sag				Final Sag	
Span (ft)	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	0’-6”	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’-22”	8’-6”	9’-0”	8’-7”	10’-9”
340	8’-4”	8’-11”	9’-5”	9’-11”	9’-6”	11’-0”
360	9’-14”	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

	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1'-0"	1'-2"	1'-3"	1'-5"	1'-6"	1'-8"	1'-9"	1'-6"	2'-2"
120	1'-4"	1'-6"	1'-8"	1'-10"	2'-0"	2'-1"	2'-3"	1'-11"	2'-9"
140	1'-10"	2'-0"	2'-2"	2'-4"	2'-6"	2'-8"	2'-9"	2'-6"	3'-4"
160	2'-4"	2'-6"	2'-9"	2'-11"	3'-1"	3'-3"	3'-5"	3'-1"	4'-0"
180	3'-0"	3'-2"	3'-4"	3'-6"	3'-9"	3'-11"	4'-0"	3'-9"	4'-9"
200	3'-8"	3'-10"	4'-0"	4'-3"	4'-5"	4'-7"	4'-9"	4'-5"	5'-6"
220	4'-5"	4'-7"	4'-10"	5'-0"	5'-2"	5'-5"	5'-7"	5'-3"	6'-4"
240	5'-3"	5'-5"	5'-8"	5'-10"	6'-1"	6'-3"	6'-5"	6'-1"	7'-3"
260	6'-2"	6'-4"	6'-7"	6'-9"	7'-0"	7'-2"	7'-5"	7'-1"	8'-3"
280	7'-2"	7'-4"	7'-7"	7'-9"	8'-0"	8'-2"	8'-5"	8'-1"	9'-3"
300	8'-2"	8'-5"	8'-8"	8'-10"	9'-1"	9'-3"	9'-6"	9'-2"	10'-4"
320	9'-4"	9'-7"	9'-9"	10'-0"	10'-3"	10'-5"	10'-8"	10'-4"	11'-6"
340	10'-7"	10'-9"	11'-0"	11'-3"	11'-5"	11'-8"	11'-10"	11'-6"	12'-10"
360	11'-10"	12'-1"	12'-4"	12'-6"	12'-9"	13'-0"	13'-2"	12'-10"	14'-2"
380	13'-3"	13'-5"	13'-8"	13'-11"	14'-2"	14'-4"	14'-7"	14'-3"	15'-6"
400	14'-8"	14'-11"	15'-2"	15'-5"	15'-7"	15'-10"	16'-0"	15'-8"	17'-0"
420	16'-3"	16'-5"	16'-8"	16'-11"	17'-2"	17'-4"	17'-7"	17'-3"	18'-7"
440	17'-10"	18'-1"	18'-4"	18'-6"	18'-9"	19'-0"	19'-2"	18'-10"	20'-2"
460	19'-6"	19'-9"	20'-0"	20'-3"	20'-5"	20'-8"	20'-11"	20'-7"	21'-11"
480	21'-3"	21'-6"	21'-9"	22'-0"	22'-3"	22'-5"	22'-8"	22'-4"	23'-8"
500	23'-2"	23'-5"	23'-8"	23'-10"	24'-1"	24'-4"	24'-6"	24'-2"	25'-7"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

Table CO 166–3: Tension — Temperature Stringing Table 17 kV 654 ACSR Covered Conductor for Heavy-Loading Areas

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1236	1078	956	864	791	733	685	818	558
120	1281	1146	1038	953	884	826	778	898	641
140	1310	1195	1100	1023	958	903	856	964	715
160	1328	1230	1146	1077	1018	967	922	1018	781
180	1336	1253	1180	1119	1065	1018	977	1061	838
200	1340	1270	1206	1152	1103	1060	1022	1096	888
220	1343	1282	1227	1178	1135	1095	1060	1126	932
240	1343	1291	1242	1199	1160	1124	1091	1150	970
260	1343	1297	1253	1215	1180	1148	1118	1170	1004
280	1342	1302	1263	1229	1197	1168	1140	1187	1034
300	1340	1305	1271	1240	1211	1184	1159	1201	1059
320	1339	1308	1277	1249	1223	1198	1175	1213	1082
340	1337	1309	1281	1256	1233	1210	1189	1223	1102
360	1335	1310	1284	1262	1240	1220	1200	1232	1119
380	1333	1310	1287	1267	1247	1228	1210	1239	1135
400	1331	1310	1289	1270	1252	1235	1219	1245	1148
420	1329	1310	1291	1274	1257	1241	1226	1250	1160
440	1327	1310	1292	1276	1261	1246	1232	1254	1171
460	1325	1309	1293	1278	1264	1251	1237	1258	1180
480	1322	1308	1293	1280	1267	1254	1242	1261	1188
500	1320	1307	1293	1280	1268	1257	1245	1263	1195

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

Table CO 166–4: Sag — Temperature Stringing Table 35 kV 654 ACSR Covered Conductor for Heavy-Loading Areas

	Sag								
	Initial Stringing Sag							Final Sag	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1'-0"	1'-2"	1'-3"	1'-4"	1'-6"	1'-7"	1'-8"	1'-6"	2'-1"
120	1'-6"	1'-8"	1'-9"	1'-11"	2'-0"	2'-1"	2'-3"	2'-0"	2'-9"
140	2'-1"	2'-2"	2'-4"	2'-6"	2'-7"	2'-9"	2'-10"	2'-8"	3'-5"
160	2'-8"	2'-10"	3'-0"	3'-1"	3'-3"	3'-5"	3'-6"	3'-4"	4'-1"
180	3'-5"	3'-7"	3'-9"	3'-10"	4'-0"	4'-2"	4'-3"	4'-1"	4'-11"
200	4'-3"	4'-5"	4'-7"	4'-8"	4'-10"	5'-0"	5'-2"	4'-11"	5'-10"
220	5'-2"	5'-4"	5'-6"	5'-8"	5'-9"	5'-11"	6'-1"	5'-11"	6'-9"
240	6'-2"	6'-4"	6'-6"	6'-8"	6'-10"	7'-0"	7'-1"	6'-11"	7'-10"
260	7'-3"	7'-5"	7'-7"	7'-9"	7'-11"	8'-1"	8'-3"	8'-0"	9'-0"
280	8'-5"	8'-7"	8'-9"	8'-11"	9'-1"	9'-3"	9'-5"	9'-3"	10'-2"
300	9'-9"	9'-11"	10'-1"	10'-3"	10'-5"	10'-7"	10'-9"	10'-7"	11'-6"
320	11'-1"	11'-3"	11'-6"	11'-8"	11'-10"	12'-0"	12'-2"	11'-11"	12'-11"
340	12'-7"	12'-9"	12'-11"	13'-1"	13'-3"	13'-5"	13'-7"	13'-5"	14'-5"
360	14'-2"	14'-4"	14'-6"	14'-8"	14'-10"	15'-0"	15'-2"	15'-0"	16'-0"
380	15'-10"	16'-0"	16'-2"	16'-4"	16'-6"	16'-8"	16'-10"	16'-8"	17'-8"
400	17'-7"	17'-9"	17'-11"	18'-2"	18'-4"	18'-6"	18'-8"	18'-5"	19'-6"
420	19'-6"	19'-8"	19'-10"	20'-0"	20'-2"	20'-4"	20'-6"	20'-4"	21'-4"
440	21'-5"	21'-7"	21'-9"	22'-0"	22'-2"	22'-4"	22'-6"	22'-3"	23'-4"
460	23'-6"	23'-8"	23'-10"	24'-0"	24'-2"	24'-4"	24'-6"	24'-4"	25'-5"
480	25'-8"	25'-10"	26'-0"	26'-2"	26'-4"	26'-6"	26'-9"	26'-6"	27'-7"
500	27'-11"	28'-1"	28'-3"	28'-6"	28'-8"	28'-10"	29'-0"	28'-9"	29'-10"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

Table CO 166–5: Tension — Temperature Stringing Table 35 kV 654 ACSR Covered Conductor for Heavy-Loading Areas

	Tension (lb)								
	Initial Stringing Tension							Final Tension	
Span (Ft)	50° F	60° F	70 ° F	80° F	90°F	100° F	110° F	70° F	130° F
100	1494	1353	1234	1135	1052	982	922	1033	732
120	1478	1366	1270	1187	1116	1055	1001	1093	820
140	1480	1388	1307	1237	1175	1120	1071	1149	898
160	1479	1403	1335	1275	1221	1172	1128	1193	965
180	1473	1409	1352	1300	1253	1211	1171	1227	1020
200	1466	1413	1364	1319	1278	1241	1206	1253	1067
220	1458	1413	1372	1333	1297	1264	1233	1274	1106
240	1452	1414	1378	1344	1313	1283	1256	1291	1140
260	1446	1413	1382	1352	1325	1299	1274	1305	1168
280	1441	1412	1385	1359	1334	1311	1289	1317	1192
300	1435	1410	1386	1363	1341	1320	1300	1325	1212
320	1430	1408	1387	1367	1347	1328	1310	1332	1230
340	1426	1406	1387	1369	1351	1334	1318	1338	1244
360	1422	1404	1387	1371	1355	1339	1325	1342	1257
380	1417	1402	1386	1371	1357	1343	1330	1346	1267
400	1413	1399	1385	1372	1359	1346	1334	1349	1277
420	1409	1397	1384	1372	1360	1348	1337	1351	1284
440	1405	1394	1382	1371	1360	1350	1339	1352	1290
460	1402	1391	1381	1370	1360	1351	1341	1352	1296
480	1398	1388	1378	1369	1360	1351	1342	1352	1300
500	1394	1385	1376	1367	1359	1351	1342	1352	1304

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

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.

This page intentionally left blank.

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 (see 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 provide stringing tensions for dynamometer use during covered conductor installation.

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 168–44 and Table CO 168–47 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

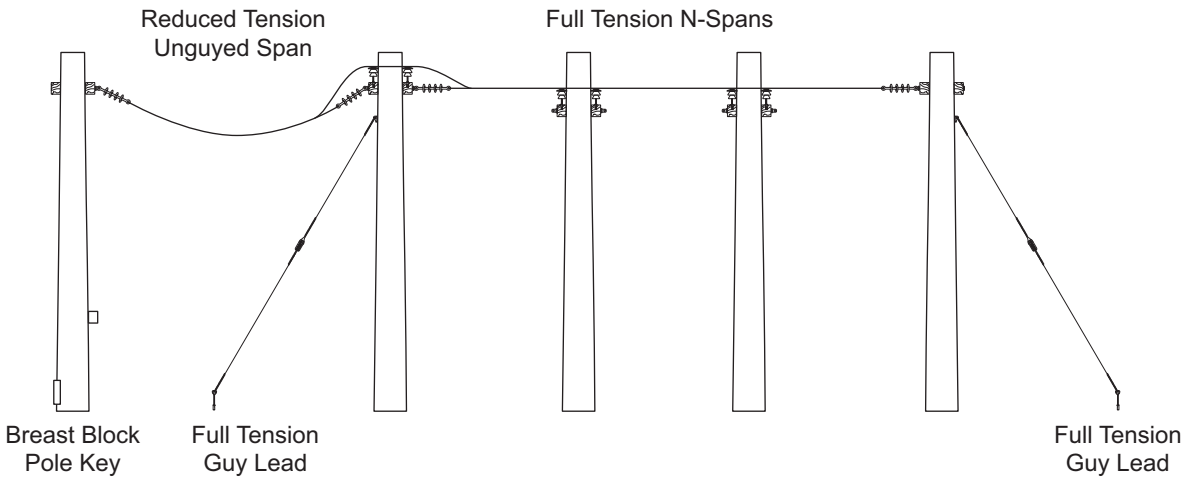


Figure CO 168–2: Reduced Tension Guyed Span Example

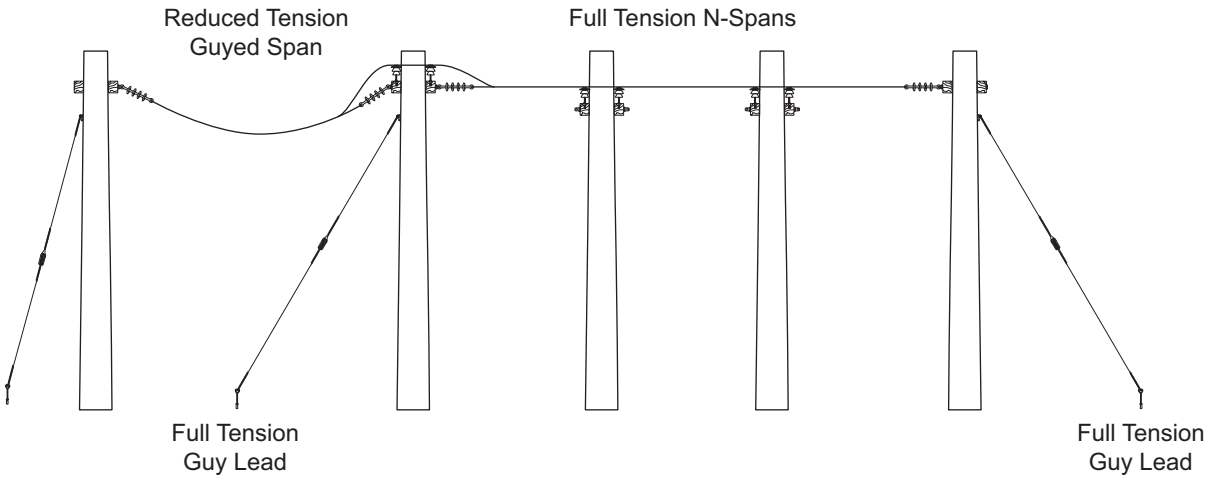


Table CO 168–1: Percent Full Tension of Conductor Light-Loading Areas

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 50–110°F	Final Sag 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 1.0 for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
1/0 ACSR	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-10"
	175	6'-4"	6'-10"
	200	7'-3"	7'-10"
336 ACSR	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-8"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-11"
	175	6'-4"	6'-11"
	200	7’-3"	8'-0"
653 ACSR	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-8"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-11"
	175	6'-4"	6'-11"
	200	7'-3"	8'-0"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

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: Sag Chart for New and Existing Reduced Tension Guyed Primary 17 kV 1/0 — 653 ACSR-AW Covered Conductors 2.0 for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
1/0 ACSR	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-11"
	175	6'-4"	6'-11"
	200	7'-3"	7'-10"
101.8 ACSR/AW	50	2'-0"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-10"
	125	4'-6"	4'-9"
	150	5'-5"	5'-9"
	175	6'-3"	6'-8"
	200	7'-2"	7-7"
336 (18/1) ACSR/AW	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-11"
	175	6'-4"	6'-11"
	200	7'-3"	7'-11"
336 (30/7) ACSR/AW	50	2'-0"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-10"
	125	4'-6"	4'-10"
	150	5'-5"	5'-10"
	175	6'-3"	6'-9"
	200	7'-2"	8'-9"
653 ACSR/AW	50	2'-1"	2'-2"
	75	3'-1"	3'-5"
	100	3'-7"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-11"
	175	6'-4"	6'-11"
	200	7'-4"	7'-11"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 168–6: Sag Chart for New and Existing Reduced Tension Guyed Primary 35 kV 1/0 — 653 ACSR Covered Conductors 1.0 for Light-Loading Areas

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

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 168–7: Sag Chart for New and Existing Reduced Tension Guyed Primary 35 kV 1/0 653 ACSR-AW Covered Conductors 2.0 for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
1/0 ACSR/AW	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-11"
	175	6'-4"	6'-11"
	200	7'-3"	7'-10"
101.8 ACSR/AW	50	2'-0"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-10"
	125	4'-6"	4'-9"
	150	5'-5"	5'-9"
	175	6'-3"	6'-8"
	200	7'-2"	7-7"
336 (18/1) ACSR/AW	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-11"
	175	6'-4"	6'-11"
	200	7'-3"	7'-11"
336 (30/7) ACSR/AW	50	2'-0"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-10"
	125	4'-6"	4'-10"
	150	5'-5"	5'-10"
	175	6'-3"	6'-9"
	200	7'-2"	8'-9"
653 ACSR/AW	50	2'-1"	2'-2"
	75	3'-1"	3'-5"
	100	3'-7"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-11"
	175	6'-4"	6'-11"
	200	7'-4"	7'-11"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

1.0 Guyed Span Tensions

Table CO 168–8: Guyed Span Tensions: 17 kV 1/0 — 653 ACSR Covered Conductor 1.0 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	1,002

Table CO 168–9: Guyed Span Tensions: 17 kV 1/0 — 653 ACSR-AW Covered Conductor 2.0 for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR/AW	50	37
	75	55
	100	81
	125	102
	150	122
	175	142
	200	162
101.8 ACSR/AW	50	54
	75	77
	100	115
	125	144
	150	173
	175	201
	200	230
336 (18/1) ACSR/AW	50	76
	75	115
	100	170
	125	212
	150	254
	175	296
	200	338
336 (30/7) ACSR/AW	50	99
	75	147
	100	219
	125	274
	150	328
	175	383
	200	437
653 ACSR/AW	50	131
	75	196
	100	291
	125	362
	150	434
	175	506
	200	577

FOR PLANNING USE ONLY

Table CO 168–10: Guyed Span Tensions: 35 kV 1/0 — 653 ACSR Covered Conductor 1.0 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	1,506
	200	1,708
653 ACSR	50	271
	75	406
	100	626
	125	782
	150	937
	175	1,091
	200	1,245

2.0 Ground Clearance

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

Table CO 168–11: Guyed Span Tensions: 35 k/V 1/0 — 653 ACSR-AW Covered Conductor 2.0 for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR/AW	50	52
	75	78
	100	115
	125	144
	150	173
	175	201
	200	230
101.8 ACSR/AW	50	68
	75	102
	100	154
	125	192
	150	230
	175	269
	200	307
336 (18/1) ACSR/AW	50	97
	75	145
	100	216
	125	269
	150	323
	175	375
	200	428
336 (30/7) ACSR/AW	50	121
	75	181
	100	269
	125	336
	150	404
	175	470
	200	536
653 ACSR/AW	50	158
	75	238
	100	354
	125	442
	150	528
	175	613
	200	698

FOR PLANNING USE ONLY

Scope CO 168.4 Sag Chart for New and Existing Reduced Tension Guyed Primary #6 — 4/0 Copper for Light-Loading Areas

Table CO 168–12: 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 168–13: Sag Chart for New and Existing Reduced Tension Guyed Primary 17 kV #2 — 4/0 Copper Covered Conductor 1.0 for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#2 Copper	50	2'-0"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-10"
	125	4'-6"	4'-9"
	150	5'-5"	5'-9"
	175	6'-4"	6'-9"
	200	7'-2"	7'-8"
2/0 Copper	50	2'-0"	2'-2"
	75	3'-0"	3'-3"
	100	3'-5"	3'-10"
	125	4'-4"	4'-9"
	150	5'-2"	5'-9"
	175	6'-0"	6'-9"
	200	6’-11"	7'-8"
4/0 Copper	50	2'-0"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-10"
	125	4'-6"	4'-9"
	150	5'-5"	5'-9"
	175	6'-4"	6'-9"
	200	7'-2"	7'-8"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

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 168–14: Sag Chart for New and Existing Reduced Tension Guyed Primary 17 kV #2 — 500 kcmil Copper Covered Conductor 2.0 for Light-Loading Areas

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

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 168–15: Sag Chart for New and Existing Reduced Tension Guyed Primary 35 kV #2 — kcmil Copper Covered Conductor 2.0 for Light -Loading Areas

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

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

1.0 Guyed Span Tensions

Table CO 168–16: Guyed Span Tensions: 17 kV #2 — 4/0 Copper Covered Conductor 1.0 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.

Table CO 168–17: Guyed Span Tensions: 17 kV #2 — 500 kcmil Copper Covered Conductor 2.0 for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
#2 Copper	50	43
	75	64
	100	95
	125	119
	150	143
	175	167
	200	191
2/0 Copper	50	77
	75	115
	100	172
	125	215
	150	258
	175	301
	200	344
4/0 Copper	50	58
	75	116
	100	174
	125	260
	150	325
	175	390
	200	455
350 kcmil	50	182
	75	273
	100	408
	125	510
	150	612
	175	714
	200	817
500 kcmil	50	255
	75	382
	100	570
	125	713
	150	855
	175	999
	200	1142

FOR PLANNING USE ONLY

Table CO 168–18: Guyed Span Tensions: 35 kV #2 — 500 kcmil Covered Conductor 2.0 for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
#2 Copper	50	57
	75	85
	100	127
	125	159
	150	191
	175	223
	200	255
2/0 Copper	50	93
	75	140
	100	210
	125	262
	150	314
	175	367
	200	419
4/0 Copper	50	135
	75	202
	100	302
	125	377
	150	454
	175	529
	200	605
350 kcmil	50	204
	75	306
	100	458
	125	572
	150	687
	175	801
	200	916
500 kcmil	50	279
	75	419
	100	626
	125	783
	150	940
	175	1097
	200	1255

FOR PLANNING USE ONLY

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 168–19: 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	Final Sag
		50–110°F	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 168–20: Sag Chart for New and Existing Reduced Tension Guyed #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	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 168–21: 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 168–22: Sag Chart for New Reduced Tension Unguyed 17 kV 1/0 — 653 ACSR Covered Conductor 1.0 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'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
336 ACSR	50	3'-10"	3'-10"
	75	5'-8"	5'-10"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
653 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-10"
	100	7'-7"	7'-9"
	125	9'-5"	9'-8"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

Note(s):

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 168–23: Sag Chart for New Reduced Tension Unguyed 17 kV 1/0 — 653 ACSR/AW Covered Conductor 2.0 for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
1/0 ACSR/AW	50	3'-9"	3'-10"
	75	5'-8"	5'-10"
	100	7'-7"	7'-9"
	125	9'-5"	9'-8"
101.8 ACSR/AW	50	3'-10"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
336 (18/1) ACSR/AW	50	3'-10"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-8"
336(30/7) ACSR/AW	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
653 ACSR/AW	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-8"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 168–24: 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'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
336 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
653 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

Table CO 168–25: Sag Chart for New Reduced Tension Unguyed 35 kV 1/0 — 653 ACSR/AW Covered Conductor 2.0 for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
1/0 ACSR/AW	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
101.8 ACSR/AW	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
336 (18/1) ACSR/AW	50	3'-10"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-9"
	125	9'-6"	9'-8"
336(30/7) ACSR/AW	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
653 ACSR/AW	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

FOR PLANNING USE ONLY

1.0 New Unguyed Span Tensions

Table CO 168–26: New Unguyed Span Tensions: 17 kV 1/0 — 653 ACSR Covered Conductor 1.0 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 168–27: 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

Table CO 168–28: New Unguyed Span Tensions: 17 kV 1/0 — 653 ACSR/AW Covered Conductor 2.0 for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR/AW	50	21
	75	31
	100	42
	125	52
101.8 ACSR/AW	50	29
	75	43
	100	58
	125	72
336 (18/1) ACSR/AW	50	44
	75	66
	100	88
	125	109
336 (30/7) ACSR/AW	50	56
	75	84
	100	111
	125	139
653 ACSR/AW	50	75
	75	113
	100	150
	125	187

FOR PLANNING USE ONLY

Table CO 168–29: New Unguyed Span Tensions: 35 kV 1/0 — ACSR/AW Covered Conductor 2.0 for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR/AW	50	29
	75	44
	100	59
	125	74
101.8 ACSR/AW	50	38
	75	58
	100	77
	125	96
336 (18/1) ACSR/AW	50	56
	75	84
	100	111
	125	139
336 (30/7) ACSR/AW	50	34
	75	68
	100	102
	125	137
653 ACSR/AW	50	90
	75	135
	100	180
	125	225

FOR PLANNING USE ONLY

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 168–30: Sag Chart for New Reduced Tension Unguyed #6 — 4/0 Copper for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	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 168–31: Sag Chart for New Reduced Tension Unguyed 17 kV #2 — 4/0 Copper Covered Conductor 1.0 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'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
2/0 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
4/0 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

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 168–32: Sag Chart for New Reduced Tension Unguyed 17 kV #2 — 500 kcmil Copper Covered Conductor 2.0 for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#2 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
2/0 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
4/0 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
350 kcmil	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
500 kcmil	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 168–33: Sag Chart for New Reduced Tension Unguyed 35 kV #2 — 500 kcmil Copper Covered Conductor 2.0 for Light-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#2 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
2/0 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
4/0 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
350 kcmil	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
500 kcmil	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

FOR PLANNING USE ONLY

1.0 New Unguyed Span Tensions

Table CO 168–34: New Unguyed Span Tensions: 17 kV #2 — 4/0 Copper Covered Conductor 1.0 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

Table CO 168–35: New Unguyed Span Tensions: 17 kV #2 — 500 kcmil Copper Covered Conductor 2.0 for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
#2 Copper	50	24
	75	36
	100	48
	125	60
2/0 Copper	50	43
	75	65
	100	86
	125	108
4/0 Copper	50	65
	75	98
	100	131
	125	163
350 kcmil	50	102
	75	154
	100	206
	125	256
500 kcmil	50	143
	75	215
	100	287
	125	358

FOR PLANNING USE ONLY

Table CO 168–36: New Unguyed Span Tensions: 35 kV #2 — 500 kcmil Copper Covered Conductor 2.0 for Light-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
#2 Copper	50	32
	75	48
	100	64
	125	80
2/0 Copper	50	53
	75	79
	100	106
	125	131
4/0 Copper	50	135
	75	202
	100	302
	125	377
350 kcmil	50	115
	75	172
	100	230
	125	288
500 kcmil	50	158
	75	236
	100	315
	125	393

FOR PLANNING USE ONLY

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 168–37: Sag Chart for New Reduced Tension Unguyed #6 — 1/0 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"
#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 168–38: 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 168–39: 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 168–40: 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'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
	150	11'-0"	11'-3"
	175	12'-4"	12'-7"
336 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
	150	11'-1"	11'-3"
	175	12'-4"	12'-8"
653 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-10"
	100	7'-6"	7'-8"
	125	9'-6"	9'-8"
	150	11'-0"	11'-3"
	175	12'-4"	12'-8"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

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 168–41: Sag Chart for Existing and Rebuild Reduced Tension Unguyed 35 kV 1/0 — 653 ACSR Covered Conductor 1.0 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'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
	150	11'-0"	11'-3"
	175	12'-4"	12'-8"
336 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-8"
	150	11'-1"	11'-3"
	175	12'-4"	12'-8"
653 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
	150	11'-0"	11'-3"
	175	12'-4"	12'-7"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

1.0 Existing and Rebuild Unguyed Span Tension

Table CO 168–42: Existing and Rebuild Unguyed Span Tensions: 17 kV 1/0 — 653 ACSR Covered Conductor 1.0 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 168–43: Existing and Rebuild Unguyed Span Tensions: 35 kV 1/0 Covered Conductor 1.0 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 168–44: 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 168–45: Sag Chart for Existing and Rebuild Reduced Tension Unguyed 17 kV #2 — 4/0 Copper Covered Conductor 1.0 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'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
	150	11'-0"	11'-3"
	175	12'-4"	12'-7"
2/0 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-8"
	150	11'-1"	11'-3"
	175	12'-4"	12'-8"
4/0 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
	150	11'-0"	11'-3"
	175	12'-4"	12'-7"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

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.

1.0 Existing and Rebuild Unguyed Span Tension

Table CO 168–46: Sag Chart for Existing and Rebuild Reduced Tension Unguyed 17 kV #2 — 4/0 Copper Covered Conductor 1.0 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 168–47: 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 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"
	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 168–48: Sag Chart for New and Existing Reduced Tension Guyed #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'-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 168–49: Sag Chart for New and Existing Reduced Tension Guyed 17 kV 1/0 — 653 ACSR Covered Conductor 1.0 for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
1/0 ACSR	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-10"
	175	6'-4"	6'-10"
336 (18/1) ACSR	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-8"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-11"
	175	6'-4"	6'-11"
336 (30/7) ACSR	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-11"
	125	4'-6"	4'-10"
	150	5'-5"	5'-10"
	175	6'-4"	6'-10"
653 ACSR	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-11"
	125	4'-6"	4'-10"
	150	5'-5"	5'-10"
	175	6'-4"	6'-10"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

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: Sag Chart for New and Existing Reduced Tension Guyed 17 kV 1/0 — 653 ACSR/AW Covered Conductor 2.0 for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
1/0 ACSR/AW	50	2'-0"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-11"
	175	6'-4"	6'-11"
101.8 ACSR/AW	50	2'-0"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-10"
	125	4'-6"	4'-9"
	150	5'-5"	5'-9"
	175	6'-3"	6'-8"
336 (18/1) ACSR/AW	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-8"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-11"
	175	6'-4"	6'-11"
336 (30/7) ACSR/AW	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-11"
	125	4'-6"	4'-10"
	150	5'-5"	5'-10"
	175	6'-4"	6'-10"
653 ACSR/AW	50	2'-1"	2'-2"
	75	3'-1"	3'-4"
	100	3'-7"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-11"
	175	6'-4"	6'-11"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

FOR PLANNING USE ONLY

Table CO 168–51: Sag Chart for New and Existing Reduced Tension Guyed 35 kV 1/0 — 653 ACSR Covered Conductor 1.0 for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
1/0 ACSR	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-11"
	175	6'-4"	6'-10"
336 (18/1) ACSR	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-8"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-11"
	175	6'-4"	6'-11"
336 (30/7) ACSR	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-11"
	175	6'-4"	6'-11"
653 ACSR	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-11"
	125	4'-6"	4'-10"
	150	5'-5"	5'-10"
	175	6'-4"	6'-10"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

Table CO 168–52: Sag Chart for New and Existing Reduced Tension Guyed 35 kV 1/0 — 6953 ACSR/AW Covered Conductor 2.0 for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
1/0 ACSR/AW	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-11"
	175	6'-4"	6'-11"
101.8 ACSR/AW	50	2'-0"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-10"
	125	4'-6"	4'-9"
	150	5'-5"	5'-9"
	175	6'-3"	6'-8"
336 (18/1) ACSR/AW	50	2'-1"	2'-2"
	75	3'-1"	3'-4"
	100	3'-7"	3'-11"
	125	4'-6"	4'-11"
	150	5'-5"	5'-11"
	175	6'-4"	7'-0"
336 (30/7) ACSR/AW	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-10"
	125	4'-6"	4'-10"
	150	5'-5"	5'-10"
	175	6'-3"	6'-10"
653 ACSR/AW	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-11"
	125	4'-6"	4'-10"
	150	5'-5"	5'-10"
	175	6'-4"	6'-11"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

1.0 Guyed Span Tensions

Table CO 168–53: Guyed Span Tensions: 17 kV 1/0 — 653 ACSR Covered Conductor 1.0 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 168–54: Guyed Span Tensions: 17 kV 1/0 — 653 ACSR/AW Covered Conductor 2.0 for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR/AW	50	37
	75	35
	100	81
	125	102
	150	122
	175	142
101.8 ACSR/AW	50	51
	75	77
	100	115
	125	144
	150	173
	175	201
336 (18/1) ACSR/AW	50	44
	75	66
	100	88
	125	109
	150	135
	175	163
336 (30/7) ACSR/AW	50	99
	75	147
	100	219
	125	274
	150	328
	175	383
653 ACSR/AW	50	131
	75	196
	100	291
	125	362
	150	434
	175	506

FOR PLANNING USE ONLY

Table CO 168–55: Guyed Span Tensions: 35 kV 1/0 — 653 ACSR Covered Conductor 1.0 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

Table CO 168–56: Guyed Span Tensions: 35 kV 1/0 — 653 ACSR/AW Covered Conductor 2.0 for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR/AW	50	52
	75	78
	100	115
	125	144
	150	173
	175	201
101.8 ACSR/AW	50	68
	75	102
	100	154
	125	192
	150	230
	175	269
336 (18/1) ACSR/AW	50	97
	75	145
	100	216
	125	269
	150	323
	175	375
336 (30/7) ACSR/AW	50	121
	75	181
	100	269
	125	336
	150	404
	175	470
653 ACSR/AW	50	158
	75	238
	100	354
	125	442
	150	528
	175	613

FOR PLANNING USE ONLY

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 168–57: Sag Chart for New and Existing Reduced Tension Guyed #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"
	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 168–58: Sag Chart for New and Existing Reduced Tension Guyed 17 kV #2 — 4/0 Copper Covered Conductor 1.0 for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	130°F
#2 Copper	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-10"
	125	4'-6"	4'-9"
	150	5'-5"	5'-9"
	175	6'-4"	6'-8"
2/0 Copper	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-10"
	125	4'-6"	4'-9"
	150	5'-5"	5'-9"
	175	6'-4"	6'-9"
4/0 Copper	50	2'-1"	2'-2"
	75	3'-1"	3'-3"
	100	3'-7"	3'-10"
	125	4'-6"	4'-9"
	150	5'-5"	5'-9"
	175	6'-4"	6'-9"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

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 168–59: Sag Chart for New and Existing Reduced Tension Guyed 17 kV #2 — 500 kcmil Copper Covered Conductor 2.0 for Heavy-Loading areas

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

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 168–60: Sag Chart for New and Existing Reduced Tension Guyed 35 #2 — 500 kcmil Copper Covered Conductor 2.0 for Heavy-Loading Areas

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

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

1.0 Guyed Span Tensions

Table CO 168–61: 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	1,036
4/0 Copper	50	322
	75	481
	100	738
	125	917
	150	1,093
	175	1,268

Table CO 168–62: Guyed Span Tensions: 17 kV #2 — 500 kcmil Copper Covered Conductor 2.0 for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
#2 Copper	50	43
	75	64
	100	95
	125	119
	150	143
	175	167
2/0 Copper	50	77
	75	115
	100	172
	125	215
	150	258
	175	301
4/0 Copper	50	116
	75	174
	100	260
	125	325
	150	390
	175	455
350 kcmil	50	182
	75	273
	100	408
	125	510
	150	612
	175	714
500 kcmil	50	255
	75	382
	100	570
	125	713
	150	855
	175	999

FOR PLANNING USE ONLY

Table CO 168–63: Guyed Span Tensions: 35 kV #2 — 500 kcmil Copper Covered Conductor 2.0 for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
#2 Copper	50	57
	75	85
	100	127
	125	159
	150	191
	175	223
2/0 Copper	50	93
	75	140
	100	210
	125	262
	150	314
	175	367
4/0 Copper	50	135
	75	202
	100	302
	125	377
	150	454
	175	529
350 kcmil	50	204
	75	306
	100	458
	125	572
	150	687
	175	801
500 kcmil	50	279
	75	419
	100	626
	125	783
	150	940
	175	1097

FOR PLANNING USE ONLY

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 — 4/0 Aluminum Duplex and Triplex for Heavy-Loading Areas

Table CO 168–64: Sag Chart for New and Existing Reduced Tension Guyed #6 — 4/0 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 168–65: 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 168–66: 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 168–67: Sag Chart for New Reduced Tension Unguyed 17 kV 1/0 — 653 ACSR Covered Conductor 1.0 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'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-8"
336 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-9"
	125	9'-5"	9'-8"
336 (30/7) ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
653 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

Table CO 168–68: Sag Chart for New Reduced Tension Unguyed 17 kV 1/0 — 653 ACSR/AW Covered Conductor 2.0 for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
1/0 ACSR/AW	50	3'-9"	3'-10"
	75	5'-8"	5'-10"
	100	7'-7"	7'-9"
	125	9'-5"	9'-8"
101.8 ACSR/AW	50	3'-10"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
336 (18/1) ACSR/AW	50	3'-10"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-8"
336 (30/7) ACSR/AW	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
653 ACSR/AW	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-8"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

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.

FOR PLANNING USE ONLY

Table CO 168–69: Sag Chart for New Reduced Tension Unguyed 35 kV 1/0 — 653 ACSR Covered Conductor 1.0 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'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
336 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-9"
	125	9'-5"	9'-8"
336 (30/7) ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
653 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
Note(s): Listed temperatures refer to conductor temperature, not ambient			

Table CO 168–70: Sag Chart for New Reduced Tension Unguyed 35 kV 1/0 — 653 ACSR/AW Covered Conductor 2.0 for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
1/0 ACSR/AW	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
101.8 ACSR/AW	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
336 (18/1) ACSR/AW	50	3'-10"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-9"
	125	9'-6"	9'-8"
336 (30/7) ACSR/AW	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
653 ACSR/AW	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-7"	7'-8"
	125	9'-5"	9'-7"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

FOR PLANNING USE ONLY

1.0 New Unguyed Span Tensions

Table CO 168–71: New Unguyed Span Tensions: 17 kV 1/0 — 653 ACSR Covered Conductor 1.0 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 168–72: New Unguyed Span Tensions: 17 kV 1/0 — 653 ACSR/AW Covered Conductor 2.0 for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR/AW	50	21
	75	31
	100	42
	125	52
101.8 ACSR/AW	50	29
	75	43
	100	58
	125	72
336 (18/1) ACSR/AW	50	44
	75	66
	100	88
	125	109
336 (30/7) ACSR/AW	50	56
	75	84
	100	111
	125	139
653 ACSR/AW	50	75
	75	113
	100	150
	125	187

FOR PLANNING USE ONLY

Table CO 168–73: 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

Table CO 168–74: New Unguyed Span Tensions: 35 kV 1/0 — 653 ACSR/AW Covered Conductor 2.0 for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
1/0 ACSR/AW	50	29
	75	44
	100	59
	125	74
101.8 ACSR/AW	50	38
	75	58
	100	77
	125	96
336 (18/1) ACSR/AW	50	56
	75	84
	100	111
	125	139
336 (30/7) ACSR/AW	50	68
	75	102
	100	137
	125	171
653 ACSR/AW	50	90
	75	135
	100	180
	125	225

2.0 Ground Clearance

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

FOR PLANNING USE ONLY

Scope CO 168.27 Sag Chart for New Reduced Tension Unguyed #6 — 4/0 Copper for Heavy-Loading Areas

Table CO 168–75: 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 168–76: Sag Chart for New Reduced Tension Unguyed 17 kV #2 — 4/0 Copper Covered Conductor 1.0 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'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
2/0 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
4/0 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

Table CO 168–77: Sag Chart for New Reduced Tension Unguyed 17 kV #2 — 500 kcmil Copper Covered Conductor 2.0 for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#2 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
2/0 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
4/0 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
350 kcmil	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
500 kcmil	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"

Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.

FOR PLANNING USE ONLY

Table CO 168–78: Sag Chart for New Reduced Tension Unguyed 35 kV #2 — 500 kcmil Copper Covered Conductor 2.0 for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag 50–110°F	Final Sag 130°F
#2 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
2/0 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
4/0 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
350 kcmil	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
500 kcmil	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

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.

FOR PLANNING USE ONLY

1.0 New Unguyed Span Tensions

Table CO 168–79: New Unguyed Span Tensions: 17 kV #2 — 4/0 Copper Covered Conductor 1.0 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

Table CO 168–80: New Unguyed Span Tensions: 17 kV #2 — 500 kcmil Copper Covered Conductor 2.0 for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
#2 Copper	50	24
	75	36
	100	48
	125	60
2/0 Copper	50	43
	75	65
	100	86
	125	108
4/0 Copper	50	65
	75	98
	100	131
	125	163
350 kcmil	50	102
	75	154
	100	206
	125	256
500 kcmil	50	143
	75	215
	100	287
	125	358

FOR PLANNING USE ONLY

Table CO 168–81: New Unguyed Span Tensions: 35 kV #2 — 500 kcmil Copper Covered Conductor 2.0 for Heavy-Loading Areas

Conductor Type	Span (ft)	Tension (lb)
#2 Copper	50	32
	75	48
	100	64
	125	82
2/0 Copper	50	53
	75	79
	100	106
	125	131
4/0 Copper	50	76
	75	114
	100	152
	125	190
350 kcmil	50	115
	75	172
	100	230
	125	288
500 kcmil	50	158
	75	236
	100	315
	125	393

FOR PLANNING USE ONLY

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 — 4/0 Aluminum Duplex and Triplex for Heavy-Loading Areas

Table CO 168–82: Sag Chart for New 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"
#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 168–83: Sag Chart for New Reduced Tension Unguyed #4 — 4/0 Aluminum Quadruplex for Heavy-Loading Areas

Conductor Type	Span (ft)	Initial Sag	Final Sag
		50–110°F	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 168–84: Sag Chart for Existing and Rebuild Reduced Tension Unguyed #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'-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 168–85: Sag Chart for Existing and Rebuild Reduced Tension Unguyed 17 kV 1/0 — 653 ACSR Covered Conductor 1.0 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'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
	150	11'-0"	11'-3"
	175	12'-4"	12'-7"
336 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-8"
	150	11'-0"	11'-3"
	175	12'-4"	12'-8"
336 (30/7) ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
	150	11'-0"	11'-3"
	175	12'-4"	12'-8"
653 ACSR	50	3'-10"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
	150	11'-0"	11'-3"
	175	12'-4"	12'-7"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

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 168–86: Sag Chart for Existing and Rebuild Reduced Tension Unguyed 35 kV 1/0 — 653 ACSR Covered Conductor 1.0 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'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
	150	11'-0"	11'-3"
	175	12'-4"	12'-7"
336 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-8"
	150	11'-0"	11'-3"
	175	12'-4"	12'-8"
336 (30/7) ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
	150	11'-0"	11'-3"
	175	12'-4"	12'-7"
653 ACSR	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
	150	11'-0"	11'-3"
	175	12'-4"	12'-7"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

1.0 Existing and Rebuild Unguyed Span Tensions

Table CO 168–87: Existing and Rebuild Unguyed Span Tensions: 17 kV 1/0 — 653 ACSR Covered Conductor 1.0 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 168–88: Existing and Rebuild Unguyed Span Tensions: 35 kV 1/0 Covered Conductor 1.0 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 168–89: Sag Chart for Existing and Rebuild 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"
	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 168–90: Sag Chart for Existing and Rebuild Reduced Tension Unguyed 17 kV #2 — 4/0 Copper Covered Conductor 1.0 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'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
	150	11'-0"	11'-2"
	175	12'-4"	12'-7"
2/0 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
	150	11'-0"	11'-2"
	175	12'-4"	12'-7"
4/0 Copper	50	3'-9"	3'-10"
	75	5'-8"	5'-9"
	100	7'-6"	7'-8"
	125	9'-5"	9'-7"
	150	11'-0"	11'-2"
	175	12'-4"	12'-7"
Note(s): Listed temperatures refer to conductor temperature, not ambient temperature.			

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.

1.0 Existing and Rebuild Unguyed Span Tensions

Table CO 168–91: Existing and Rebuild Unguyed Span Tensions: 17 kV #2 — 4/0 Copper Covered Conductor 1.0 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 168–92: 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.

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 10216646) 10' Arm	4 Conductor X-Arm Matl. (SAP 10216646) 10' Arm	4 Conductor X-Arm (SAP 10216645) 8' Arm	2 Conductor X-Arm Matl. (SAP 10216647) 5' Arm	3 Conductor X-Arm Matl. (SAP 10216646) 10' Arm	3 Conductor X-Arm Matl. (SAP 10216645) 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.

This page intentionally left blank.

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
101.8 Petrel	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
350 kcmil Copper CC	Double Arm	Double Arm	Double Arm
500 kcmil Copper CC	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.

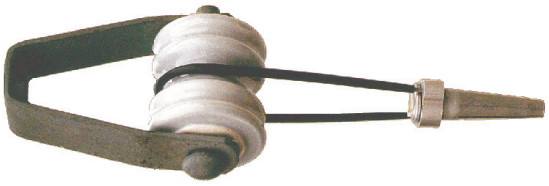
This page intentionally left blank.

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.

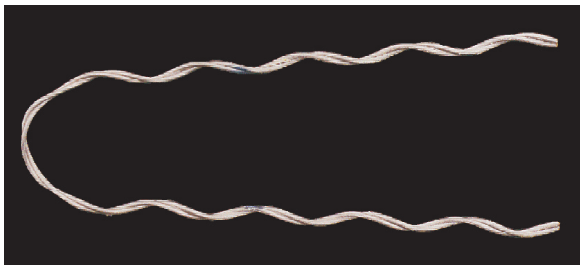
1.2 Material

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

Quadrant Clamps shall be used for:

1. All primary voltage full tension conductors in Extra Heavy Loading areas (above 5,000 feet elevation) regardless of span length.
2. Engineered spans where 336 30/7 (Oriole) bare or covered ACSR is required for ground clearance.
3. All 350 and 500 kcmil size copper conductor due to conductor weight and tension.

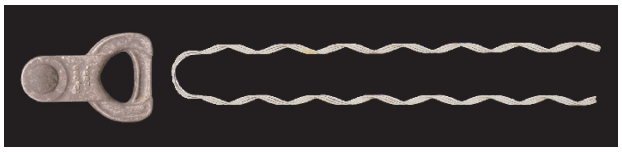
Table CO 207–1: Conductor Range and SAP Numbers

Conductor Range	Conductor Type	SAP
#6 Sol. to 4/0	Cu	10214153[a/]
350 to 500	Cu	10067538
#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):

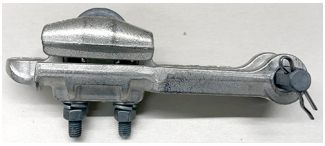
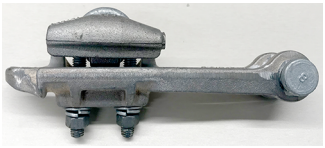
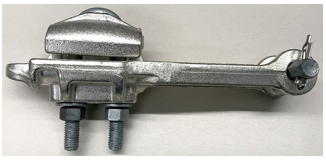
1. Use Thimble Dead-End, SAP 10067656, for #4 — 336.4 kcmil.
2. Not to be used for #4 3-stranded copperweld conductor. See CO 215 for dead-ending copperweld.

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	
#4 Sol. Cu — 2/0 Str. Cu Or #4 ACSR — 1/0 ACSR	Side Opening	Preferred: Cu Alternate: ACSR	10067485 (See Note 1, 2, and 3)	
#4 ACSR — 1/0 ACSR	Side Opening	ACSR Only	10215648	
4/0 Str. Cu Or 4/0 ACSR — 336.4 kcmil	Side Opening	Preferred: Cu Alternate: ACSR	10067490 (See Note 1 and 2)	
4/0 ACSR — 336.4 ACSR	Side Opening	ACSR Only	10215649	

Note(s):

1. Dead-end Clamps that are used on ACSR/CU must have Tin Plated, (TP) stamped on the clamp and will also be equipped with a hex (6-sided) pin. See Figure CO 207-3 for examples of each.
2. Installations within 1 mile of the coast or in high corrosion environments (see GR 215) shall utilize copper automatic dead-ends. See CO 217 for application and SAP numbers.
3. Utilize copper automatic dead-ends for #6 solid copper conductor.

Figure CO 207–3: Tin-Plated Dead-End Identifiers



Figure CO 207–3.1: "TP" Stamp Examples



Figure CO 207–3.2: Hex-Pin Example

3.2 Recommended torques on clamps are:

Table CO 207–4: Recommended Torque on Clamps

Size	MIN	MAX
3/8" Bolt	20 ft-lb	25 ft-lb
1/2" Bolt	40 ft-lb	45 ft-lb
5/8" Bolt	55 ft-lb	60 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 5).

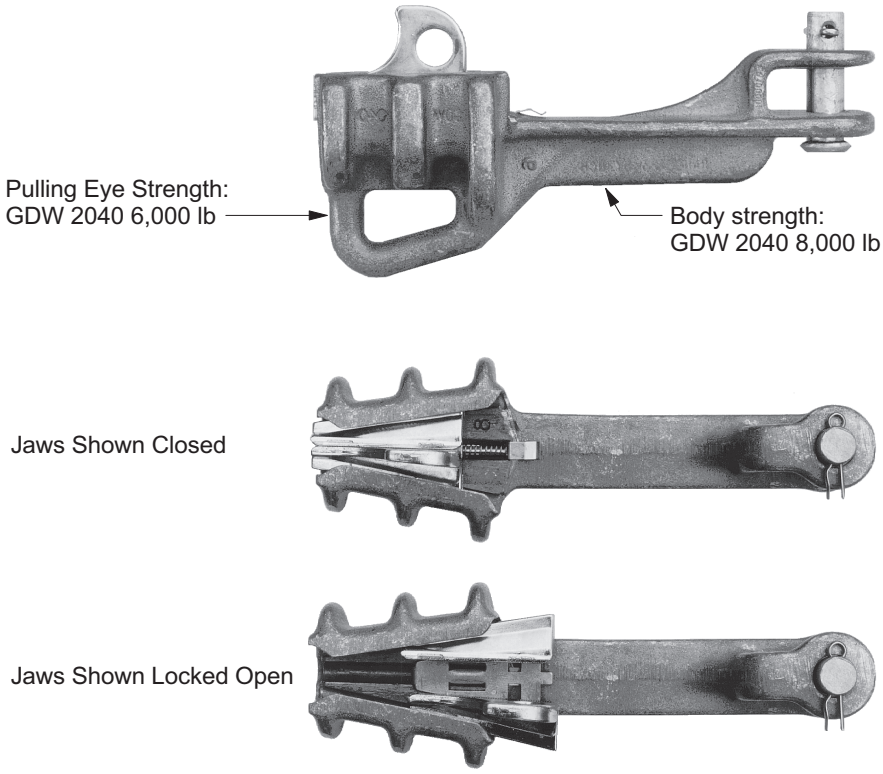


Table CO 207–5: Conductor Range

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.

This page intentionally left blank.

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).

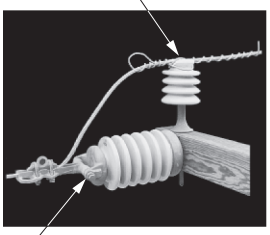
C. Use post insulator extension bracket when clamp top insulators are used for dead-ending and are mounted on double or triple crossarm assemblies.

1.2 The insulator materials shown below will be used for existing construction only.

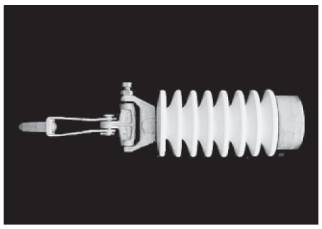
1.3 For new construction, composite-type insulators will be used to prevent radio interference. See GR 210 for details.

Figure CO 209–1: Dead-End Insulator Materials

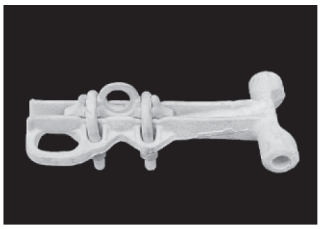
Clamp Top Line Post Insulator
SAP 10116417–12 kV
SAP 10116424–16 kV
SAP 10116425–33 kV



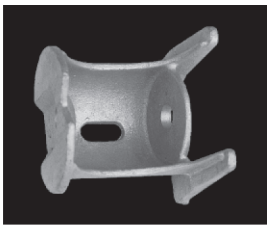
Tighten locking stud finger tight plus one quarter turn only—then lock in place.



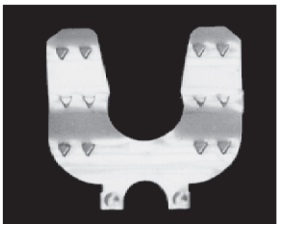
Clamp Top Insulator Adapter
SAP 10068600



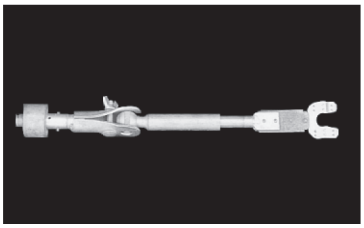
Slack Span Dead-end Clamp



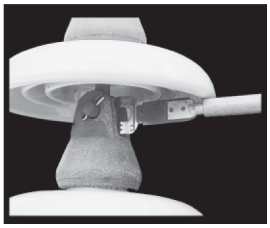
Post Insulator Extension Bracket
SAP 10067364



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 suppresion.

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)

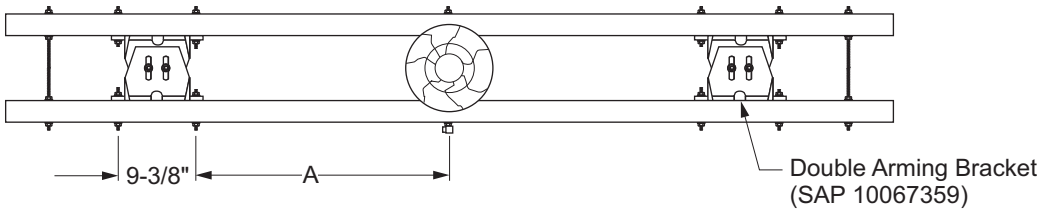


Figure CO 211–1.2
(See Note 6)

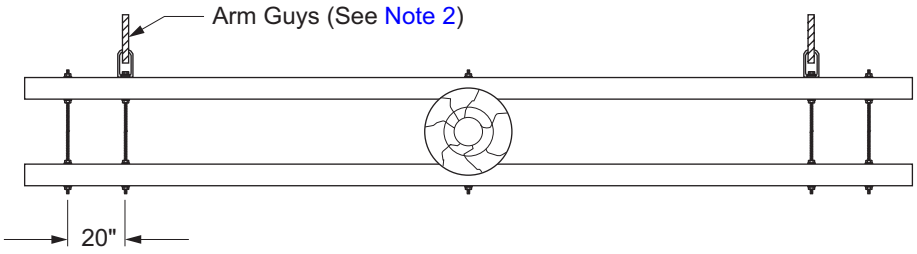


Figure CO 211–1.3
(See Note 7)

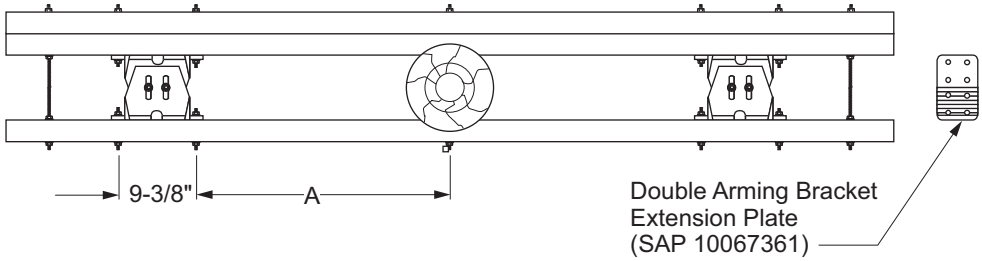
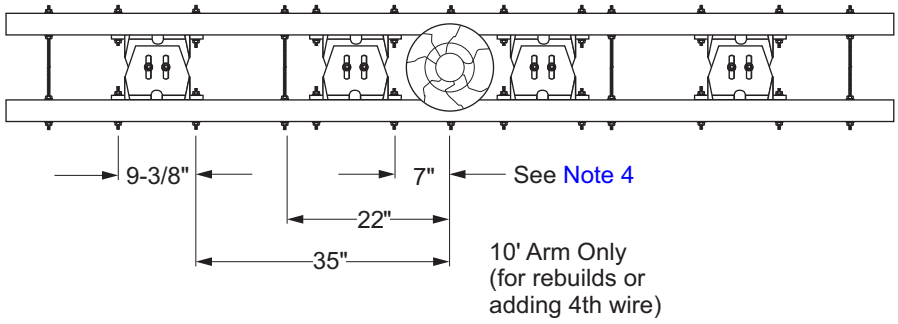


Figure CO 211–1.4
(See Note 8)



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

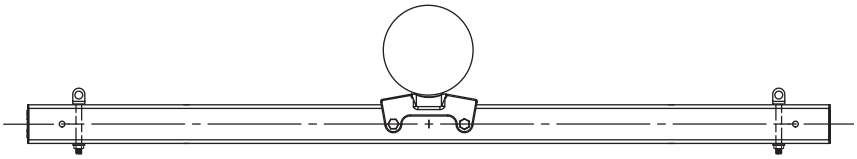


Figure CO 212–1.2: 8 ft Double

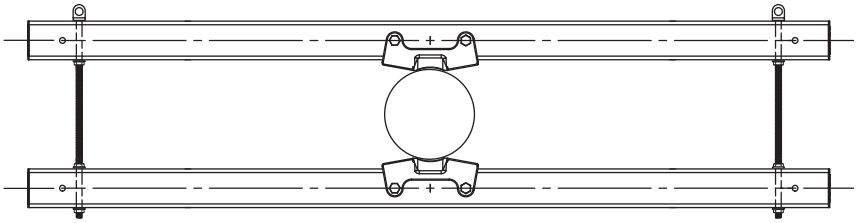


Figure CO 212–1.3: 10 & 12 ft Single

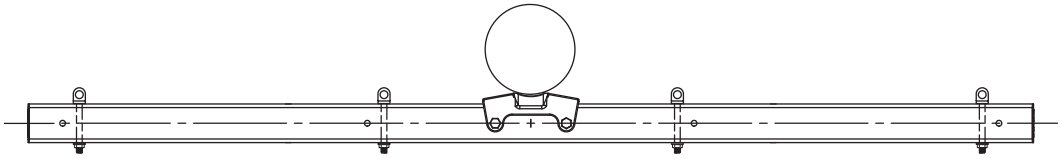
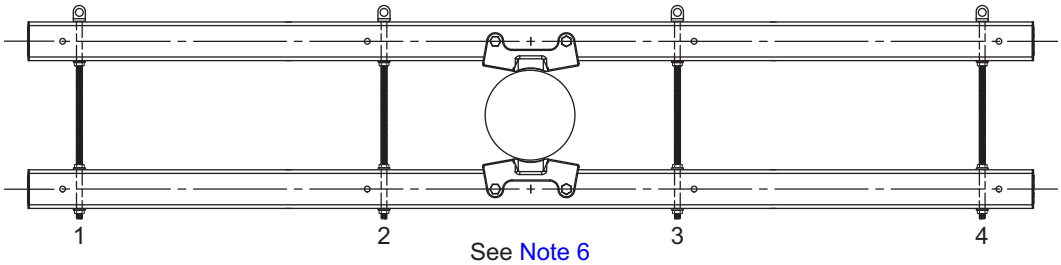


Figure CO 212–1.4: 10 & 12 ft Double



See Note 6

Note(s):

1. Mount arm bracket to pole with 3/4-inch bolts and spring washers.
2. Use flat square washers on all crossarm bolts. Refer to PO 370 for washer size requirements.
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.

This page intentionally left blank.

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)

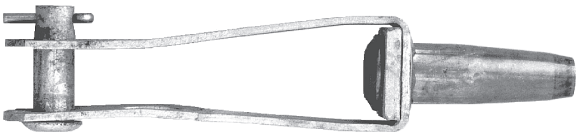
1.1 Application

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)

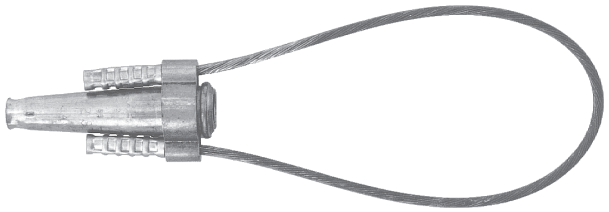
2.1 Application

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)



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)

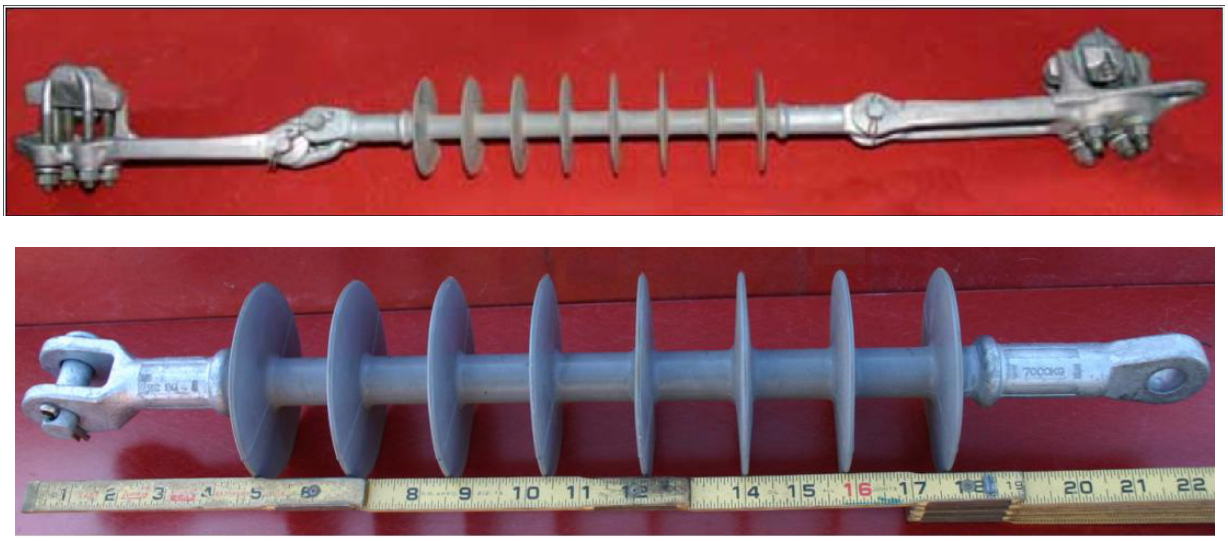
FOR ONLY



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

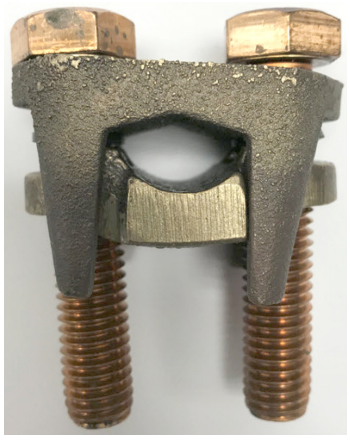
Secondary copper-to-copper connections, in non-HFRA.

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

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.
- Secondary voltage connections (Cu-Cu).
- Applicable for CC 1.0 and CC 2.0

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

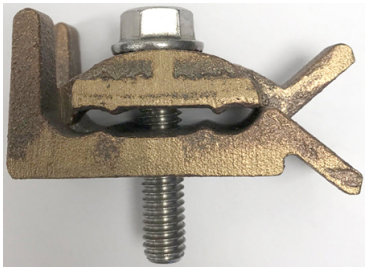


Table CO 300–5: Aluminum-to-Aluminum or Aluminum-to-Copper Parallel Groove Connectors for CC 2.0

		Main/Run	Tap	
SAP Code	Bolts	ACSR (Compact)	ACSR (Compact)	Copper
10112370	1	1/0, 101.8	1/0, 101.8	#6 Sol - 2/0 Str.
10112369	1	336.4 (18/1 or 30/7)	1/0, 101.8	#6 Sol - 2/0 Str.
10112368	3	336.4 (18/1 or 30/7)	336.4 (18/1 or 30/7)	4/0
10112374	1	653.9	1/0, 101.8	#6 Sol - 2/0 Str.
10112371	2	653.9	336.4 (18/1 or 30/7)	4/0, 350
10112372	3	653.9	653.9	500

FOR PLANNING USE ONLY

5.0 Hot Line Clamp

5.1 Application

Hot Line Clamps for primary distribution connections shall only be used on:

- Transformers in non-HFRA
- Potential Transformers in all areas
- Lightning Arresters in all areas

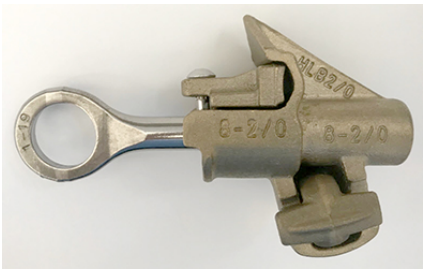
Material:

Table CO 300–6: Hot Line Clamp (Copper-to-Copper Connections Only)

Conductor Range				
Copper Run		Copper 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



NOTE

Previously approved hot line clamps for copper-to-copper connections were tin-plated, and had a similar appearance to aluminum versions. Effort should be made to ensure the appropriate connector is being installed on the correct conductor.

Scope CO 300.2 Connectors - Copper Compression Lugs

1.0 Application

Copper compression lugs shall be used to make up apparatus terminal connections when copper conductors/jumpers are used. Refer to DOH CO 480 for torquing requirements and application guidelines. This standard shall apply to the following apparatus/equipment terminals:

— Overhead Switches including Remote Control Switches (RCS)
— Hook-Stick Operated Disconnects
— Automatic Recloser Terminations

Figure CO 300–6: Copper Compression Lug



Table CO 300–7: Copper Compression Lug SAP Codes

Conductor Size	SAP Codes
#2	10210869
2/0	10210868
4/0	10210867
350	10111063

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 Vise (Fargo) Connector

Figure CO 305–2: Vise (Fargo) Connector



2.1 Application

To be used in the following applications:

— Capacitor Bank
— Transformers in HFRA
— Alternative to bolted wedge connector for mainline to mainline or tap/branchline connections (Al-Al or Al-Cu ONLY)

Table CO 305–3: Vise (Fargo) Connector SAP Codes

SAP Number	Number of bolts	Bolt Head Size	Run	Tap	
			ACSR	ACSR	Copper
10215832	1	5/16”	#4	#4	#6 Sol - #4 Str.
10215833	1	3/8”	#4, #2	#4, #2	#6 Sol - #2 Str.
10215834	1	3/8”	1/0	#4 - 1/0	#6 Sol - 2/0
10215835	1	½”	#2 - 4/0	#2 - 4/0	2/0, 4/0
10215836	1	½”	#2 - 4/0	#2 - 4/0	#6 Sol - 2/0
10215837	1	½”	4/0, 336.4 (18/1 or 30/7)	4/0, 336.4 (18/1 or 30/7)	4/0
10215838	1		4/0, 336.4 (18/1 or 30/7)	#4 - 4/0	#6 Sol - 4/0
10215839	1	½”	4/0, 336.4 (18/1 or 30/7), 653.9	#4 - 1/0	#6 Sol - 2/0
10215840	1	½”	653.9	4/0, 336.4 (18/1)	-
10215841	2	½”	336.4 (18/1 or 30/7), 653.9	336.4 (18/1 or 30/7), 653.9	-
10215842	2	½”	336.4 (18/1 or 30/7), 653.9	4/0, 336.4 (18/1 or 30/7)	4/0

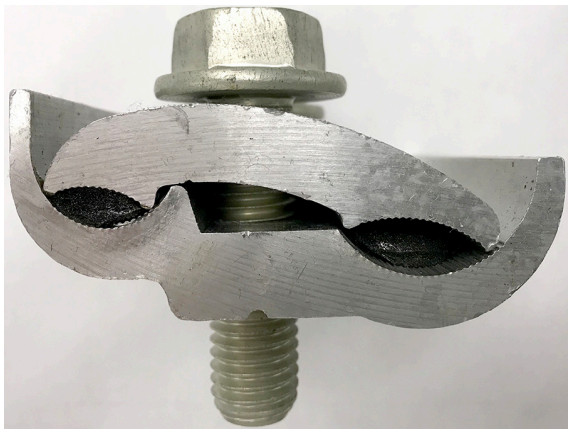
Table CO 305–4: Aluminum-to-Aluminum or Aluminum-to-Copper Vise (Fargo) Connectors for CC 2.0

SAP Code	Run	Tap	
	ACSR (Compact)	ACSR (Compact)	Cu
10215834	1/0	1/0	#6 Sol - 2/0
10215835	1/0, 101.8	1/0, 101.8	2/0, 4/0
10215836	336.4, 1/0, 101.8	1/0, 101.8	#2 Str.
10215837	336.4 (18/1 or 30/7)	1/0	2/0
10215838	336.4 (18/1 or 30/7)	1/0	#6,#4 Sol
10215839	336.4 (18/1 or 30/7), 653.9	1/0, 101.8	#2 Str.
10215840	653.9	101.8, 336.4 (18/1 or 30/7)	350
10215841	653.9	653.9	500
10215842	653.9	336.4 (18/1 or 30/7)	4/0, 350

FOR PLANNING USE ONLY

3.0 Parallel Groove

Figure CO 305–3: Parallel Groove



3.1 Application

To be used in the following applications:

— Alternative to bolted wedge connectors or GA9000 Series (Fargo) connector

— Secondary connections (Al-Al or Al-Cu)

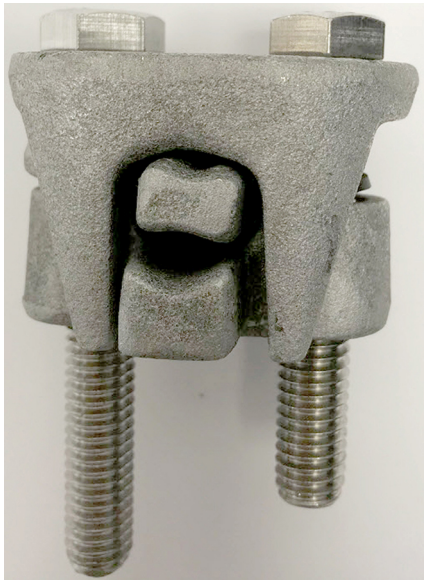
Table CO 305–5: Parallel Groove for CC 1.0

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.

4.0 Two-Bolt

Figure CO 305–4: Two-Bolt



4.1 Application

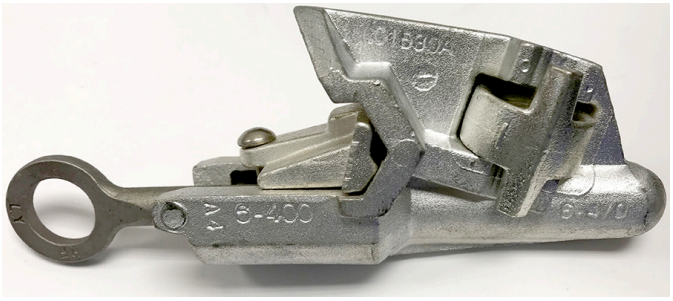
Secondary connections larger than 4/0 all-aluminum or 4/0 ACSR.

Table CO 305–6: 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

5.0 Hot Line Clamp

Figure CO 305–5: Hot Line Clamp



5.1 Application

Hot line clamps are for primary distribution tap connections shall only be used on:

- Transformers in Non-HFRA
- Potential Transformers in all areas
- Lightning Arresters in all areas

Table CO 305–7: Hot Line Clamp (Aluminum-to-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/] Clamp uses 11/16 inch tap nut.
[b/] Figure CO 305–5: Hot Line Clamp
[c/] Clamp uses 3/4 inch tap nut.

Scope CO 305.2 Connectors - Tinned Aluminum Compression Lugs

1.0 Application

Tinned aluminum compression lugs shall be used to make up apparatus terminal connections when aluminum conductors/jumpers are used. Refer to DOH CO 480 for torquing requirements. This standard shall apply to the following apparatus/equipment terminals:

— Overhead Switches including Remote Control Switches (RCS)
— Hook-Stick Operated Disconnects
— Automatic Recloser Terminations (when applicable)

Figure CO 305–6: Tinned Aluminum Compression Lug



Table CO 305–8: Tinned Aluminum Compression Lug SAP Codes

Conductor Size	SAP Code
1/0 ACSR	10210622
336.4 (18/1 or 30/7) ACSR	10112305
653.9 ACSR	10112306

CO 310P 600V Insulation Piercing Connectors

Scope CO 310P.1 Insulation Piercing Connectors (IPCs)

1.0 General Information

Insulation Piercing Connectors (IPCs) are designed to make electrical contact with conductors via teeth that pierce into conductor insulation and the conductor strands. Benefits of the IPCs are as follows:

- — Removal of the conductor insulation is not required
- — The connection is water-tight, preventing moisture intrusion and the introduction of oxidation
- — Connectors are equipped with silicone grease at the location of insulation piercing
- — Tinned copper teeth allow for connections to aluminum or copper conductor
- — Connectors are equipped with shear bolts which shear off once appropriate torque is achieved, and the teeth have made contact with the conductors

CAUTION **IPCs have limitations on how they can be applied to SCE's secondary system.**

The following rules shall be following when installing IPC's:

- — Connectors are single use and shall not be re-used
- — Installed in non-tension applications
- — Shall not be used for customer service connections at weather heads
- — Connectors shall not be used to pick-up or drop load

PILOT

Table CO 310P–1: IPC Data

Manufacturer	Part Number	Main Range (Al/Cu)	Tap Range (Al/Cu)	Shear Head Bolt Size	Shear Head Breaking Torque (ft-lbs)
TE	P3X4/0[a/]	#4 - 4/0	#4 - 4/0	9/16"	13
Sicame	TTD1010XFBTA UNI	#8 - 1/0	#10 - #2	½"	8
	TTD2710 XFBTA UNI	#4 - 250	#6 - 4/0	½"	13

[a/] When making up a copper-to-copper connection, the maximum combination allowed is 2/0 to 2/0.

Figure CO 310P–1: TE IPC

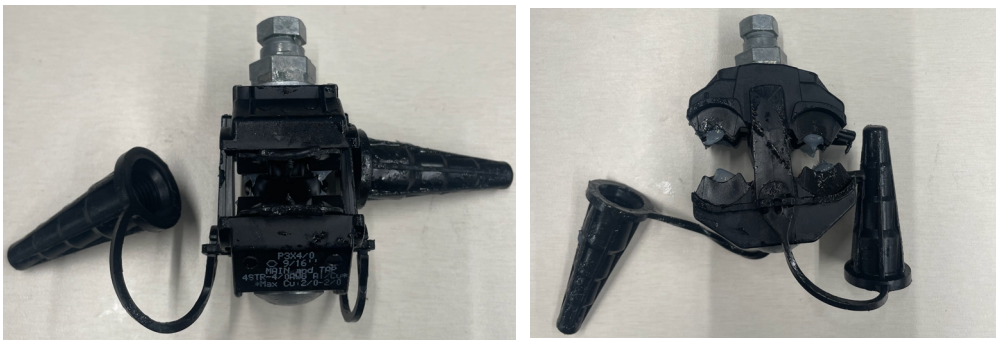


Figure CO 310P–2: Sicame IPC

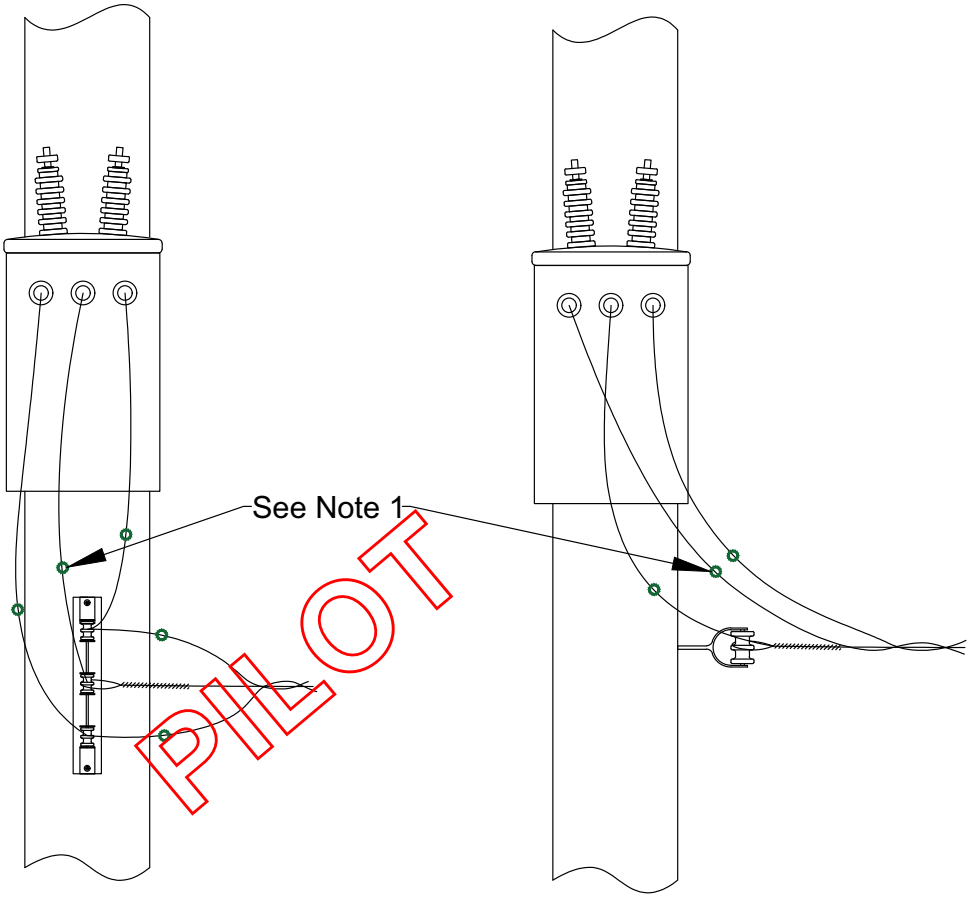


PILOT

Scope CO 310P.2 Construction and Application

The following figures represent potential construction configurations where IPCs may be applied. For additional questions, contact Apparatus Engineering.

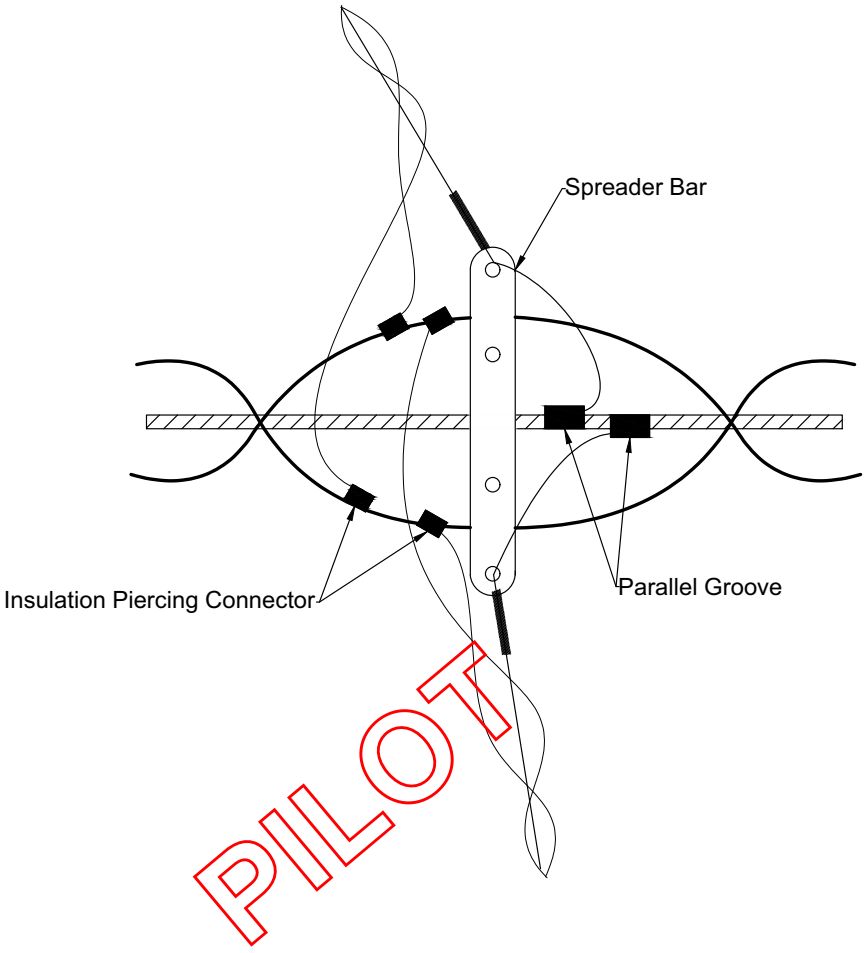
Figure CO 310P–3: Transformers Taps



Note(s):

1. IPC may only be used if connecting two insulated conductors. If there is a transition from insulated conductor to bare conductor, then parallel groove shall be used.

Figure CO 310P–4: Connections at Spreader Bar



PILOT

Note(s):

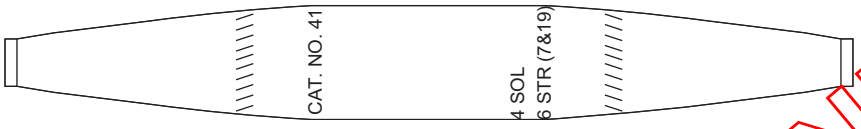
1. Quantity of mid-span services may be limited due to the size of the IPC's. Ensure that proper clearance is maintained between connectors so that the connector or the conductors are not in contact with each other.
2. Parallel groove connectors shall still be used for neutral taps at mid-span connections.
3. If additional space is needed for more services, two spreader bars may be installed to create additional space for phase connections.

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			
Copperweld	Solid Cu	Stranded Cu	SAP
		#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):

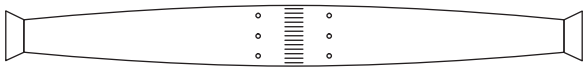
1. Automatic splices shall not be installed for repairs or new construction.

FOR REFERENCE ONLY

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.

FOR REFERENCE ONLY

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

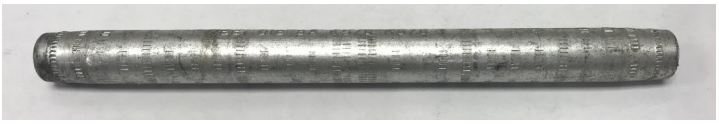
Wire Size	Splice SAP	MD-6 Die Number and SAP	Y34A Die Number and SAP	Y35-Y39-12HA Die Number and SAP	UT-15 Die Number and SAP	Number of Crimps per End
#8 SOL	10110772	W-161 10148858	N/A	N/A	N/A	1
#6 SOL	10110773	W-161 10148858	N/A	N/A	N/A	2
#4 SOL	10110774	W-162 10148861	N/A	N/A	N/A	5
#2 SOL	10110775	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)

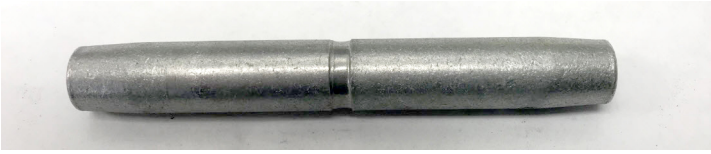
Wire Size	Splice SAP	Repair Splice SAP	MD-6 Die Number and SAP	Y35-Y39-12HA Die Number and SAP	UT-15 Die Number and SAP	Number of Crimps per End
#4 (6/1)	10112090	10212509	W-687 10148864	U-243 10148908	See Note 1	MD6=12 Others=6
#2 (6/1)	10112091	10212510	W-687 10148864	U-243 10148908	See Note 1	MD6=14 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.

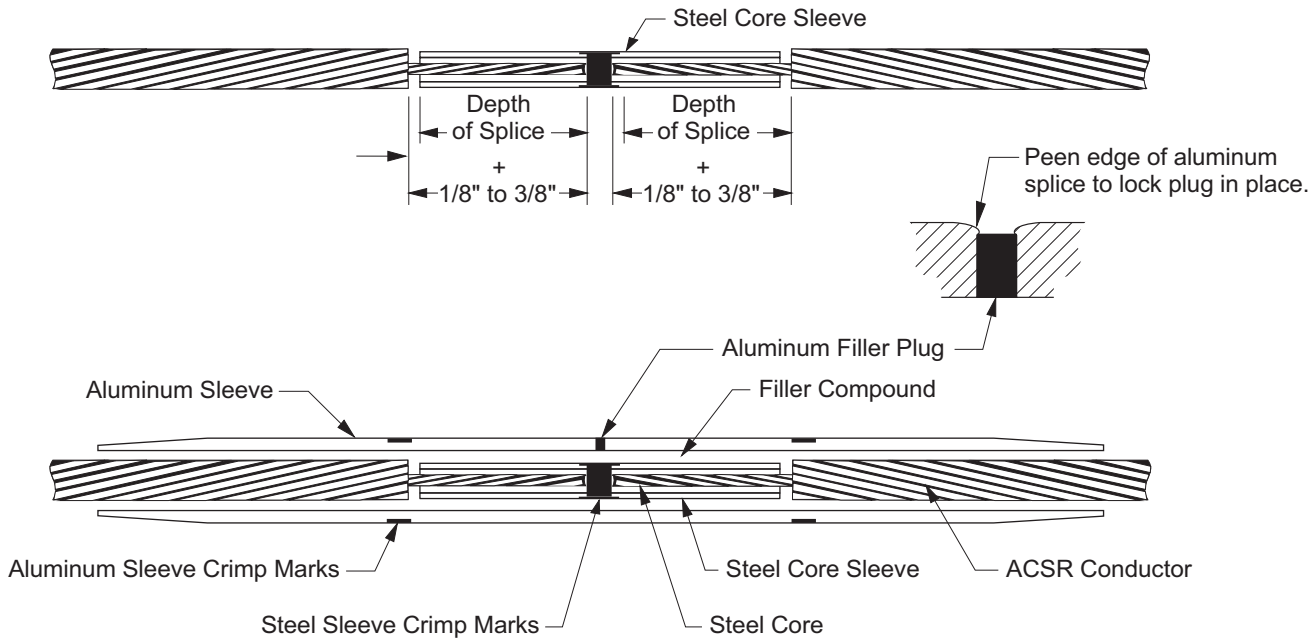


Table CO 410–5: Instructions for Installing Full Tension, Double-Sleeve, Compression Splices for ACSR Conductors

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):

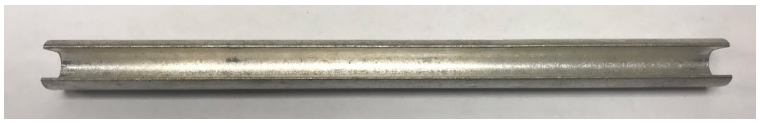
1. Surfaces of the conductor shall be cleaned of all foreign matter before splicing. Use a wire brush before applying a coat of filler compound (SAP 10064145).
2. The ends of conductor strands shall be examined for defects (burrs, nicks, and so forth) and the strands shall be counted to verify that they 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.



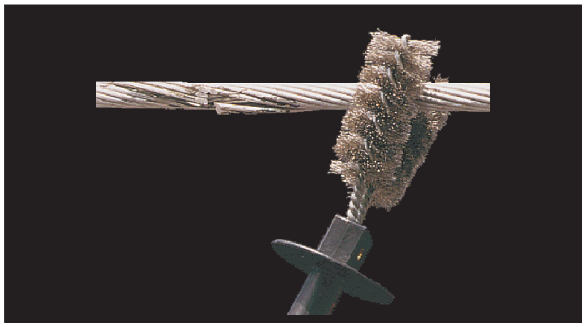
B. Select the splice, correct die, and the crimping tool from the table. Verify die with etching on splice body.

Conductor Size	SAP	Length (in)	Die	
			MD-6	12HA, UT-15, Y-35
#4 ACSR	10111822	7	See splice body	See splice body
1/0 ACSR	10111823	8	W-165, W-166	U-165, U-166

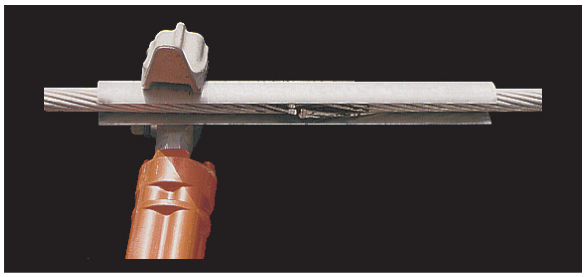
C. Reseat the damaged strands to the line. This may take a little time and may involve trimming a few strands. Damage to the conductor (including any necessary trimming) must not exceed 1 inch in length.



D. Properly clean and grease conductor. This step is very important to ensure a good electrical splice.

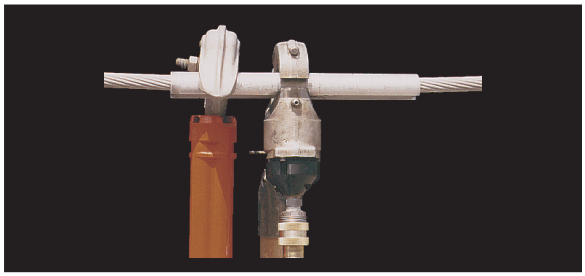


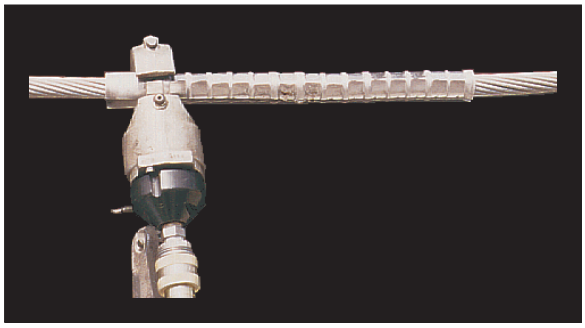
E. Install splice — generally install the U-shaped splice on top of the conductor and center on the damaged area, so that the open side of the splice is pointed down. A duckbill ground clamp is used to install the splice onto the conductor.



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.



This page intentionally left blank.

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

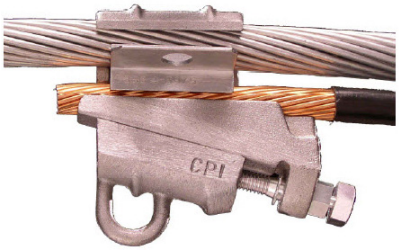


Figure CO 420–3: CU - CU



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

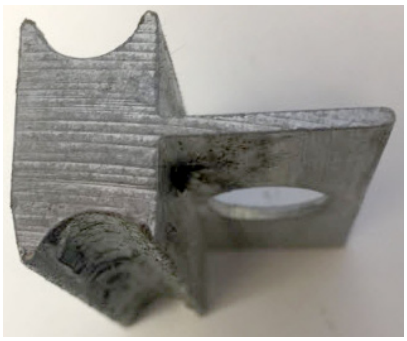


Figure CO 420–6: Stamped Interface



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

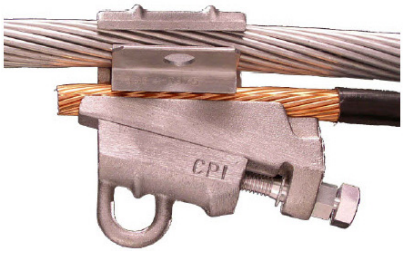


Table CO 420–1: Bolted Wedge Connectors for CC 1.0

Conductor Range (in)						Connector	Connector Cover
Run			Tap				
ACSR	CU	Ø	ACSR	CU	Ø		
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 inTable CO 420–1 are stranded unless notes as solid (Sol).

Table CO 420–2: Bolted Wedge Aluminum or Aluminum-to-Copper for CC 2.0

	Run	Tap	
SAP Code	ACSR-AW	ACSR-AW	Cu
10211100	1/0, 101.8	-	#6,#4 Sol, #2 Str.
10211099	1/0	1/0	-
10211099	101.8	1/0	#2 Str.
10213121	101.8	1/0	2/0
10211203	336.4 (18/1)	-	#6,#4 Sol
10211098	336.4 (18/1)	-	#2 Str.
10211619	336.4 (18/1 or 30/7)	1/0	-
10211097	336.4 (18/1 or 30/7)	101.8	2/0, 4/0
10211200	336.4 (18/1 or 30/7)	336.4 (18/1)	-
10211096	336.4 (30/7)	336.4 (30/7)	-
10212175	653.9	1/0	#6,#4 Sol, #2 Str.
10212174	653.9	101.9	2/0, 4/0
10212173	653.9	336.4 (18/1 or 30/7)	-
10212172	653.9	653.9	-

Table CO 420–3: Bolted Wedge Copper-to-Copper Connectors for CC 2.0

SAP Code	Run	Tap
	Cu	Cu
10212440	#2	#6,#4 Sol, #2 Str.
10211105	2/0	#6,#4 Sol, #2 Str.
10211104	2/0	2/0
10211103	4/0	#6,#4 Sol, #2 Str.
10211102	4/0	2/0
10211101	4/0	2/0

FOR PLANNING USE ONLY

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

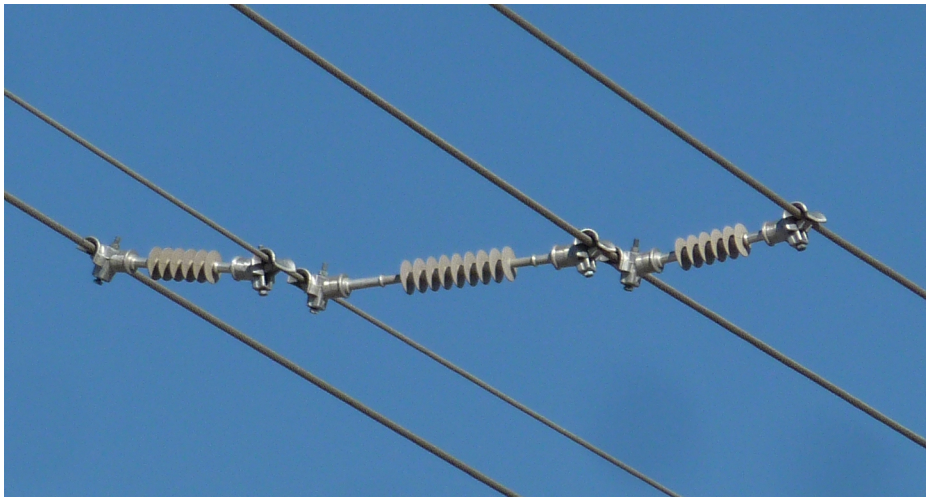
1. Line guard or armor rod protection shall be installed on all conductors that the wire spacers are to be attached to per Table CO 450–2 and Table CO 450–3. Maximum conductor sizes for wire spacers is 653 ACSR. More than one spacer can fit on a line guard or armor rod. The spacer clamp shall be installed directly to bare conductor or armor rod/line guard if applied.
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. If additional sag is created due to the weight of standard spacers, lightweight spacers can be considered as a substitute, as long as the conductor fits within the clamping range of the spacer clamp.
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.
8. For remediations carried out under the Wildfire Program for Conductor Clashing Mitigation, also known as the Long Span Initiative (LSI), please refer to decision tree for conductor clashing remediations in DDS 10 Section 5.7.

Figure CO 450–1: Insulated Overhead Wire Spacers Installed on a Horizontal 4-Conductor System



2.0 Application

Table CO 450–1: Insulated Overhead Wire Spacer SAP Numbers and Conductor Range

Spacer Length (in)	MAX Voltage (kV)	Standard		ACSR Range	CU Range	Lightweight		ACSR Range	CU Range
		SAP	Weight (lb)			SAP	Weight (lb)		
15	4	-	-	-	-	10215196	2	#4 to 1/0	#6 Sol to #2 Str/4A Cwld
23	25	10116357	7.2	2/0-653	2/0 to 4/0	10213526	3.1		
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.
3. The clamping range of standard spacers is 0.2” – 1.34”. The clamping range of lightweight spacers is 0.2” – 0.92.”

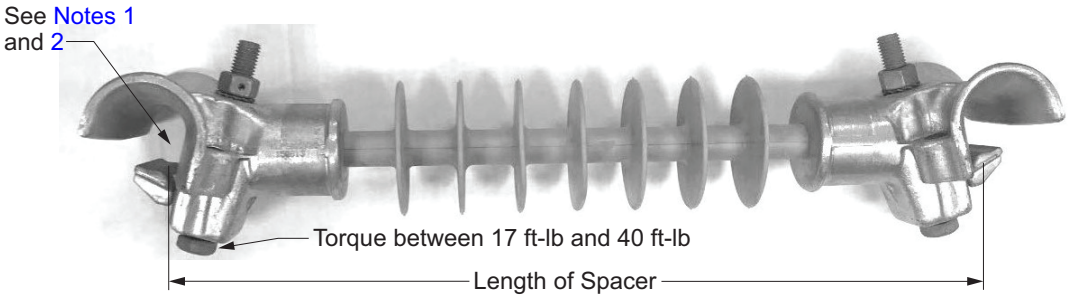
Table CO 450–2: Line Guard SAP Numbers and Requirements

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 CO 450–3: Armor Rod SAP Numbers and Requirements

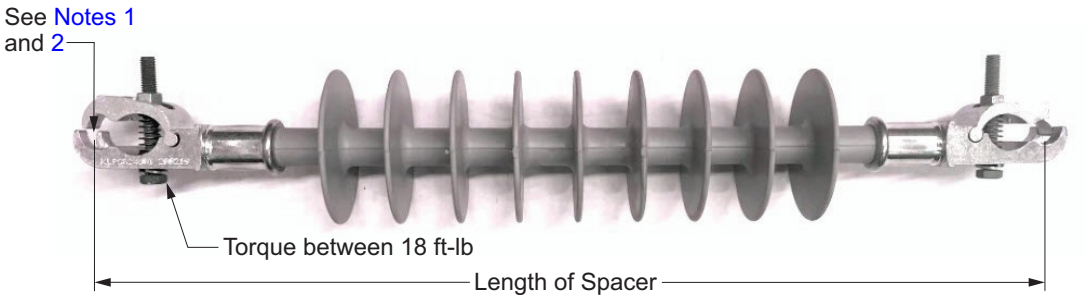
Conductor size	SAP	Armor Rod	Spacer Type
#6 Sol Cu	10212369	Required	Lightweight
#4 Sol Cu/8A Cwld	10068381	Required	Lightweight
#4 Str. Cu/6A Cwld	10212637	Required	Lightweight
#2 Sol Cu	10212638	Required	Lightweight
#2 Str. Cu/4A Cwld	10068382	Required	Lightweight
2/0 Cu	10068383	Optional	Standard
4/0 Cu	10068384	Optional	Standard

Figure CO 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 CO 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

The following installation criteria applies to spans that have not been identified as part of any program to install wire spacers, such as the Long Span Initiative (LSI).

1. Any span for which the sag is equal to or exceeds the minimum conductor separation (Either at the crossarm or throughout the span) shall have overhead wire spacers installed.
2. Exception: Wire spacers are not required when conductor separation is 72 inches or greater. *Note the longest spacer is 71 inches.
3. If there is no bucket access, ridge-pin (3-wire only), box (4-wire only), or “zig-zag” (3-wire only) construction may be considered. For Zig-Zag construction, see DC 587.
4. Determination of sag can be field measured by line of sight (sag board method), or conductor sag charts using 130 degree final sag (light or heavy loading should be considered).

Example: A 4-wire 50-foot span has 4 feet of sag, conductor separation at a 10-foot crossarm or throughout the span is 36 inches (3 feet). The span has more sag than the conductor spacing, spacers are required.

Example: A 2-wire 300-foot span has 5 feet of sag, the conductor separation at a 10-foot crossarm or throughout the span is 9 feet. The span has less sag than the conductor spacing, spacers are not required.

Figure CO 450–4: 3-Wire Installation Up To 400' Application with Mid-Span Access (Overhead View)

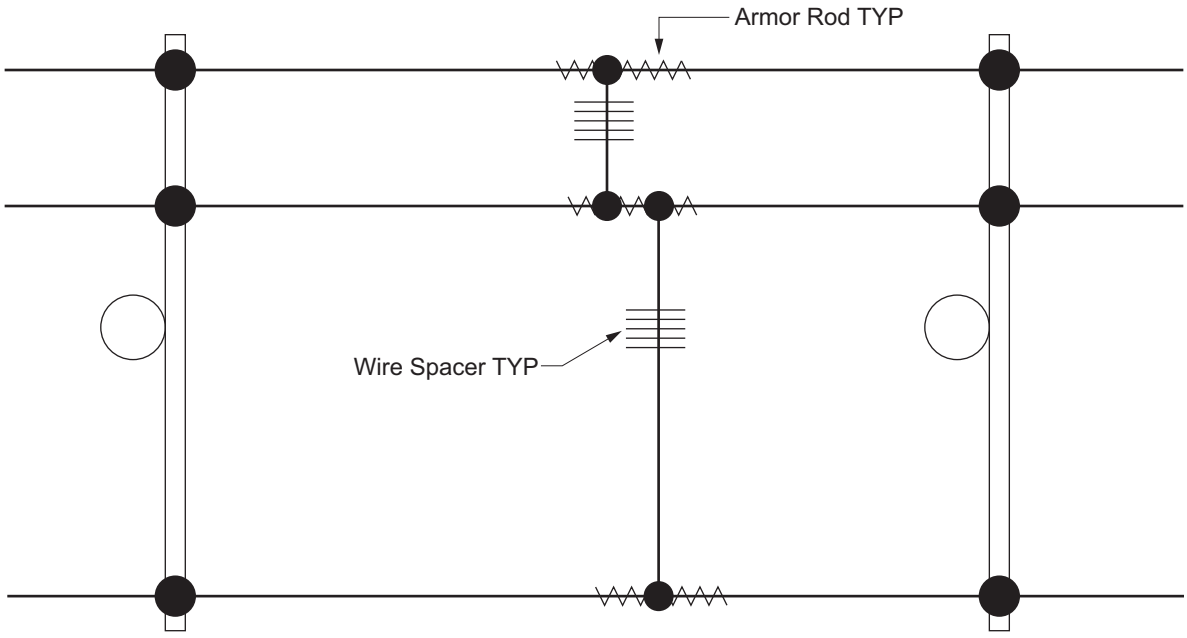


Figure CO 450–5: 4-Wire Installation Up To 400' with Mid-Span Access (Overhead View)

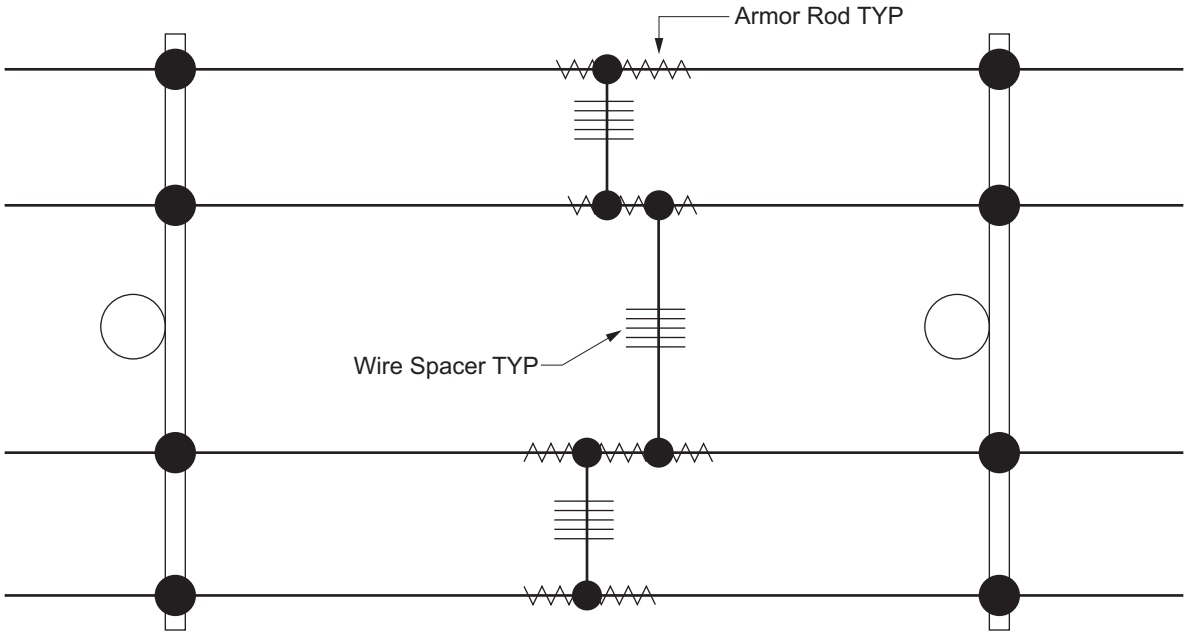


Figure CO 450–6: 3-Wire Installation Over 400' without Mid-Span Access (Overhead View)

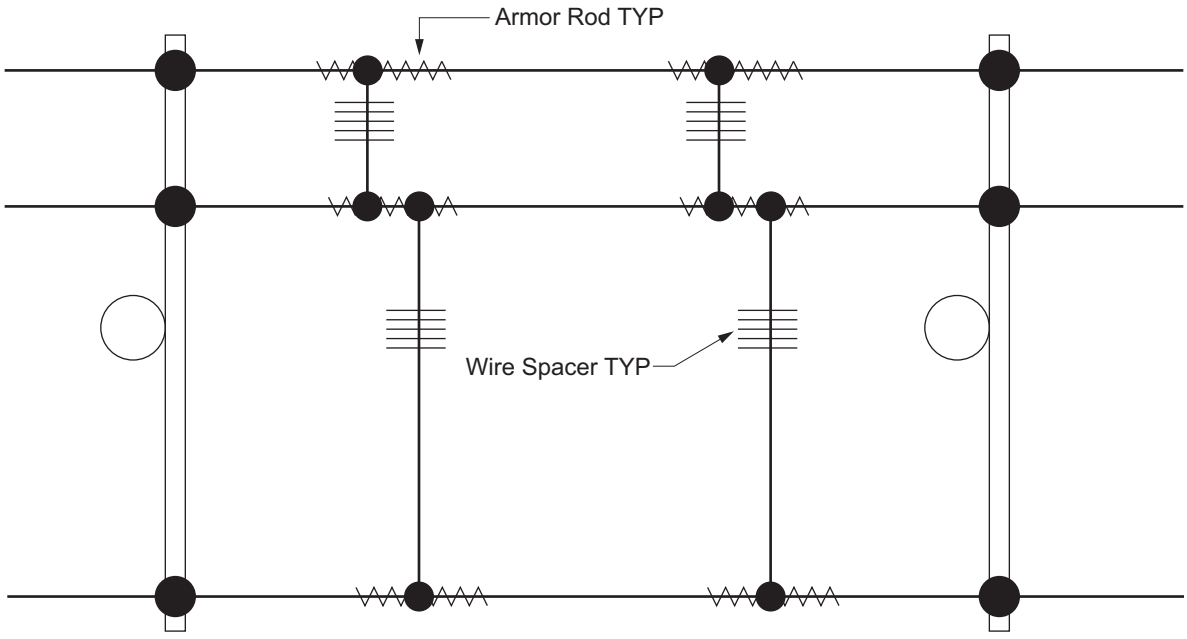
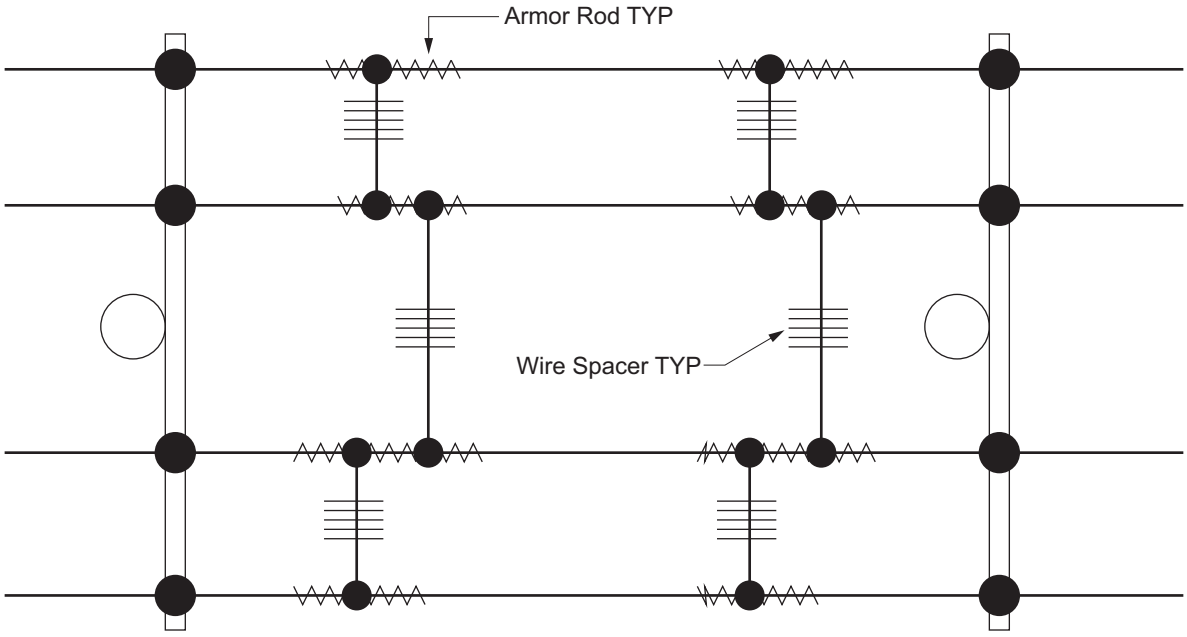


Figure CO 450–7: 4-Wire Installation Over 400' without Mid-Span Access (Overhead View)



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 CO 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 CO 450–4.

Figure CO 450–8: Vertical Configuration Line Guard or Armor Rod Installation (Side View)

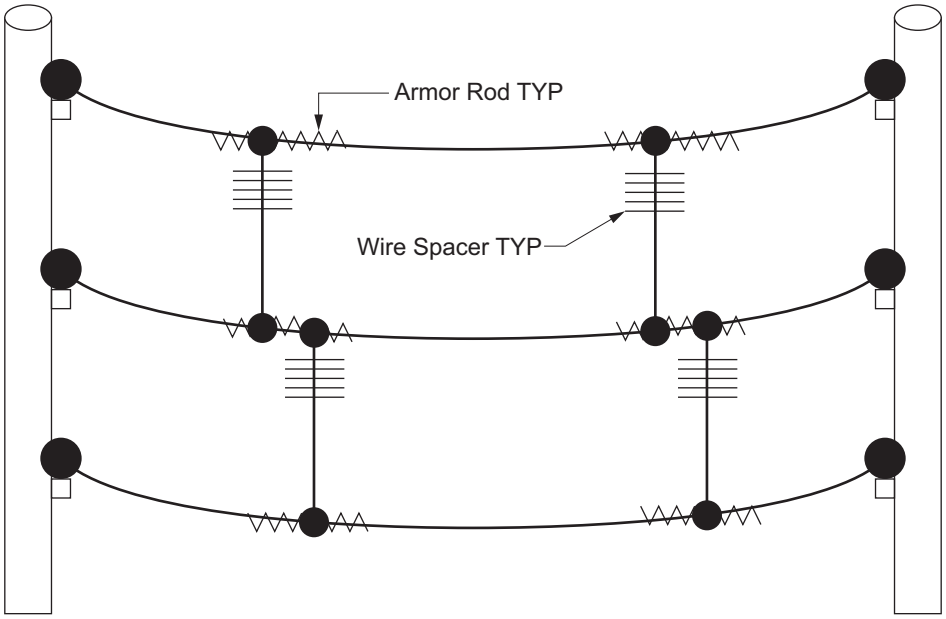


Table CO 450–4: Number of Spacers for Vertical Construction Based on Span Length

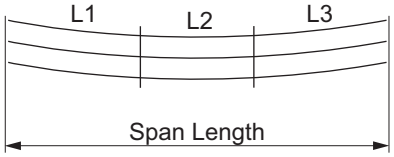
Span Length	No. of Spacers Required per Conductor Pair
190–400	2
410–590[a/]	3

[a/] For span lengths greater than 590 feet, contact Linear & Structural Strategies.

Note(s):
1. See Paragraph 1 (Page 7) for application to mitigate conductor galloping.
2. On a three wire system, assuming from the topmost conductor to the bottommost 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 CO 450–5: Span Lengths from 190 ft to 400 ft (Vertical Configuration)

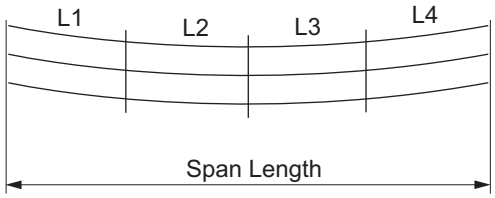
Two Spacers Per Conductor Pair Per Span



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 CO 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):

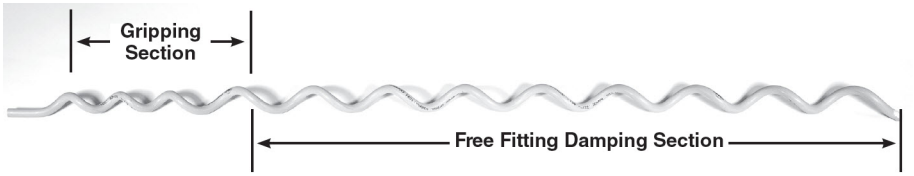
1. On a three wire system, assuming from the topmost conductor to the bottommost conductor, the following labeling, 123, the conductor pairs are defined as 1-2 and 2-3. For four wire (1234), the conductor pairs are 1-2, 2-3, and 3-4.

This page intentionally left blank.

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

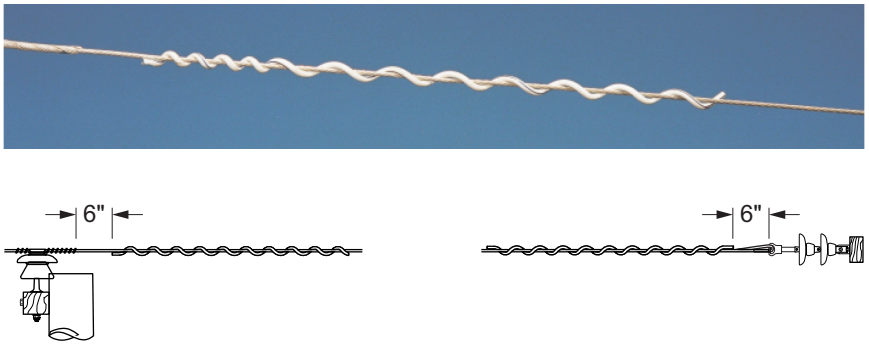


Figure 460–2.1: Two Vibration Dampers Per Conductor — Span Length 300'–800'

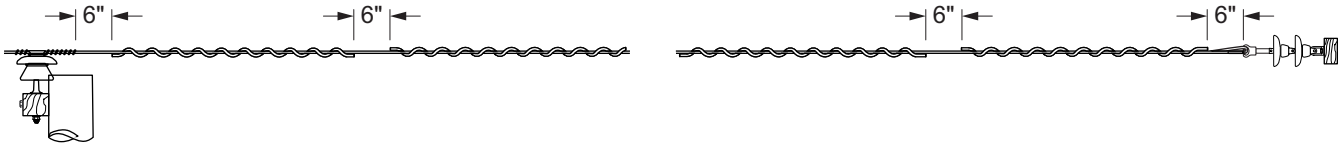


Figure 460–2.2: Four Vibration Dampers Per Conductor — Span Length 801'–2,400'

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.

This page intentionally left blank.

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



This page intentionally left blank.

CO 480 Torque Recommendations for Bolted Connectors and Bolted Connections

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			
	Galvanized Steel, Stainless 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	1,050	87.5	660	55

Scope CO 480.2 Bolted Connections Using Compression Lugs

1.0 Application

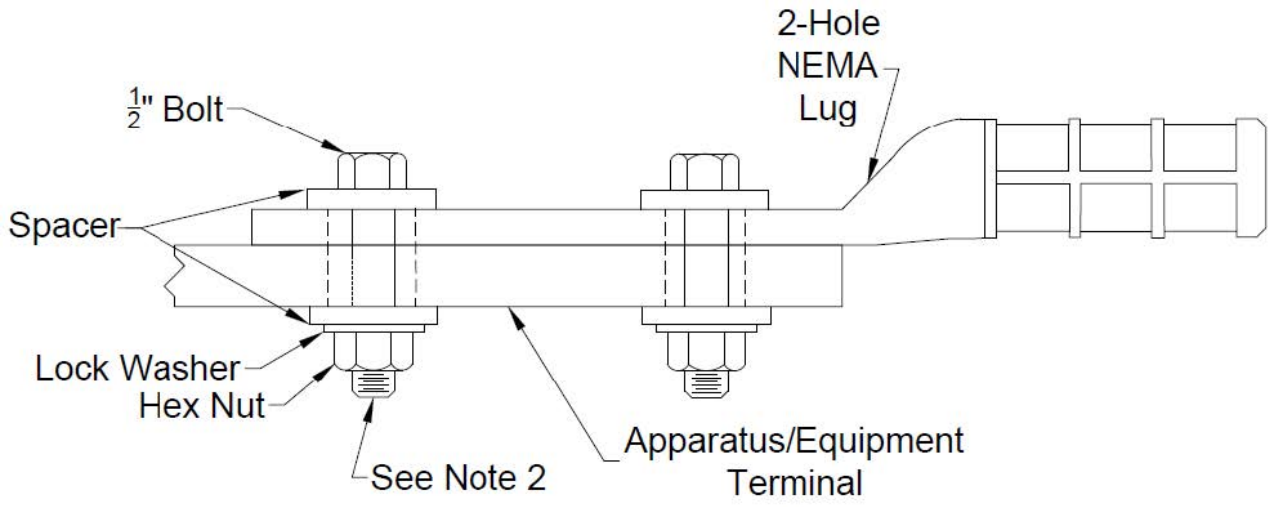
Below are construction details applicable to terminations that utilize 2-hole NEMA style compression lugs/connectors. Refer to DOH CO 300 and CO 305 for SAP codes. This standard shall apply to the following apparatus/equipment terminals:

— Overhead Switches including Remote Control Switches (RCS)
— Hook-Stick Operated Disconnects
— Automatic Recloser Terminations

The following practices shall be followed:

- All tinned (tinned aluminum or tinned copper) or copper connections shall utilize silicon bronze (Everdur) hardware (nuts, bolts, spacers, and lock washers).
- Connections installed on silver plated terminals (SC&C overhead switches) shall utilize stainless steel hardware.

Figure CO 480–2: Typical Connection Using 2-Hole NEMA Compression Lug



Note(s):

1. Bolts shall be torqued per Table CO 480-2.
2. Assembled bolts shall have full thread engagement. A minimum of one thread protrusion shall be evident to assure full thread engagement.
3. All surfaces shall be thoroughly cleaned to remove any oxide build up. Care should be taken to note abrade any plating that exists on the equipment terminal or the compression lug. Inhibitor/grease shall be applied to all connection types.
4. If any previously made bolted connection have been loosened or taken apart for any reason, surfaces shall be cleaned and greased along with utilizing new hardware.

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

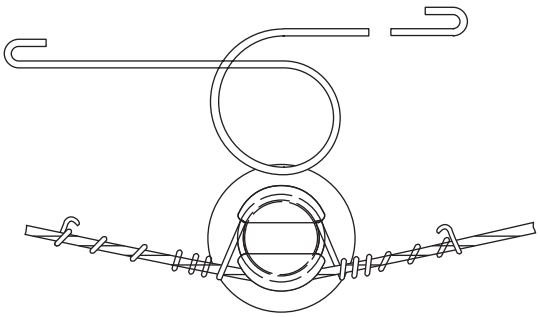


Table CO 500–1: Side Tie — Single Arm

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"	

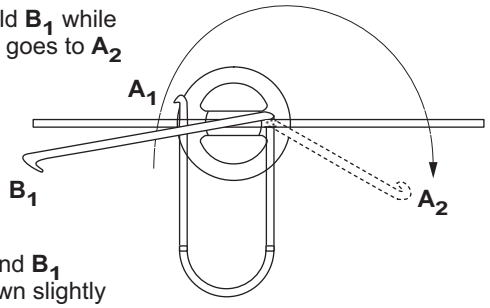
Note(s):

1. Not for use with Covered Conductors.

Figure CO 500–2: Top Tie — Single Arm

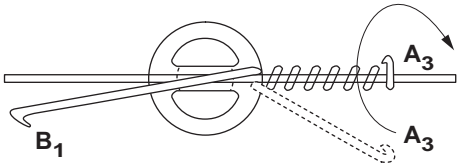
1

Hold B_1 while A_1 goes to A_2



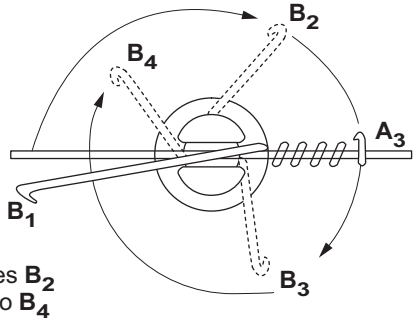
Bend B_1 down slightly

2



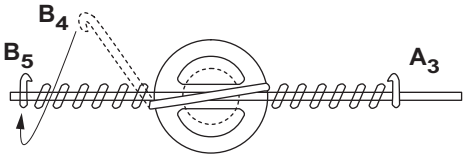
Hold B_1 while serving A_2 into Position A_3

3



B_1 goes B_2 to B_3 to B_4

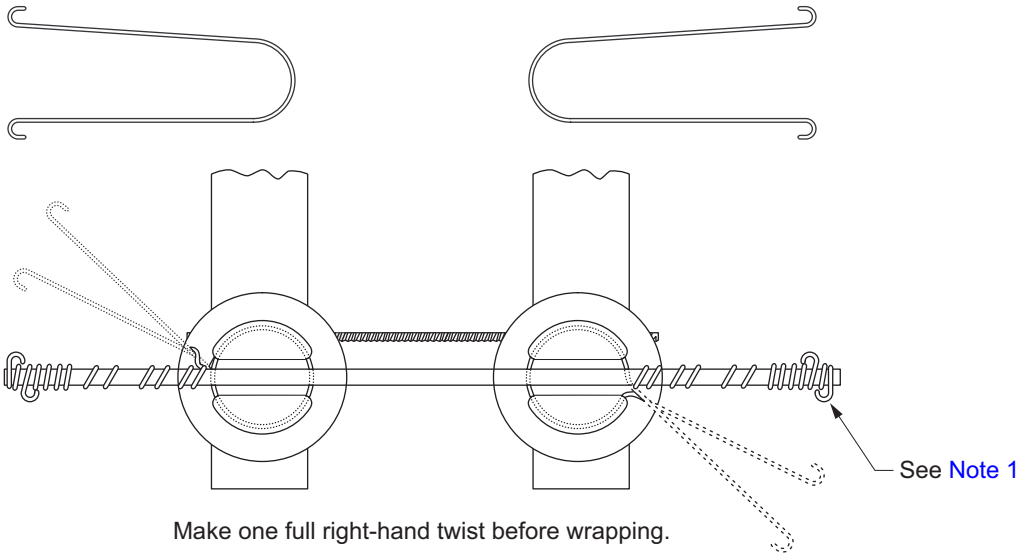
4



Pass B_4 over Line Wire and Serve. Finish at B_5.

Scope CO 500.2 Insulator Ties Copper and Aluminum

Figure CO 500–3: Top Tie — Double Arm

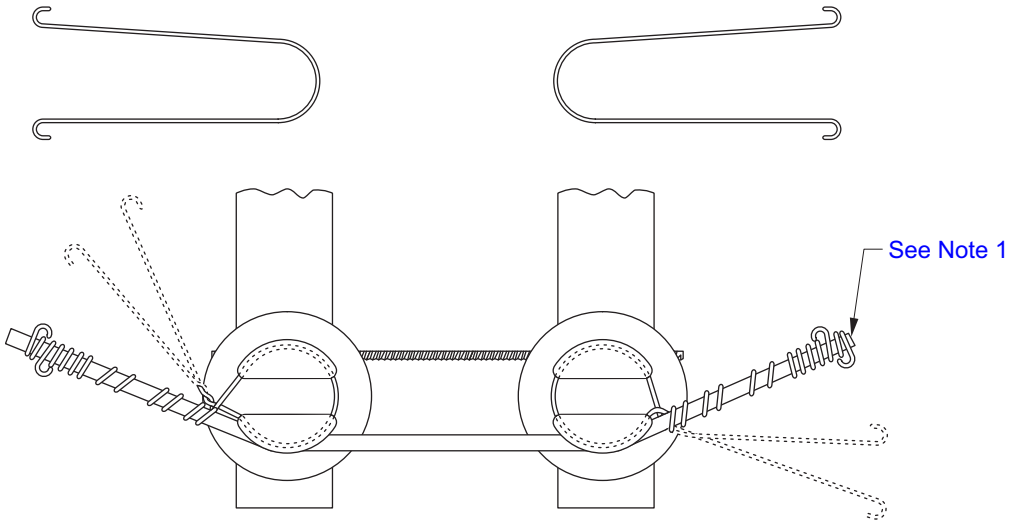


Make one full right-hand twist before wrapping.

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



Make one full right-hand twist before wrapping.

Note(s):

1. End of wire should be bent back firmly against conductor to prevent radio interference.

This page intentionally left blank.

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

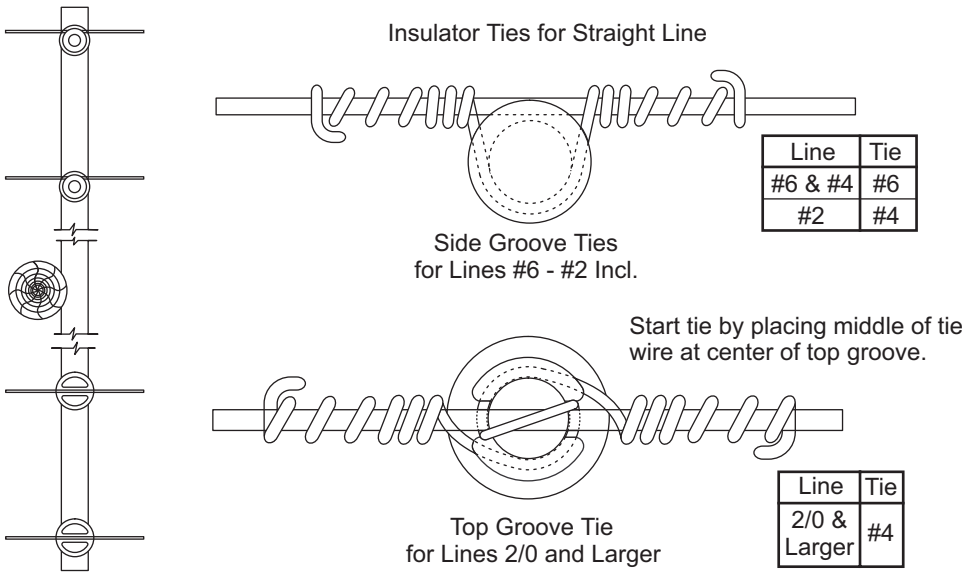
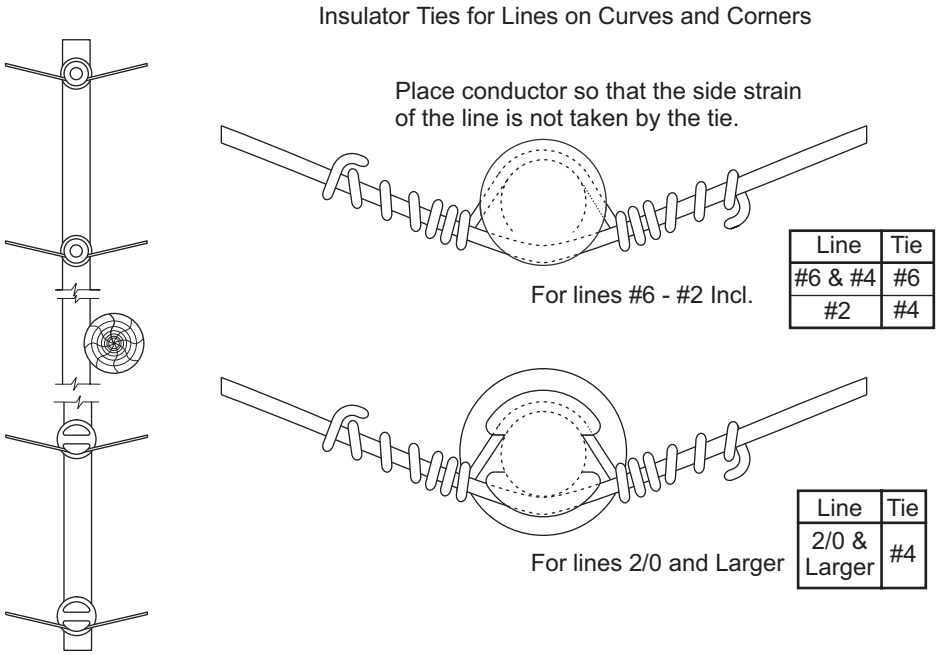


Figure CO 505–2: Insulator Ties for Lines on Curves and Corners



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.

This page intentionally left blank.

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 Trunnion Top Post Insulators

Figure CO 510–2: Clamp for Trunnion Top Post Insulators

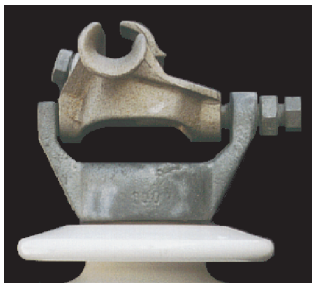


Table CO 510–2: Clamp for Trunnion Top Post Insulators — Bare Conductor

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. Armor Rod/Line Guard shall be used for #4–1/0 ACSR and #6 Sol.–#2 Str. Copper in tangent and deviation angle construction. It is not required for these conductor sizes for jumpers on double dead-ends or line/buck poles.
2. For deviation angles, see DC 575.

Table CO 510–3: Clamp for Trunnion Top Post Insulators — Covered Conductor

SAP	Conductor Range	Acceptable Covered Conductor Size	
		17 kV Rating	35 kV Rating
10067576	0.6"–1.06"	#2, 2/0, 4/0 Cu, 1/0, 336 (18/1) ACSR	1/0 ACSR
10067577	.25"–0.8"	#2, 2/0 Cu, 1/0 ACSR	N/A
10067579	0.8"–1.22"	4/0 Cu, 336.4 ACSR	1/0 ACSR
10067580	1"–1.5"	336.4, 653.9 ACSR	1/0, 336.4 ACSR
10067581	1.5"–2"	N/A	653.9 ACSR

Note(s):
1. See CC 110 for additional conductor data.
2. Armor Rod/Line Guard shall not be used on covered conductors.

This page intentionally left blank.

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.

This page intentionally left blank.

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.

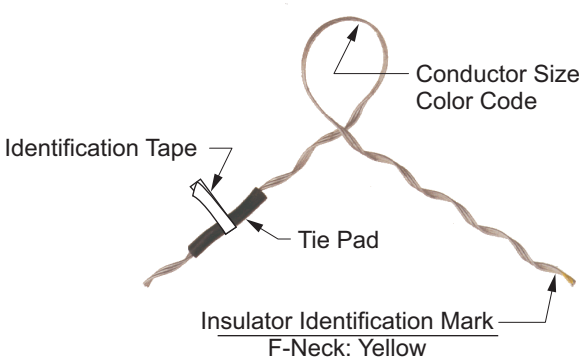
Table CO 520–1: Conductor Size and Color Codes for F-Neck Side Tie

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

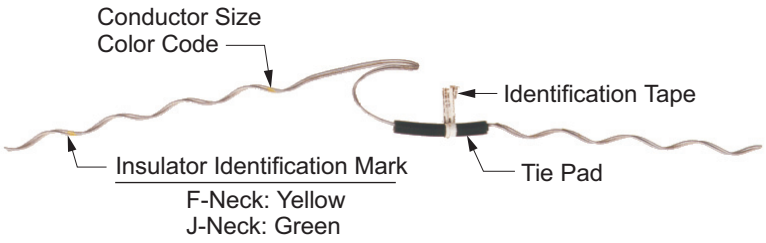
Table CO 520–3: Conductor Size and Color Codes for J-Neck Tie

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)



This page intentionally left blank.

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 1000 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

This page intentionally left blank.

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)

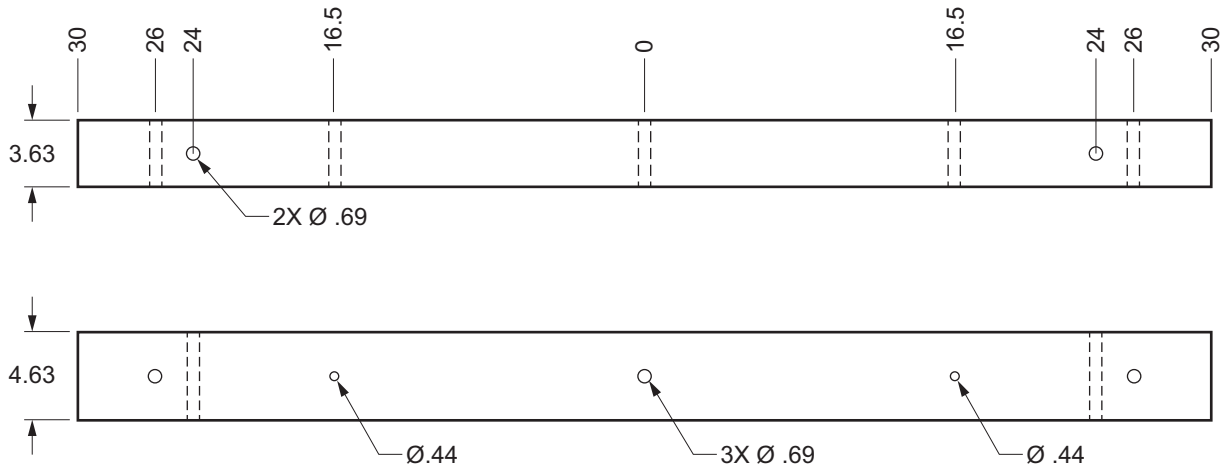


Figure CO 700–2: 8' Dead-End Composite Crossarm Pre-Drilled Holes (SAP 10060796)

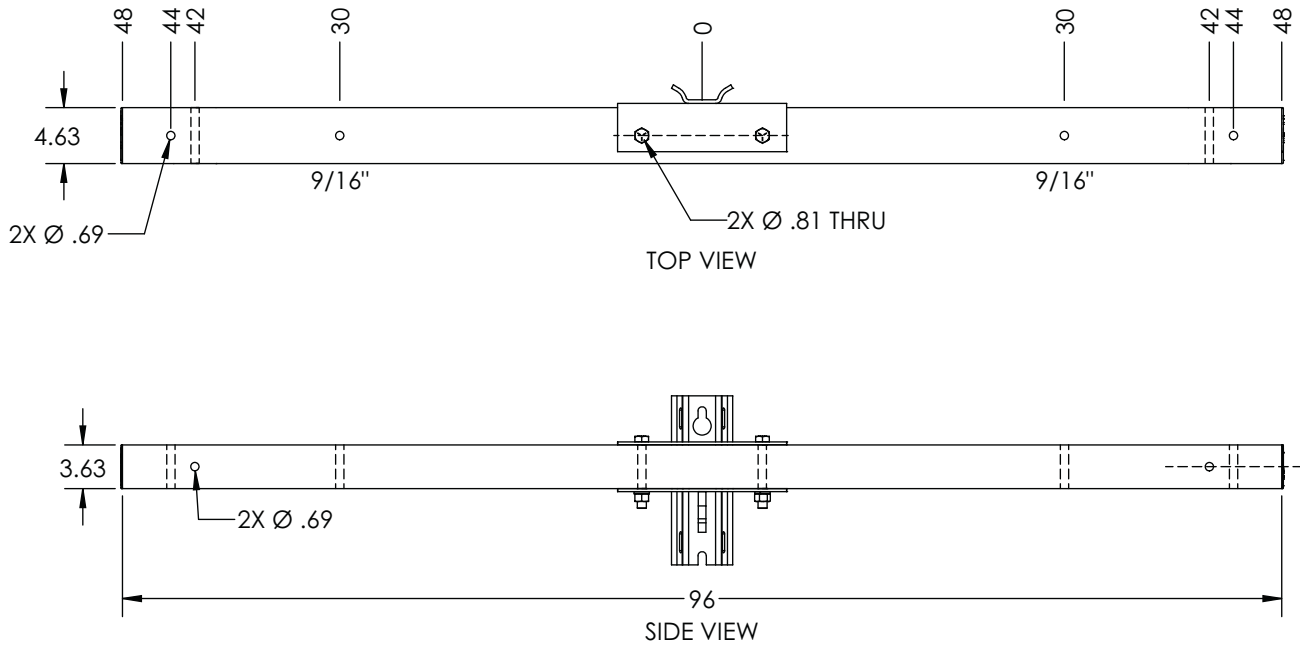


Figure CO 700–3: 8' Tangent Composite Crossarm Pre-Drilled Holes (SAP 10060793)

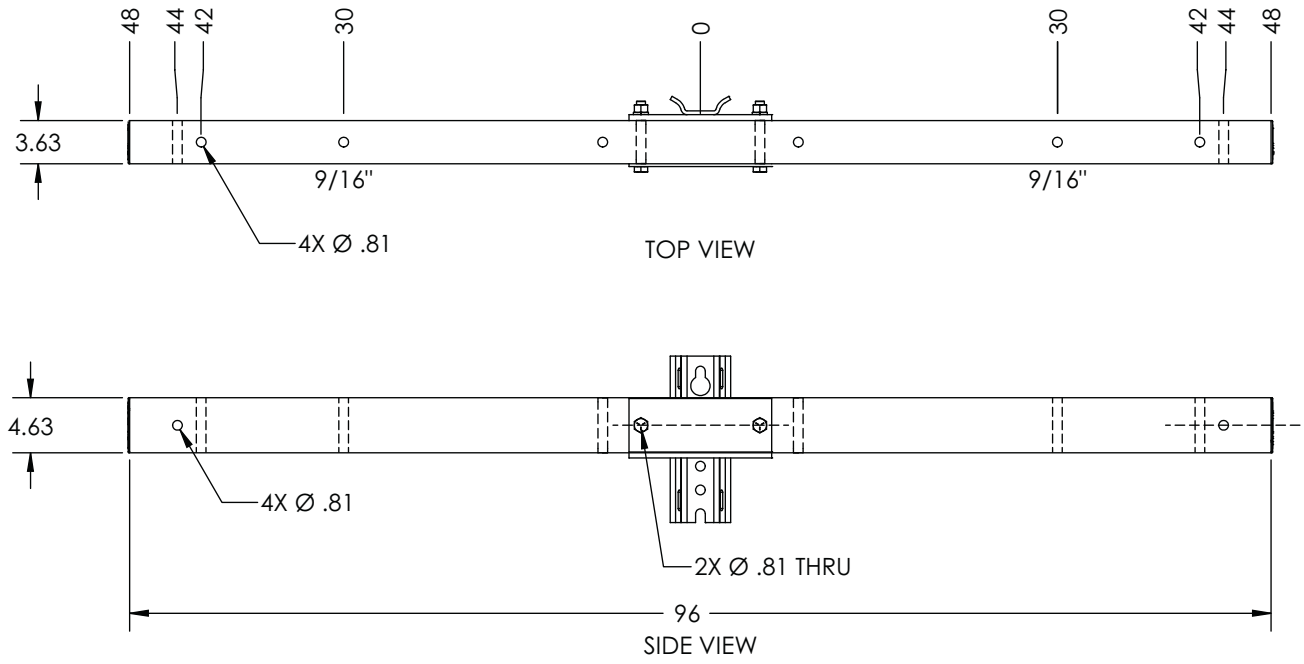


Figure CO 700–4: 10' Dead-End Composite Crossarm Pre-Drilled Holes (SAP 10060797)

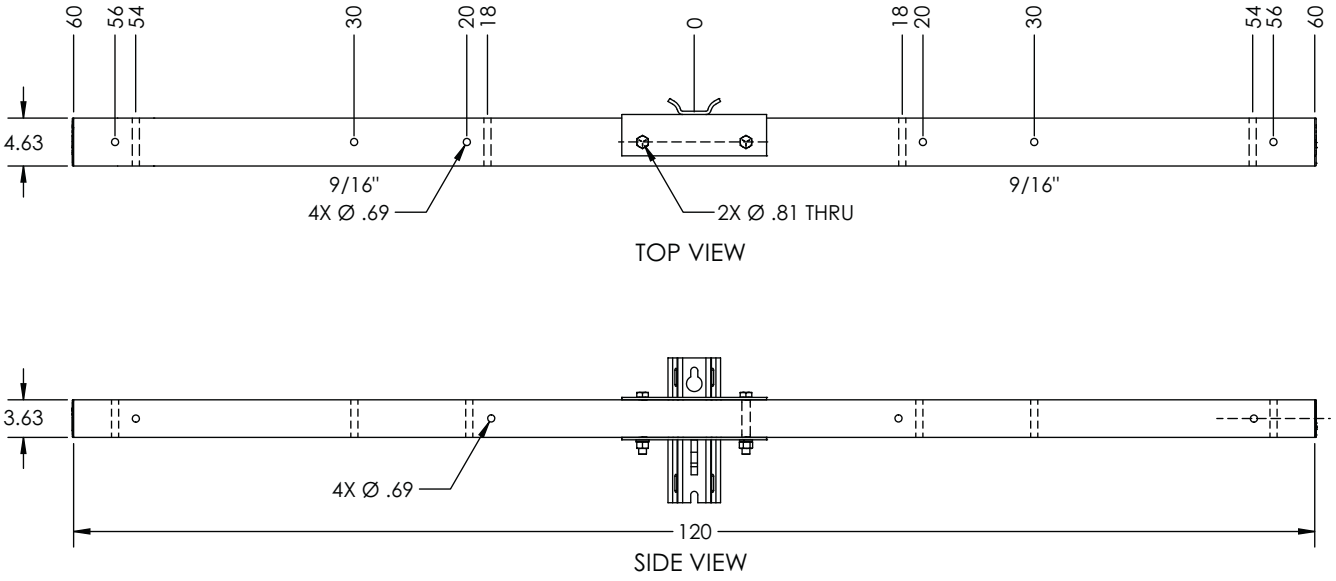


Figure CO 700–5: 10' Tangent Composite Crossarm Pre-Drilled Holes (SAP 10060794)

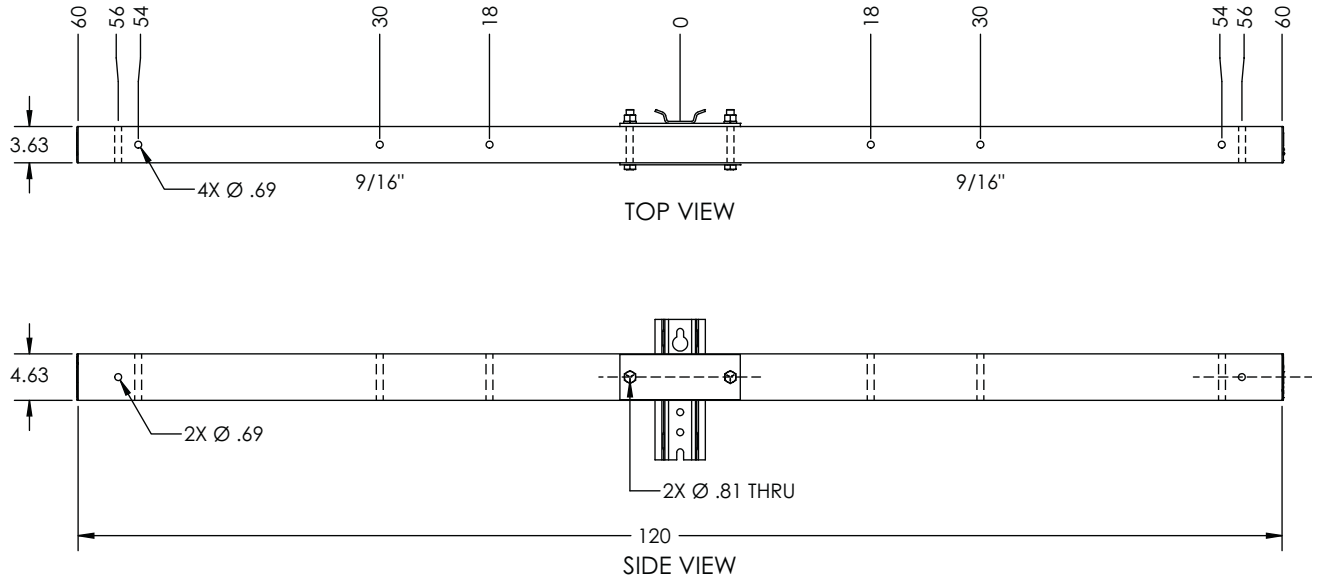


Figure CO 700–6: 12' Dead-End Composite Crossarm Hole Drilling (SAP 10060798)

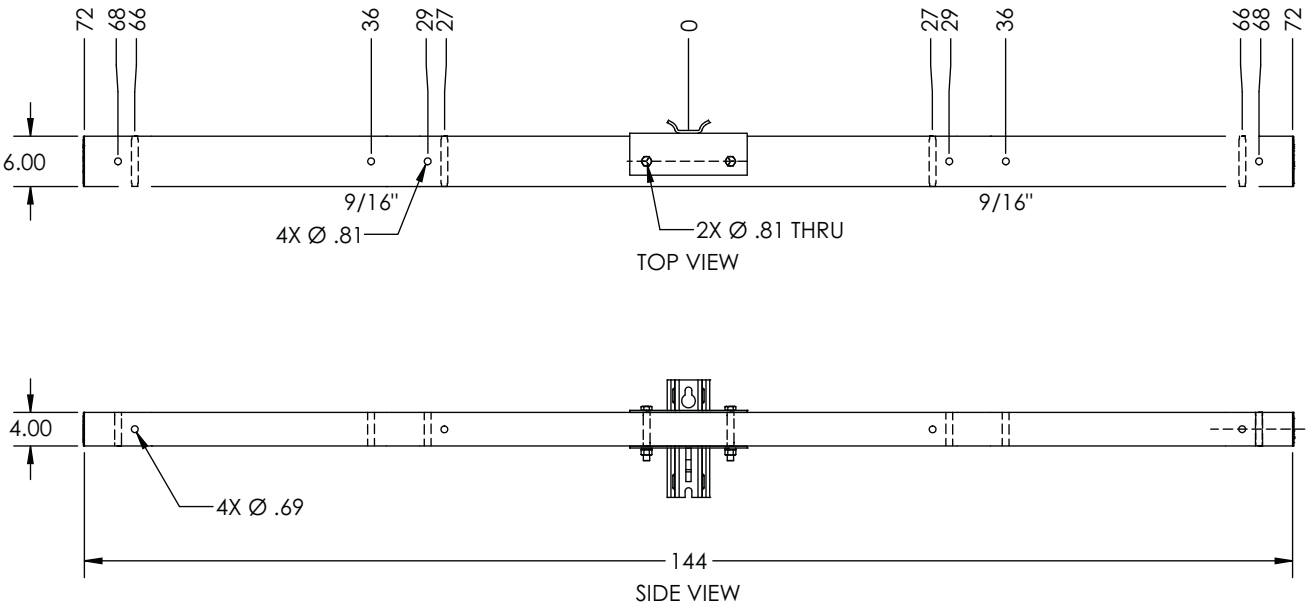


Figure CO 700–7: 12' Tangent Composite Crossarm Hole Drilling (SAP 10060795)

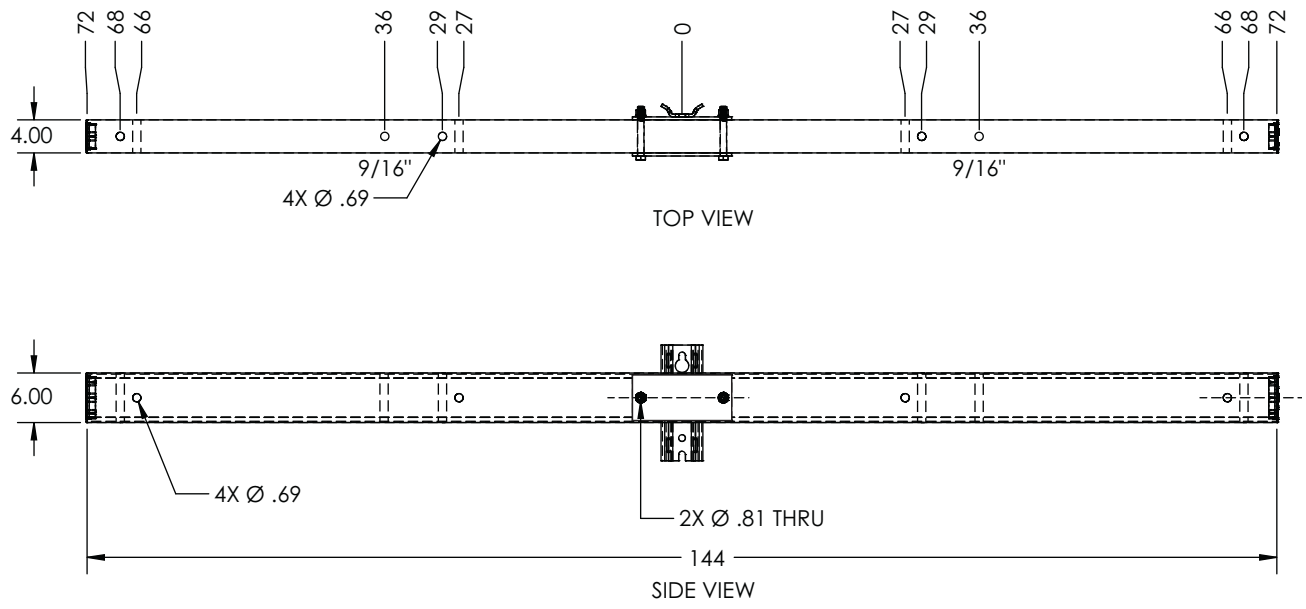


Figure CO 700–8: 10' Tangent Alley Composite Crossarm Pre-Drilled Holes (SAP 10211423)

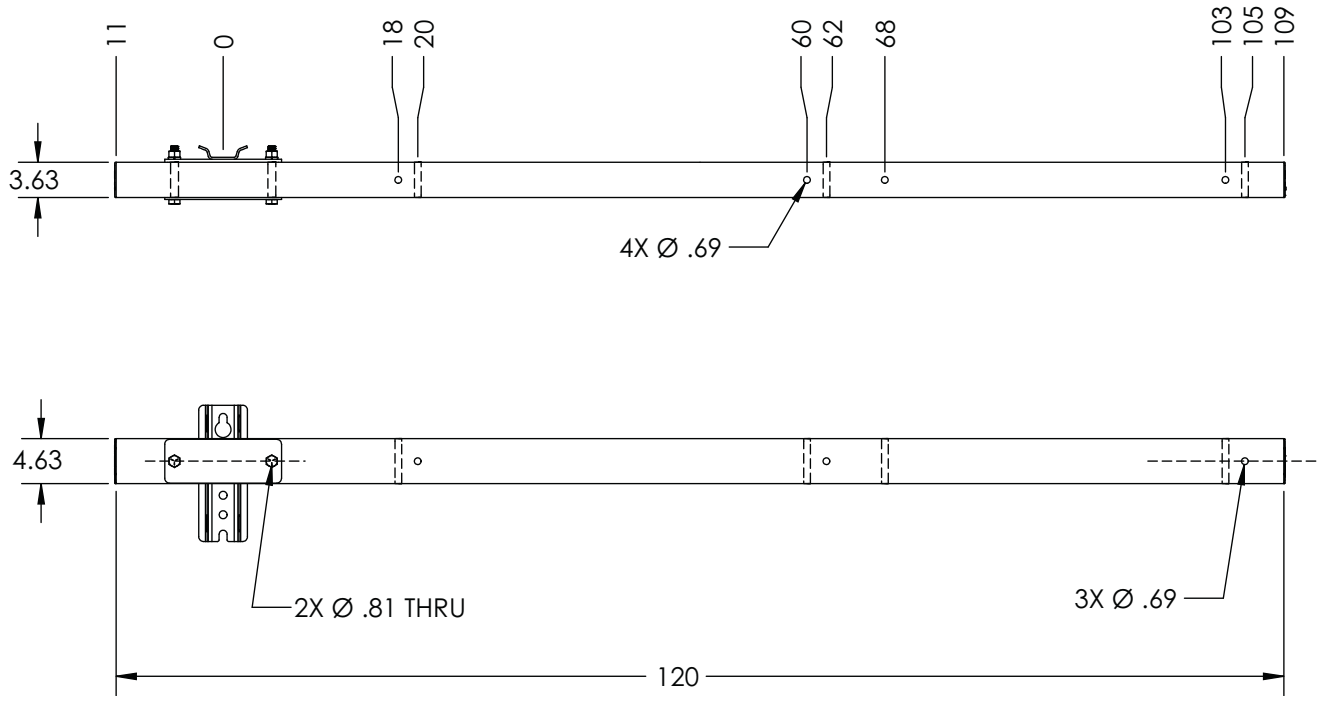


Figure CO 700–9: 12' Tangent Alley Composite Crossarm Pre-Drilled Holes (SAP 10211424)

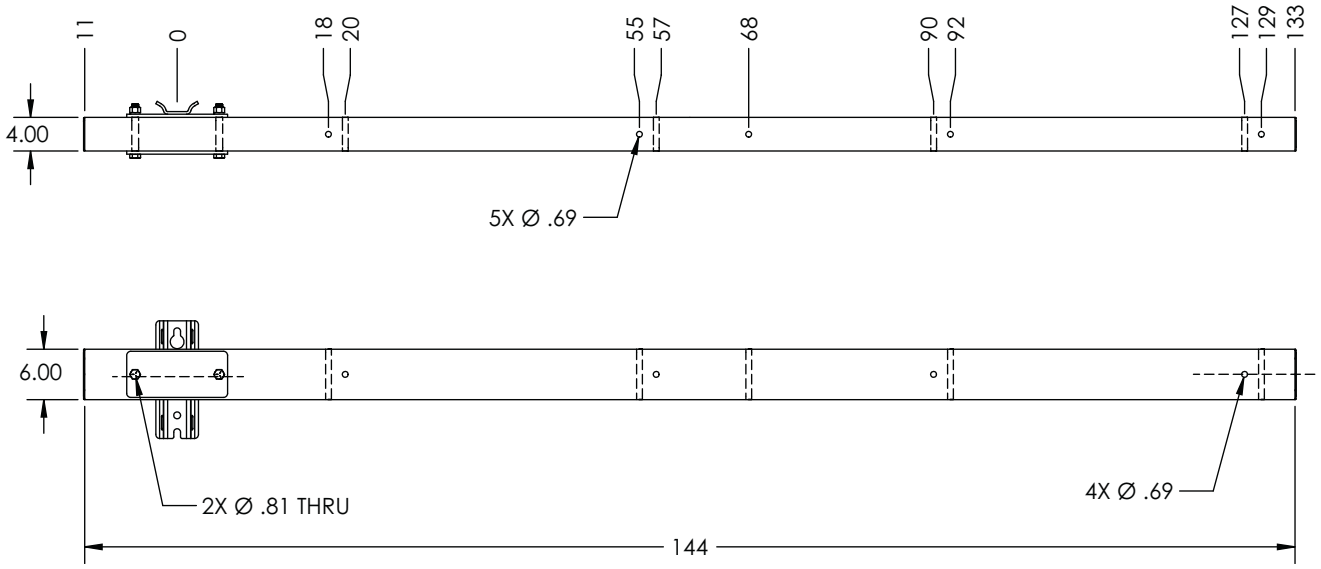


Figure CO 700–10: 20' Dead-End Composite Crossarm Pre-Drilled Holes (SAP 10208513)

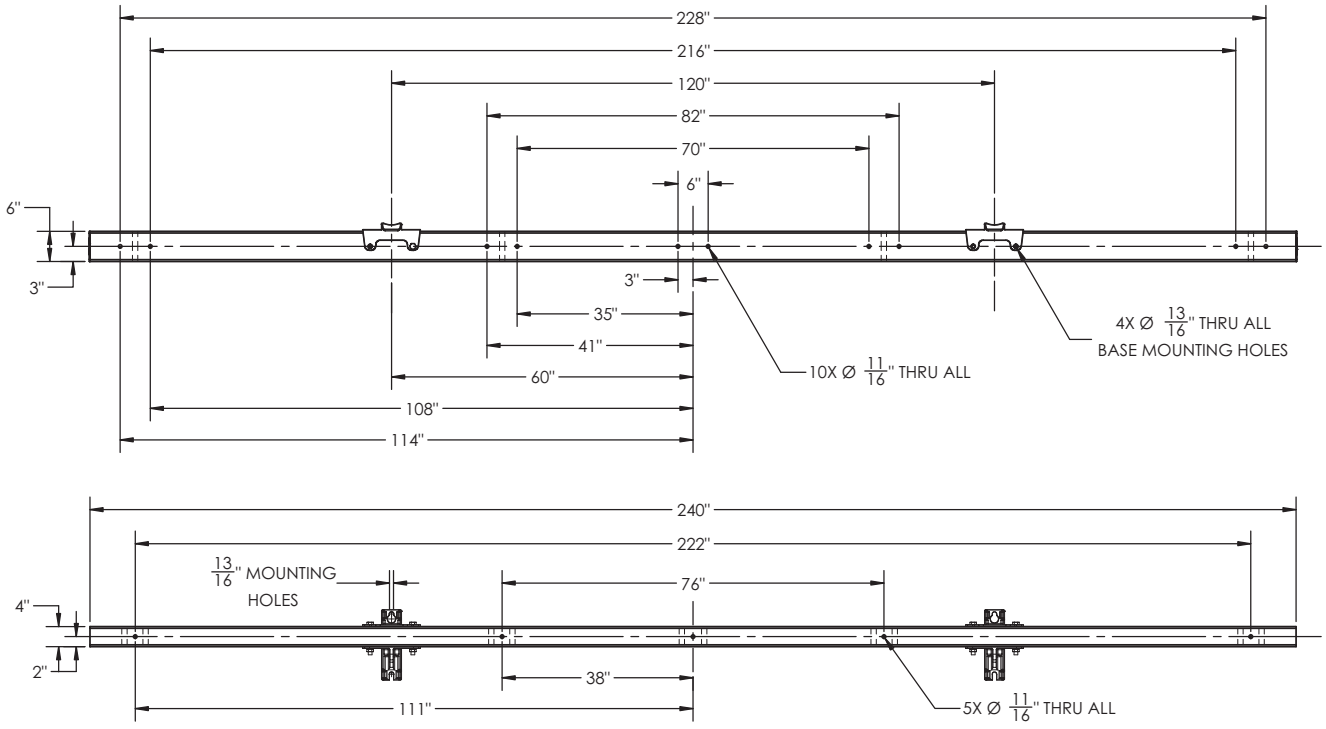
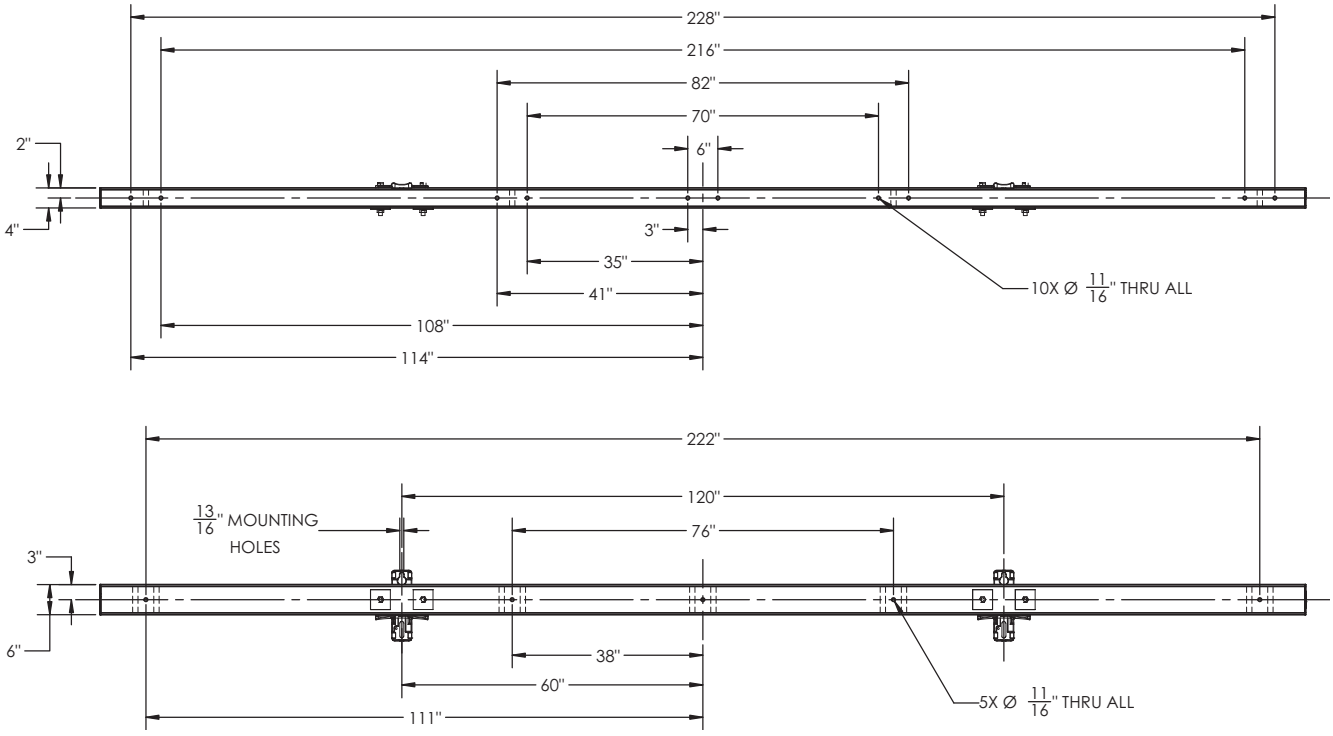


Figure CO 700–11: 20' Tangent Composite Crossarm Pre-Drilled Holes (SAP 10208033)



Scope CO 700.3 8' and 10' Composite Crossarm Mounting Bracket Details

Figure CO 700–12: PUPI Dead-End Mounting Bracket Detail

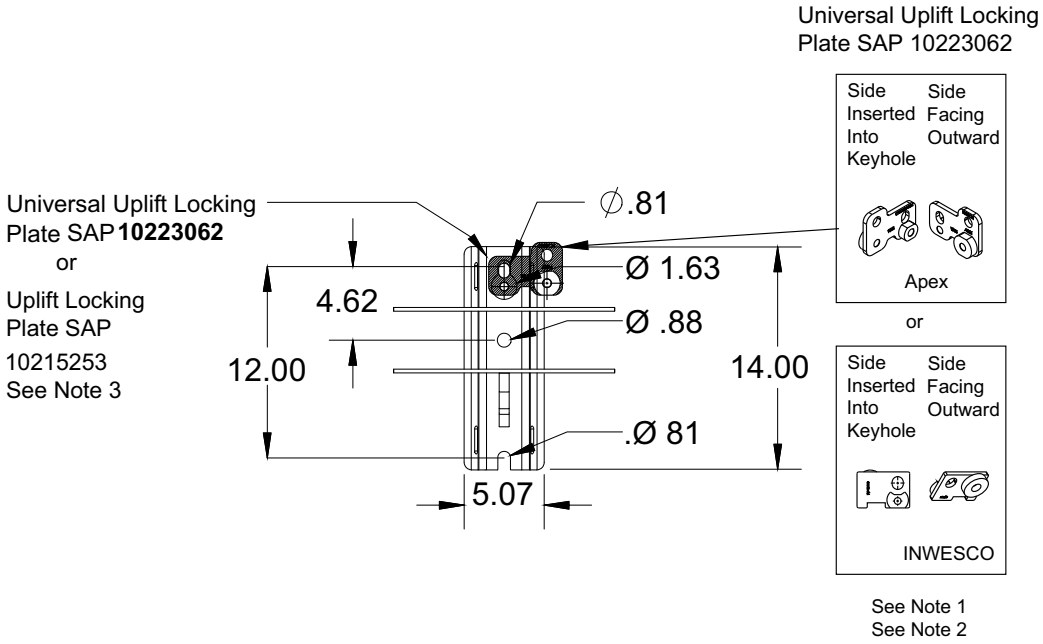


Figure CO 700–13: MacLean Dead-End Mounting Bracket Detail

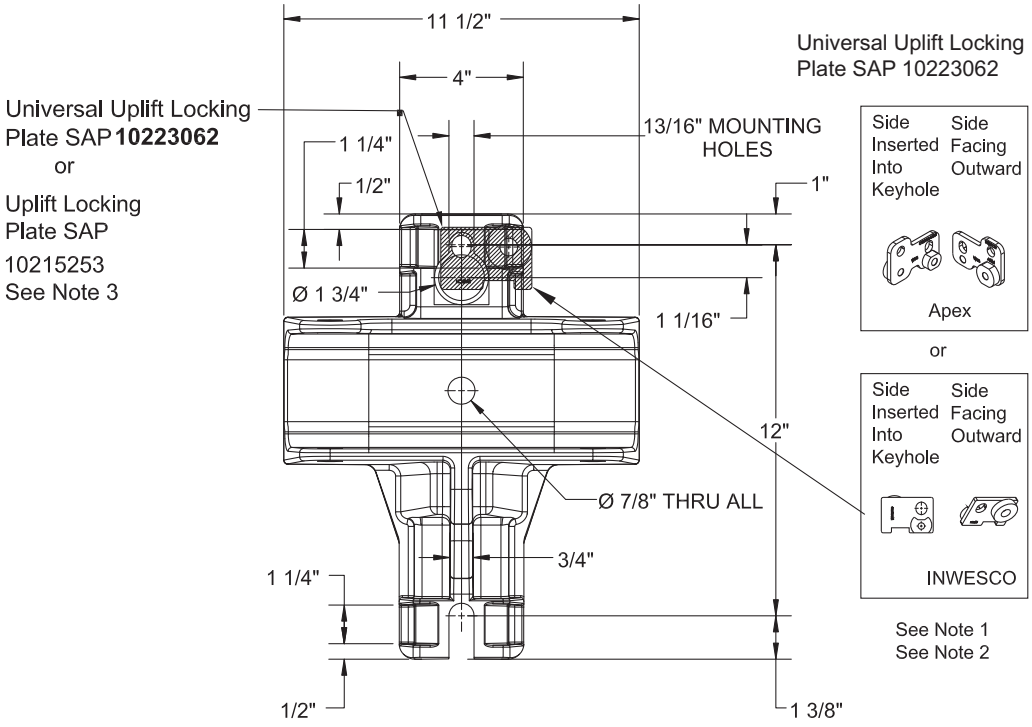


Figure CO 700–14: PUPI Tangent Mounting Bracket Detail

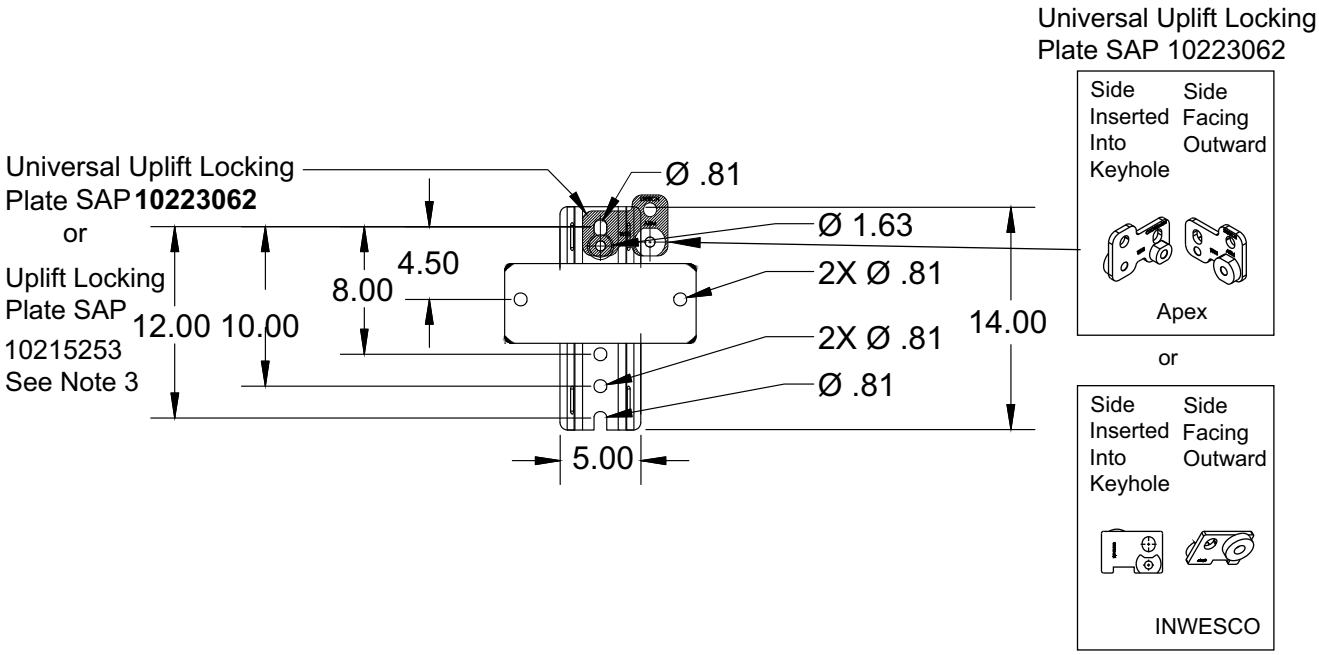
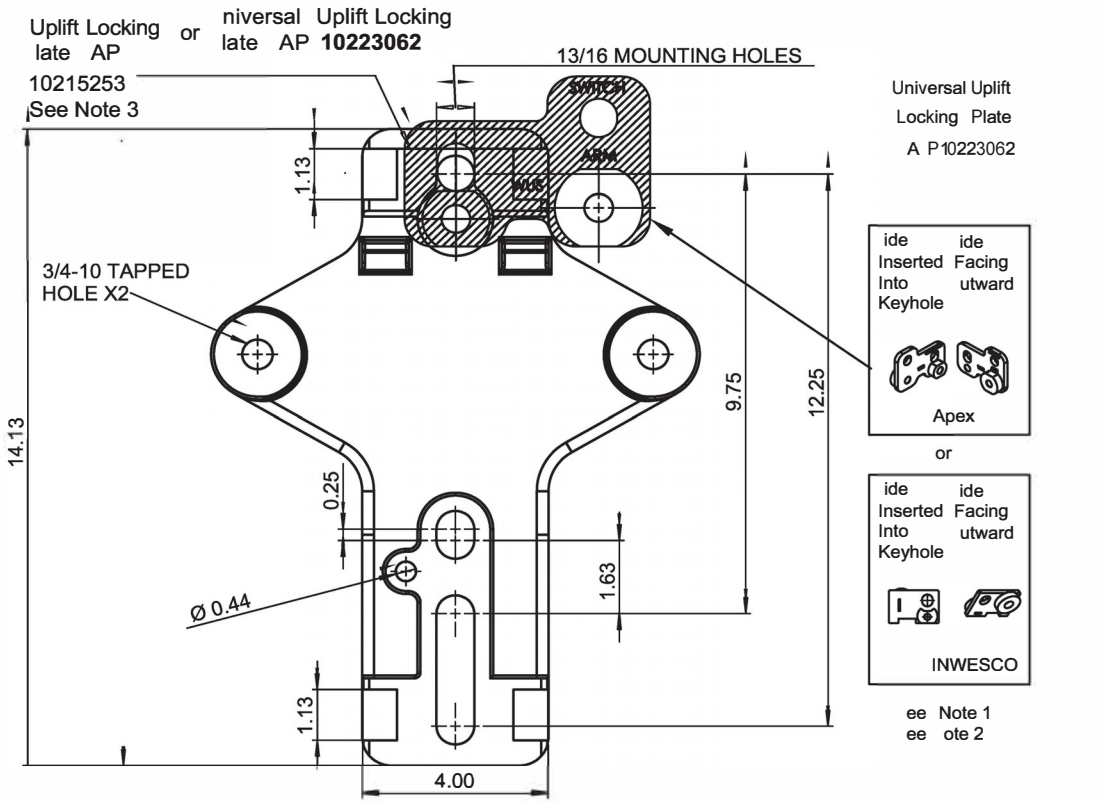


Figure CO 700–15: MacLean Tangent Mounting Bracket Detail



Scope CO 700.4 12' and 20' Composite Crossarm Mounting Bracket Details

Figure CO 700–16: PUPI Dead-End Mounting Bracket Detail

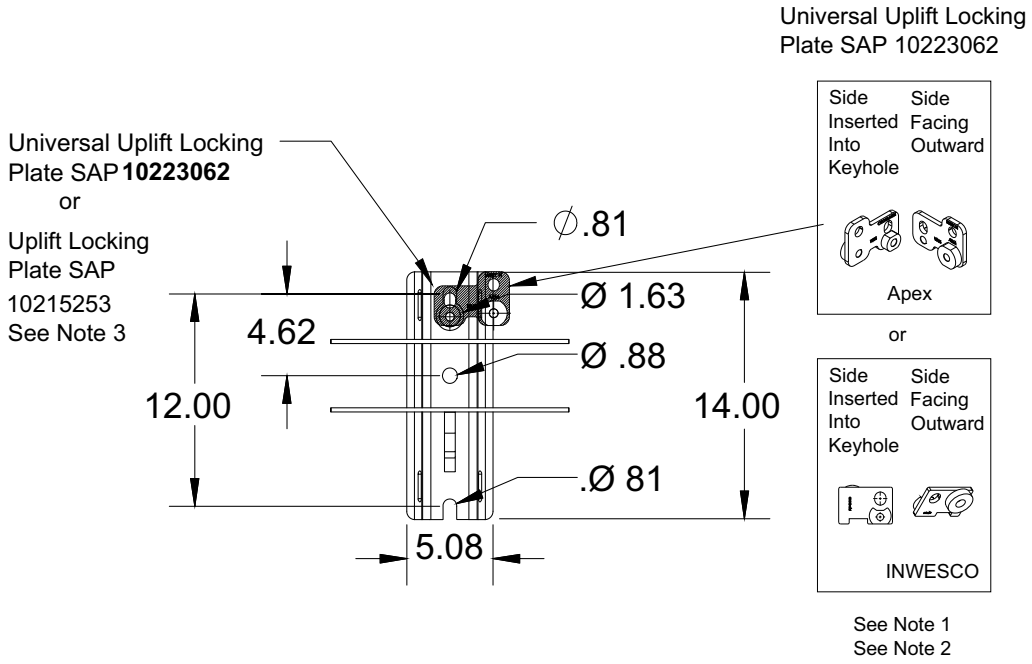


Figure CO 700–17: MacLean Dead-End Mounting Bracket Detail

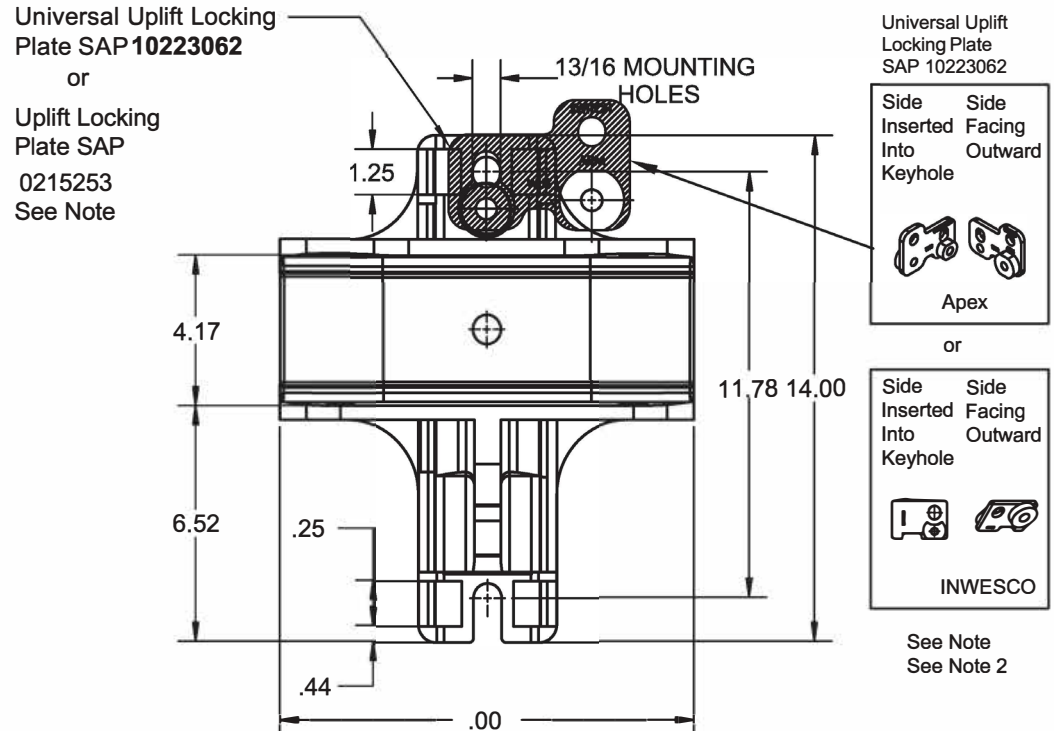


Figure CO 700–18: PUPI Tangent Mounting Bracket Detail

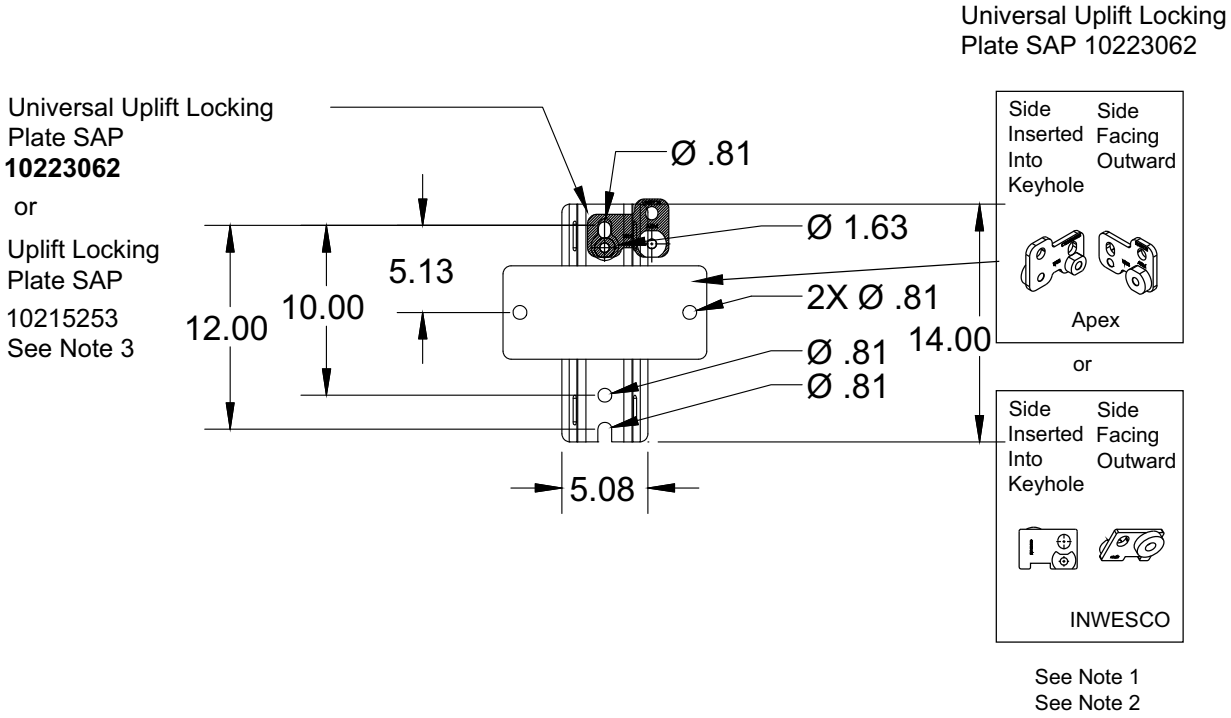
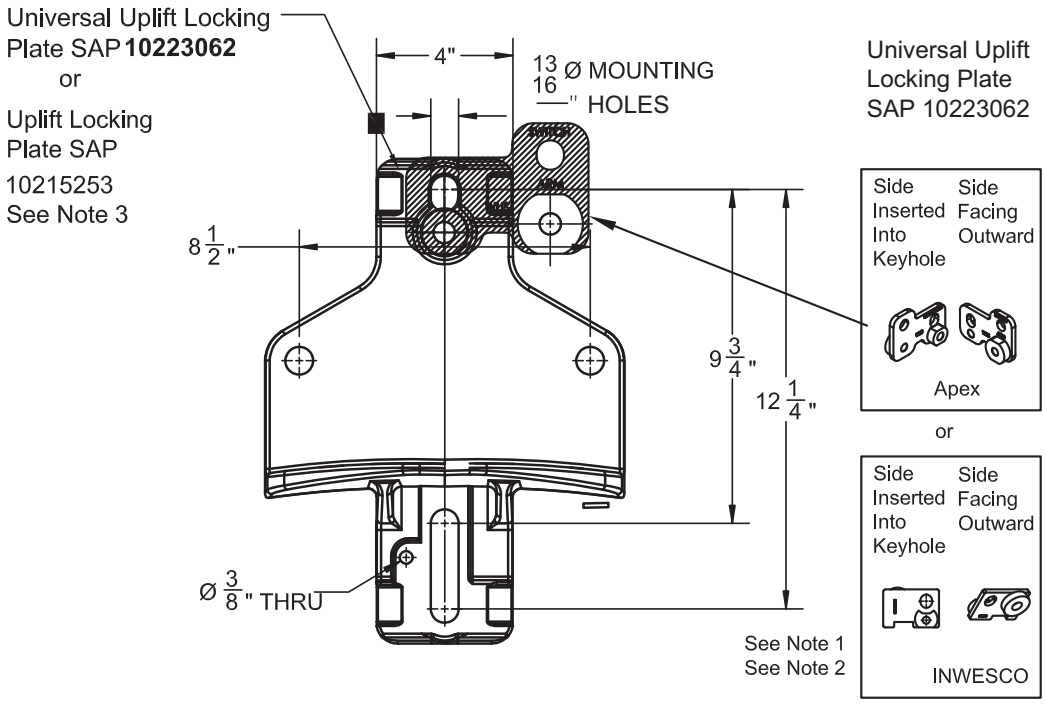


Figure CO 700–19: MacLean Tangent Mounting Bracket Detail



Note(s):

1. Insert a Universal Uplift Locking plate for all crossarms that are not equipped with V Braces.
2. Both Universal Uplift Locking Plate Manufacturers (Apex or INWESCO), are Compatible with All Crossarm Bracket Keyholes in CO 700.
3. 10215253 is Key 6, use until stock depleted.

Figure CO 700–20: Hardward for Universal Uplift Locking Plate as Applied to Crossarms



When applied to switches 'SWITCH' stamped side inserted into keyhole. 'CROSSARM' stamped side faces out.



APEX, Front and Back

INWESCO, Front and Back



APEX, PUPI Mounting



INWESCO, PUPI Mounting



APEX, MPS Mounting



INWESCO, MPS Mounting

APEX



APEX, Mounting Hardware

INWESCO



INWESCO, Mounting Hardware



APEX,
Mounting Hardware Assembled

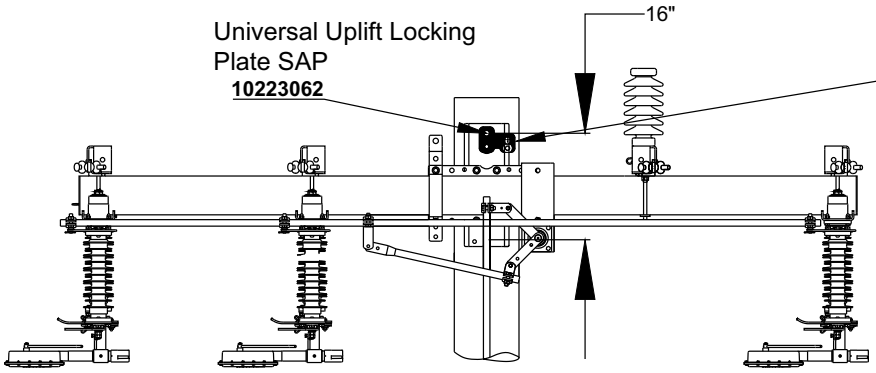


INWESCO,
Mounting Hardware Assembled

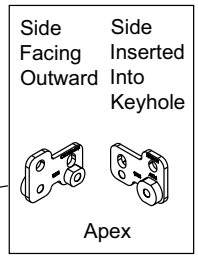
Figure CO 700–21: Operated Switches

Universal Uplift Locking Plate SAP 10223062

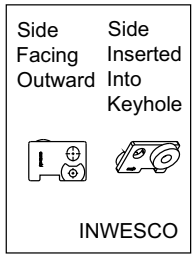
Applied to Crossarms and Group Operated Switches



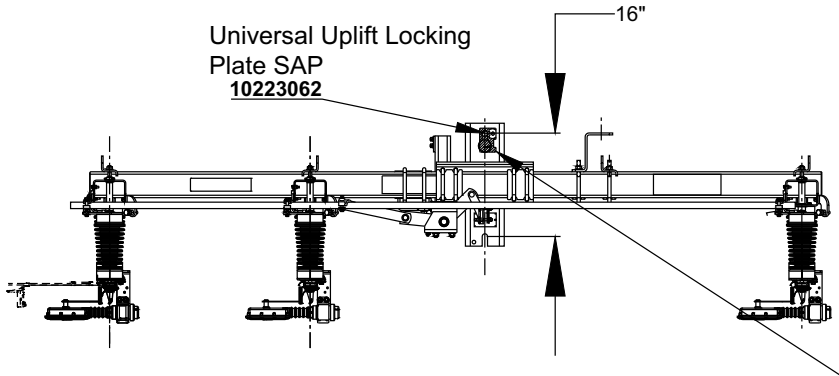
Inertia Engineering LineBoss, Typical Type



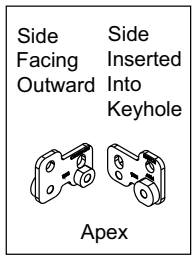
or



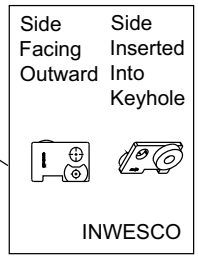
See Note 1
See Note 2



S&C OmniRuper, Typical Type, Locking Plate
Applicable to all Horizontal Types



or



See Note 1
See Note 2

Note(s):

1. Insert a Universal Uplift Locking Plate for all switch mounting brackets where switches are not equipped with V Braces. For example, CVS (vertical switches) and AldutiRupter switches do not require Locking Plates.
2. Both Universal Uplift Locking Plate Manufacturers (Apex or INWESCO), are Compatible with All Switch Bracket Keyholes in DAP AP 300.

Figure CO 700–22: Hardware for Universal Uplift Locking Plate as Applied to Group Operated Switches



When applied to switches 'SWITCH' stamped side inserted into keyhole. 'CROSSARM' stamped side faces out.



APEX, Front and Back

INWESCO, Front and Back



APEX, S&C Switch Mounting



INWESCO, S&C Switch Mounting



APEX, Inertia Switch Mounting



INWESCO, Inertia Switch Mounting

APEX



APEX, Mounting Hardware

INWESCO



INWESCO, Mounting Hardware



APEX,
Mounting Hardware Assembled



INWESCO,
Mounting Hardware Assembled

CO 700.5 Wood Crossarm Pre-Drilled Holes

Figure CO 700–1: 5' Wood Crossarm Pre-Drilled Holes (SAP 10216647)

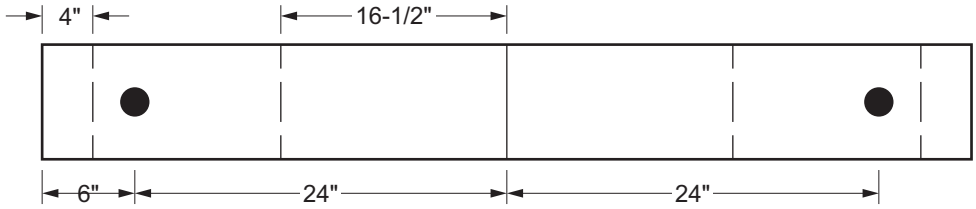


Figure CO 700–2: 8' Wood Crossarm Pre-Drilled Holes (SAP 10216645)

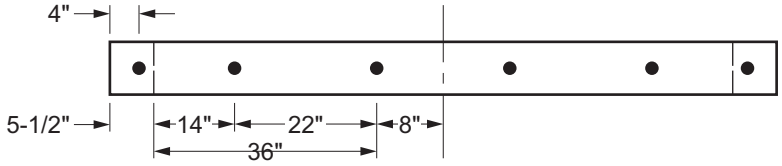


Figure CO 700–3: 10' Wood Crossarm Pre-Drilled Holes (SAP 10216646)

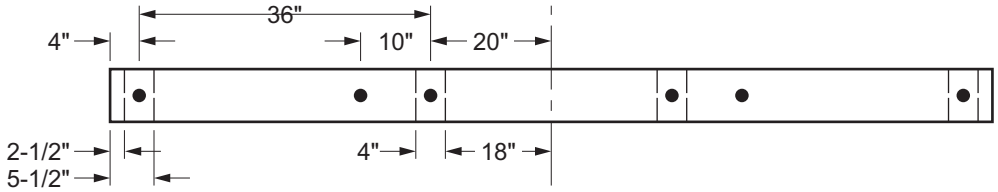
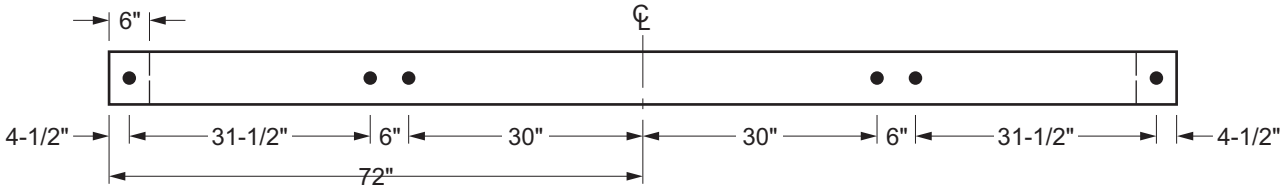


Figure CO 700–4: 12' Wood Crossarm Pre-Drilled Holes (SAP 10216637)



This page intentionally left blank.

DOH–DC: Distribution Construction

TABLE OF CONTENTS

STANDARD	TITLE
DC 100	Climbing/Working Space — General
DC 100.1	General Climbing and Working Space Requirements for Crossarm Construction
DC 100.2	Climbing and Working Space without Crossarms
DC 100.3	Climbing Space and Horizontal Conductor Spacing
DC 110	Climbing/Working Space 3-Wire Corner
DC 110.1	Climbing/Working Space 3-Wire Corner
DC 120	Climbing/Working Space 4-Wire Corner
DC 120.1	Climbing/Working Space 4-Wire Corner
DC 200	Typical Poleheads/Clearances
DC 200.1	Polehead, Conductor Clearances, and Grade Clearances for Various Sizes of Poles
DC 220	Typical Poleheads/Clearances — Wire Line Communication
DC 220.1	Typical Poleheads/Clearances — Wire Line Communication
DC 222	Non-SCE Antennas
DC 222.1	Non-SCE Antennas
DC 230	Centerline Dead-Ending 3-Wire Corner
DC 230.1	Centerline Dead-Ending 3-Wire Corner
DC 240	Blackwell Corner 12/16 kV 3/4 Wire Alternate Method (for Existing Installations)
DC 240.1	Blackwell Corner 12/16 kV 3/4 Wire Alternate Method (for Existing Installations)
DC 320	Triplex/Straight Line Construction
DC 320.1	Typical Straight Line Construction for Triplex Conductors
DC 321	Triplex/Dead-ends/Corners
DC 321.1	Typical Secondary Construction for Triplex/Dead-Ends/Corners
DC 322	Triplex/Angle Construction
DC 322.1	Angle Construction
DC 323	Triplex/Service Terminations
DC 323.1	Triplex/Service Terminations
DC 324	Triplex/Splicing Method
DC 324.1	Triplex/Splicing Method
DC 325	Secondary Aluminum/Dead-End/Splicing Material
DC 325.1	Secondary Aluminum Supply Dead-End Grips and Splices
DC 330	Service Breakaway System
DC 330.1	General Information
	Figure DC 330–11: Typical Installation of Storm Safe Breakaway System (Transformer Pole)
DC 400	Distribution Circuits 0–750 V Secondaries
DC 400.1	Distribution Circuits 0–750 V Secondaries

STANDARD	TITLE
DC 410	0–7500 V Straight-Line Pole — Typical
DC 410.1	Typical Pole Configurations for 0–7500 V Straight-Line Construction
DC 415	0–7500 V Angle Pole — Typical
DC 415.1	0–7500 V Angle Pole — Typical
DC 415	0–7500 V Angle Pole — Typical
DC 415.1	0–7500 V Angle Pole — Typical
DC 500	Rural, Standard, and Long Span Construction for 3-Wire 12 kV, 16 kV, and 33 kV Horizontal Configuration
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
DC 510	12/16 kV 4-Wire Straight Line — Typical
DC 510.1	Typical Pole Configuration for Straight Line Horizontal Construction — 12/16 kV — 4-Wire Circuit
DC 520	Distribution Circuit — Extra Heavy-Loading Areas above 5,000 Feet Elevation
DC 520.1	Construction Requirements for Extra Heavy-Loading Areas above 5,000 Feet Elevation — All Distribution Primary Voltages Construction General Requirements
DC 520.2	Territory Map of Extra Heavy-Loading Areas above 5,000 Feet Elevation
DC 520.3	Typical Construction Practices for 3-Wire and 4-Wire — Extra Heavy Loading above 5,000 Feet Elevation
DC 520.4	Typical Horizontal 3-Wire Straight Line Configuration — Extra Heavy Loading above 5,000 Feet Elevation
DC 520.5	Composite Arms Above 5,000 feet Corner Pole 3-Wire Construction with V-Brace Covered Conductor
DC 520.6	Composite Arms Above 5,000 feet 3-Wire Ridge Pin Construction with V-Braces Covered Conductor 10 feet Composite Arm Polymer Post Type Insulator
DC 520.7	Composite Arms Above 5,000 feet 3-Wire Ridge Pin Construction with V-Braces Covered Conductor 10 feet Composite Arm Polymer Post Type Insulator
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 Post Type Insulator
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 Post Type Insulator
DC 530	All Distribution Voltages 3/4-Wire Suspension Construction
DC 530.1	Distribution Suspension Construction — High-Wind Areas Only
DC 535	Wildlife-Safe Power Line Construction
DC 535.1	Wildlife-Safe Power Line Construction
DC 536P	Nesting Platform Construction
DC 536P.1	Nesting Platform Construction
DC 536P.2	Nesting Platform Construction on Bare Pole
DC 536P.3	Nesting Platform Construction on Pole with Equipment
DC 536P.4	Nesting Platform Construction on Pole Top Extension (PTX)

STANDARD	TITLE
DC 537	Nesting Deterrent Pucks
DC 537.1	Application of Nesting Deterrent Pucks
DC 537.2	Aerial Line Marker
DC 538	Line Crossing Marker
DC 538.1	Line Crossing Marker
DC 539	Aerial Obstruction Marker Balls
DC 539.1	Aerial Obstruction Marker Balls
DC 540	12/16/25/33 kV 3/4-Wire Vertical Construction
DC 540.1	Typical Construction for 12/16/25/33 kV 3/4-Wire Vertical Construction
DC 550	All Distribution Voltages, 3/4-Wire Alley Arm Construction
DC 550.1	All Distribution Voltages, 3/4-Wire Alley Arm Construction
DC 550.2	All Distribution Voltages, 3/4-Wire Composite Alley Arm Construction
DC 560	12/16/25/33 kV 3/4-Wire Barre Corner Construction
DC 560.1	12/16/25/33 kV 3/4-Wire Barre Corner Construction
DC 570	4/12/16 kV 3/4-Wire Dead-End Construction
DC 570.1	4/12/16 kV 3/4-Wire Dead-End Construction
DC 575	12/16/25/33 kV 3/4-Wire Angle Pole Construction
DC 575.1	12/16/25/33 kV 3- or 4-Wire Angle Pole Construction
DC 580	12/16/33 kV 3- or 4-Wire Double Dead-End Construction for Wood and Composite Arms
DC 580.1	12/16/33 kV 3- or 4-Wire Double Dead-End Construction for Wood and Composite Arms
DC 585	Determination of Deviation Angle
DC 585.1	Determination of Deviation Angle
DC 585.2	Determination of Line Angle and Deviation Angle for Use in Switch and Line Pole Angle Determination
DC 586	3- and 4-Wire Transposition and Transition Construction
DC 586.1	3- and 4-Wire Transposition Construction
DC 587	“Zig-Zag” Construction
DC 587.1	3-Wire “Zig-Zag” Construction
DC 590	Mid-Span Tap Construction
DC 590.1	Mid-Span Tap Construction
DC 605	Distribution Circuits — High Fire Risk Area Requirements
DC 605.1	2.4 kV through 33 kV Special Overhead Construction Line Requirements for Areas Affected by Dispatchers High Fire Risk
DC 610	4/12/16 kV OH Branch Line Fusing
DC 610.1	Typical Branch Fuse Construction for 1Ø Double Dead-End Straight Line Pole
DC 610.2	Typical Branch Fuse Construction for 3Ø Double Dead-End Straight Line Pole Construction
DC 610.3	Typical Branch Fuse Construction for 3Ø 3/4 Wire Double Dead-End Straight Line Pole Construction

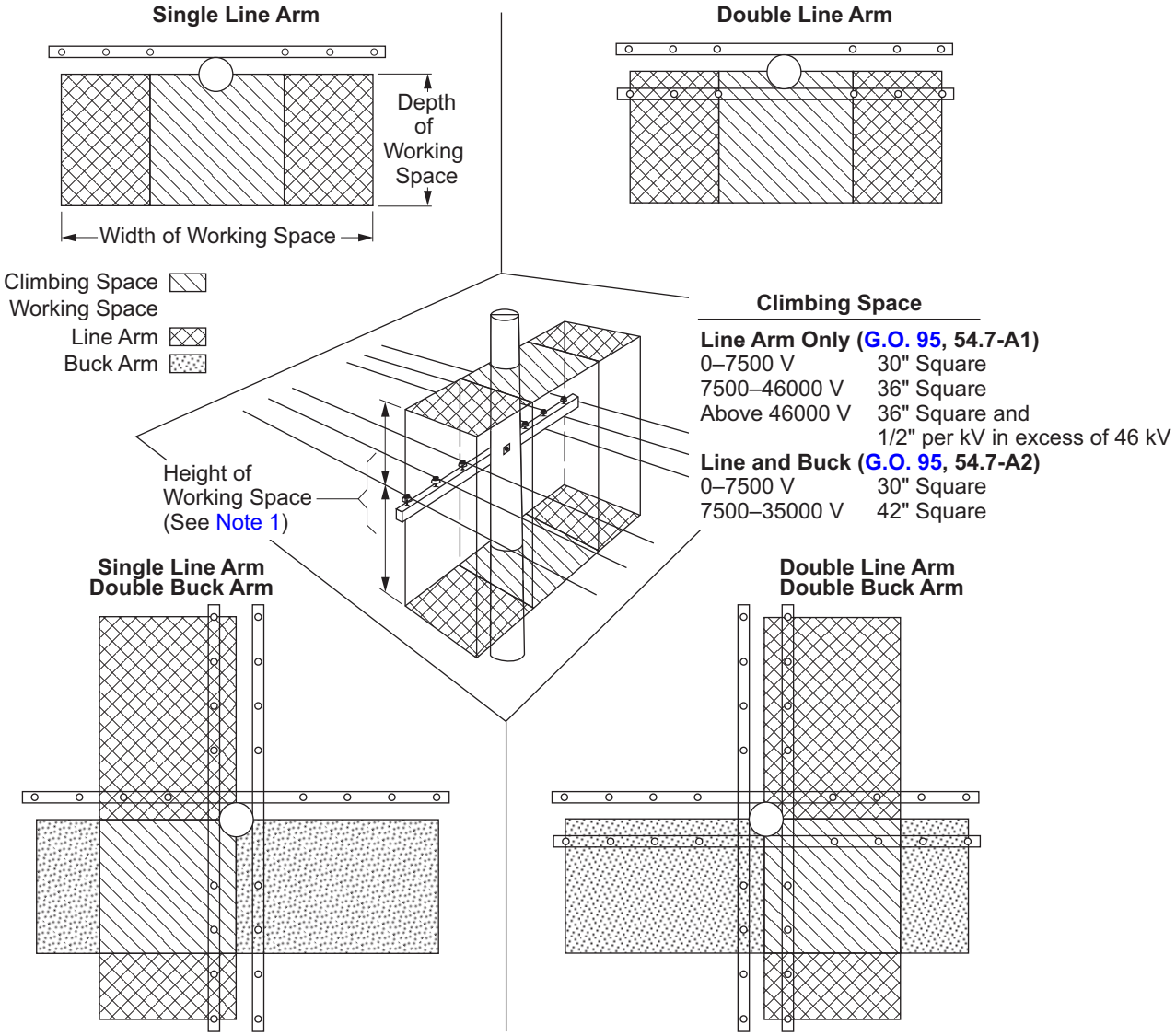
STANDARD	TITLE
DC 610.4	Typical 12/16 kV Branch Fuse Construction for 3Ø Centerline Double Dead-End Straight Line Pole Construction — Top of Pole Only — 3-Wire Construction
DC 610.5	Typical Branch Fuse Construction for 1Ø/3Ø Break-Off Pole
DC 610.6	Typical Branch Fuse Construction for 1Ø/3Ø Break-Off Pole — Top of Pole Only
DC 612	Spring Washer Hardware Connection Details
DC 612	Spring Washer Hardware Connection Details
DC 615	Back Brace Installation Criteria
DC 615	Back Brace Installation Criteria
DC 620	Suggested Location of Ferroresonance Safety Instruction Signs
DC 620.1	Suggested Location of Ferroresonance Safety Instruction Signs
DC 630	H-Frame 3- and 4-Wire Construction (All Distribution Voltages)
DC 630.1	H-Frame, Single Circuit, Single-Arm, Suspension, 3-Wire, 20-foot (6" × 6") Timbers
DC 630.2	H-Frame, Single Circuit, Single-Arm, Suspension, 3-Wire, 16-foot (3-1/2" × 5-1/2") Timbers
DC 630.3	H-Frame, Single Circuit, Single-Arm, Suspension, 4-Wire, 20-foot (6" × 6") Timbers
DC 630.4	H-Frame, Single Circuit, Single-Arm, Suspension, 4-Wire, 16-foot (3-1/2" × 3-1/2") Timbers
DC 630.5	H-Frame, Single Circuit, Double-Arm, Suspension or Dead-End, 3-Wire, 20-foot (6" × 6") Timbers
DC 630.6	H-Frame, Single Circuit, Double-Arm, Suspension or Dead-End, 3-Wire, 16-foot (3-1/2" × 5-1/2") Timbers
DC 630.7	H-Frame, Single Circuit, Double-Arm, Suspension or Dead-End, 4-Wire, 20-foot (6" × 6") Timbers
DC 630.8	H-Frame, Single Circuit, Double-Arm, Suspension or Dead-End, 4-Wire, 16-foot (3-1/2" × 5-1/2") Timbers
DC 635	Smith Corner 3- and 4-Wire Construction, Composite and Wood 10' Crossarm (All Distribution Voltages)
DC 635.1	Wood Crossarm, Double Circuit, Post-Type Jumper Support Insulators, Smith Corner, 3-Wire
DC 635.2	Wood Crossarm, Double Circuit, Suspension Jumper Support Insulators, Smith Corner, 3-Wire
DC 635.3	Wood Crossarm, Double Circuit, Post-Type Jumper Support Insulators, Smith Corner, 4-Wire
DC 635.4	Wood Crossarm, Double Circuit, Suspension Jumper Support Insulators, Smith Corner, 4-Wire
DC 635.5	Composite Crossarm, Double Circuit, Post-Type Jumper Support Insulators, Hughes Corner, 3-Wire
DC 635.6	Composite Crossarm, Double Circuit, Suspension Jumper Support Insulators, Hughes Corner, 4-Wire
DC 635.7	Composite Crossarm, Double Circuit, Post Type Suspension Jumper Support Insulators, Hughes Corner, 3-Wire
DC 635.8	Composite Crossarm, Double Circuit, Suspension Jumper Support Insulators, Smith Corner, 4-Wire

STANDARD	TITLE
DC 640	Overhead Platform Rack Structures
DC 640.1	Overhead Platform Rack Structures (2-Pole and 3-Pole Design)
DC 640.2	Equipment Anchorage for Overhead Platform Racks

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

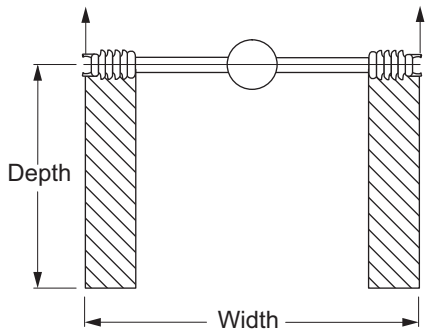


Figure DC 100–2.1

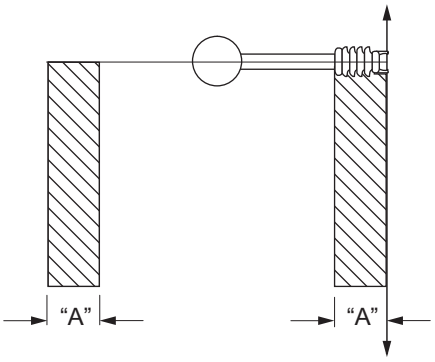


Figure DC 100–2.2

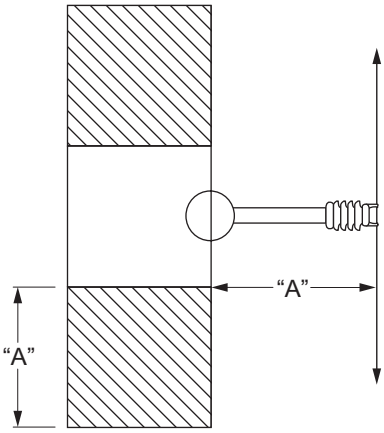


Figure DC 100–2.3

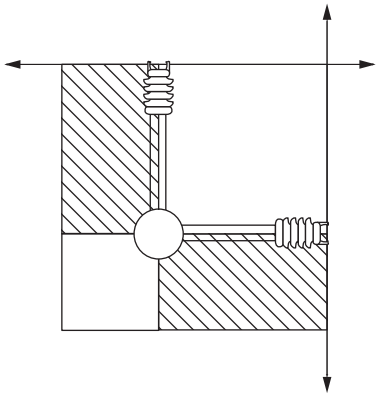


Figure DC 100–2.4

Climbing Space Working Space

Climbing Space for Armless Construction
(More Than 750 Volts)
G.O. 95, 54.11-F

750–46000 V	36" Square
46000–75000 V	48" Square
More than 75000 V	48" Square Plus 1/2" per kV in Excess of 46000 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

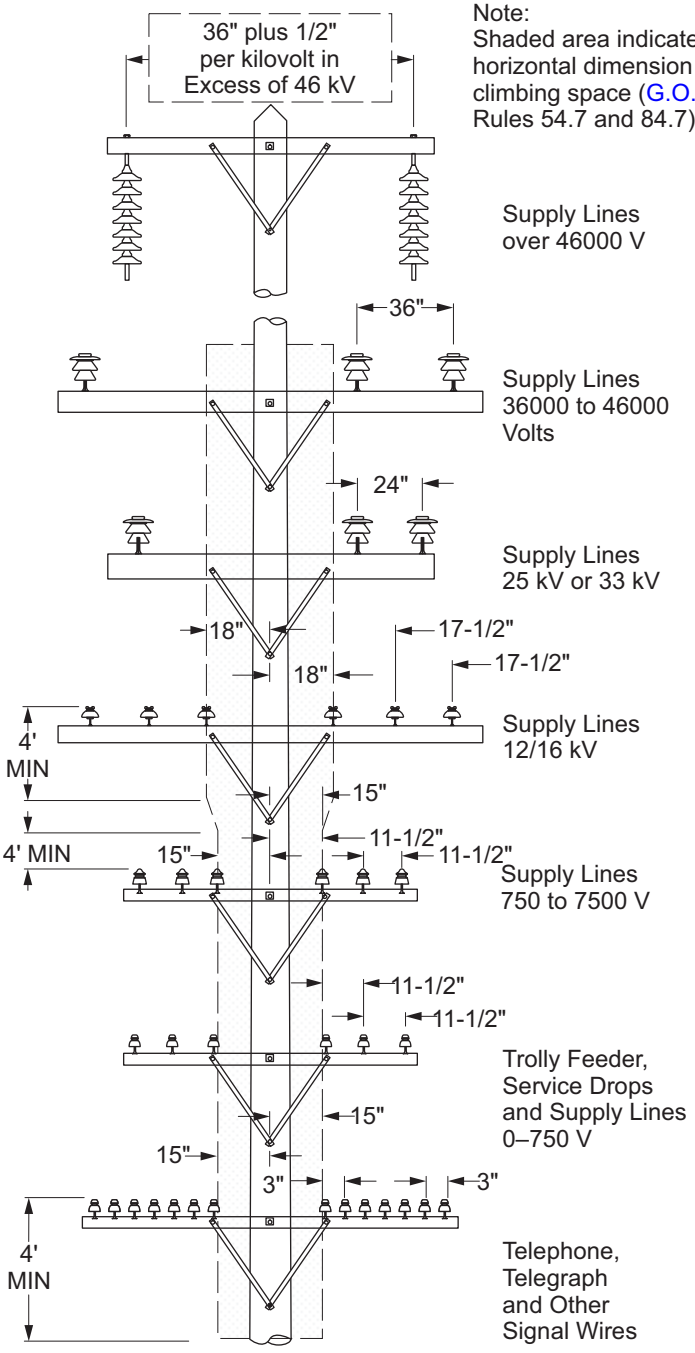
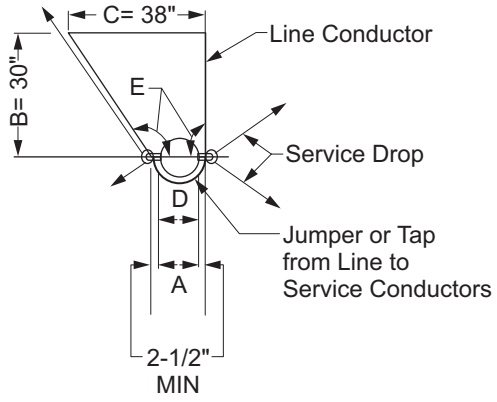


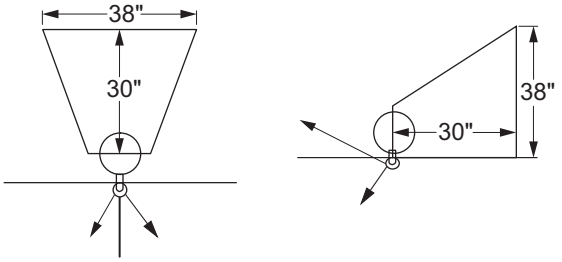
Figure DC 100–4: Secondary Line/Service Drop Configurations

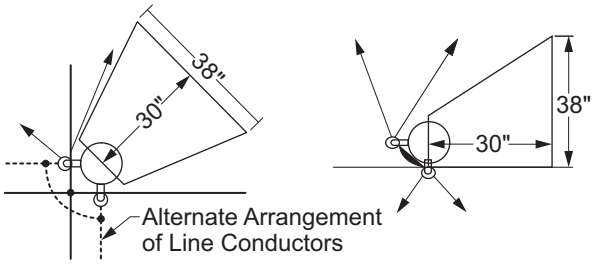
Climbing Space Low Voltage Racks
0–750 V
G.O. 95, Rule 54.9

Secondary Line
Service Drop

A = D + 5" = D + 2 × 2-1/2"
B = 38" MIN
C = 38" MIN
D = Pole DIA
E = Not Less than 90°



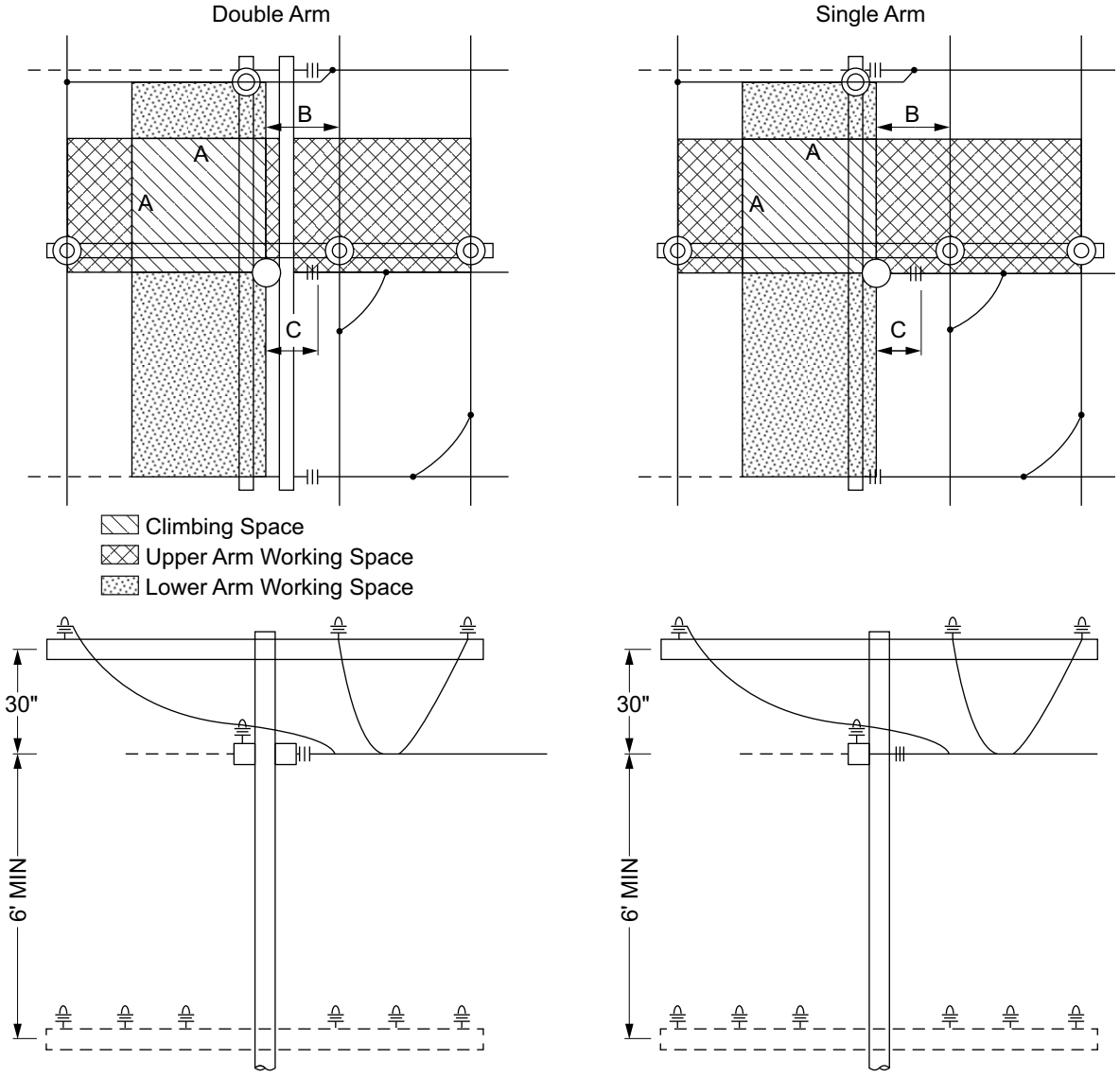




DC 110 Climbing/Working Space 3-Wire Corner

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):

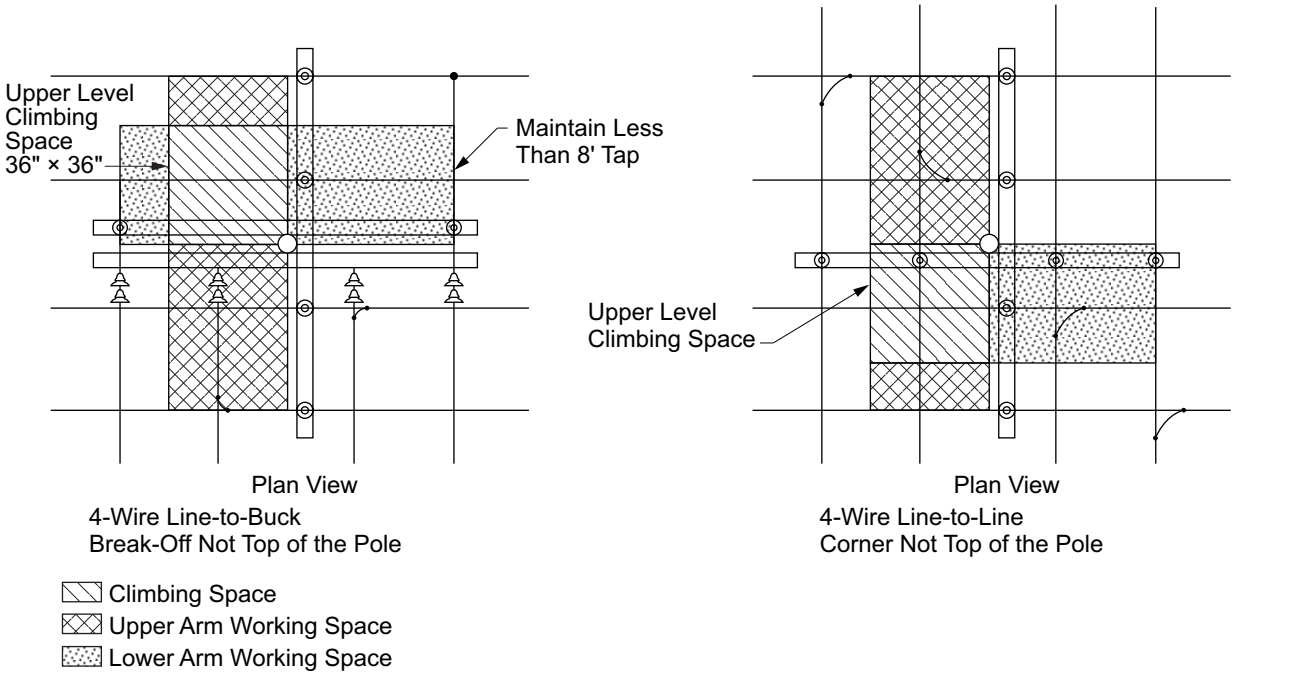
1. A single-phase tap may be pulled in as shown by dotted lines.
2. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.

This page intentionally left blank.

DC 120 Climbing/Working Space 4-Wire Corner

Scope DC 120.1 Climbing/Working Space 4-Wire Corner

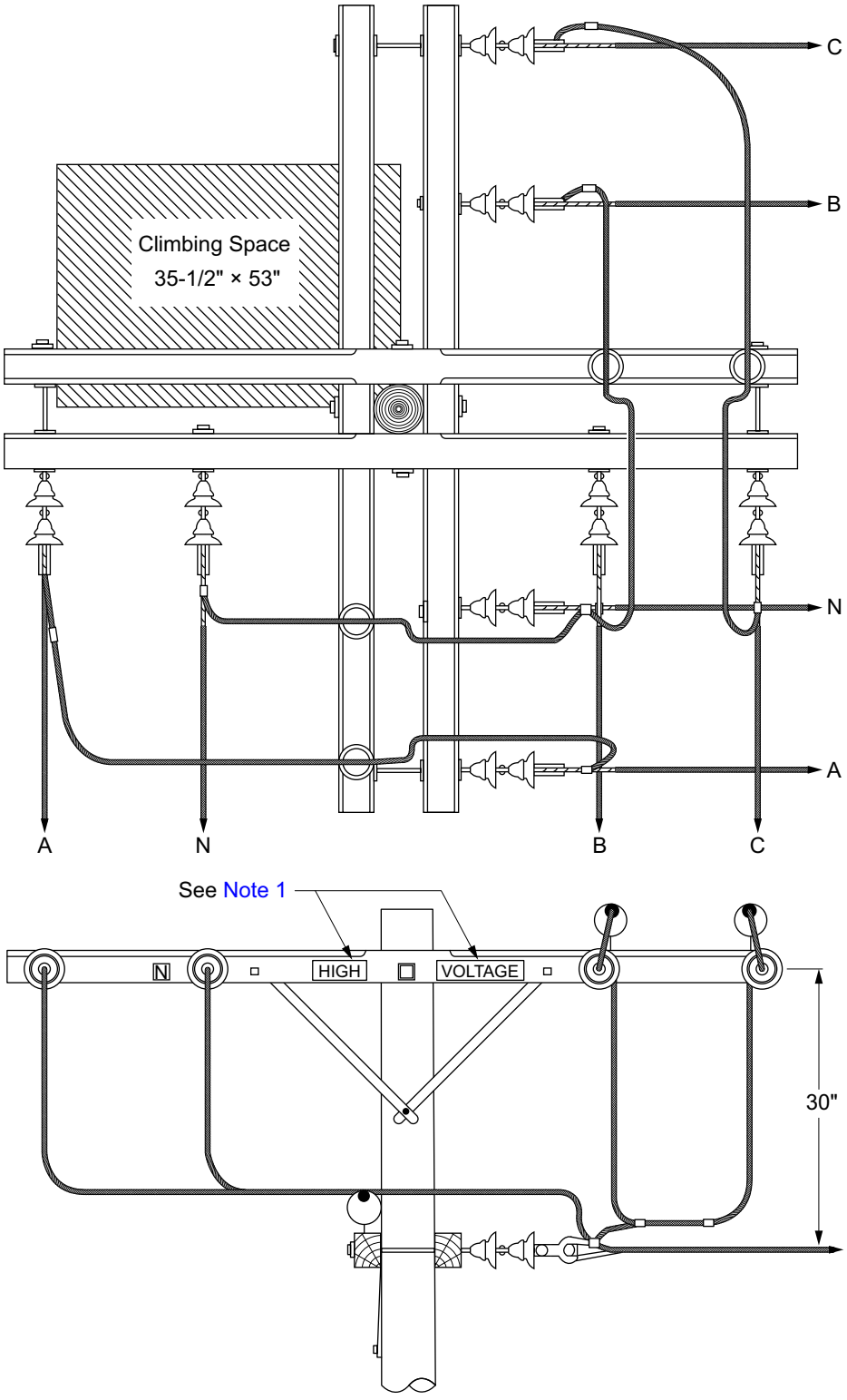
Figure DC 120–1: Climbing/Working Space 4-Wire Corner



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):

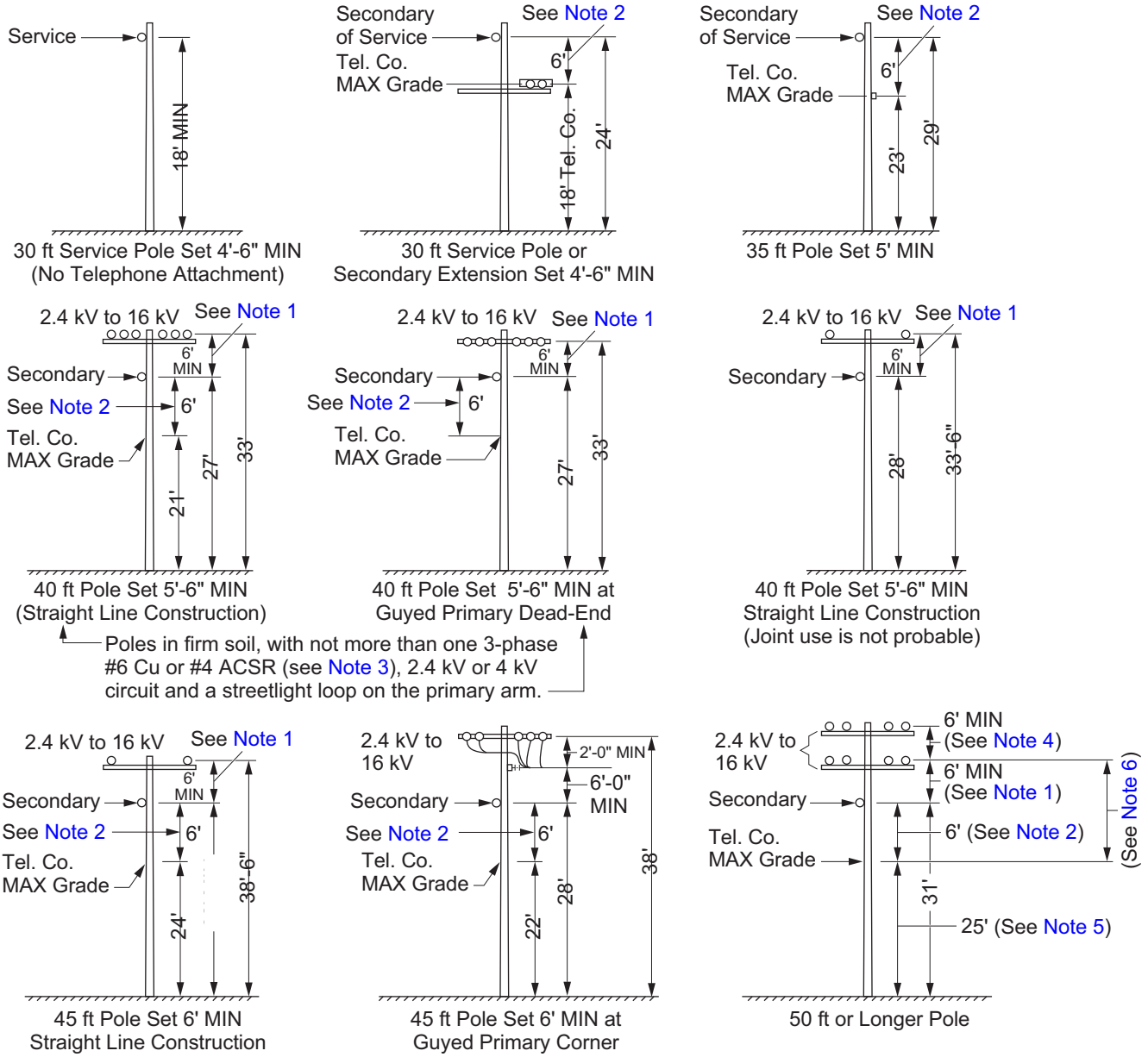
1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.

This page intentionally left blank.

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 CO Section 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

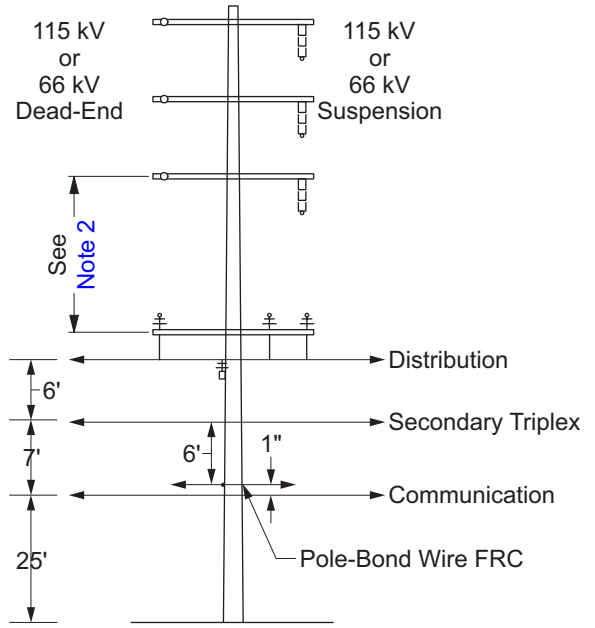


Figure 1

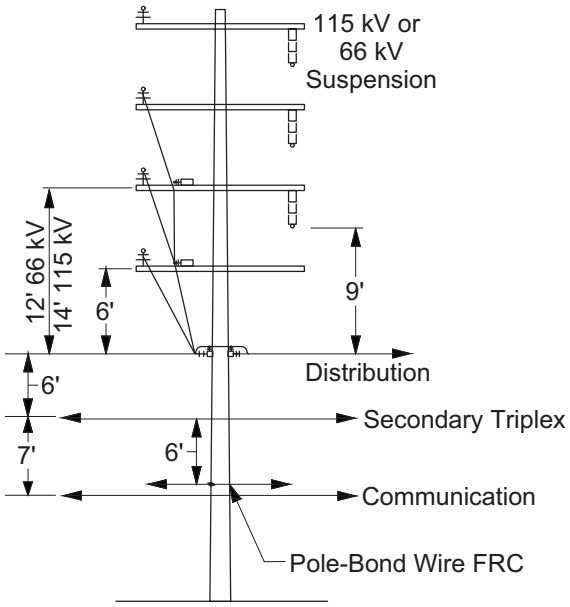


Figure 2

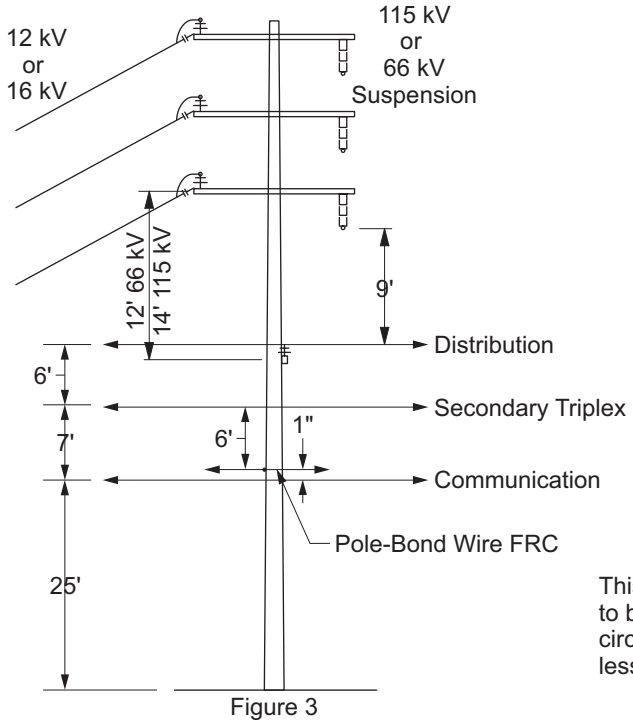


Figure 3

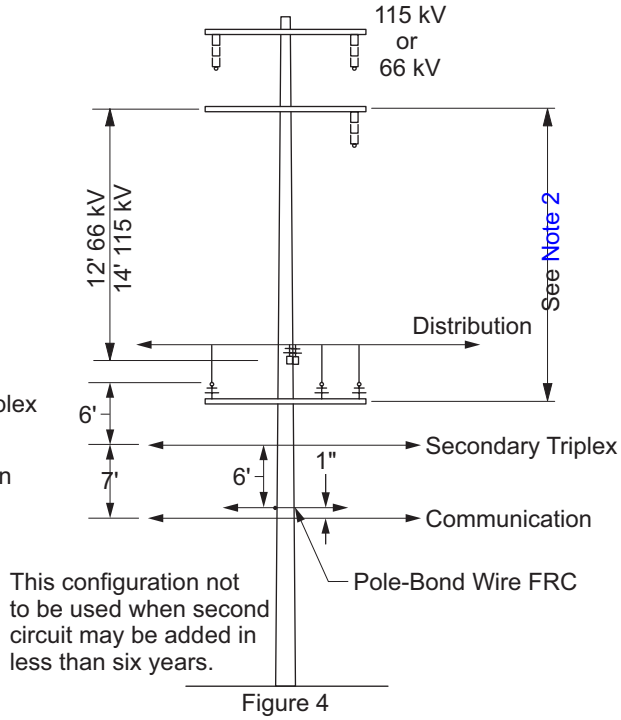


Figure 4

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

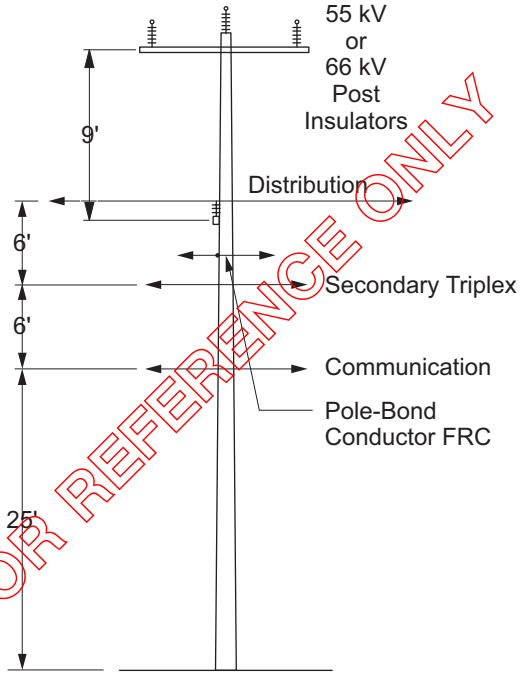


Figure 1

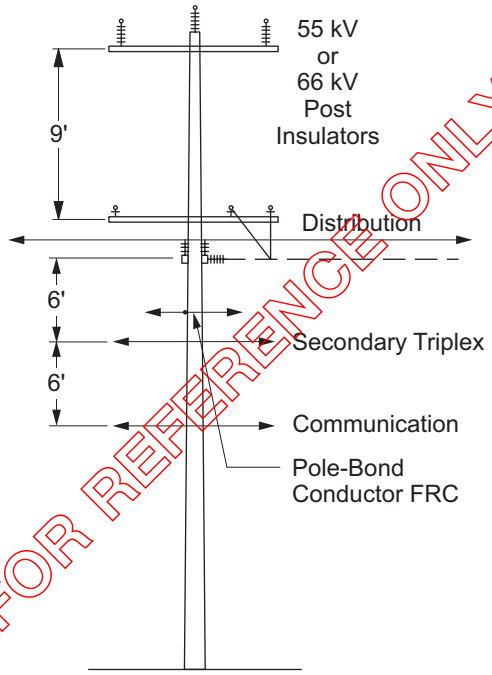


Figure 2

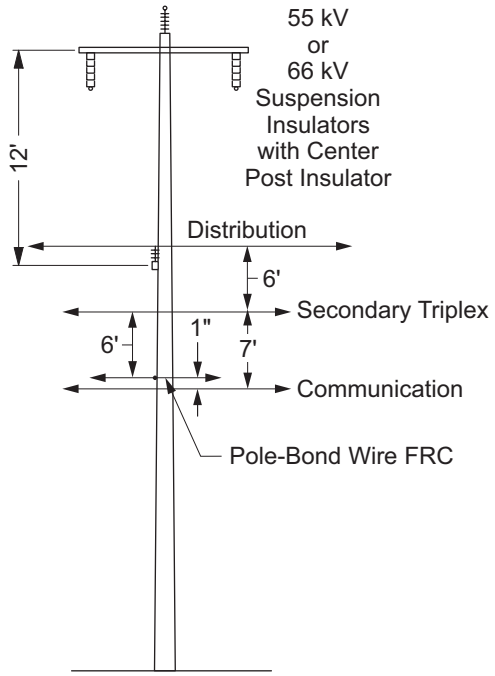


Figure 3

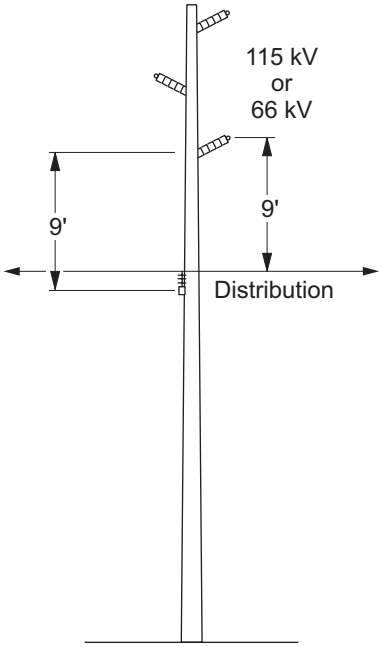


Figure 4

FOR REFERENCE ONLY
FOR REFERENCE ONLY

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

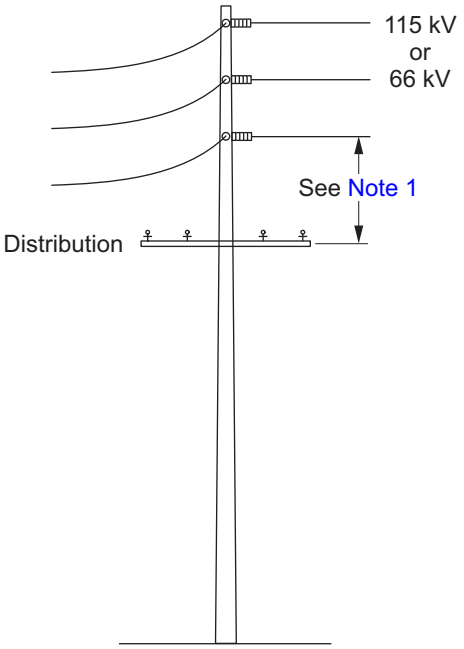


Figure 1

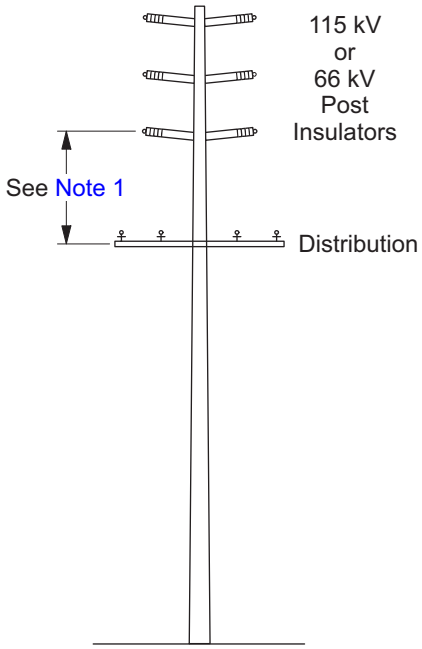


Figure 2

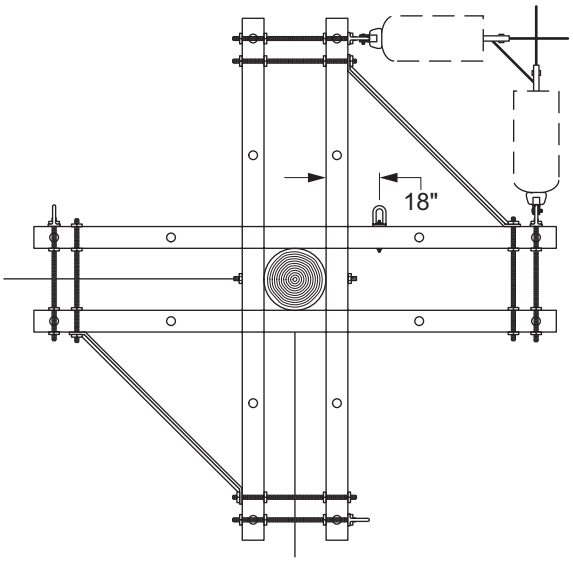


Figure 3

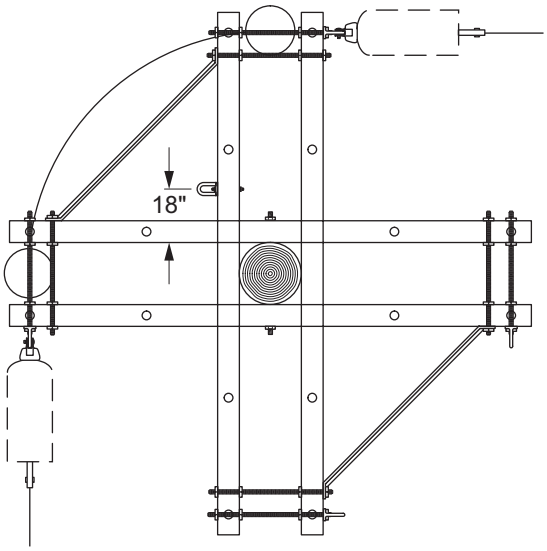


Figure 4

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	

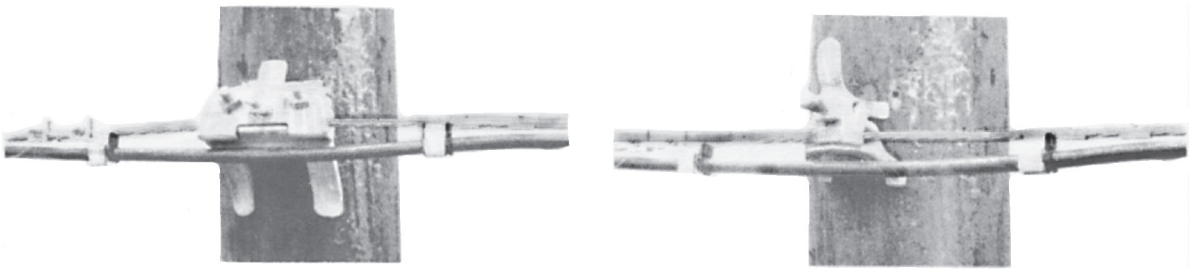
Note(s):

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.

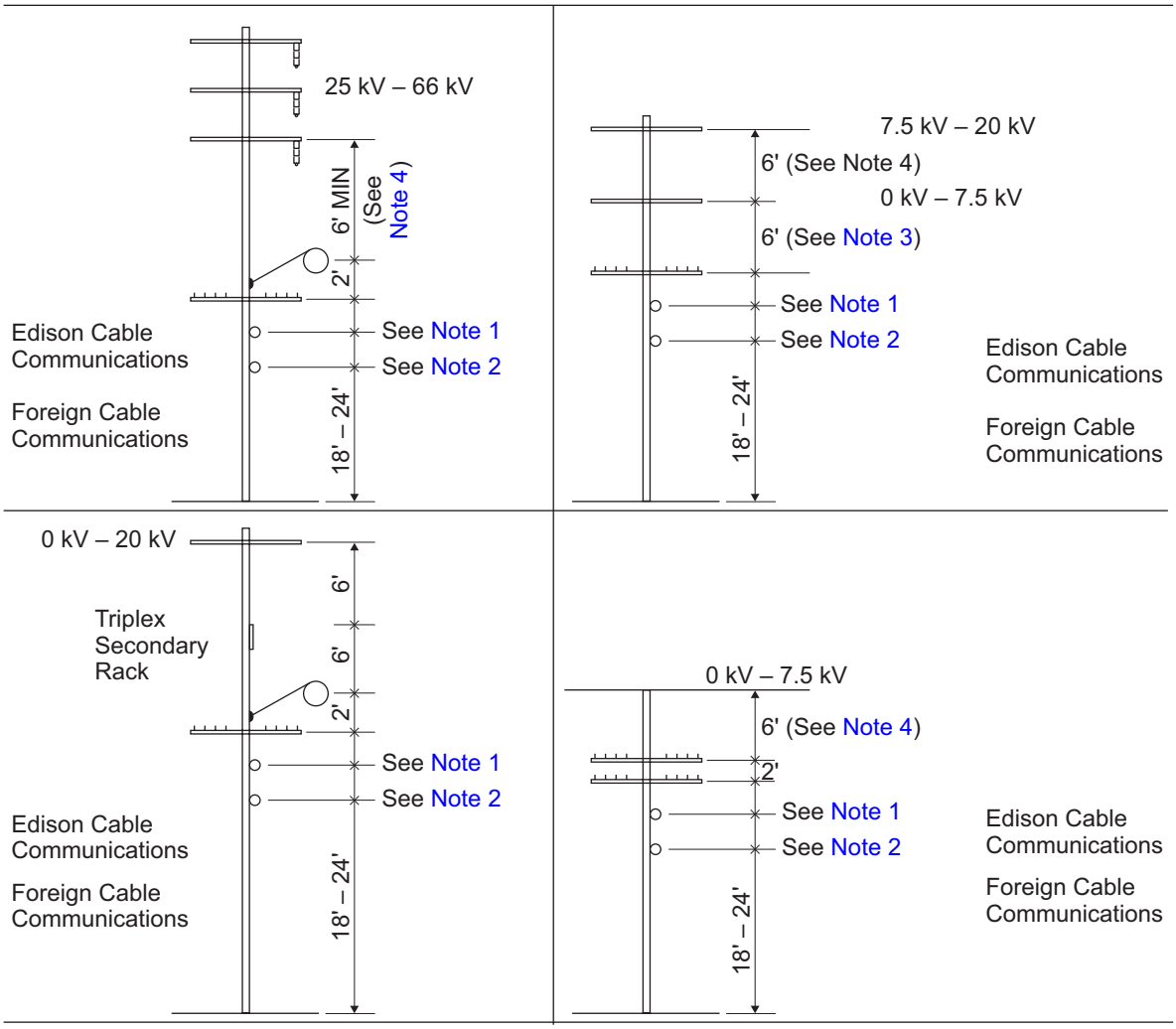
DC 220 Typical Poleheads/Clearances — Wire Line Communication

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 95 (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.

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), DDS-10, Section 5.7 H.

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 Subsection 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

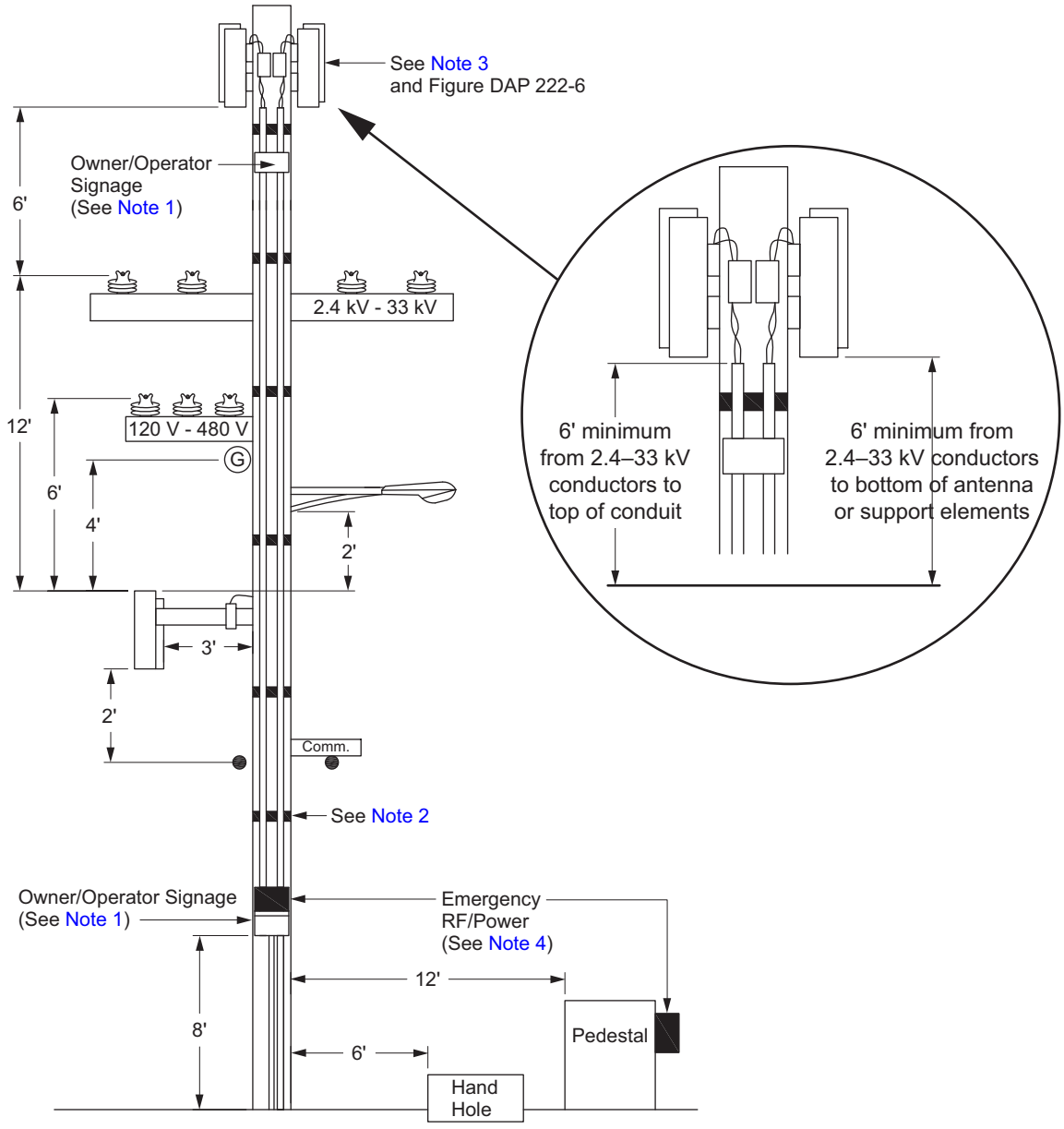
9.1 Antennas affixed to poles supporting lines, and/or guys, shall be installed with a device that disconnects all RF energy.

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.

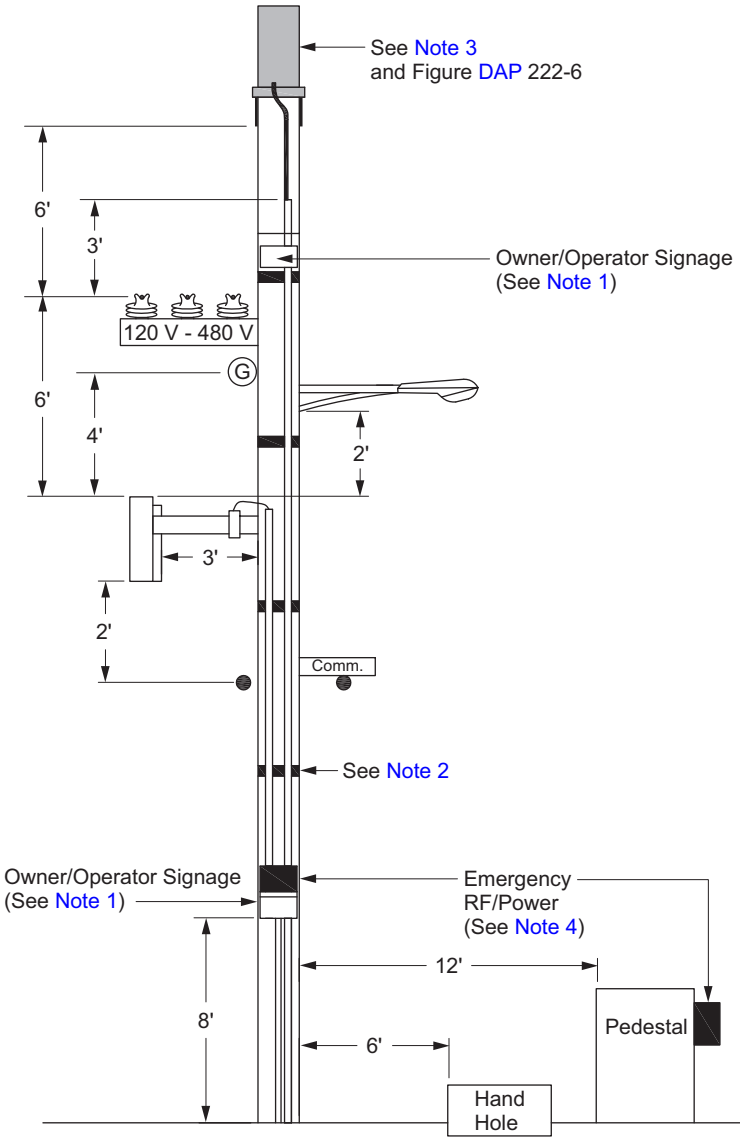
Figure DC 222–1: Typical High Voltage Distribution Pole Non-SCE Antennas



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.

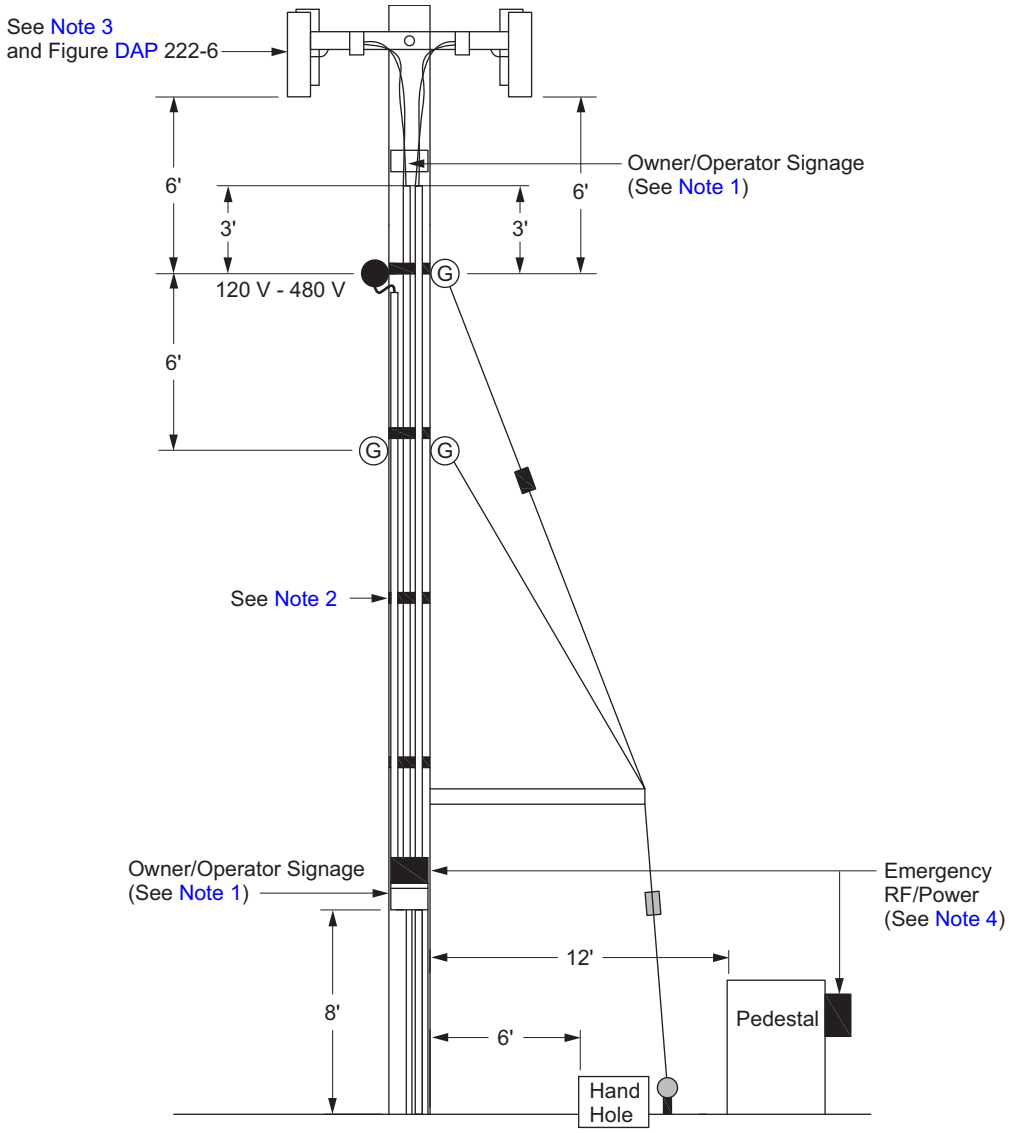
Figure DC 222–2: Typical Low Voltage Distribution Pole with Non-SCE Antenna



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.

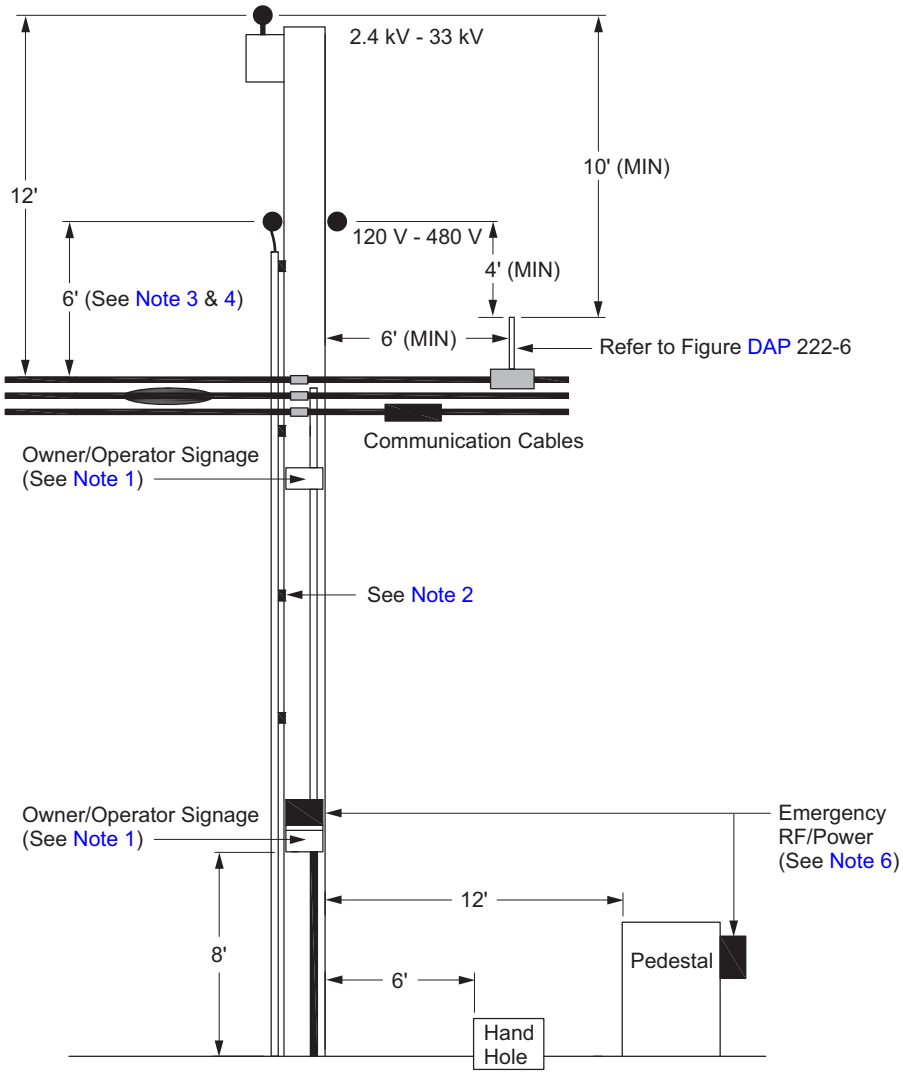
Figure DC 222–3: Typical Guy Pole Non-SCE Antennas



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



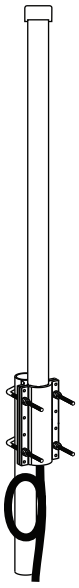
Note(s):

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.

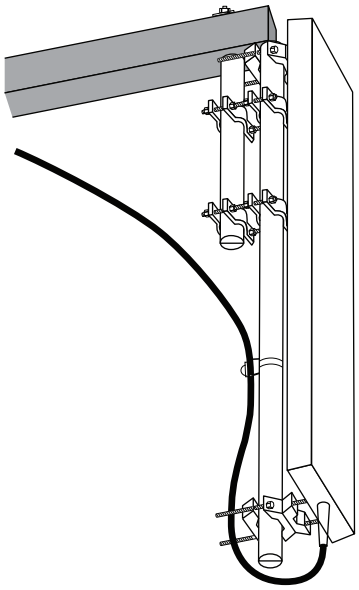
Figure DC 222–5: Emergency RF/Power Shut-Off Switch



Figure DC 222–6: Omni-Directional Antenna and Directional Antenna



Omni-Directional Antenna

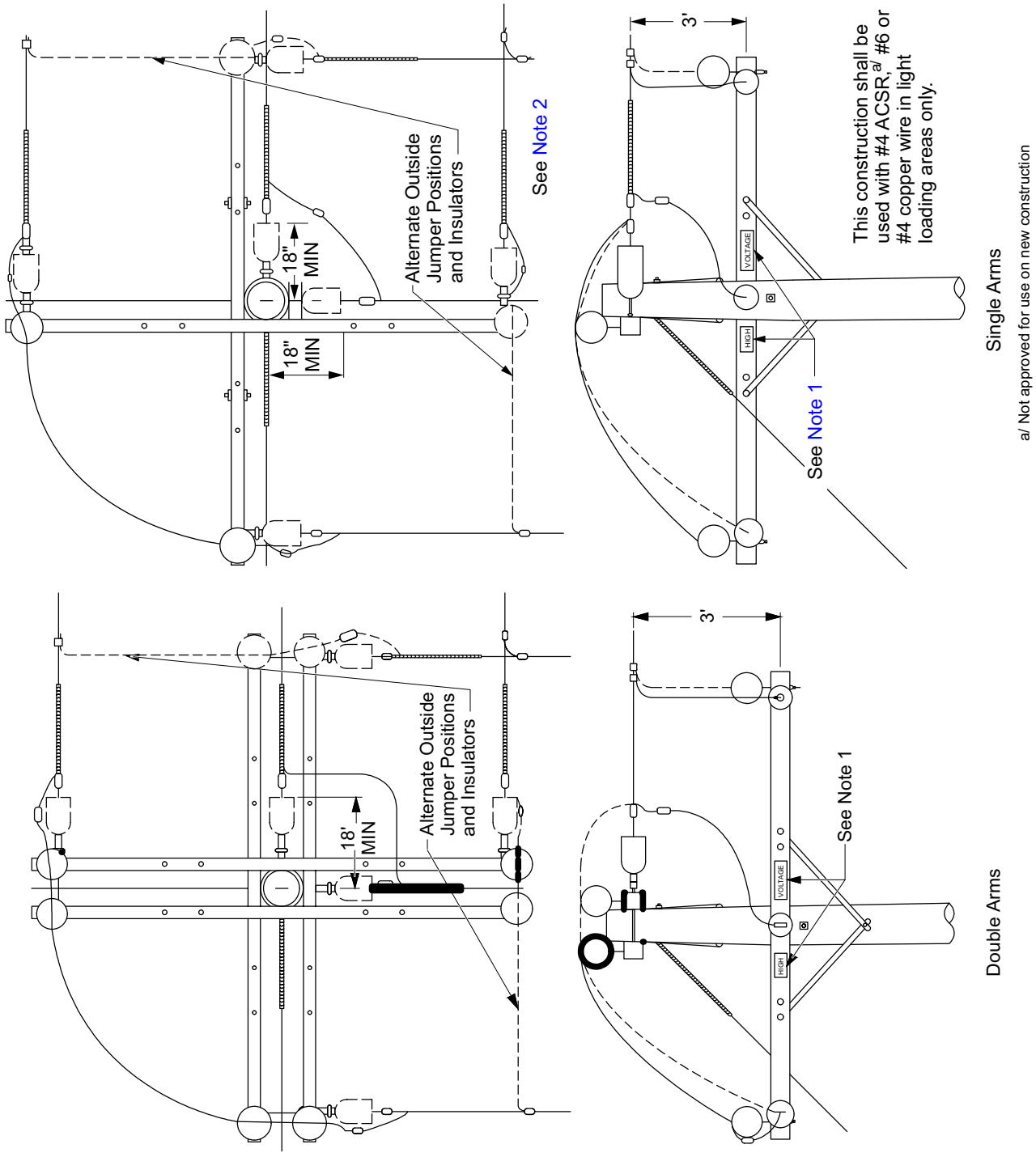


Directional Antenna

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



a/ Not approved for use on new construction

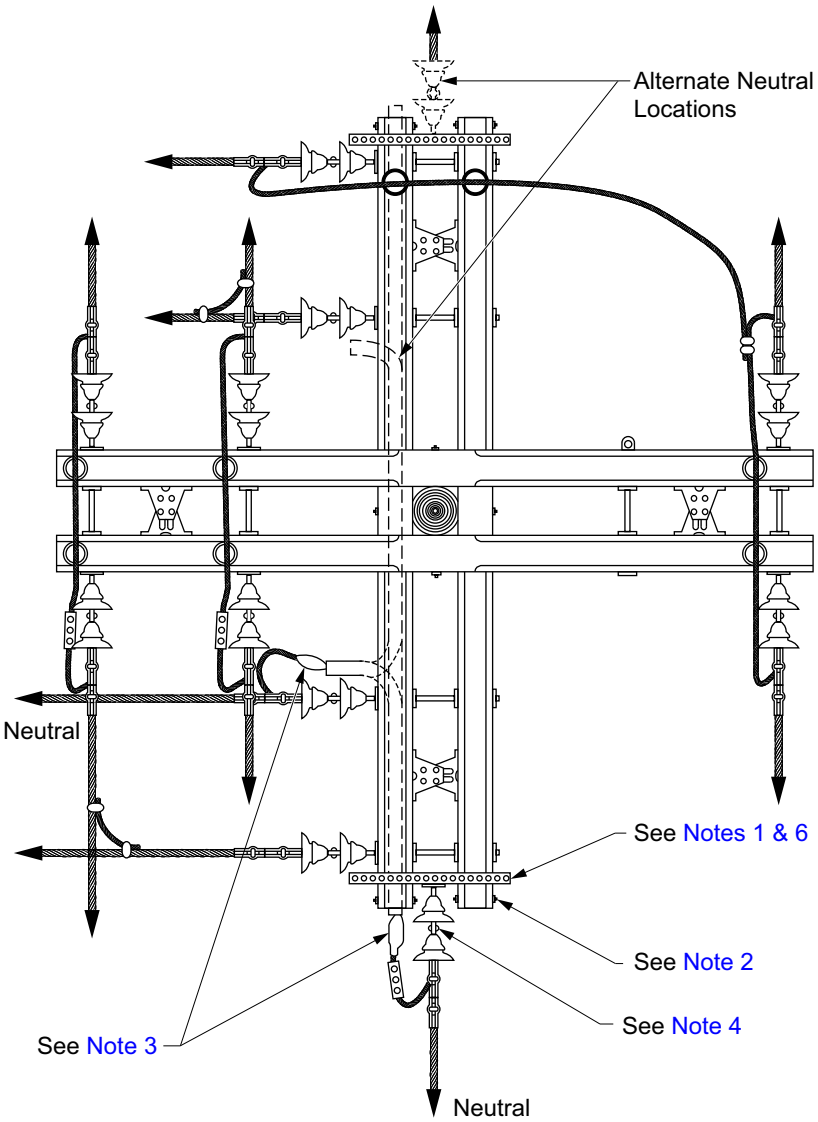
Note(s):

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. Angle Iron Support 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).

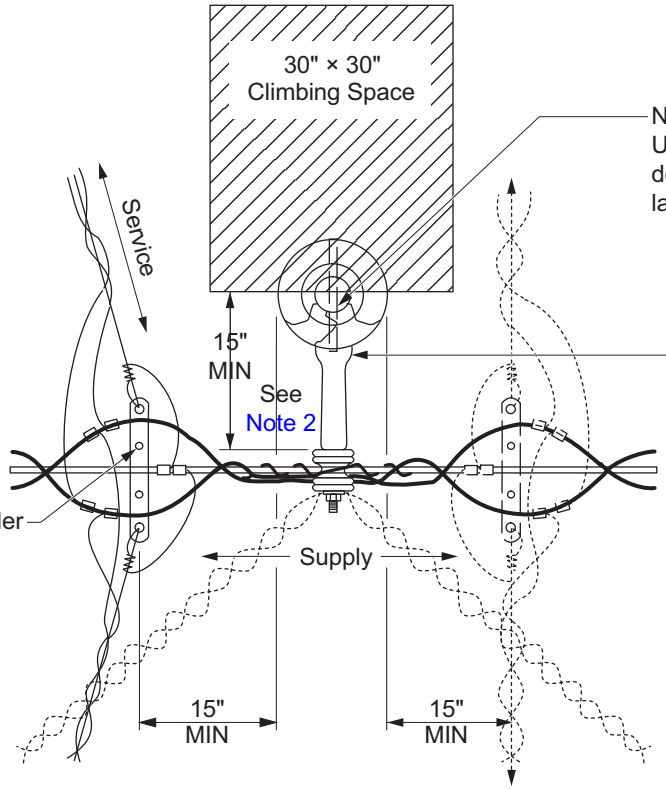
5. Per DC 535, Wildlife Protection shall be constructed and installed as applicable for insulators, taps, leads, arresters, cable terminations, and equipment bushings.
6. Sandwich reinforcing plate SAP 1021341 between Angle Iron Support and crossarms.

DC 320 Triplex/Straight Line Construction

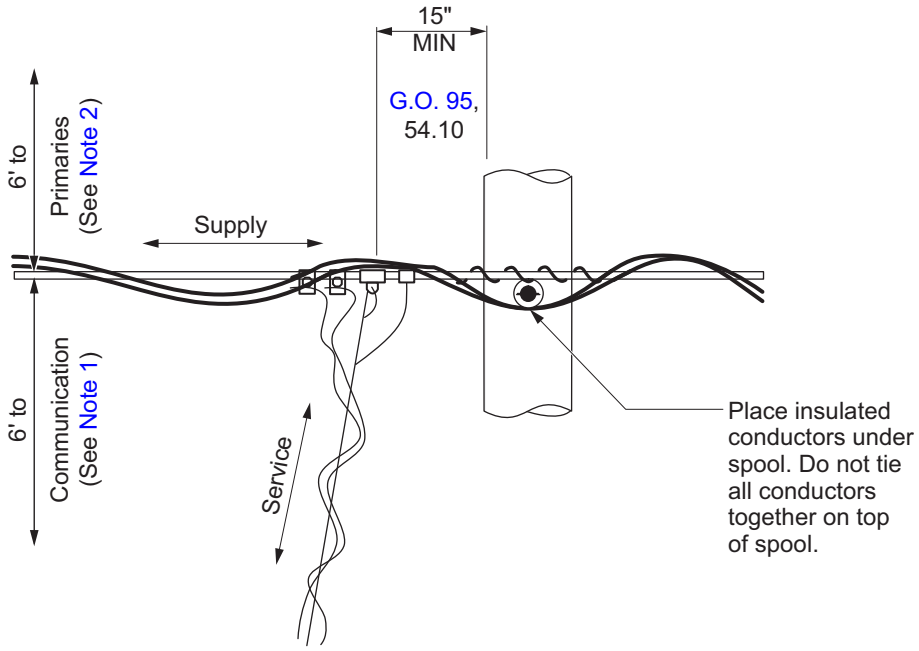
Scope DC 320.1 Typical Straight Line Construction for Triplex Conductors

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.



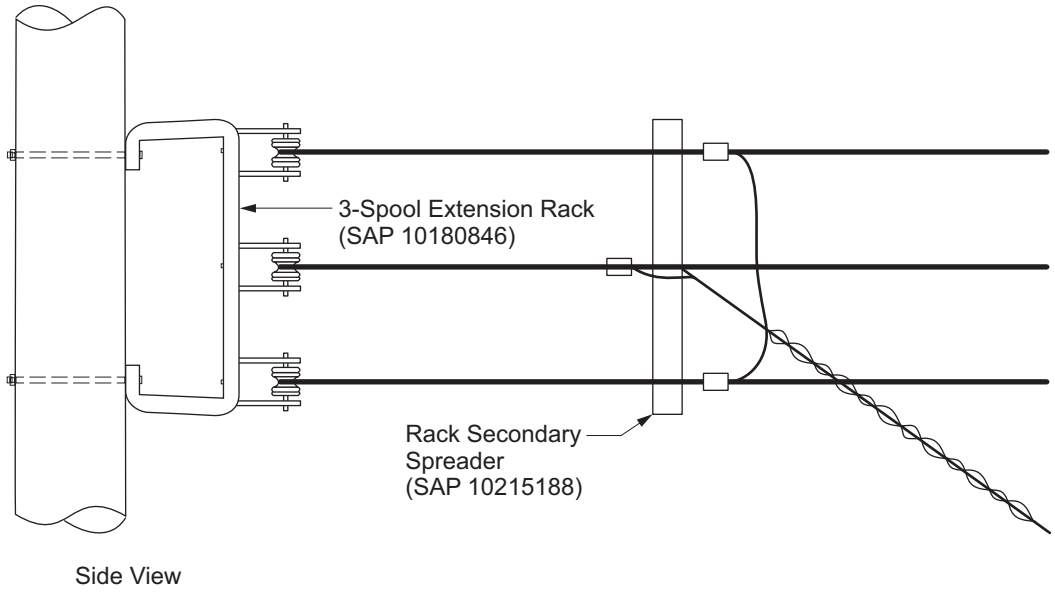
See G.O. 95, 54.10 for complete vertical clearance requirements.



Note(s):

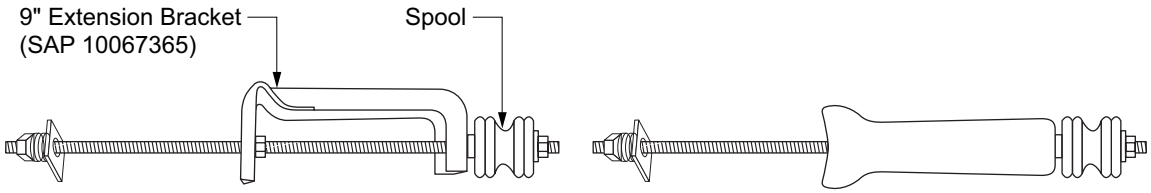
1. May be reduced to 4 feet with installation of guard arm above communication cables attached to surface of the pole.
2. May be reduced to 4 feet with installation of a guard arm, or covered with suitable protection, or installed 15 inches or more from center of pole.

Figure DC 320–2: Rack Secondary Spreader for Mid-span Service



Side View

Figure DC 320–3: 9-inch Extension Bracket



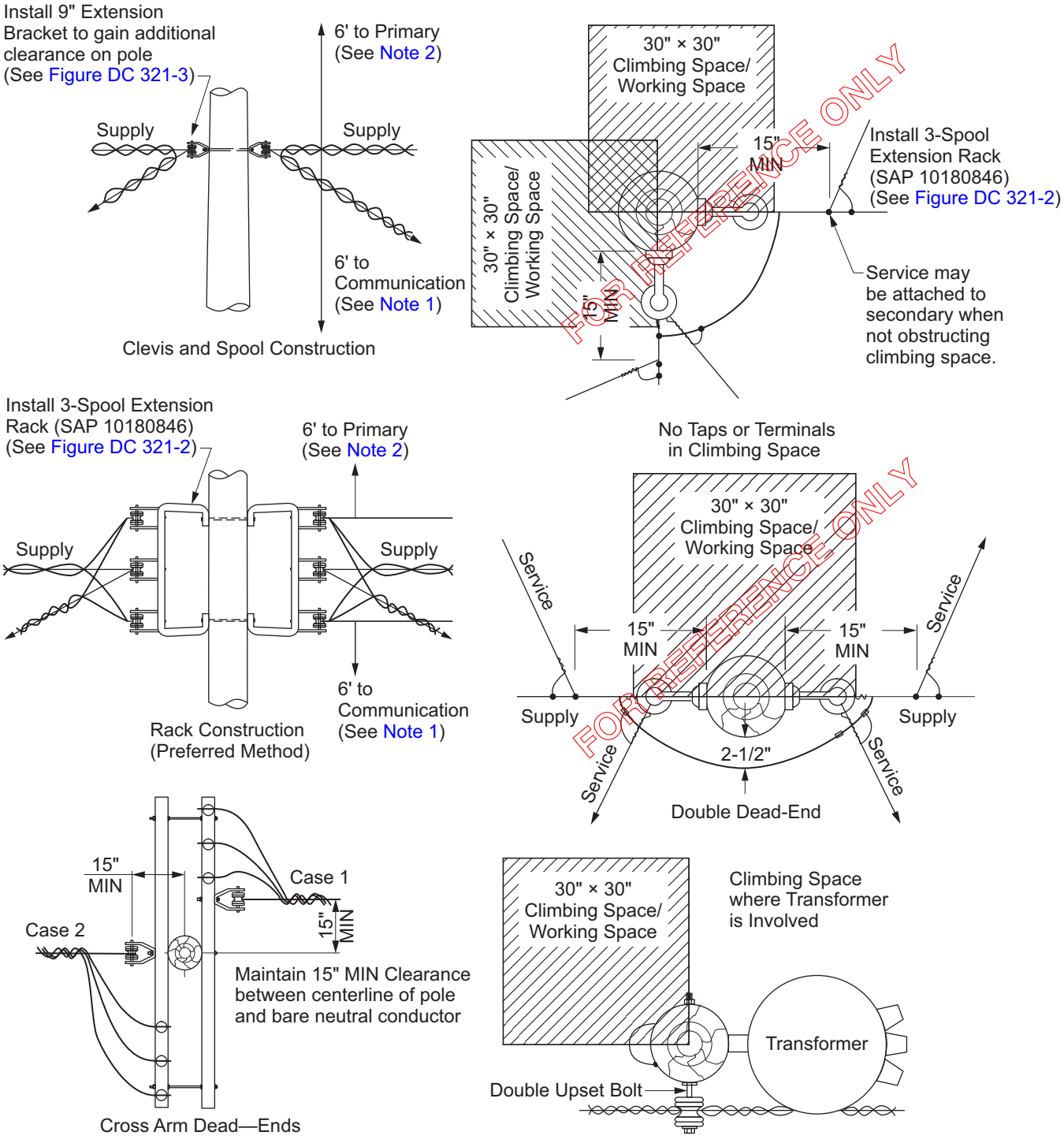
Side View

Top View

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

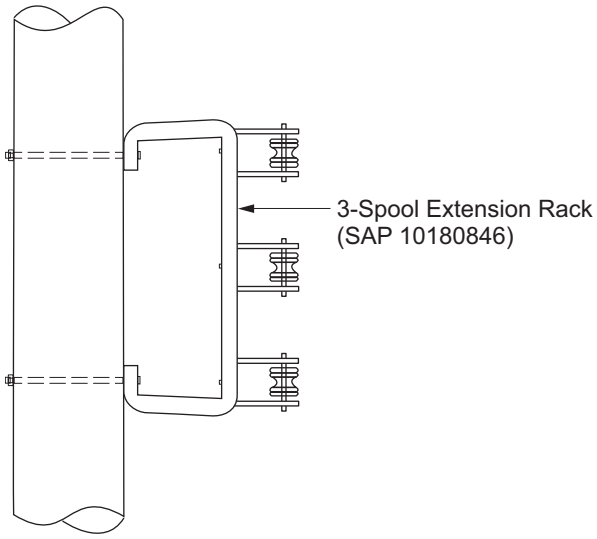


Figure DC 321–2.1: 3-Spool Extension Rack

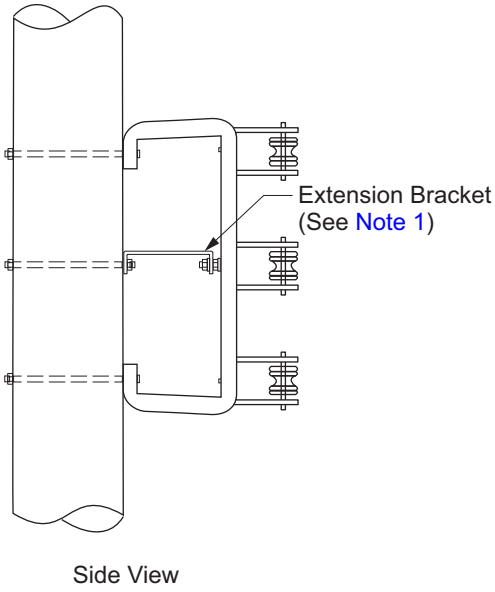


Figure DC 321–2.2: 3-Spool Extension Rack with Extension Bracket

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

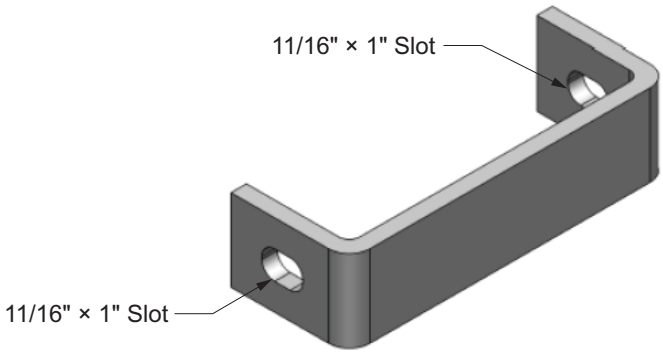
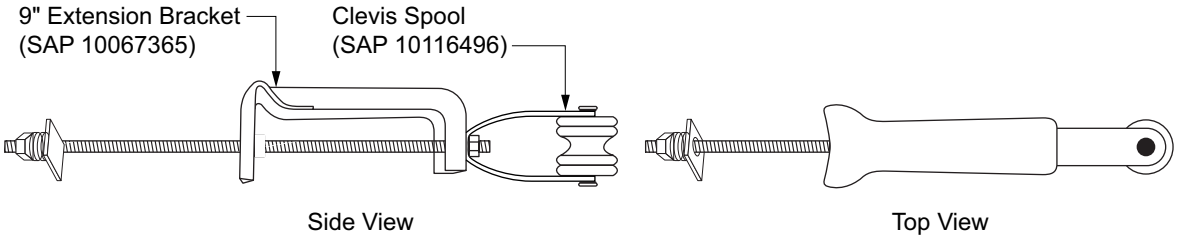


Figure DC 321–4: 9-Inch Angle Extension Bracket with Clevis Spool

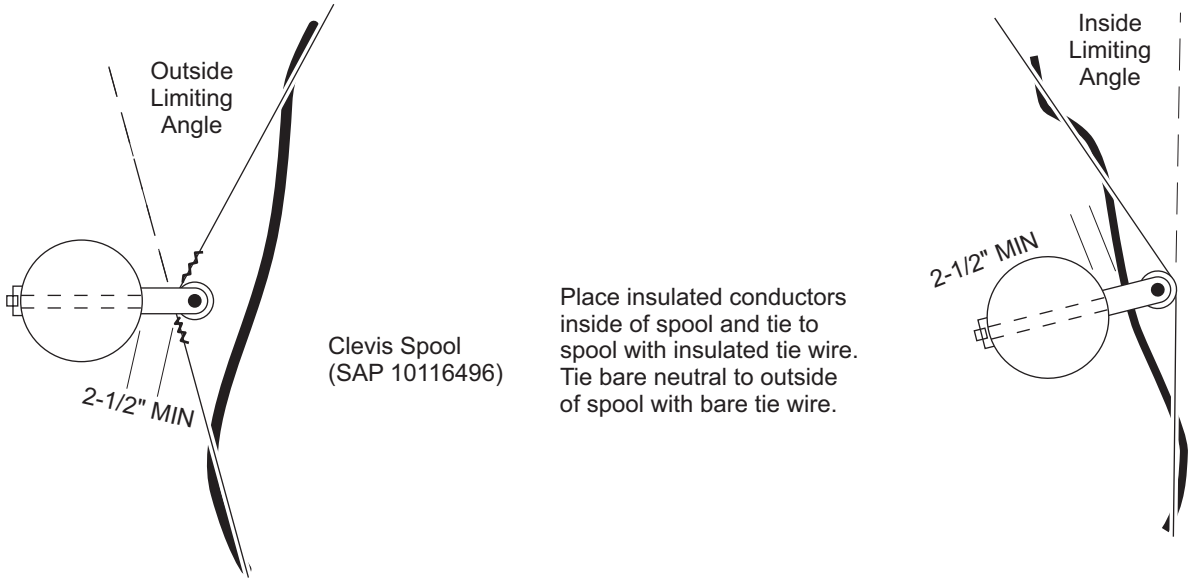


This page intentionally left blank.

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



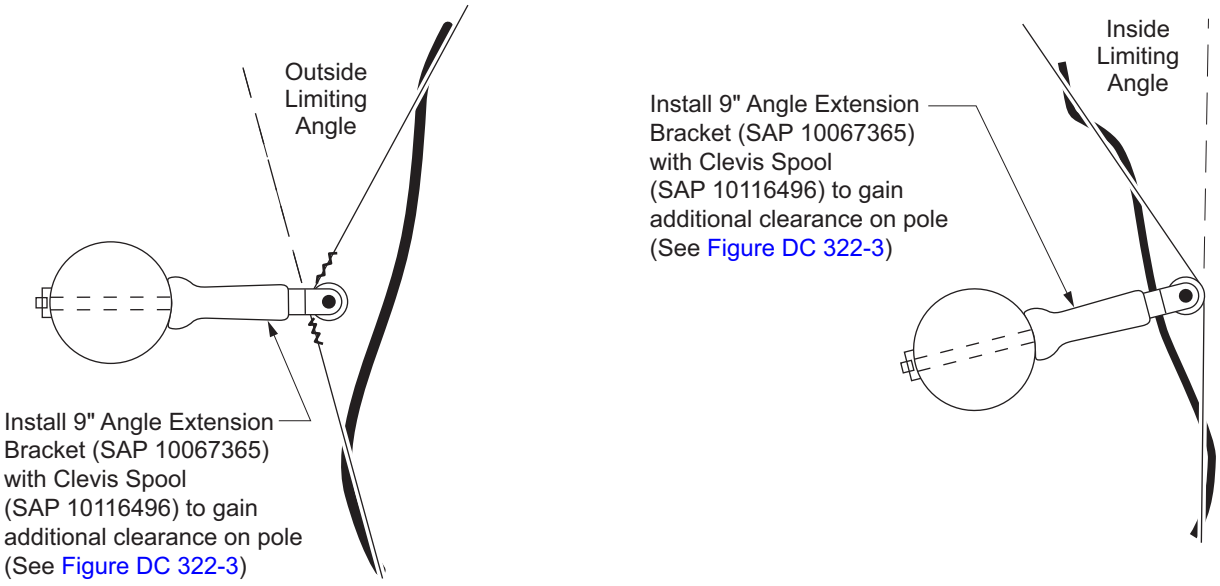


Table DC 322–1: Limiting Angle on Spool

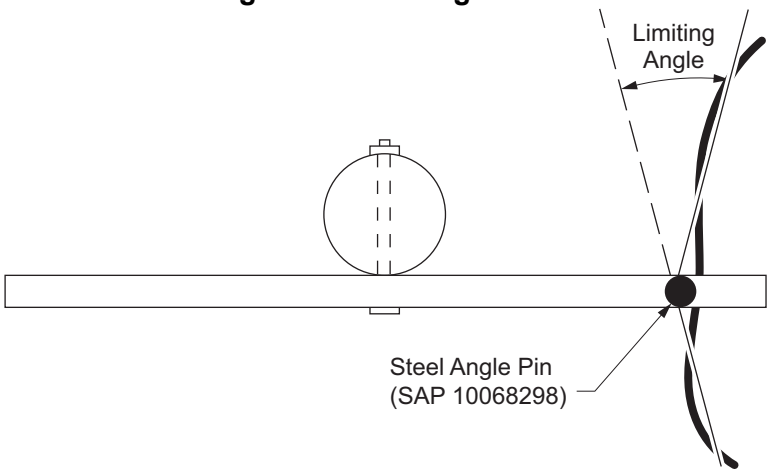
Conductor Size		Limiting Angle	
Al	Cu	Outside Degree	Inside Degree
1/0	—	40	30
4/0	—	20	20

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

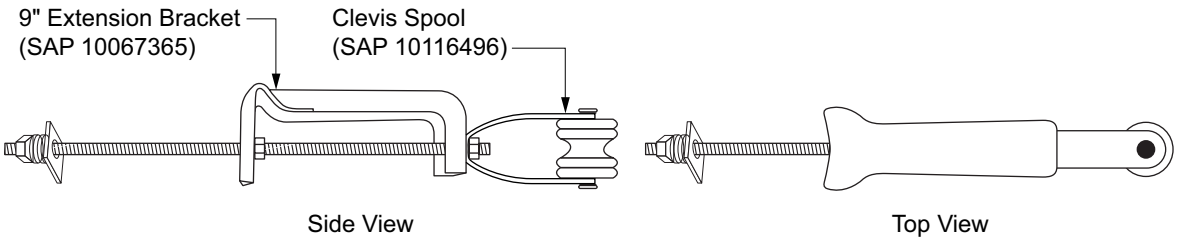
On double arms, use double pins. Where the limiting angle is exceeded, use double dead-end construction.



Note(s):

1. For guying line angles, see PO Section.

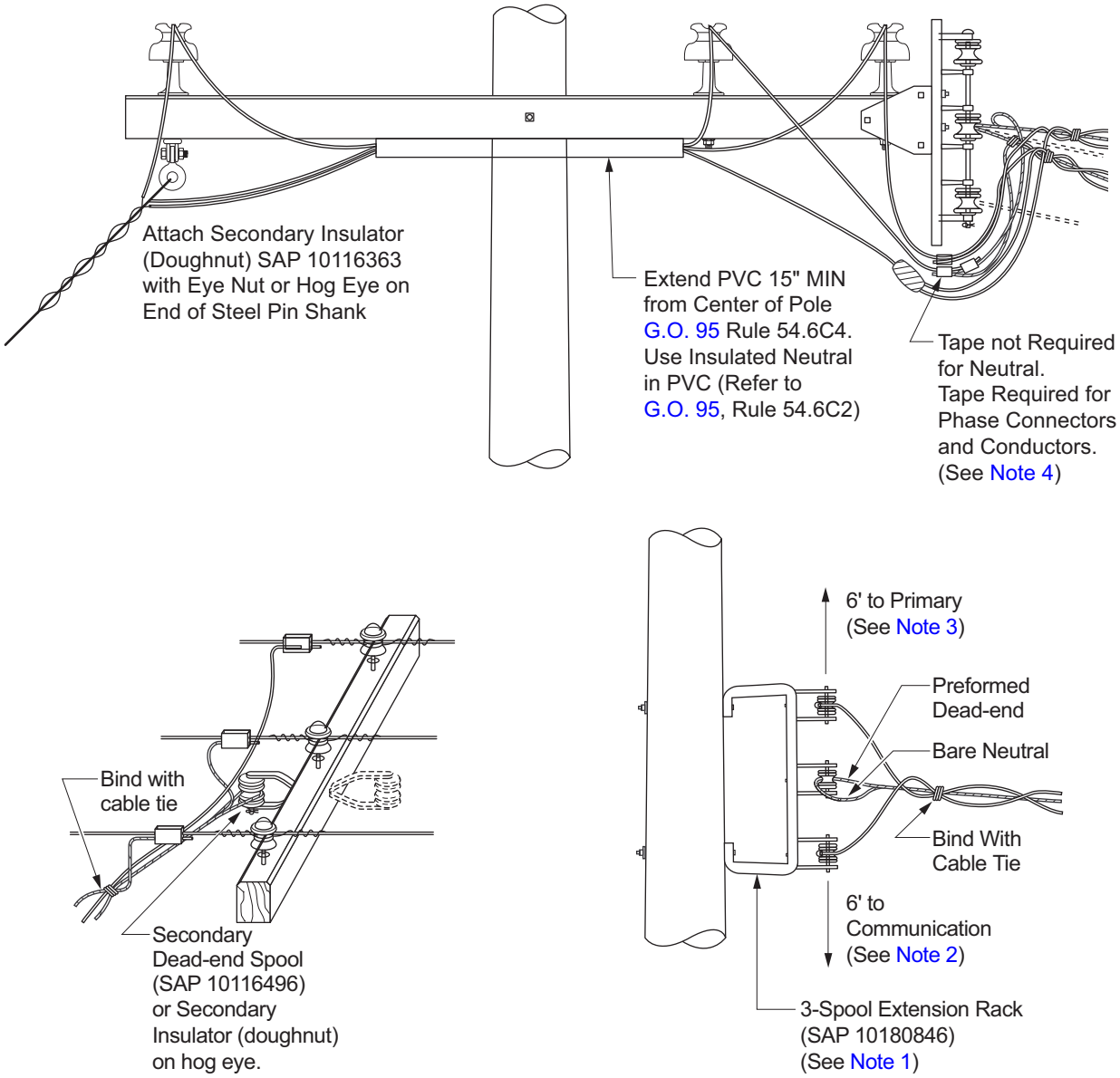
Figure DC 322–3: 9-Inch Angle Extension Bracket with Clevis Spool



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 6.0 for more details.

This page intentionally left blank.

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:

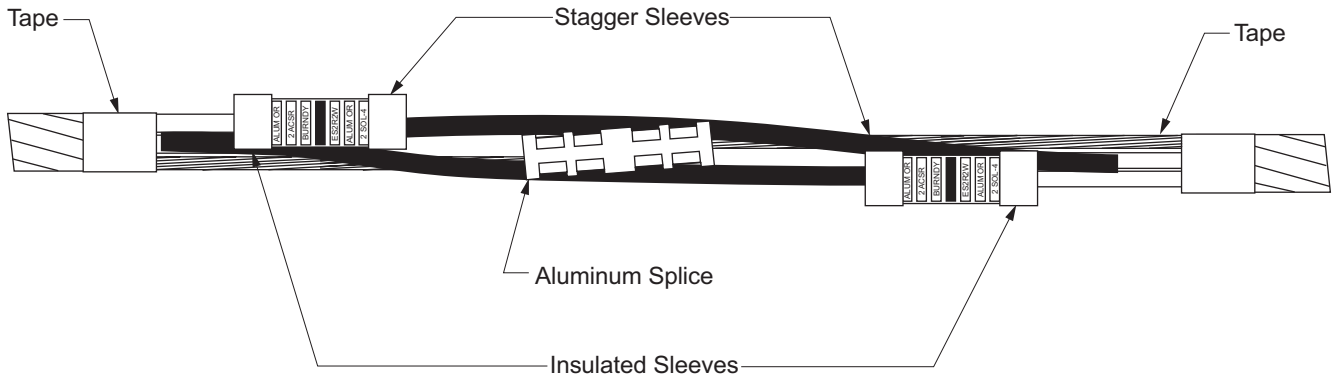
A. Triplex may be spliced when an existing service is relocated.

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.

This page intentionally left blank.

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.**

This page intentionally left blank.

DC 330 Service Breakaway System

Scope DC 330.1 General Information

The service breakaway system is designed to breakaway (or disconnect) the source transformer (or service pole) from the secondary system due to falling vegetation or severe wind events during extreme weather. The primary use case for implementing the service breakaway system is to support the HFRA Wildfire Mitigation Plan (WMP), specifically the Targeted Undergrounding (TUG) Initiative. Use of the breakaway system is currently only allowed for TUG scope.

The breakaway system can be considered as an alternative to undergrounding of services or multiple service poles. Refer to TUG guidelines for application.

The following guidelines shall be followed when using the service breakaway system.

- Triplex neutral shall be 6-12” longer than the phase conductors in order to have the neutral/ground as the last disconnect point.
- Connectors shall be oriented horizontally rather than vertically to prevent water from dripping down towards the connector/cover.
- Breakaway connectors and matieral shall be installed on the “load” side of service poles in order to create a de-energized wire down in the event of an operation.

Note(s): Condition of breakaway connectors shall always be visually inspected and cleaned after a disconnect event. If connectors are free of damage (for example, bending, dents, deep scratches/abrasions, melting/charring, etc.) , they may be re-used. If there are any signs of damage, connectors shall be replaced.

Figure DC 330–1: Example of Service Breakaway System (Exposed Connectors)



Figure DC 330–2: Example of Service Breakaway System (Covered Connectors)



Table DC 330–1: List of Materials

Item[a/]	SAP Code
1/0 ACSR Kit[b/]	10220628
#2 ACSR Kit [b/]	10220627
#4 ACSR Kit [b/]	10220626
750lb Rated Breakaway Link	10220625
500lb Rated Breakaway Link	10220624

a/ All kits come with 3 sets of receiver/input connectors, two sets of seals/covers with an additional cover for the source neutral, one (1) breakaway link, and one bail.

b/ 1/0 and #2 kits will come with 750lb breakaway links. #4 kits will come with a 500lb breakaway link. Replacement links shall be used based on kit combinations.

Figure DC 330–3: Input Connector (Install on Load Side of Triplex)



Figure DC 330–4: Receiving Connector (Installed on Line/Source Side of Triplex)



Figure DC 330–5: Example of Connection (without Seal Covers)

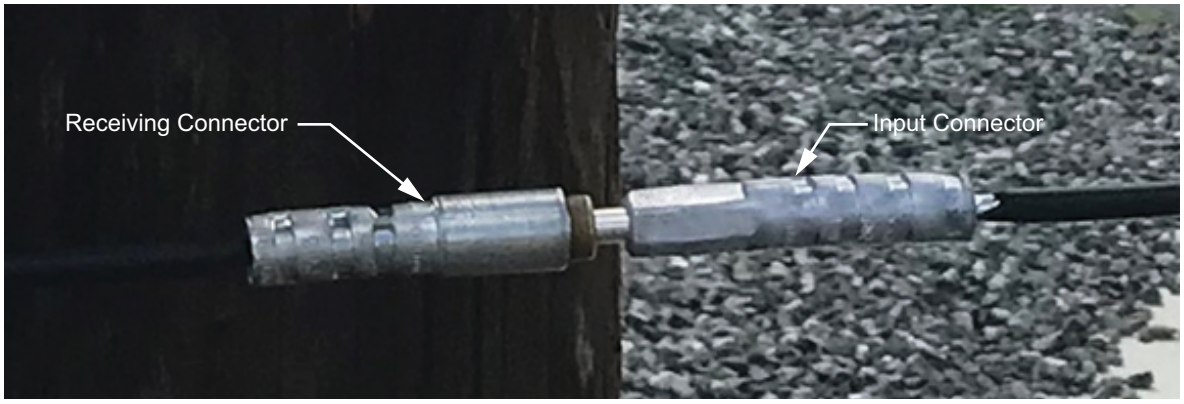


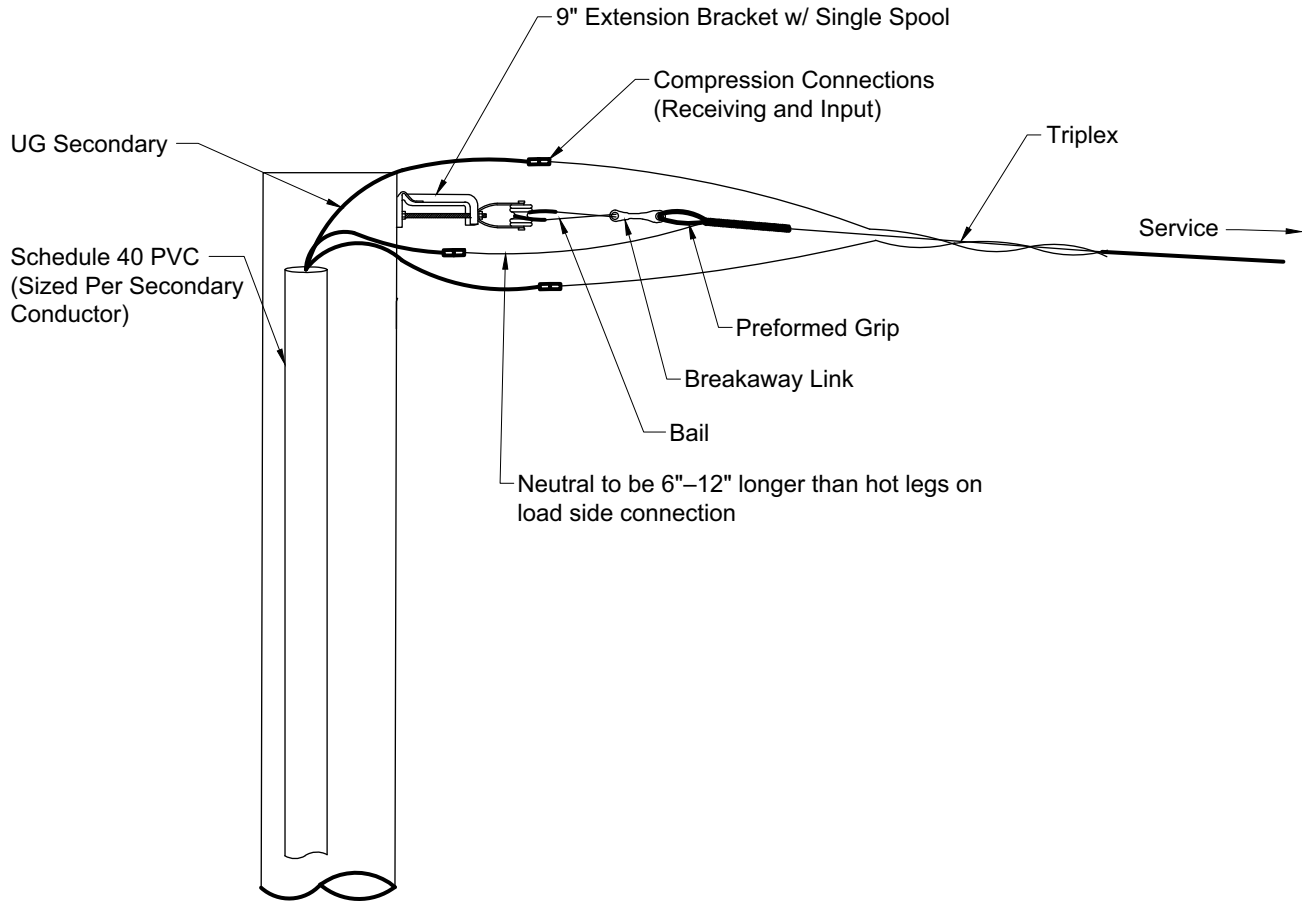
Figure DC 330–6: 750 lb Rated Breakaway Link



Figure DC 330–7: Breakaway Link Bail



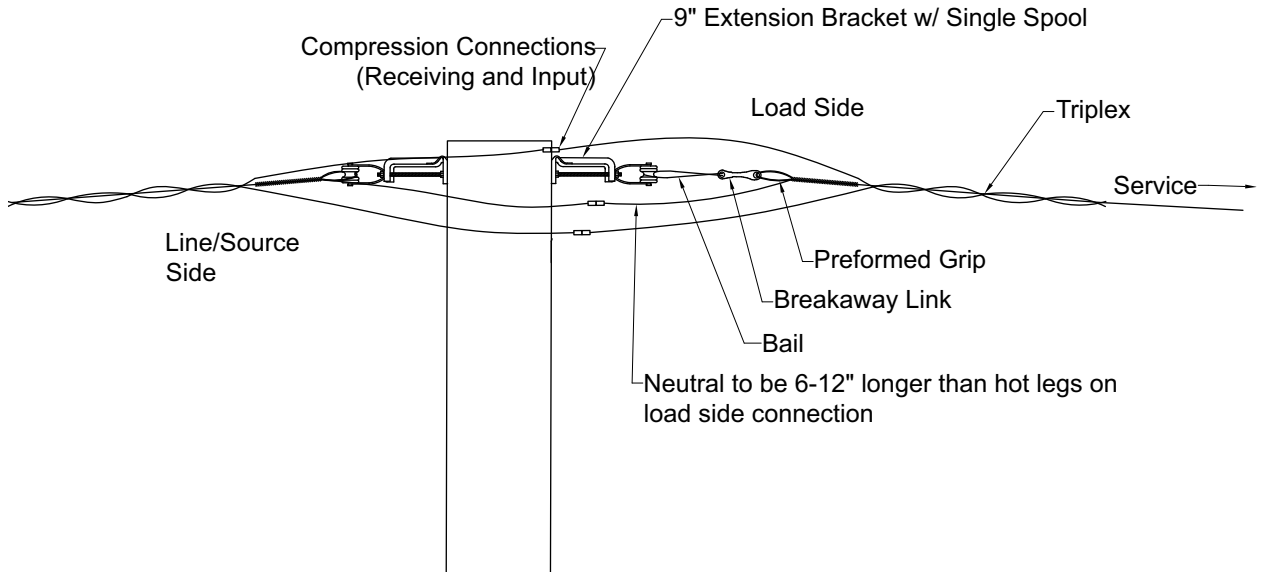
Figure DC 330–8: Typical Installation of Service Breakaway System (Secondary Riser)



Note(s):

1. Applies to transformers that are converted to underground, while maintaining overhead secondary/services.
2. Breakaway system should be installed at the service pole. If there is a string of secondary poles leading to the service, the breakaway system shall be installed at the last (that is, service) pole. Refer to Figure 9 for details.
3. If heavy vegetation is present in a string of secondary poles, the breakaway system shall be installed on the service pole that would most likely be affected by falling vegetation..
4. Ensure that the service drop is appropriately dead-ended at the point of customer attachment

Figure DC 330–9: Installation of Service Breakaway System (String of Service Poles)



Note(s):

1. If heavy vegetation is present in a string of secondary poles, the breakaway system shall be installed on the service pole that would most likely be affected by falling vegetation.
2. Refer to Figure DC 330-11 for installation of breakaway system in a string of multiple service poles.
3. Ensure that the service drop is appropriately dead-ended at the point of curstomer attachment.

Figure DC 330–10: Example of Breakaway Installations in a String of Service Poles

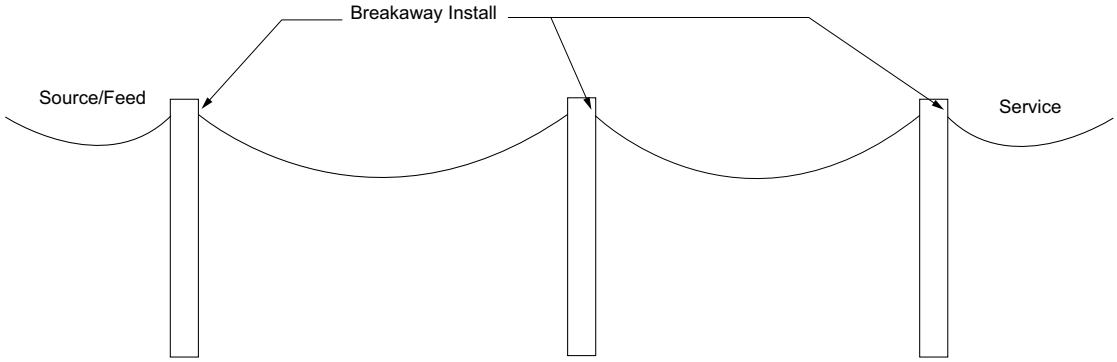
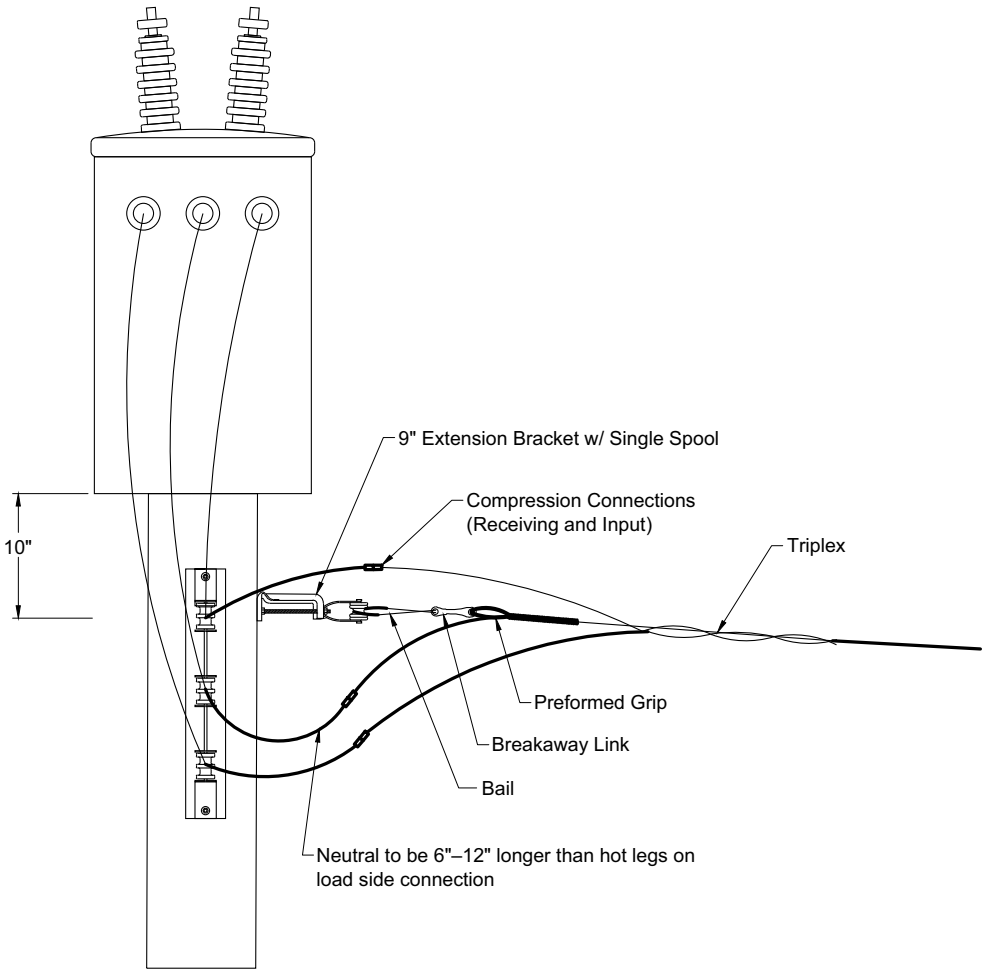


Figure DC 330–11: Typical Installation of Storm Safe Breakaway System (Transformer Pole)



Note(s):

1. Triplex neutral shall be 6"–12" inches longer than phase conductors. This will ensure that energized phase conductors will disconnect prior to the grounded neutral disconnecting.
2. Breakaway link shall be replaced if found to be broken. If the connectors are found disconnected, connectors shall be cleaned of any debris and reconnected to receiving ends.
3. If connectors appear to have severe damage from ground impact or arcing, connectors shall be removed and replaced.
4. If pole does not have sufficient space to install a 3-spool extension rack, the 3-spool rack may be omitted and conductors with breakaway connections can be terminated directly to the transformer.

This page intentionally left blank.

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.

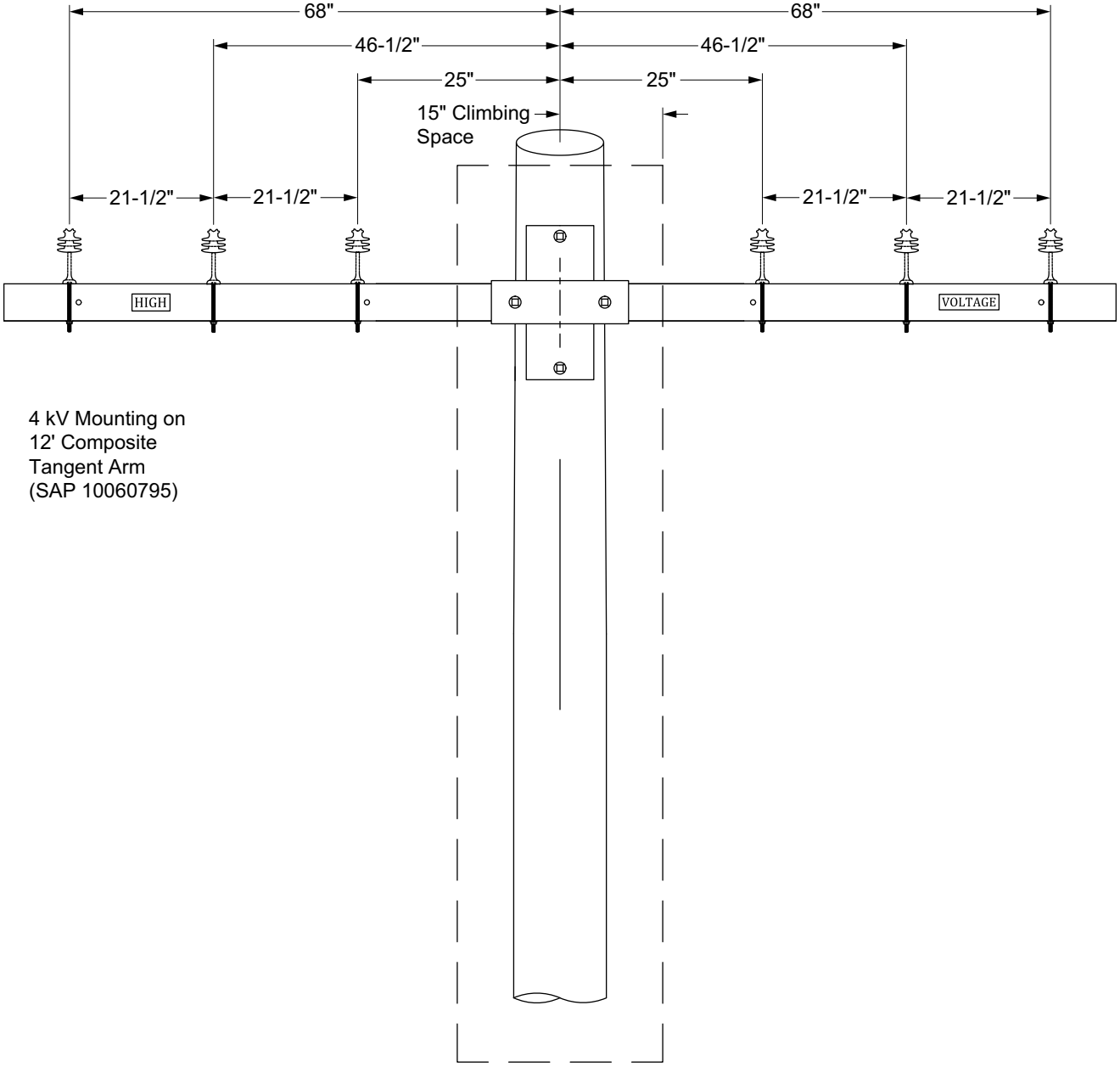
Refer to the Distribution Design Standards (DDS) Manual for proper sizing of service wire and voltage drop calculation.

This page intentionally left blank.

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

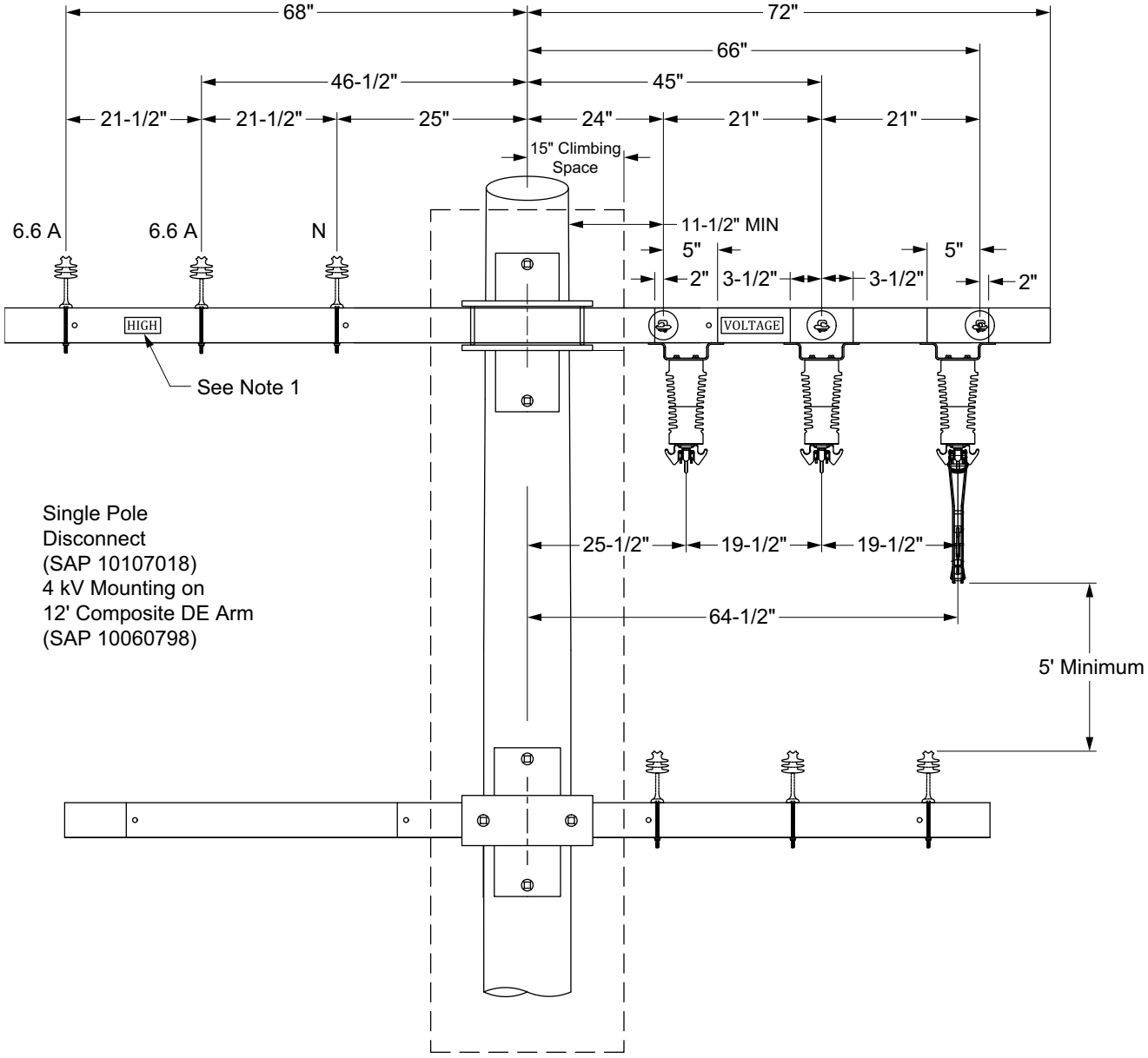


Table DC 410–1: Jumper Wire and Connectors

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 10111472)	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 10111472)	Hylug Copper, 1 ea. (SAP 10210869)

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

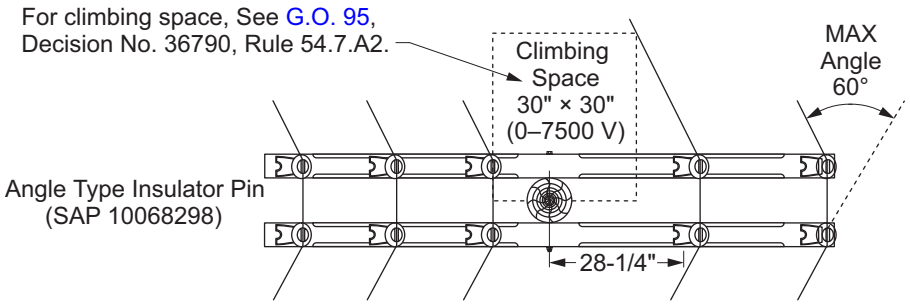


Table DC 415–1: 0–7500 V Angle Pole — Typical — Five Wires Maximum

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: 0–7500V Angle Pole — Typical — Five Wires Maximum

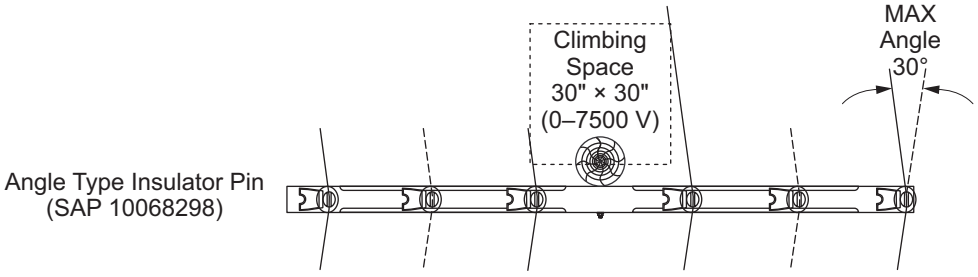


Table DC 415–2: 0–7500 V Angle Pole — Typical — Limiting Angles

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°

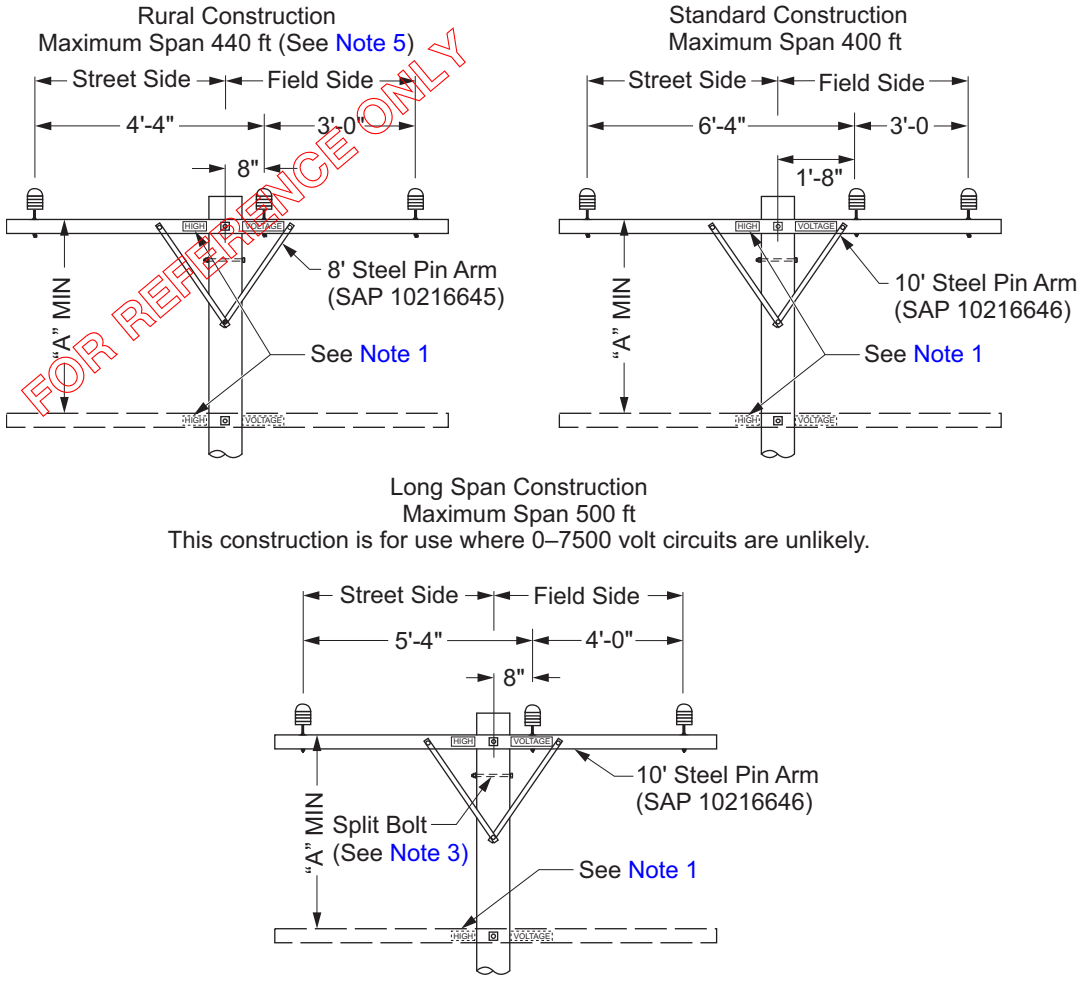
Note(s):

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



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.
6. For Distribution Span exceeding 500', contact Pole Engineering.

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/]	—

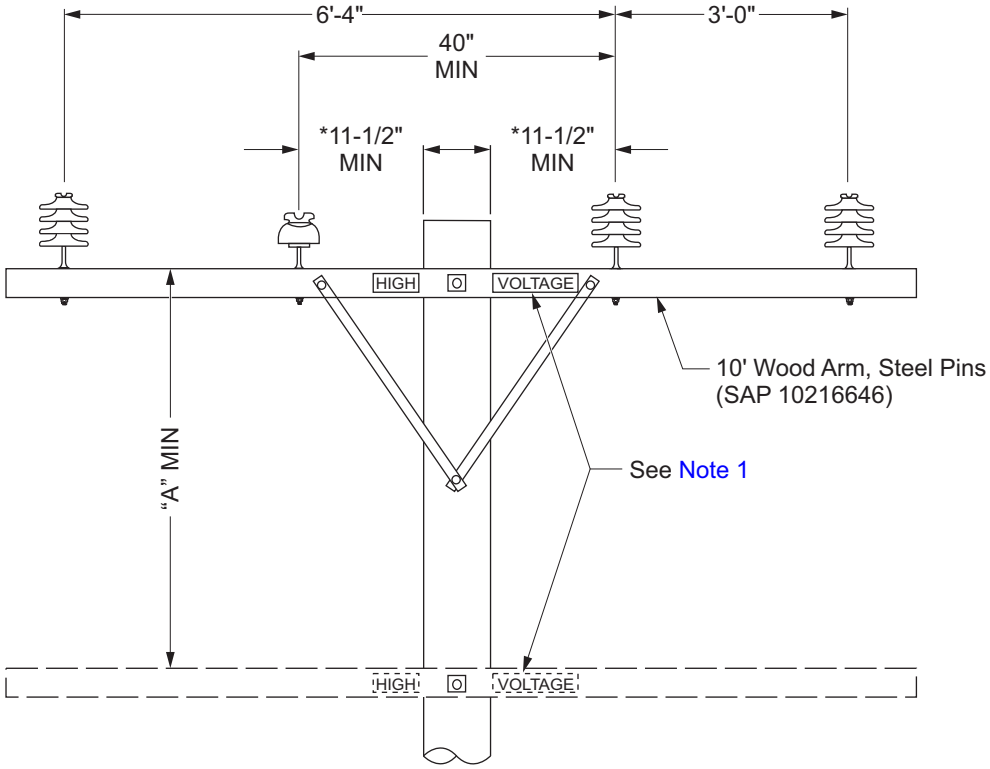
a/ A 6-foot clearance between primary circuits will be used on new line construction and on pole replacements when minimum sag requirements per CO Section can be maintained.

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 10216637) 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.

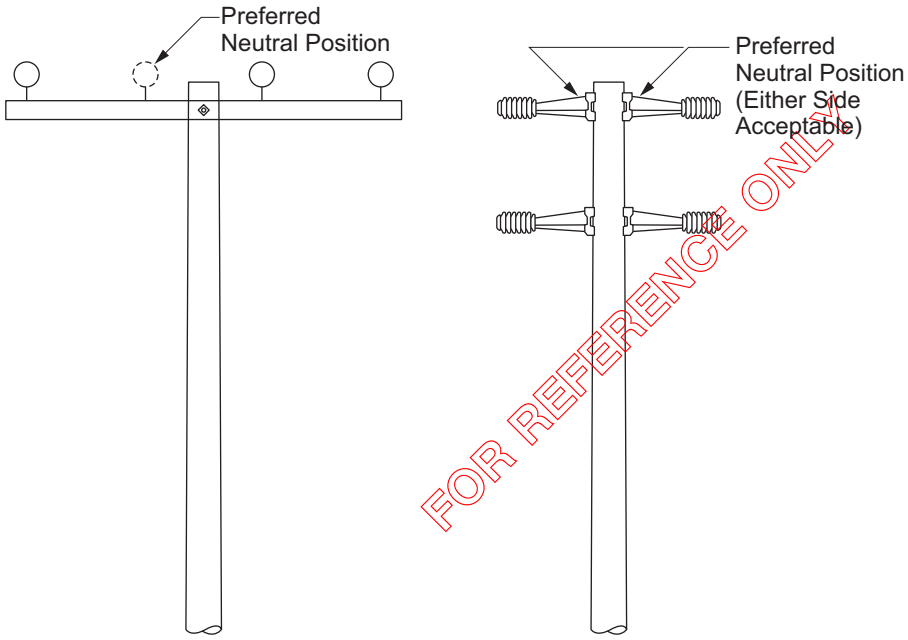
Table DC 510–1: Minimum Conductor Spacing for Dimension "A"

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.

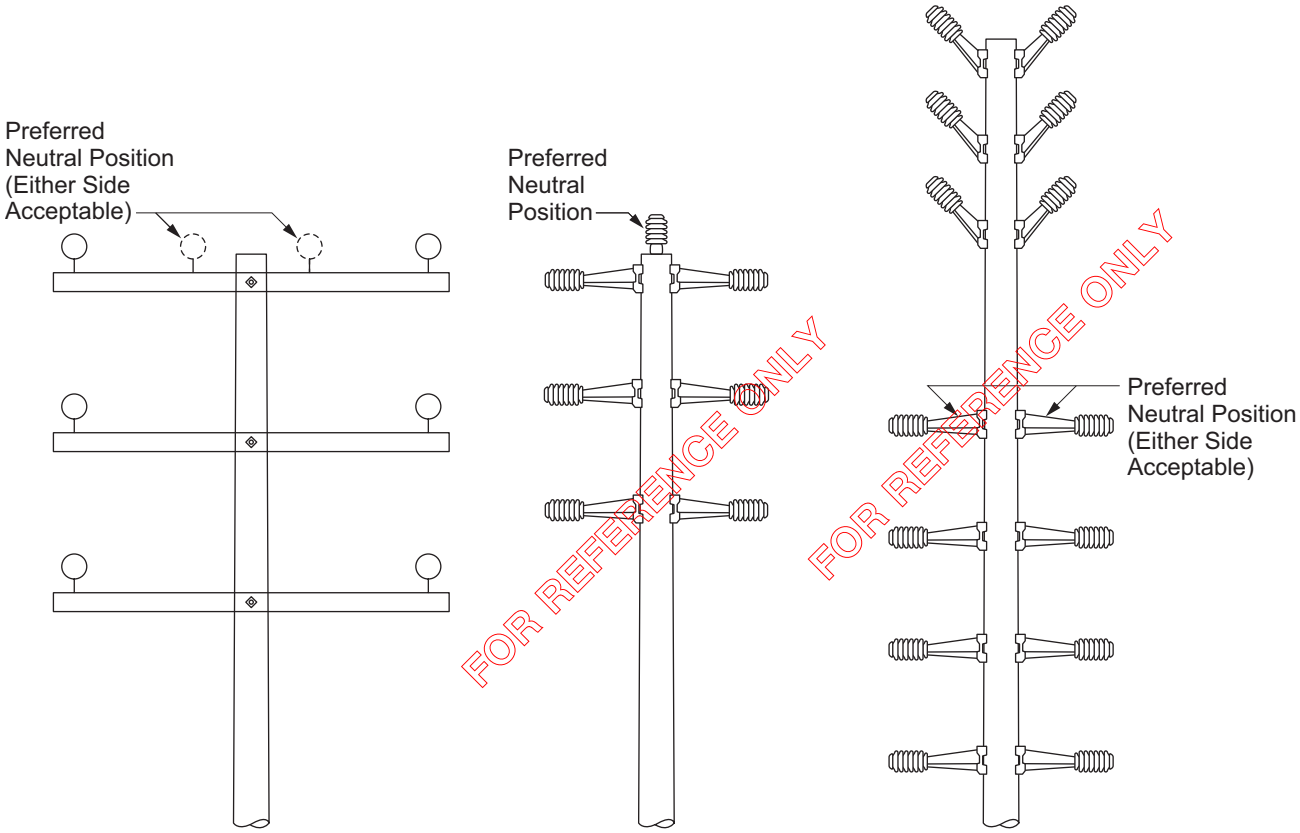
[b/] Clearance may be reduced to 5 feet on existing installations.

Figure DC 510–2: 3Ø Single Circuit 12/16 kV 4-Wire



FOR REFERENCE ONLY

Figure DC 510–3: 3Ø Double Circuit 12/16 kV 4-Wire



FOR REFERENCE ONLY
FOR REFERENCE ONLY

This page intentionally left blank.

DC 520 Distribution Circuit — Extra Heavy-Loading Areas above 5,000 Feet Elevation

Scope DC 520.1 Construction Requirements for Extra Heavy-Loading Areas above 5,000 Feet Elevation — All Distribution Primary Voltages Construction General Requirements

Normal “heavy-loading” areas are between 3,000 feet and 5,000 feet elevation. This section provides general requirements to be used in extra heavy loading areas above 5,000 feet elevation 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.”

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.

All covered conductor construction requires double crossarm and insulators for line conductor support, which includes: tangent, angle and dead-end installations. Crossarms which support jumpers related to equipment or gang operated switches may remain as single crossarms unless otherwise required by design or equipment standards.

See additional pole-line hardware construction requirements in Section 4.0

4.0 Pole-Line Hardware

See Figure DC 520–1.

4.1 Due to high mechanical strengths required in these areas, the following practices shall be followed:

A. Use 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 3/4-inch threaded stud construction on all distribution primary voltages. On all conductor sizes use 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. For covered conductor applications, V-braces are required, regardless of crossarm type. See Figure DC 520–4 through Figure DC 520–8.

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 Extra Heavy-Loading Areas above 5,000 Feet (All Distribution Voltages)

Conductor Size ACSR	Limiting Deviation Angle[a/ b/] (in Degrees)			
	Steel Pin Type Insulator		Post Type Insulator	
	Single Arm	Double Arm	Single Arm	Double Arm[c/]
1/0 (7 × 1)	10	20	13	26
336.4 (18 × 1)	6	12	6	12
336.4 (30 × 7)	3	6	5	10
653.9 (18 × 3)	3	6	5	10
101.8 Petrel	-	-	5	10

[a/] If angle of line exceeds above limits for double arm, use double dead-end construction. If angle of line exceeds 60 degrees, use line and buck "Corner" construction.
[b/] Limiting Deviation Angle = Angle at which side tension does not exceed G.O. 95 safety factor for insulators and hardware
[c/] Per Section 3.0, covered conductor systems require double crossarms design.

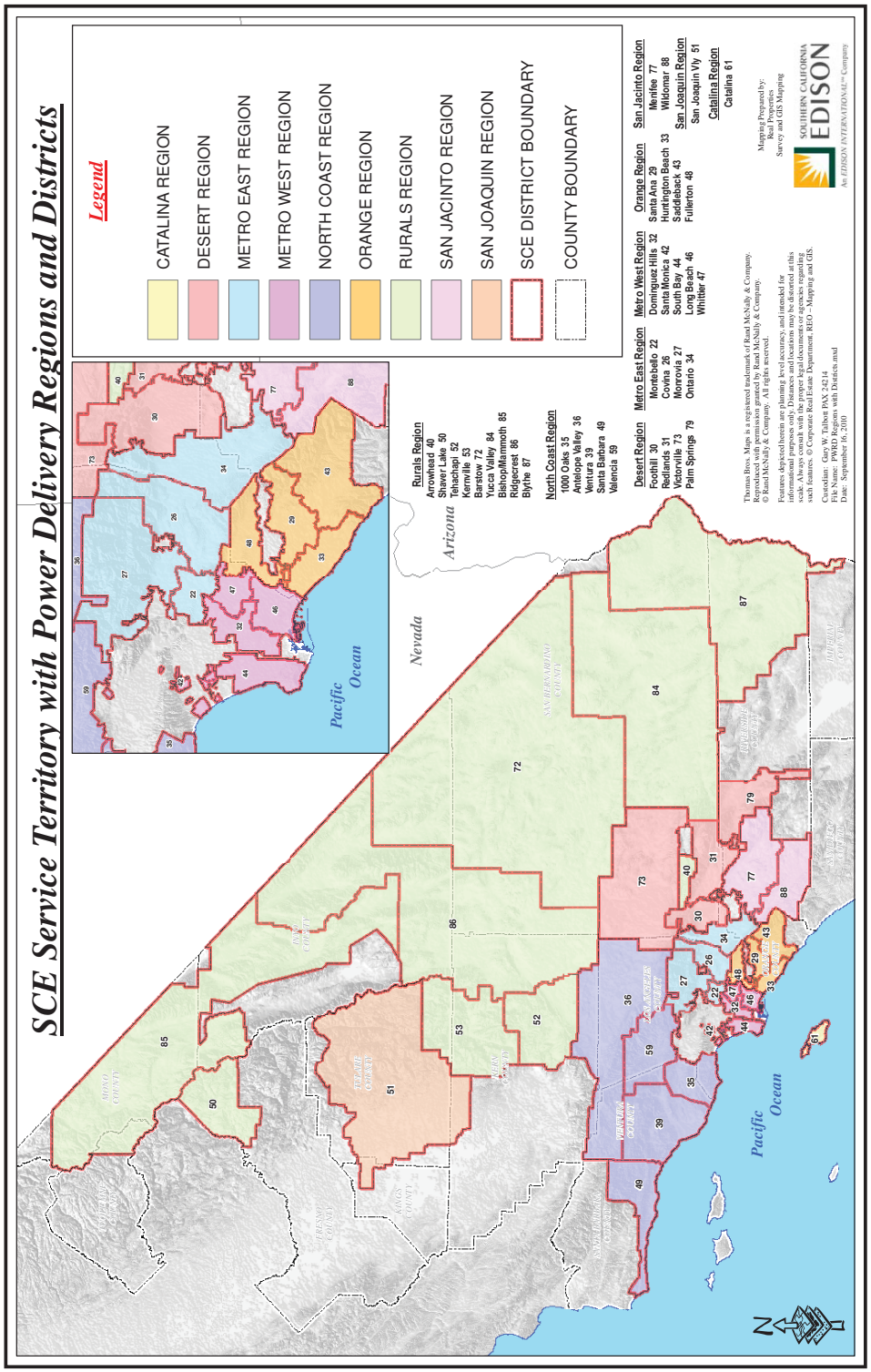
Note(s):

1. Pin-Type insulators are not approved for new construction in Extra Heavy-Loading areas.

= For Reference Only

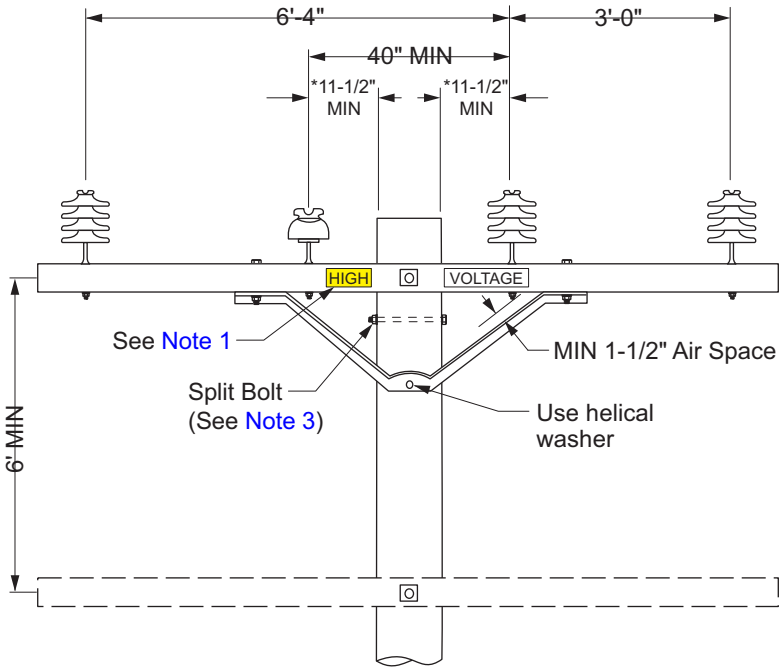
Scope DC 520.2 Territory Map of Extra Heavy-Loading Areas above 5,000 Feet Elevation

Figure DC 520–1: Territory Map of Extra Heavy-Loading Areas above 5,000 Feet Elevation



Scope DC 520.3 Typical Construction Practices for 3-Wire and 4-Wire — Extra Heavy Loading above 5,000 Feet Elevation

Figure DC 520–2: Typical Construction Practices for 3-Wire and 4-Wire — Extra 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 — Extra 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.

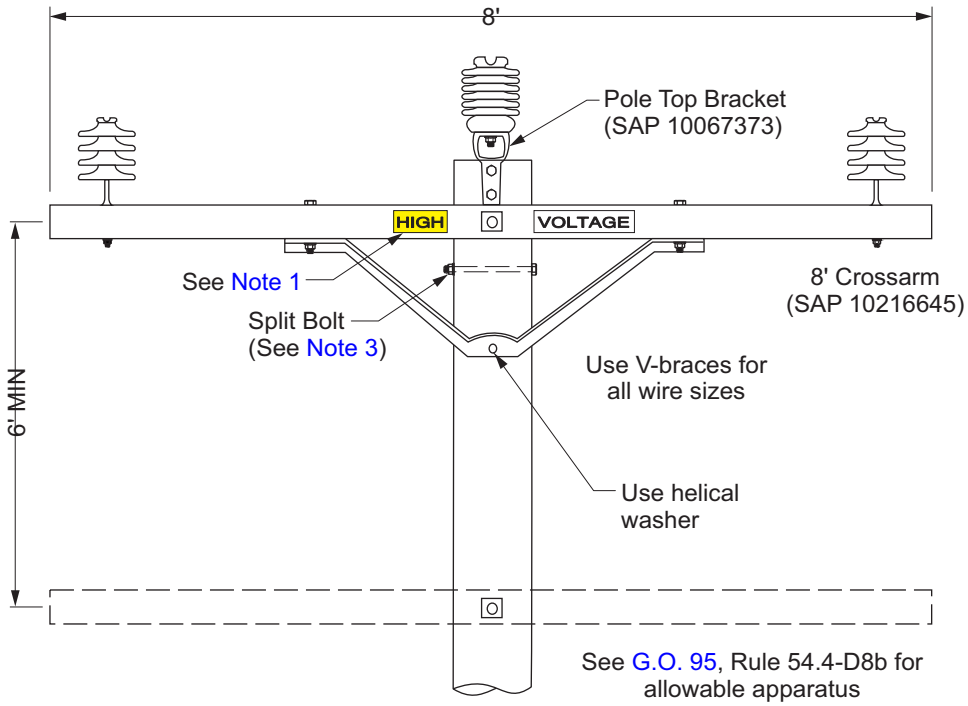
With transmission above, large poles may require one of the following in order to maintain 11-1/2 inches:

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 10216637) 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 — Extra Heavy Loading above 5,000 Feet Elevation

Figure DC 520–3: Typical Horizontal 3-Wire Straight Line Configuration — Extra 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.

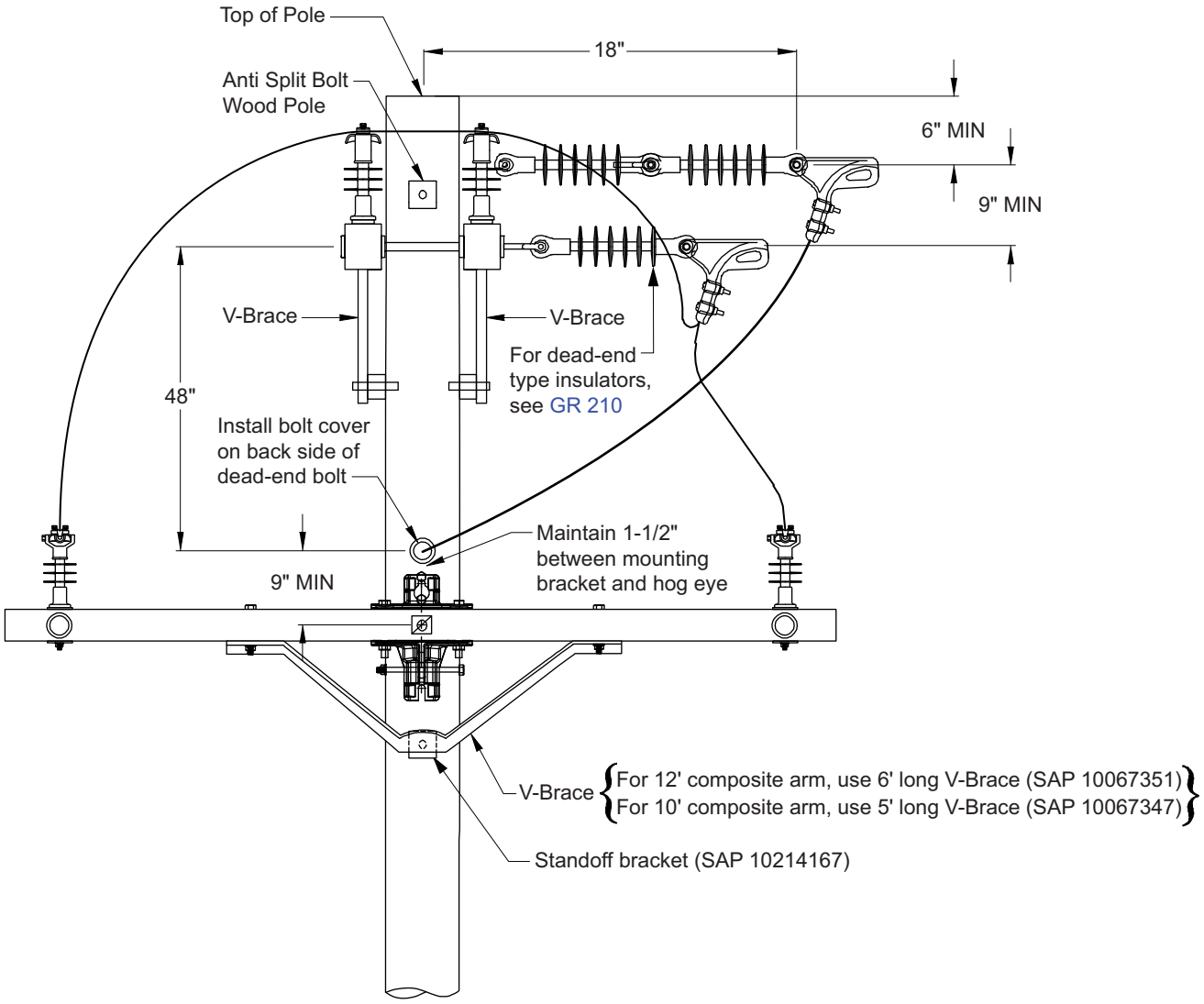
Table DC 520–4: Maximum Span Length for Horizontal 3-Wire Straight Line Configuration — Extra Heavy Loading above 5,000 Feet Elevation

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.

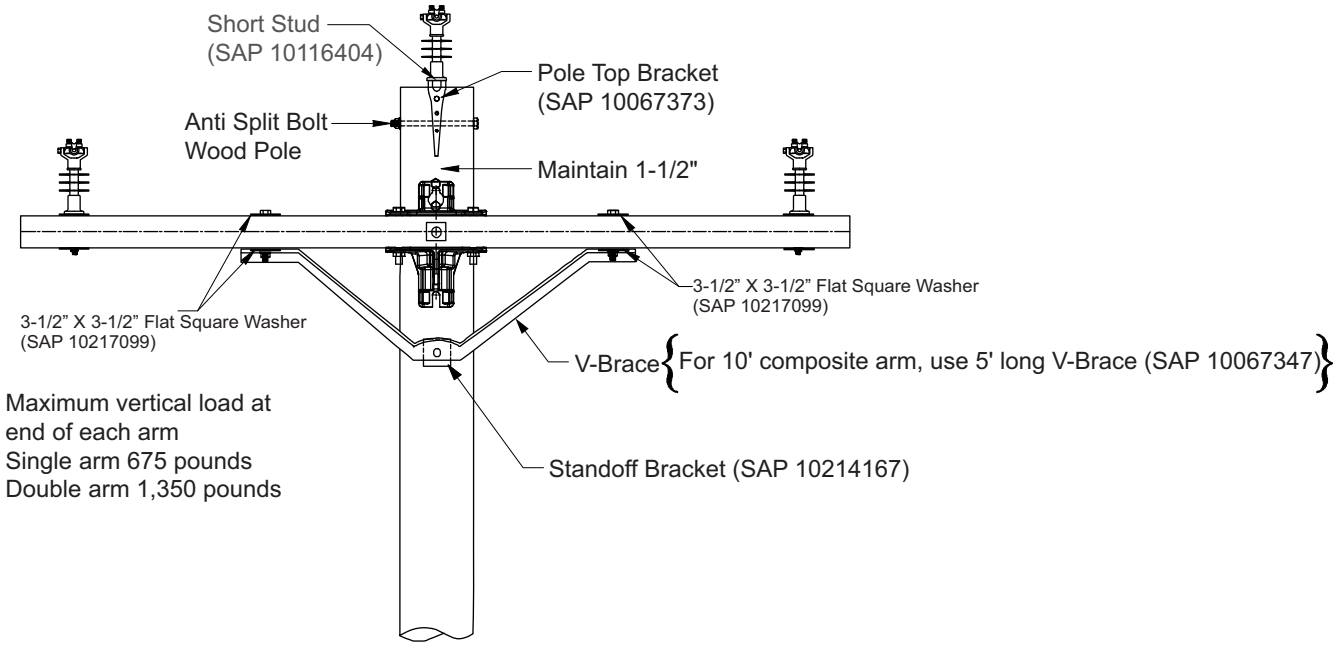
Scope DC 520.5 Composite Arms Above 5,000 feet Corner Pole 3-Wire Construction with V-Brace Covered Conductor

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 Post 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 Post Type Insulator

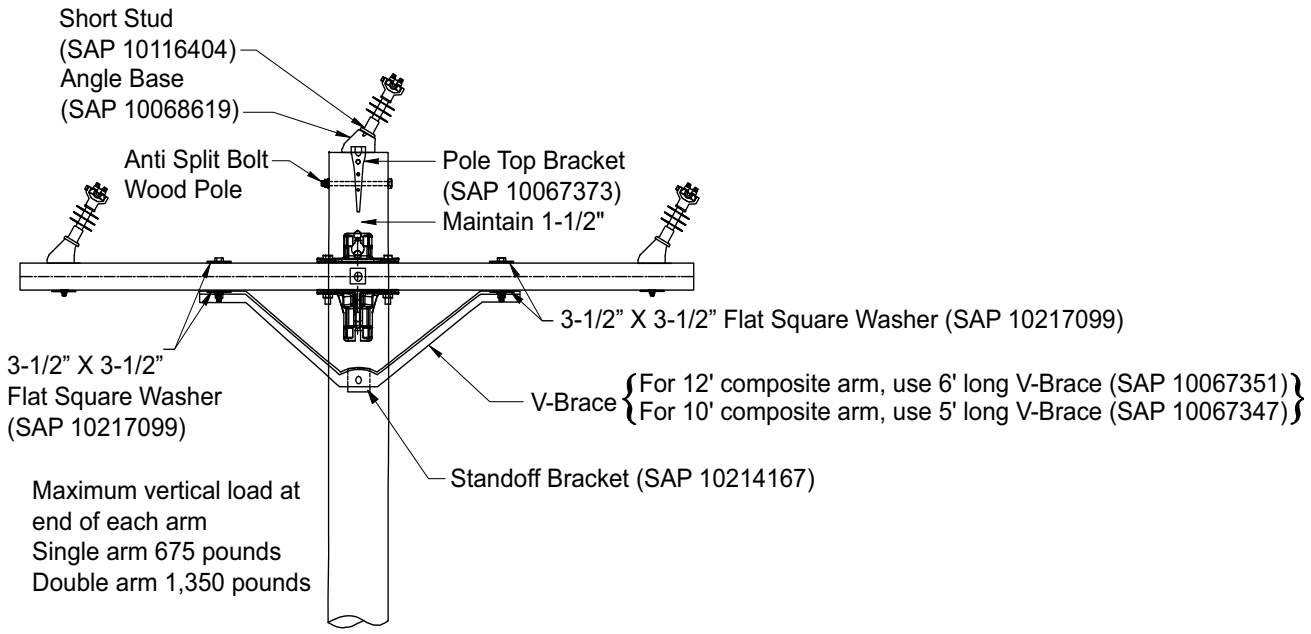


Note(s):

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 3-1/2" X 3-1/2" Flat Square Washers (SAP 10217099):
   - Between V-Brace and crossarm
   - On top side of V-Brace bolt
   - On underside of crossarm in post-type insulator installations. Refer to PO 370 Section 2.0 for washer size requirements on base of post-type insulators.
3. Install spring washers on nut end of all bolts.
4. See GR 205 for post-type insulators.
5. See Table DC 520–4 for maximum span lengths.
6. Install standoff bracket between V-Brace and Pole.

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 Post 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 Post Type Insulator

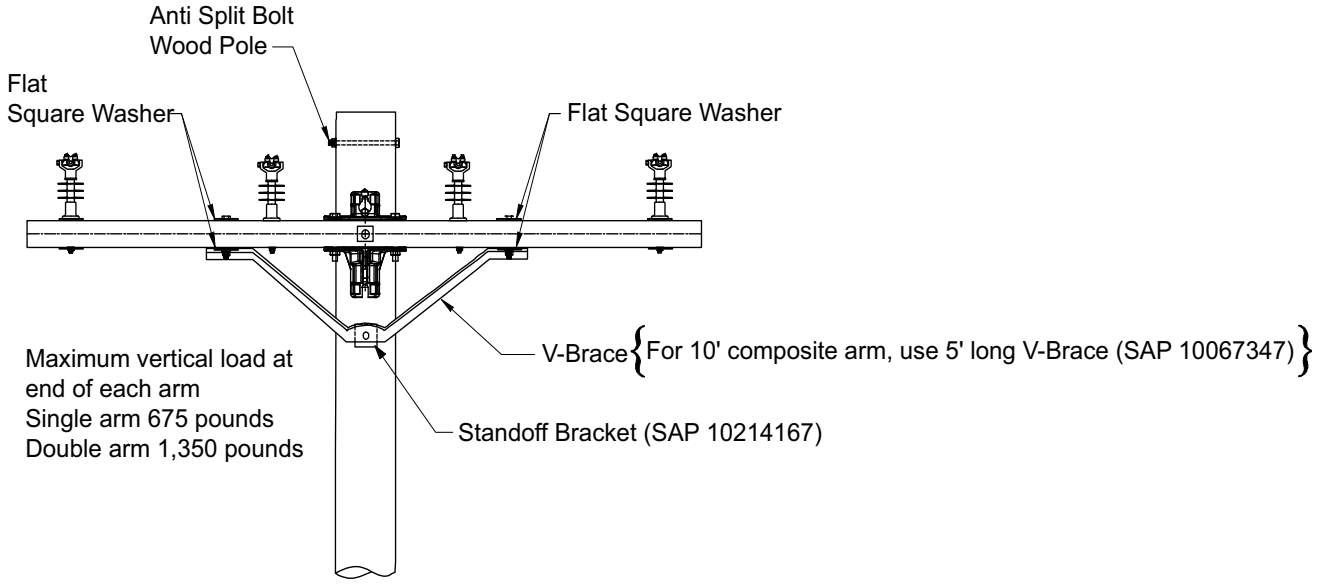


Note(s):

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 3-1/2" X 3-1/2" Flat Square Washers (SAP 10217099):
   - Between V-Brace and crossarm
   - On top side of V-Brace bolt
   - On underside of crossarm in post-type insulator installations. Refer to PO 370 Section 2.0 for washer size requirements on base of post-type insulators.
3. Install spring washers on nut end of all bolts.
4. See GR 205 for post-type insulators.
5. See Table DC 520–4 for maximum span lengths.
6. Install standoff bracket between V-Brace and Pole.

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 Post 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 Post Type Insulator

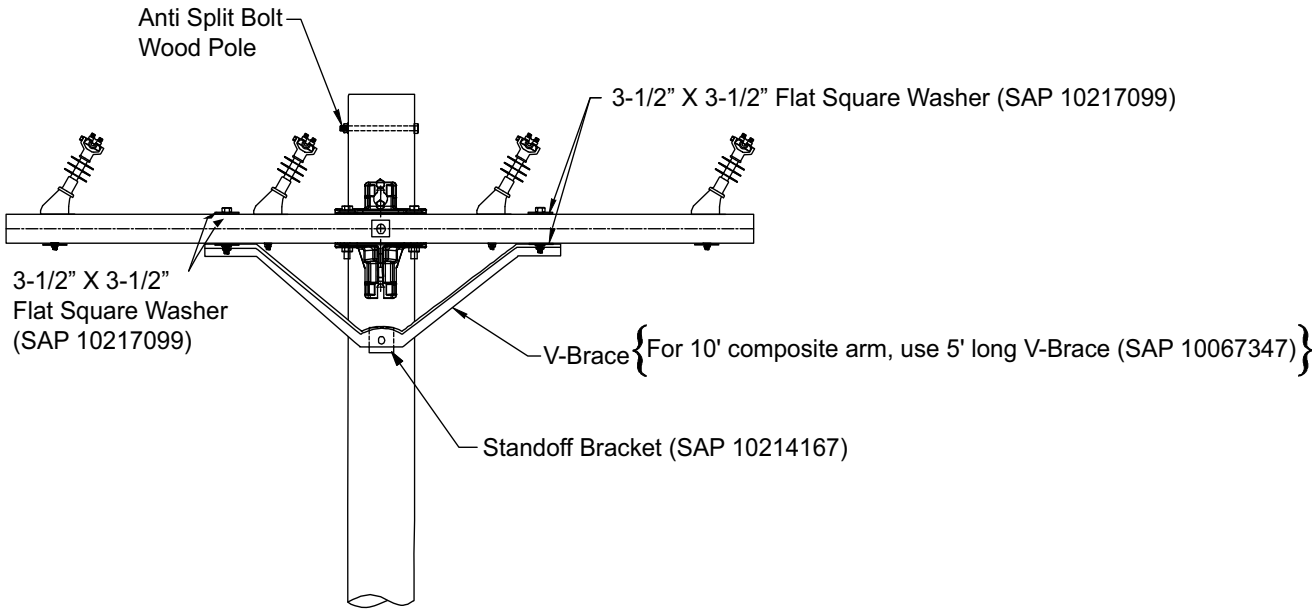


Note(s):

1. Install Flat Square Washers sized according to DOH PO 370 Section 2.0.
   - Between V-Brace and crossarm
   - On top side of V-Brace bolt
   - On underside of crossarm in post-type insulator installations. Refer to PO 370 Section 2.0 for washer size requirements on base of post-type insulators.
2. Install spring washers on nut end of all bolts.
3. See GR 205 for post-type insulators.
4. See Table DC 520–4 for maximum span lengths.
5. Install standoff bracket between V-Brace and Pole.

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 Post 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 Post Type Insulator



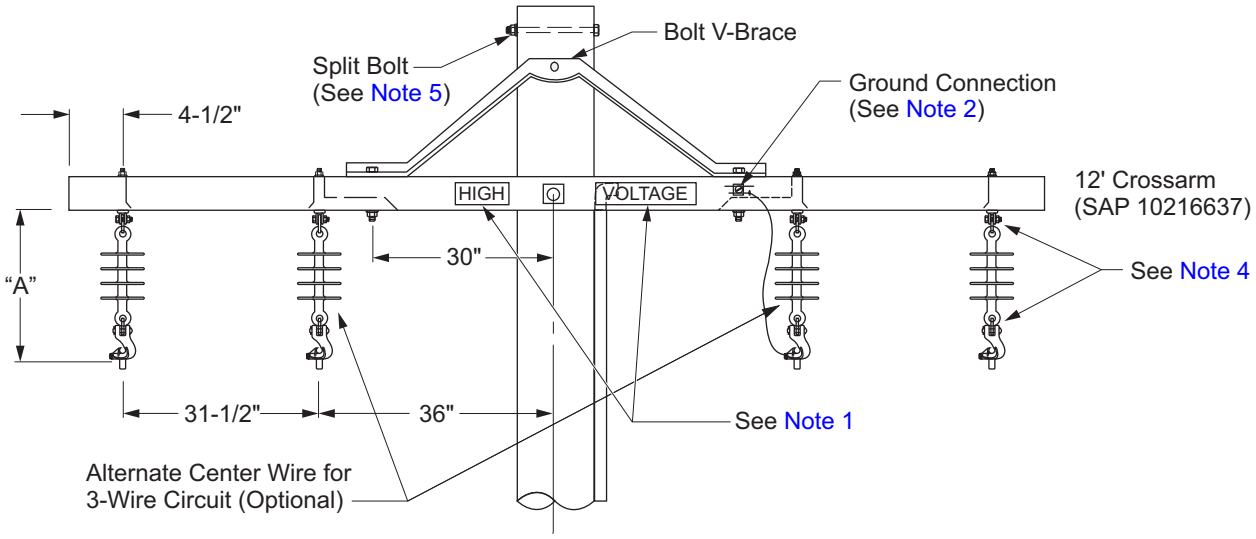
Note(s):

1. Install 3-1/2" x 3-1/2" Flat Square Washers (SAP 10217099).
   - Between V-Brace and crossarm
   - On top side of V-Brace bolt
   - On underside of crossarm in post-type insulator installations. Refer to PO 370 Section 2.0 for washer size requirements on base of post-type insulators.
2. Install spring washers on nut end of all bolts.
3. See GR 205 for post-type insulators.
4. See Table DC 520–4 for maximum span lengths.
5. Install standoff bracket between V-Brace and Pole.

DC 530 All Distribution Voltages 3/4-Wire Suspension Construction

Scope DC 530.1 Distribution Suspension Construction — High-Wind Areas Only

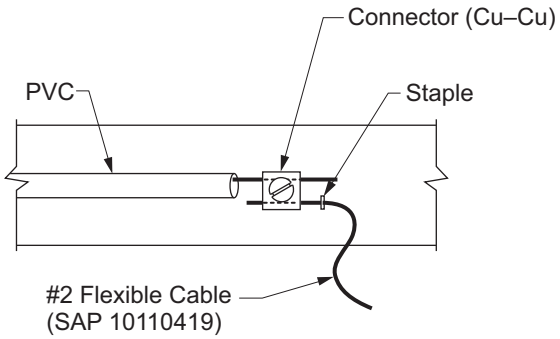
Figure DC 530–1: All Distribution Voltages



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 16 kV 33 kV	1-13" polymer D 1-17" polymer DE 1-22" polymer DE	10116431 10116332 10116432	24" 28" 33"

Table DC 530–2: Suspension Clamp — 3/4 Wire Suspension Construction — All Distribution Voltages

Suspension Clamp		
Conductor Size	Clamp SAP	
	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: Suspension Clamp — 3/4 Wire Suspension Construction — Covered Conductor, All Distribution Voltages

SAP Number	Conductor Range	Acceptable Covered Conductor Size	
		17 kV Rating	35 kV Rating
10067612	0.3"–0.7"	#2 Cu	N/A
10067614	0.5"–0.7"	#2 Cu	N/A
10067616	0.68"–1"	#2, 2/0, 4/0 Cu, 1/0 ACSR	N/A
10067624	1"–1.313"	336.4, 653.9 ACSR	1/0 ACSR
10067615	1.10"–1.62"	N/A	336.4, 653.9 ACSR

Table DC 530–4: 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
#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.

This page intentionally left blank.

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 distribution 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).

  For new construction and during maintenance work, wildlife protection material shall be used in bare wire and covered conductor systems. Spacing and covers shall be constructed per Figure DC 535–13.
- Covered conductor systems will be an all-covered system. This includes exposed dead-ends, exposed connectors and splices. Apparatus terminations shall be covered as they would in bare wire systems, by utilizing the appropriate covers listed in Table DC 535–1. See CC 150 for additional details.



NOTE Covered Conductor systems do not require use of wildlife hoods, wildlife hood extenders, and/or protective tubing.

- All overhead taps, leads, and jumper wires shall utilize covered conductors (that is, covered conductor or Protected ground wire used as equipment taps). If covered conductors cannot be utilized in a bare wire system, split-tubes may be used as an alternative option.
- See Section 3.0 and Section 4.0 for additional details on wildfire covers on terminations and various apparatus.
- 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
- Regardless of phase and grounding point separation, wildlife protection material shall be used in bare wire and covered conductor systems. Spacing and covers shall be constructed per Figure DC 535–13.
- 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.

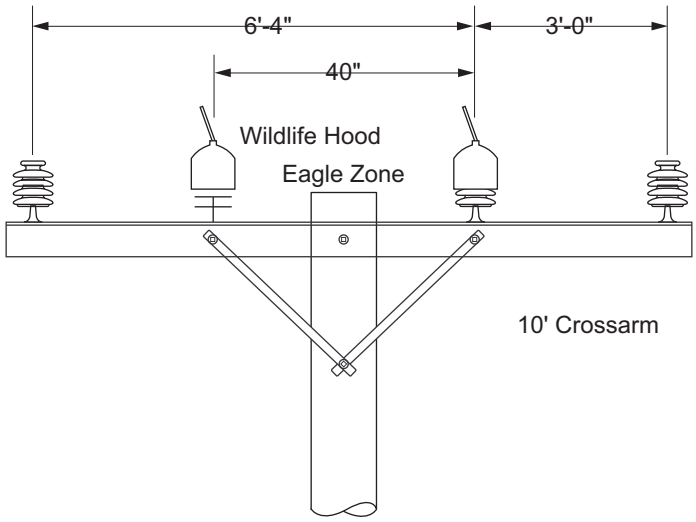
1.3 For the purposes of this standard, wood poles/crossarms and composite poles/crossarms are not considered “grounded”.

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 secondaries shall be utilized in replacement. Aluminum secondaries/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 such as 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

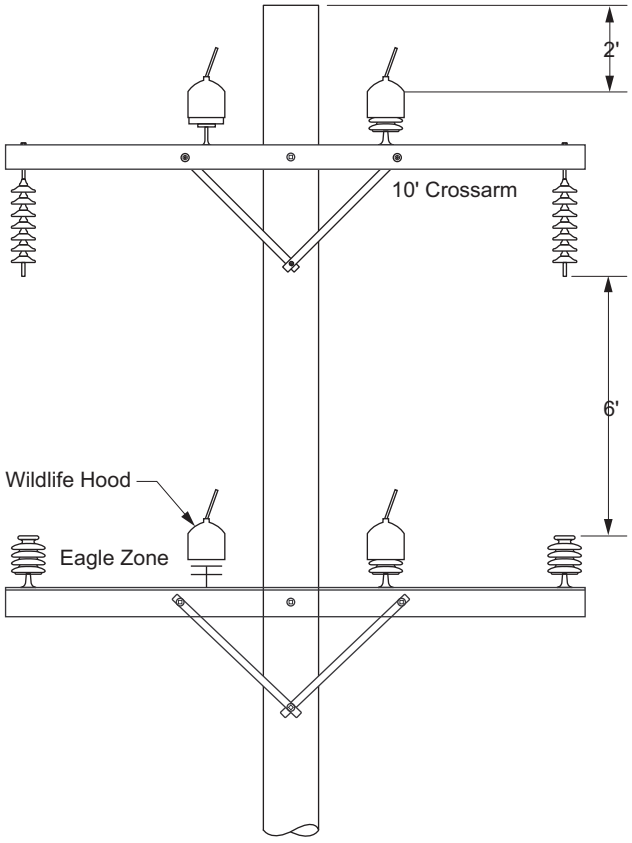


Note(s):

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

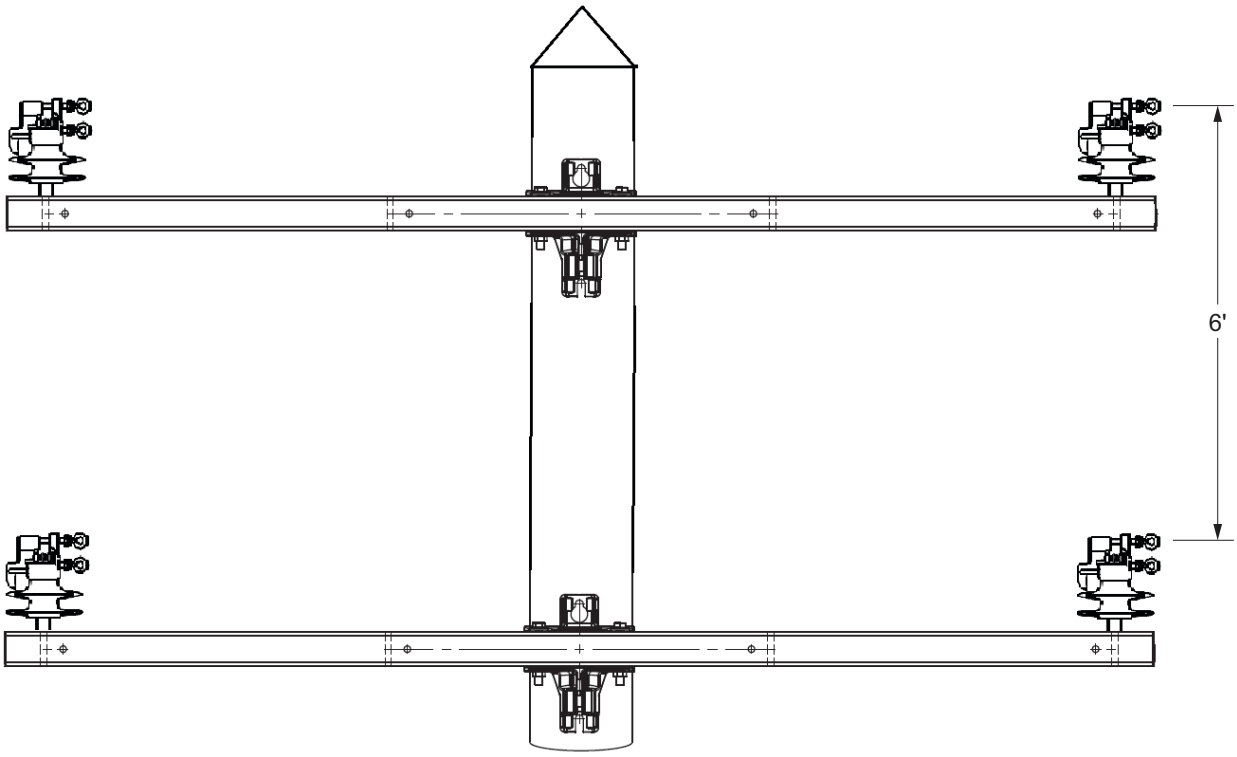


Note(s):

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

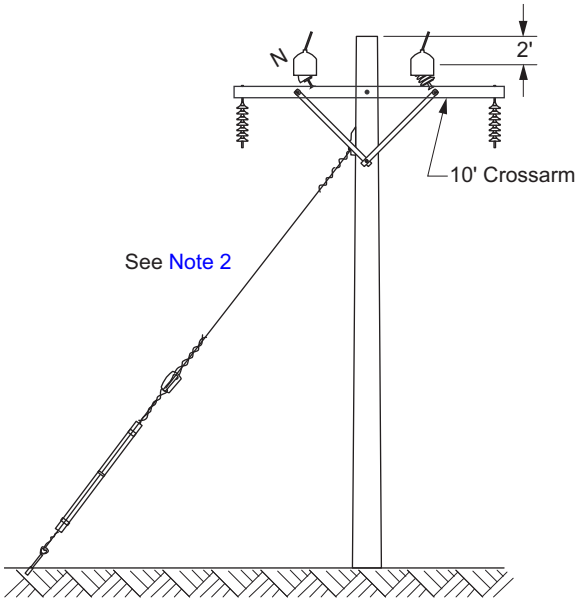


Note(s):

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

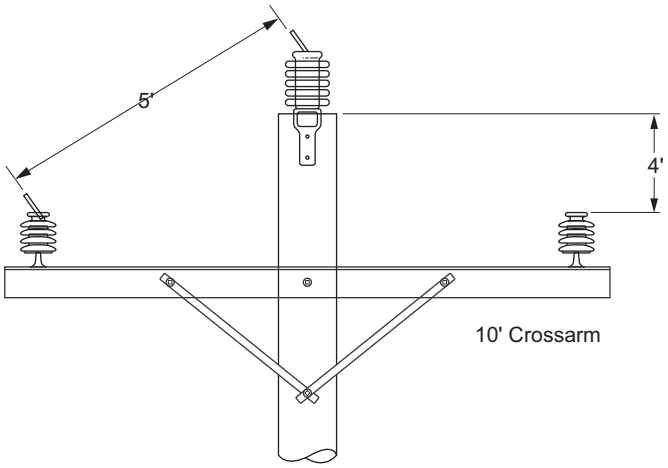


Note(s):

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



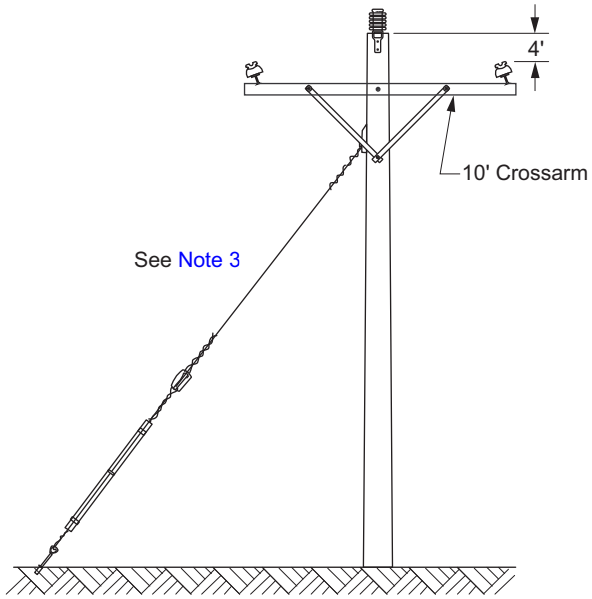
Note(s):

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

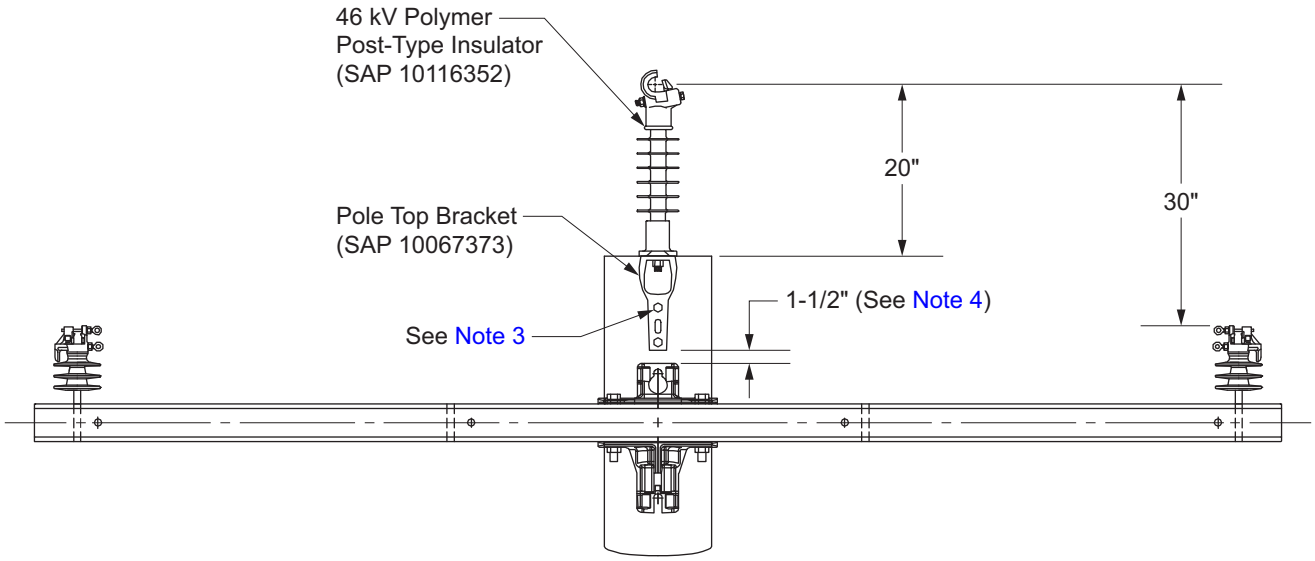


Note(s):

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

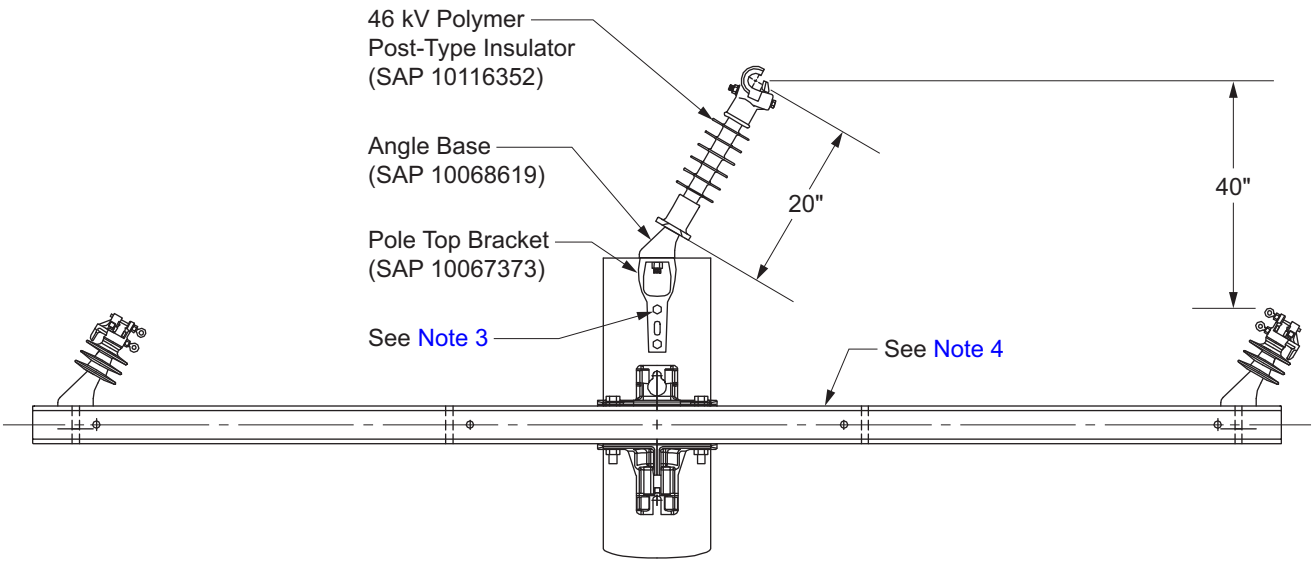


Note(s):

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

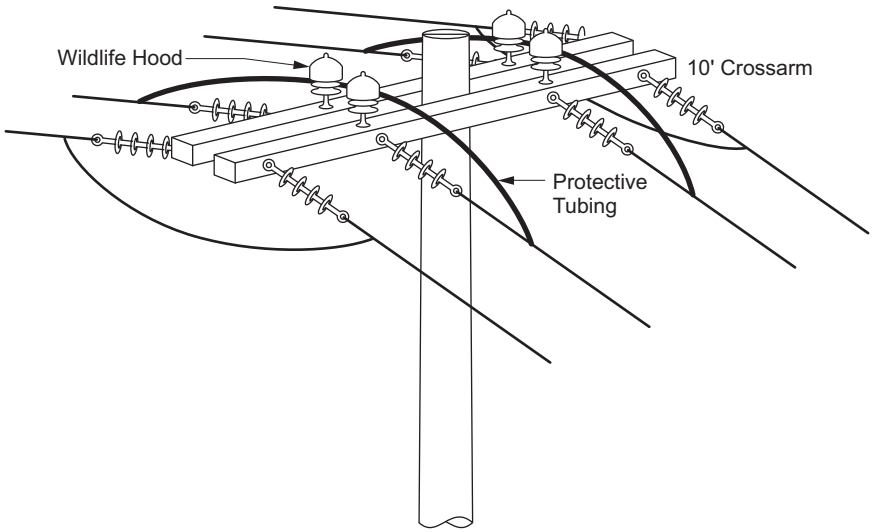


Note(s):

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

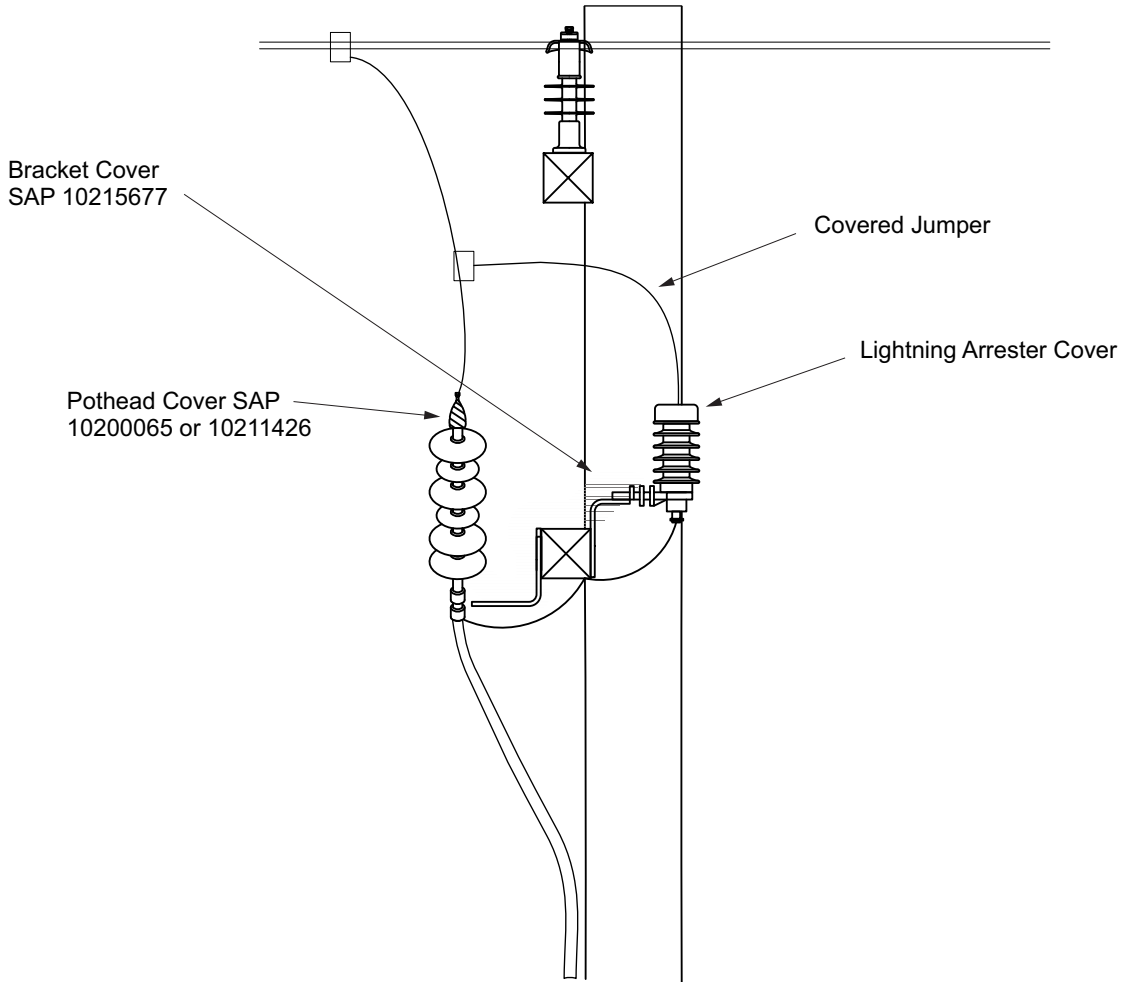


Note(s):

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 4/12/16/25/33 kV Riser (Pothead) Construction, Single Arm

Figure DC 535–10: Single Arm Riser Construction Using Bracket Covers

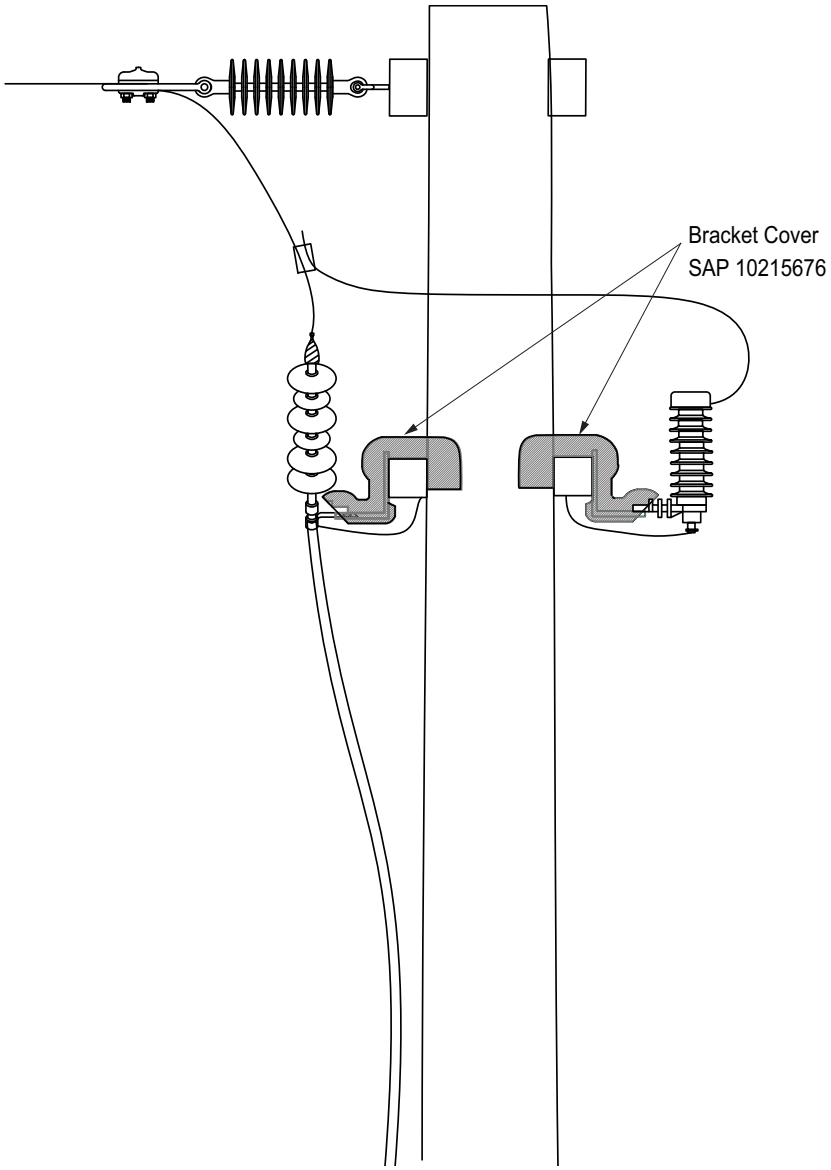


Note(s):

1. See Section 3.3 and Section 3.5 for application of bracket covers.
2. Refer to DUG TP section for additional construction details of riser (pothead) installations.
3. Bracket covers are not designed to be installed with hot-sticks.

2.11 4/12/16/25/33 kV Riser (Pothead) Construction, Double Arm

Figure DC 535–11: Double Arm Riser Construction Using Bracket Covers

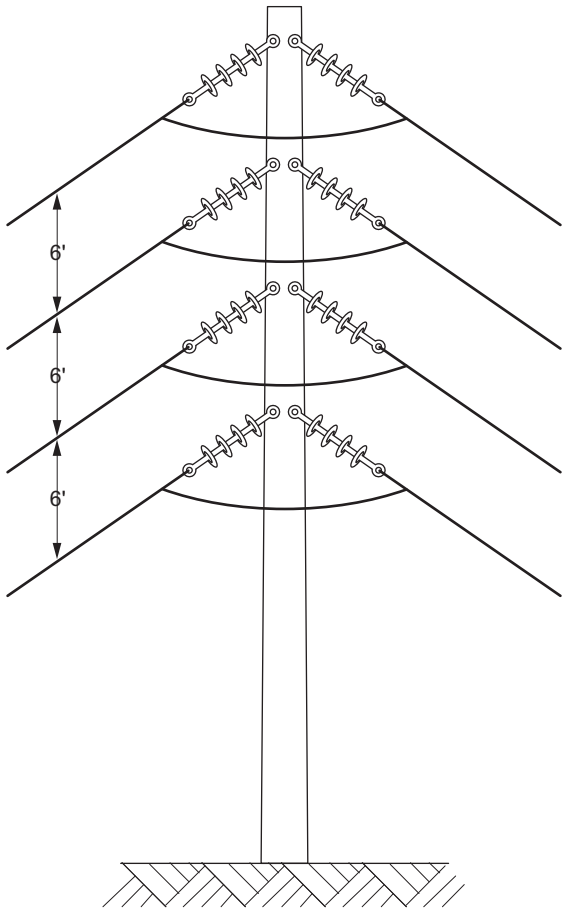


Note(s):

1. See Section 3.3 and Section 3.5 for application of bracket covers.
2. Refer to DUG TP section for additional construction details of riser (pothead) installations.
3. Bracket covers are not designed to be installed with hot-sticks.

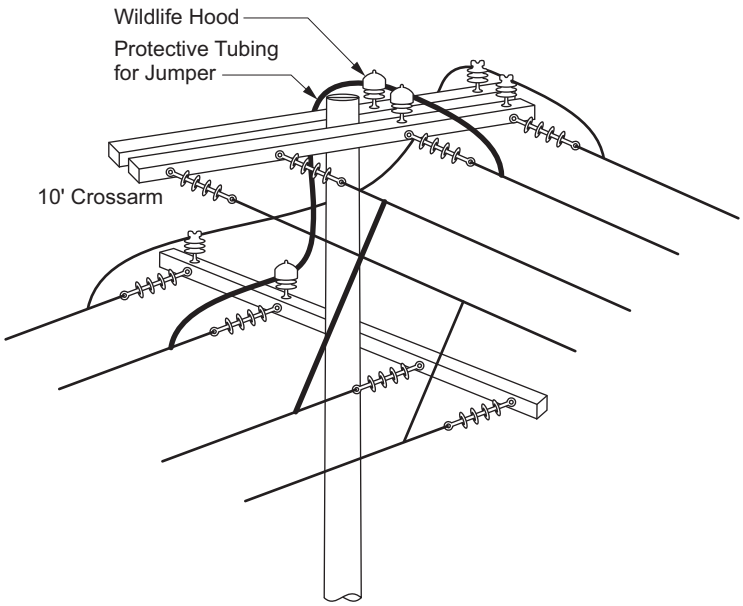
2.12 3-Wire or 4-Wire, Corner Pole, Vertical Construction

Figure DC 535–12: 3-Wire or 4-Wire, Corner Pole, Vertical Construction



2.13 3-Wire or 4-Wire, Corner Pole, Horizontal Construction

Figure DC 535–13: 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.

2.14 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

For new installations or de-energized maintenance work, field personnel shall construct the pole to comply with the avian protection standards stated below in Subsections 3.1 through 3.8.

For energized maintenance work, the following standards shall also be applied when practical.

If standards cannot be followed based on working conditions (that is, emergency repairs or work that requires an outage) at the time, a Priority 2 notification will be generated in order to return to the structure to apply the appropriate wildlife cover.

3.1 Connectors and Equipment Connections

A. Primary Voltage Connectors

Connectors shall be installed at a minimum of 40 inches above mounting brackets (for example, cable terminations, arresters, or fuse holders).

For new installations and/or maintenance activities (when appropriate work practices allow), bare jumpers and exposed connectors that are installed above mounting brackets shall be reconstructed with the following:

- Covered jumpers or PGW (when applicable)
- Connections shall be landed directly to equipment terminals, under wildlife covers.

All connectors, except for ground connectors, shall be covered in covered conductor systems. The appropriate covers to be used are SAP 10212441 or SAP 10212442, depending on connector size.

B. Secondary Voltage Connectors

Taping over connectors shall be required only at the load end of service and secondary conductors and connectors in HFRA.

C. Equipment Connections

Connections shall be landed directly to equipment terminals under wildlife covers when practicable. Conductor covers (that is, split-tubing, covering on PGW or covered conductors) shall extend under the equipment terminal cover when possible.

D. Dead-Ends

Dead-end covers are required in covered conductor systems. To prevent the dead-end cover from rotating, anti-rotation clips shall be installed when the jumper of the dead-end is oriented downward or not coming out of the top of the cover. If the jumper is routed through the top of the cover, the anti-rotation clip is not required, but it may be installed as an additional measure to prevent rotation of the cover.

The dead-end cover is preferred on the outside of the first dead-end insulator skirt/shed. For ease of routing the conductor out of the top of the dead-end cover, one skirt/shed can be covered.

3.2 Transformers

New transformers shall have bushing covers equipped with handwheels (SAP 10214746) for primary bushings (including neutrals). Jumpers between the fuse holder and primary bushing may be Protected Ground Wire (PGW) or bare copper conductor with split-tubing. Similar rules shall apply to the taps between the mainline connection and the top of the fuse holder.

If a transformer is de-energized for any maintenance work, handwheel covers shall be installed if no covers exist. If there are existing covers installed, orientation of the covers shall be changed in order for the openings of the covers to be pointed away from the opposing bushing cover.

3.3 Fuses/Fuse Holders

All fuse holders shall have appropriate wildlife protection applied based on the fuse holder type/design. This includes all apparatus fuses (e.g. transformers, capacitor banks, etc.), branch line fuses, and riser/dip fuses. Best practice should be made so that protective coverings (split tubing or PGW covering) extend to the fuse holder connector and underneath the covering.

3.4 Lightning Arresters

SAP 10109289 and SAP 10223386 are deployed for Cal-Fire Exempt lightning arresters and standard lightning arresters, respectively. When working on a pole, if there are existing arresters that do not have covers, replacements shall be installed.

When working on a pole, if there are existing arresters that do not have covers, replacements shall be installed. If a hot-stickable cover is required, SAP 10200065 shall be used. Taps to lightning arresters shall be made up with PGW or bare conductors with protective tubing.

For new construction and de-energized maintenance work, lighting arrester brackets shall be in the inverted “L” orientation in order to create additional spacing between the arrester jumper and mounting hardware. Refer to DAP AP 410 for details.

For covering lightning arrester brackets at pothead installations, see Section 3.5.

3.5 Cable Terminations (Potheads)

Cable terminations shall have protective covers (SAP 10222957 or SAP 10222956, depending on cable size) over the energized, upper part of the termination, and covered tubing for the termination taps. The jumper or tap area immediately adjacent to or above the grounded metal termination bracket and crossarm must also be adequately covered. Covers shall be installed for new installations and retrofit work as covers can be installed with a hot-stick.

For new installations or de-energized retrofit work in HFRA, bracket covers shall be installed over termination (potheads) and lightning arrestor mounting brackets. The bracket cover will serve as a means to prevent wildlife contacts between energized

jumpers or connections and grounded termination brackets. The appropriate bracket cover shall be chosen depending on the crossarm configuration (that is, Double Arm or Single Arm).

See Figure DC 535-11 for double arm installation example, and DC 535-12 for single arm installation. These covers may also be used in areas that experience frequent outages due to phase-to-ground contacts on riser poles.

3.6 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. “L” shaped bushing/CLD covers (SAP 1067793) shall be installed on potential transformers. The cover shall be installed in a manner that covers the bushing terminal and CLD.

3.7 Automatic Reclosers (AR) and Regulators

ARs and regulators shall have protective covers over exposed bushings. When possible, line taps shall be covered with protective tubing. “L” shaped bushing/CLD covers (SAP 1067793) shall be installed on potential transformers. The cover shall be installed in a manner that covers the bushing terminal and CLD.

3.8 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.

Wildlife cover shall be applied so that it only covers the top skirt on bushings, potheads, and insulators.

Some wildfire covers have small gaps or seams as part of the covering design. Installation of the cover should be considered in order to allow moisture to drain through said gaps or openings. Additionally, orientation of the gap/seam should be pointed away from other energized or grounded parts in the immediate vicinity (typically 18 inches).

= For Reference Only

Table DC 535–1: Wildlife Protection Material

SAP	Description	Applications	Photo
10224286	Wildlife Bushing Cover without Handwheel, 4" Max Diameter, Black Color.	Transformer Bushing NOTE: Restricted to PILOT ONLY.	
10067758	Wildlife Bushing Cover 3.25" to 4.25" Skirt Diameter, HDPE Material, Grey Color.	Transformer Bushing	
10067783	Wildlife Bushing Cover 4.5" Maximum Skirt Diameter, HDPE Material, Grey Color.	Transformer Bushing (Non-HFRA retrofit only)	
10067753	Wildlife Bushing Cover, 5.00" to 6.25" Skirt Diameter, HDPE Material, Grey Color.	• Automatic Recloser • Voltage Regulator	
10200065	Wildlife Terminator/Pothead Cover 4-1/2" × 8" Outside Dimensions, HDPE Material, Grey Color.	• Terminators/Potheads (may be doubled up for additional protection of the terminator) • Transformer Bushings (Hot-Stick) • Arresters (Hot-Stick)	
10211426	Wildlife Terminator/Pothead Cover, 4-1/2" × 16" Outside Dimensions, HDPE Material, Grey Color.	Terminators/Potheads (350–1500 kcmil)	

Table DC 535–1: Wildlife Protection Material *(Continued)*

SAP	Description	Applications	Photo
10109289 (now being used for Figure CC 150-12)	Lightning Arrester Stud Cover, PVC Material, Grey Color.	Lightning/Surge Arresters Stud Cover, PVC Material, Grey Color	
10215677	Mounting Bracket Cover, Pothead/Arrester Kind. HDPE Material	Riser Termination and Arrester Mounting Bracket (Single Arm)	
10215676	Mounting Bracket Cover, Pothead/Arrester Kind, HDPE Material	Riser Termination and Arrester Mounting Bracket (Double Arm)	See Figure DC 535–11
10067793	Wildlife Bushing Cover Install Either Horizontal or Vertical Position, HDPE Material, Red or Grey Color.	Control Power Transformers with Current Limiting Device (CLD)	
10211487	Dead End Clamp, HDPE Material, Grey Color.	Covered Conductor Dead-ends	
10214048	Dead-End Clamp Anti-Rotation Clip.	Retrofit clip for covered conductor dead-end covers	
10214588	Dead-End Extension Cover, 31.5" Long, Grey Color.	Required: Covered Conductor Dead-ends where grounding is anticipated. Alternate: Mid-Span Ground Cover in Covered Conductor Systems.	
10215385	Quadrant Clamp Dead-end Cover, Large Size, Grey Color.	Quadrant Clamp Dead-Ends (SAP 10067492 or SAP 10067495, see CO 207).	

Table DC 535–1: Wildlife Protection Material *(Continued)*

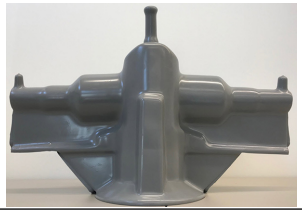
SAP	Description	Applications	Photo
10215386	Quadrant Clamp Dead-end Cover, Small/Medium Size, Grey Color.	Quadrant Clamp Dead-Ends (SAP 10214153 or SAP 10067489, see CO 207).	
10212441	Large Bolted Wedge Connector Cover, to be used on 653 to 653 ACSR conductors.	Bolted Wedge Connector (see CO 420 for appropriate connector sizes).	
10212442	Small Bolted Wedge Connector Cover, to be used on all size conductors except 653 to 653ACSR.	Bolted Wedge Connector (see CO 420 for appropriate connector sizes.	
10200066	Brace Bolt Cover, HDPE Material, Grey Color.	Covering V-Brace Bolt on Crossarms installed on Steel Poles.	
10184084	Wildlife Insulator Cover, Grey Color.	Porcelain Post-Type Insulators (use with SAP 10067847 Extenders).	
10067846	Wildlife Insulator Cover, Grey Color.	Post-Type Insulators and Vice-Top Insulators (use with SAP 10067847 Extenders).	
10213525	Wildlife Insulator Cover, Grey Color.	Trunnion Type Post Insulator (use with SAP 10067847 Extenders)	

Table DC 535–1: Wildlife Protection Material *(Continued)*

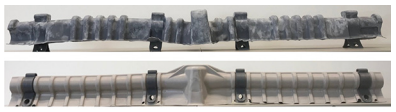
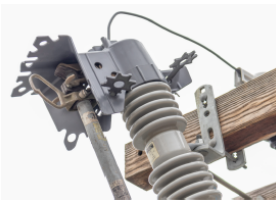
SAP	Description	Applications	Photo
10067847	Extenders for 60" Coverage, Set of 2, Grey Color.	Extenders to be Used with SAP 10184084 or SAP 10067846 Body.	
10184091	Wildlife Insulator Cover, 1-piece, 60", Grey or Tan Color.	Post-Type and Vice-Top Insulators.	
10184097	Wildlife Cutout Cover, Large, XLPE Material, Grey Color.	For 150kV BIL Universal and SMD Porcelain Cutouts (12 and 16kV).	
10184093	Wildlife Cutout Cover, HDPE Material, Grey Color, Equipped with Securing Pins.	For 110/150kV BIL Universal Porcelain and Polymer Cutouts (4, 12, and 16kV).	
10184094	Wildlife Cutout Cover, HDPE Material, Grey Color, Equipped with Securing Pins.	For 110/150/200kV BIL SMD Style Porcelain Cutouts (4, 12, 16, and 33kV).	
10215936	Wildlife Cutout Cover, HDPE Material, Grey Color.	Stainless Steel Polymer Cutouts (see PR 129).	
10117060	Non-split Tubing, 5/16" ID × 2' Long, 5/32" Wall Thickness, PVC Material, Grey Color.	#6 Bare Cu — #2 Cu Str.	

Table DC 535–1: Wildlife Protection Material *(Continued)*

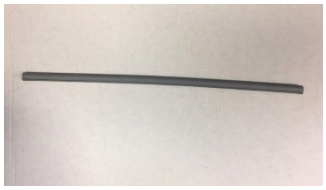
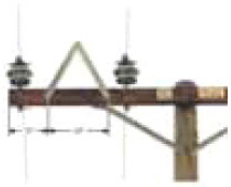
SAP	Description	Applications	Photo
10117061	Non-split Tubing, 0.45" ID × 2' Long, 5/32" Wall Thickness, PVC Material, Grey Color.	#2 Cu Str. — 1/0 ACSR	
10117062	Non-split Tubing, 3/4" ID × 2' Long, 5/32" Wall Thickness, PVC Material, Grey Color.	336.4 kcmil ACSR	
10147890	Split-Tube Conductor Covering, 3/8" ID × 2' Long, (25) Per Box, Ozone Resistant Rubber Material, Grey Color.	Covering for Primary Conductors, #6 Cu — 1/0 ACSR	
10200336	Split-Tube Conductor Covering, 3/8" ID × 50' Long Coil, Ozone Resistant Rubber Material, Grey Color.	Covering for Primary Conductors, #6 Cu — 1/0 ACSR	
10180176	Split-Tube Conductor Covering, 5/8" ID × 50' Long Coil, Ozone Resistant Rubber Material, Grey Color.	Covering for Primary Conductors, 2/0 Cu — 336.4 kcmil	
10180177	Split-Tube Conductor Covering, 3/4" ID × 25' Long Coil, (2) Coils Per Box, Ozone Resistant Rubber Material, Grey Color.	Covering for Primary Conductors, 653–750 kcmil	
10109302	Protected Ground Wire (PGW), LDPE, #6 AWG CU.	• Transformer High-Side Bushing Taps • Capacitor Bank Taps (See CO 106 for ampacities)	
10109304	Protected Ground Wire (PGW), LDPE, #4 AWG CU	• Transformer High-Side Bushing Taps • Capacitor Bank Taps (See CO 106 for ampacities)	
10224292	Protected Ground Wire (PGW), LDPE, #2 AWG CU	• Transformer High-Side Bushing Taps • Capacitor Bank Taps (See CO 106 for ampacities)	

Table DC 535–1: Wildlife Protection Material ***(Continued)***

SAP	Description	Applications	Photo
10067816	Triangular Wildlife Guard, Adjustable, 2-1/4" × 24-1/4", Polyethylene Material	To be Mounted on Crossarms between Phases. Note: Contact Environmental Services for approval.	

= For Reference Only

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.

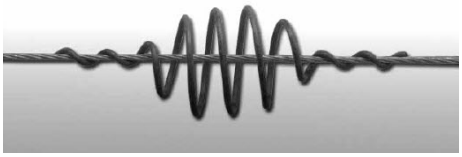
Note(s): Eagle Zones with Exception Rules

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 535–14: Swan Diverter



If required, Swan Diverters shall be installed starting 15 feet from the pole, at 15 foot intervals, per Figure DC 535–15.

Figure DC 535–15: Swan Diverter Installation

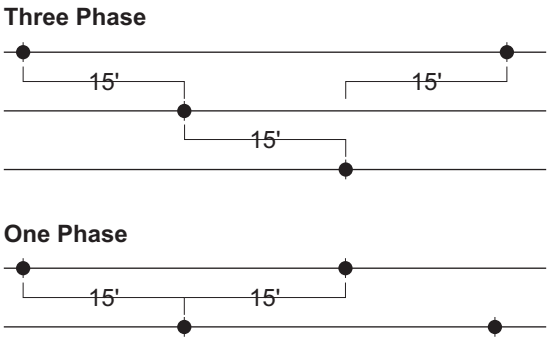


Table DC 535–3: Swan Diverters for Bare Conductor Application

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.

This page intentionally left blank.

DC 536P Nesting Platform Construction

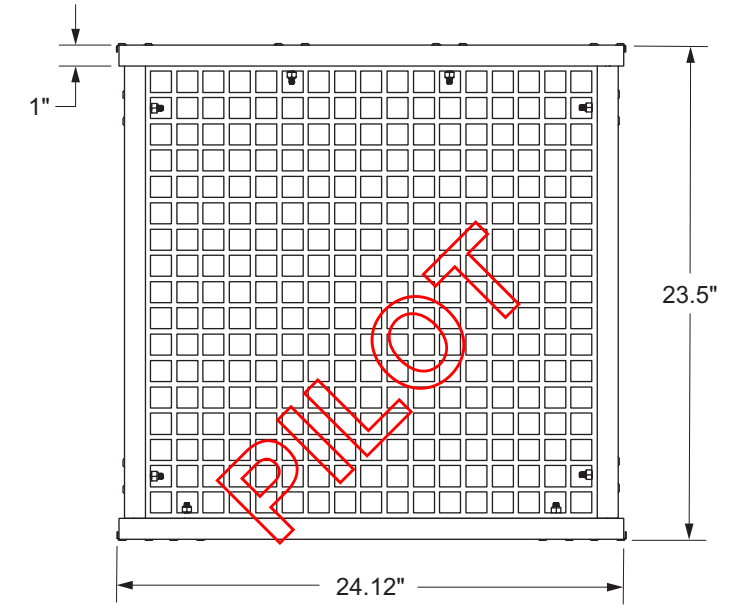
Scope DC 536P.1 Nesting Platform Construction

1.0 General Information

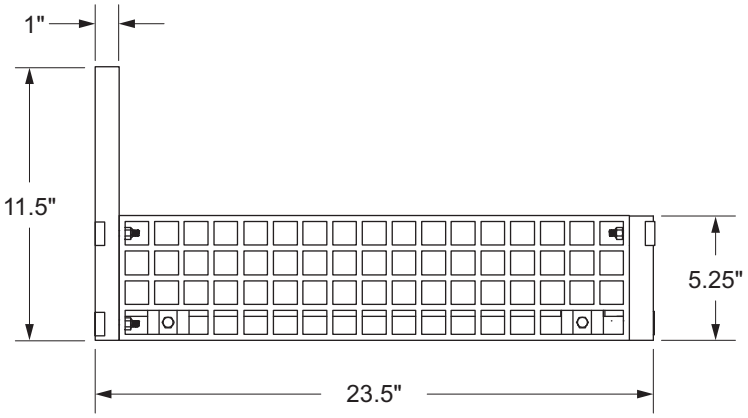
Nesting platforms are intended to mitigate against outages and damage to electrical equipment caused by contact with bird nests. This standard is intended to guide field personnel on the construction of nesting platforms in various configurations that include: on a bare pole, on a pole with existing 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



TOP VIEW

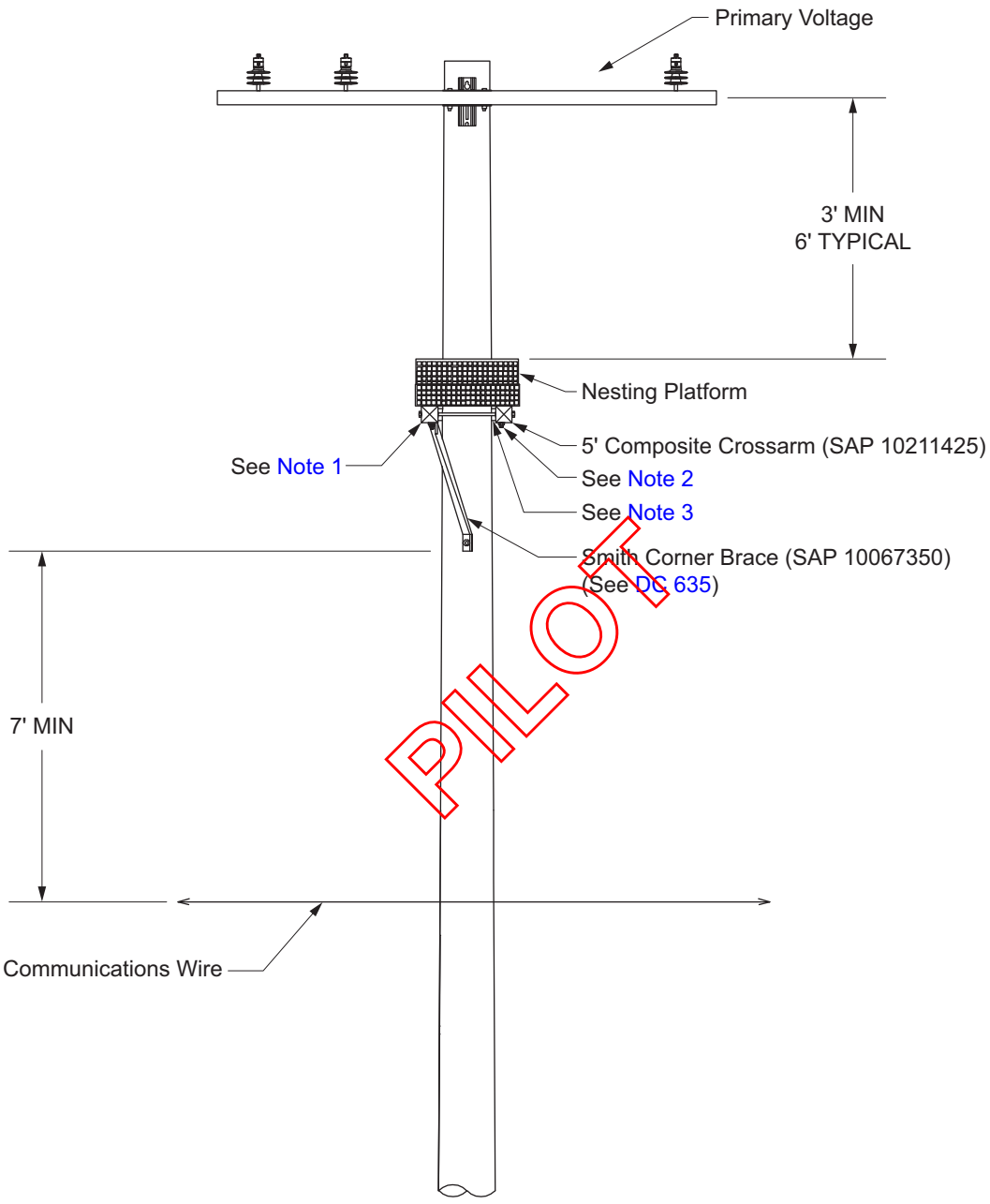


Weight: 22 lb

SIDE VIEW

Scope DC 536P.2 Nesting Platform Construction on Bare Pole

Figure DC 536P–2: Nesting Platform on Bare Pole

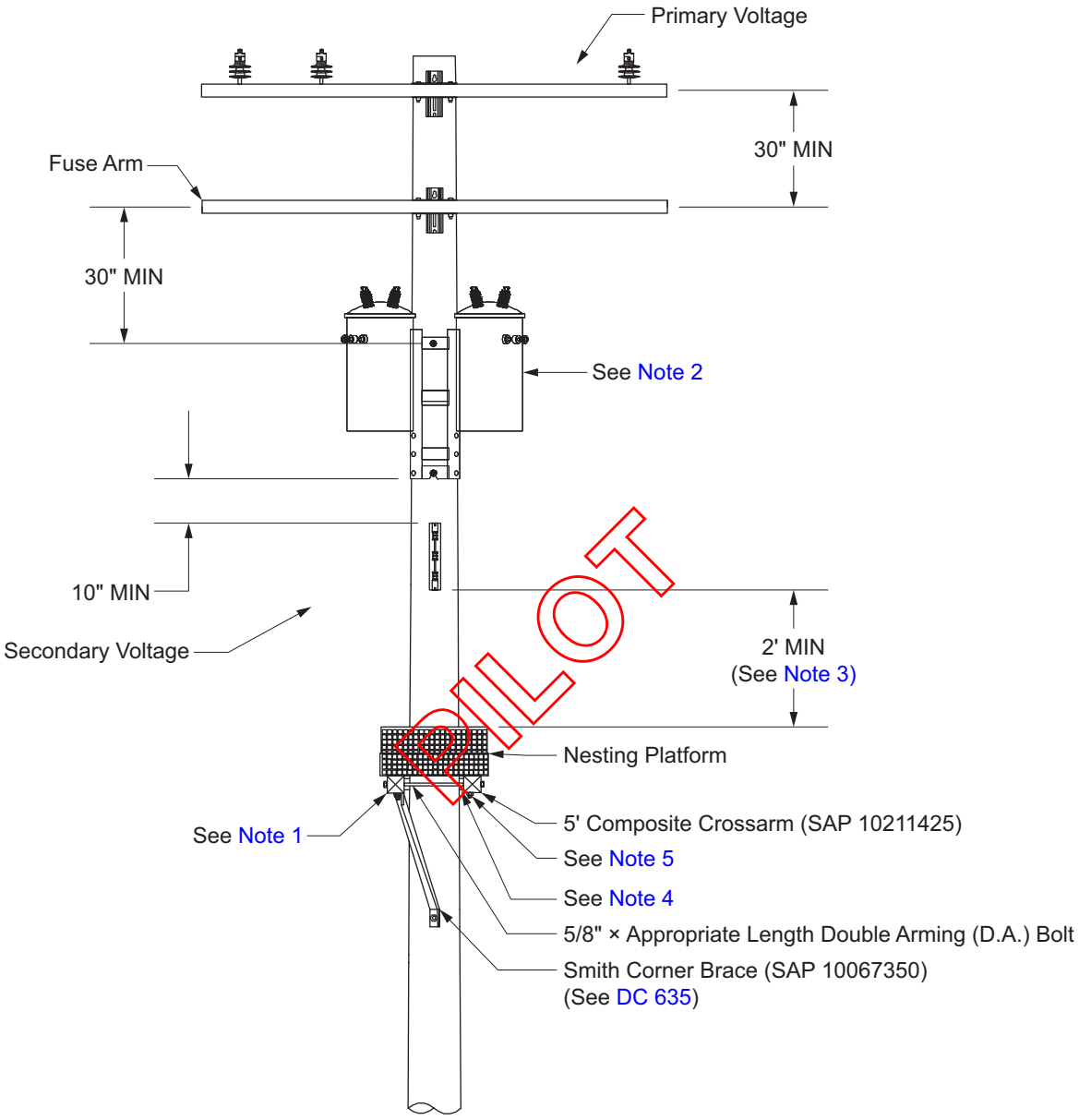


Note(s):

1. Use two (2) 5-foot composite crossarms in “alley arm” configuration using one smith corner brace and a 5/8" × appropriate length Double Arming (D.A.) Bolt using flat washers between the base and arm. Add 4” flat square washer between arm and smith corner brace.
2. To fasten nesting platform onto crossarm, use two (2) 5/8" × 8" bolts one on each cross arm installed diagonally from each other with a 4-inch flat square washer between the bolt head and on the underside of the composite 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



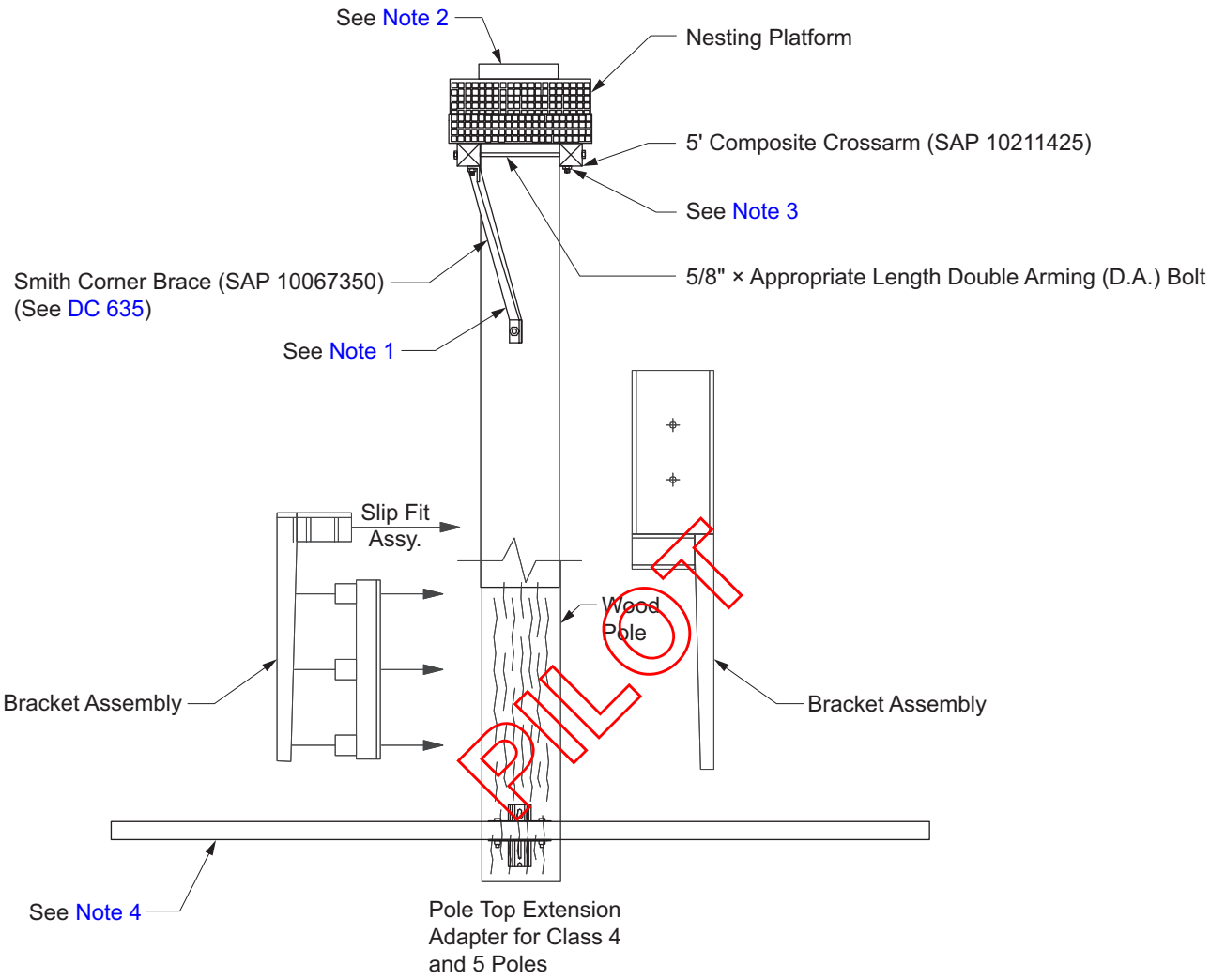
PILOT

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 flat washers between the base and arm. Add 4” flat square washer between arm and smith corner brace.
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 nesting platform, use two (2) 5/8" × 8" bolts one on each cross arm installed diagonally from each other with a 4-inch flat square washer between the bolt head and nesting platform, and on the underside of the composite 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 flat washers between the base and arm. Add 4” flat square washer between arm and smith corner brace.
2. A 7-foot pole top extension (SAP 10067761) is shown (see Scope PO 150.1).
3. To fasten nesting platform, use two (2) 5/8" × 8" bolts one on each cross arm installed diagonally from each other with a 4-inch flat square washer between the bolt head and nesting platform, and on the underside of the composite 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





PILOT

This page intentionally left blank.

DC 537 Nesting Deterrent Pucks

Scope DC 537.1 Application of Nesting Deterrent Pucks

1.0 General Information and Application

Nest deterrent pucks are small 2.5” magnetic dishes that are filled with gel material that is designed to prevent birds from creating a nest on equipment. They are to be installed on a true magnetic surface and have an expected useful life of 5 years.

Figure DC 537–1: Nest Deterrent Puck



The magnetic nest deterrents are approved for use in the following applications/scenarios.

— Transformers located in nest prone areas
  - Pucks can be applied during nest removal activities, opportunity maintenance, or new installations as a preventative effort

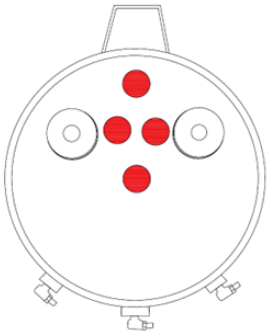
— Overhead Apparatus Equipment maintained by Distribution Apparatus including capacitor banks, reclosers, regulators, and switches.

Puck quantity can vary depending on the equipment involved. In all cases, pucks should be spaced 6-10 inches between each other. Additional details for installing the pucks can be found in Figures 537-2 through 537-4.

Table DC–1: Nest Deterrent Puck Material

Description	SAP
Nesting Deterrent Pucks - Box (200-count)	10223818
Nesting Deterrent Pucks - Box (24-count)	10223027

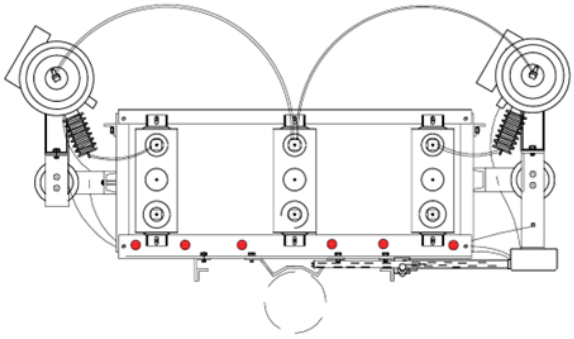
Figure DC 537–2: Typical Transformer/Regulator Installation



Note(s):

1. Pucks should be placed closer to the surface of the pole and bushings due to typical placement of nests.
2. A minimum of 4 pucks should be used for transformers and regulators.
3. Power Partners (PPI) transformers use non-magnetic material for the transformer lid. If pucks are required on PPI transformers, use X as an adhesive.

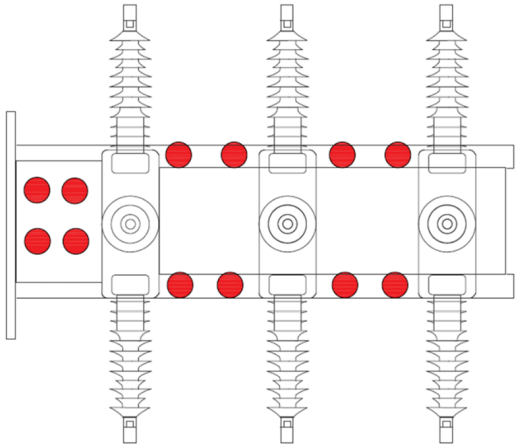
Figure DC 537–3: Typical Capacitor Bank Installation



Note(s):

1. Pucks should be placed on the galvanized steel mounting frame.

Figure DC 537–4: Typical Recloser Installation



Note(s):

1. Pucks should be placed on the galvanized steel mounting frame around the recloser and/or in the space between the recloser tank and mounting frame. Pucks will not remain in place if placed directly on the recloser tank.

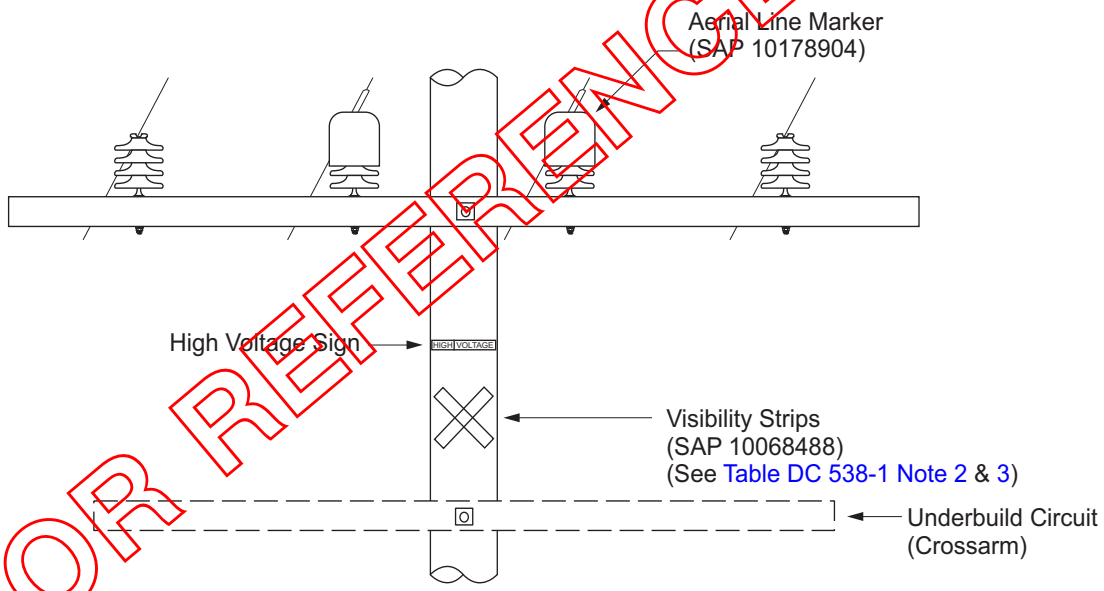
Scope DC 537.2 Aerial Line Marker

1.0 Aerial Line Marker

Aerial Line Markers (orange-colored hoods) and 'X' Markers (visibility strips configured as an 'X', see Figure DC 537–6) 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 537–5: Installation of Aerial Line Marker (Typical)



3-Wire or 4-Wire Construction with Aerial Line Markers

FOR REFERENCE ONLY

Figure DC 537–6: Distribution Poles that Shall Be Marked at an Overhead Transmission-Distribution Line Crossing

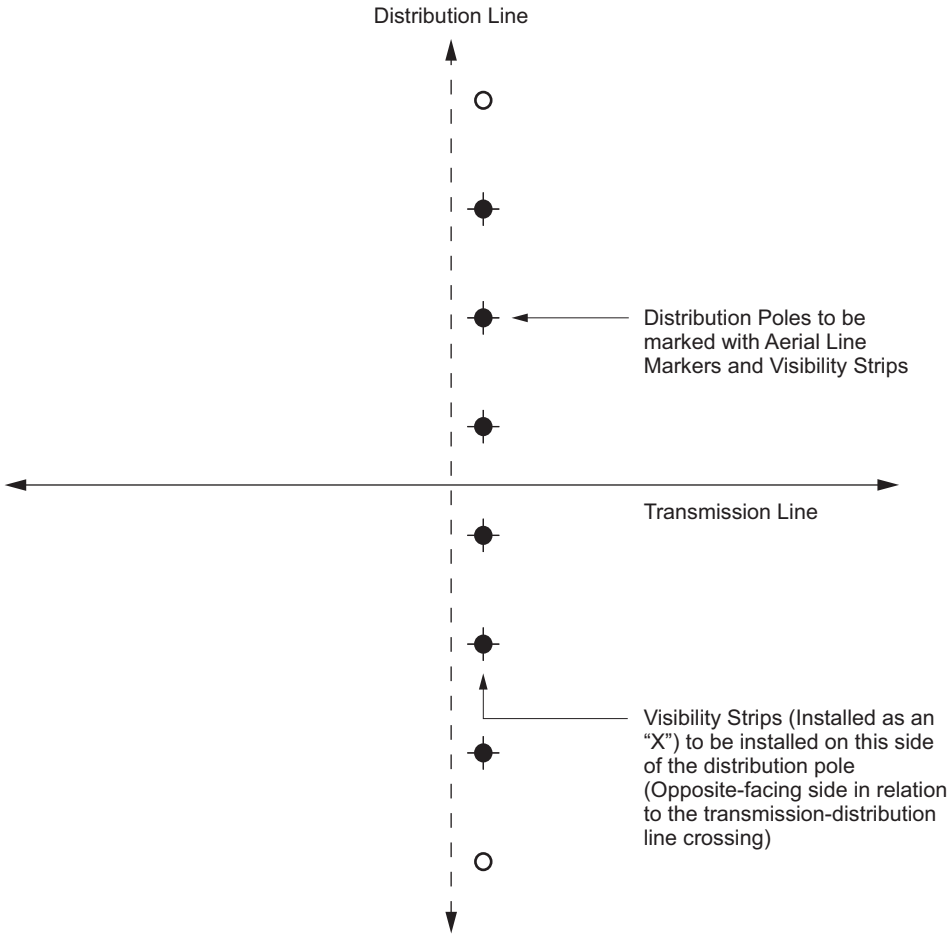


Table DC 537–2: Aerial Line Markers for Distribution Insulators

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):

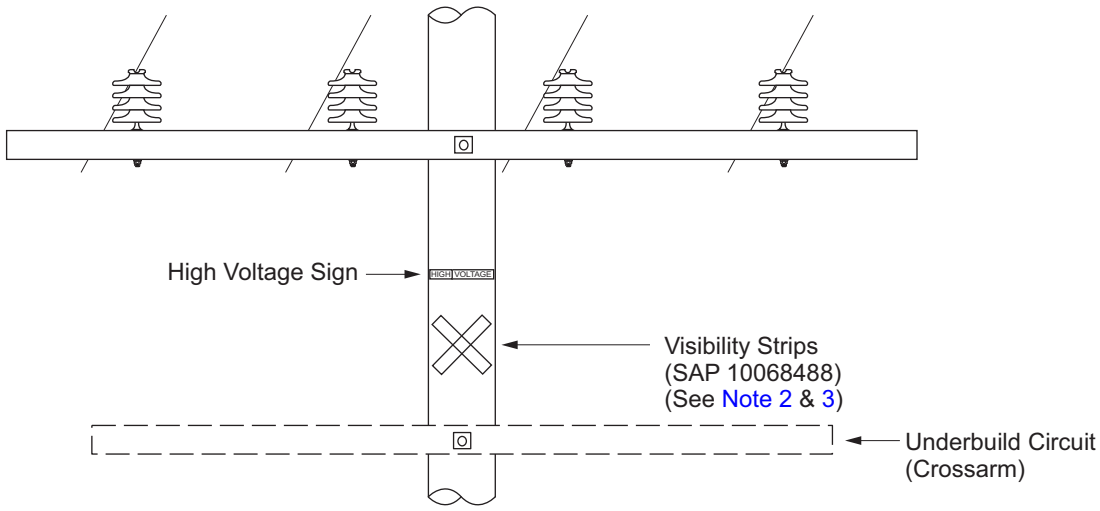
2. Aerial Line Markers (orange-colored hoods) are only to be installed on distribution poles as agreed upon by Air Ops.
3. Where transmission lines cross over distribution lines, four Visibility Strips (SAP 10068488) shall be installed in an ‘X’ configuration in conjunction with the installation of Aerial 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 537–6).
4. 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.
5. See PO 120 for HIGH VOLTAGE sign installation requirements.

DC 538 Line Crossing Marker

Scope DC 538.1 Line Crossing Marker

The “X” Markers (visibility strips configured as an X) shall be installed on the three distribution poles immediately preceding and following a transmission-distribution line crossing. See Figure DC 538-1 and Figure DC 538–2.

Figure DC 538–1: Installation of Visibility Strips (Typical)

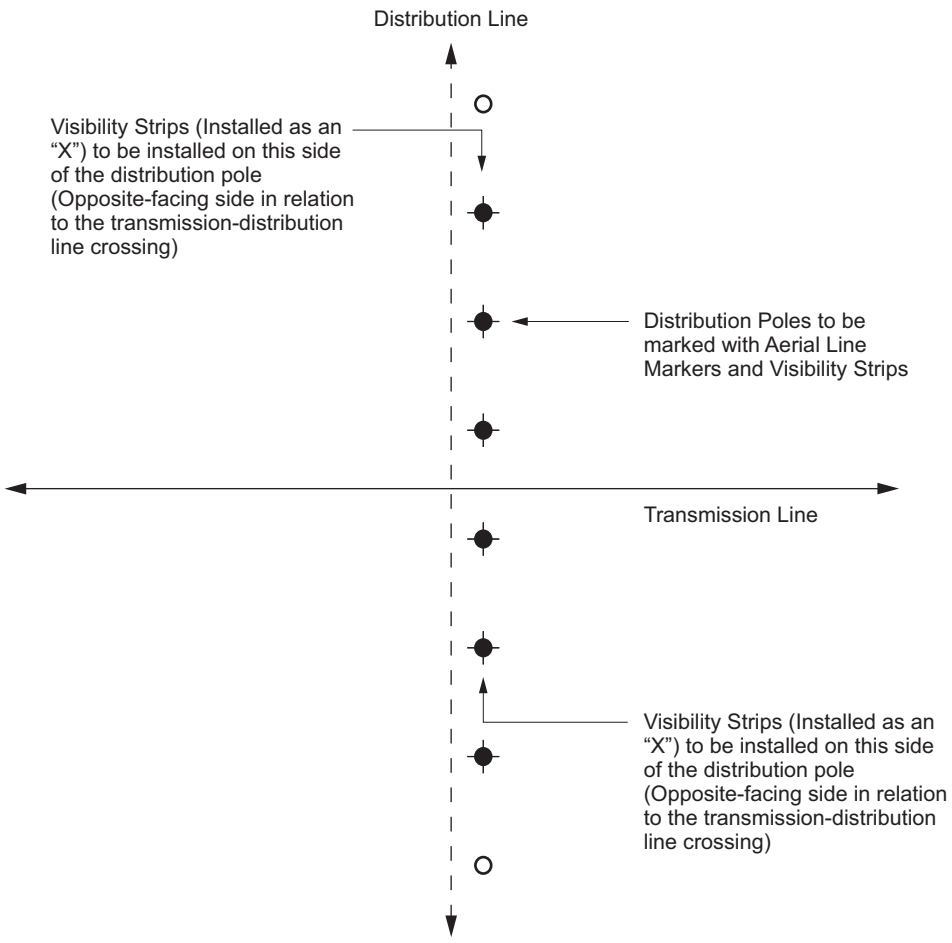


3-Wire or 4-Wire Construction with Visibility Strips

Note(s):

1. Where transmission lines cross over distribution lines, Visibility Strips (SAP 10068488) shall be installed in an “X” configuration. 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).
2. The “X” visibility strips ARE NOT to be used at locations where there are no transmission-distribution line crossings.
3. See PO 120 for HIGH VOLTAGE sign installation requirements.

Figure DC 538–2: Distribution Poles that Shall Be Marked at an Overhead Transmission-Distribution Line Crossing



DC 538 Aerial Line Marker

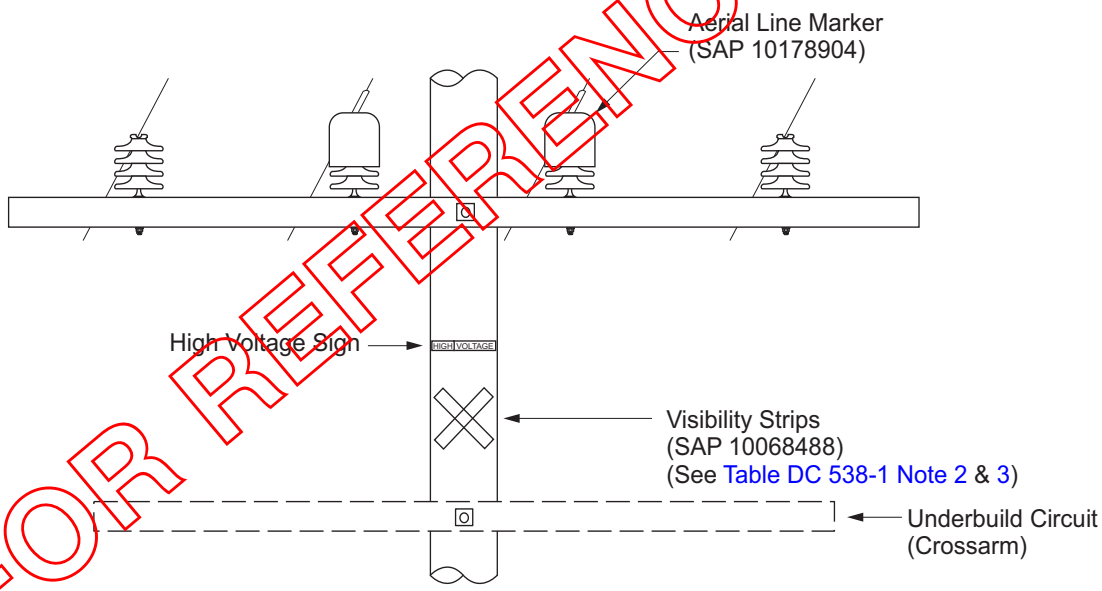
Scope DC 538.2 Aerial Line Marker

1.0 Aerial Line Marker

Aerial Line Markers (orange-colored hoods) and 'X' Markers (visibility strips configured as an 'X', see Figure DC 538–4) 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.

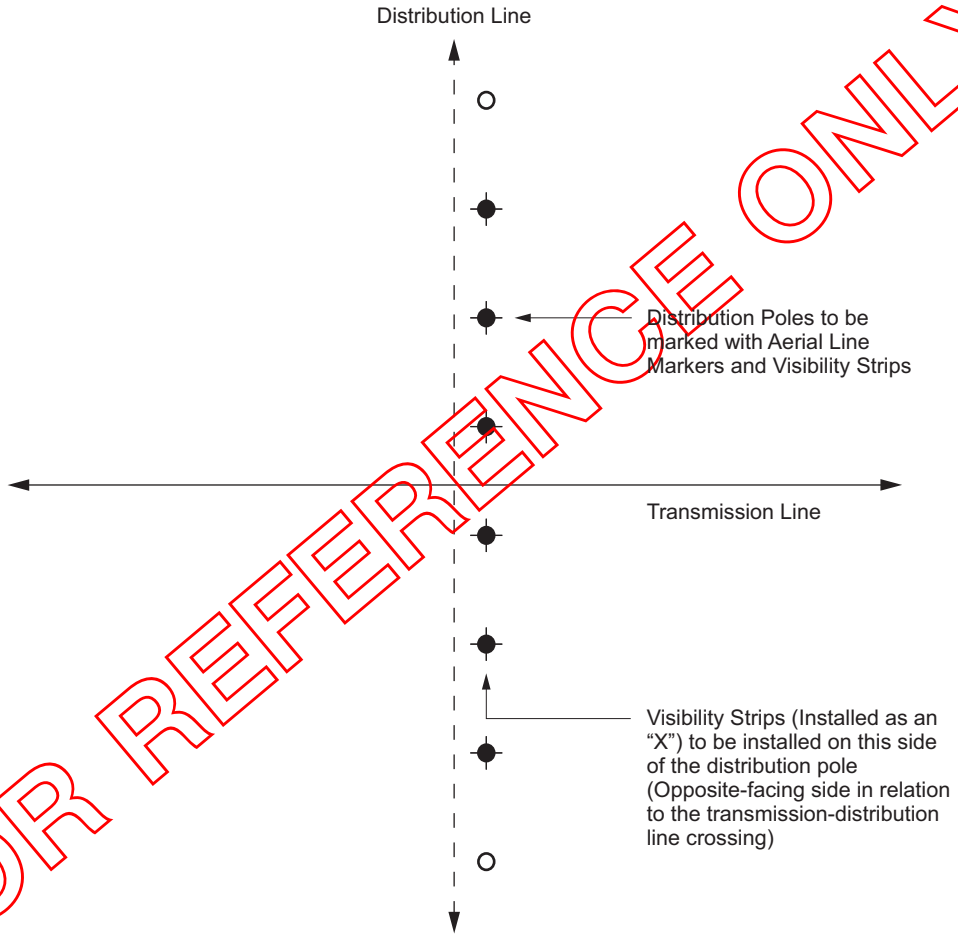
Figure DC 538–3: Installation of Aerial Line Marker (Typical)



3-Wire or 4-Wire Construction with Aerial Line Markers

FOR REFERENCE ONLY

Figure DC 538–4: Distribution Poles that Shall Be Marked at an Overhead Transmission-Distribution Line Crossing



FOR REFERENCE ONLY

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.	

FOR REFERENCE ONLY

Note(s):

4. Aerial Line Markers (orange-colored hoods) are only to be installed on distribution poles as agreed upon by Air Ops.
5. 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 538–4).
6. 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.
7. See PO 120 for HIGH VOLTAGE sign installation requirements.

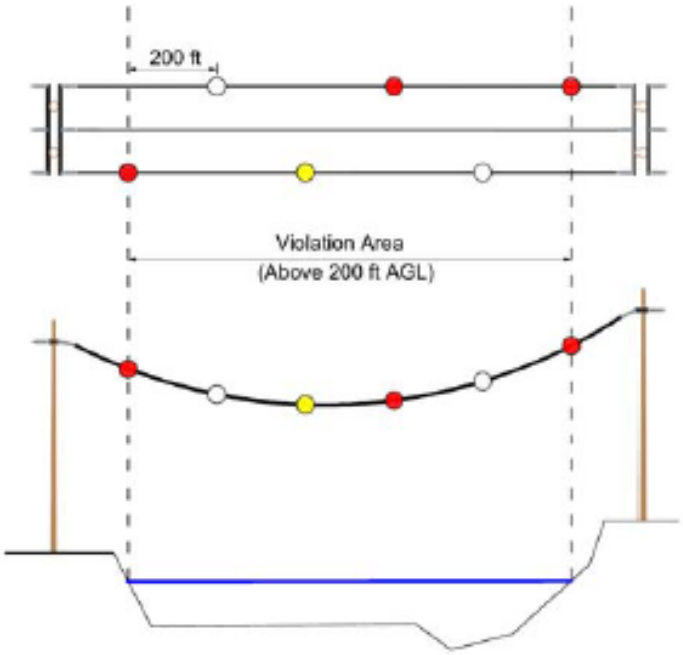
This page intentionally left blank.

DC 539 Aerial Obstruction Marker Balls

Scope DC 539.1 Aerial Obstruction Marker Balls

Aerial obstruction marker balls are spherical markers typically attached to overhead powerlines and shield wire as a visual warning where it could impair aviation safety and they are made in three colors: aviation orange, white and yellow. Transmission/Distribution lines where the height above ground level exceeds 200-feet or are located near airports, heliports, across rivers, canyons, lakes or freeways where an aircraft is likely to approach would require aviation marking. AirOps or the FAA may also designate other locations besides overhead powerline crossing like glide slopes into airports where aerial obstruction marker balls shall be installed. For new construction, contact AFM@SCE.COM to determine if markers are required. These aerial marker balls can be installed on distribution lines if it is the highest conductor on the span. Marker balls shall be evenly spaced along the span at approximately 200-ft intervals. Unlighted markers should alternate between aviation orange, white, yellow with aviation orange markers positioned at each end. When less than four marks are used, they shall all be in aviation orange.

Figure DC 539–1: Installation of Marker Balls (Typical)



Note(s):

1. Reach out to AF&M at AFM@SCE.COM for FAA filing questions, constructing or altering overhead lines spanning rivers, freeways, and canyons or if in doubt.
2. Contact Transmission Engineering for analysis.

1.0 Marker Ball Installation

Figure DC 539–2: Marker Ball Installation



1.1 Application

A. Marker balls for distribution will come with a “FastBall” style clamp for ease of installation. Fastball clamps has a conductor range of 0.39” to 2.75” and will clamp directly onto the bare or covered conductor.

B. For conductors with a diameter of 0.39” or smaller, armor rods will be required prior to the installation of the Fastball Marker Ball.

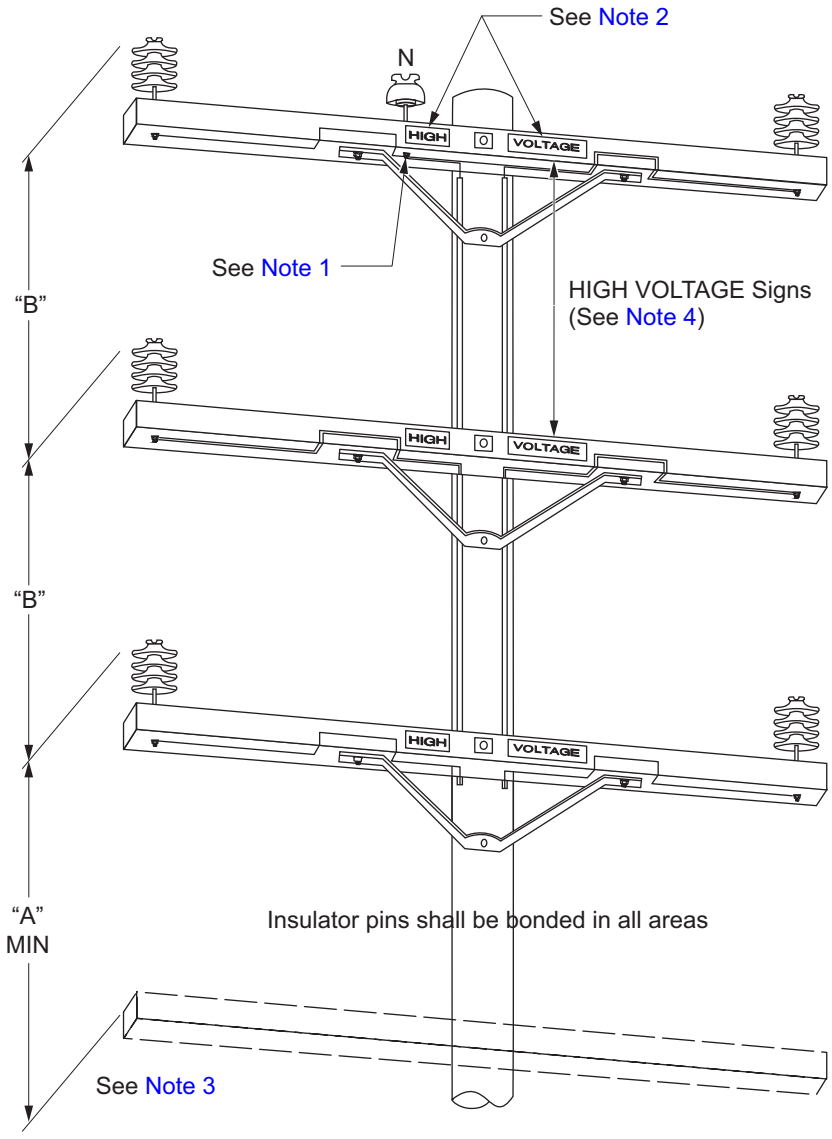
Table DC 539–1: Marker Ball and Armor Rods

Description	SAP #
Marker Ball, Fast Clamp, 20” Sphere in Aviation in Orange	10222061
Marker Ball, Fast Clamp, 20” Sphere in White	10222062
Marker Ball, Fast Clamp, 20” Sphere in Yellow	10222063
Armor Rod for #4 ACSR 6/1 Conductor	10222117
Armor Rod for #2 ACSR 6/1 Conductor	10222118

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"

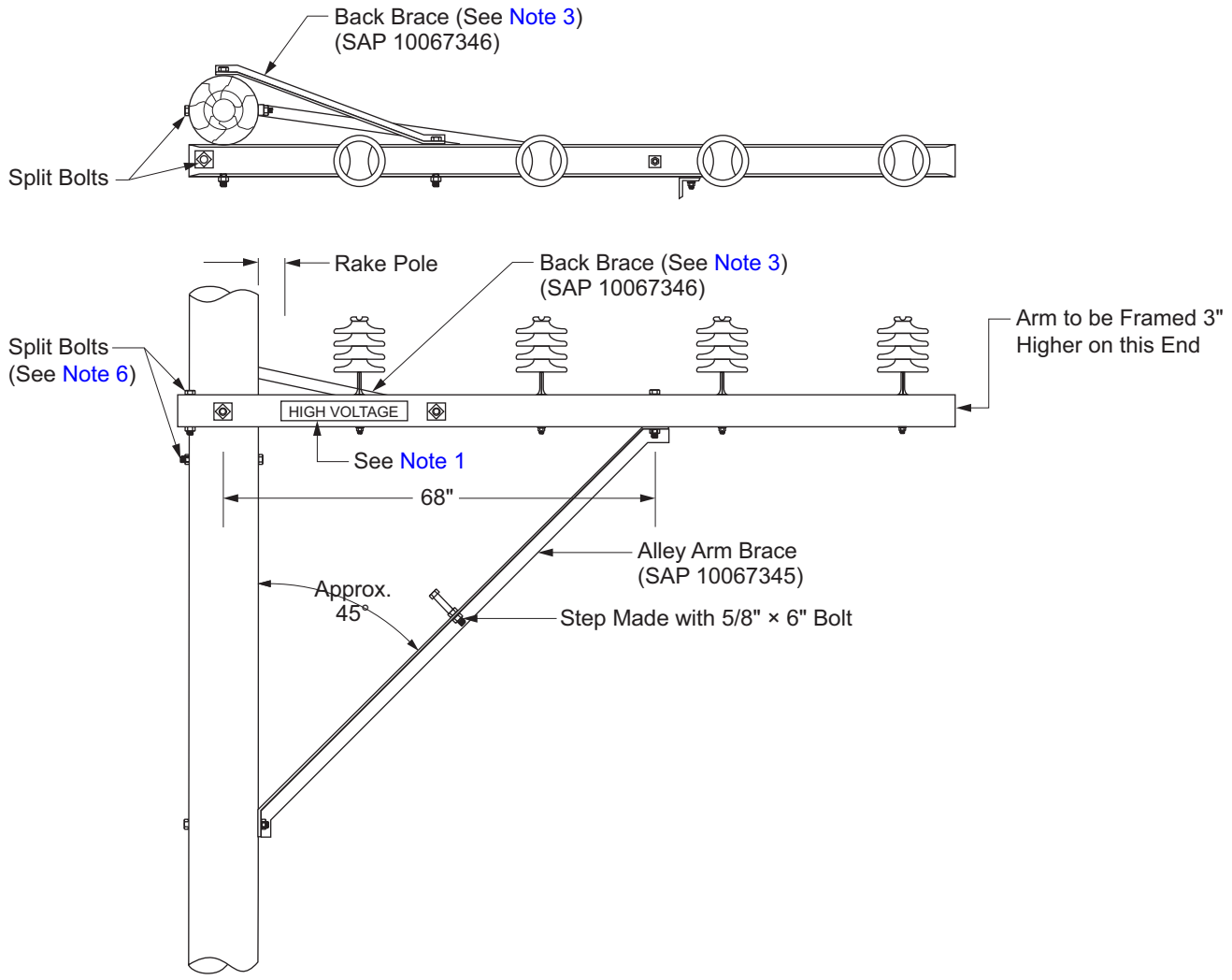
Span Length (ft)	Minimum Conductor Spacing[a/]	
	12/16 kV	25/33 kV
0–300	6'-0"[b/]	6'-0"[b/]
301–499	6'-0"[b/]	6'-0"[c/]

[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

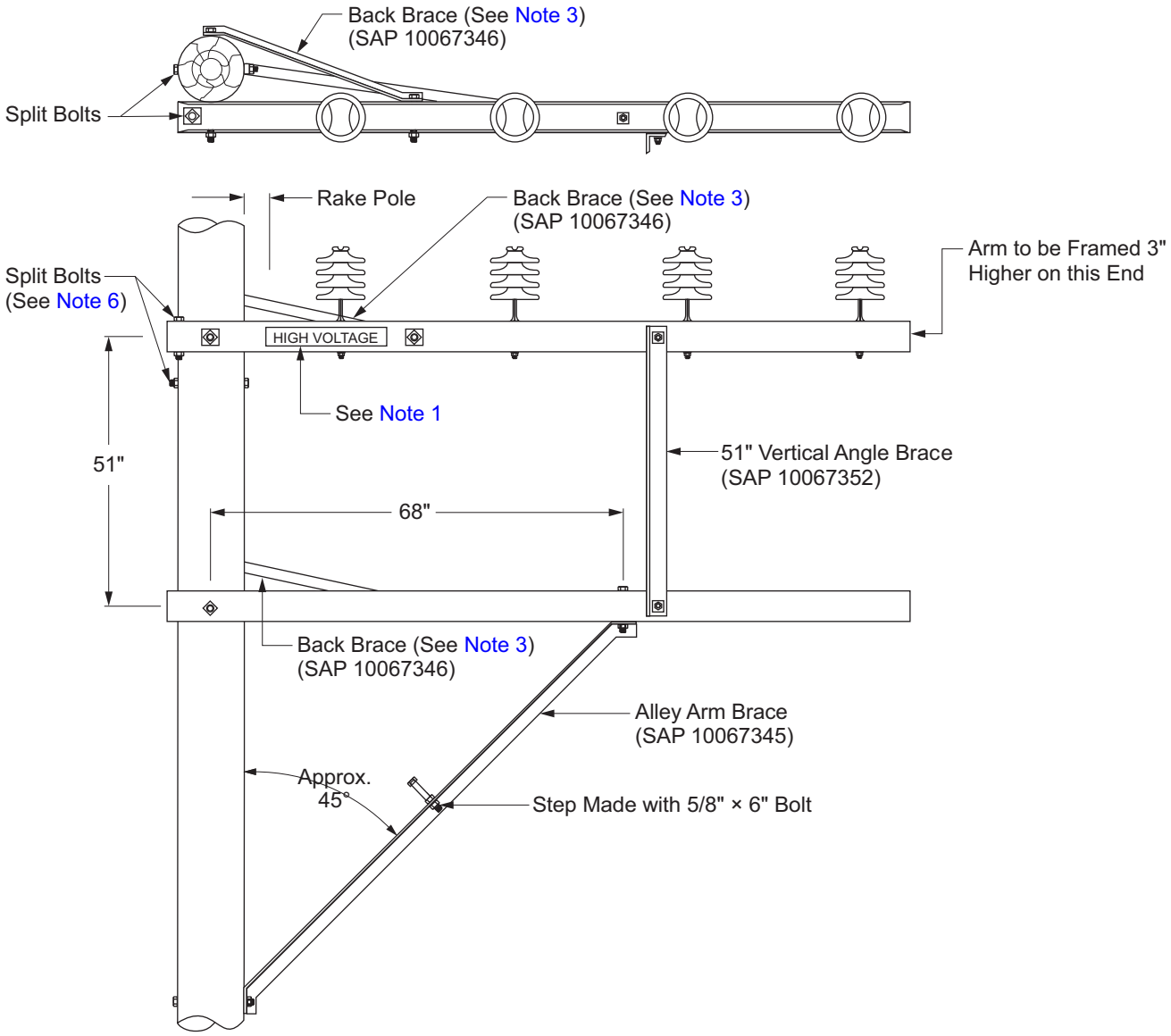
Figure DC 550–1: All Distribution Voltages, 3/4-Wire Alley Arm Construction (Single Arm – Preferred)



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.

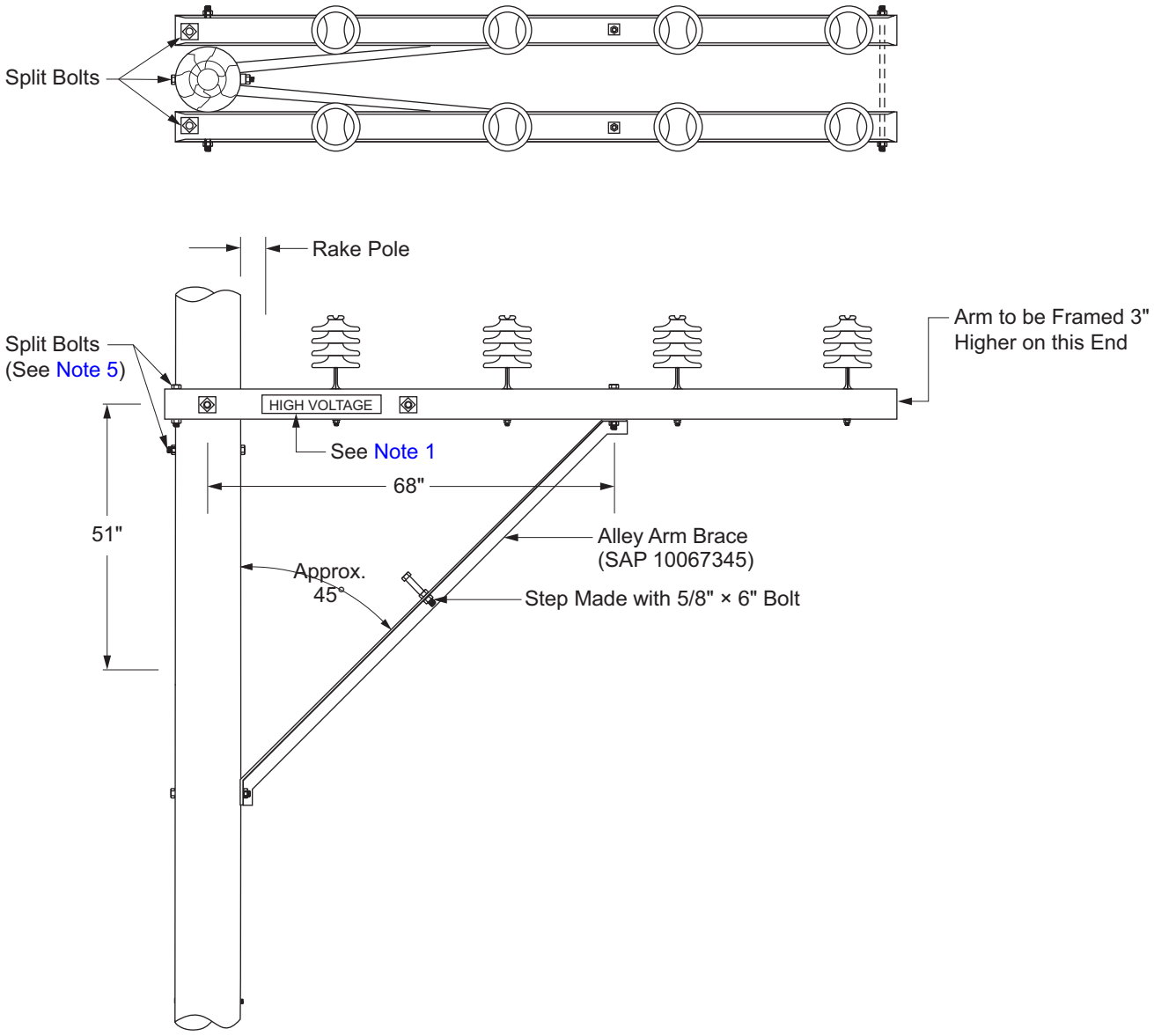
Figure DC 550–2: All Distribution Voltages, 3/4-Wire Alley Arm Construction (Single Arm — Alternate)



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.

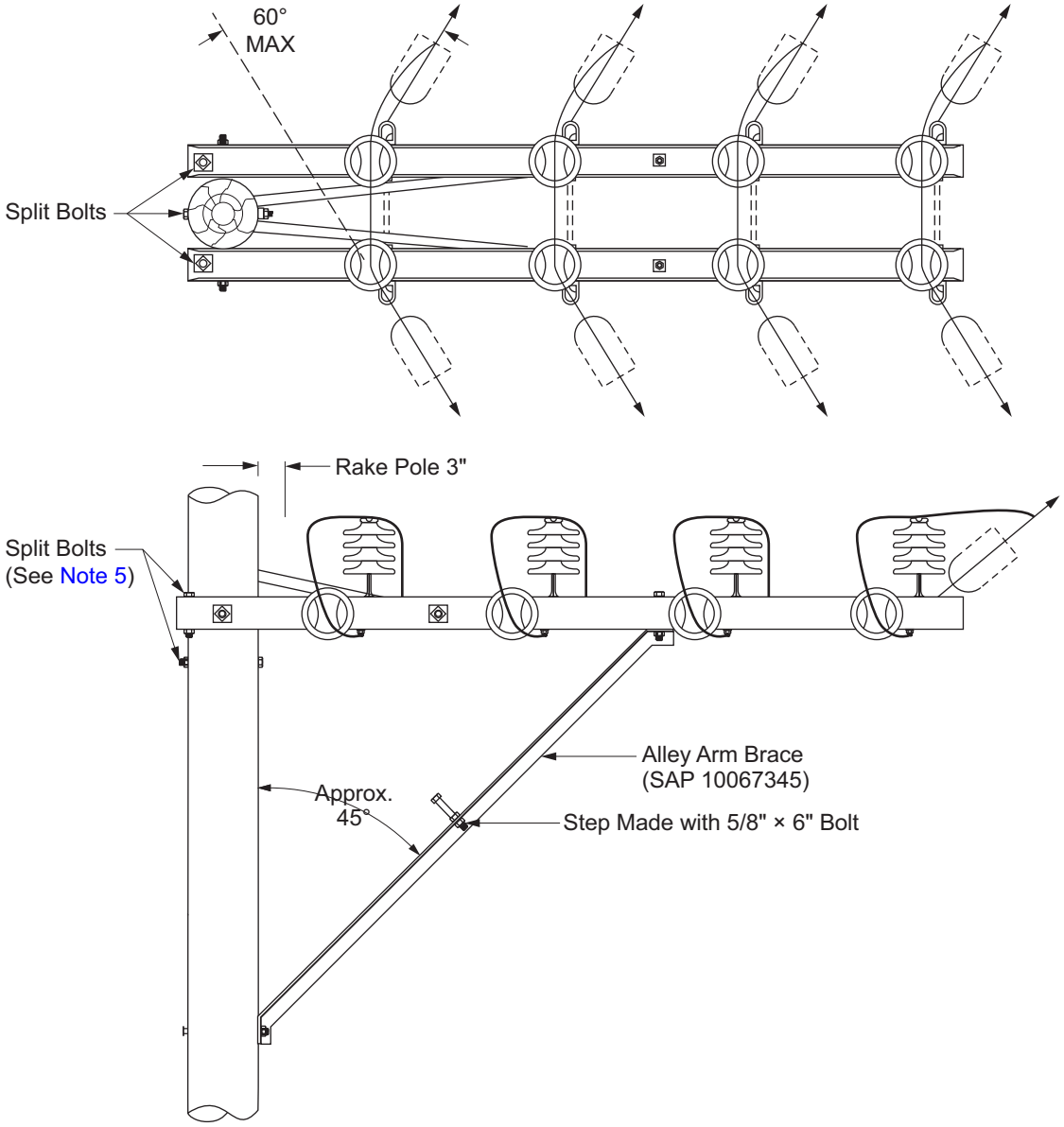
Figure DC 550–3: All Distribution Voltages, 3/4-Wire Alley Arm Construction (Double Arm — Pin and Insulator)



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)

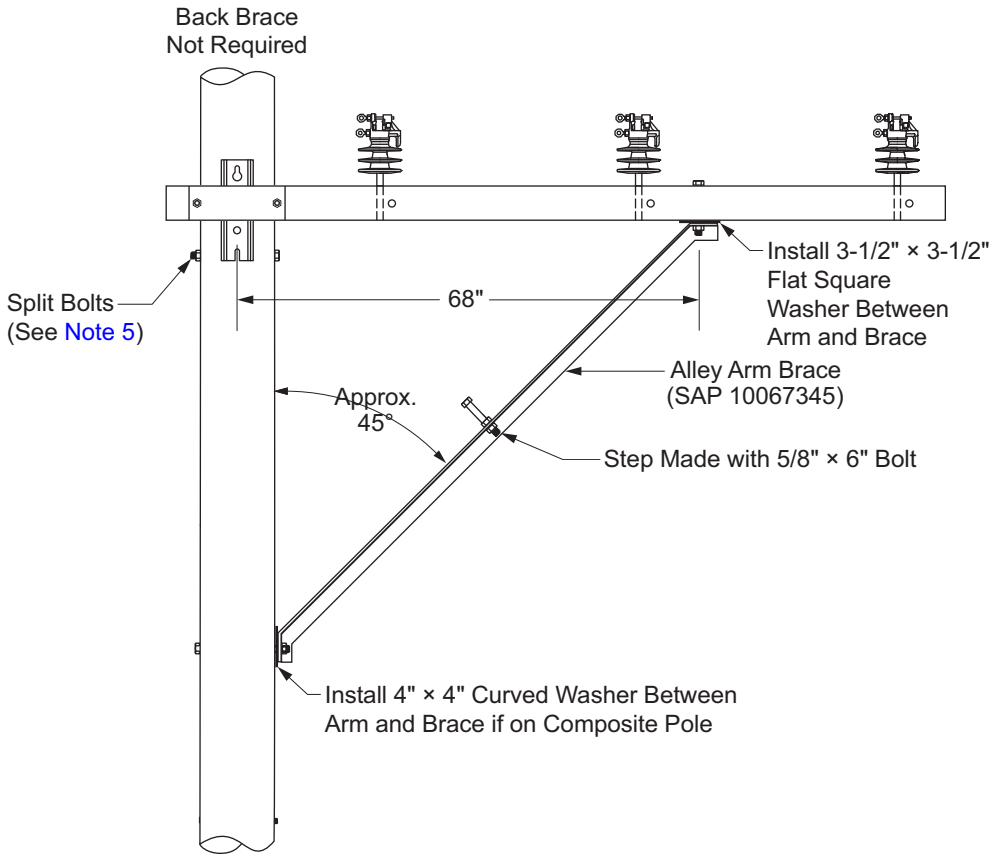


Note(s):

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

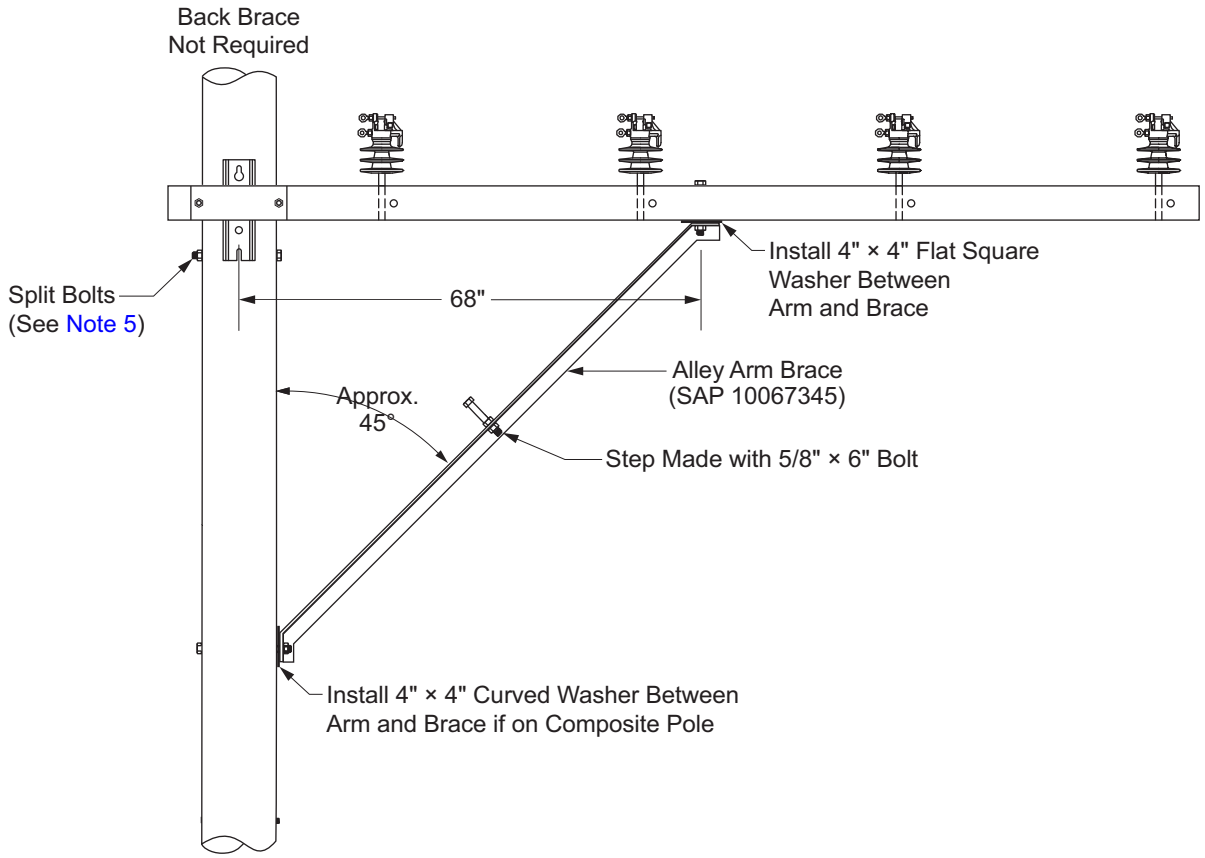
Figure DC 550–5: All Distribution Voltages, 3-Wire Composite Alley Arm Construction — Single 10' Arm



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.
6. For compsite crossarms length 10’ and below, use 3-1/2” x 3-1/2” washers (SAP 10217099).

Figure DC 550–6: All Distribution Voltages, 4-Wire Composite Alley Arm Construction — Single 12' Arm



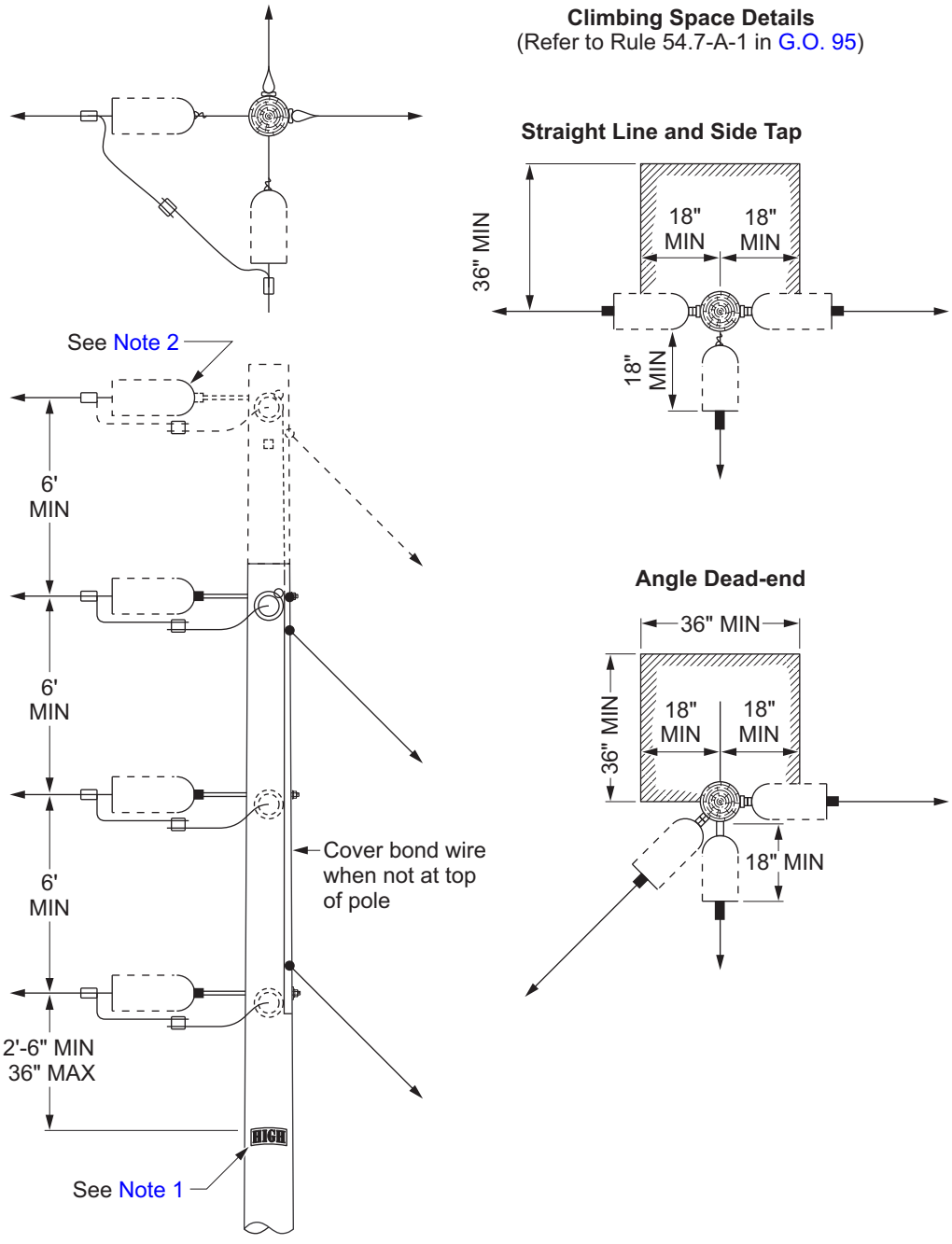
Note(s):

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.
6. For composite crossarms length 12’ and above, use 4” x 4” washers (SAO 10071859).

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.

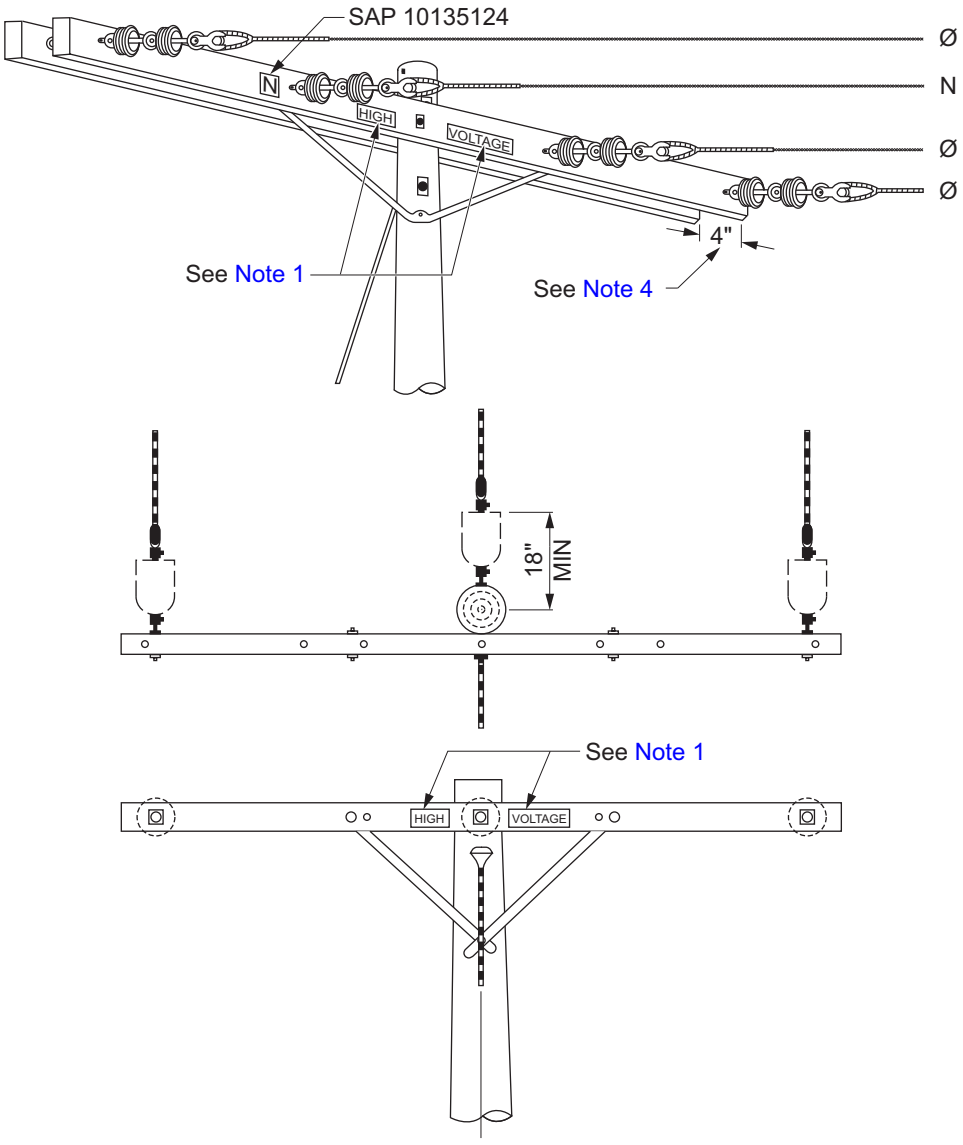
Approved by: RR	12/16/25/33 kV 3/4-Wire Barre Corner Construction	DC 560
Effective Date: 01-29-2021	**What's Changed?** Updated phase-to-phase clearance to 6 feet minimum.	Sheet 1 of 1
		DOH

This page intentionally left blank.

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).

This page intentionally left blank.

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

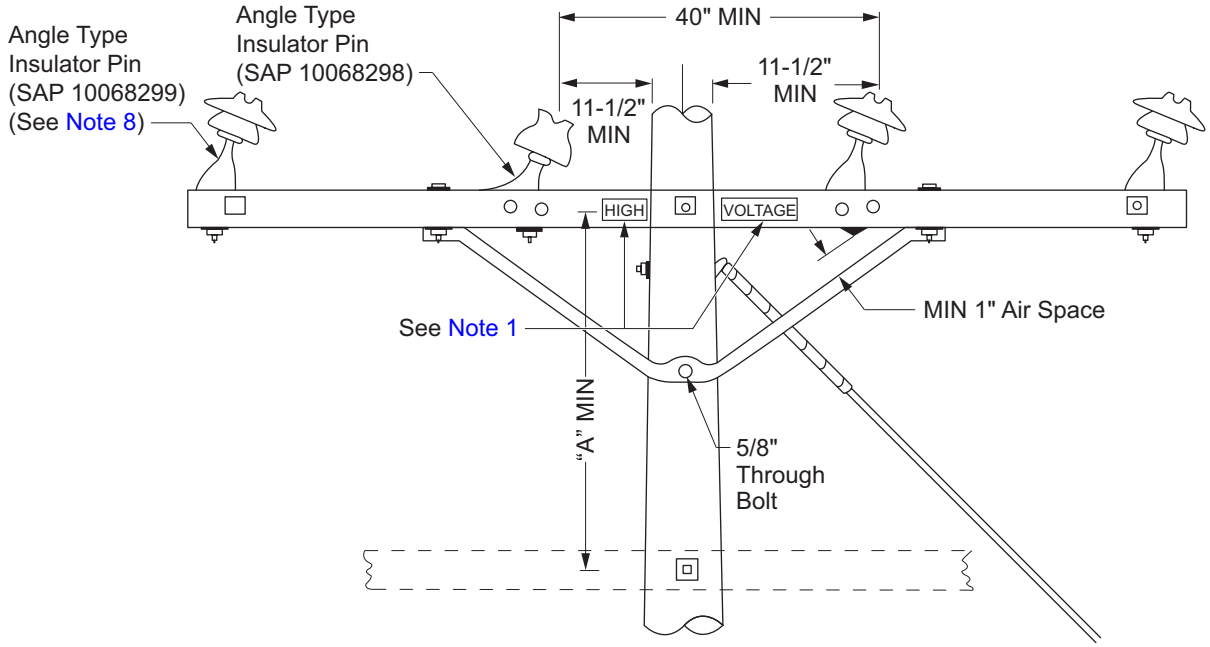


Table DC 575–1: Table for Dimension "A" — 12/16/25/33-kV 3- or 4-Wire Angle Pole Construction

Top Circuit kV	Lower Circuit kV		
	0–7.5	12 or 16	25 or 33
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):

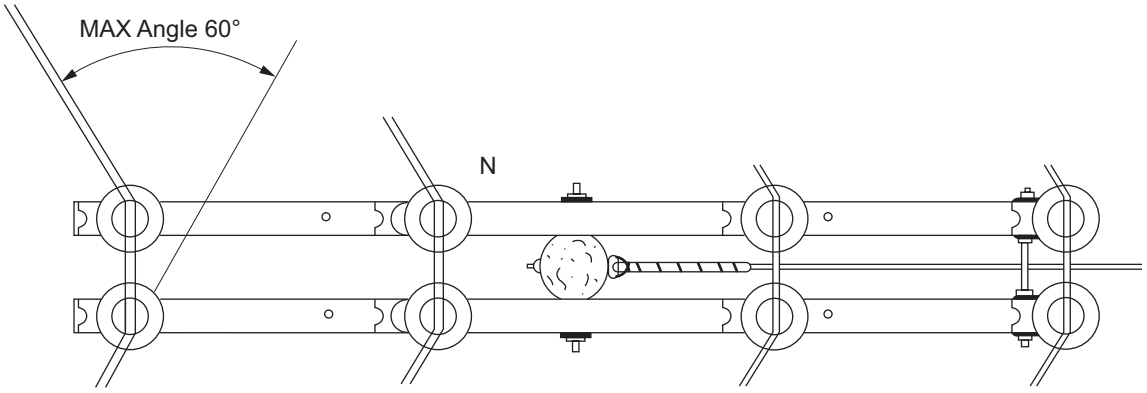
1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. If universal clamps are to be used, see CO Section.
3. Use V-braces for wire sizes larger than #2 copper and 1/0 ACSR.
4. With transmission above, large poles may require one of the following steps to maintain 11-1/2 inches:
   A. Move 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 10216637) 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	
	Single Arm	Double Arm
653.9 ACSR / CC	5	10
336.4 ACSR (30X7) / CC	5	10
336.4 ACSR (18X1) / CC	6	12
101.8 Petrel / CC	5	10
4/0 ACSR Bare[a/]	6	12
1/0 ACSR / CC	13	26
#4 ACSR Bare[a/]	30	60
4/0 CU CC	6	12
2/0 CU CC	10	20
#2 CU CC	20	40
#6 CU Bare[a/]	45	60
350 kcmil CU CC	5	10
500 kcmil CU CC	5	10

[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.

This page intentionally left blank.

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 150–1, 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 150–2, 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

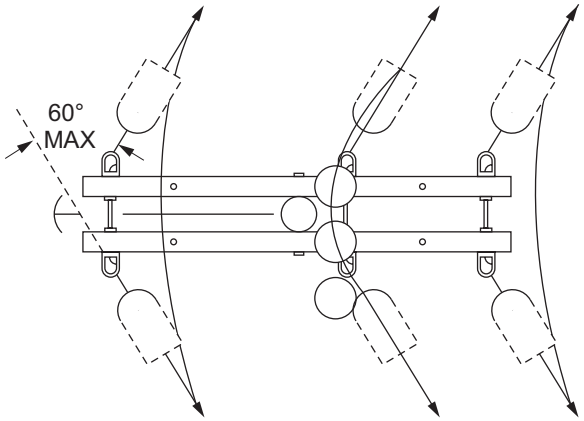


Figure 1

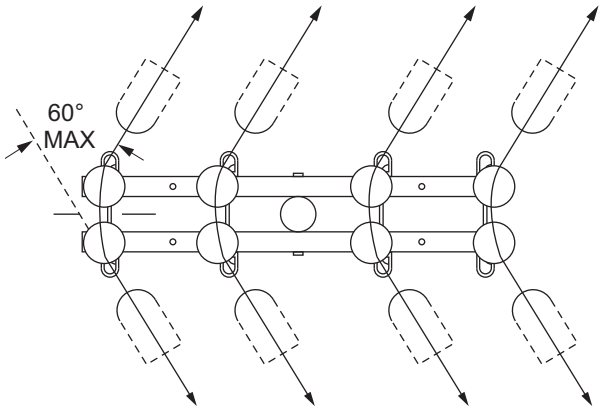
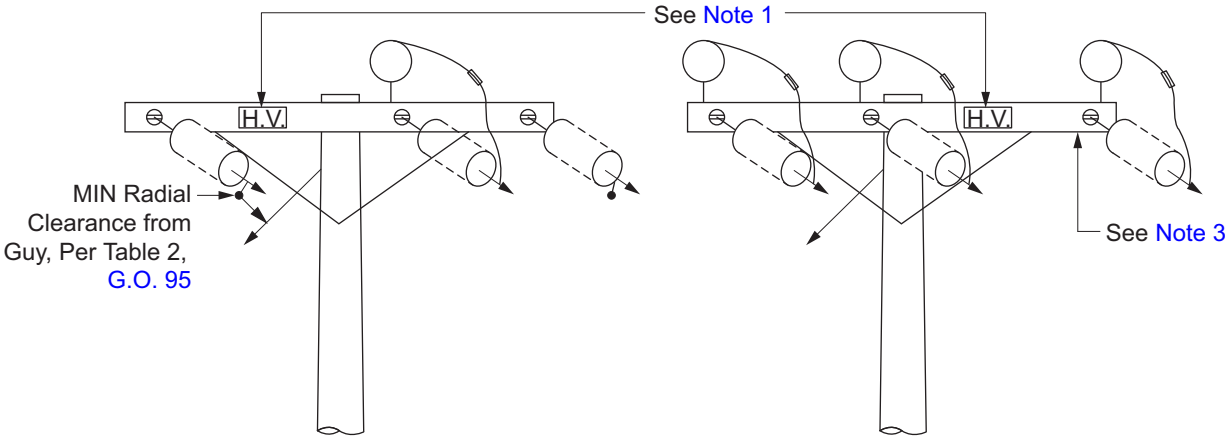


Figure 2



Note(s):

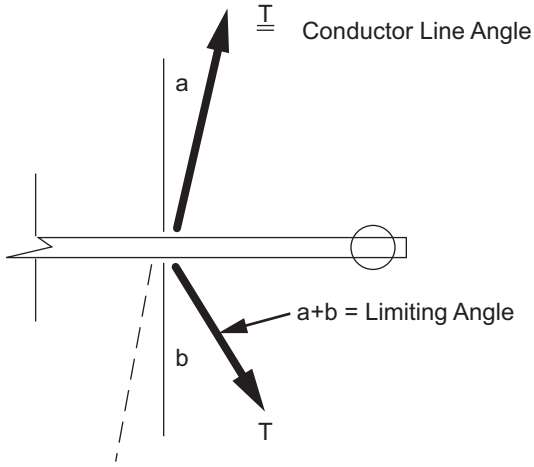
1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. Place jumper under arm as in Figure 1 whenever clearance to circuit below is obtainable. If it is not obtainable, Figure 2 may be used.
3. When 33 kV circuits are below 33 kV or higher-voltage circuits, the conductors shall not be less 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

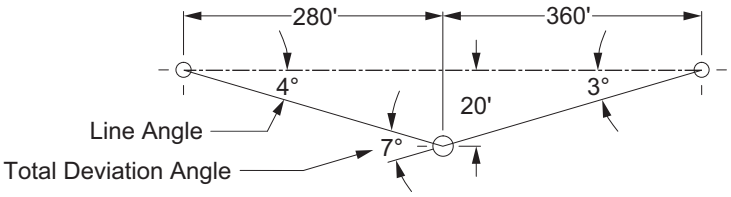
Limiting Deviation Angle = Angle at which side tension does not exceed G.O. 95 safety factor for insulators and hardware.

Figure DC 585–1: Determination of Deviation Angle



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

	Span Length (ft)															
	100	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**	**320**	**340**	**360**	**380**	**400**
1° **2°**	1.5 3.5	2.0 4.0	2.5 5.0	2.8 6.0	3.0 6.5	3.5 7.0	3.8 8.0	4.0 8.5	4.5 9.0	4.8 10.0	5.0 10.5	5.5 11.0	6 12	6.3 12.5	6.6 13.0	7 14
3° **4°**	5 7	6 8	7.5 10.0	8 11	9.5 13.0	10 14	12 15	13 17	14 18	15 20	16 21	17 22	18 24	19 25	20 27	21 28
5° **6°**	8.5 10.5	10 13	12 15	14 17	16 19	17 21	19 23	21 25	23 27	25 29	26 32	28 34	30 36	31 38	33 40	35 42
7° **8°**	12 14	15 17	17 19	20 22	22 25	25 28	27 31	29 34	32 37	34 39	37 42	39 45	42 48	44 51	47 53	49 56
9° **10°**	16 18	19 21	22 25	25 28	29 32	32 35	35 39	38 42	41 46	44 49	48 53	51 56	54 60	57 63	60 67	63 71
11° **12°**	19 21	23 26	27 30	31 34	35 38	39 43	43 47	47 51	51 55	54 60	58 64	62 68	66 72	70 77	74 81	78 85
13° **14°**	23 25	28 30	32 35	37 40	42 45	46 50	51 55	55 60	60 65	65 70	69 75	74 80	78 85	83 90	88 95	92 100
15° **16°**	27 29	32 34	38 40	43 46	48 52	54 57	59 63	64 69	70 75	75 80	80 86	86 92	91 97	96 103	102 109	107 115
17° **18°**	31 32	37 39	43 45	49 52	55 58	61 65	67 71	73 78	79 84	86 91	92 97	98 104	104 110	110 117	116 123	122 130
19° **20°**	34 36	41 44	48 51	55 58	62 66	69 73	76 80	83 87	90 95	96 102	103 109	110 116	117 124	124 131	131 138	138 146
21° **22°**	38 40	46 48	54 57	61 65	69 73	77 81	84 89	92 97	100 105	107 113	115 121	123 129	131 137	138 145	146 154	154 162
23° **24°**	42 45	51 53	59 62	68 71	76 80	85 89	93 98	102 107	110 116	119 125	127 134	136 142	144 151	153 160	161 169	170 178
25° **26°**	47 49	56 59	65 68	75 78	84 88	93 98	103 107	112 117	121 127	131 137	140 146	149 156	159 166	168 176	177 185	187 195
27° **28°**	51 53	61 64	71 74	82 85	92 96	102 106	112 117	122 128	132 138	143 149	153 160	163 170	173 181	183 191	194 202	204 213
29° **30°**	55 58	67 69	78 81	89 92	100 104	111 115	122 127	133 139	144 150	155 162	166 173	177 185	188 196	200 208	211 219	222 231

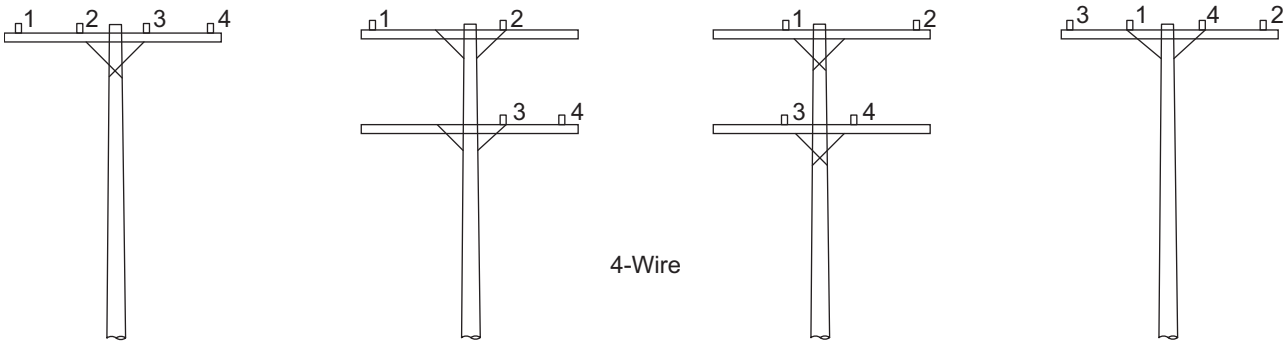
OUT OF LINE DISTANCE

This page intentionally left blank.

DC 586 3- and 4-Wire Transposition and Transition Construction

Scope DC 586.1 3- and 4-Wire Transposition Construction

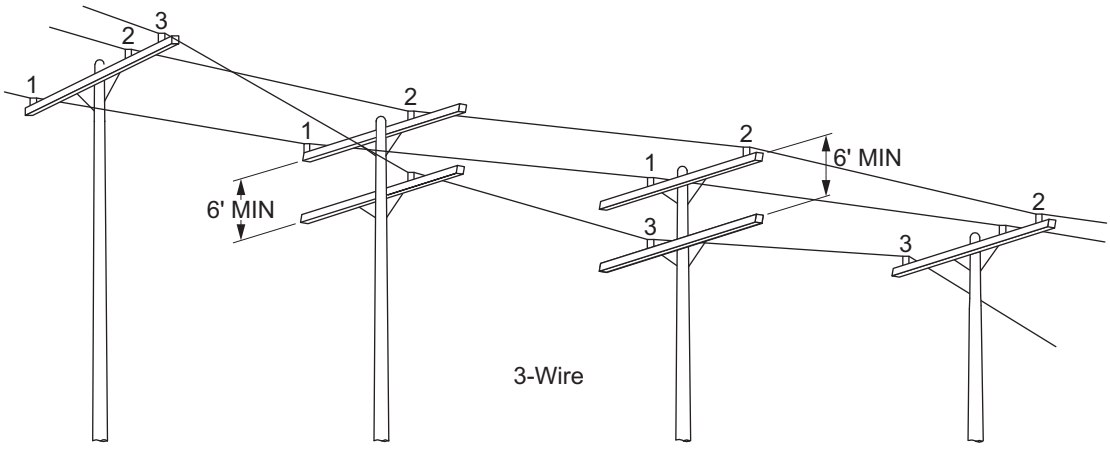
Figure DC 586–1: 3- and 4-Wire Transposition Construction



4-Wire

MAX Span For:

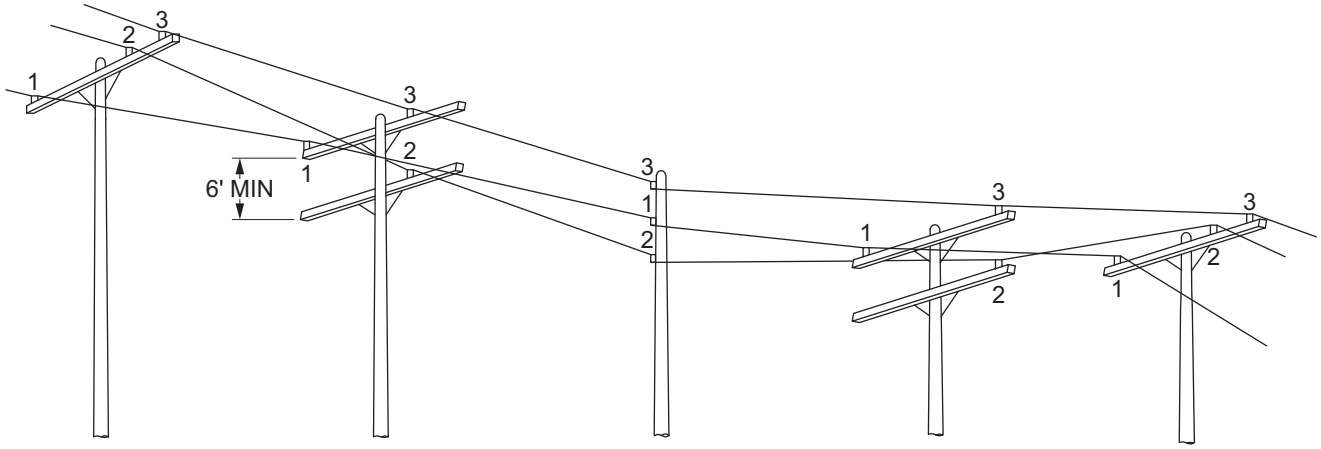
0-10 Percent Slope is 440 ft
10-30 Percent slope is 400 ft
30-45 Percent Slope is 360 ft



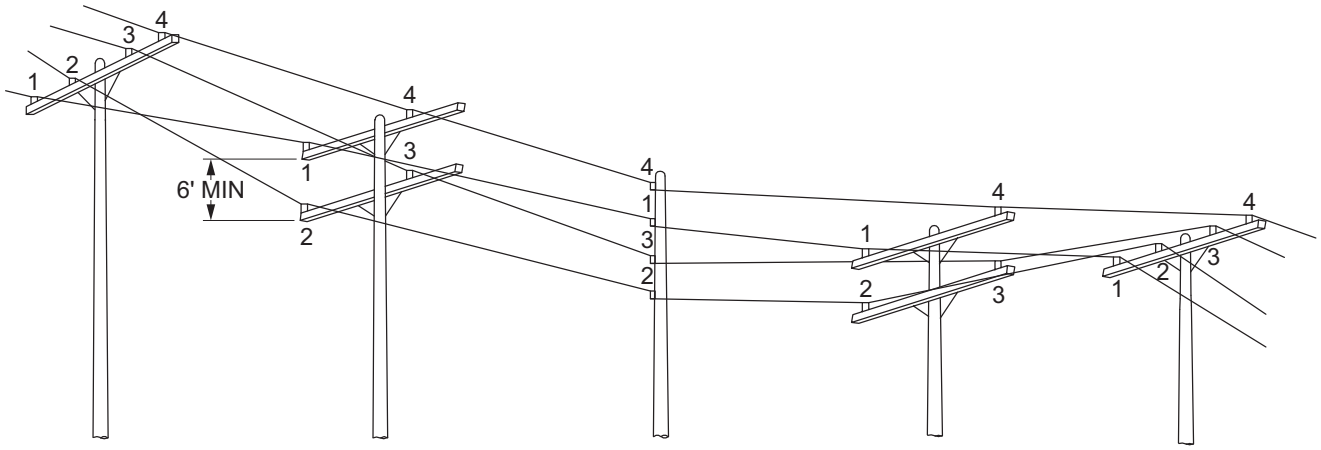
3-Wire

Scope DC 586.2 3- and 4-Wire Transition Construction

Figure DC 586–2: 3- and 4-Wire Transition Construction



3-Wire



4-Wire

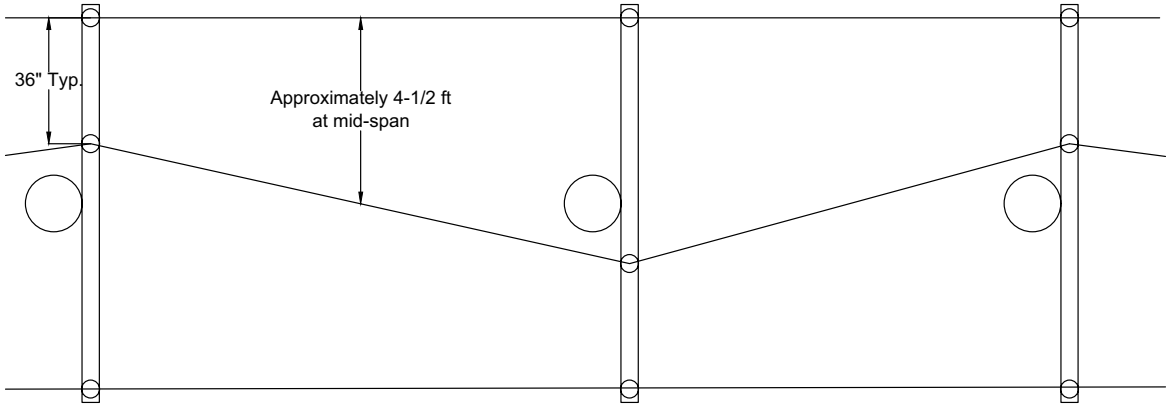
DC 587 "Zig-Zag" Construction

Scope DC 587.1 3-Wire "Zig-Zag" Construction

1.0 General Information

The 3-Wire "zig-zag" construction can be utilized to gain additional phase-to-phase separation throughout the span. This is achieved by alternating the location of the center phase on either side of the pole for adjacent poles. This construction may be utilized as an alternative to installing insulated wire spacers, see CO 450 for details.

Figure DC 587–1: 3-Wire "Zig-Zag" Construction



Note(s):

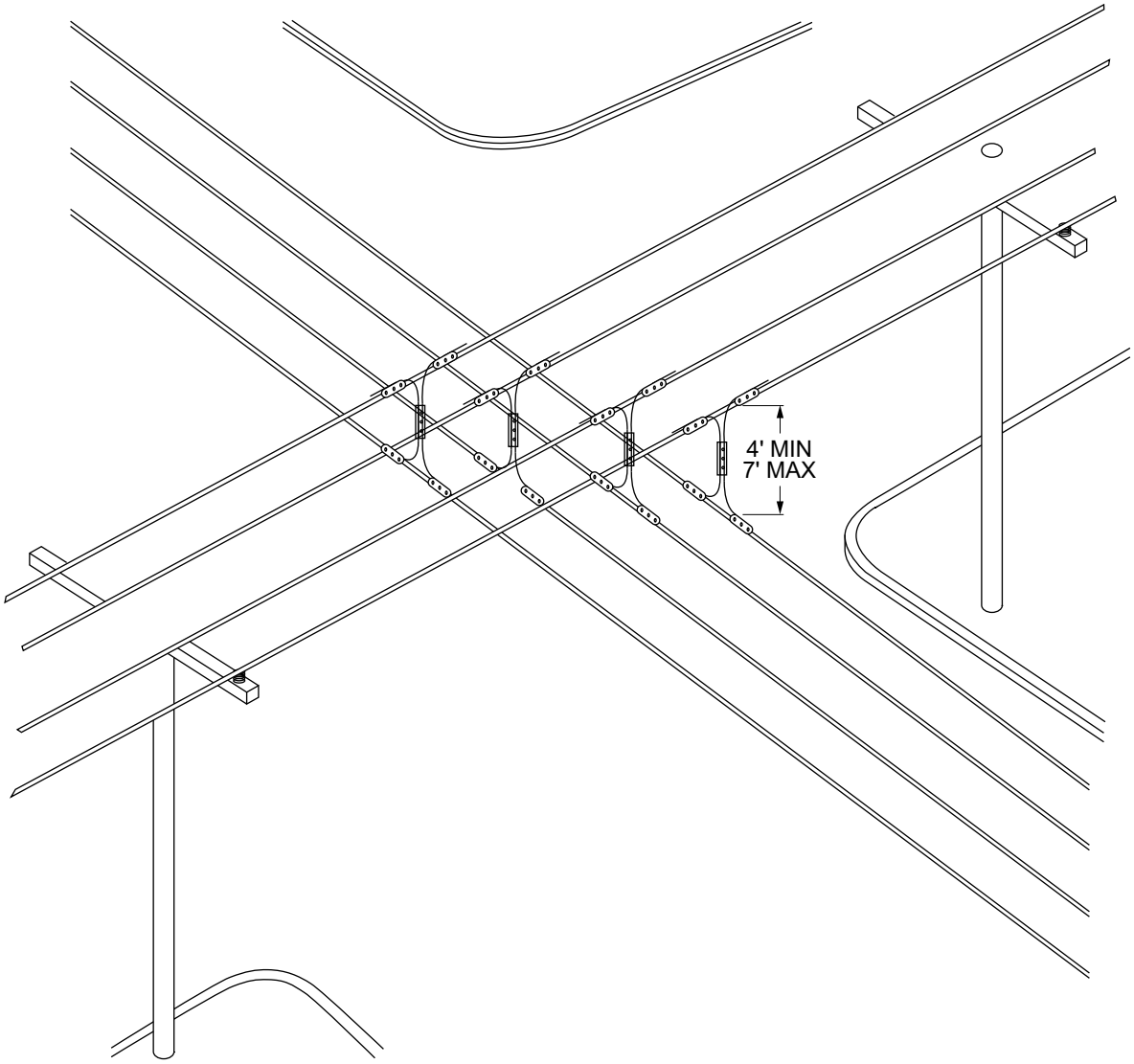
1. If retrofitting, splicing the center phase conductor may be required to maintain conductor sag/tension requirements.
2. When in tangent (straight through) construction, center phase insulators do not require angle pins or angle bases.
3. This construction only applies to 3-wire circuits. Consideration should be given prior to moving to zig-zag construction if the circuit will be converted to 4-wire construction in the future.
4. Planners to add work order map note indicating zig-zag construction required from starting pole to last pole (for example, structure XXXXXE to XXXXXE).

This page intentionally left blank.

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.

This page intentionally left blank.

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, Valiant 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

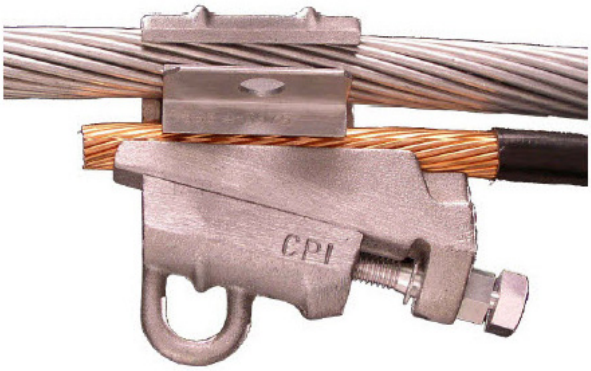
5.1 Firebreak clearings will be maintained around working poles[1/] in primary watershed areas from January 1 to December 31 each year, and around working poles in secondary watershed areas from May 1 to December 31 each year, in accordance with the Power Line Fire Prevention Field Guide and the Customer 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

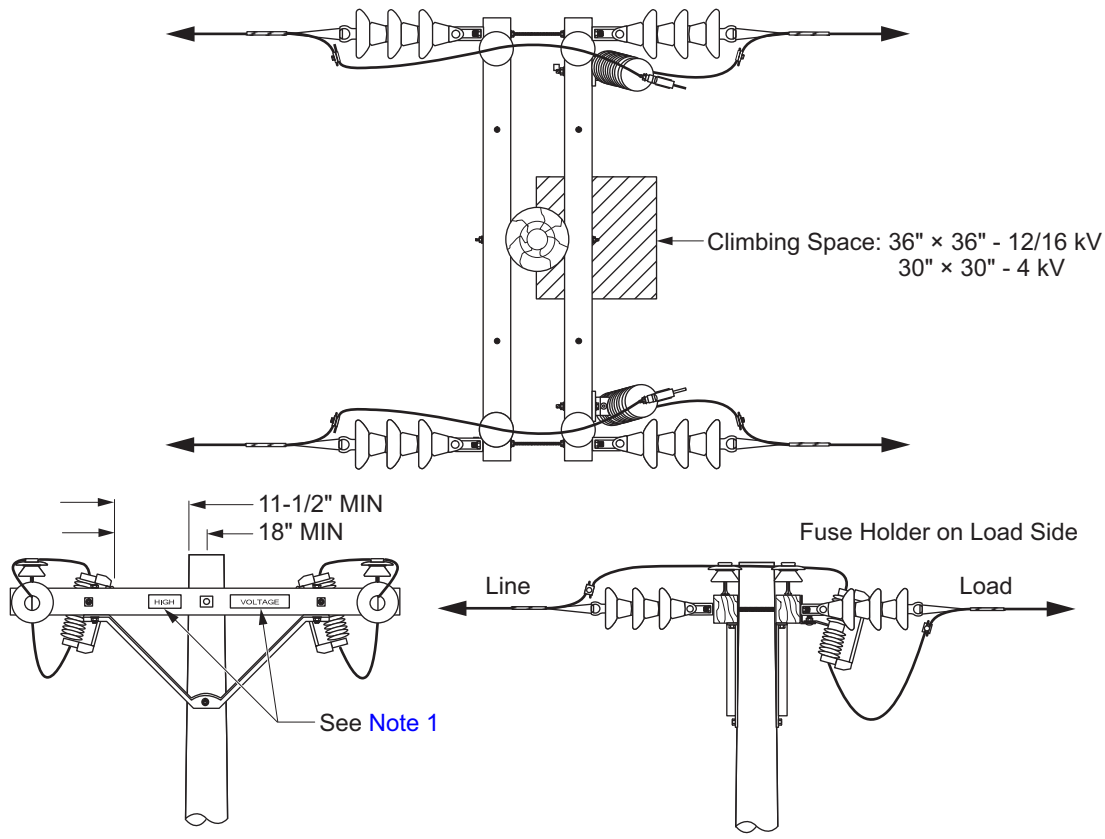


[1/] The term “Working Pole,” means any pole (or tower) with switches, fuses, transformers, surge arresters, dead-ends or corner poles (with taps), or poles with connections other than bolted wedge connectors.

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

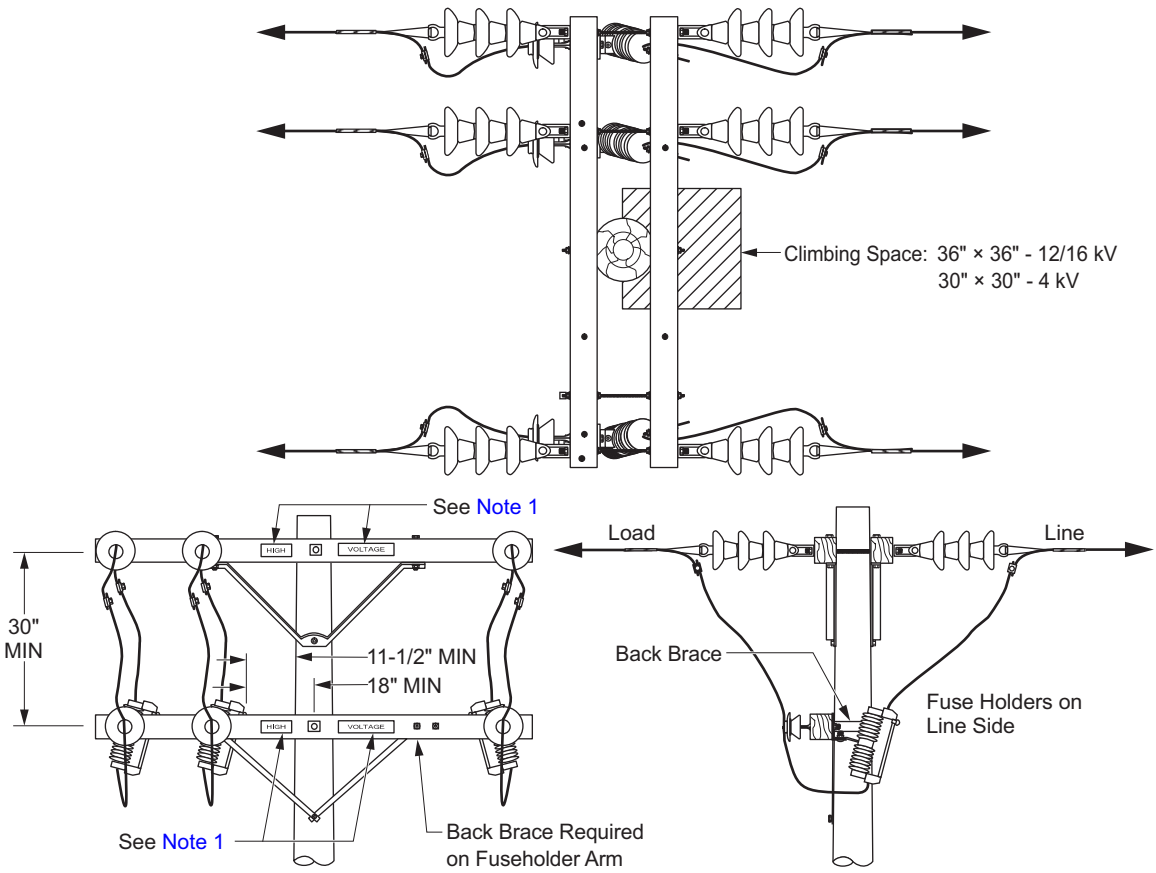


Note(s):

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 and CC 131).
9. For double dead-end construction where the fuse holder is on the line arm, fuse holders shall only be installed on the load side.

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

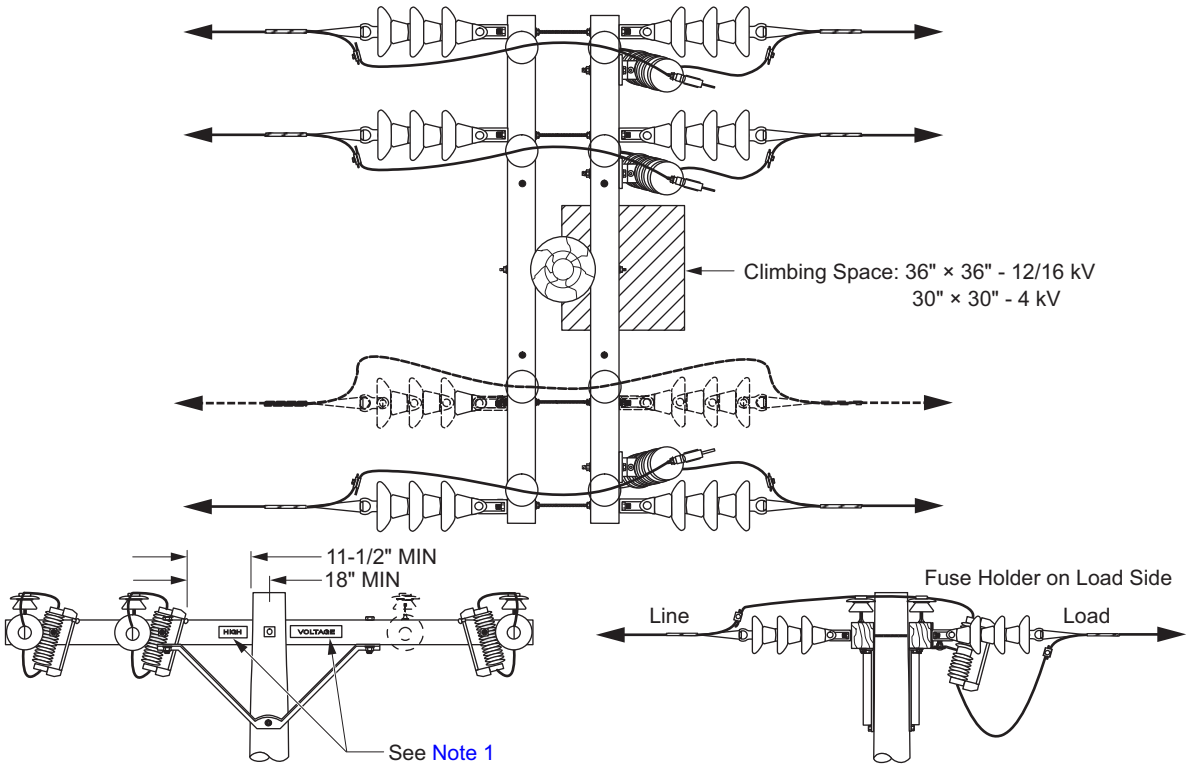


Note(s):

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 and CC 131).
9. For double dead-end construction where the fuse holder is on the separate fuse holder arm, fuse holders shall only be installed on the line side.

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

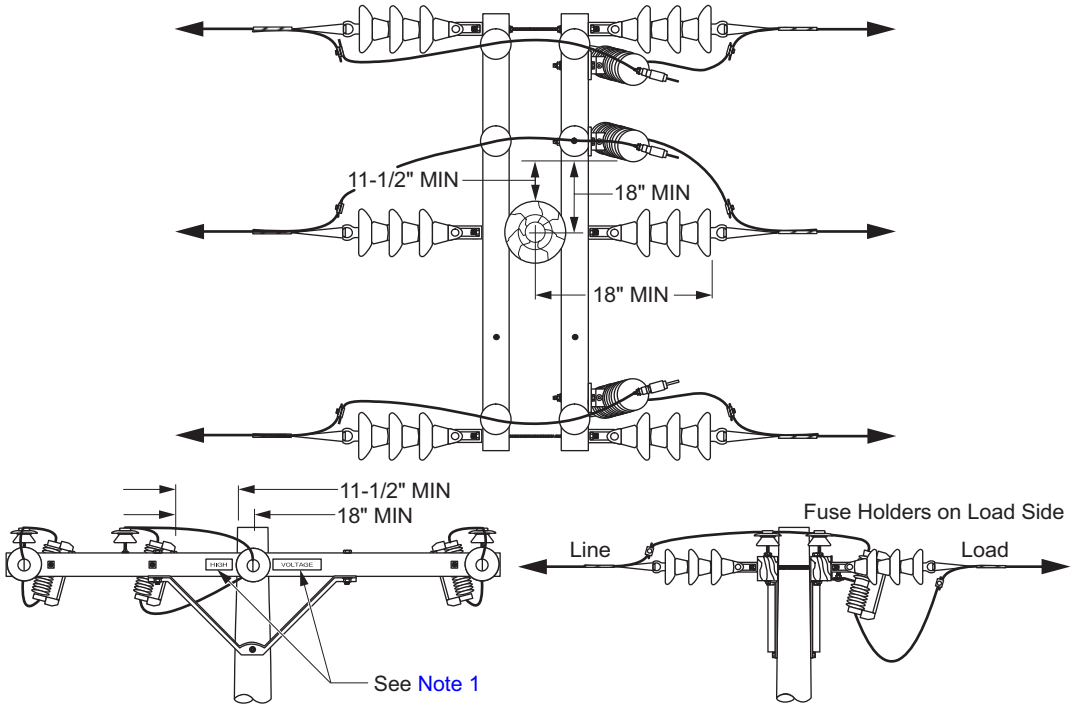


Note(s):

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 and CC 131).
11. For double dead-end construction where the fuse holder is on the line arm, fuse holders shall only be installed on the load side.

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

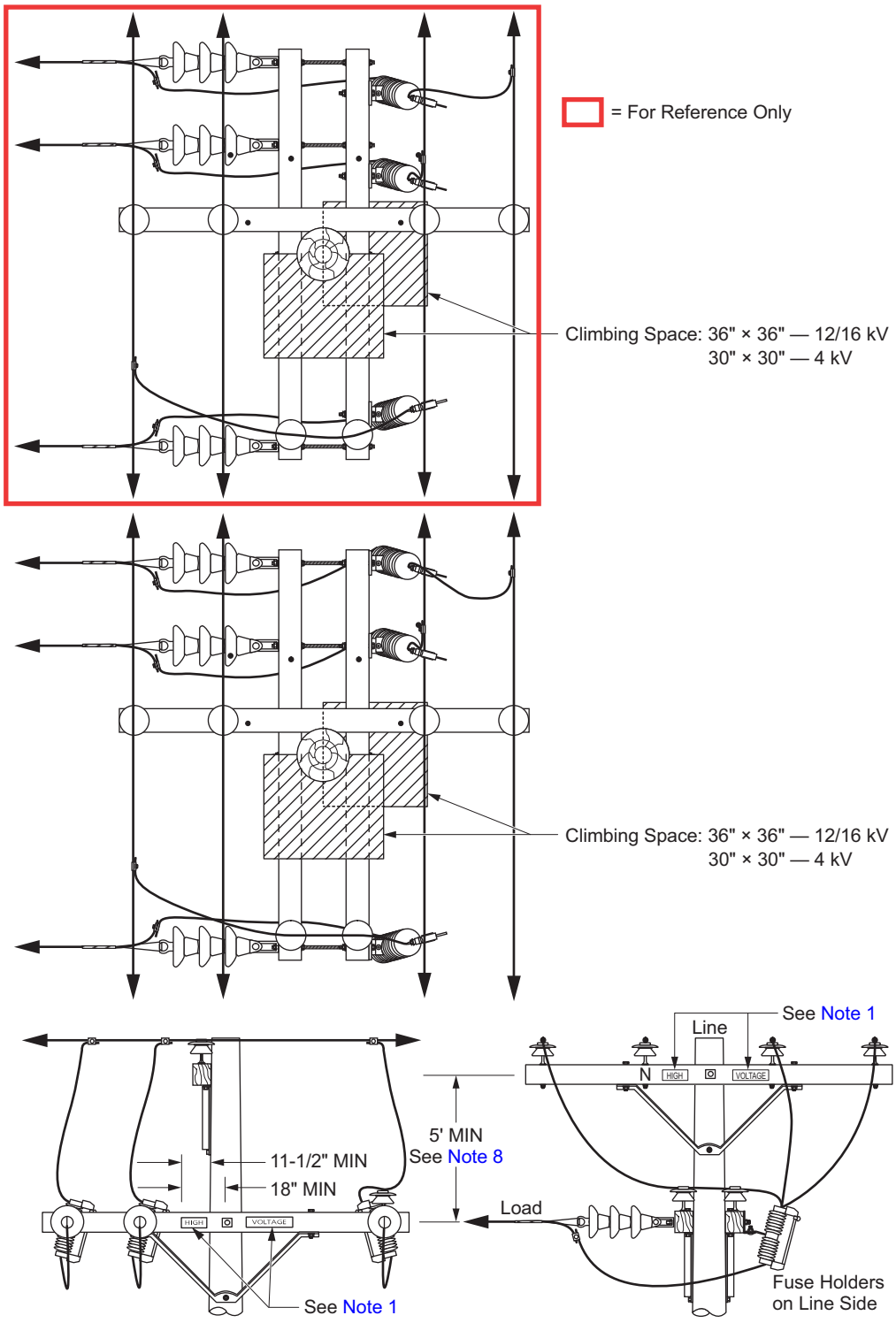


Note(s):

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 and CC 131).
12. For double dead-end construction where the fuse holder is on the line arm, fuse holders shall only be installed on the load side.

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

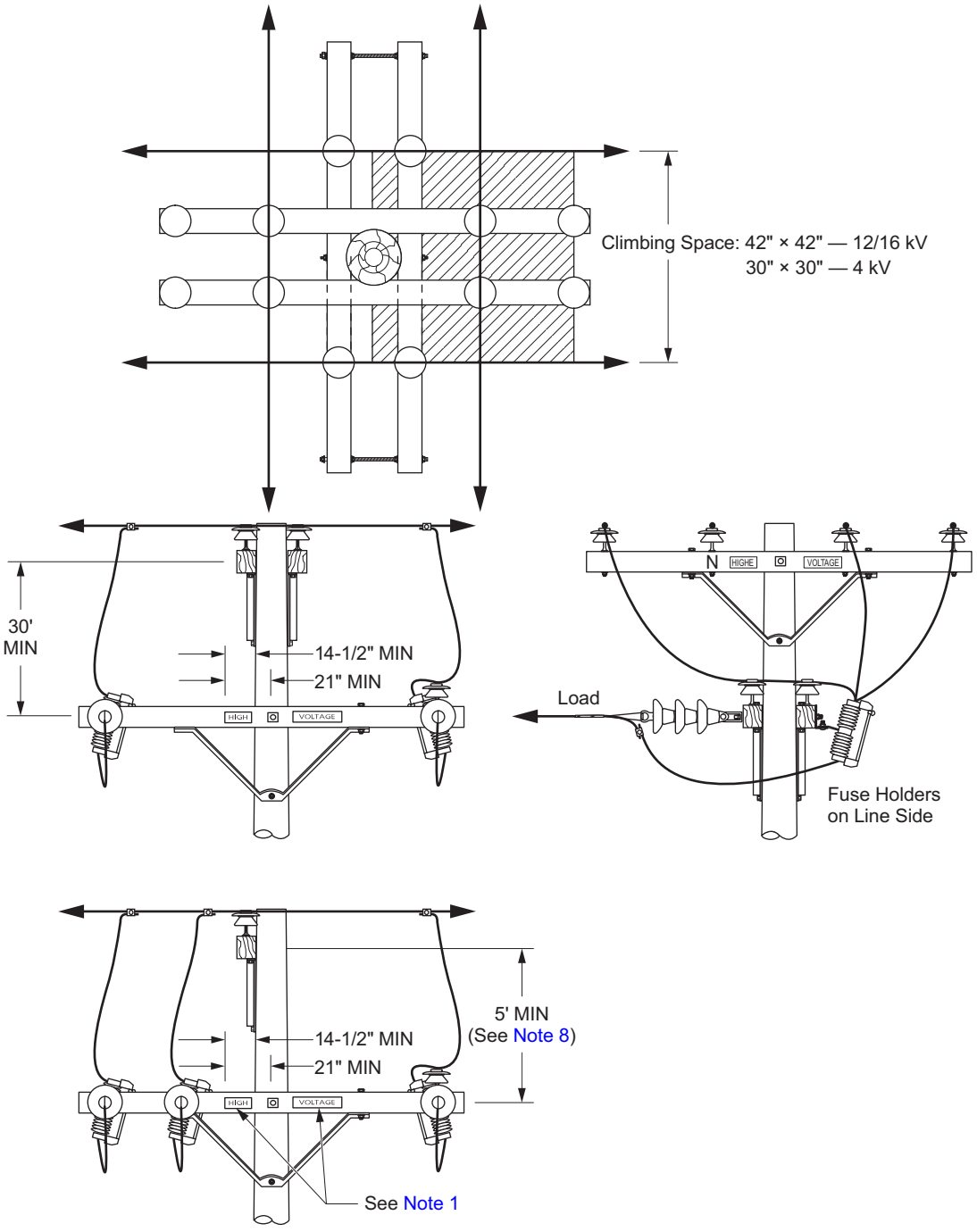


Note(s):

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 and CC 131).
10. Fuse holders shall be installed on the DA bolts on the line side of Dead-End Buck Arm.

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



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 and CC 131).
10. Fuse holders shall be installed on the DA bolts on the line side of Dead-End Buck Arm.

DC 612 Spring Washer Hardware Connection Details

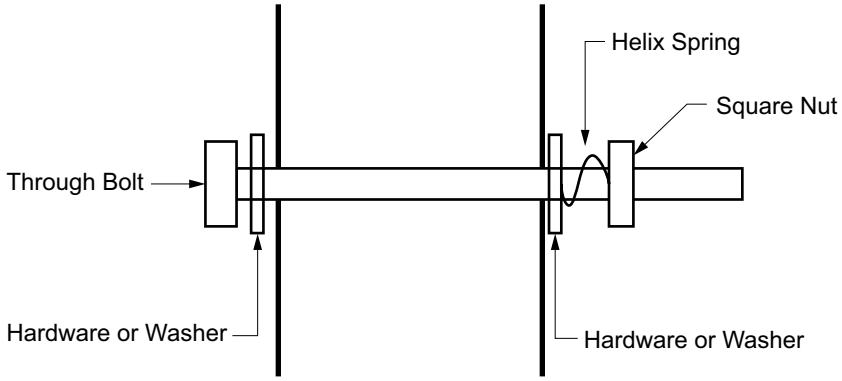
Scope DC 612.1 Typical Non-Tension Hardware

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

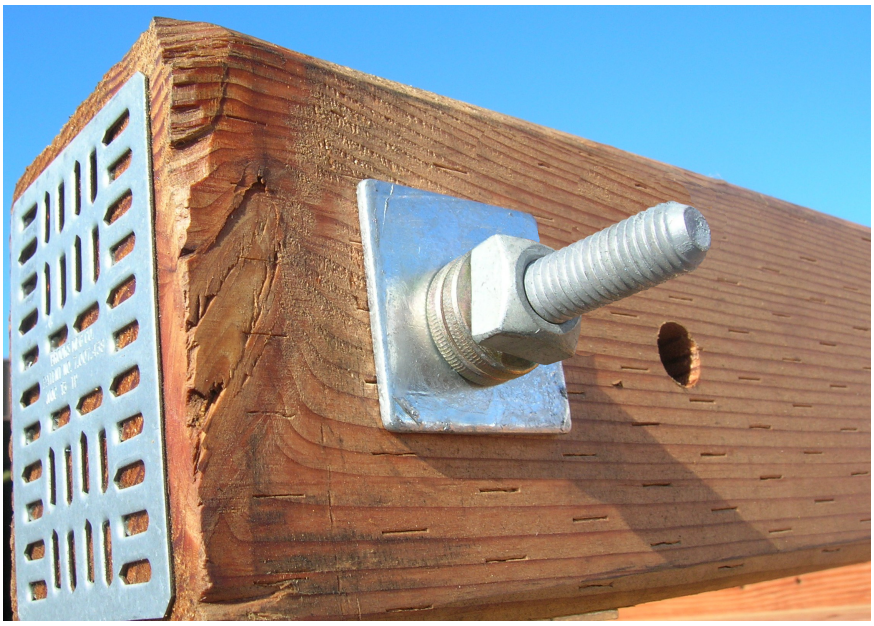


Figure DC 612–3: Spring Washer Hardware Assembly for Flat Brace on Crossarm

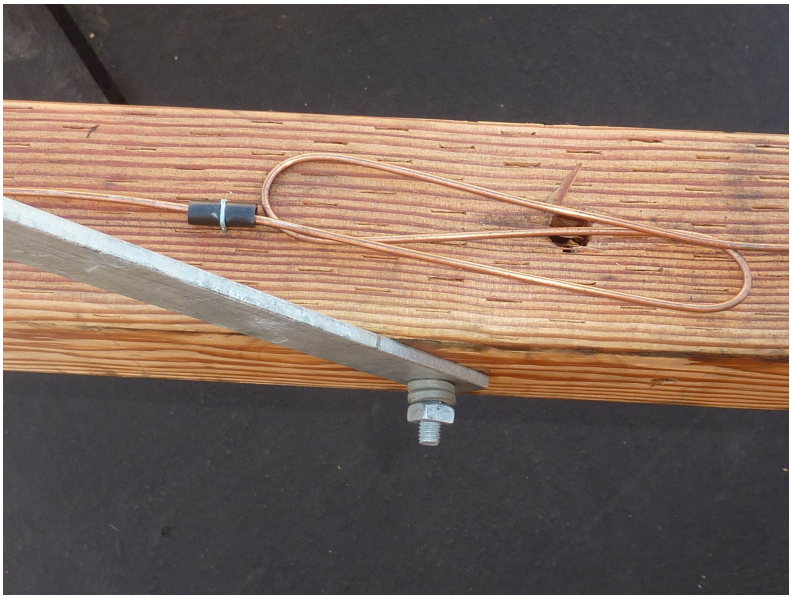


Figure DC 612–4: Cross Section of Hardware Assembly for Double Crossarm

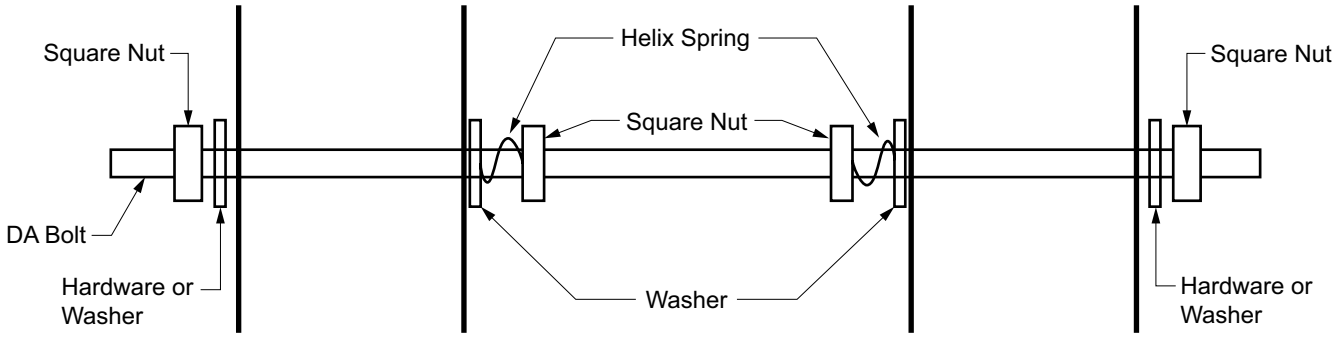


Figure DC 612–5: Spring Washer Hardware Assembly for Double Crossarm



Figure DC 612–6: Cross Section of Hardware Assembly for Poles

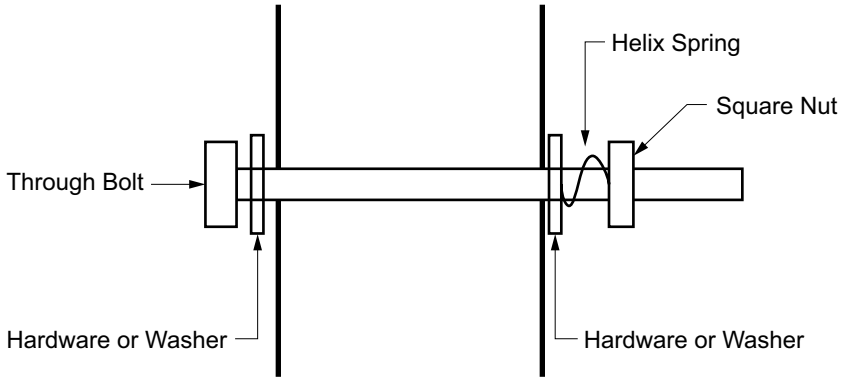


Figure DC 612–7: Spring Washer Hardware Assembly for Poles



Scope DC 612.2 Typical Tension Hardware

Figure DC 612–8: Typical Spring Washer Hardware Assembly for Double Crossarm and Bonding



This page intentionally left blank.

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

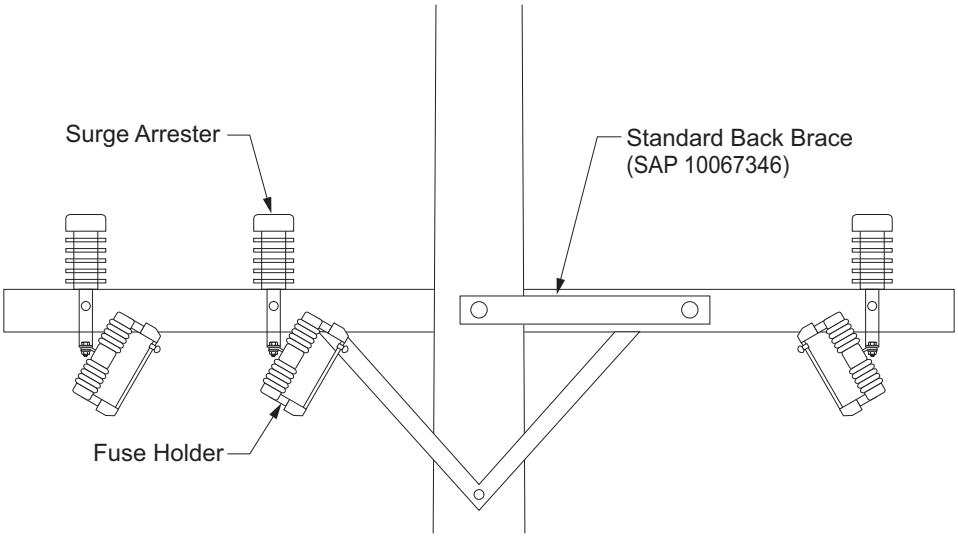
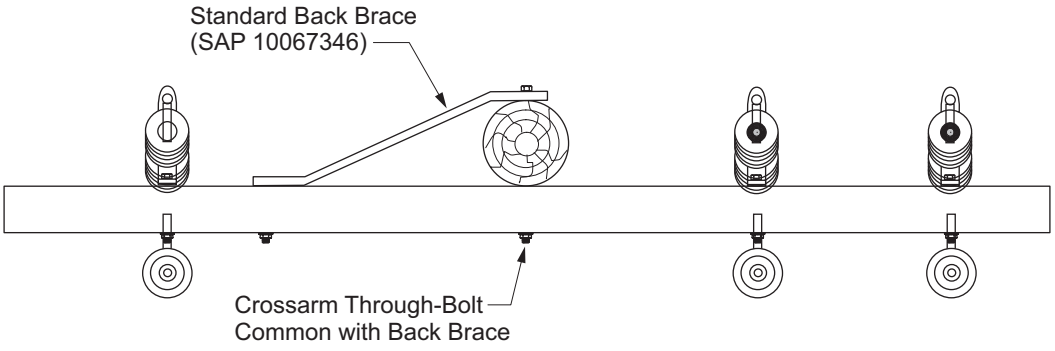


Figure DC 615–2: Standard Back Brace Typical Top View



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

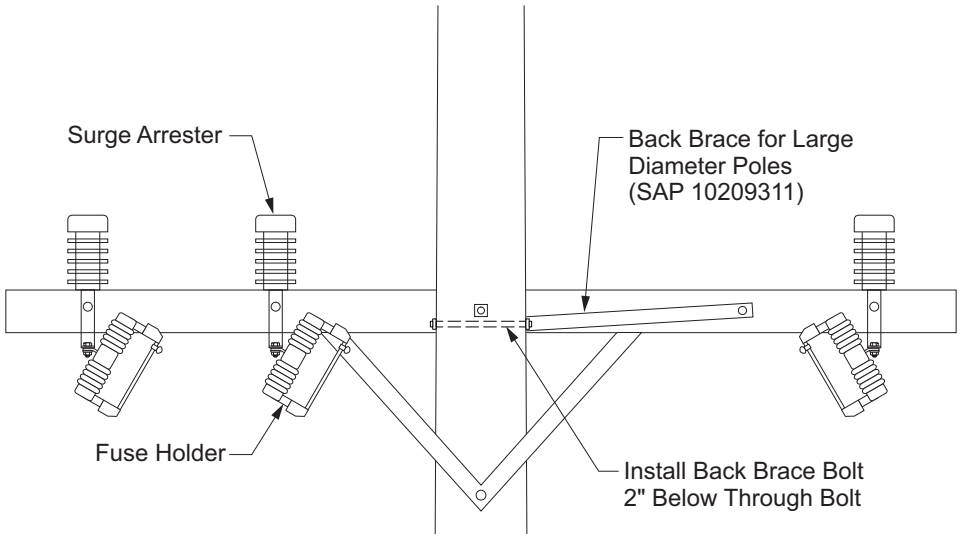
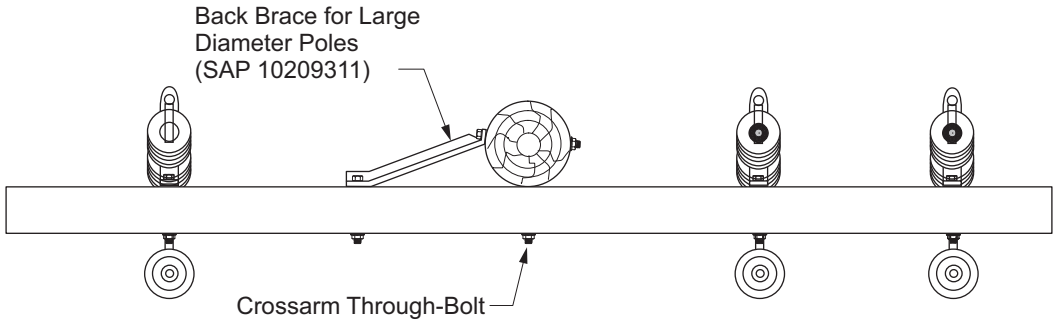


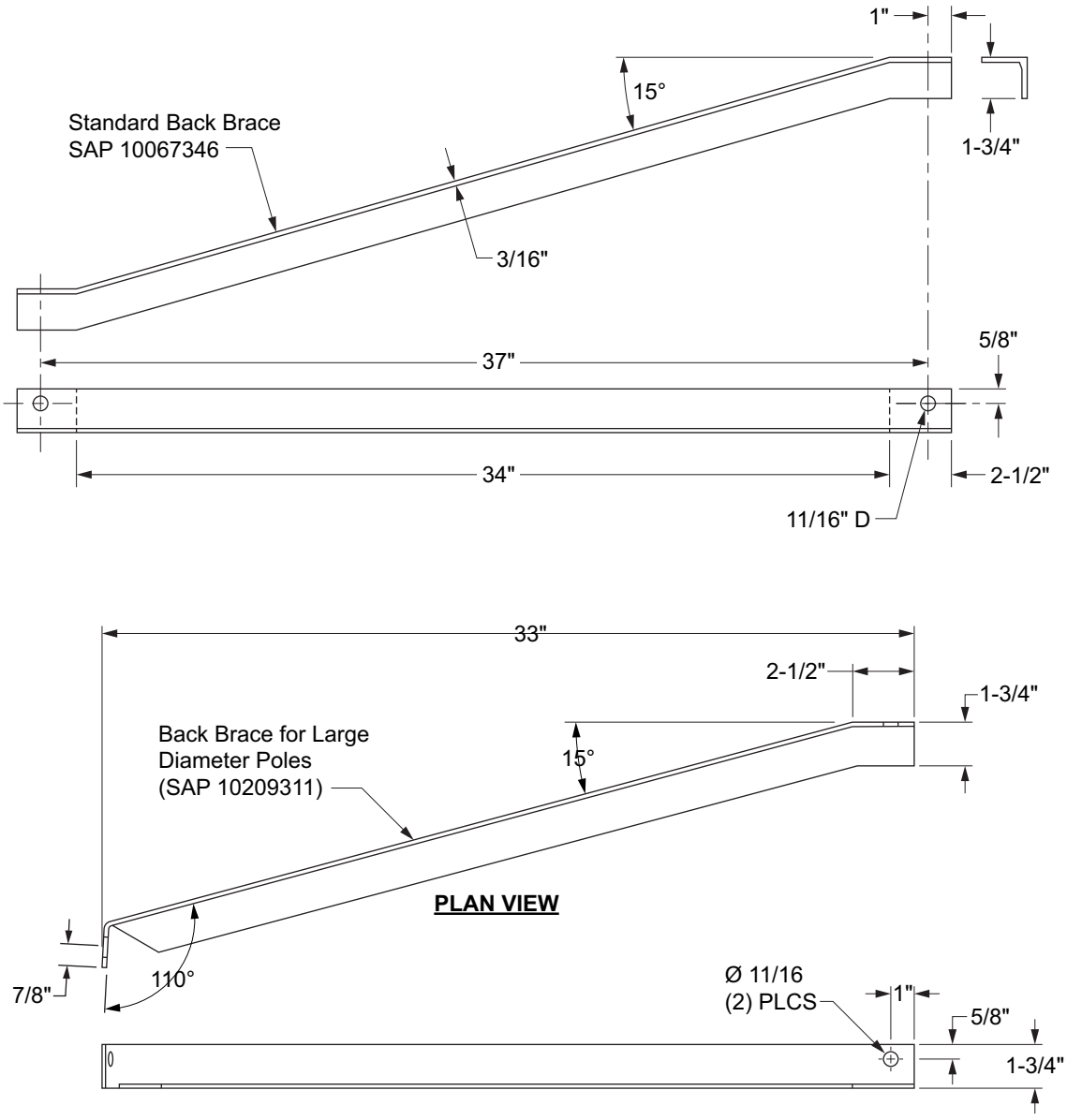
Figure DC 615–4: Back Brace for Large Diameter Poles Typical Top View



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.

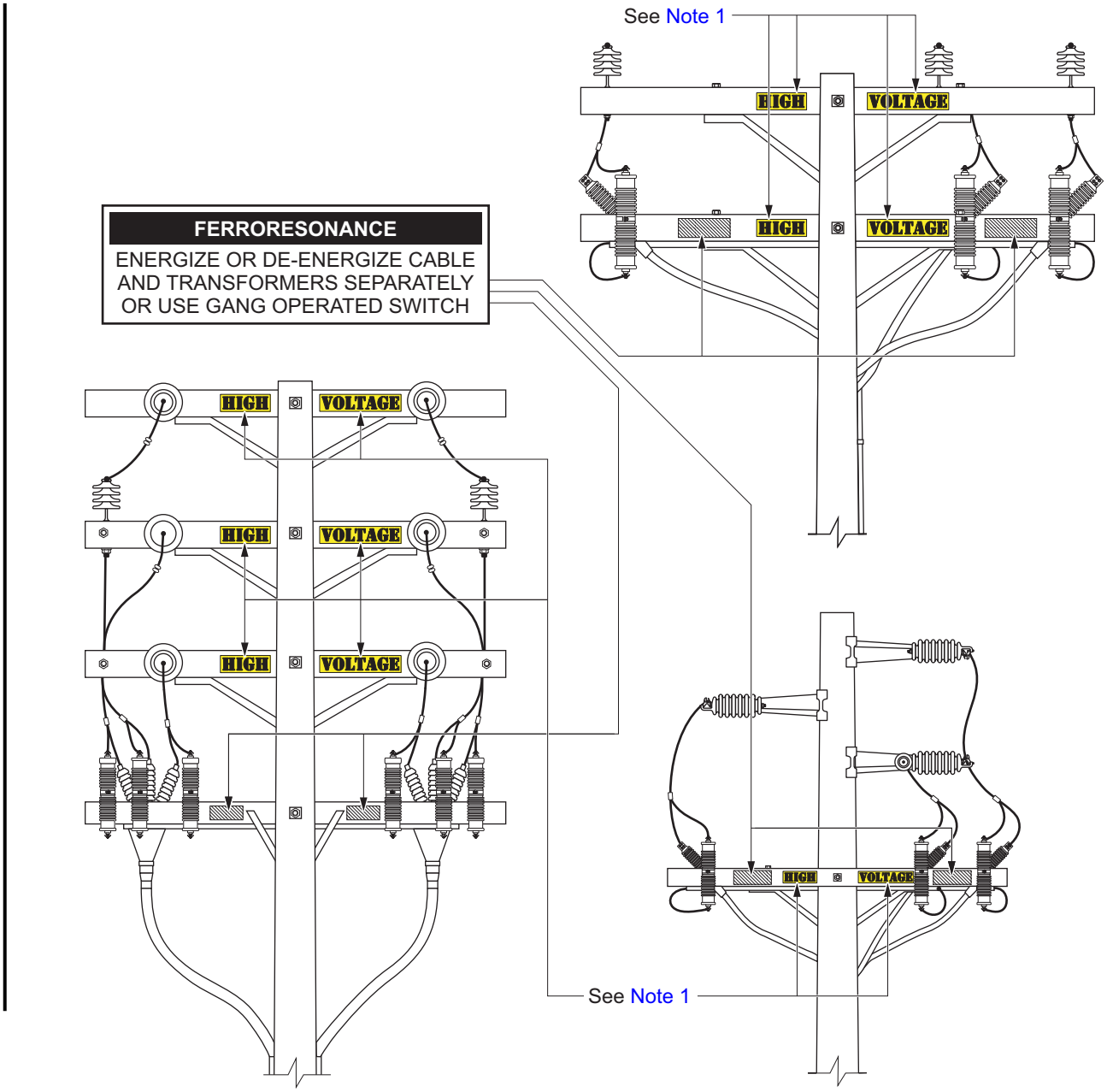
- Fuse holder crossarm associated with polemount transformer or switched capacitor banks that do not have support channels which connect to the crossarm.
- Fuse holder crossarm for fixed capacitor banks.
- When the crew foreman or troubleman deems necessary.
- Whenever detailed equipment specific standards 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.

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):

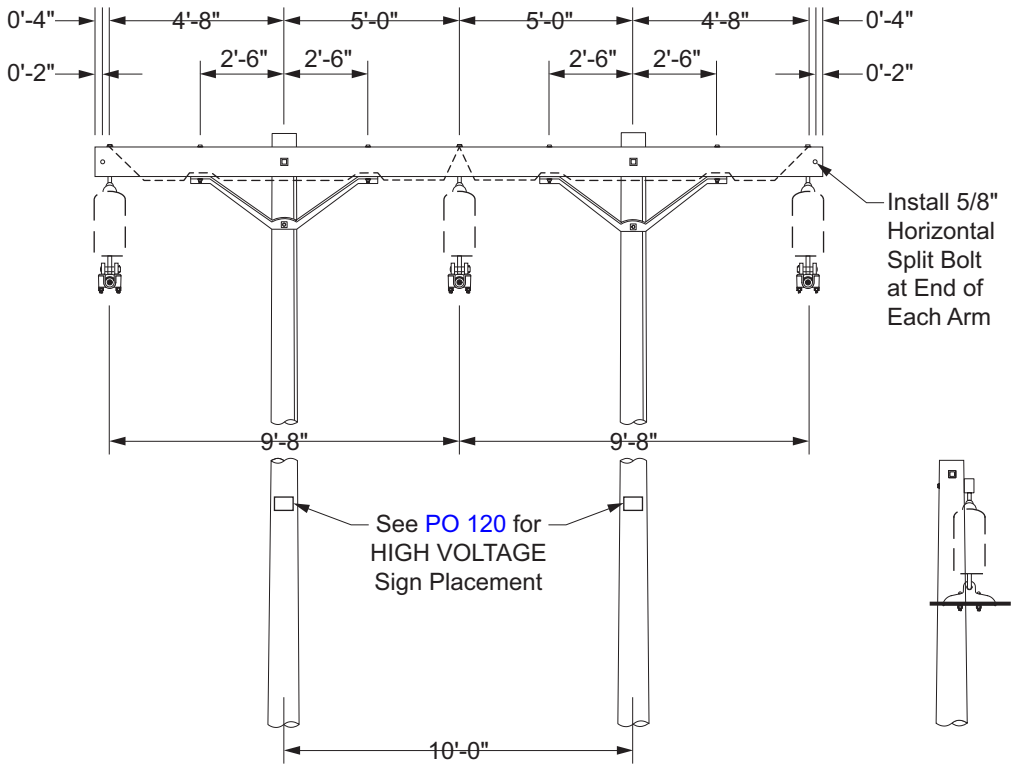
1. See PO 120 for HIGH VOLTAGE sign installation requirements.
2. The ferroresonance signs shall be placed at the riser pole on both sides of the pothead arm (or the fuseholder arm where the pothead arm is not available) so that they will be seen by any one who attempts to energize or de-energize a potentially ferroresonant system on phase at a time.

This page intentionally left blank.

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)

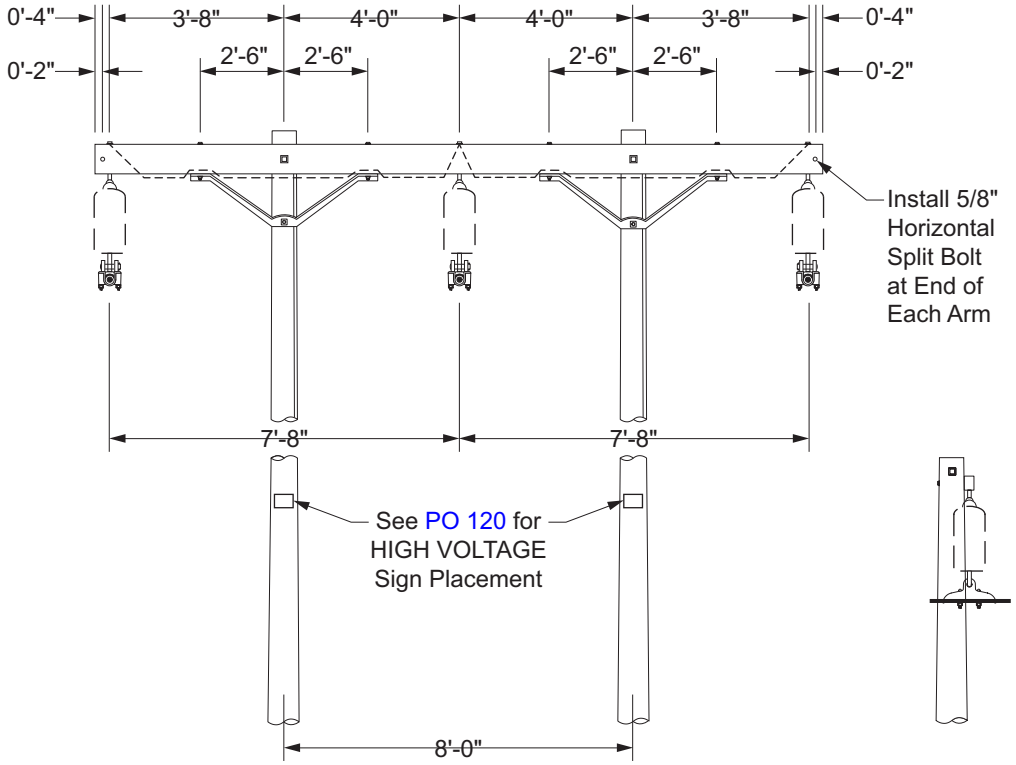


Note(s):

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)

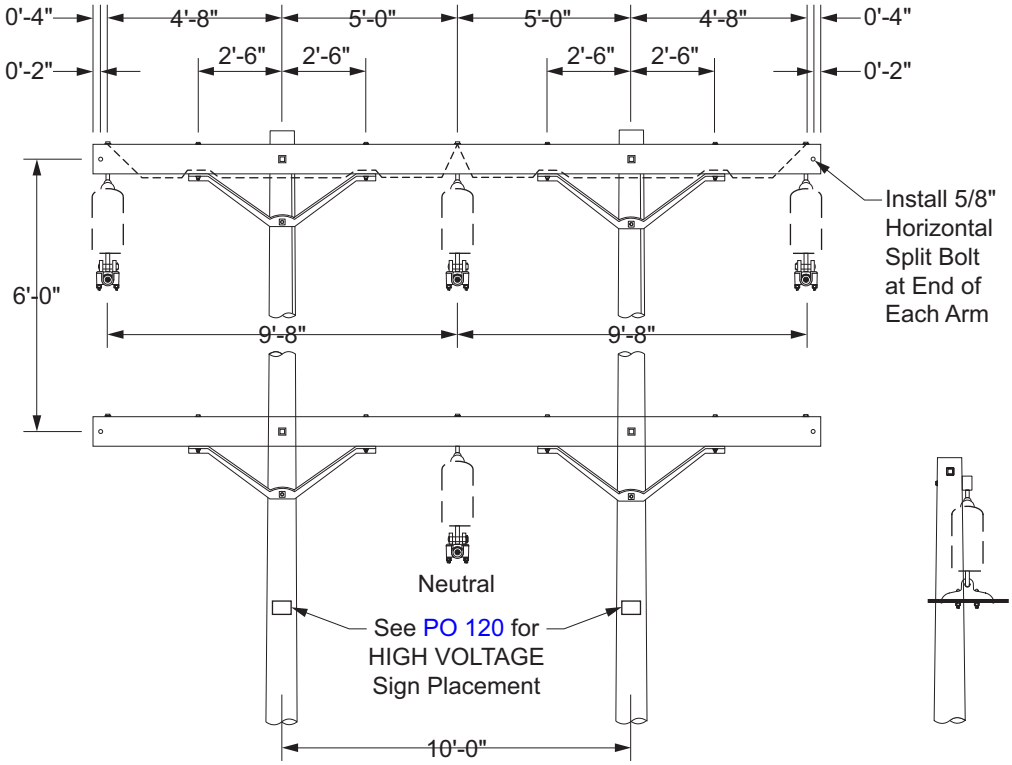


Note(s):

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)

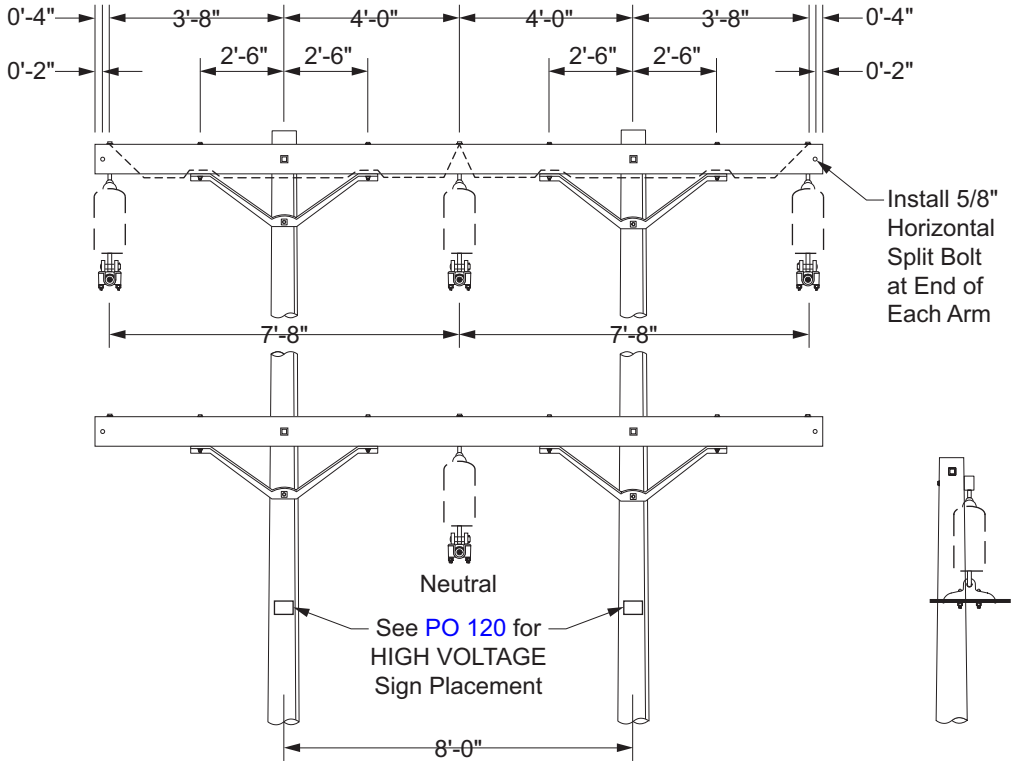


Note(s):

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)

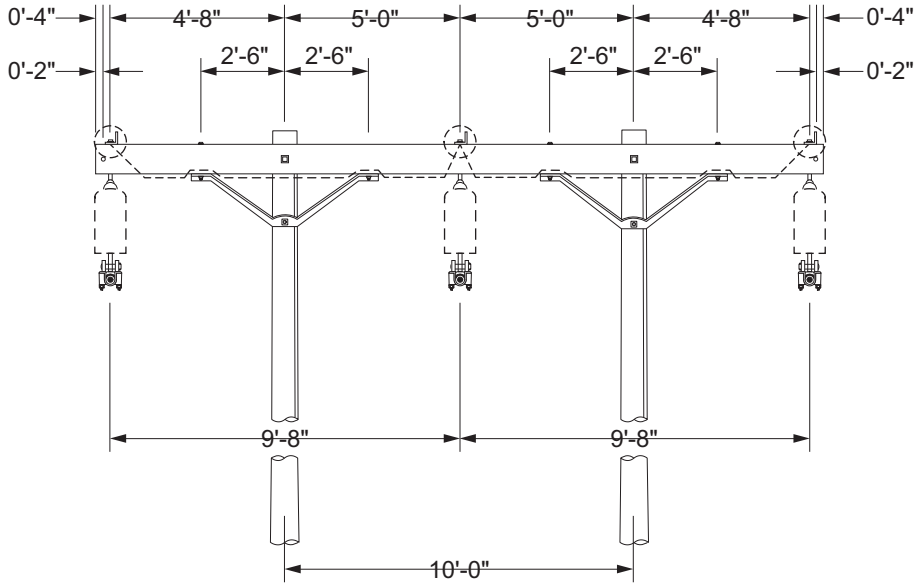


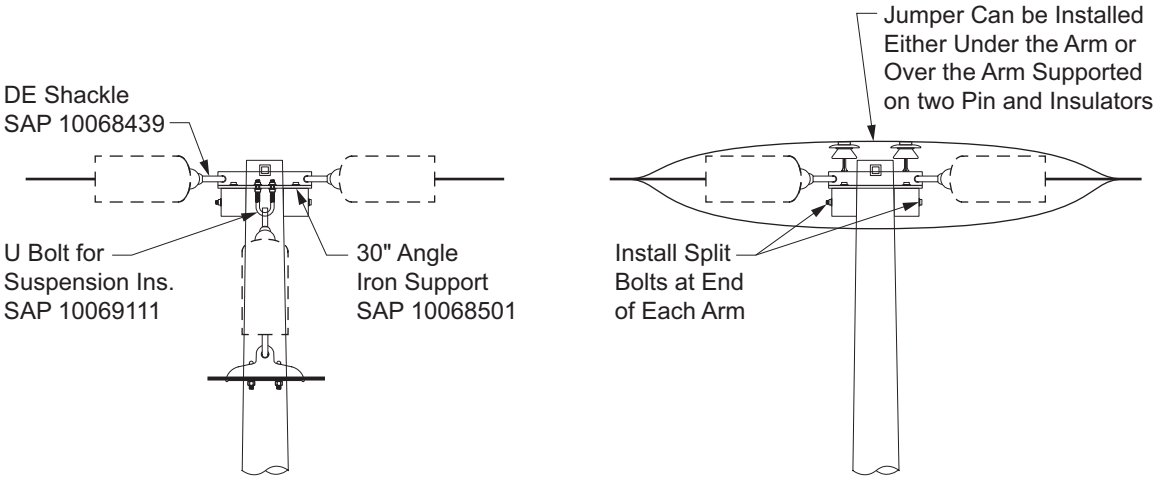
Note(s):

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)



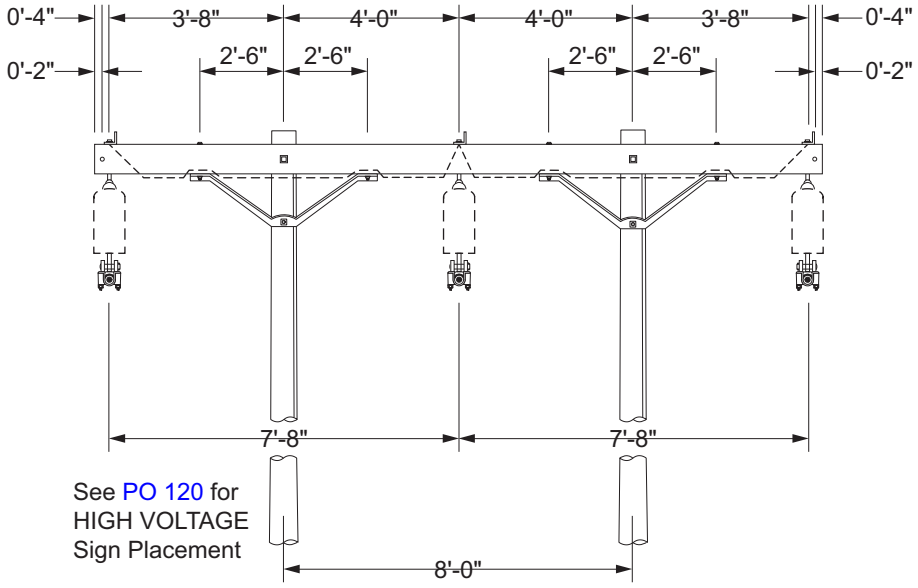


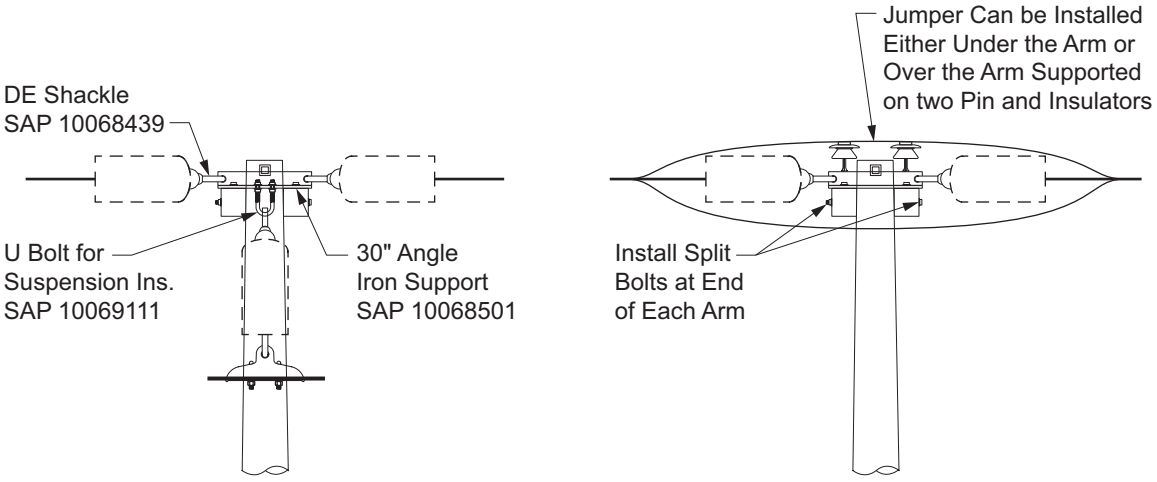
Note(s):

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)



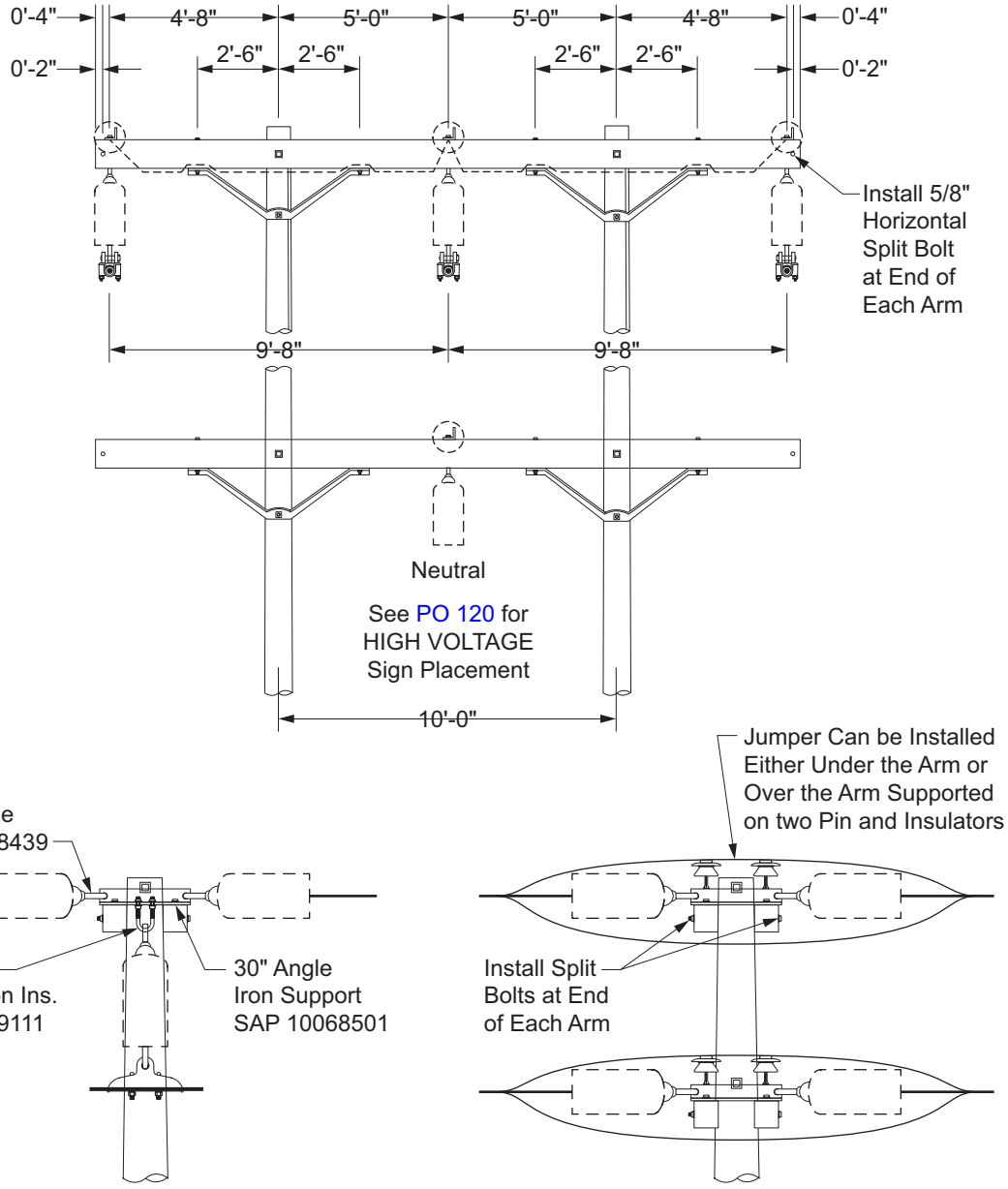


Note(s):

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.

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)

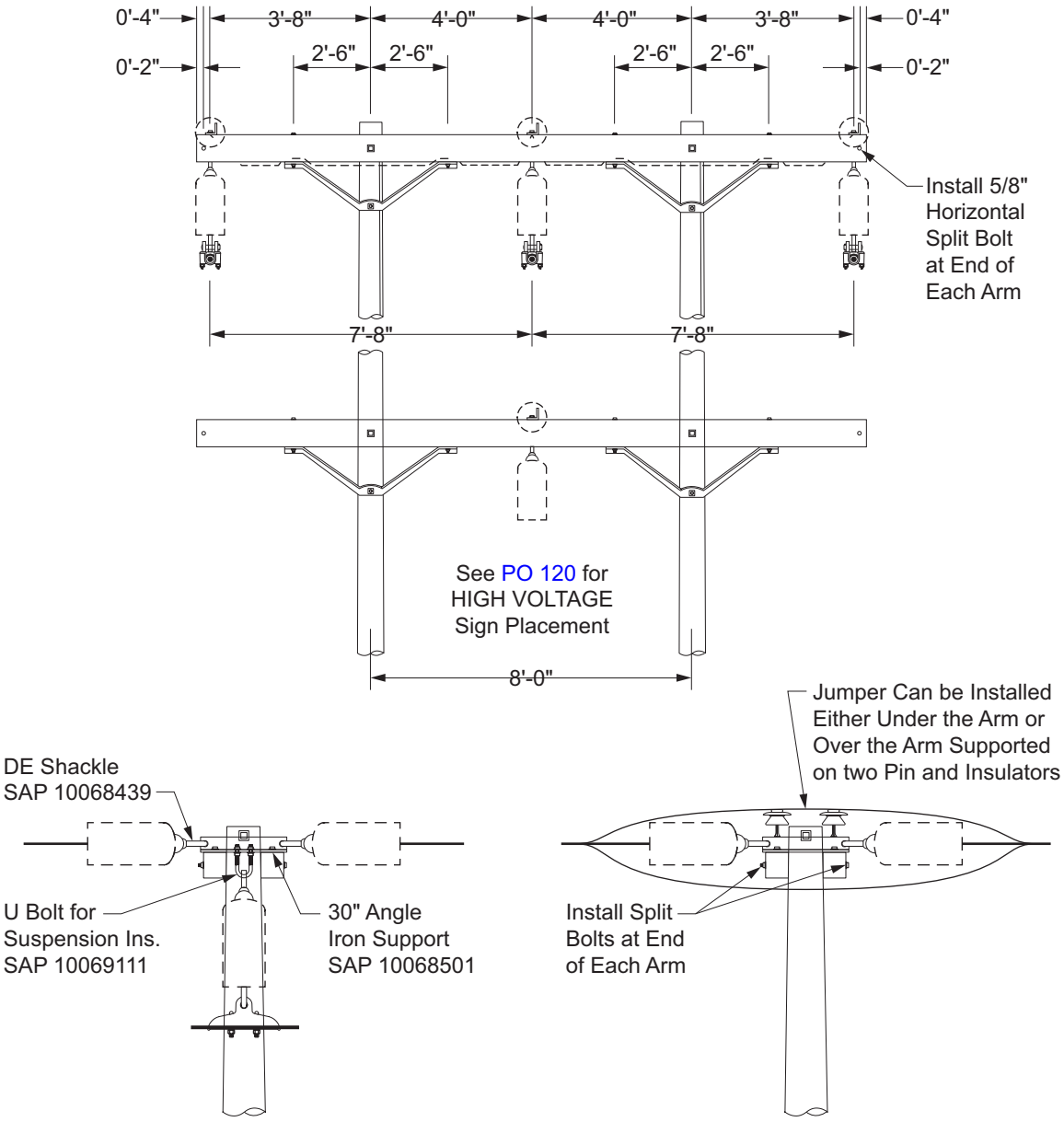


Note(s):

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)



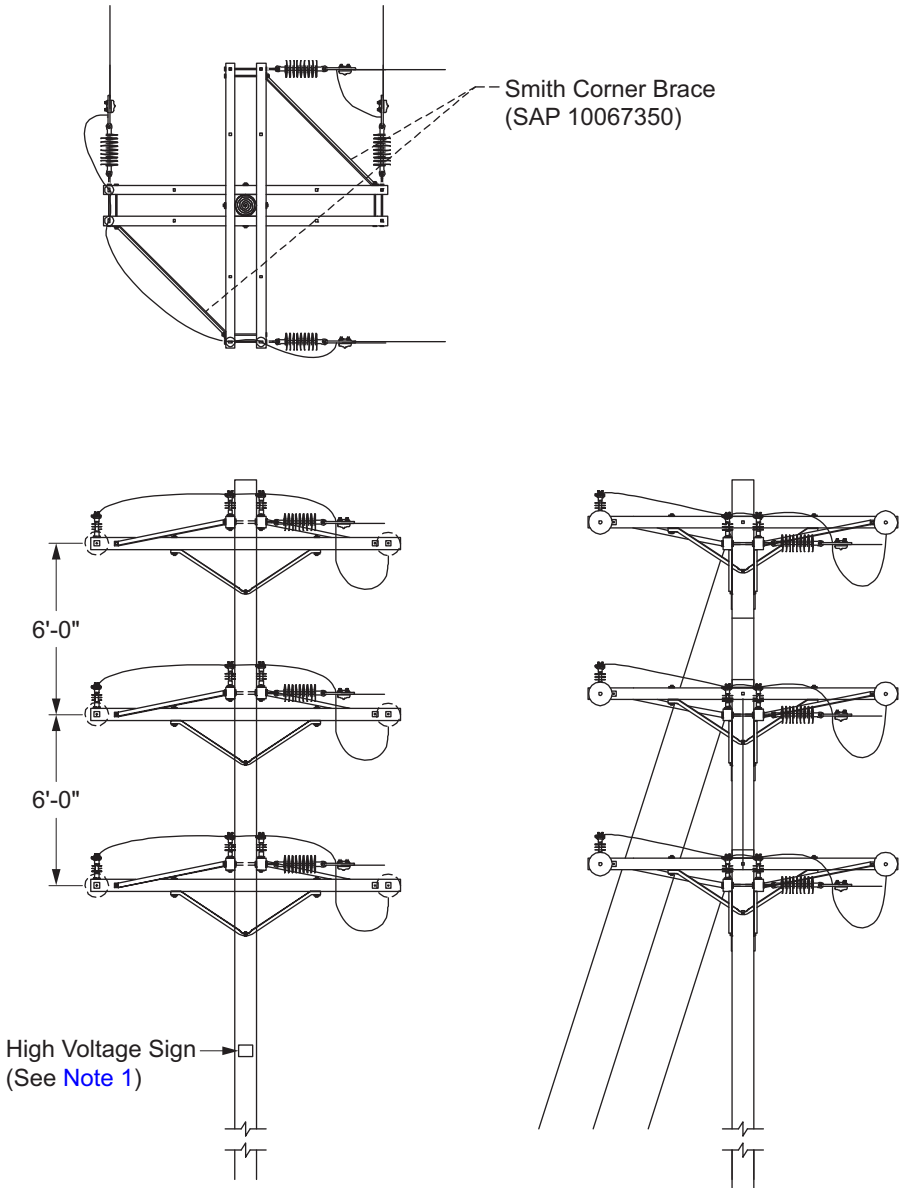
Note(s):

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

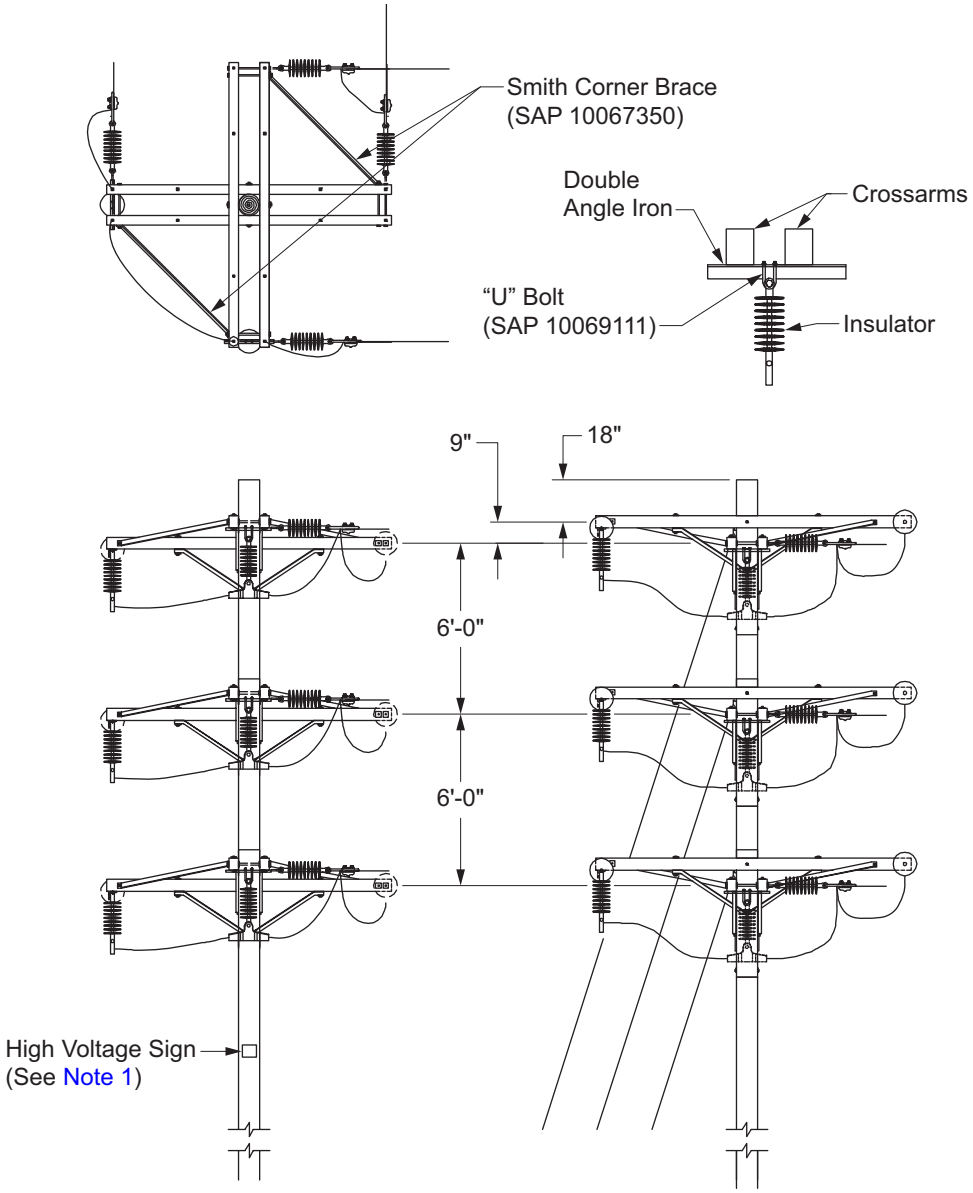


Note(s):

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

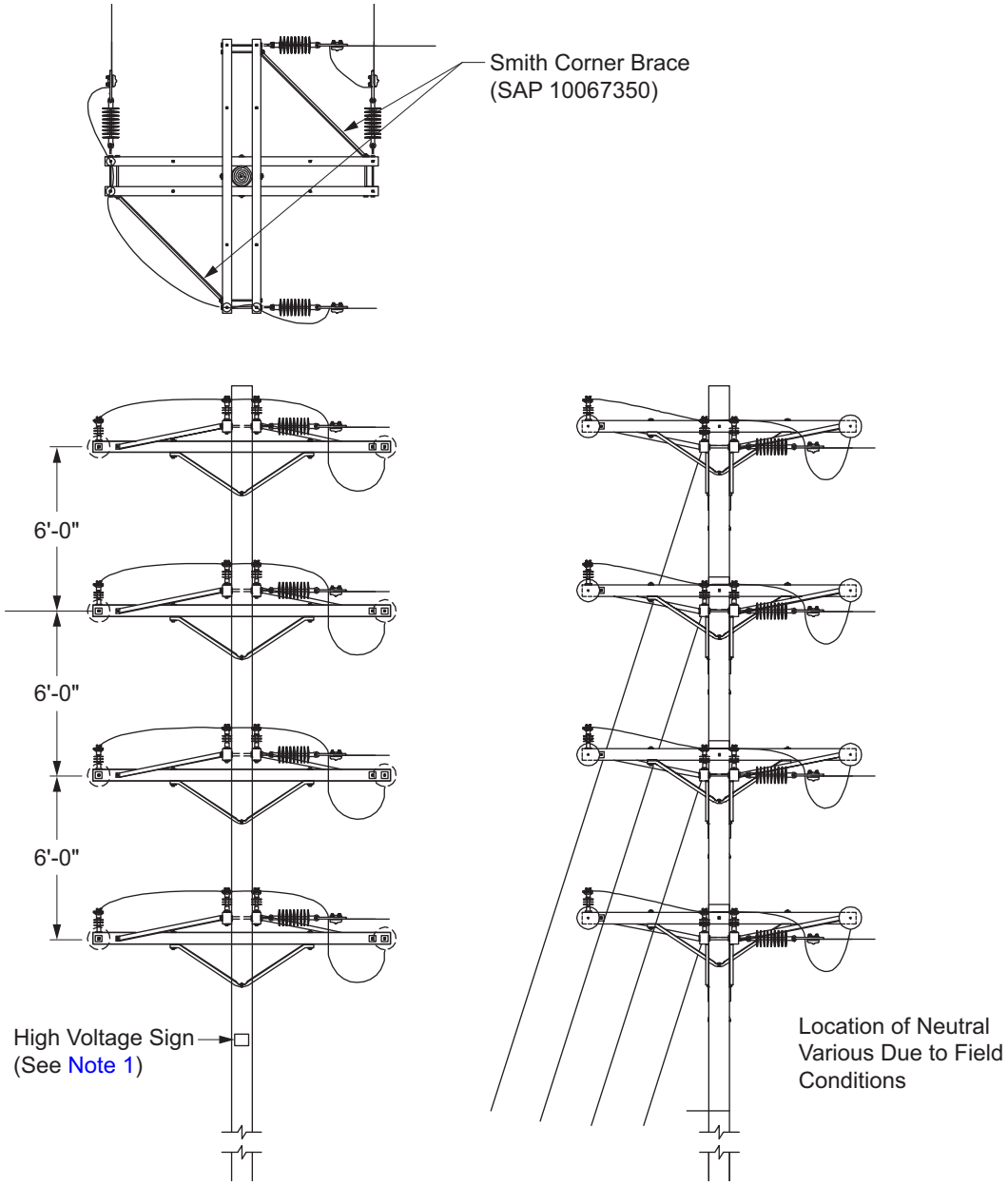


Note(s):

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

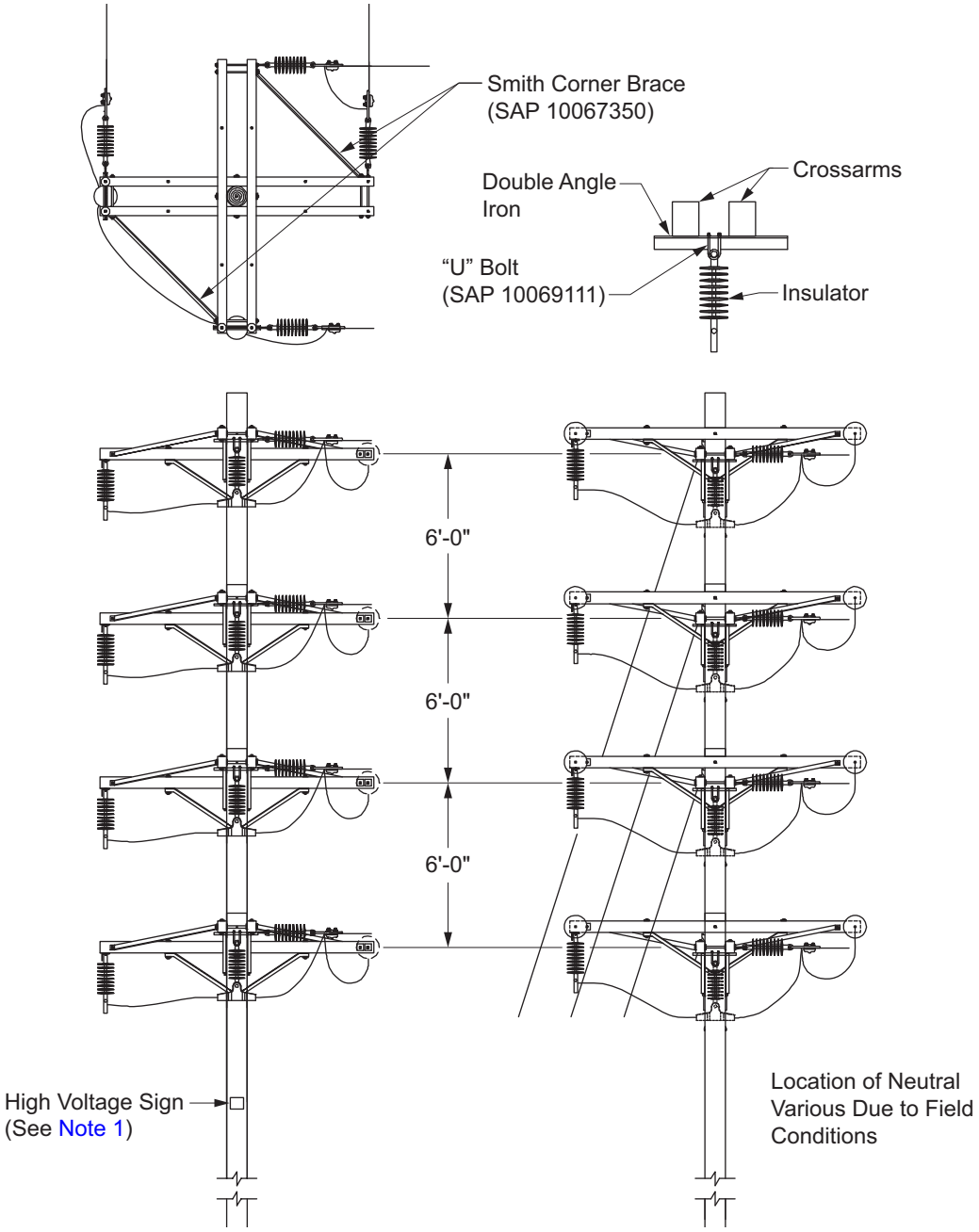


Note(s):

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

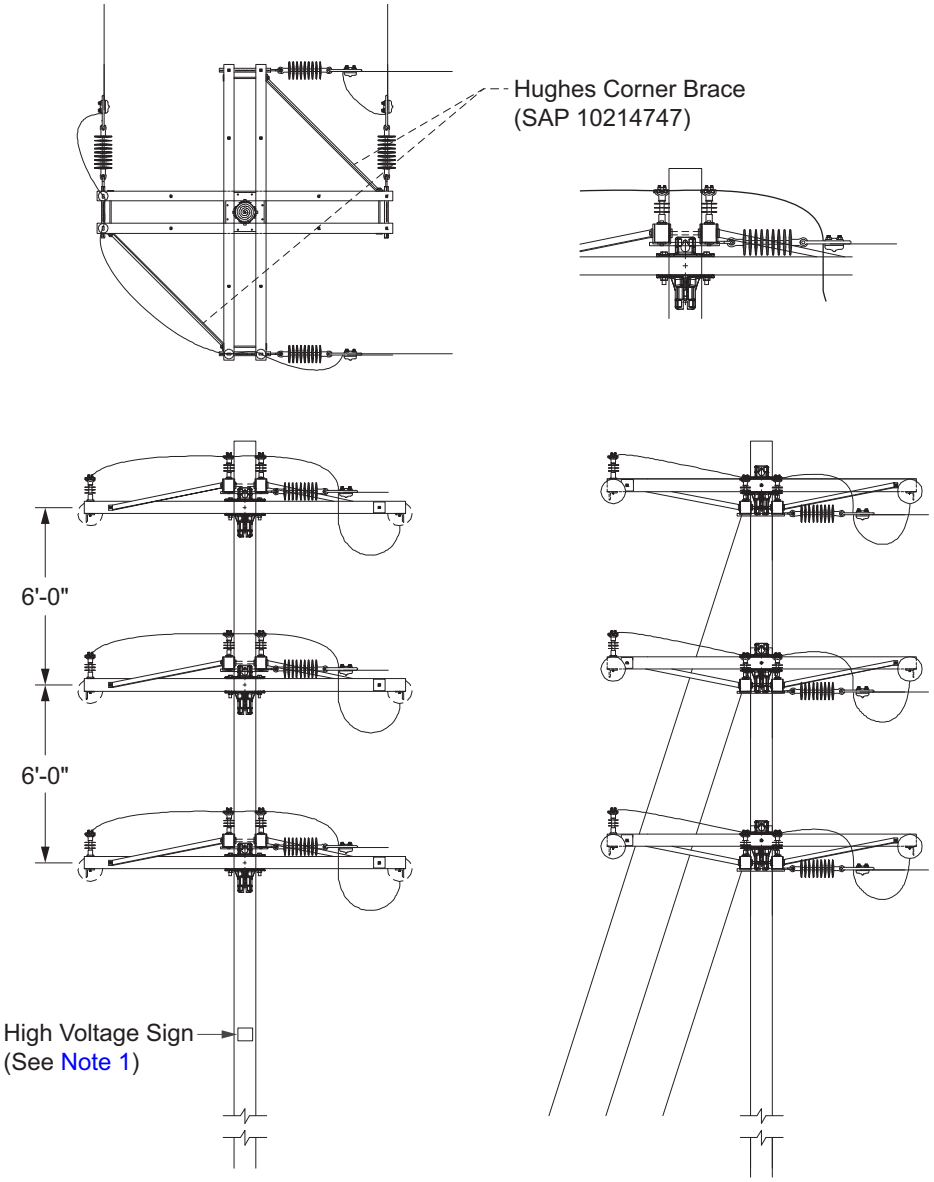


Note(s):

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

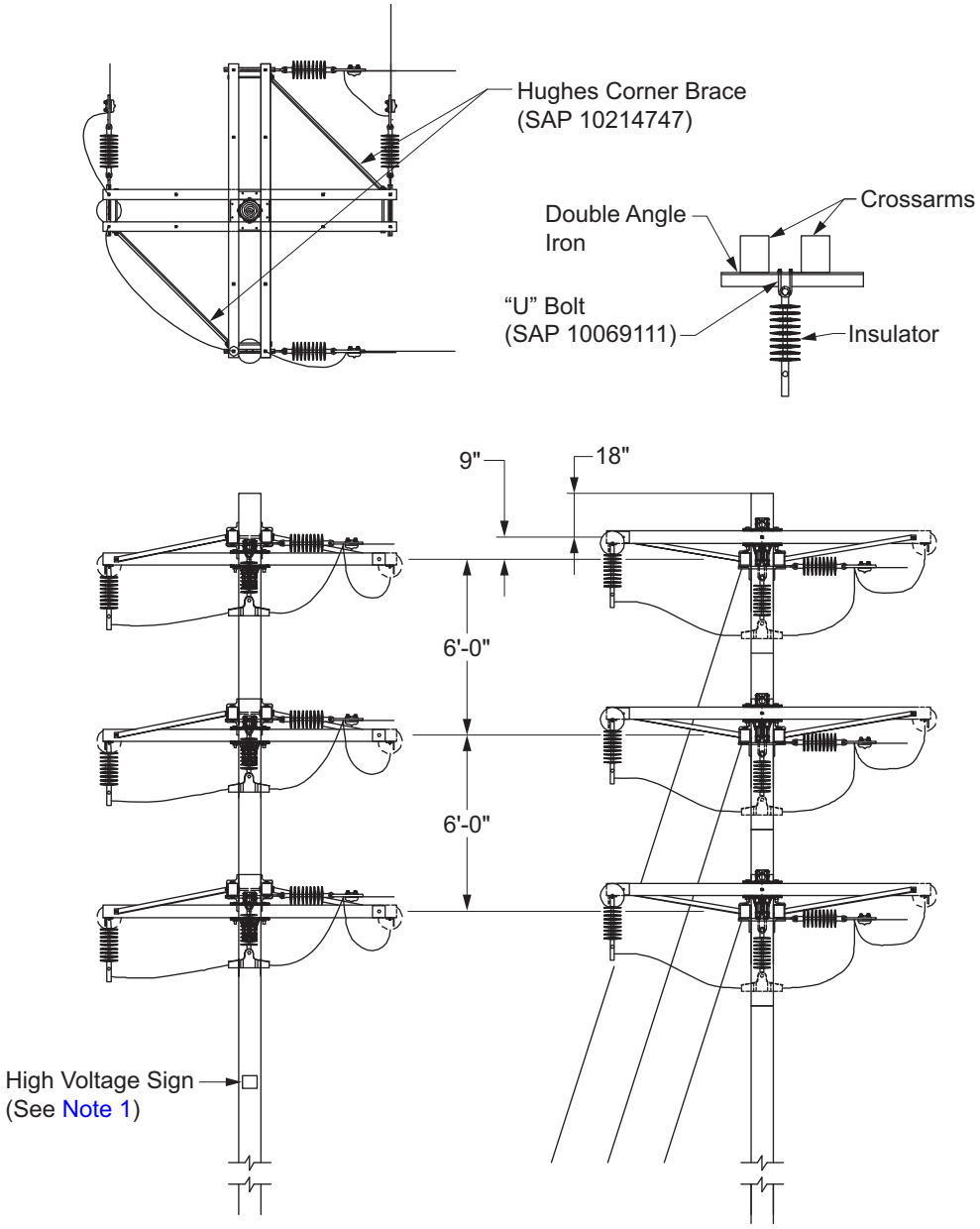


Note(s):

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

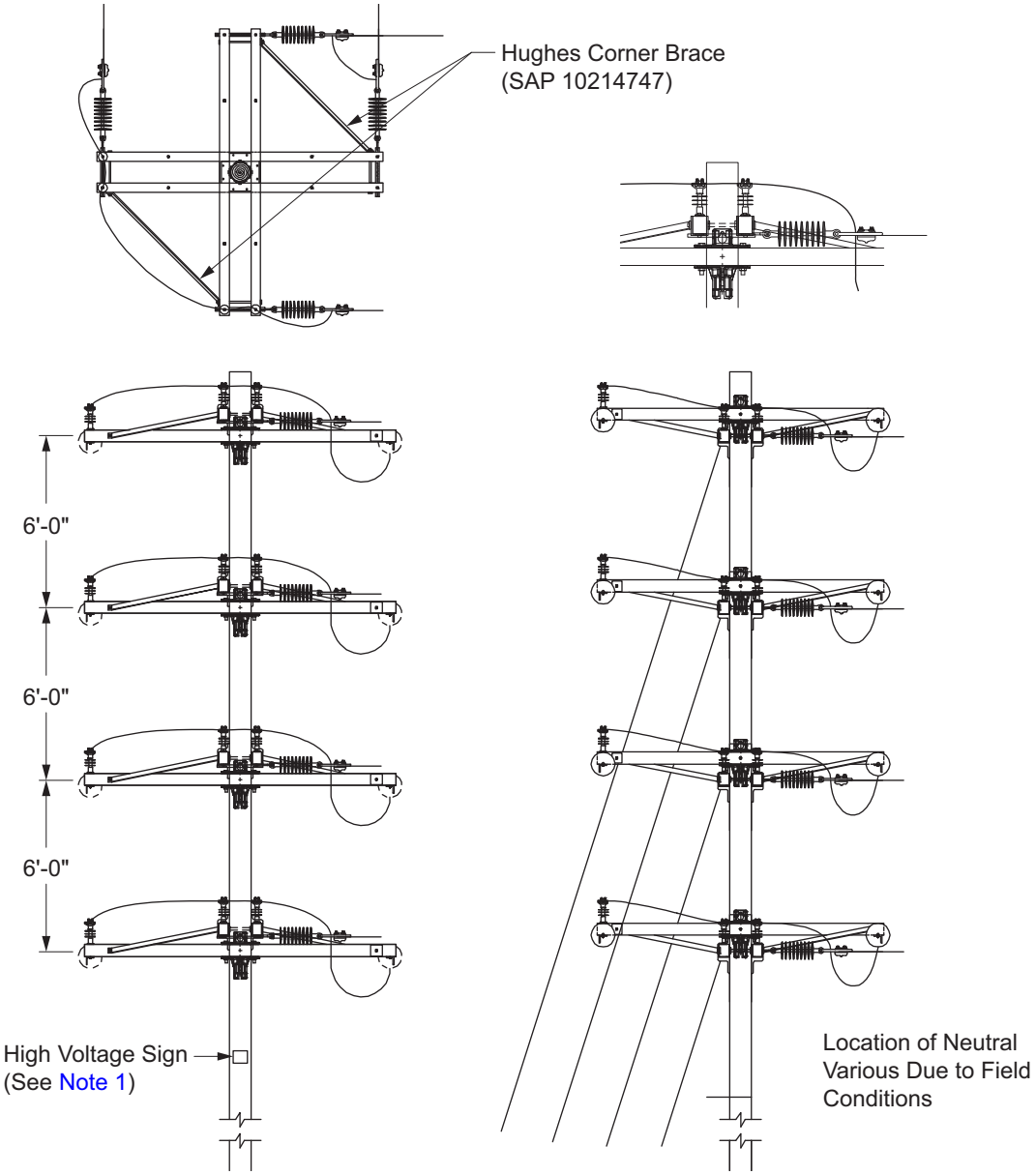


Note(s):

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

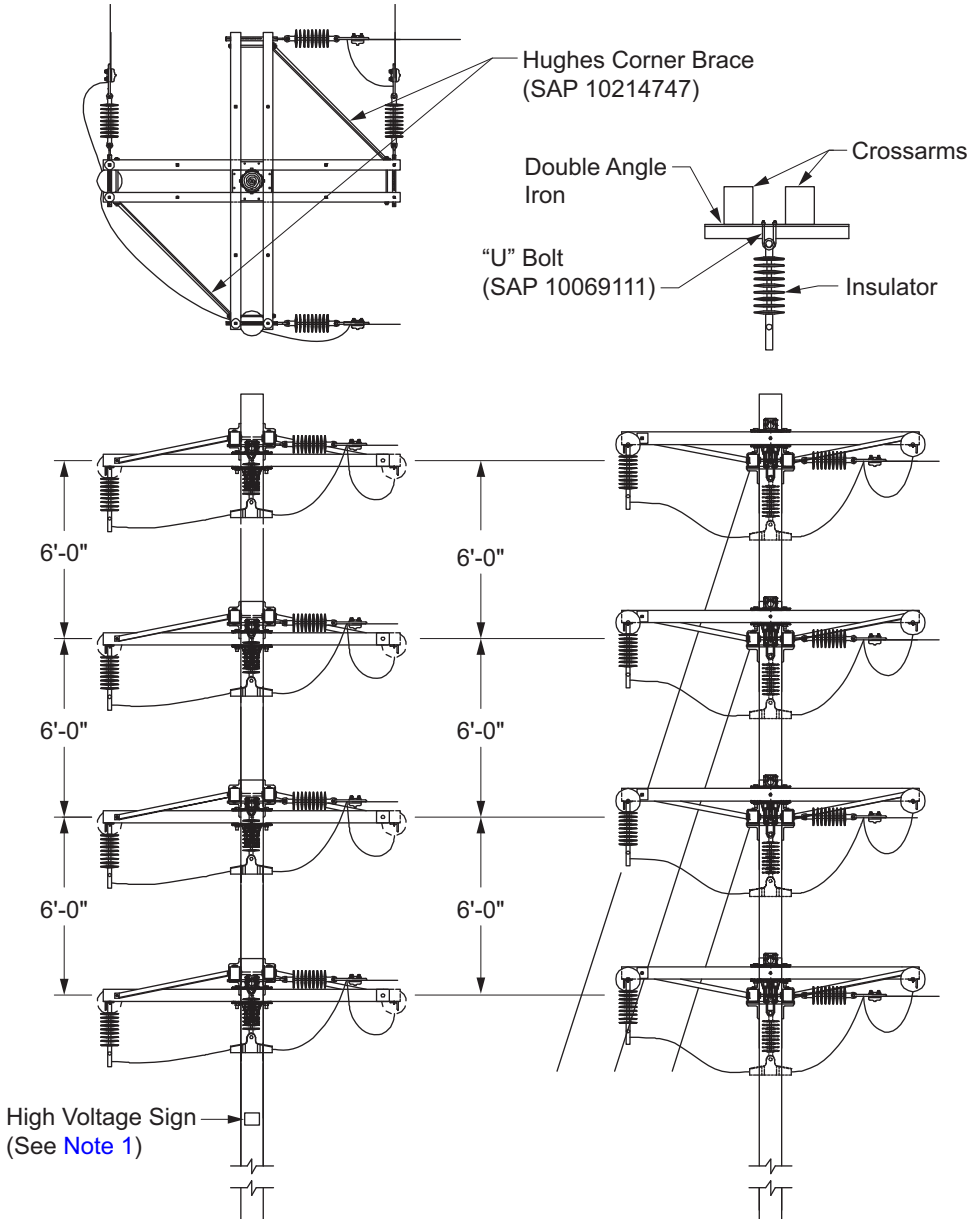


Note(s):

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:

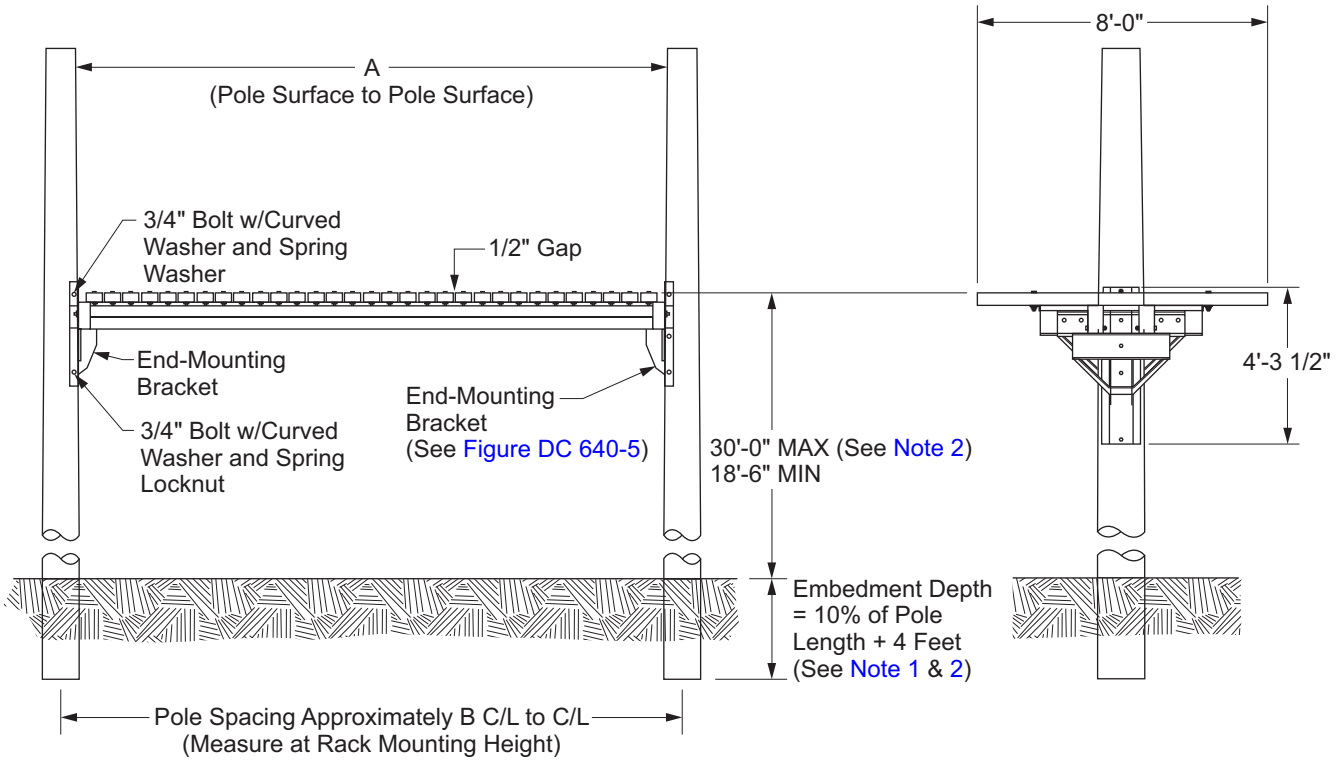
- Cable Tie Down Assembly per Scope DC 640.1, Section 1.2 (preferred method).
- Wood Brace Assembly per Scope DC 640.1, Section 1.3.

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 10178677	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 10178677 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)



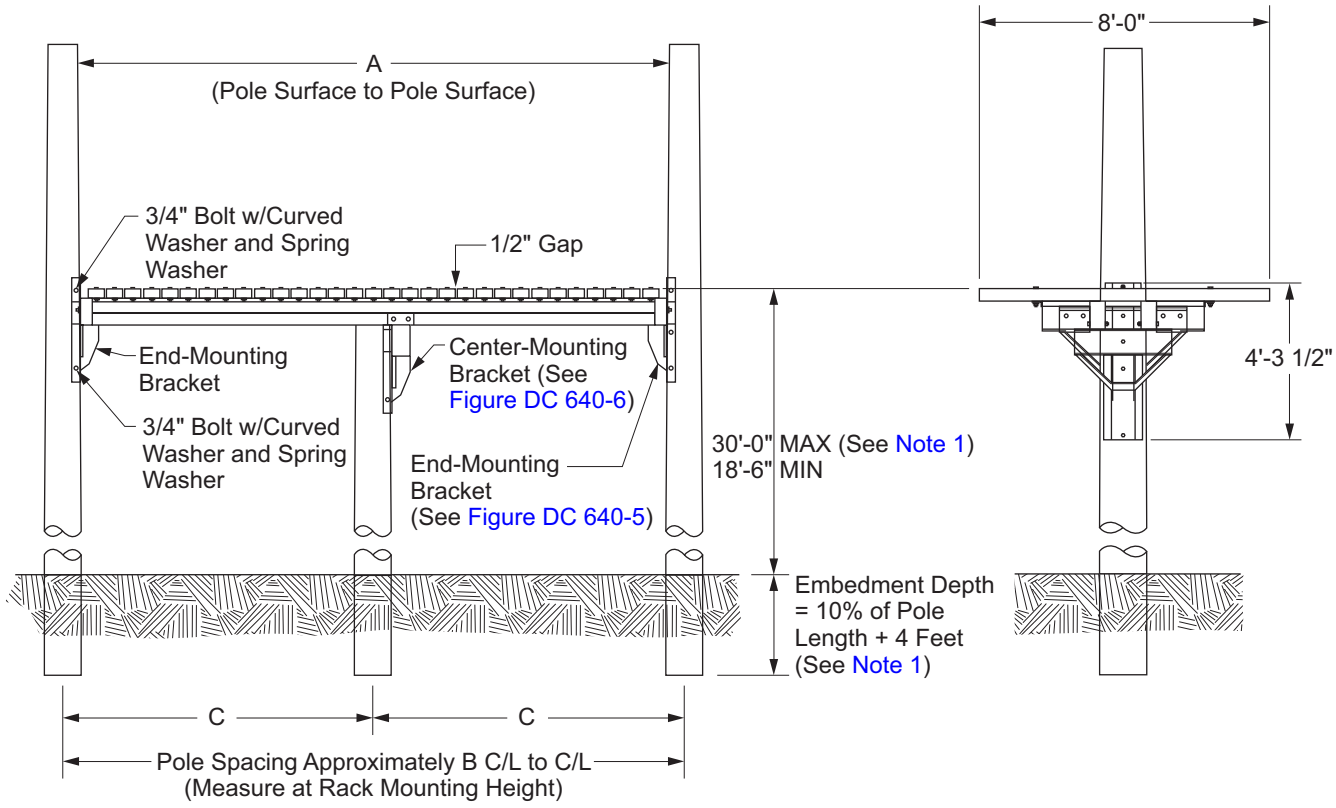
Note(s):

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)



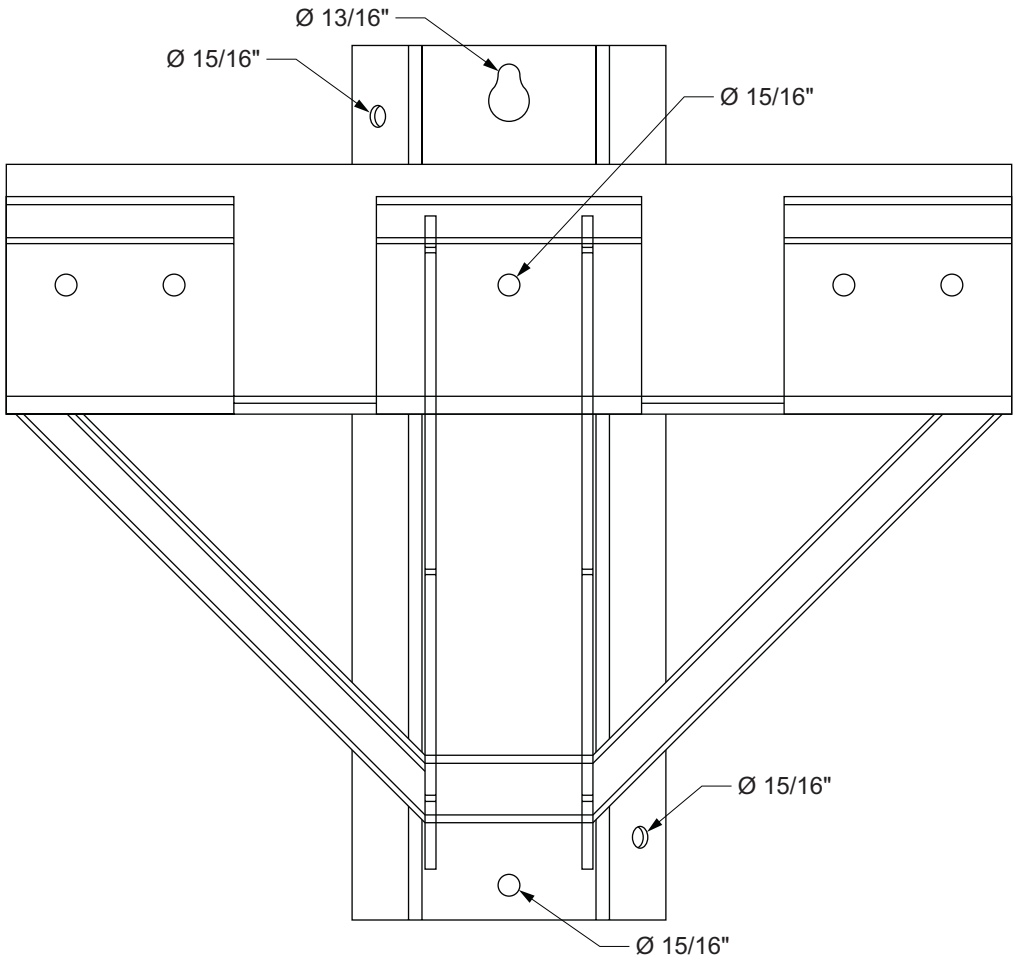
Note(s):

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

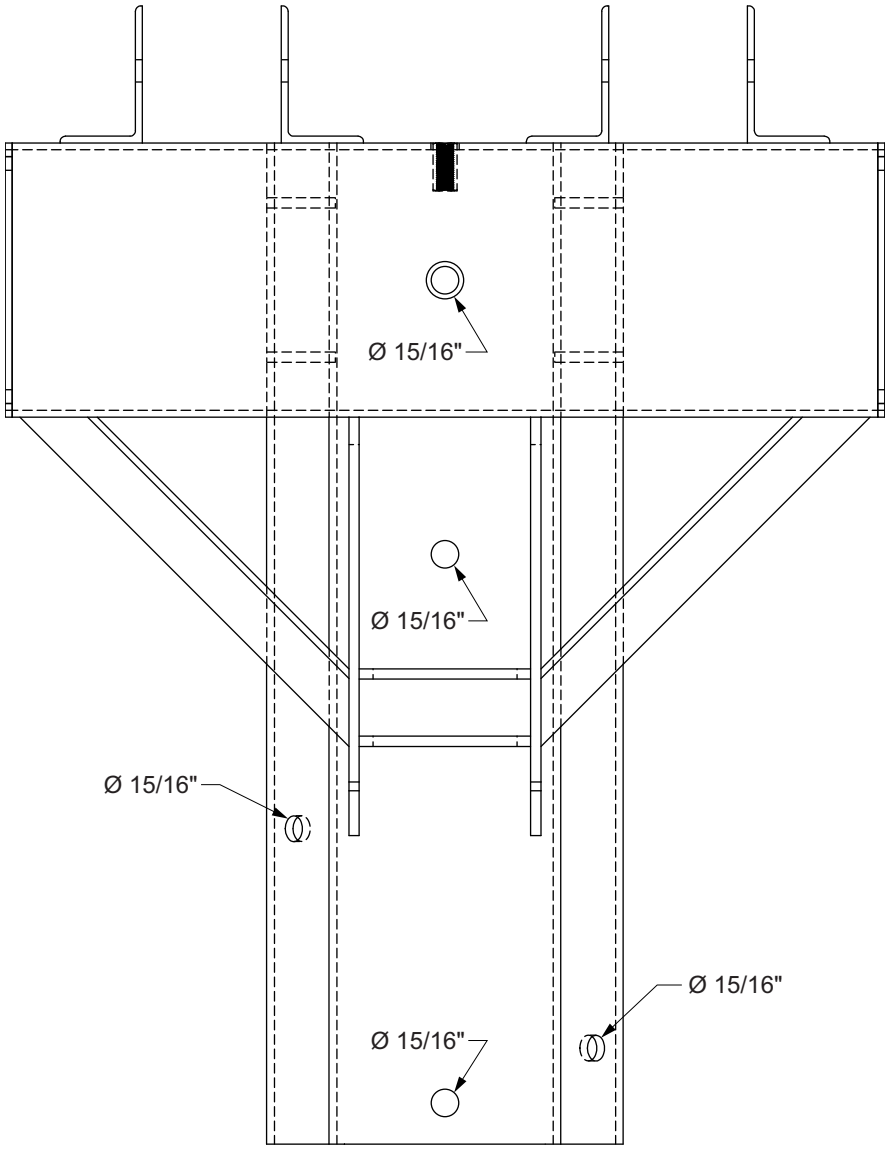


FRONT VIEW

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

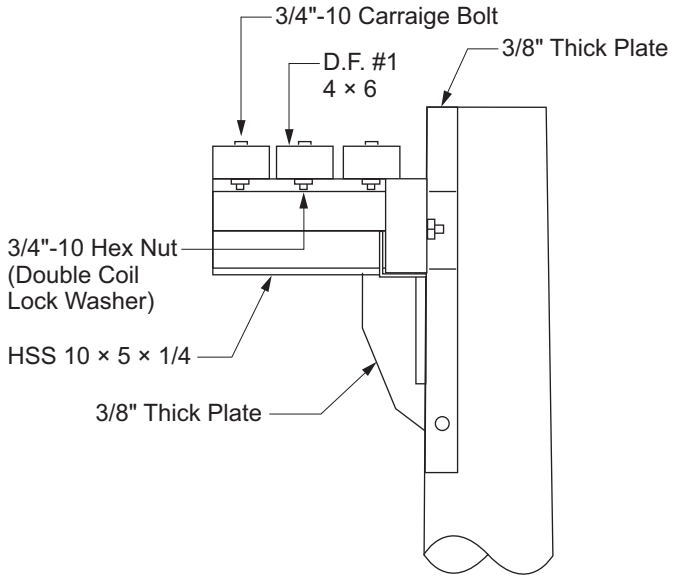
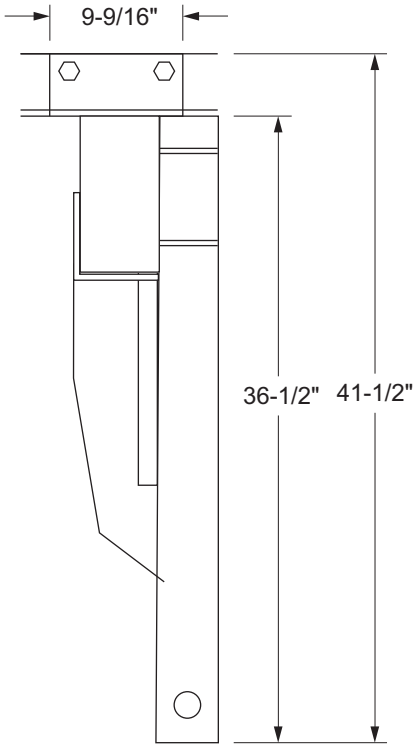


Figure DC 640–6: Center-Mounting Bracket Detail



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.

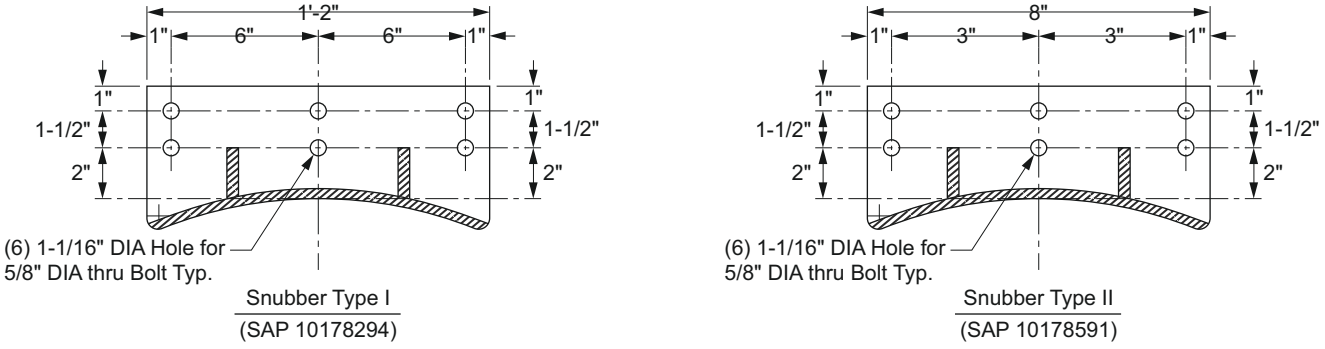
Note: Apply strips of foam protective tape to cover the inside surface of each snubber to avoid metal to metal contact with the equipment.

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

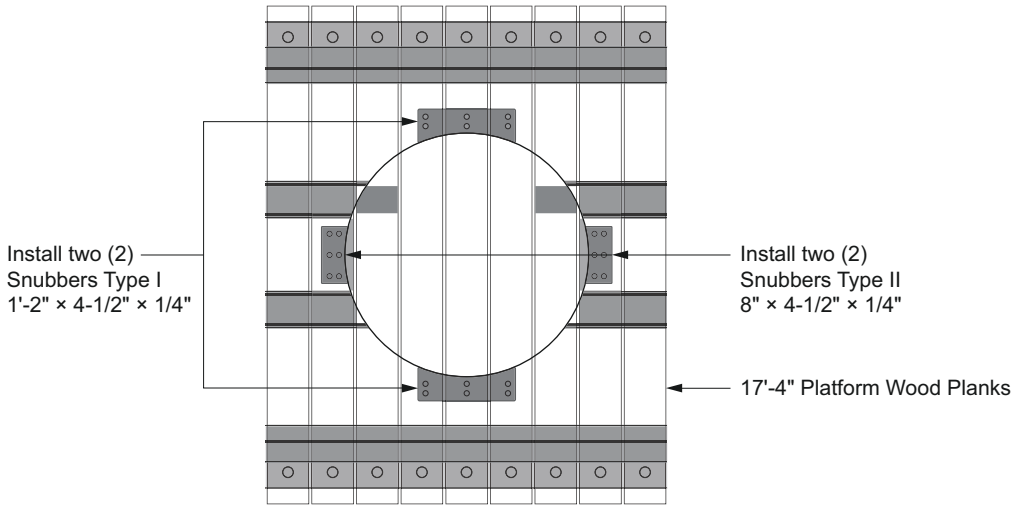
Item	Description	SAP
1	Type I Snubbers (Round-Base)	10178294
2	Type II Snubbers (Round-Base)	10178591
3	Type III Snubbers (Square-Base)	10179217

Figure DC 640–7: Snubbers Type I and Type II for Round-Based Equipment



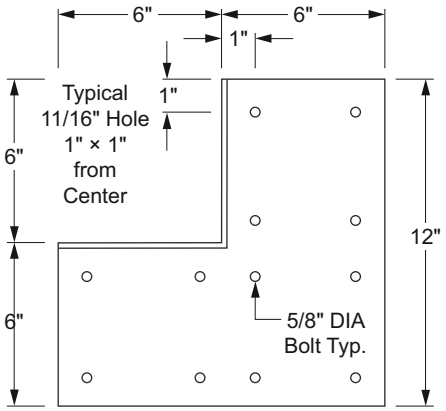
Snubber Type I (SAP 10178294)

Snubber Type II (SAP 10178591)

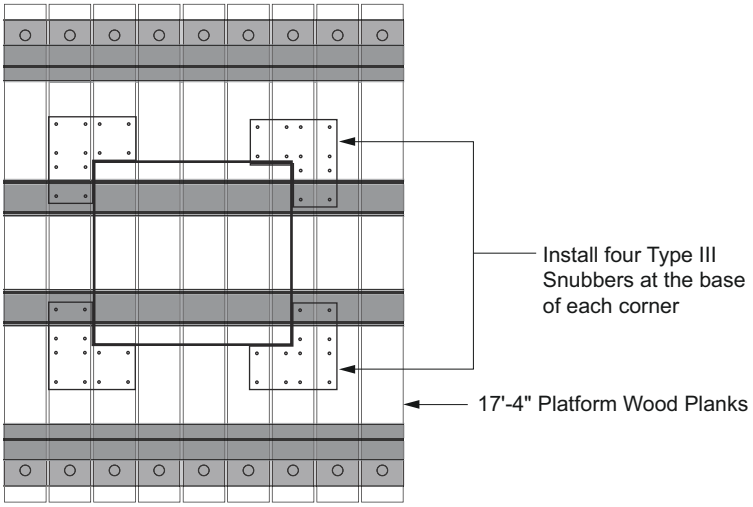


Round-Based Snubbers
Placement of Type I and Type II Snubbers

Figure DC 640–8: Snubbers Type III for Square-Based Equipment



Snubber Type III (SAP 10179217)



Square-Based Snubbers
Placement of Type III

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

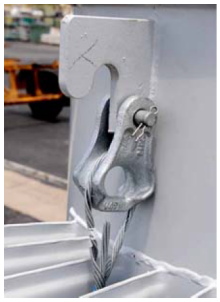
Item	Description	SAP
1	Cable Tie Down Assembly:	
	Clevis, Electrical Type, 18,000 LB Rating	10067656
	Thimbleye, 2" × 4" Size	10068524
	9/32" Guy Wire	10067958
	Dead End, 9/32" and 5/16" Stranded STL	10067504
	Guy Wire Conductor, Automatic Short Bail Kind	
	Cable Hold-Down Roller Adapter[a/]	10183302

[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

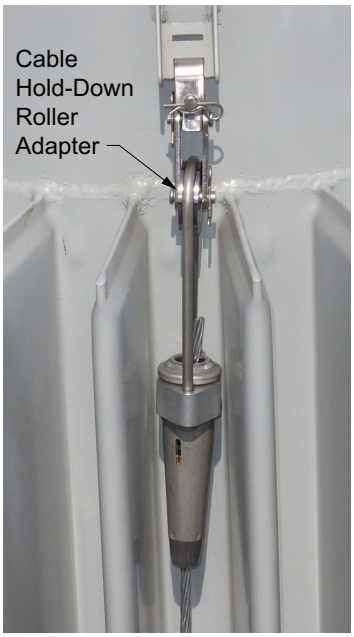
Note(s):

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

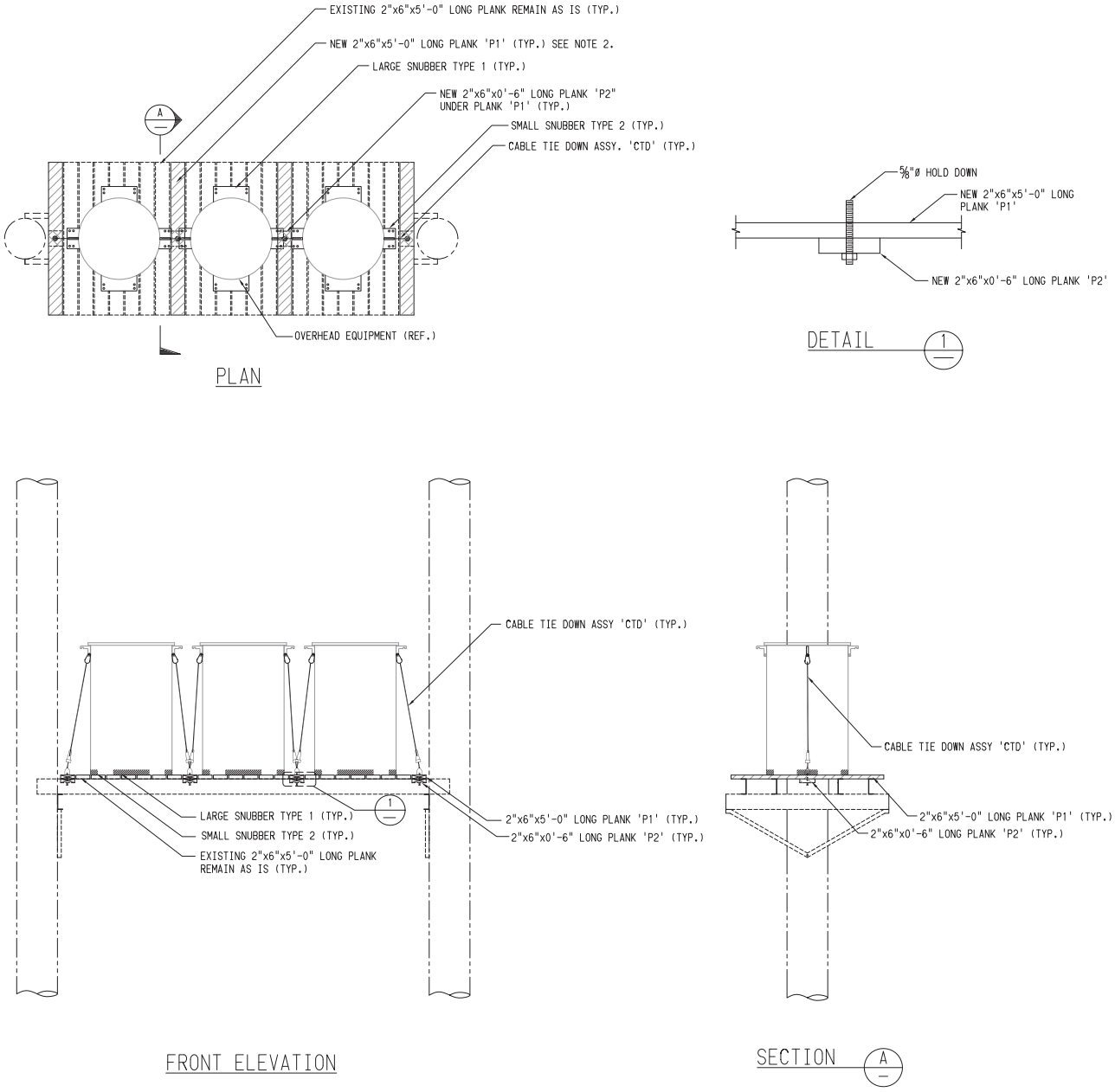
Note(s):

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.

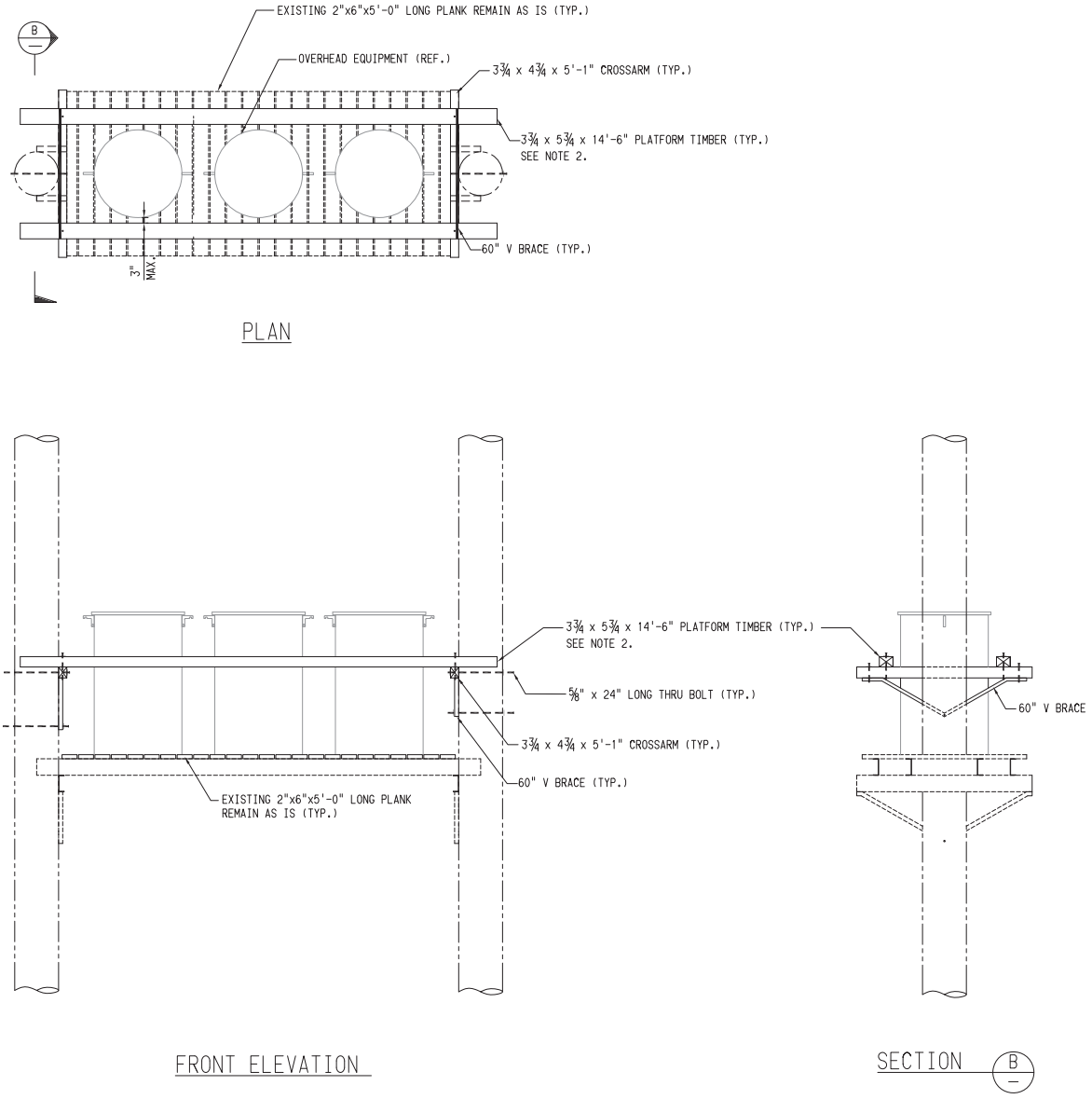
1.3 Wood Brace Assembly

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.	M 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

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.

DOH–GR: Grounding Bonds and Insulators

TABLE OF CONTENTS

STANDARD	TITLE
GR 100	Grounding — General Requirements
GR 100.1	Grounding Applications Involving Wood or Composite Poles
GR 103	Grounding — Lightweight Steel Poles
GR 103.1	Grounds and Attachments Made to Lightweight Steel Poles
GR 105	Grounding Methods — Wood and Composite Poles
GR 105.1	Preferred Grounding Installation on Wood Poles Using Protected Ground Wire (PGW) with Integral Protective Covering
GR 105.2	Alternate Grounding Installation on Wood Poles Using Wood Molding Over Bare Ground Wire
GR 106	Transformer Ground Conductor Size Requirements
GR 106.1	Transformer Ground Conductor Size Requirements
GR 106.2	Grounding of Subtransmission Light Duty Steel Poles
GR 107	Method of Securing Surge Arrester Ground under the Crossarm
GR 107.1	Method of Securing Surge Arrester Ground under the Crossarm
GR 110	Establishing Neutral Grounds — 4-Wire System
GR 110.1	Establishing Neutral Grounds — 4-Wire System
GR 111	Electrical Connection of Neutral Conductors to Lightweight Steel (LWS) Poles
GR 111.1	Electrical Connection of Neutral Conductors to LWS Poles
GR 120	Secondary Grounds on Transformers
GR 120.1	Secondary Grounds on Transformers
GR 200	Pin-Type Line Insulators
GR 200.1	Porcelain Pin-Type Line Insulators
GR 200.2	Polymer Pin-Type Line Insulators — Tie Top
GR 200.3	Polymer Pin-Type Line Insulators — Vise-Top, Aluminum Inserts
GR 200.4	Polymer Pin-Type Line Insulators — Vise-Top, Bronze Inserts
GR 200.5	Polymer Pin-Type Line Insulators — Vise-Top, Nylon Inserts
GR 200.6	Pin-Type Insulator Installation Instructions
GR 200.7	Polymer Pin Type Line Insulators — Clamp Top with Universal Inserts
GR 205	Post-Type Line Insulators
GR 205.1	Porcelain Post-Type Line Insulators — Tie-Top
GR 205.2	Porcelain Post-Type Line Insulators — Trunnion-Top
GR 205.3	Polymer Post-Type Line Insulators — Aluminum Universal Clamp-Top
GR 205.4	Polymer Post-Type Line Insulators — Trunnion-Top
GR 205.5	Porcelain and Polymer Post-Type Insulator Installation Instructions
GR 205.6	Polymer Post-Type Line Insulators — Tin-Plated Universal Clamp-Top

STANDARD	TITLE
GR 210	Line Insulators — Dead-Ends
GR 210.1	Typical Dead-end Type Insulators
GR 215	Contamination Area Map
GR 215.1	Contamination Area Map
GR 300	Bonding Requirements 12 kV to 115 kV
GR 300.1	Requirements for Bonding of 12 kV to 115 kV Line Hardware
GR 305	Bonding Methods 12 kV to 66 kV
GR 305.1	Bonding Methods 12 kV to 66 kV
GR 400	Deep Grounding Electrode
GR 400.1	Deep Grounding Electrode General Requirements

GR 100 Grounding — General Requirements

Scope GR 100.1 Grounding Applications Involving Wood or Composite Poles

1.0 General Information

1.1 Ground wires are to be attached to ground rods (ground electrodes). Two (2) ground rods shall be one-piece, corrosion resisting and a minimum of 8 feet in length and 5/8 inches in diameter. Typically, ground rods will be installed on opposite sides of the pole.

A. Two (2) 3/4-inch X 10-foot ground rods may also be used when driven through undisturbed or compacted earth at 30 degree angle to the pole. See Figure GR 105–2).

B. In rocky soil, two (2) 3/4-inch X 10-foot ground rods, seperated 2 feet (min), may also be used when driven through undisturbed or compacted earth parallel to the pole. See Figure GR 105–4).

1.2 Each of the two ground rods shall be installed so that the tip of the rods are at least 6 feet apart and 8 feet below grade.

1.3 Ground conductors, running laterally under the ground, must be a minimum of 18 inches below finished grade. The top of the ground rods must be at least 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 bonded to 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.

2.6 Protective covering shall be removed from buried ground wires starting at 6-inches below grade.

2.7 Refer to DOH GR 105 for grounding installations using PGW with integral protective covering.

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 4 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 4 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.

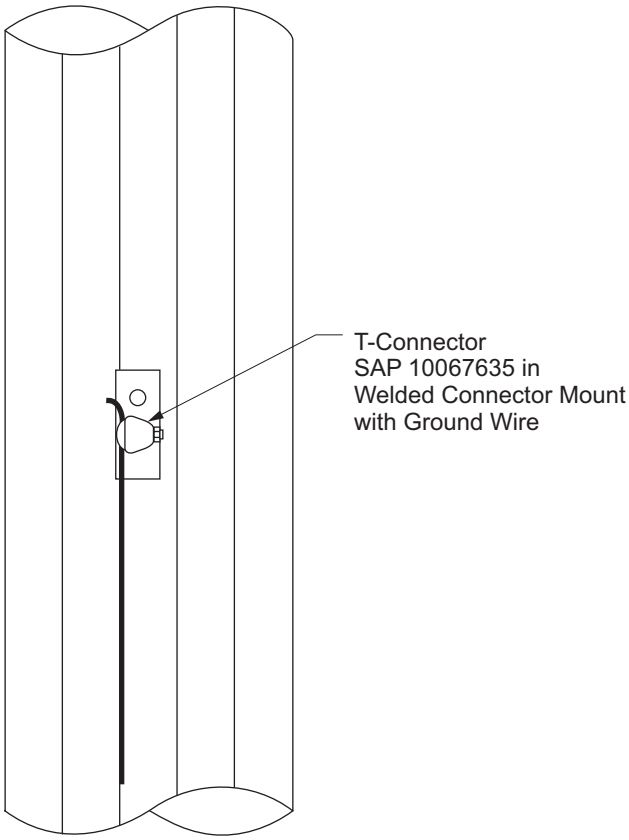
7.4 On 115 kV and 66 kV lines where an overhead ground wire is attached to the pole, the bonding system will be attached to the ground wire. This will create a completely grounded structure. If any of the subject poles are supported by grounded guys, the grounded guys will be attached to the bonding 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.

GR 103 Grounding — Lightweight Steel Poles

Scope GR 103.1 Grounds and Attachments Made to Lightweight Steel Poles

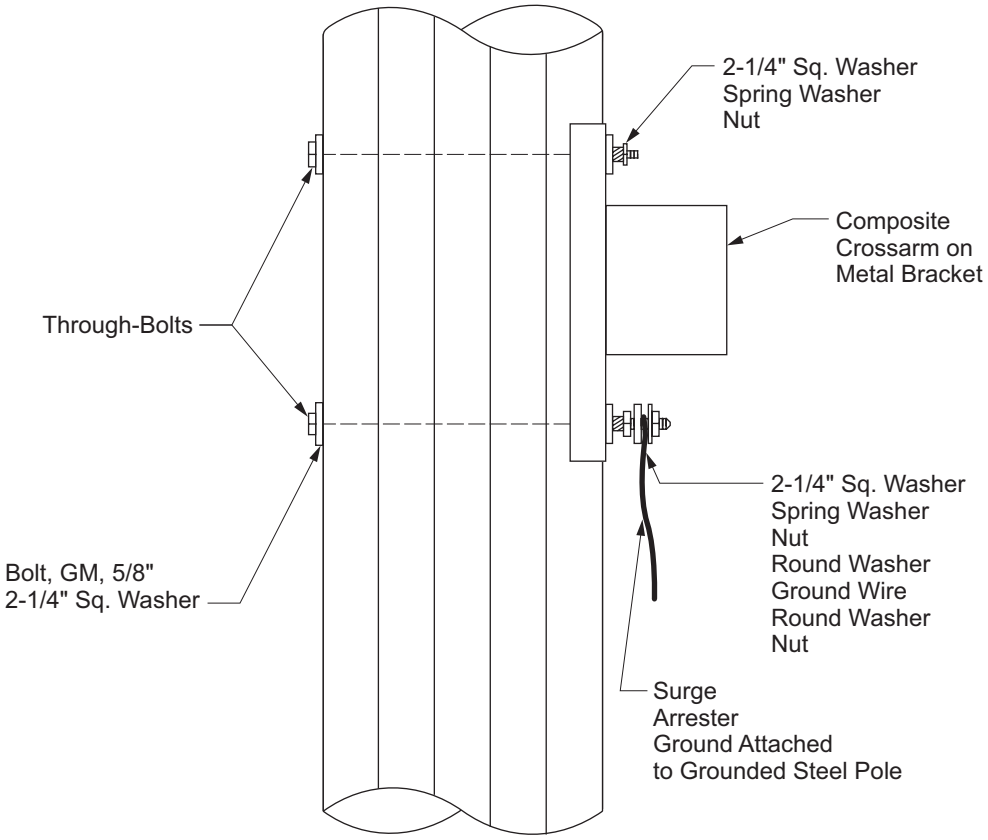
Grounds, transformer attachments, and hardware attachments shall be made to LWS poles with a T-connector if a welded connector mount is available at the appropriate height. Otherwise the attachment shall be made with a through-bolt. (See Figure GR 103.2 [Sheet 2] through Figure GR 103–3 [Sheet 3]).

Figure GR 103–1: Installation of a T-Connector and a Ground Wire in a Welded Connector Mount



GR 103.2 Grounding of Subtransmission Light Duty Steel Poles

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

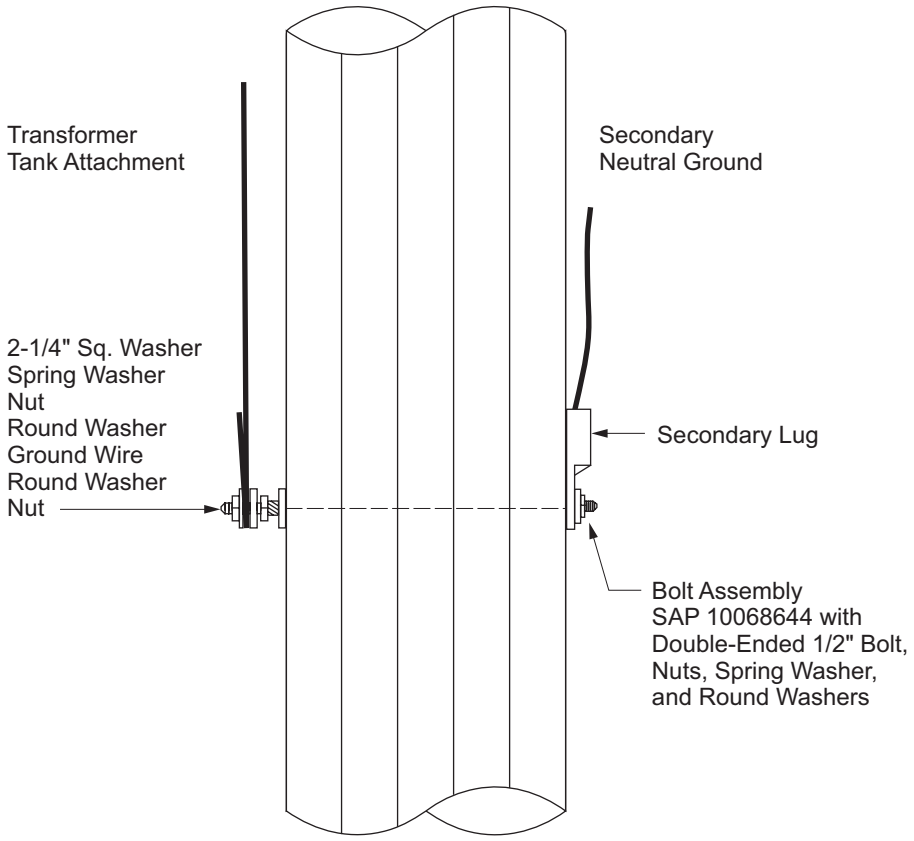
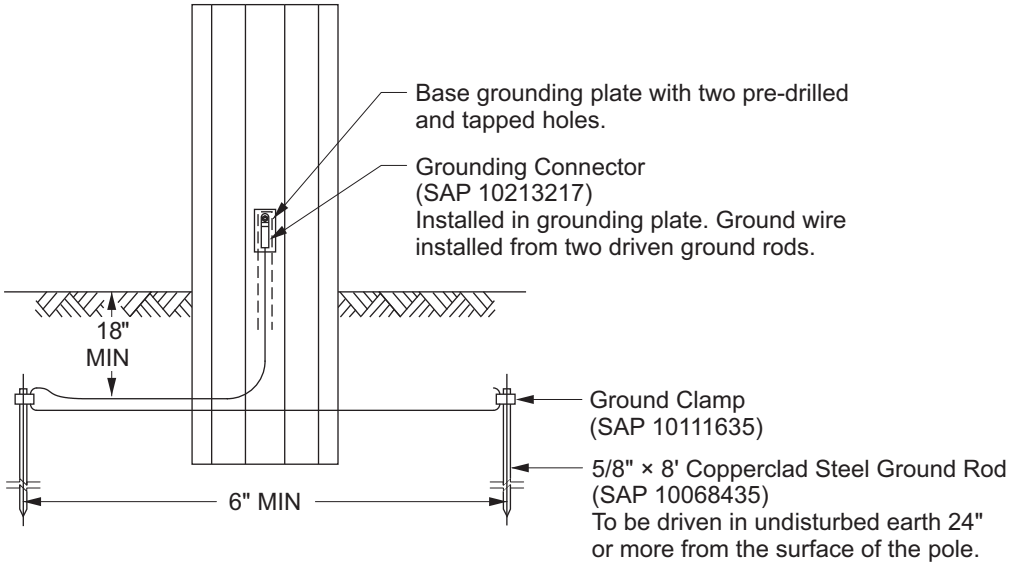


Figure GR 103–4: Installation of Ground Rods Installed at the Base of a Steel Pole with a Coated Base



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.

Figure GR 103–5: Grounding Method for LWS Poles: Grounding Installation with 3/4" X 10' Angled Ground Rods

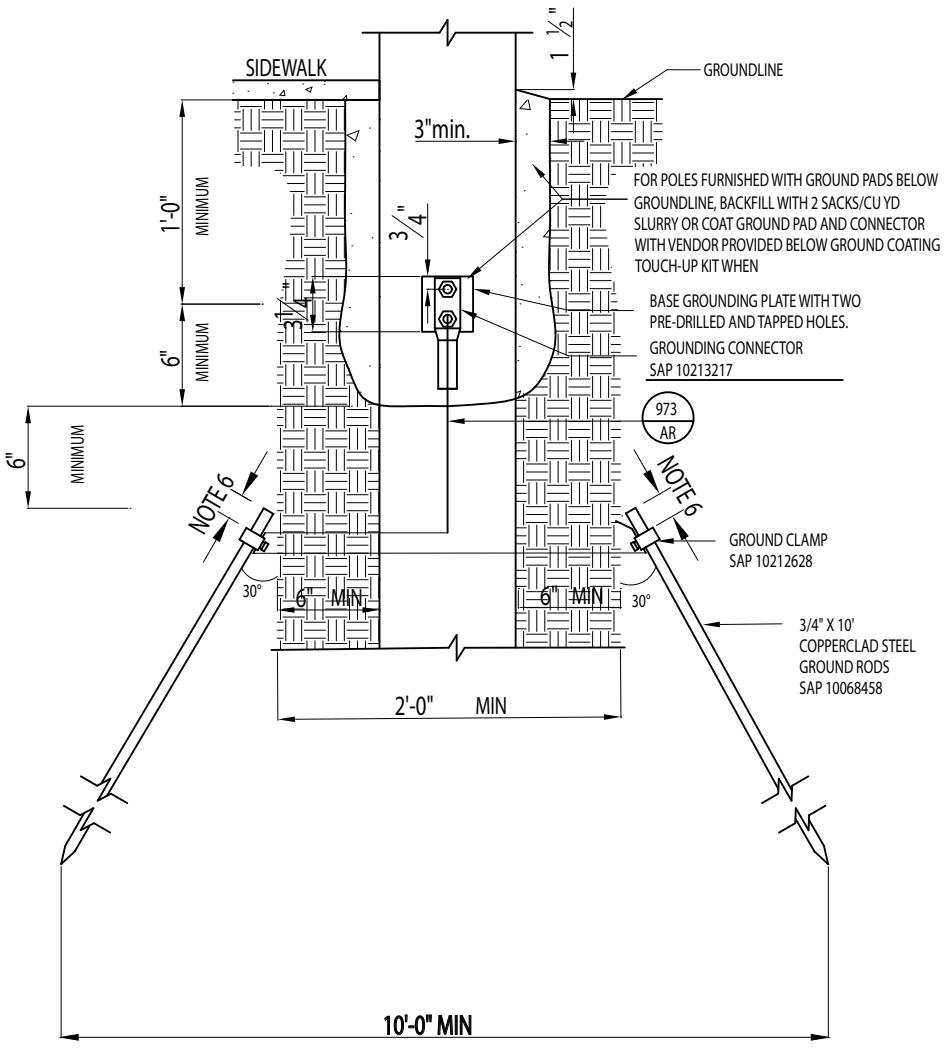


***Figure footnote:** This method can also be used to ground wood and composite poles. See Figure GR 105–2 (Sheet 3)

Note(s):

1. Ground wire will be #4 Cu.
2. Ground rods shall be driven into undisturbed earth and shall be 6 inches or more from the surface of the pole.
3. Keep new LWS ground rods at minimum 10 feet away from pipelines carrying flammable liquids or gases operating at high pressure [1030 kPa (150 lbs/in2)] or greater.
4. Do not damage mastic coating while installing pole. Ensure sufficient space between the ground rod and pole.
5. The grounding clamp shall be installed at a minimum of 6 inches from the top of the rod.
6. Poles fabricated after 2019 are furbished with ground pads below ground line.
7. See Table GR 103–1 for list of materials.

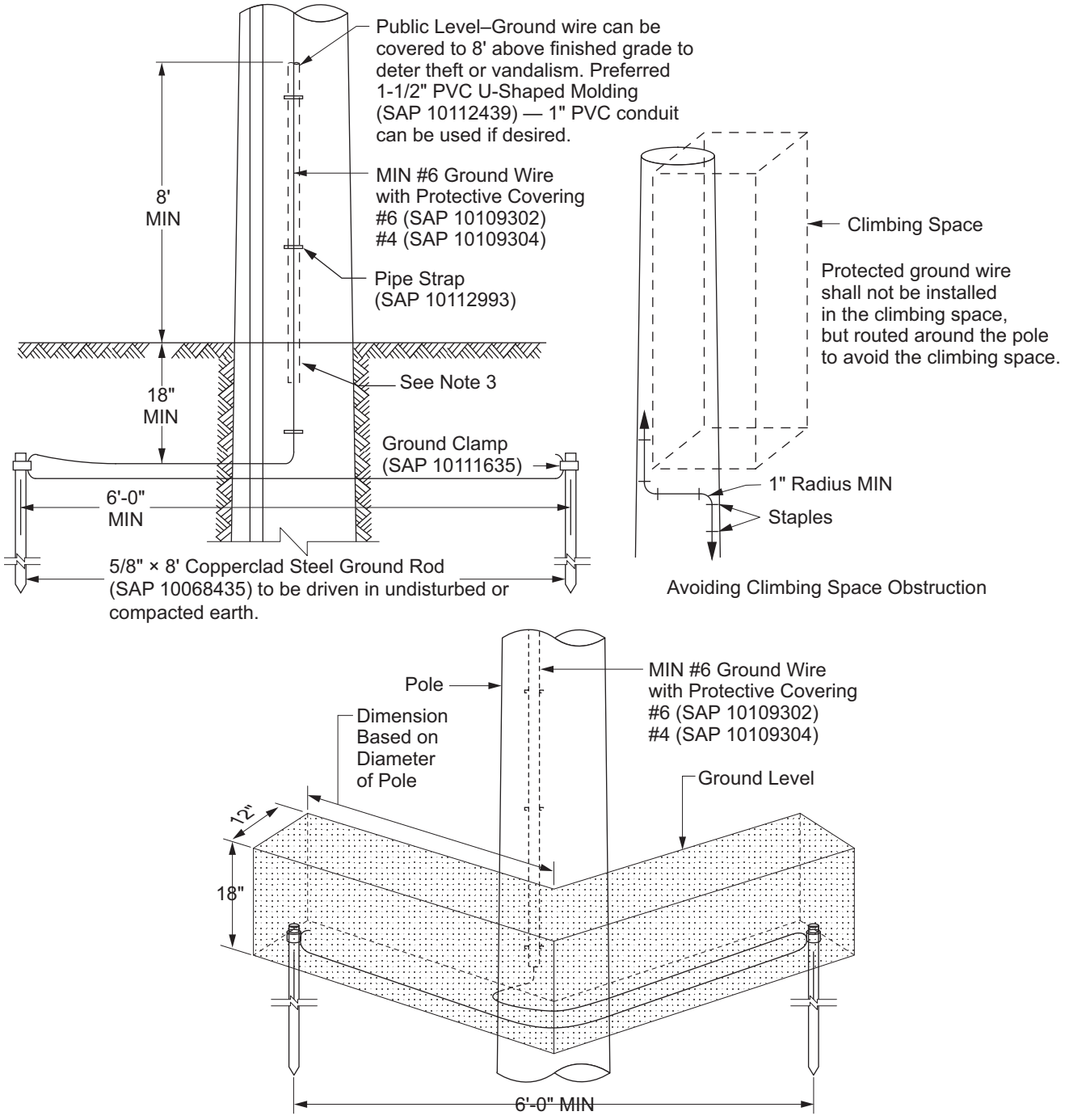
Table GR 103–1: Materials for Grounding Installation with Angled Ground Rods

Item Number	Qty	SAP	Description
—	2	10068458	ROD, ground kind, 3/4-inch × 10 feet, large size
973	12	10109325	CONDUCTOR, electrical, #4, Cu, solid, 7.911 feet/pounds.
—	2	10212628	CLAMP, grounding, #2 AWG stranded wire.
—	1	10213217	CLAMP, grounding type, #4 Cu, solid

GR 105 Grounding Methods — Wood and Composite Poles

Scope GR 105.1 Preferred Grounding Installation on Wood Poles Using Protected Ground Wire (PGW) with Integral Protective Covering

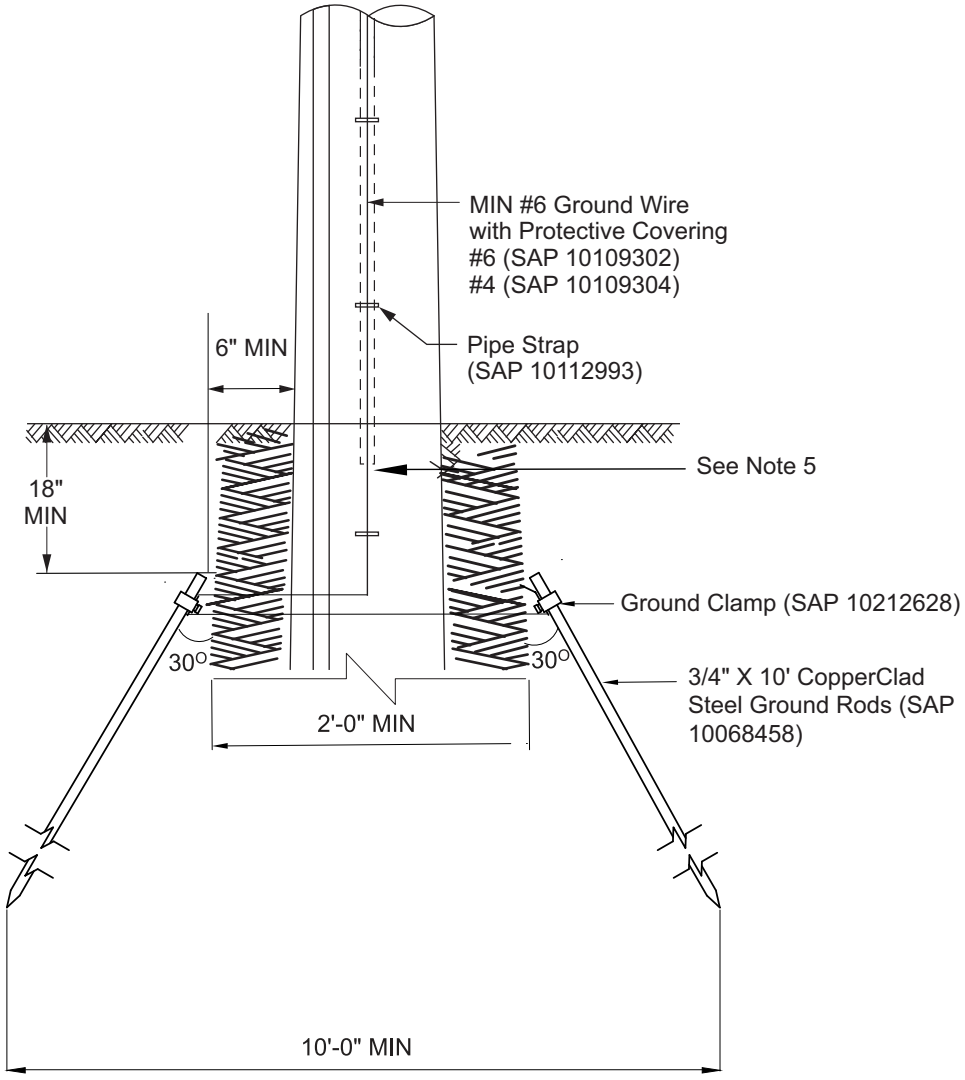
Figure GR 105–1: Grounding Installation with 5/8” x 8’ Ground Rods



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.
3. Remove protective covering from buried ground wires starting at 6 inches below grade.
4. See Figure GR 105–2 and Figure GR 105–4 for other approved ground rod installation method.

Figure GR 105–2: Grounding Installation with 3/4" X 10' Angled Ground Rods



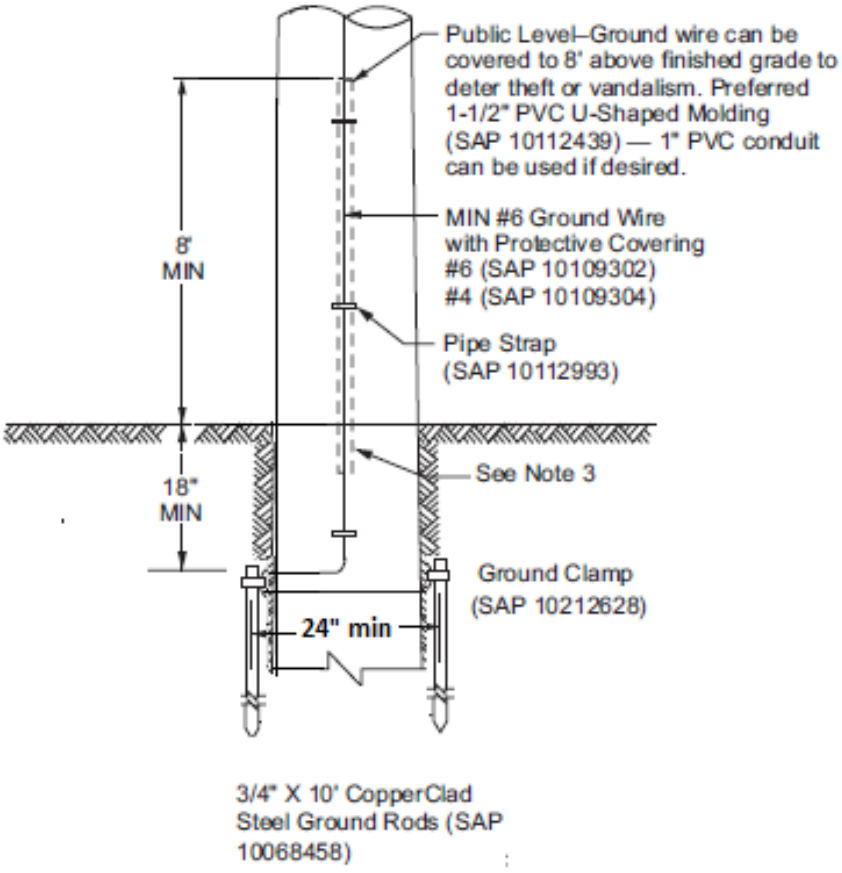
Note(s):

1. Ground wire shall be a minimum #6 copper.
2. Ground rods shall be driven into undisturbed or compacted earth and shall be 6 inches or more from the surface of the pole.
3. Ensure sufficient space between the ground rod and pole.
4. The grounding clamp shall be installed at a minimum of 6 inches from the top of the rod.
5. Remove protective covering from buried ground wires starting at 6-inches below grade.
6. See Table GR 105–1 for list of materials.

Table GR 105–1: Materials for Grounding Installation with 10-Foot Ground Rods

Item Number	Qty	SAP	Description
—	2	10068458	ROD, ground kind, 3/4-inch × 10-foot, large size.
973	12	10109325	CONDUCTOR, electrical, #4, Cu, solid, 7.911 foot/pound.
—	2	10212628	CLAMP, grounding, #2 AWG stranded wire.
—	1	10213217	CLAMP, grounding type, #4 Cu, solid.

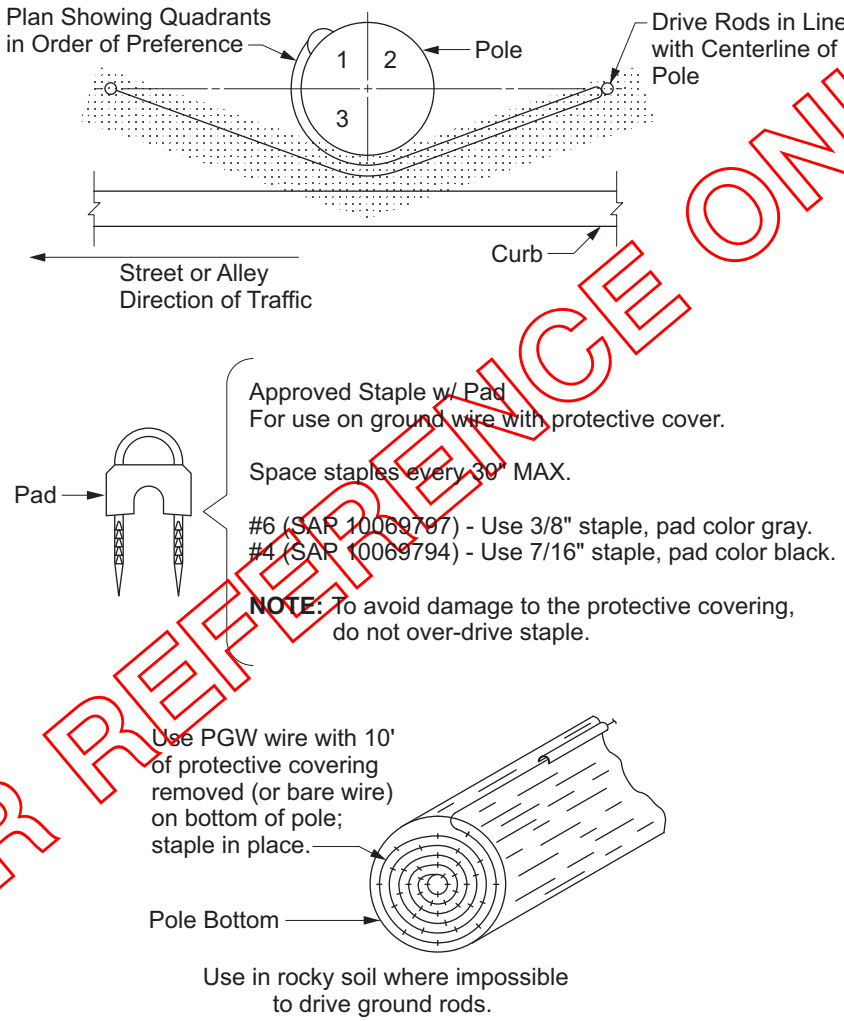
Figure GR 105–3: Ground Installation with 3/4” x 10’ Ground Rods in Same Pole Hole



Note(s):

1. Drive two (2) 3/4” x 10’ ground rods on opposite sides of the pole minimum 2’ apart (can be driven into the backfilled and compacted pole hole soil). Maintain 3” minimum distance from pole.
2. See Table GR 105–1 for list of materials.

Figure GR 105–4: Preferred Grounding — Wood Pole Butt-Wrap



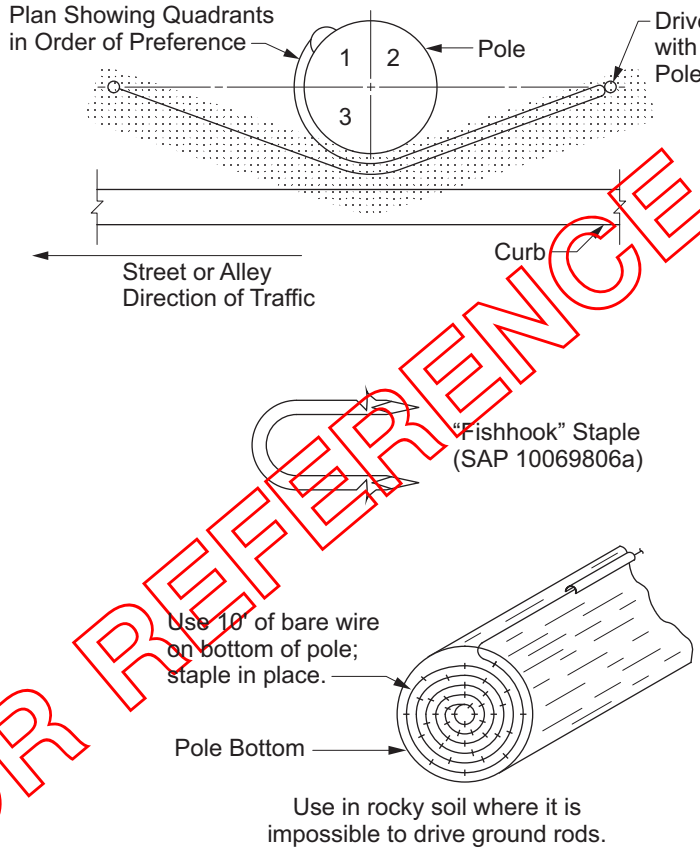
FOR REFERENCE ONLY

Note(s):

1. Pole butt wrap grounding is not approved for new construction or rebuilds.
2. See Figure GR 105–3 for grounding installation in compacted or rocky soils.

Scope GR 105.2 Alternate Grounding Installation on Wood Poles Using Wood Molding Over Bare Ground Wire

Figure GR 105–5: Alternate Grounding, Wood Poles Butt Wrap



FOR REFERENCE ONLY

Note(s):

1. Use only where PGW cannot be used or on existing wood molding instalations.

This page intentionally left blank.

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/]
1000–2500	#2/0 BC
3750	#4/0 BC

[a/] Bare Copper

This page intentionally left blank.

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

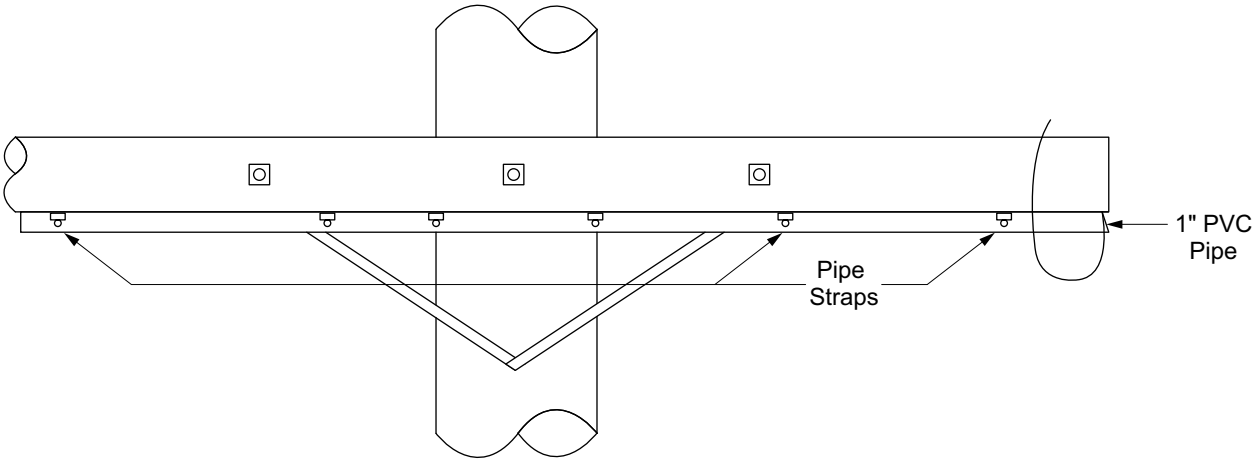
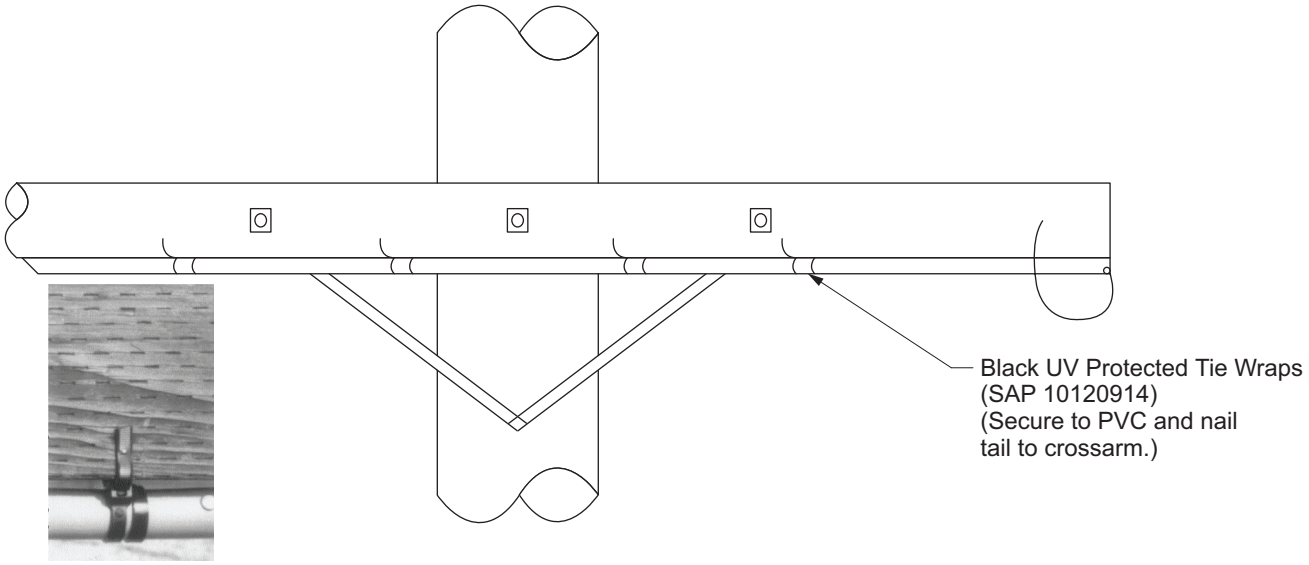


Figure GR 107–2: Method "B" Using Tie-wraps where Metal Clearance to Bond is Impaired



This page intentionally left blank.

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

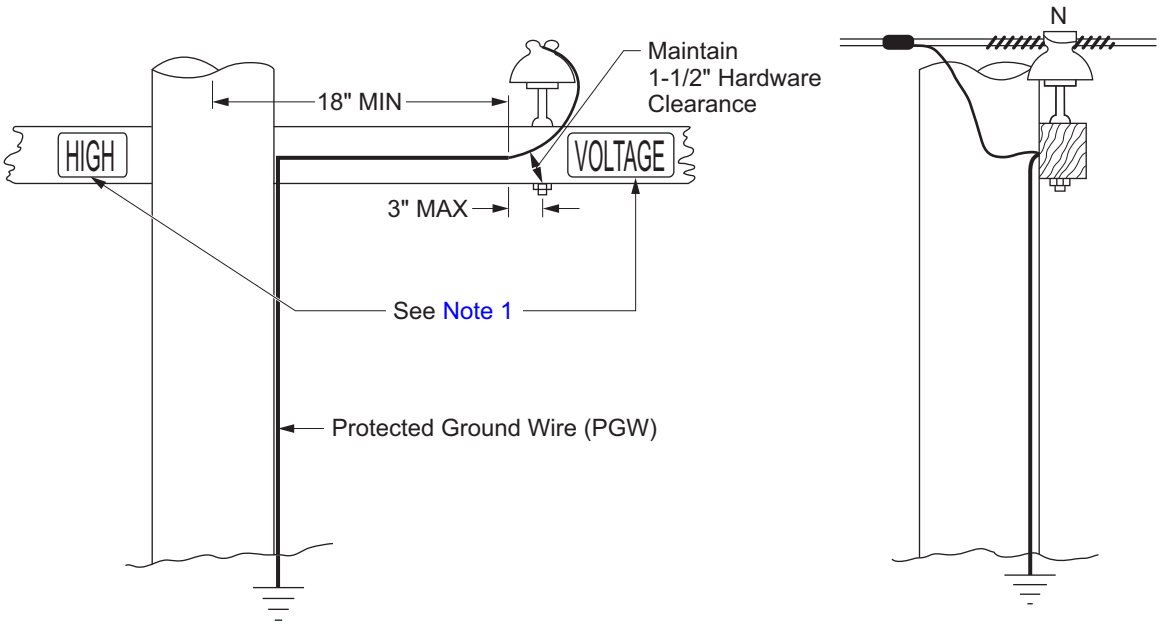


Figure GR 110–1.2: Preferred Method

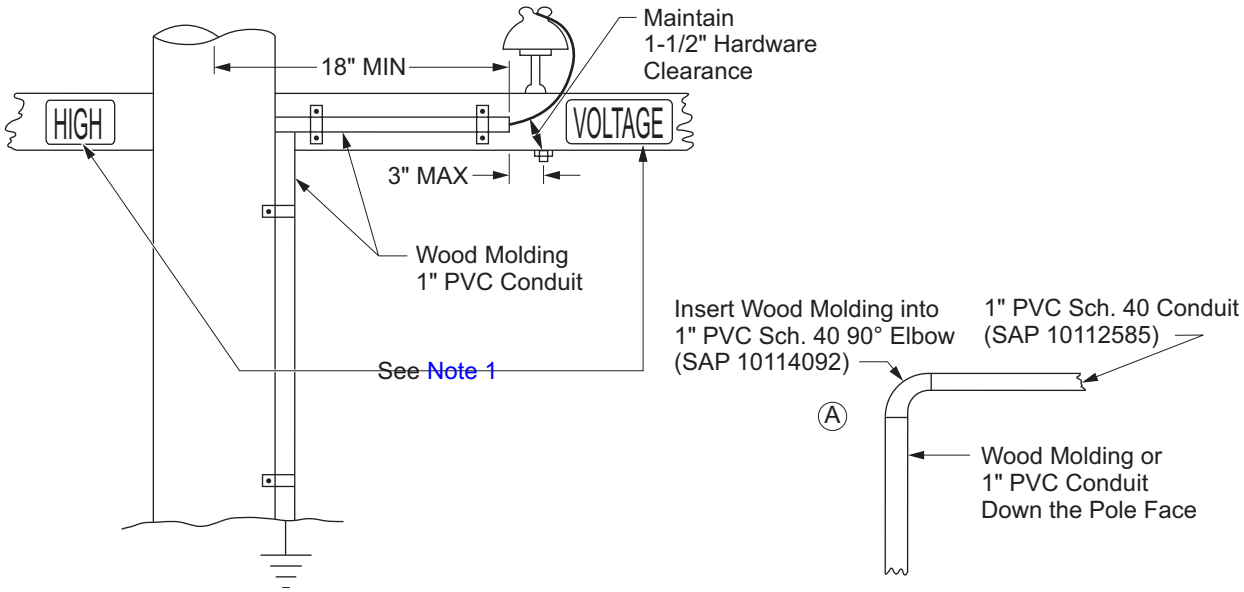


Figure GR 110–1.3: Alternate Method 1

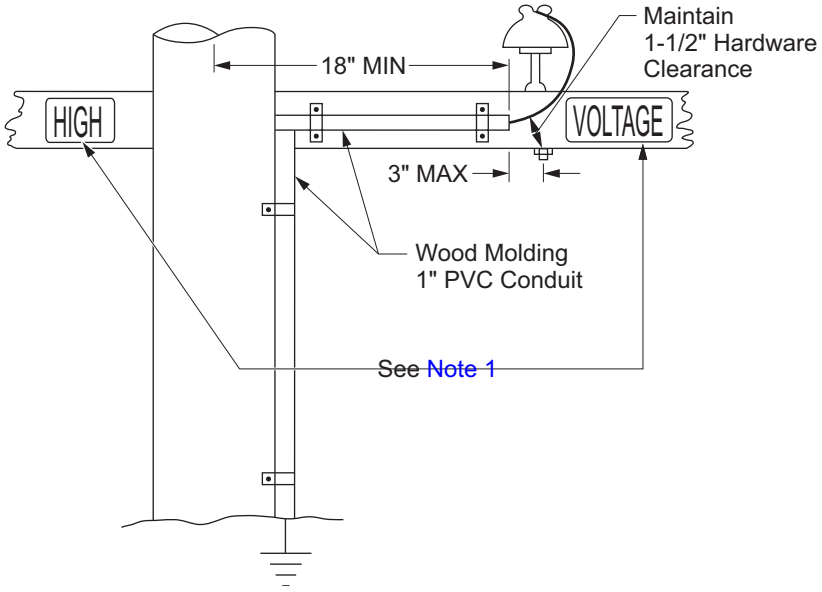


Figure GR 110–1.4 Alternate Method 2

Note(s):

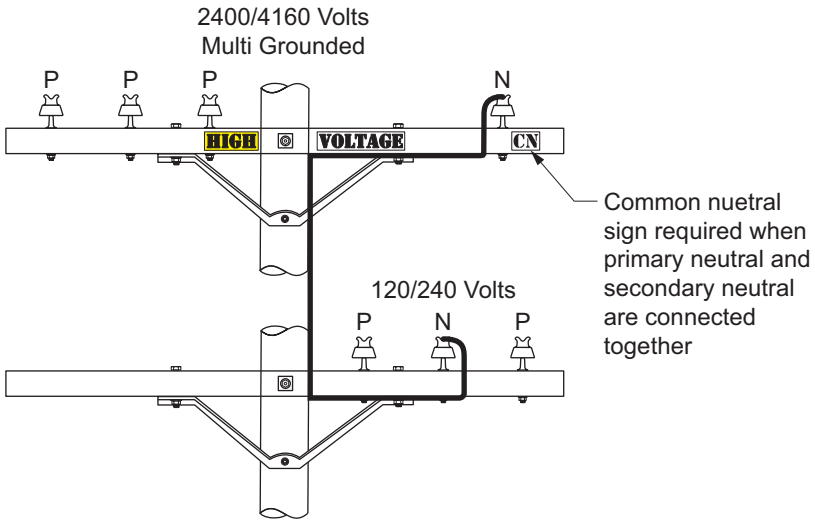
1. See PO 120 for HIGH VOLTAGE sign installation requirements.

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 4 kV isolated neutral). 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

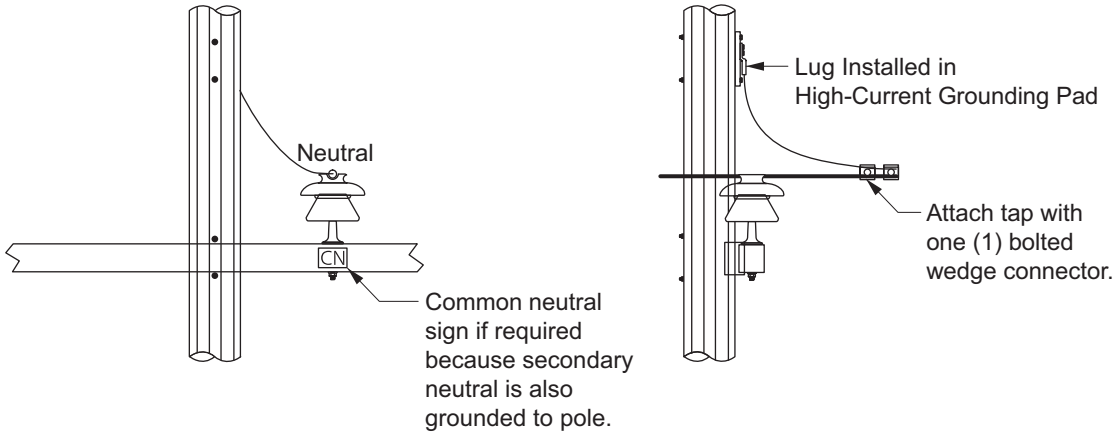


Figure GR 111–2: Primary Neutral Ground Pad Installation

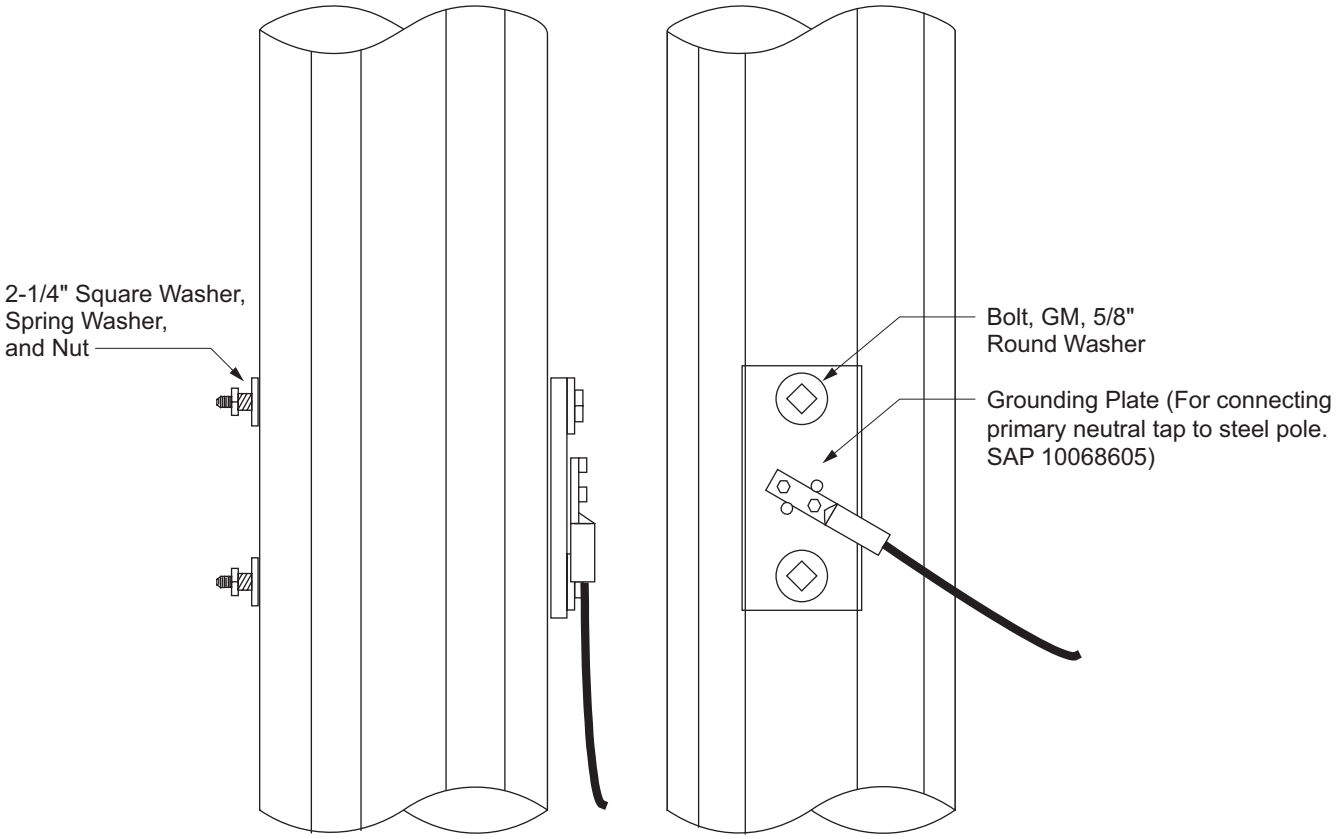


Table GR 111–1: Primary Neutral High-Current Ground Pad Installation

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

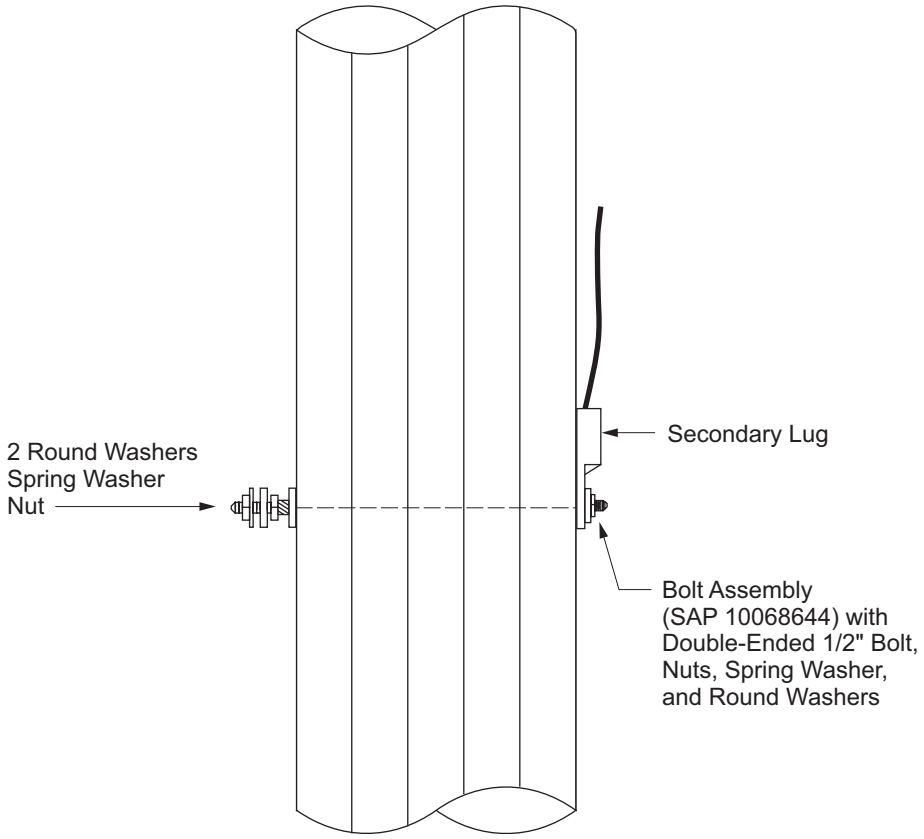


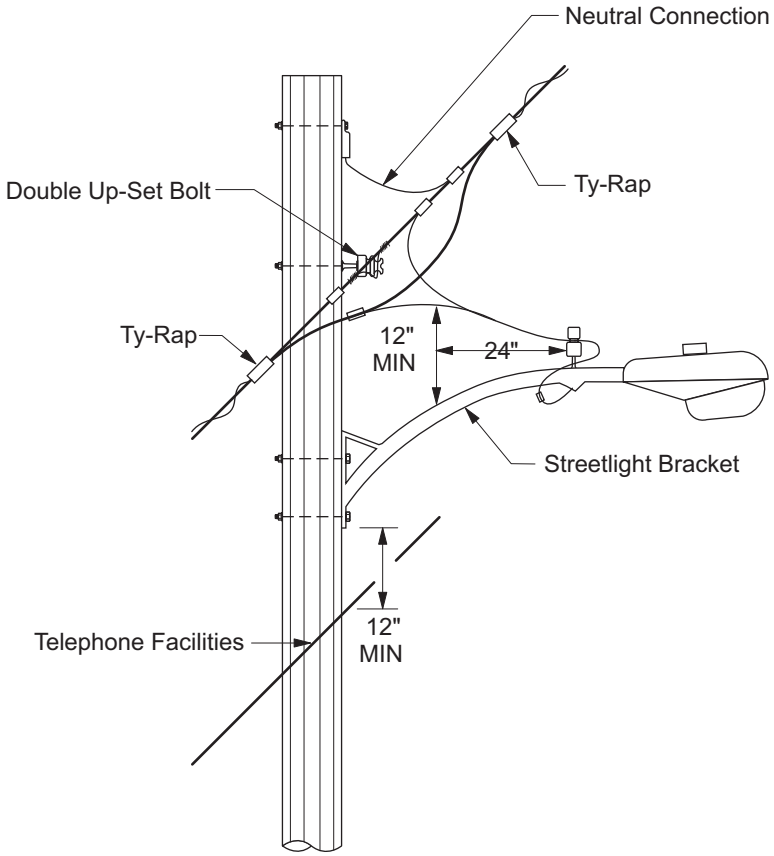
Table GR 111–2: Secondary Neutral Ground Installation

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

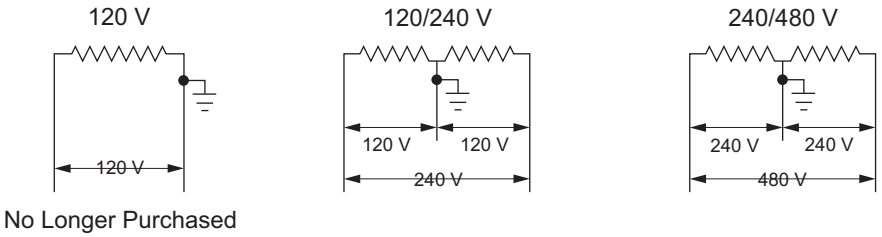
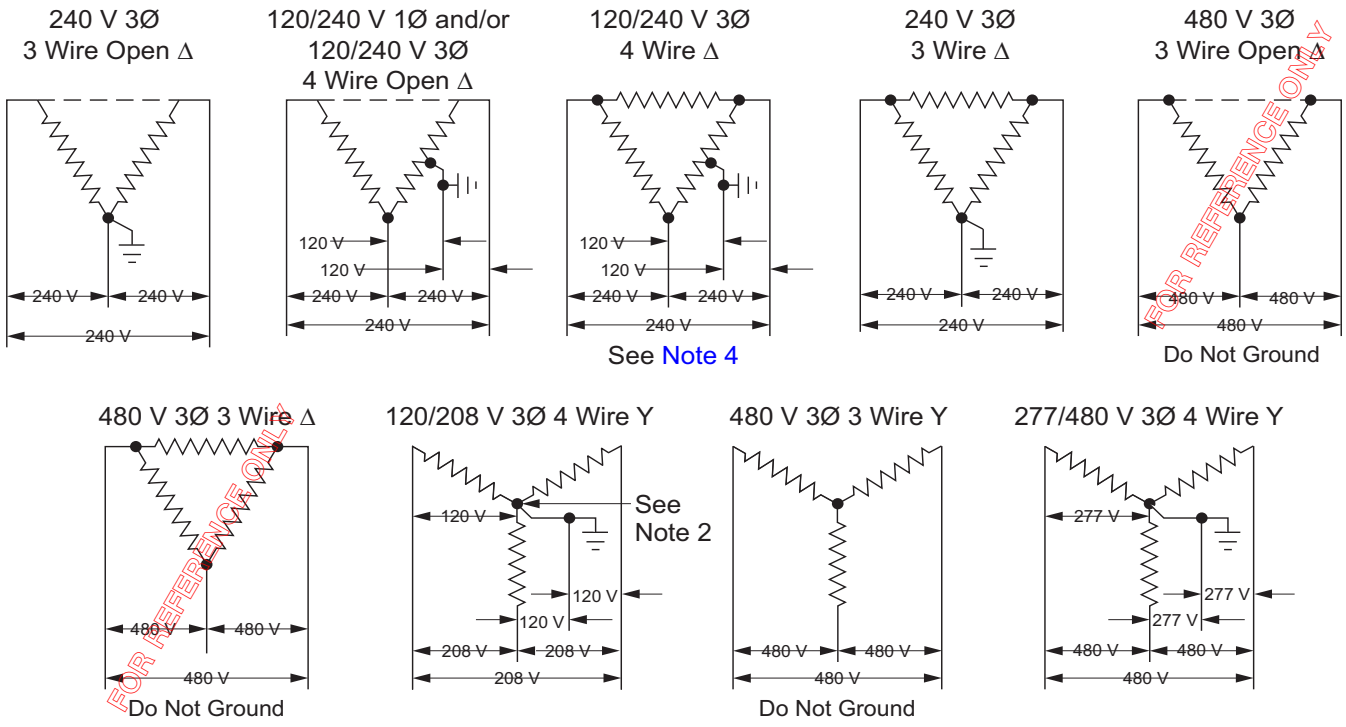


Figure GR 120–2: Bank of Two or Three Transformers — Single- and/or 3-Phase Services



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)

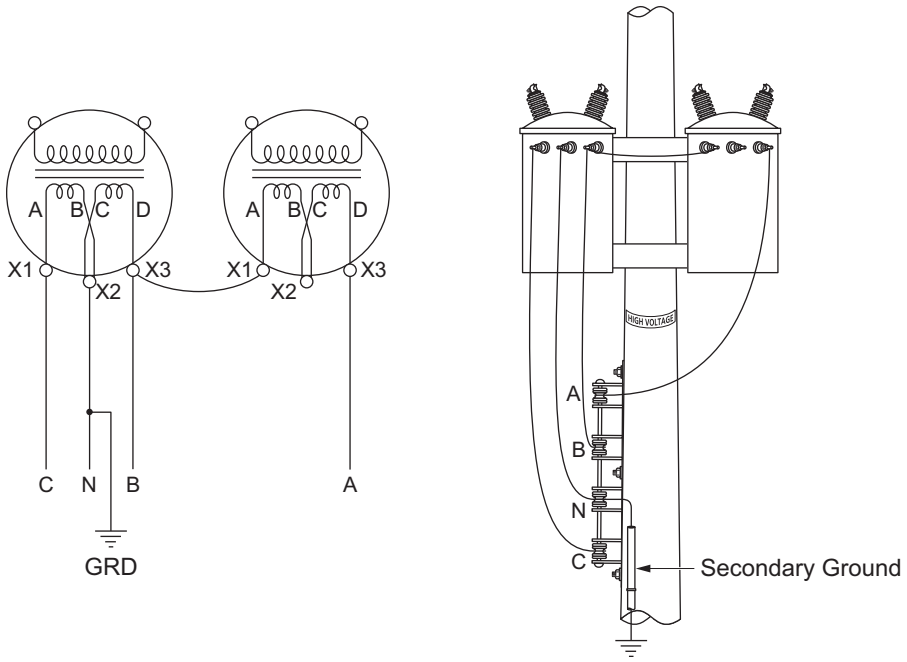
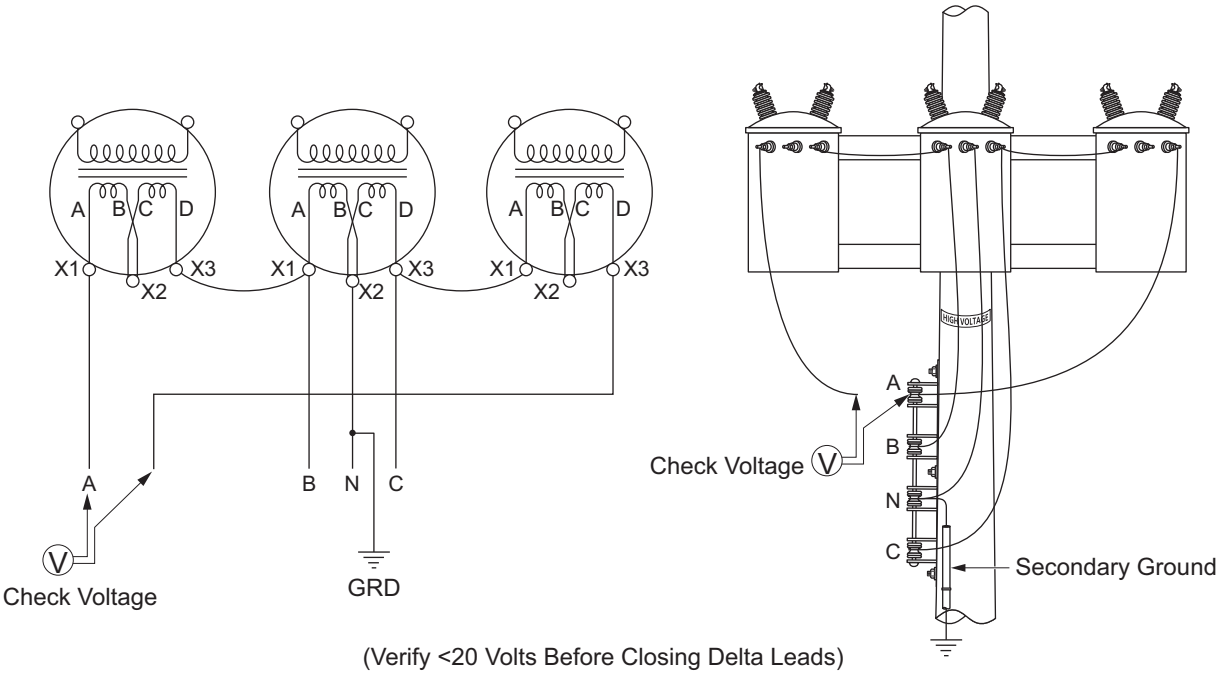
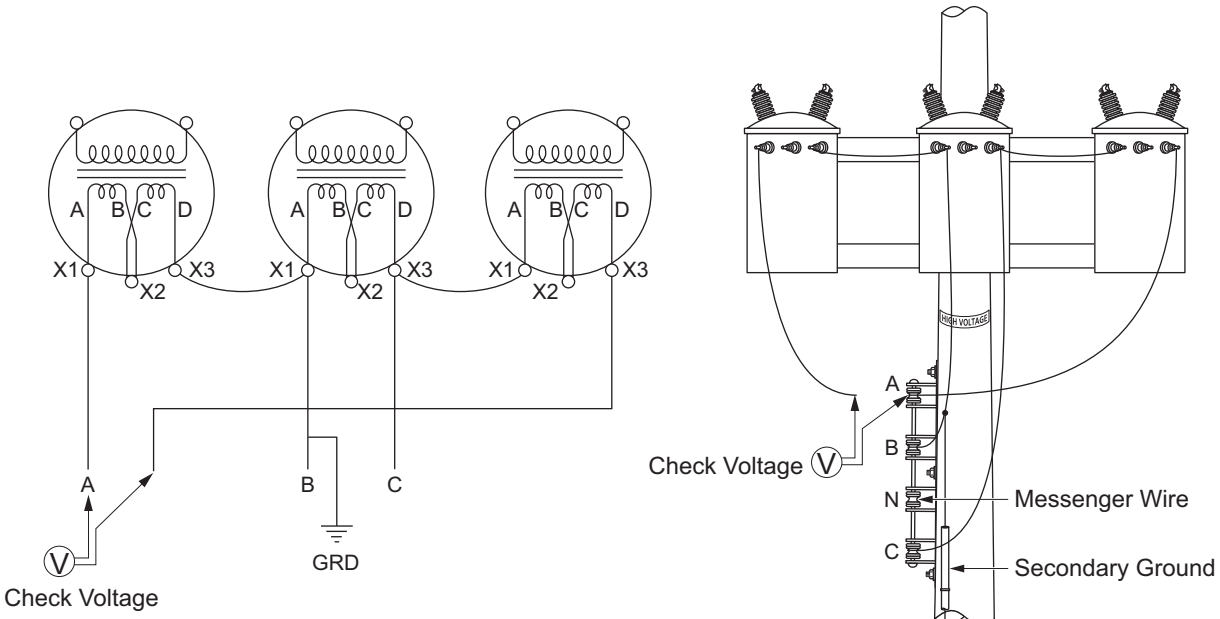


Figure GR 120–4: 120/240 V, 3Ø, 4 Wire Delta
(3-1Ø Transformers With 120/240 V Secondary Windings)



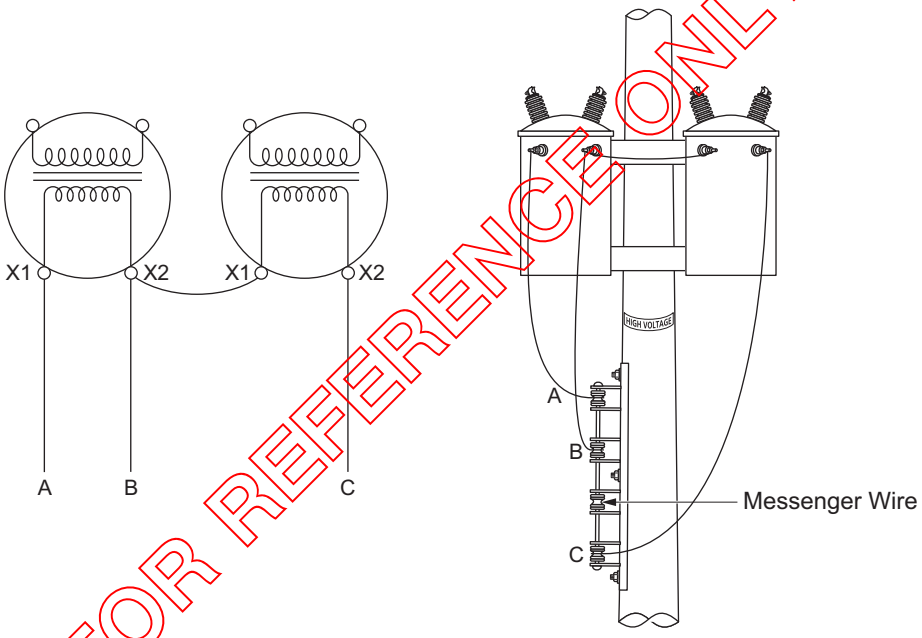
(Verify <20 Volts Before Closing Delta Leads)

Figure GR 120–5: 240 V, 3Ø, 3 Wire Delta, Corner Grounded
(3-1Ø Transformers With 120/240 V Secondary Windings)



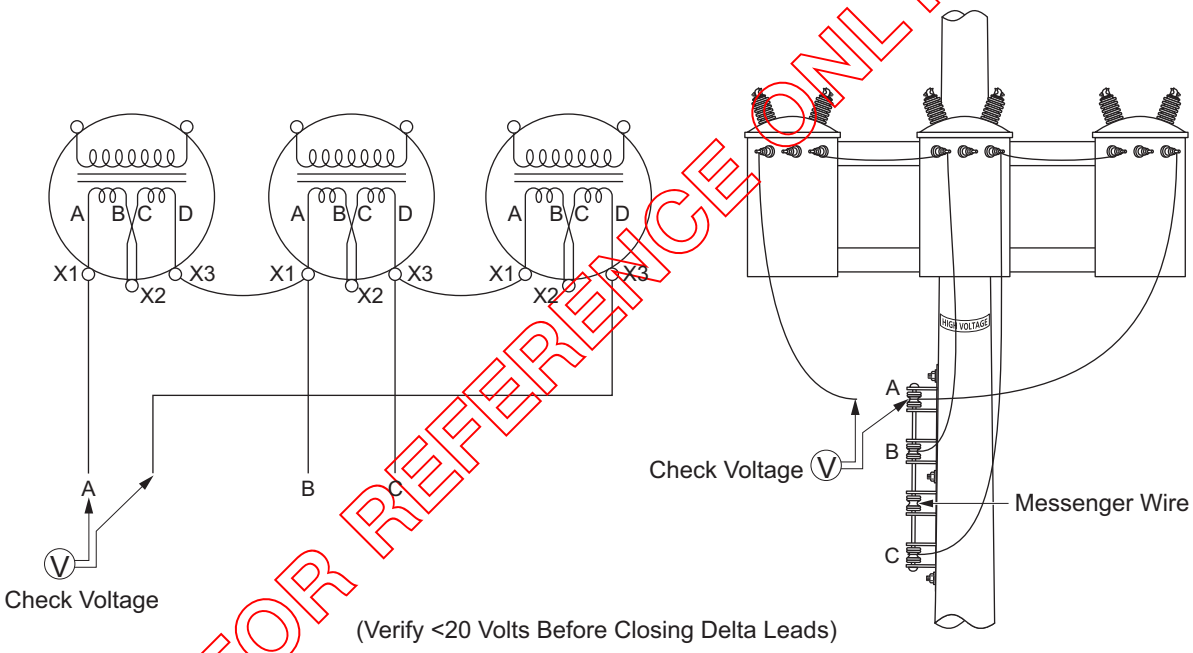
(Verify <20 Volts Before Closing Delta Leads)

Figure GR 120–6: 480 V, 3Ø, 3 Wire Open Delta
(2-1Ø Transformers With 480 V Secondary Windings)



FOR REFERENCE ONLY

Figure GR 120–7: 480 V, 3Ø, 3 Wire Closed Delta
(3-1Ø Transformers With 240/480 V Secondary Windings)



FOR REFERENCE ONLY

Figure GR 120–8: 120/208 V, 3Ø, 4 Wire Wye
(3-1Ø Transformers With 120/240 V Secondary Windings – Cutover to 120 V)

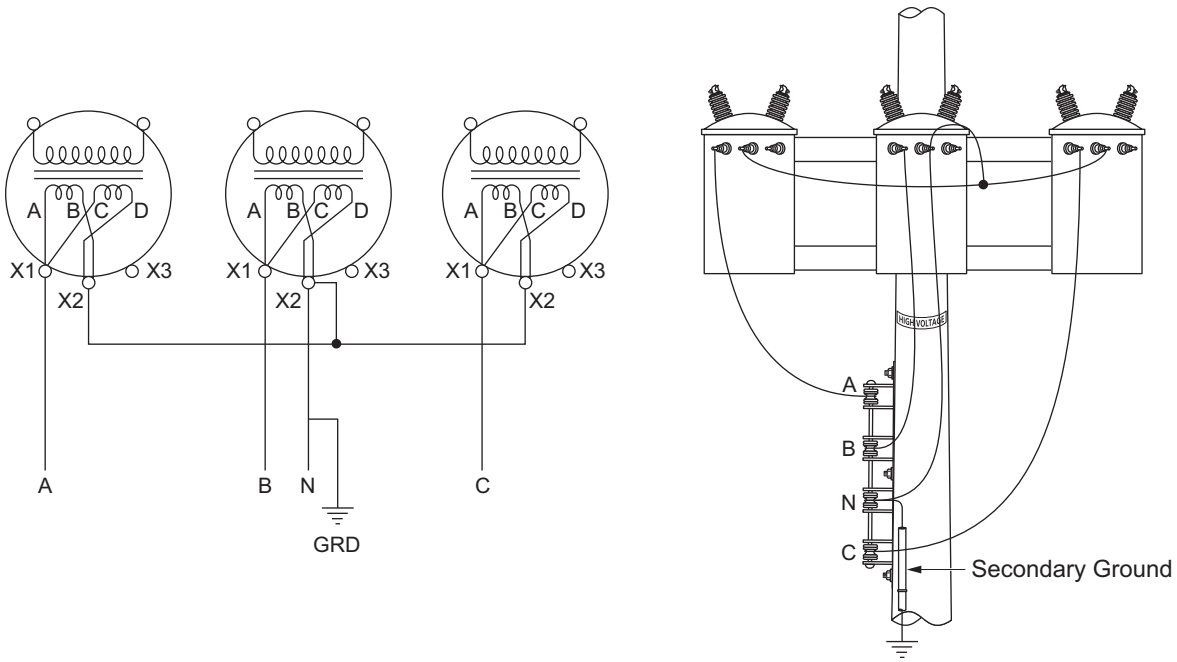


Figure GR 120–9: 480 V, 3Ø, 3 Wire Secondary, Ungrounded-Wye
(3-1Ø Transformers With 277 V Secondary Windings)

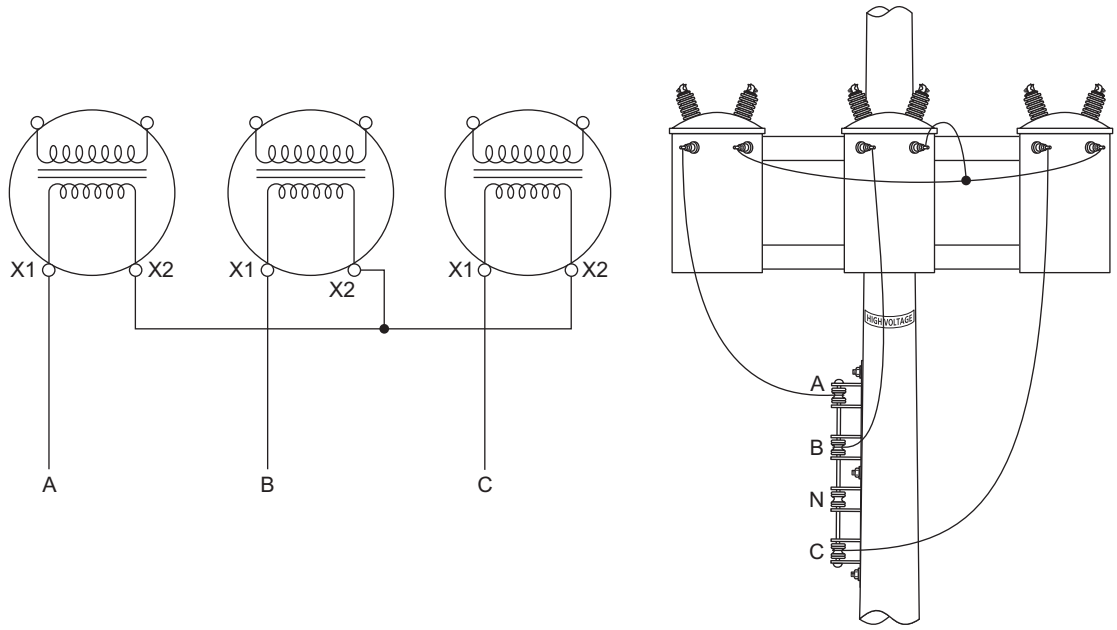
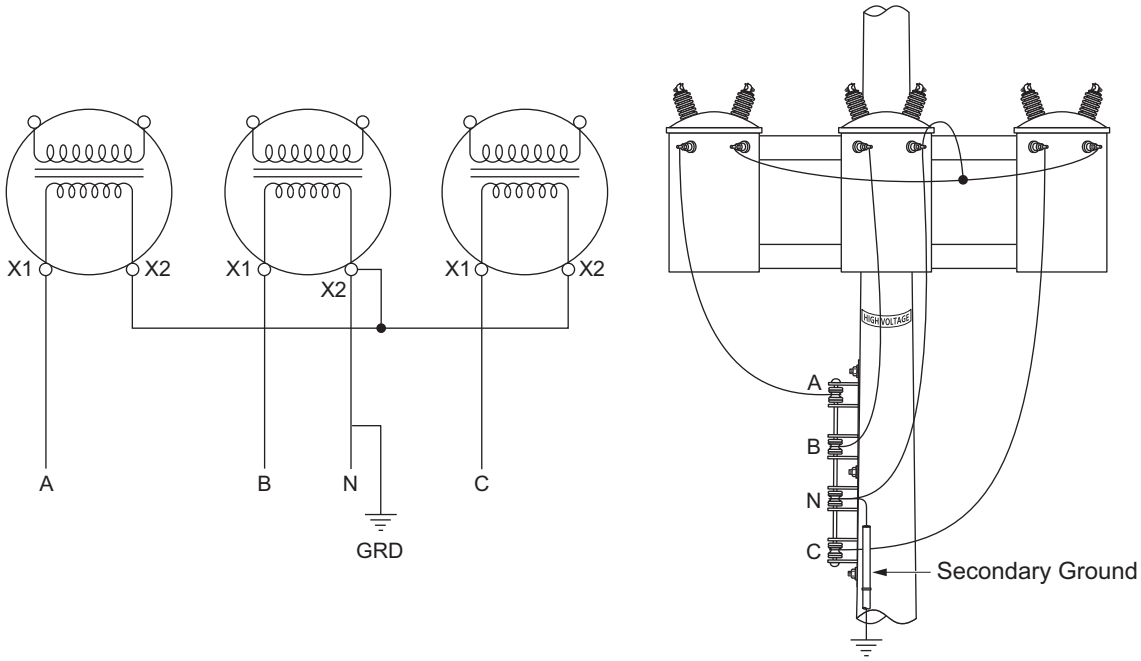


Figure GR 120–10: 277/480 V, 3Ø, 4 Wire Wye
(3-1Ø Transformers With 277 V Secondary Windings)



This page intentionally left blank.

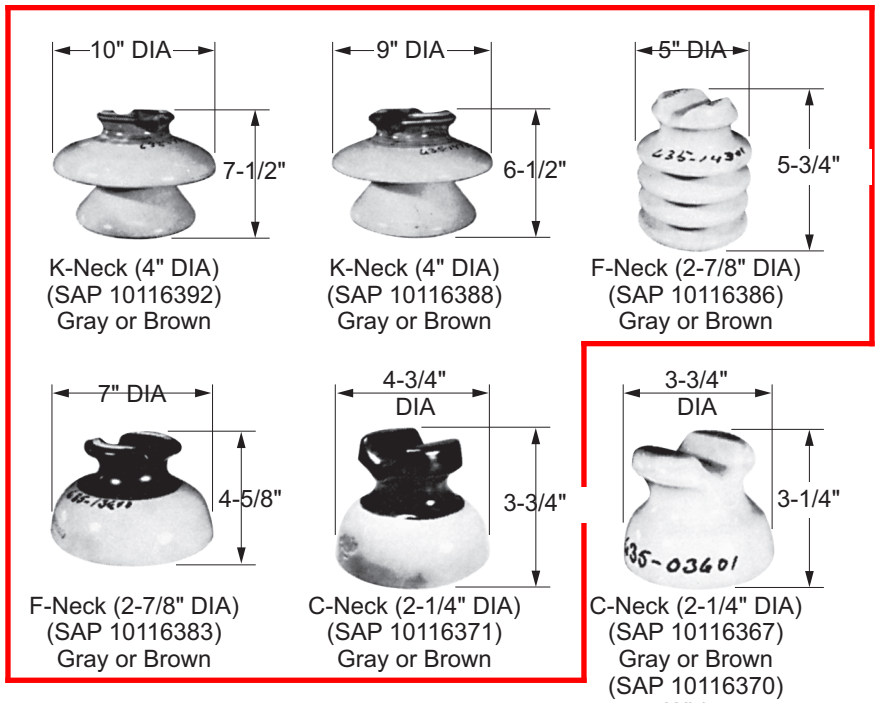
GR 200 Pin-Type Line Insulators

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



= FOR REFERENCE ONLY

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

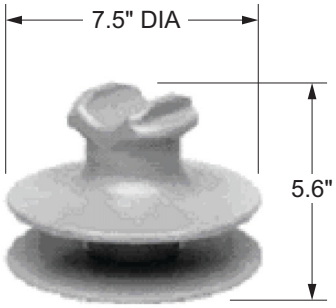
[a/] New units purchased will be gray; however, brown units may be supplied by the re-use of returned units.
[b/] For 25 kV, use 12 kV or 16 kV type A insulator.
[c/] With Region approval, SAP 10116383 may also be used on phase conductors in Northwestern and Eastern Regions, with SAP 10116371 then being used on the neutral conductor.
[d/] Use on 4 kV in extreme contamination areas along beach (with steel pin and spring washer).

Note(s):

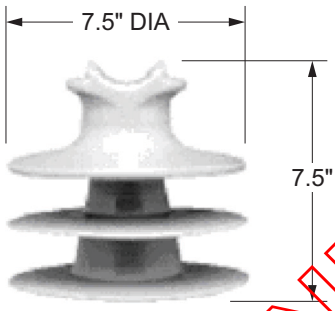
1. See DC 535 for Wildlife Protection standards.
2. Do not install upside down.
3. Not for use with covered conductor.
4. On 12 foot dead-end arm (4" × 6"), use 7-1/2 inch Long Shank Pin (SAP 10068281).
5. See Figure GR 200–2 and Figure GR 200–3 for photos of insulator vertical and angle pins.

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.

FOR REFERENCE ONLY

Scope GR 200.3 Polymer Pin-Type Line Insulators — Vise-Top, Aluminum Inserts

Figure GR 200–5: Polymer Pin-Type Insulators — Vise-Top, Aluminum Inserts (For Use with Aluminum Conductor)



25 kV Class (SAP 10181690)



35 kV Class (SAP 10181692)

FOR REFERENCE ONLY

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 — Vise-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.

Scope GR 200.4 Polymer Pin-Type Line Insulators — Vise-Top, Bronze Inserts

Figure GR 200–6: Polymer Pin-Type Insulators — Vise-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 — Vise-Top, Bronze 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	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.

FOR REFERENCE ONLY

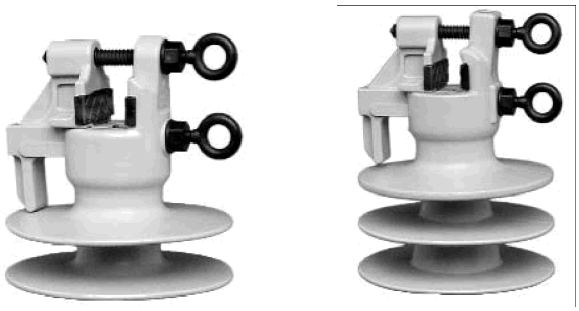
Scope GR 200.5 Polymer Pin-Type Line Insulators — Vise-Top, Nylon Inserts

1.0 Application

Vise-top insulators with nylon inserts shall only be used in covered conductor systems. They shall be used for the following construction applications as an alternate to post insulators. Additional details can be found in CC 150:

- Tangent (Straight-Through) Poles in Light and Normal Heavy Loading areas.
- Poles requiring jumper support such as double dead-ends, line/buck poles, or vertical installations with jumpers.
- Transformer delta leg support (for bare or covered conductor circuits).

Figure GR 200–7: Polymer Pin-Type Insulators — Vise-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.
2. Insulators shall be installed with two nylon inserts present.
3. Vise Tops with Nylon inserts can be utilized in bare wire circuits that require vertical jumper support. Jumpers shall be covered conductor or covered with split tubing. No additional coverings is necessary if PGW is being supported.

Table GR 200–5: Polymer Pin-Type Insulators — Vise-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/c/]	10116334	10068306	10068299
4 and 12	A, B, C	25	10116334	10068306	10068299
	Neutral	25[b/c/]	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.
[c/] If 25kV class insulators are unavailable, utilize 35kV class insulators.

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.

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.

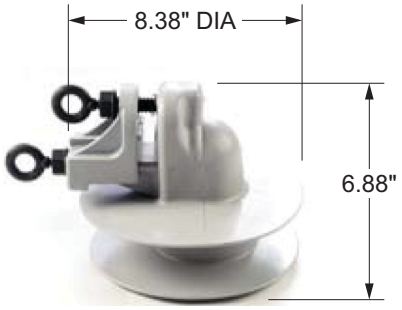
Note(s):

1. Do not tighten polymer pin-type insulators more the 6 complete turns.
2. Do not install upside down.

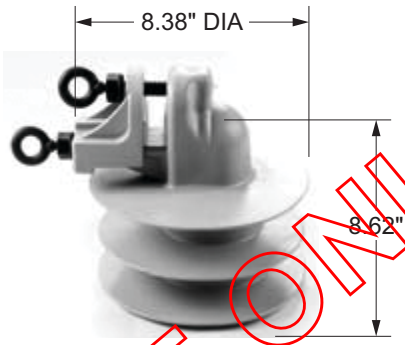
Scope GR 200.7 Polymer Pin Type Line Insulators — Clamp Top with Universal Inserts

If universal insulators exist on a structure, they shall be replaced on an opportunity basis as long as work methods and circuit status allows for such work to be performed. If a single universal insert insulator is being replaced on a structure, all insulators shall be replaced.

Figure GR 200–8: Polymer Pin Type Insulators — Clamp Top with Universal Inserts



25 kV Class
(SAP 10204194)



35 kV Class
(SAP 10204196)

FOR REFERENCE ONLY

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	Pin-Type Insulators		Insulator Pins	
		Nom. kV Rating	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.

This page intentionally left blank.

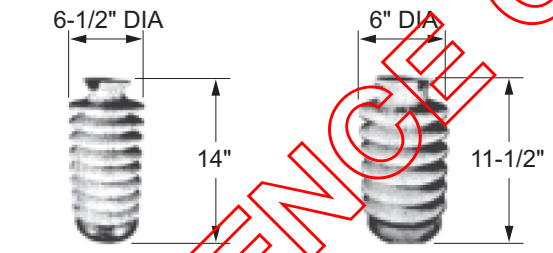
GR 205 Post-Type Line Insulators

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 polymer 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



F-Neck (2-7/8" DIA)
(SAP 10116399)
Gray or Brown

F-Neck (2-7/8" DIA)
(SAP 10116397)
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.

FOR REFERENCE ONLY

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")	Long (7-1/2" to 8")	Extra Long (10")
					SAP	SAP	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.

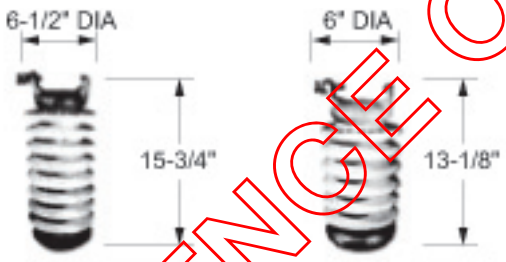
FOR REFERENCE ONLY

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 polymer 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

FOR REFERENCE ONLY

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")	Long[e/] (7-1/2" to 8")	Extra Long (10")
					SAP	SAP	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 — Aluminum Universal Clamp-Top

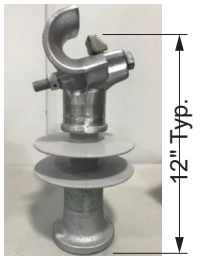
1.0 Application

Aluminum clamp-top post-type insulators shall be used for all bare aluminum wire applications.

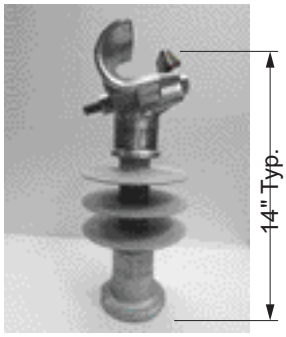
Post-type insulators with aluminum universal clamp tops shall also be used for covered conductor for the following applications:

- Extra Heavy Loading Areas above 5,000 feet with double crossarms and double insulators as required in DC 520
- High Contamination Areas
- Construction where conductor uplift exists.
- Deviation angle applications. For limiting angles and wire sizes for wood and composite arms in light loading areas, see DC 575.

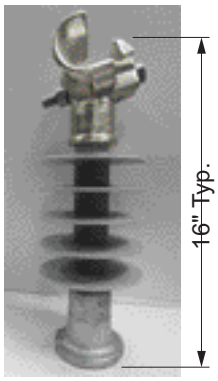
Figure GR 205–3: Polymer Post-Type Insulators — Aluminum Clamp-Top



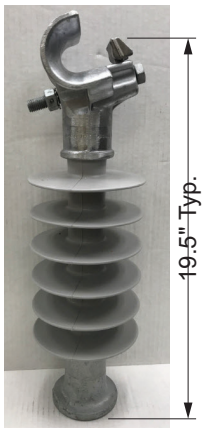
15 kV Class
(SAP 10116349)



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 — Aluminum 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 shall be used for bare #4 - 1/0 ACSR in tangent and deviation angle construction. It is not required for these conductor sizes for jumpers on double dead-ends or line/buck poles. It is not required for conductors larger than1/0 ACSR.

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 for the following applications:

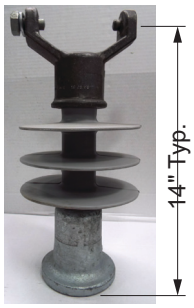
- Circuitry utilizing bare copper conductors
- Conductors and poles that experience inclines/declines in elevation associated with traversing mountainous terrain. Contact Distribution Apparatus Engineering for additional application guidance.

These insulators may also be used as alternatives to clamptop post-type insulators (see Scope GR 205.3).

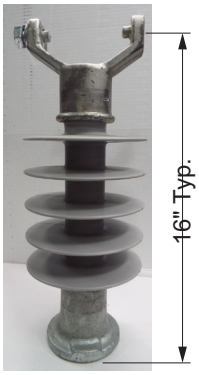
Figure GR 205–6: Polymer Post-Type Insulators — Trunnion-Top



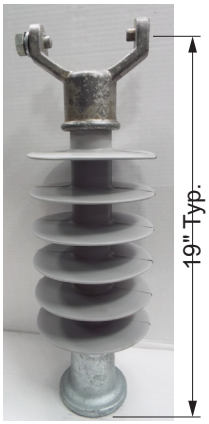
15 kV Class
(SAP 10116326)



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. See CO 510 for Trunnion Top Clamp SAP numbers.
3. Armor Rod/Line Guard shall be used on bare #4-1/0 ACSR and #6 Sol-#2 Str. Copper in tangent and deviation angle construction. It is not required on jumpers on double dead-ends or line/buck configurations. It is not required on larger conductors.

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.

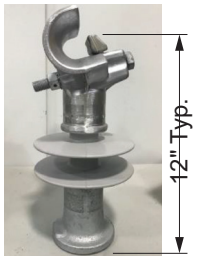
1.4 For Clamp-top insulators:
- Place conductor in the clamp and tighten.

Scope GR 205.6 Polymer Post-Type Line Insulators — Tin-Plated Universal Clamp-Top

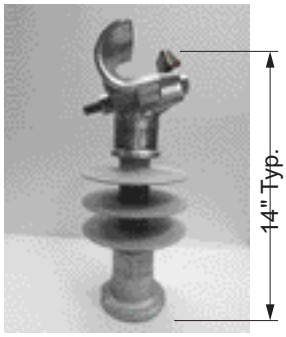
1.0 Application

Tin-plated clamp-top post-type insulators may be used as an alternative to trunnion-top post-type insulators for copper wire applications in light-moderate contamination areas (see DOH GR 215, Contamination Area Map).

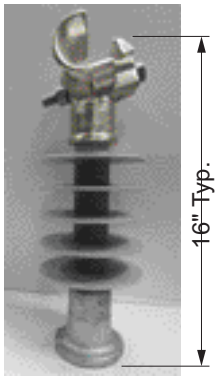
Figure GR 205–7: Polymer Post-Type Insulators — Tin-Plated Clamp Top



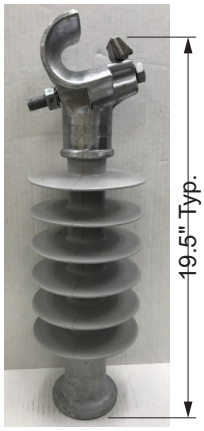
15 kV Class
(SAP 10224499)



28 kV Class
(SAP 10224498)



35 kV Class
(SAP 10224500)



46 kV Class
(SAP 10224501)

Table GR 205–5: Polymer Post-Type Insulators — Tin-Plated 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	B, C	46	10224501	10116404	10116398	10213439
16	B, C	28	10224498	10116404	10116398	10213439
	Neutral	28[c/]	10224498	10116404	10116398	10213439
12 and below	B, C	15	10224499	10116404	10116398	10213439
	Neutral	15[c/]	10224499	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).

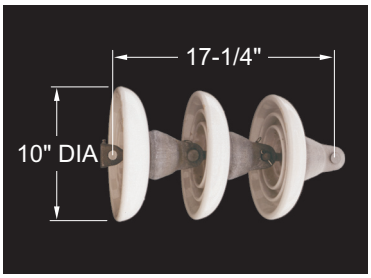
Note(s):

1. See DC 535 for Wildlife Protection standards.
2. Line guard shall be used for bare #6 - #4 HDCU in tangent and deviation angle construction. It is not required for these conductor sizes for jumpers on double dead-ends or line/buck poles. It is not required for conductors largers than #4 HDCU.

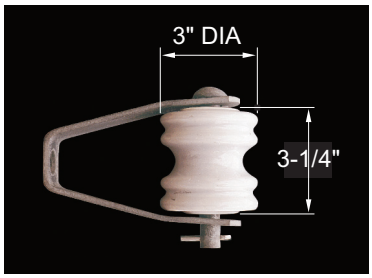
GR 210 Line Insulators — Dead-Ends

Scope GR 210.1 Typical Dead-end Type Insulators

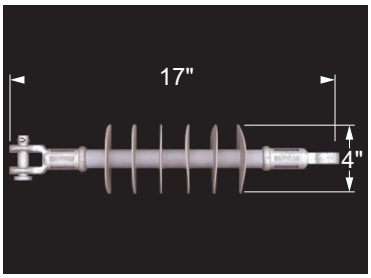
Figure GR 210–1: Dead-end Type Insulators



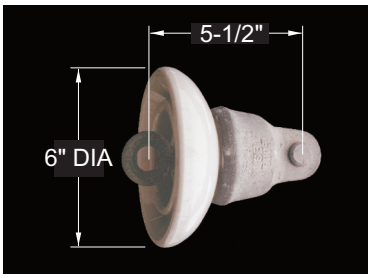
SAP 10116461 (Gray)
(3 Units)



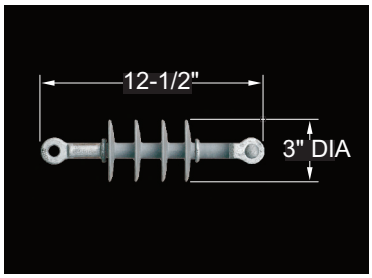
SAP 10116496 (Gray or Brown)
(See Note 1)



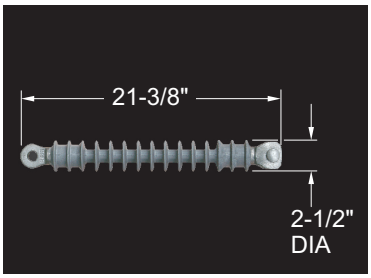
SAP 10116332 (Gray)
(See Note 2 and 3)



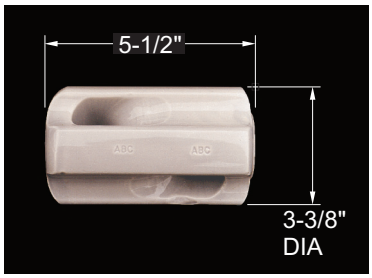
SAP 10116434 (Gray or Brown)
(See Note 1)



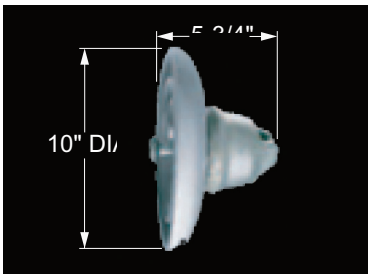
SAP 10116431 (Gray)
(See Note 2 and 4)



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

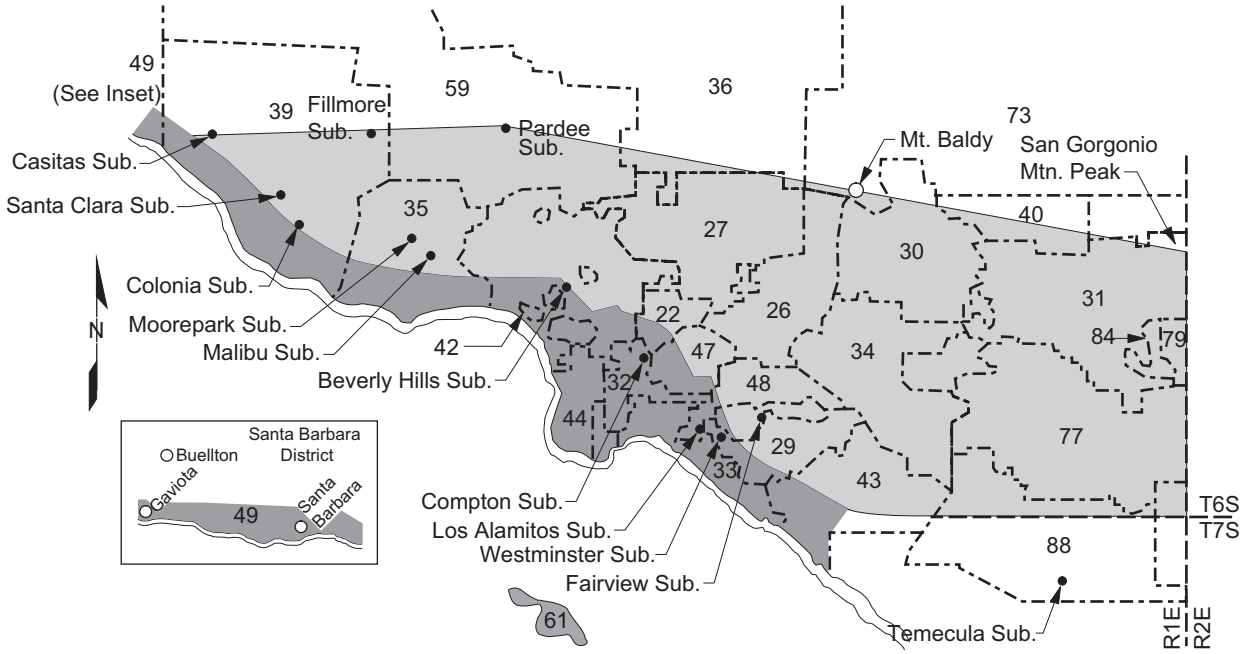
Line Voltage (kV)	Contamination Area[a/]	Dead-end Type Insulators			
		Number of Units	SAP	Wet Flashover (kV)	Mechanical Strength (lb)
25 or 33	A, B, C A, B, C	1 3	10116432[b/] 10116462[b/]	130 130	15,000 20,000
16[b/]	A, B, C A, B, C	1 3	10116332 10116434	110 80	15,000 10,000
12[b/]	A, B, C A, B, C	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

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):

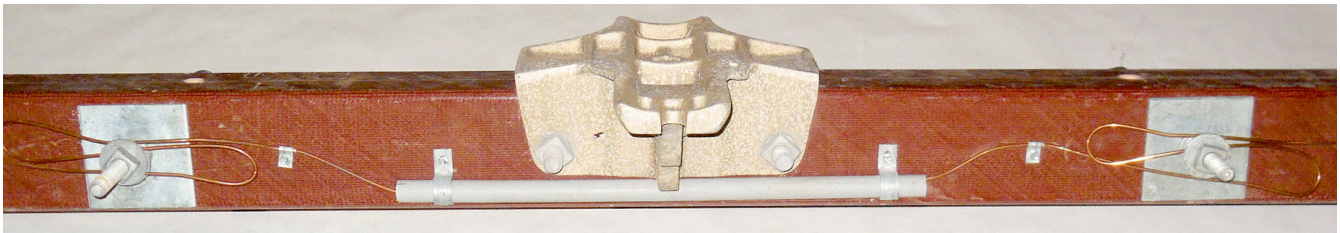
1. For insulators, see GR Section.
2. For more accurate location of insulation area boundaries, see service center maps. This map, due to small scale used, is approximate only.
3. Districts not shown on map are considered to have light contamination.
4. Service center personnel should determine contamination boundaries from experience encountered. This also includes pockets of higher level contamination in an area.

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

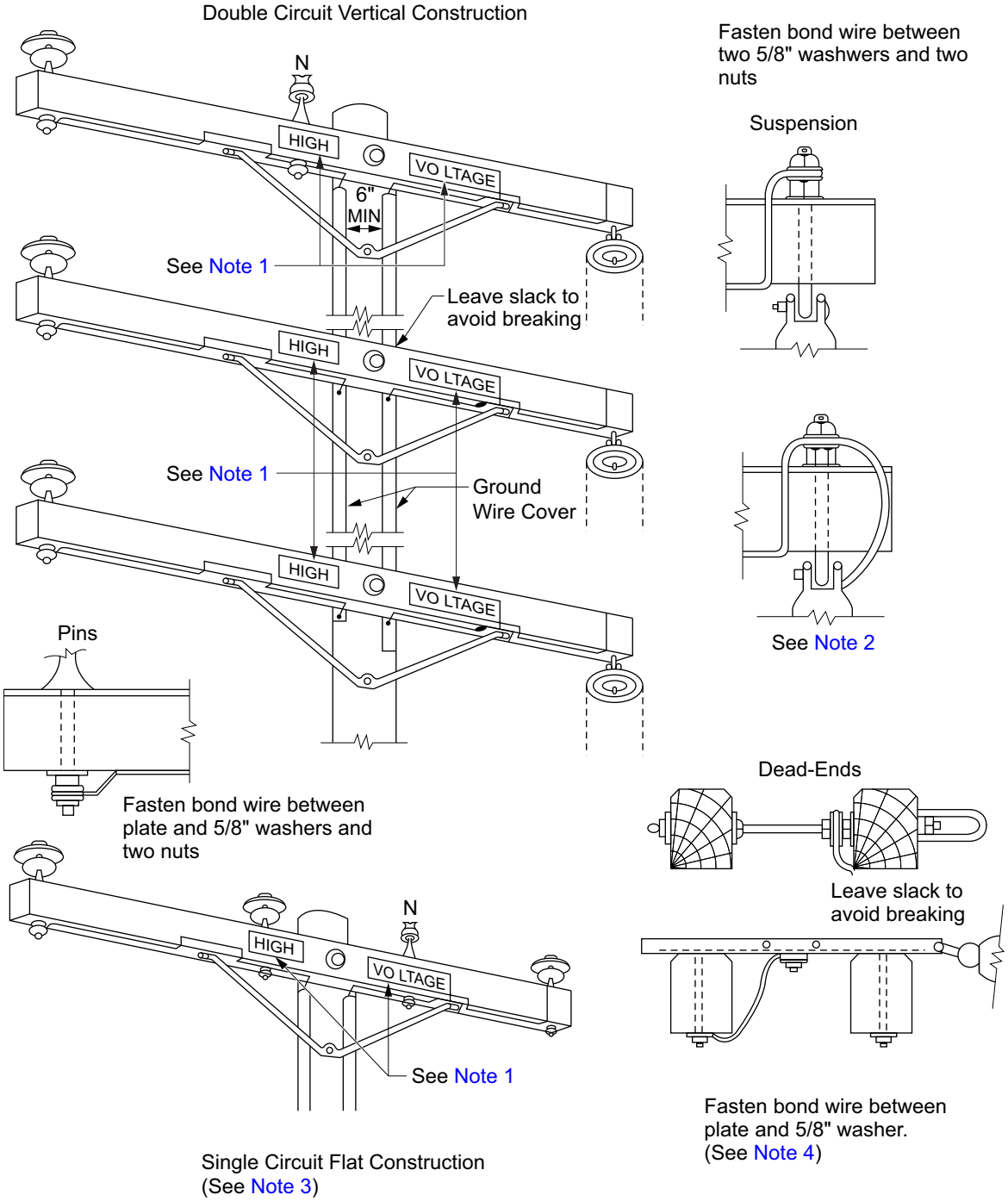


This page intentionally left blank.

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.

GR 400 Deep Grounding Electrode

Scope GR 400.1 Deep Grounding Electrode General Requirements

1.0 General Information

The deep grounding electrode is used to provide a low resistance ground connection for distribution equipment that injects continuous current through the ground.

2.0 Installation Requirements

2.1 A deep grounding electrode is made up of two sections of #4 PGW, that are interconnected in a handhole to form a continuous loop, and runs from one side of the pole to the bottom of a drilled hole, then continues back up the drilled hole and up the opposite side of the pole. See Table GR 400-1 for handhole material codes. See Figure GR 400P–1 for deep grounding electrode conductor information.

2.2 The deep grounding electrode wires shall be encased in conduit for the first 10 feet below grade. Backfill around the conduit with native soil.

2.3 The length of #4 PGW that runs from the bottom of the conduit at 10 feet below grade to the bottom of the drilled hole and back up to another conduit at 10 feet below grade, shall be stripped so that the electrode is bare wire.

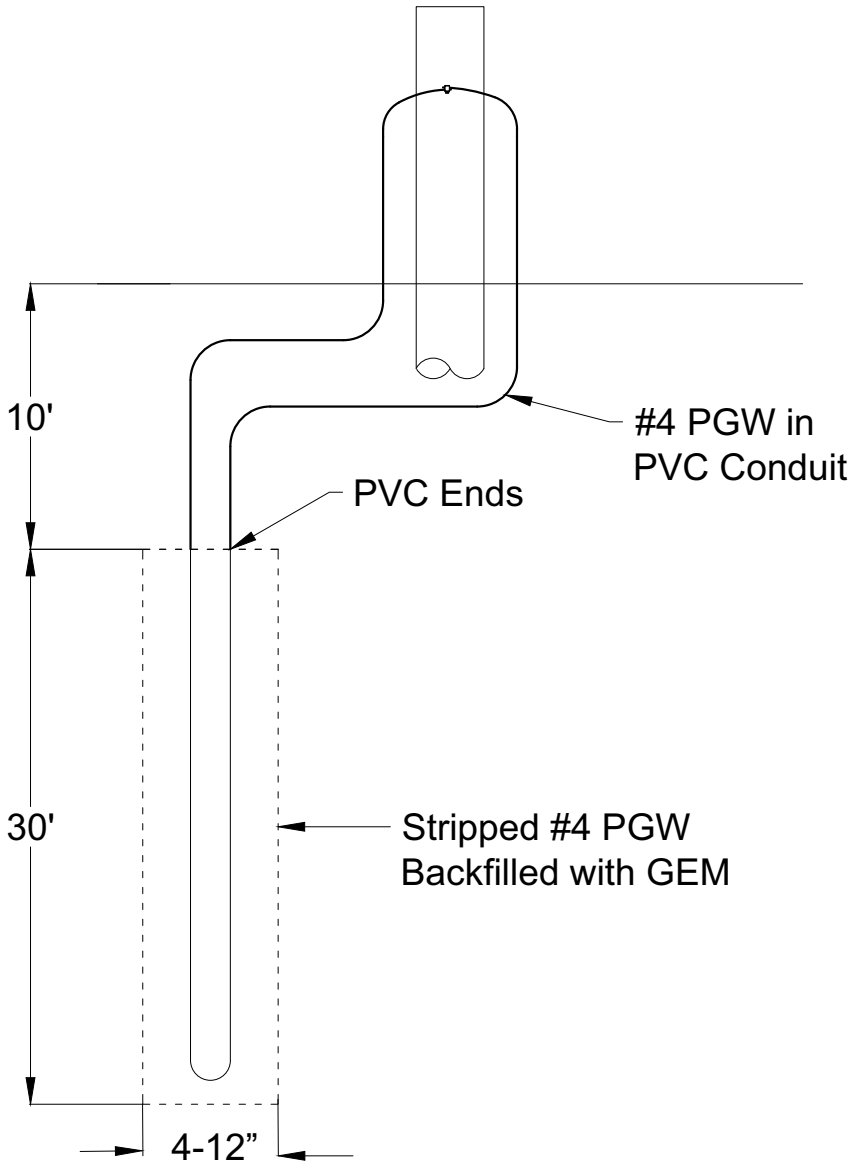
2.4 The section of bare wire from 10 feet below grade to the bottom of the drilled hole, shall be backfilled with ERICO Ground Enhancement (GEM) (SAP 10064425).

2.5 To provide sufficient grounding with a single deep grounding electrode, the section of the drilled hole that contains bare wire and is backfilled with GEM must reach a depth 30 feet lower than the end of the conduit. See Section 3.0 for drilling requirements to determine if more than one deep grounding electrode is required.

Table GR 400–1: Preferred Handholes for Deep Grounding Electrode

Material	Location	Structure (W x L x D)	Item Number	SAP	Traffic Rating
Polymer Concrete (RPM)	All	17” x 30” x 18”	HH-16	10220633	ANSI/SCTE 77 Tier 15
Polymer Concrete (RPM)	All	17” x 30” x 18”	HH-19	10220636	ANSI/SCTE 77 Tier 122
Concrete	All	17” x 30” x 12”	HH-20	10220652	AASHTO HS-20

Figure GR 400–1: Deep Grounding Electrode — Conductor Details



3.0 Drilling Requirements

3.1 To provide sufficient grounding the section of the drilled hole that contains stripped #4 PGW and is backfilled with GEM must reach a depth 30 feet lower than the bottom of the conduit.

3.2 To achieve this with a single deep grounding electrode the drilled hole must reach 40 feet below grade, where the first 10 feet of the drilled hole is the #4 PGW encased in PVC conduit and the bottom 30 feet of the drilled hole contains stripped #4 PGW and is backfilled with GEM.

3.3 If the drilled hole does not reach a minimum depth of 40 feet below grade, one or more additional deep grounding electrodes are required. For combined drilled hole depth when multiple electrodes are required, see Table GR 400P–1. For the location of drilled holes for additional deep grounding electrodes see Figure GR 400P–2, Figure GR 400P–3, Figure GR 400P–4 and Figure GR 400P–5. The figures are examples of potential hole layouts that could be used.

Site conditions may prevent any of those examples from being applicable. In that case, another layout not shown may be used given that it meets the minimum requirements of each drilled hole being a minimum of 5 feet away from the pole and a minimum of 6 feet away from all other drilled holes.

3.4 Each drilled hole should have a diameter between 4 and 12 inches. Consult Apparatus Engineering if another diameter is required.

3.5 For construction details on the deep grounding electrode see Figure GR 400P–6. Construction above grade does not change when installing one or multiple deep grounding electrodes. For below grade construction details of multiple deep grounding electrodes see Figure GR 400–8.

Table GR 400–2: Total Drilled Hole Depth by Number of Deep Grounding Electrodes

Number of Deep Grounding Electrodes Required	Combined Depth of Drilled Holes	Combined Depth of Stripped #4 PGW Backfilled with GEM
1	40 Feet	30 Feet
2	50 Feet	30 Feet
3	60 Feet	30 Feet
4	70 Feet	30 Feet

Figure GR 400–2: Bird's Eye View of Drilling Locations for Additional Deep Grounding Electrodes - Example 1

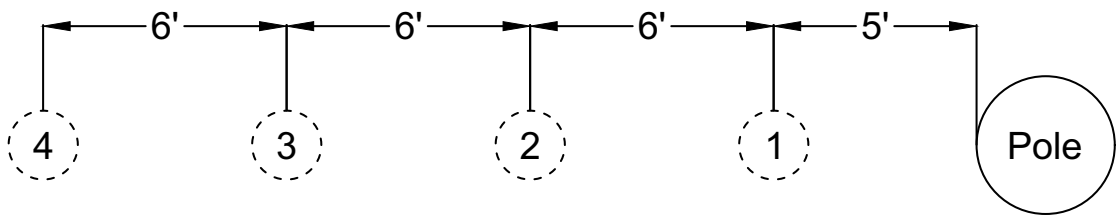


Figure GR 400–3: Bird's Eye View of Drilling Locations for Additional Deep Grounding Electrodes - Example 2

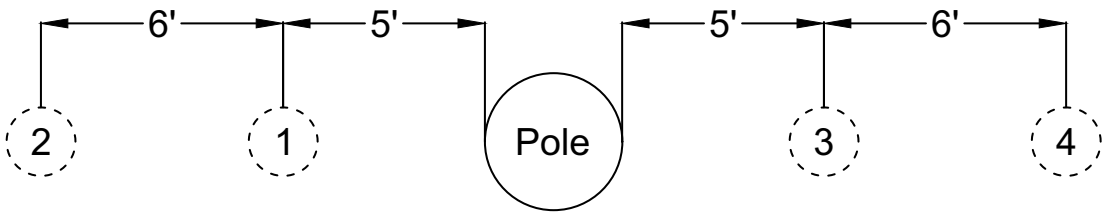


Figure GR 400–4: Bird's Eye View of Drilling Locations for Additional Deep Grounding Electrodes - Example 3

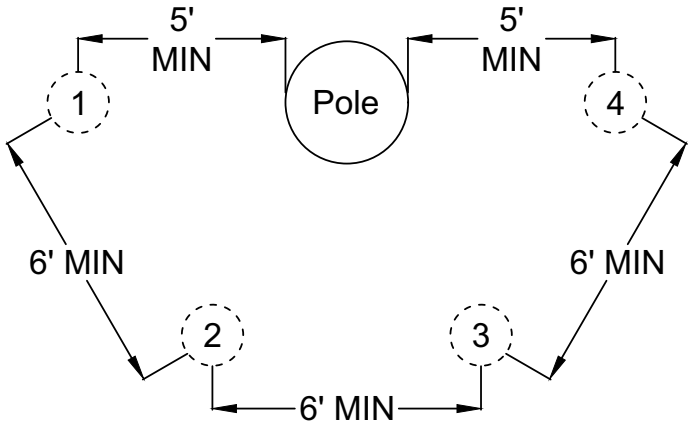
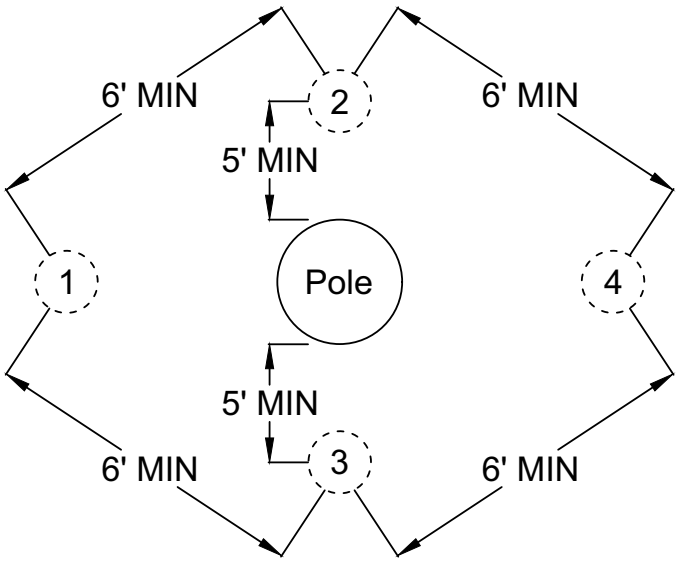


Figure GR 400–5: Bird's Eye View of Drilling Locations for Additional Deep Grounding Electrodes - Example 4



3.6 Determination of required depth of drilled holes for additional deep grounding electrodes

A. Example 1

The drilling contractor attempts to drill 40 feet deep hole but is unable to drill past 28 feet. The section of the drilled hole below the PVC conduit that will contain stripped #4 PGW backfilled with GEM is 18 feet.

To provide sufficient grounding, an additional hole will need to be drilled and will need to reach a minimum depth of 22 feet below grade so that the combined depth of the two holes is 50 feet.

The drilling contractor succeeds at drilling the second hole to a depth of 22 feet. The section of second drilled hole below the PVC conduit that will contain stripped #4 PGW backfilled with GEM is 12 feet.

Between the two grounding electrodes the combined depth of the drilled holes is 50 feet with a total depth of 30 feet containing stripped #4 PGW backfilled with GEM. No additional drilling is required.

B. Example 2

The drilling contractor attempts to drill a 40 feet deep hole but is unable to drill past 24 feet.

To provide sufficient grounding, an additional hole will need to be drilled and will need to reach a depth of 26 feet below grade so that the combined depth of the two holes is 50 feet.

The drilling contractor is unable to drill the second hole past 20 feet. The combined depth of the two drilled holes is 44 feet.

To provide sufficient grounding a third hole will need to be drilled and will need to reach a depth of 16 feet below grade so that the combined depth of the three drilled holes is 60 feet.

The drilling contractor succeeds at drilling the third hole to a depth of 16 feet below grade.

Between the three grounding electrodes the combined depth of the holes is 60 feet with a total depth of 30 feet of stripped #4 PGW backfilled with GEM. No additional drilling is required.

Scope GR 400.2 Deep Grounding Electrode Construction Details

Figure GR 400–6: Deep Grounding Electrode Construction Details

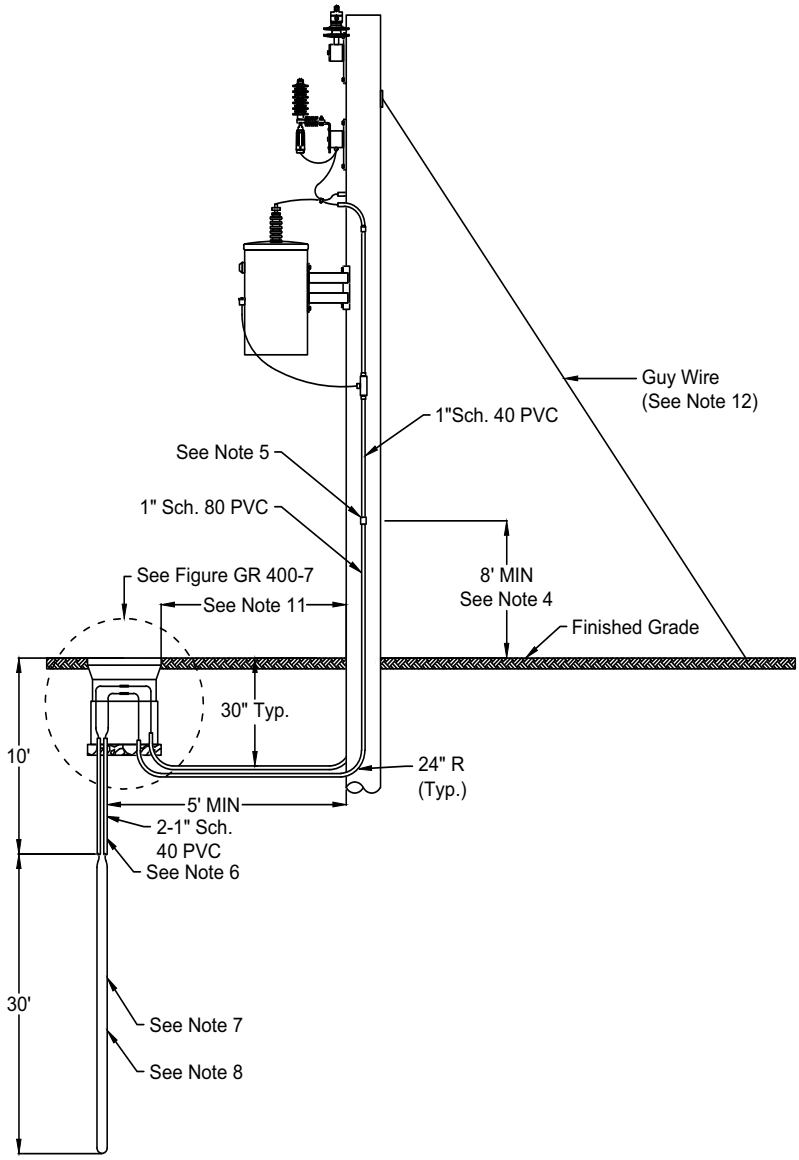
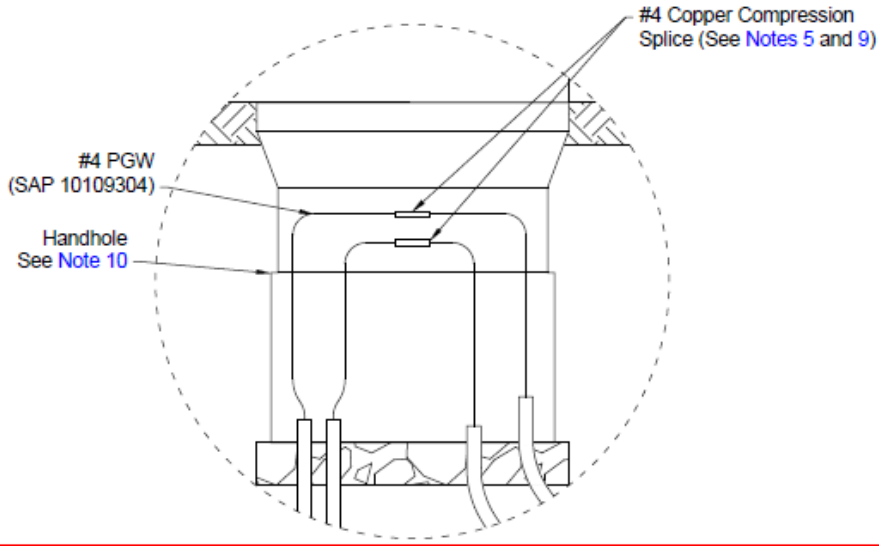


Figure GR 400–7: Deep Grounding Electrode Handhole Details



Note(s):

1. Ground electrode transformer connections are the only shown in this schematic. For Capacitive Balancing Unit connections, refer to DAP AP 240P and DAP AP 241P.
2. Tie two ground wires together and jumper to the transformer bushing as shown in Figure GR 400–6. Install a cover of any section of PGW where the covering has been stripped. One wire in each of the two Sch. 80 1" PVC conduits.
3. No above or below grade connections to ground wire except those shown in DAP AP 240P and DAP AP 241P.
4. Conduit from top of the riser bend 30" below grade to 8' above finished grade is to be 1" Sch. 80 PVC.
5. Drilling contractor's scope of work ends at leaving two tails of #4 PGW inside the handhole. Edison crews installing the CBU shall splice additional #4 PGW to each tail using a copper full tension compression splice (SAP 10110774). The additional #4 PGW shall be routed in 2-1" Sch. 80 PVC to 8' above finished grade on opposite side of the pole. From 8' above grade to above the transformer bushings the #4 PGW shall be in 2-1" Sch. 40 conduit on opposite sides of the pole.
6. First 10 feet depth below grade in conduit. Backfill around conduit with native soil.
7. One #4 Protected Ground Wire (SAP 10109304) stripped for center 60 feet and folded so bottom 30 feet of electrode is bare wire.
8. Backfill with ERICO Ground Enhancement (GEM) (SAP 10064425) to 10 feet below grade.
9. Compression splices shall be covered with Gel Wrap (SAP 10221125). If the Gel Wrap is not available, the compression splices shall be covered with Aqua-Seal (SAO 10116816) and 33 Tape (SAP 10116921). The Aqua-Seal shall cover any exposed conductor and extend over the insulation a minimum of 1". Apply a minimum of 2-1/2 layers of 33 Tape over the aqua seal onto the surface of the PGW insulation to form a good seal.
10. See UGS HP 200 and HP 205 for handhole requirements and installation details.
11. The distance between the edge of the pole and the edge of the handhole shall be a minimum of three times the diameter of the pole at the ground level, measured from the face of the pole. If closer installation is required or there is unstable/varying soil conditions, contact Pole Engineering for a more in depth analysis. See PLM Table 1 for minimum pole diameter at ground level.
12. If a guy wire is installed on the pole, the handhole shall be installed on the opposite side of the pole whenever possible. If it is technically feasible to install the handhole on the opposite side of the pole, the handhole may be installed on the same side of the pole as the guy wire. Maintain a minimum 2' clearance from the edge of the handhole to the guy anchor.

Figure GR 400–8: Construction Details for Multiple Deep Grounding Electrodes - Full View

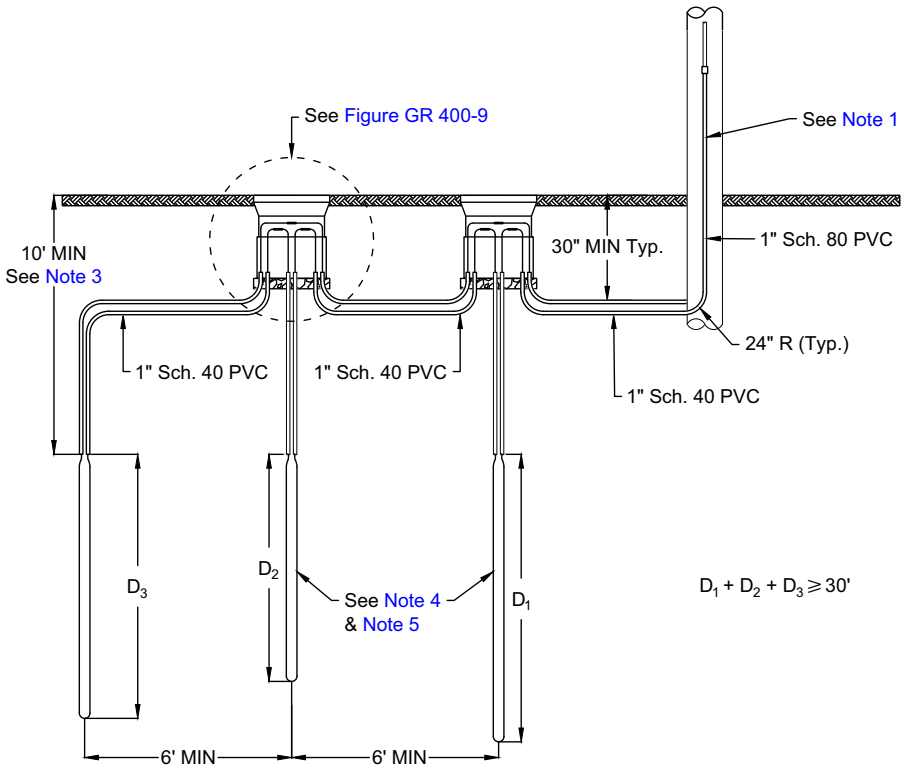
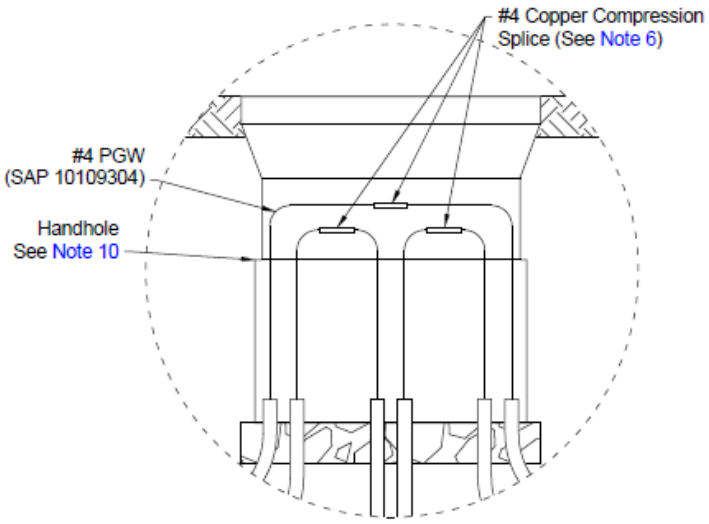


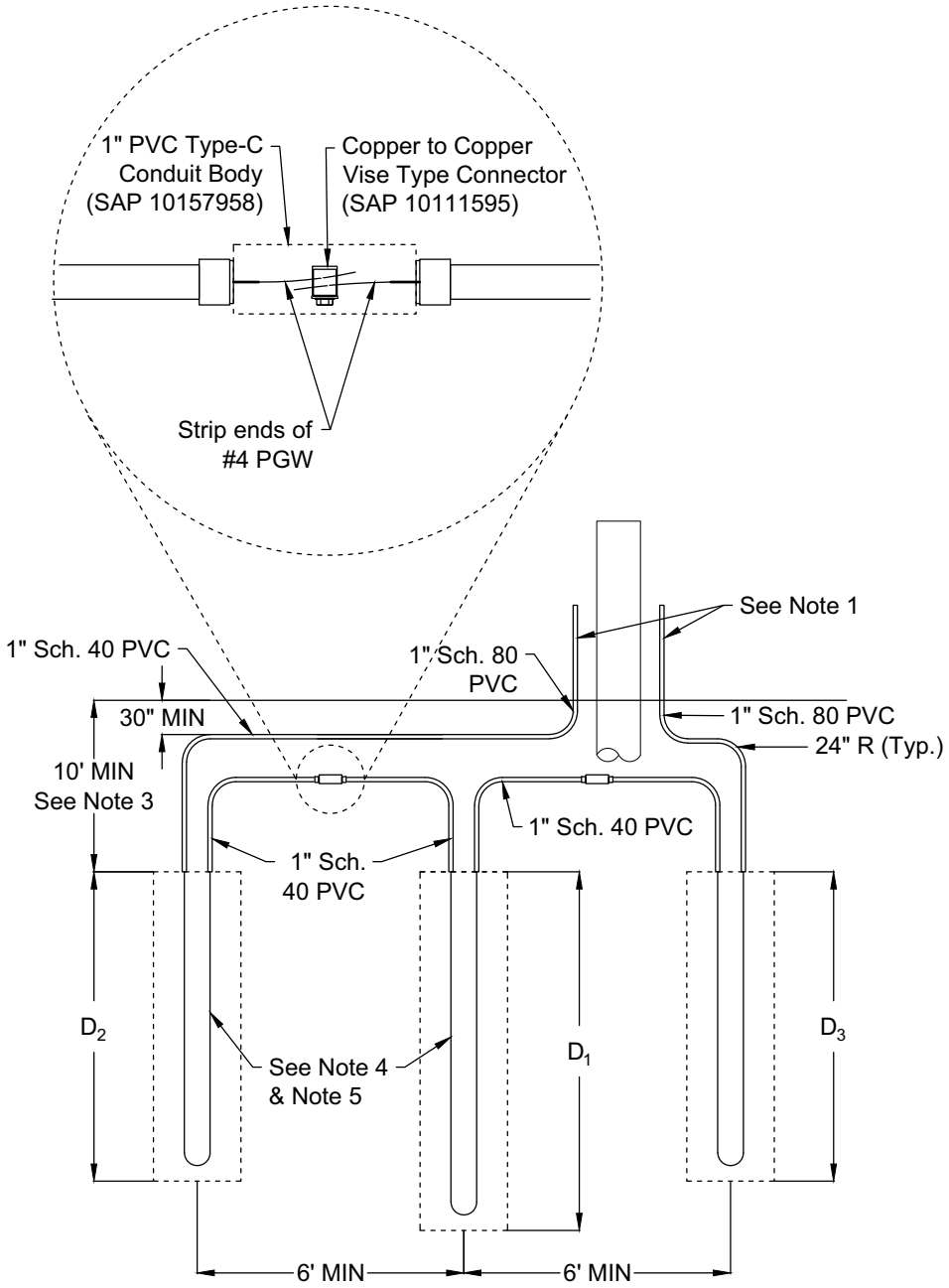
Figure GR 400–9: Deep Grounding Electrode Handhole Details



Note(s):

1. Below grade construction requirements for multiple deep grounding electrodes are the only shown in this schematic. For above grade construction for deep grounding electrodes, see Figure GR 400–6.
2. No below grade connections shall be made to the deep grounding electrodes except for those shown in this schematic.
3. First 10 feet of depth below grade shall be in conduit. Backfill around conduit with native soil.
4. For each drilled hole, use one #4 protected ground wire. For each wire strip the middle portion that will be below 10 feet of depth so that the bottom portion of the electrode is bare wire.
5. Backfill the bare wire with ERICO Ground Enhancement (GEM) (SAP 10064425) to 10 feet below grade.
6. Compression splices shall be covered with Gel Wrap (SAP 10221125). If the Gel Wrap is not available, the compression splices shall be covered with Aqua-Seal (SAP 10116816) and 33 Tape (SAP 10116921). The Aqua-Seal shall cover any exposed conductor and extend over the insulation a minimum of 1". Apply a minimum of 2-1/2 layers of 33 Tape over the aqua seal onto the surface of the PGW insulation to form a good seal.
7. See UGS HP 200 and HP 205 for handhole requirements and installation details.
8. The distance between the edge of the pole and the edge of the handhole(s) shall be a minimum of three times the diameter of the pole at ground level, measured from the face of the pole. If closer installation is required or there is unstable/varying soil conditions, contact Pole Engineering for a more in depth analysis. See PLM Table 1 for minimum pole diameter at ground level.
9. If a guy wire is installed on the pole, the handhole shall be installed on the opposite side of the pole whenever possible. If it is technically infeasible to install the handhole on the opposite side of the pole, the handhole may be installed on the same side of the pole as the guy wire. Maintain a minimum 2' clearance form the edge of the handhole to the guy anchor.

Figure GR 400–10: Construction Details for Multiple Grounding Electrodes



Note(s):

1. Below grade construction for multiple deep grounding electrodes are the only shown in this schematic. For above grade construction for deep grounding electrodes, see Figure GR 400P–3.
2. No below grade connections shall be made to the deep grounding electrodes except for those shown in this schematic.
3. First 10 feet of depth below grade shall be in conduit. Backfill around conduit with native soil.
4. For each drilled hole, use one #4 protected ground wire. For each wire strip the middle portion that will be below 10 feet of depth so that the bottom portion of the electrode is bare wire.
5. Backfill the bare wire with ERICO Ground Enhancement (GEM) (SAP 10064425) to 10 feet below grade.

This page intentionally left blank.

DOH–PO: Poles and Guying

TABLE OF CONTENTS

STANDARD	TITLE
PO 100	Poles — General Information
PO 100.1	Wood Poles
PO 100.2	Steel Poles
PO 100.3	Handling and Framing of Wood and Steel Poles
PO 100.4	Pole Steps on Distribution Wood Poles
PO 100.5	Setting and Removing for Wood Poles
PO 100.6	Dimensions and Weights for Wood and Steel Poles
PO 105	Temporary Cover for Pre-Dug Pole Holes
PO 105.1	Temporary Cover for Pre-Dug Pole Holes
PO 110	Pole Steps on Subtransmission Wood Poles
PO 110.1	Pole Steps on Subtransmission Wood Poles with Distribution Risers and/or Apparatus
PO 112	Composite Poles
PO 112.1	General Information
PO 112.2	Handling, Setting, and Framing
PO 112.3	Assembly and Removal
PO 112.4	Composite Pole Reference
PO 112.5	Intelli-Pole® Sectional Composite Pole
PO 114P	Hybrid Poles — Pilot
PO 114P.1	General Information
PO 114P.2	Handling and Framing
PO 114P.3	Assembly
PO 115	Temporary Attachment of Pole Sections with Third-Party Facilities to Composite Poles
PO 115.1	Temporary Attachment of Wood Pole Sections with Third-Party Facilities to Composite Poles
PO 120	Pole Numbering, Marking, and HIGH VOLTAGE Signs
PO 120.1	Typical Pole Numbering
PO 120.2	Pole Marking Using Brands, Metal Bands, Visibility Strips and High Voltage Signs
PO 121	Phasing Identification Labeling
PO 121.1	Pole Labeling
PO 130	Pole-Key and Block Support
PO 130.1	Pole-Key and Block Support
PO 140	Pole, Temporary Wood Stubbing/Straightening
PO 140.1	Pole, Temporary Wood Stubbing/Straightening
PO 140.2	Use of Pole Set-Urethane Foam for Pole Reinforcement
PO 141P	Star Pole Anchor Pilot
PO 141P.1	Star Pole Anchor Pilot

STANDARD	TITLE
PO 142	Pole Push Brace
PO 142.1	Method of Installing a Push Brace
PO 143	Caisson Installation
PO 143.1	Caisson and Sono Tube General Information
PO 144P	Pole Cushion for Vehicle Hit Wood Poles Pilot
PO 144P.1	Pole Cushion for Vehicle Hit Wood Poles Pilot
PO 145	Modular Pole Butt Replacement for Damaged Poles, Pole Relocation
PO 145.1	Modular Pole Butts
PO 145.2	Step-By-Step Procedure for Installing Mod-Pole
PO 145.3	Grout and Pea Gravel Requirements for Modular Pole Butts
PO 147	Reinforcement and Replacement of Deteriorated Poles
PO 147.1	Ground Line Reinforcement of Wood Poles
PO 148	Wood Pole with FR Wrap
PO 148.1	Wood Pole with FR Wrap — New Construction and Rebuilds
PO 148.2	FR Wrap In-Service Wood Poles
PO 150	Pole Top Extensions
PO 150.1	Applications for Pole Top Extensions
PO 151P	Woodpecker Wood Pole Damage Repair
PO 151P.1	Woodpecker Damage Repair
PO 200	Grade “A” and Limited Access Highway Crossing — General Requirements
PO 200.1	General Information
PO 200.2	Grade “A” Crossing General Requirements
PO 300	Guying — General Information
PO 300.1	Guying — General Information
PO 300.2	Types of Guying
PO 300.1	Guying Subtransmission Lightweight Steel Poles
PO 310	Anchors for Guys
PO 310.1	Anchors for Guys
PO 310.2	Heavy-Duty Power-Installed Screw Anchors (PISA)
PO 310.3	Holding Strength Calculations for PISA Anchors
PO 315	Anchor and Guying Components
PO 315.1	Anchor and Guying Components
PO 320	Determination of Anchor/Guy Size
PO 320.1	Instructions for Use of Guy Requirement Tables
PO 320.2	Conductor Dead-End Tensions for the Determination of Anchor/Guy Size
PO 330	Determination of Anchor Deviation Angle
PO 330.1	Determination of Anchor Deviation Angle

STANDARD	TITLE
PO 350	Guy Guards
PO 350.1	Approved Guy Guards, Application, and Installation Information
PO 370	Composite Pole Hardware
PO 370.1	Composite Pole Hardware

This page intentionally left blank.

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)
3. Dichlorooctylisothiazolinone (DCOI)

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. The only exception is in non-HFRA areas during material shortages and with Engineering approval.

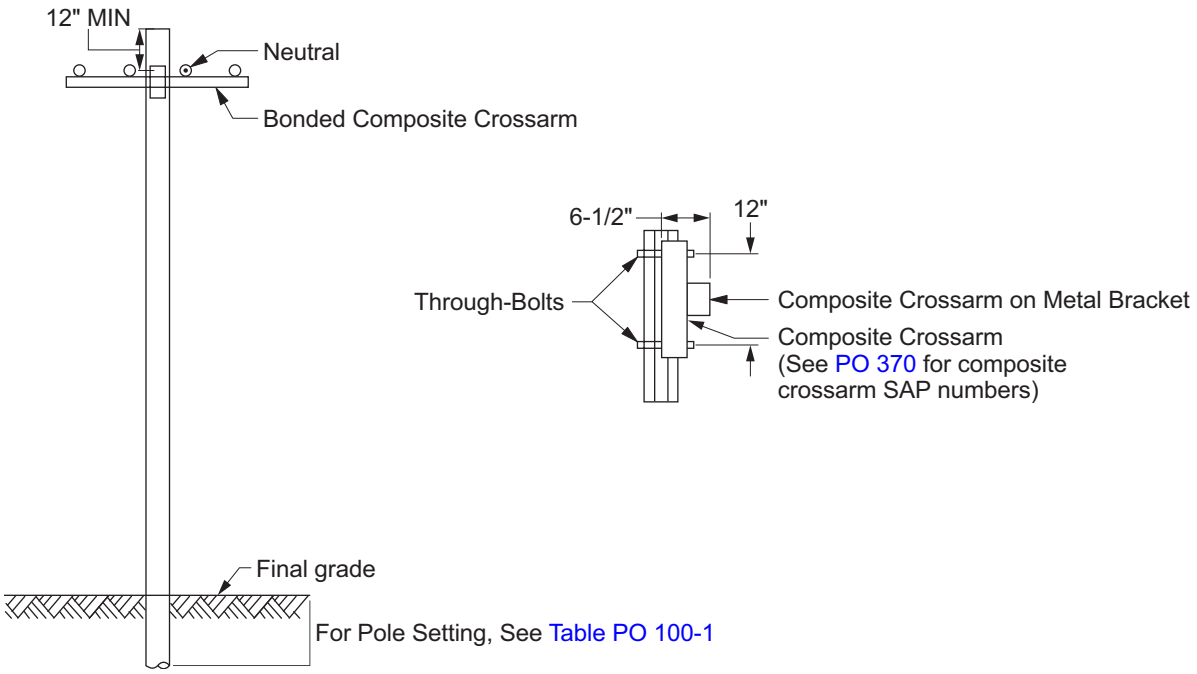
E. When installing a composite crossarm, the first hole for the bracket shall be placed 12 inches minimum from the top of the pole (see Figure PO 100–1).

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



F. Refer to APM Rule 209 for working in elevated positions on poles.

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.

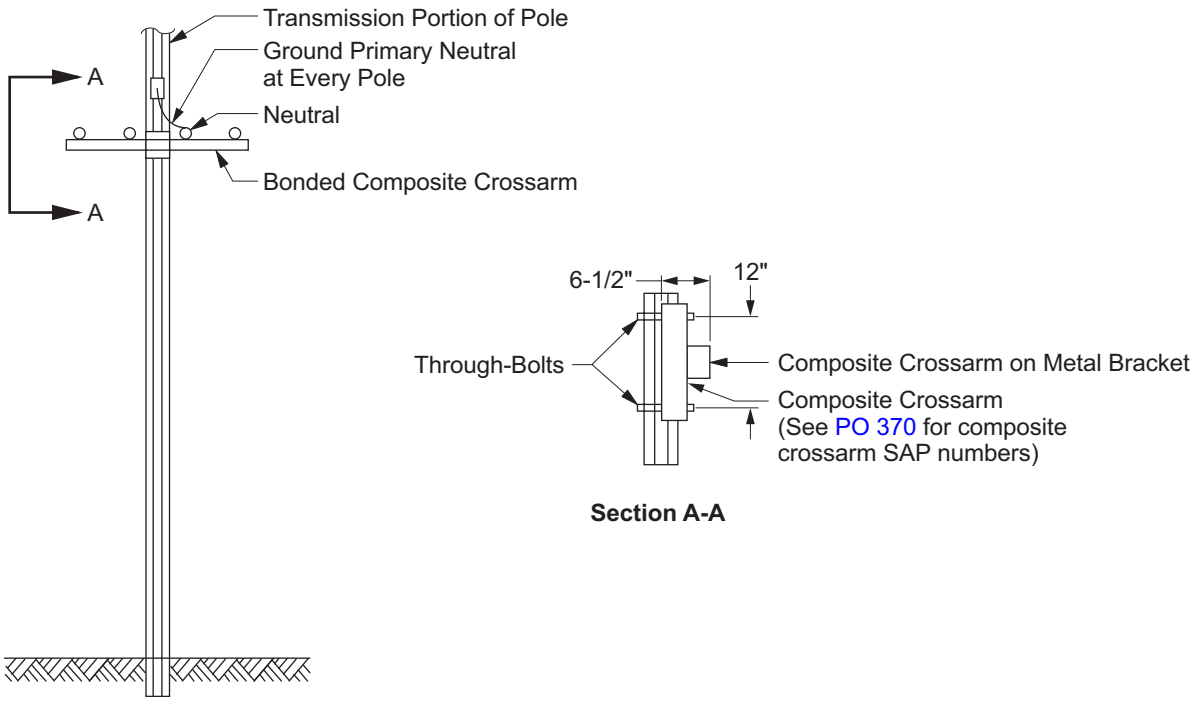
B. All distribution apparatus grounds will be attached to the pole. See Sections GR 100 and DAP AP 100 for these equipment grounds on subtransmission LWS poles.

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



Section A-A

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.

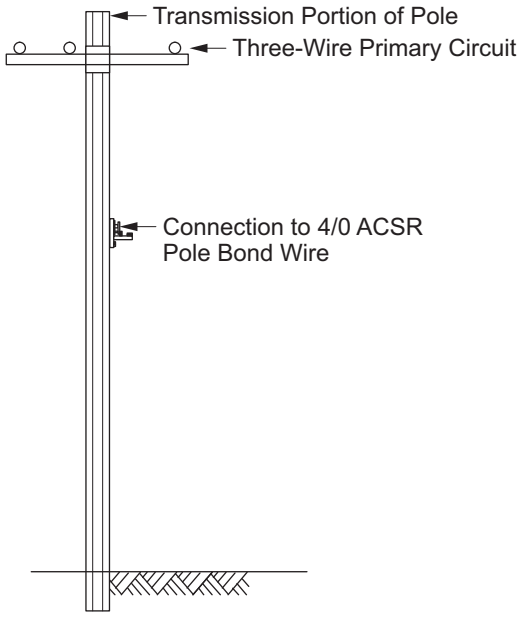
I. Use a composite crossarm with mounting bracket for distribution and/or communication facilities. Use bonding clips (SAP 10113253) to attach bond wire to composite crossarms. Do not attach crossarm hardware bond wire to the grounded steel pole. For composite crossarms see PO 370.

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.

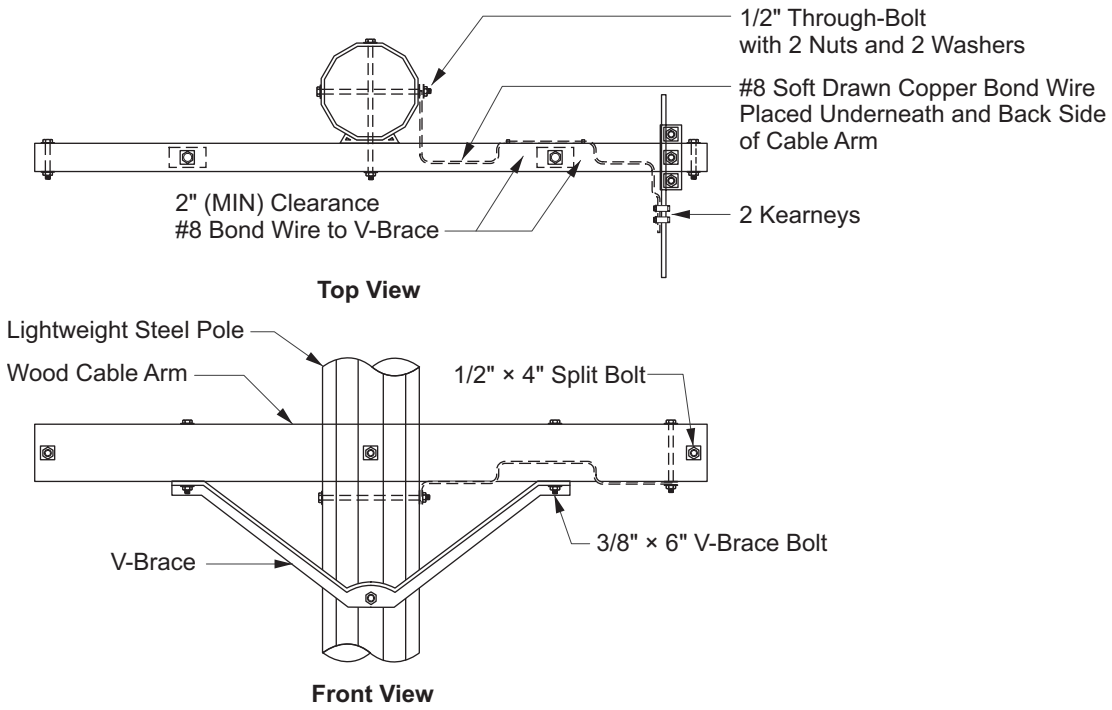
Figure PO 100–3: Steel Pole with Three-Wire Primary



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.

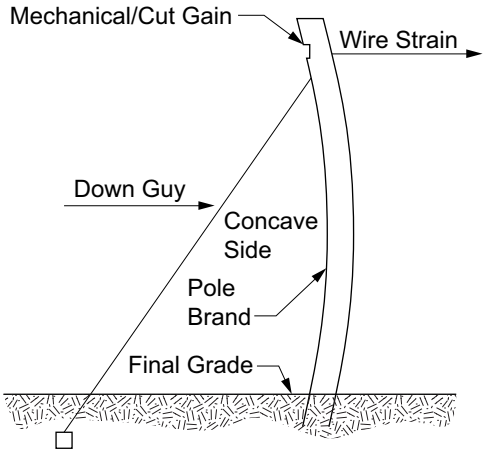
Note: The center of the top gain and through-bolt hole shall be a minimum of 6-1/2 inches from the top of the pole for new 40 foot poles and longer.

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

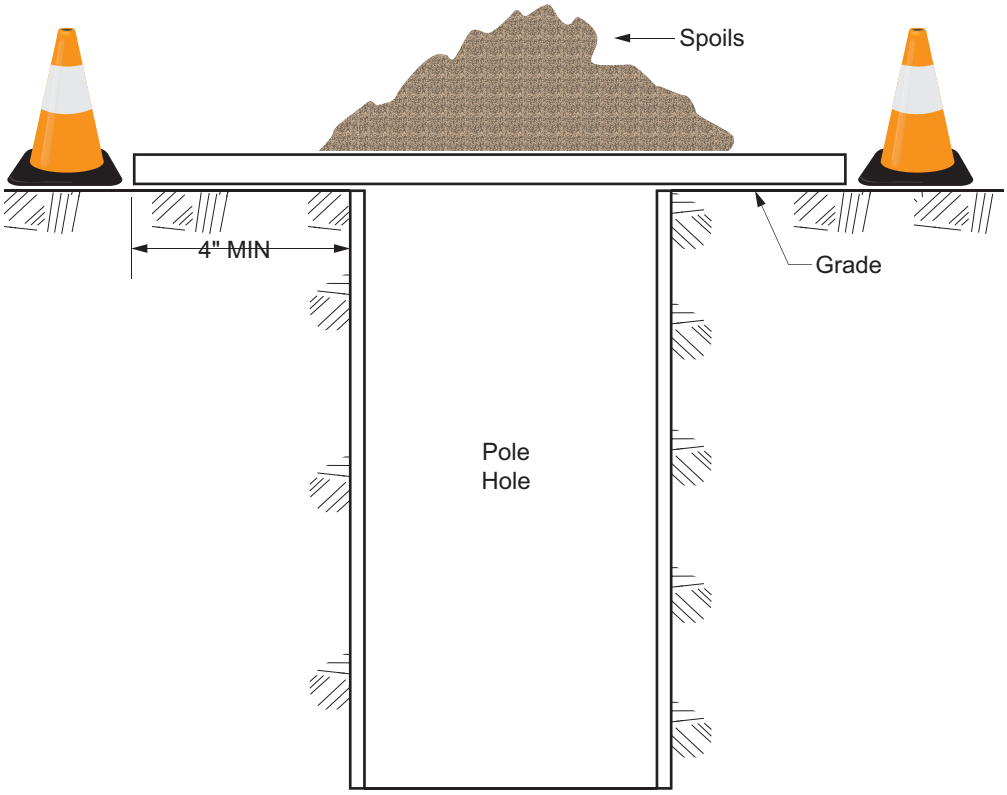


40-inch Composite Pole-Hole Cover
SAP 10184645



Top/Bottom of
Wooden Cable Reel

Figure 105–2: Covered Pre-Dug Hole



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

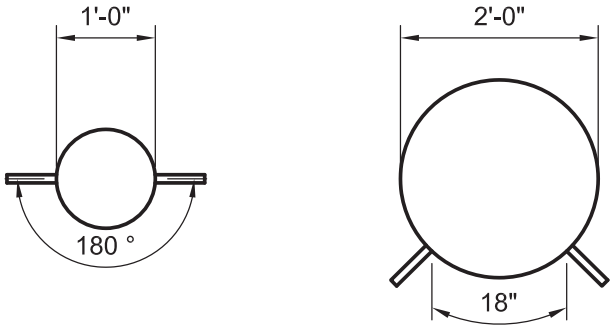
2.1 General

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



Pole less than or equal to 12" diameter

Pole greater than 12" diameter

Figure PO 110–2: Pole Step (SAP 10068469)

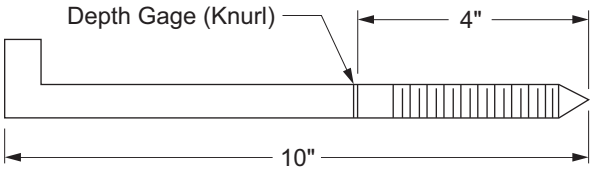


Figure PO 110–3: Pole Step Location — Example of a Climbing Space with Distribution Apparatus

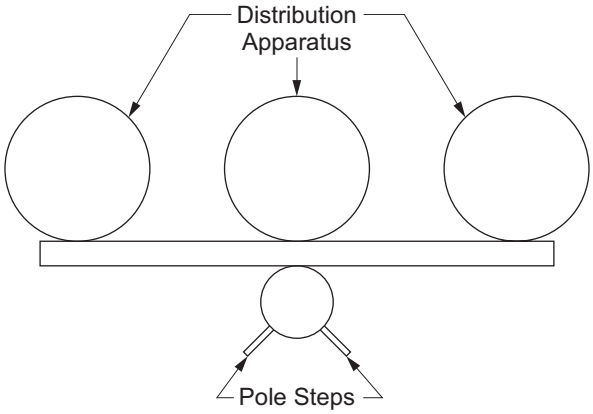
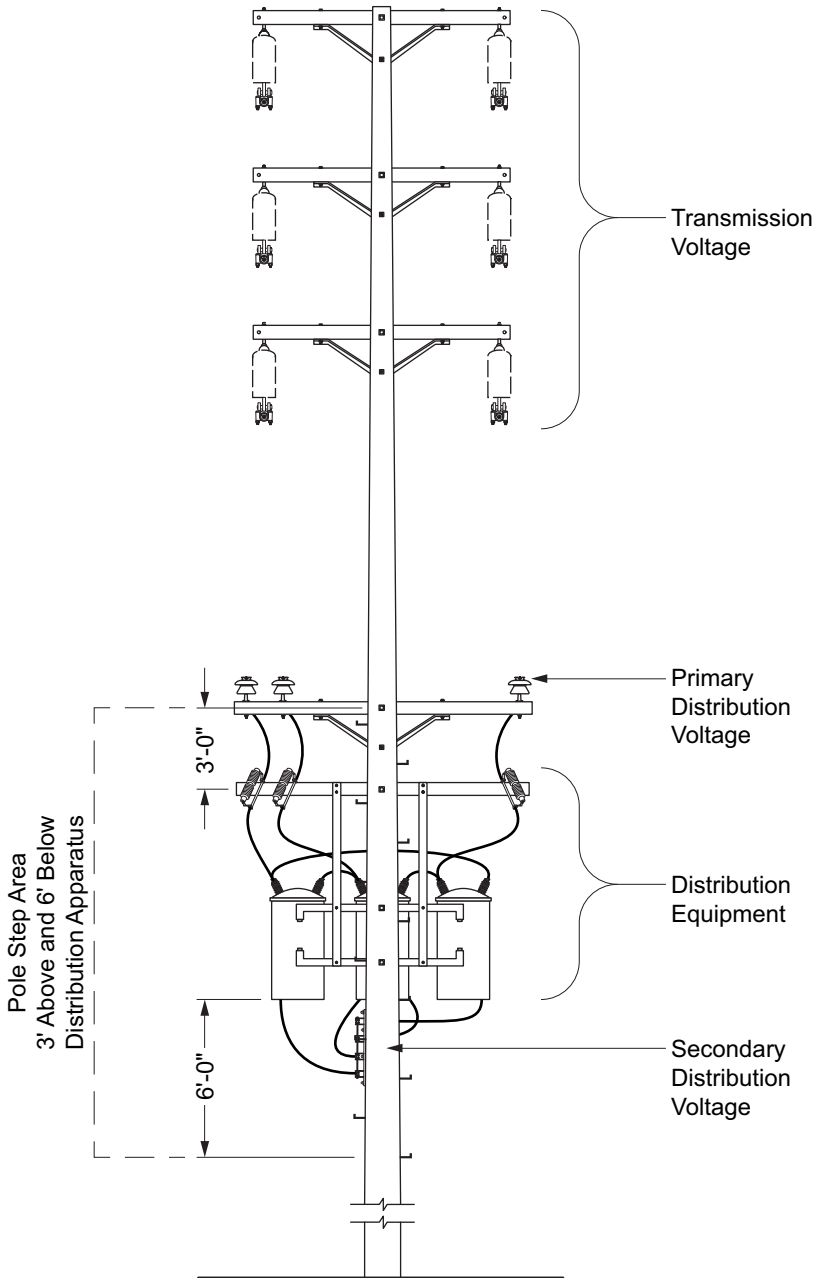


Figure PO 110–4: Pole Step Locations — Area of Step Installation with Distribution Apparatus (Typical)



This page intentionally left blank.

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.

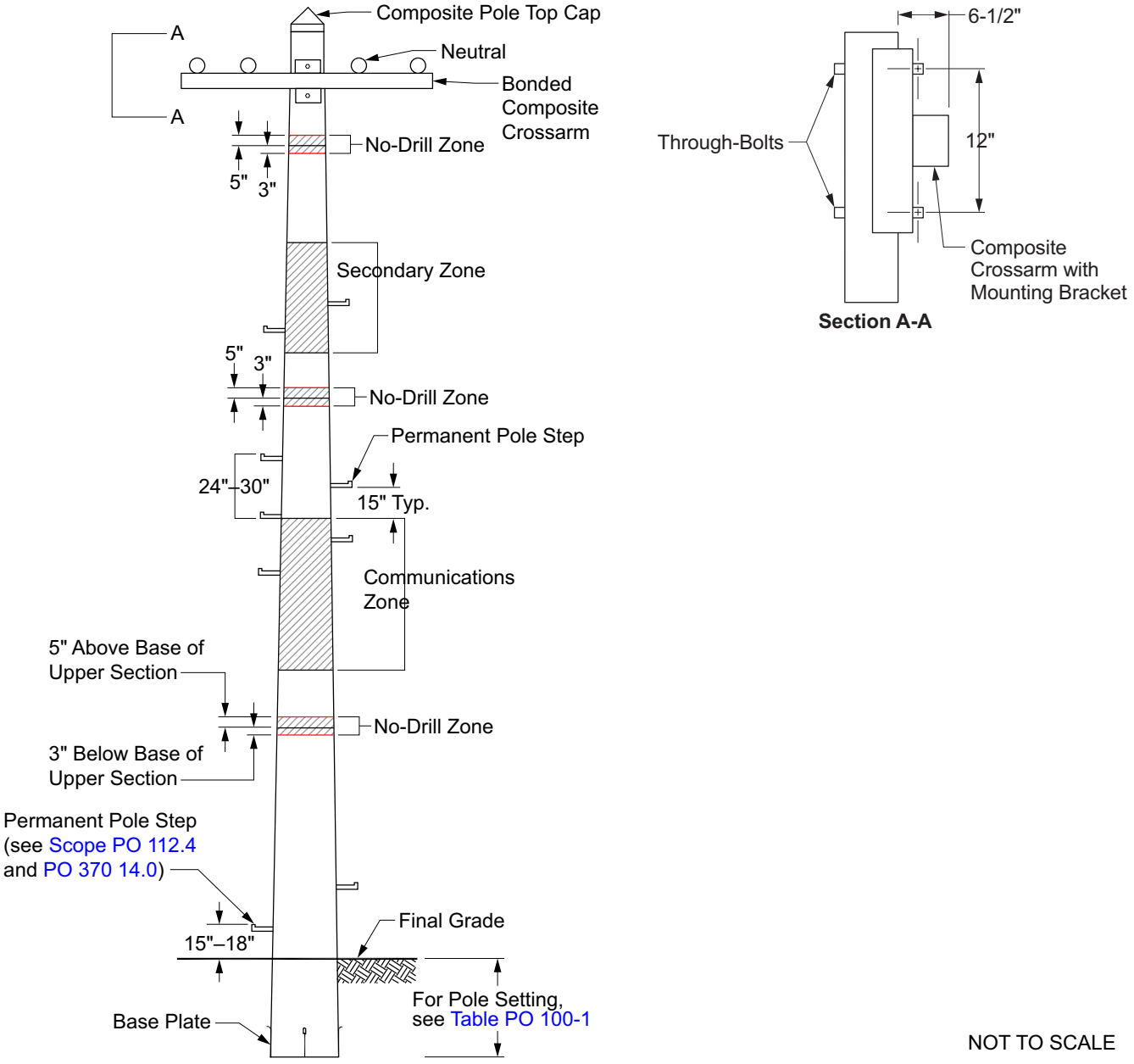
Refer to APM Rule 209 for working on elevated positions on poles.

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



Note(s):

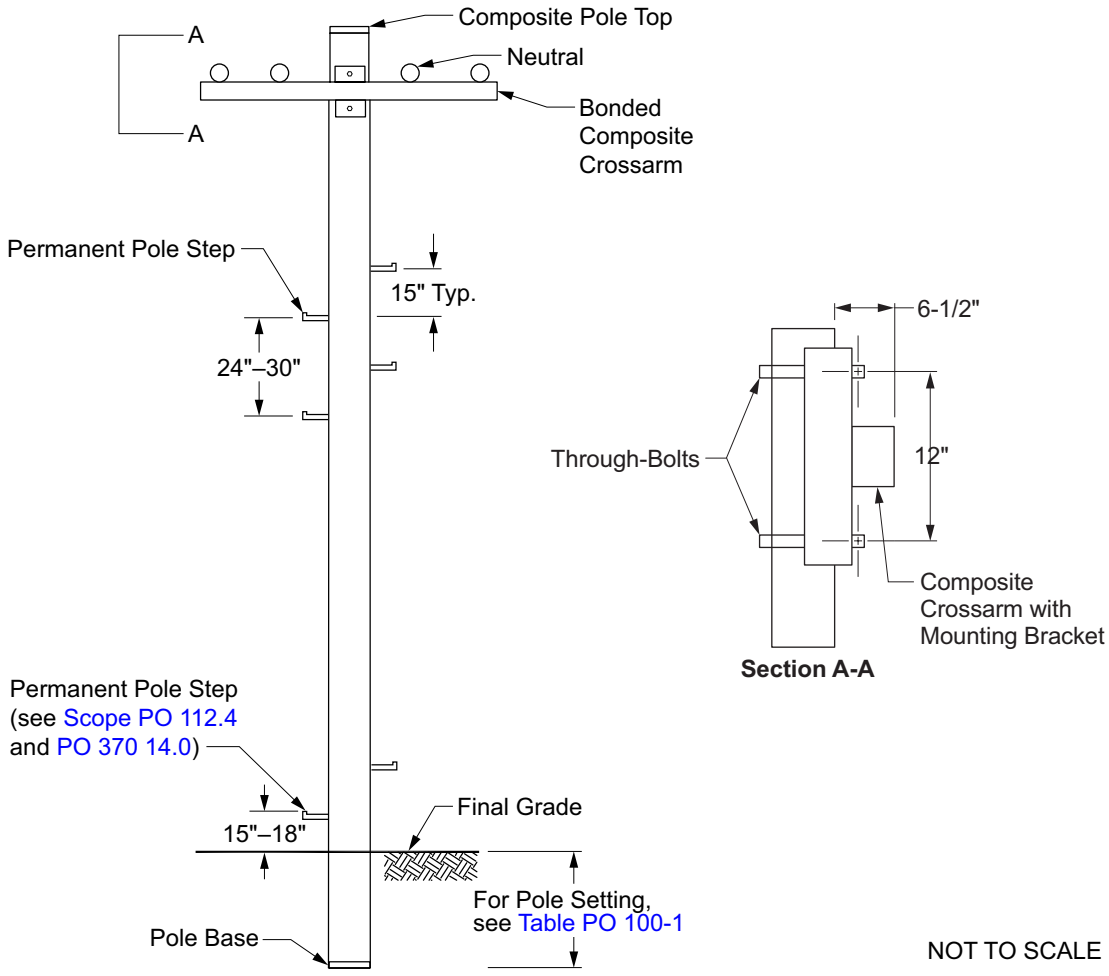
1. Use pole bands for attachments within no-drill zones (see PO 370 for pole band SAP numbers).
2. If needed to ascend and descend the pole during construction or maintenance, utilize permanent steps. After work is completed, remove permanent steps so that the remaining first step is located at least 9-feet above the ground line. Cover unused holes with pole plugs referenced in Table PO 370–6.

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. Cover unused holes with pole plugs referenced in Table PO 370–6.

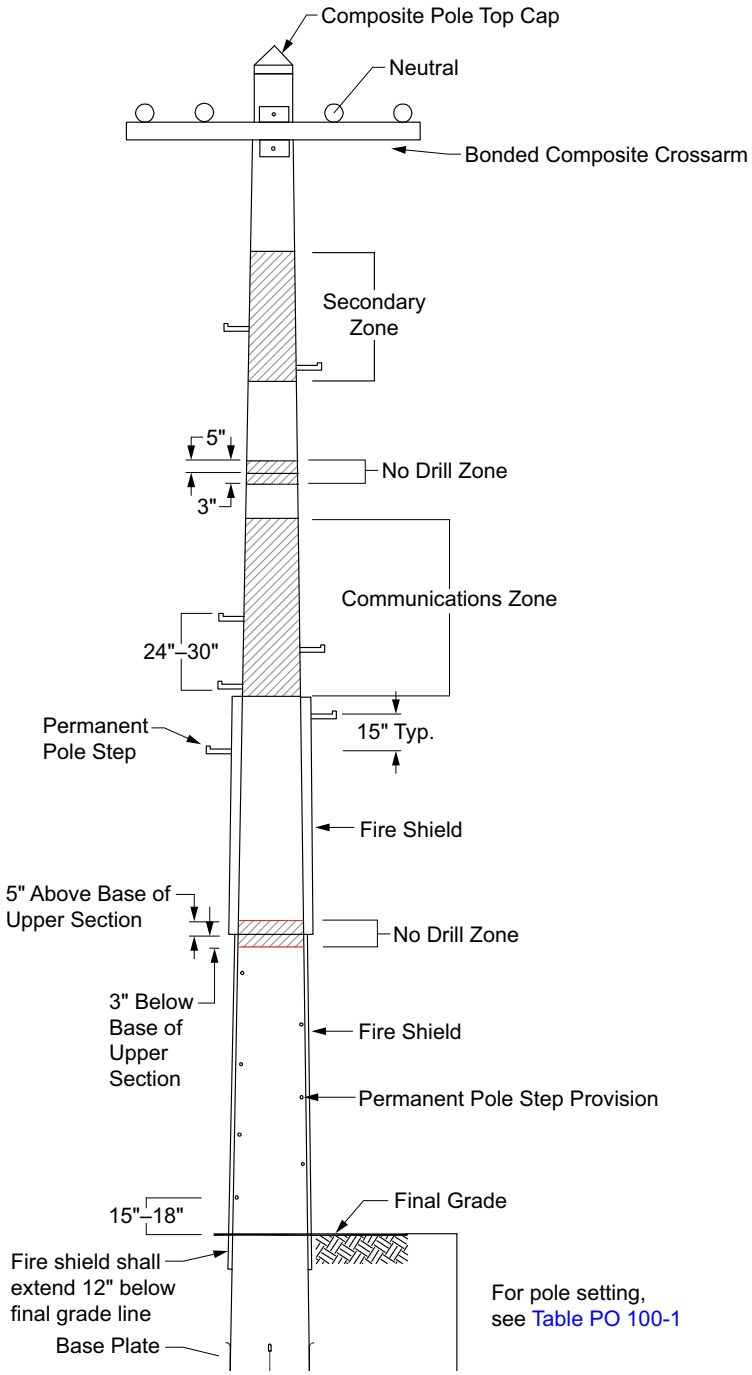
1.3 Composite Poles with Fire (or Protective) Shields

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.

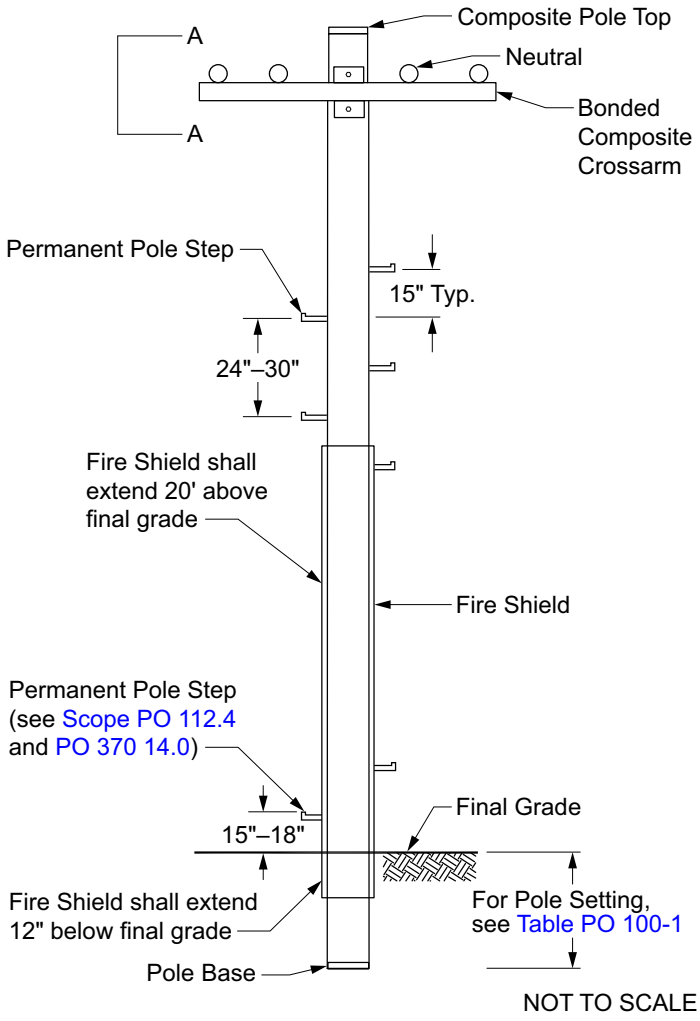
Figure PO 112–3: Typical RS Composite Pole with Fire Shield



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. Cover unused holes with pole plugs referenced in Table PO 370–6.
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. Cover unused holes with pole plugs referenced in Table PO 370–6.

1.4 Dimension and Weights of Composite Poles

Table PO 112–1: Dimensions, Weights and SAP Numbers

Pole Length and Description	ANSI Size Class	Section Numbers	Height Above Ground-line	Manufacture	Butt Diameter (in)[a/]	Ground-line Circumference (in)	Top Circumference (in)	Weight (lb)	SAP	Total # of Pole Step Holes	# of Pole Step Holes Below 9 feet
35 ft Sectional Pole	2	1, 2, 3	29	RS	15.3	43.7	29.3	448[b/]	10209239	32	6
35 ft Continuous Pole	H1	—	29	CPI	12	37.7	37.7	585[b/]	10214978	21	7
35 ft Continuous Pole	H4	—	29	CPI	16	50.3	50.3	781[b/]	10214980	21	7
40 ft Sectional Pole	1	2, 3, 4	34	RS	18.27	52.8	32.7	617[b/]	10209233	38	7
40 ft Continuous Pole	1	—	34	CPI	12	37.7	37.7	670[b/]	10214982	26	8
40 ft Continuous Pole	H4	—	34	CPI	16	50.3	50.3	892[b/]	10214984	26	8
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	2, 3, 4	38.5	RS	18.27	52.4	28.9	663[b/]	10209234	40	7
45 ft Continuous Pole	1	—	38.5	CPI	12	37.7	37.7	754[b/]	10214986	30	8
45 ft Continuous Pole	H4	—	38.5	CPI	16	50.3	50.3	1,004[b/]	10214987	30	8
50 ft Sectional Pole	1	2, 3, 4, 5	43	RS	21.3	61.4	37.1	920[b/]	10209235	48	6
50 ft Continuous Pole	1	—	43	CPI	12	37.7	37.7	838[b/]	10214988	34	8
50 ft Continuous Pole	H3	—	43	CPI	16	50.3	50.3	1,115[b/]	10214989	34	8
55 ft Sectional Pole	1	2, 3, 4, 5	47.5	RS	21.3	61	33.3	971[b/]	10209236	54	6
55 ft Continuous Pole	2	—	47.5	CPI	12	37.7	37.7	921[b/]	10214991	28	8
55 ft Continuous Pole	H3	—	47.5	CPI	16	50.3	50.3	1,227[b/]	10214993	38	8
60 ft Sectional Pole	1	3, 4, 5/6	52	RS	24.8	72	38.7	1,238[b/]	10209237	46	6
60 ft Continuous Pole	2	—	52	CPI	12	37.7	37.7	1,005[b/]	10214995	42	8
60 ft Continuous Pole	H3	—	52	CPI	16	50.3	50.3	1,338[b/]	10214997	38	8
65 ft Sectional Pole	1	3, 4, 5/6	56.5	RS	24.8	71.6	34.9	1,296[b/]	10209238	50	6
65 ft Continuous Pole	3	—	56.5	CPI	12	37.7	37.7	1,089[b/]	10214999	46	8
65 ft Continuous Pole	H2	—	56.5	CPI	16	50.3	50.3	1,450[/]	10215001	46	8
70 ft Continuous Pole	3	—	61	CPI	12	37.7	37.7	1,173[b/]	10215003		

Pole Length and Description	ANSI Size Class	Section Numbers	Height Above Ground-line	Manufacture	Butt Diameter (in)[a/]	Ground-line Circumference (in)	Top Circumference (in)	Weight (lb)	SAP	Total # of Pole Step Holes	# of Pole Step Holes Below 9 feet
70 ft Continuous Pole	H1	—	61	CPI	16	50.3	50.3	1,561[b/]	10215005	50	8
75 ft Continuous Pole	3	—	65.5	CPI	12	37.7	37.7	1,256[b/]	10215007	54	8
75 ft Continuous Pole	H1	—	65.5	CPI	16	50.3	50.3	1,699[b/]	10215009	54	8
80 ft Continuous Pole	3	—	70	CPI	12	37.7	37.7	1,340[b/]	10215011		
80 ft Continuous Pole	H1	—	70	CPI	16	50.3	50.3	1,784[b/]	10215013	58	8

[a/] Butt diameter value helps determine sono tube or caisson size.

[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 Structures and Wires Engineering for additional pole heights and classes.
2. Lead time for composite pole ordering is 6–8 weeks.
3. When the pole is bucket truck accessible, pole steps are NOT required for each pole step hole. Use pole plugs to fill all step holes. When the pole is NOT bucket truck accessible, use steps for each pole step hole 9 feet and above and pole plugs for the holes at 9 feet and below after climbing is completed. Install additional pole plugs where steps are within public reach. See Table PO 370–6.

Table PO 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 PO 112–3: Dimensions, Weights, and SAP Numbers for Fire Shield Composite Poles

Pole Length and Description	ANSI Size Class	Height Above Ground-line	Manufacture	Butt Diameter (in)[a/]	Ground-line Circumference (in)	Top Circumference (in)	Weight (lb)	SAP	Total # of Pole Step Holes	# of Pole Step Holes Below 3 ft.
35 ft Continuous Pole with FR Shield	H1	29	CPI	12.75	39.7	39.7	738[b/]	10214979	21	7
35 ft Continuous Pole with FR Shield	H4	29	CPI	16.75	52.2	52.2	976[b/]	10214981	21	7
40 ft Continuous Pole with FR Shield	1	34	CPI	12.75	39.7	39.7	822[b/]	10214983	26	8
40 ft Continuous Pole with FR Shield	H4	34	CPI	16.75	52.2	52.2	1,087[b/]	10214985	26	8
45 ft Sectional Pole (Partially Pre-Assembled) with FR Shield	1	38.5	RS	18.27	54.9	28.9	663[c/ b/]	10210664	40	7

Pole Length and Description	ANSI Size Class	Height Above Ground-line	Manufacture	Butt Diameter (in)[a/]	Ground-line Circumference (in)	Top Circumference (in)	Weight (lb)	SAP	Total # of Pole Step Holes	# of Pole Step Holes Below 3 ft.
45 ft Sectional Pole (Partially Pre-Assembled) with Shield	H1	38.5	RS	21.28	62.8	38	1,006[c/ b/]	10212589	38	7
45 ft Continuous Pole with FR Shield	1	38.5	CPI	12.75	39.7	39.7	906[b/]	10210665[d/]	30	8
45 ft Continuous Pole with FR Shield	H4[4]	38.5	CPI	16.75	52.2	52.2	1,221[b/]	10212590[d/]	30	8
50 ft Sectional (Partially Pre-Assembled) Pole with Shield	1	43	RS	21	61.4	37.1	1,158[c/ b/]	10210666	48	6
50 ft Continuous Pole with FR Shield	1	43	CPI	12.75	39.7	39.7	989[b/]	10210667[d/]	34	8
50 ft Continuous Pole with FR Shield	H3	43	CPI	16.75	52.2	52.2	1,310[b/]	10214990	34	8
55 ft Sectional (Partially Pre-Assembled) Pole with Shield	1	47.5	RS	21.3	62	33.3	1,204[c/ b/]	10212455	54	6
55 ft Continuous Pole with FR Shield	2	47.5	CPI	12.75	39.7	39.7	1,073[b/]	10214992	28	8
55 ft Continuous Pole with FR Shield	H3	47.5	CPI	16.75	52.2	52.2	1,422[b/]	10214994	38	8
60 ft Sectional (Partially Pre-Assembled) Pole with Shield	1	52	RS	24.8	72	38.7	1,557[c/ b/]	10212456	46	6
60 ft Continuous Pole with FR Shield	2	52	CPI	12.75	39.7	39.7	1,157[b/]	10214996	42	8
60 ft Continuous Pole with FR Shield	H3	52	CPI	16.75	52.2	52.2	1,533[b/]	10214998	38	8
65 ft Sectional (Partially Pre-Assembled) Pole with Shield	1	56.5	RS	24.8	74	34.9	1,529[c/ b/]	10212457	50	6
65 ft Continuous Pole with FR Shield	3	56.5	CPI	12.75	39.7	39.7	1,241[b/]	10215000	46	
65 ft Continuous Pole with FR Shield	H2	56.5	CPI	16.75	52.2	52.2	1,645[b/]	10215002	46	
70 ft Sectional (Partially Pre-Assembled) Pole with Shield	1	61	RS	27.9	83.6	42.6	1,903[c/ b/]	10212458	53	6
70 ft Continuous Pole with FR Shield	3	61	CPI	12.75	39.7	39.7	1,324[b/]	10215004		
70 ft Continuous Pole with FR Shield	H1	61	CPI	16.75	52.2	52.2	1,756[b/]	10215006	50	8
75 ft Sectional (Partially Pre-Assembled) Pole with Shield	1	65.5	RS	27.9	83.4	38.7	1,961[c/ b/]	10212459	51	7
75 ft Continuous Pole with FR Shield	3	65.5	CPI	12.75	39.7	39.7	1,408[b/]	10215008	54	8
75 ft Continuous Pole with FR Shield	H1	65.5	CPI	16.75	52.2	52.2	1,864[b/]	10215010	54	8
80 ft Continuous Pole with FR Shield	3	70	CPI	12.75	39.7	39.7	1,472[b/]	10215012		
80 ft Continuous Pole with FR Shield	H1	70	CPI	16.75	52.2	52.2	1,979[b/]	10215014	58	8

a/ Butt diameter value helps determine sono tube or caisson size.

b/ Nominal weight + 10%. Refer to manufacturer ID tag for actual weight.

c/ See Table PO 112–5 for weights of partially pre-assembled and individual pole sections for RS poles with fire shields.

d/ See Table PO 112–4 for RS fully assembled composite poles with fire shields when CPI cannot be procured.

Table PO 112–4: RS Fully Assembled Composite Poles with Fire Shields

Pole Length and Description	ANSI Size Class	Height Above Ground-line	Manufacture	Butt Diameter (in)	Circumference (in)	Ground-Line Circumference (in)	Top Weight (lb)	SAP	Total # of Pole Step Holes	# of Pole Step Holes Below 9 ft.
45 ft Fully Pre-Assembled Pole with FR Shield	1	38.5	RS	18.27	54.9	28.9	770	10221872	40	7
45 ft Fully Pre-Assembled Pole with FR Shield	H2[4]	38.5	RS	24	73.2	47.1	1,218	10221873	36	8
45 ft Fully Pre-Assembled Pole with FR Shield	H4[4]	38.5	RS	27	82.6	55.9	1,378	10222368	38	7
50 ft Fully Pre-Assembled Pole with FR Shield	1	43	RS	27	61.4	37.1	1,158	10221874	48	7

Note(s):

1. Lead time for fire shield composite pole ordering is 6 to 8 weeks.
2. Contact Structures and Wires Engineering for additional pole heights and classes.
3. When the pole is bucket truck accessible, pole steps are NOT required for each pole step hole. Use pole plugs to fill all step holes. When the pole steps are NOT bucket truck accessible, use steps for each pole step hole 9 feet and above and pole plugs for the holes at 9 feet and below after climbing is completed. Install additional pole plugs where steps are within public reach. See Table PO 370–6.
4. SCE no longer sources H2 pole, please use CPI 45 ft class H4 for any designs needing smaller “H” classes.

Table PO 112–5: 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 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.

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.

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.

A pole that is accesible by a bucket truck does not require the installation of permanent pole steps. All unused holes shall be covered with pole plugs referenced in Table PO 370–6.

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.

= FOR REFERENCE ONLY

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)

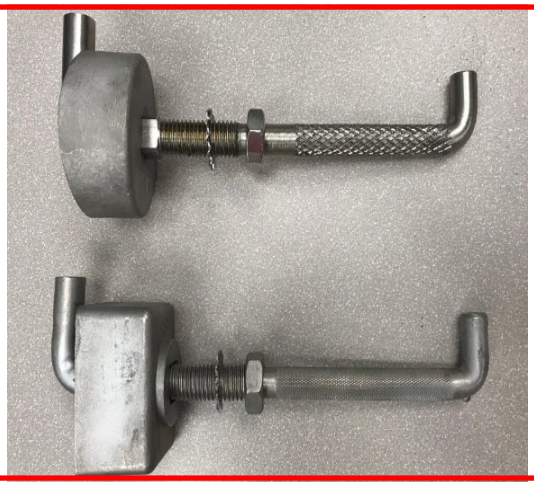


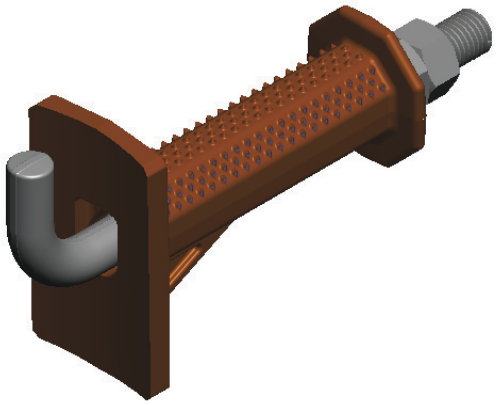


The first permanent step (SAP 10068660) shall not be less than 9 feet above grade or any easily climbable foreign structure from which one could reach or step. Permanent climbing steps shall be installed using a 1-inch hole.

= FOR REFERENCE ONLY

Figure PO 112–6: Permanent/Temporary Climbing Steps for Composite Poles





= FOR REFERENCE ONLY

New 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 with pole plugs referenced in Table PO 370–6.

Standard pole plugs that are already installed should be reused whenever possible. Before reuse, ensure the plugs remain in good condition and securely fit the unused holes. If a plug is damaged or does not provide a proper seal, replace it with a new one as specified inTable PO 370–6.

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 112–6 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 PO 112–6: 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.

FOR REFERENCE ONLY

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 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 18) 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 17), and repeat STEP 8 (Page 17)–STEP 13 (Page 17).

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 18)–STEP 21 (Page 18).

STEP 26. If another section is being installed, repeat STEP 22 (Page 18)–STEP 25 (Page 18).

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.

FOR REFERENCE ONLY

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 18) and secure using 4-inch curved square washers and square nuts.

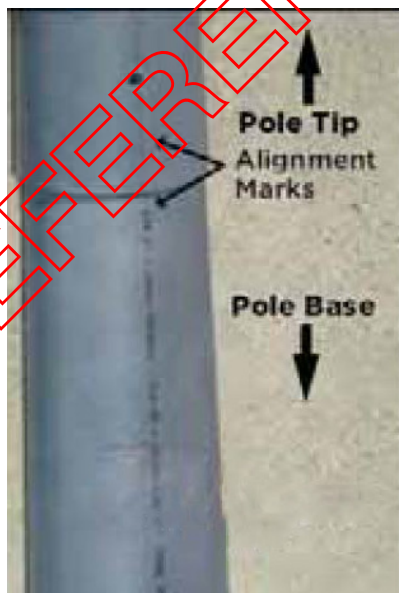
STEP 11. Repeat for STEP 4 (Page 17)–STEP 9 (Page 17) for all remaining sections.

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



FOR REFERENCE ONLY

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.

= FOR REFERENCE ONLY

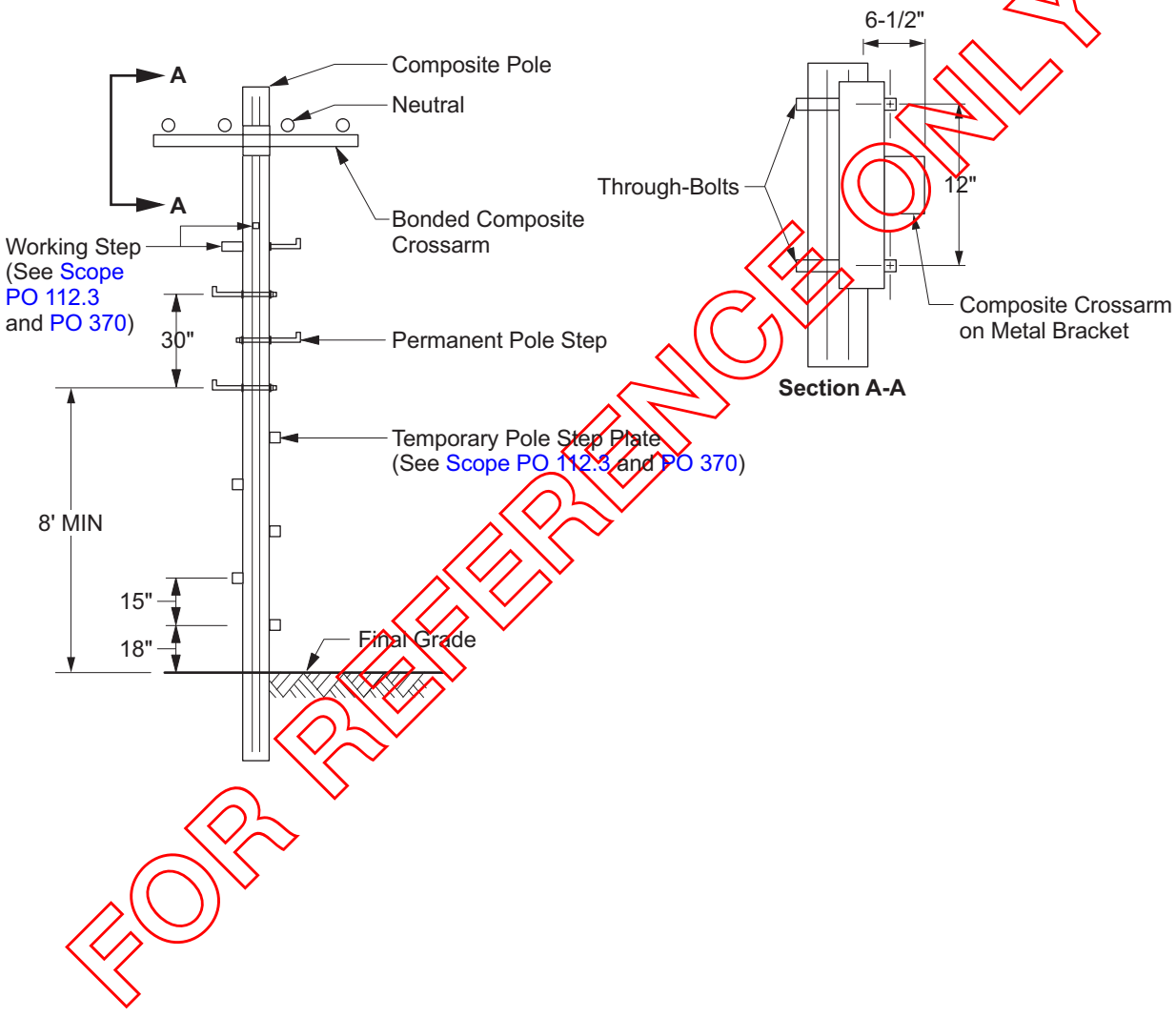
Scope PO 112.4 Composite Pole Reference

1.0 Overview

1.1 Octagonal Single-Piece Composite Poles

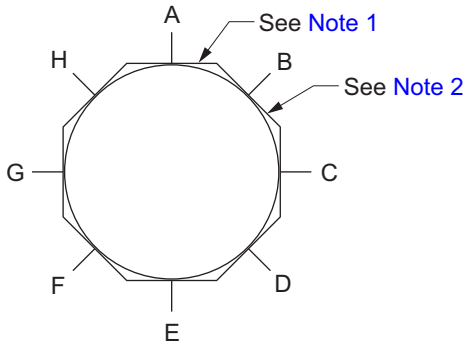
Octagonal single-piece composite poles manufactured by Creative Pultrusions, previously known as Powertrusion, are earlier generations of single piece composite poles previously used by SCE. The octagonal poles are non-tapered, and have a 10-inch outside diameter.

Figure PO 112–8: Octagonal Single-Piece Composite Poles



FOR REFERENCE ONLY

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

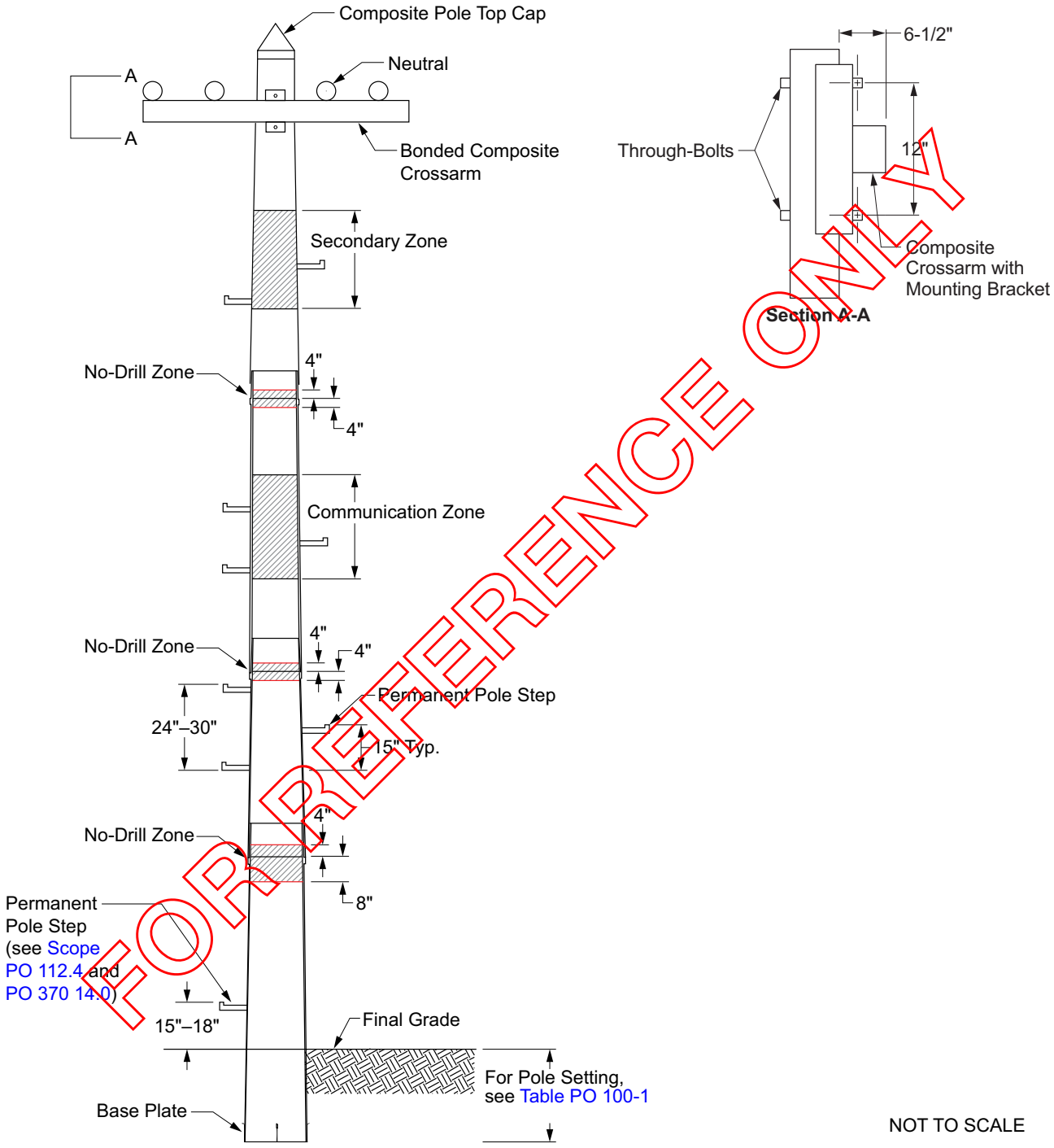
1.0 Intelli-Pole® Sectional Composite Poles

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

FOR REFERENCE ONLY

Figure PO 112–10: Typical Intelli-Pole® Round Sectional Tapered Composite Poles



FOR REFERENCE ONLY

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 PO 112–7: 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 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.

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 25) through STEP 25 (Page 25) 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)

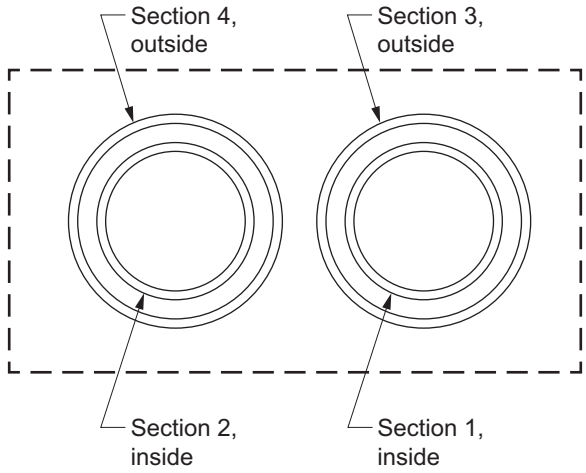


Figure PO 112–12: Nested Intelli-Pole® Sectional Composite Poles (Top-view)

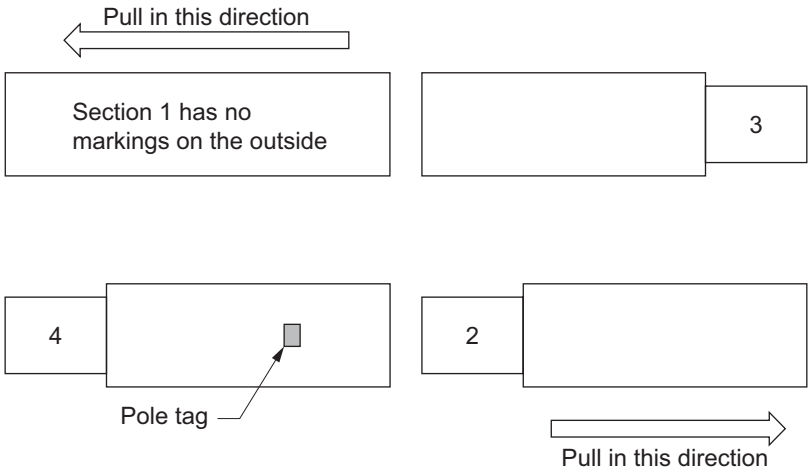


Figure PO 112–13: Slip Joint Assembly of Intelli-Pole® Sectional Composite Pole

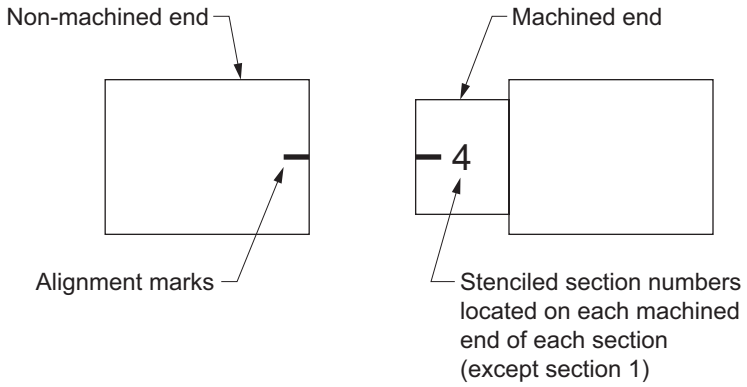
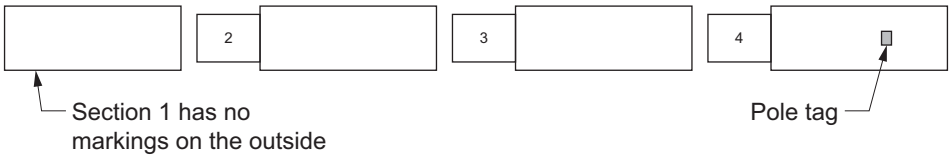


Figure PO 112–14: Intelli-Pole® Sectional Composite Pole Assembly Sequence and Numbering



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)



PILOT

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	1,353	15.9	8.3
50	28/22	H1	1,569	16.7	8.5

[a/] Total weight of assembled single pole.

Figure PO 114P–2: Hybrid Pole Sections with Flanges



PILOT

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



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 PO 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.

PILOT

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

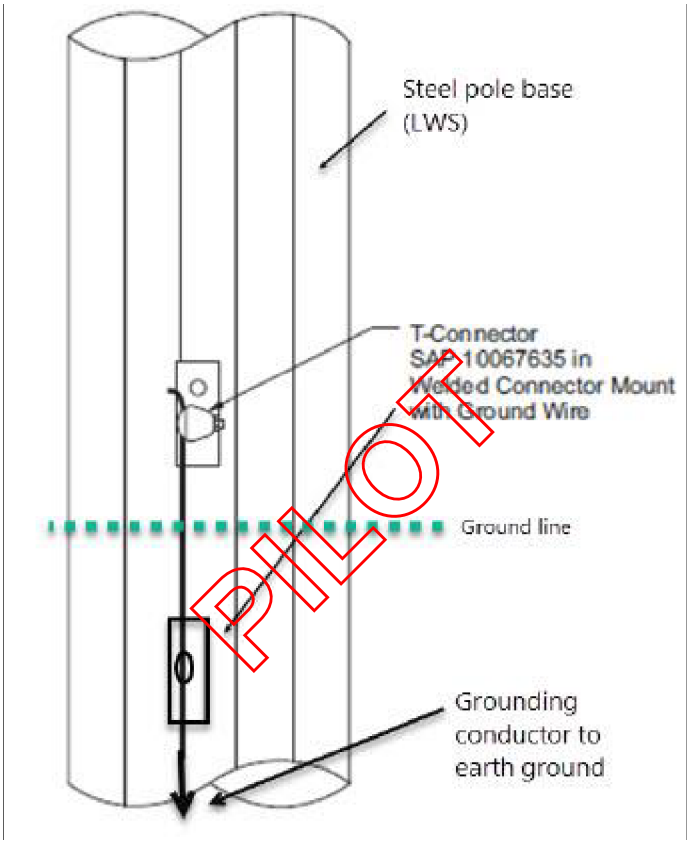
Hybrid poles for use in pilot will be non-stepped and vehicle (bucket) access only.

PILOT

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

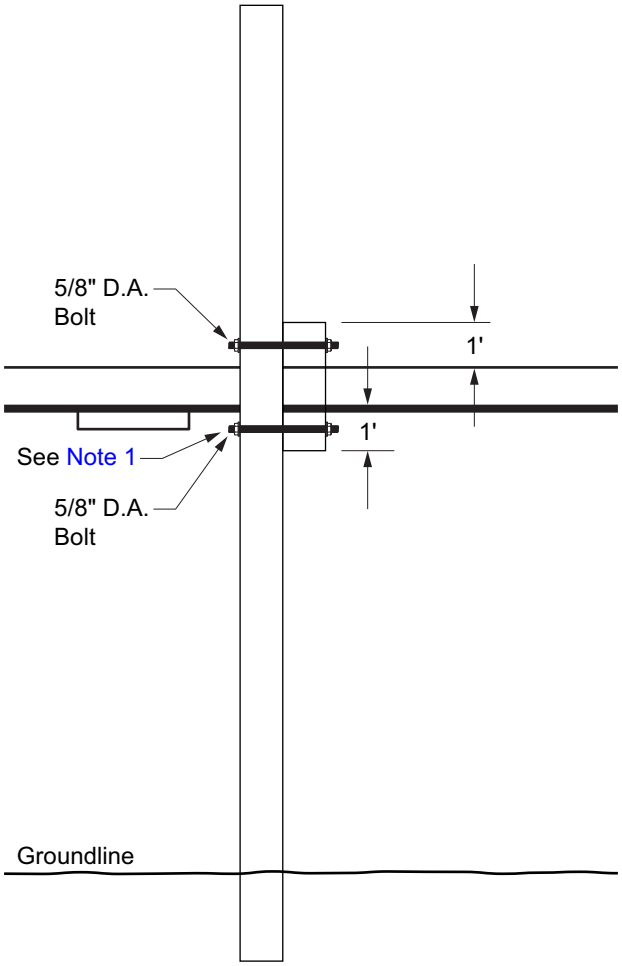
Scope PO 115.1 Temporary Attachment of Wood Pole Sections with Third-Party Facilities to Composite Poles

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.

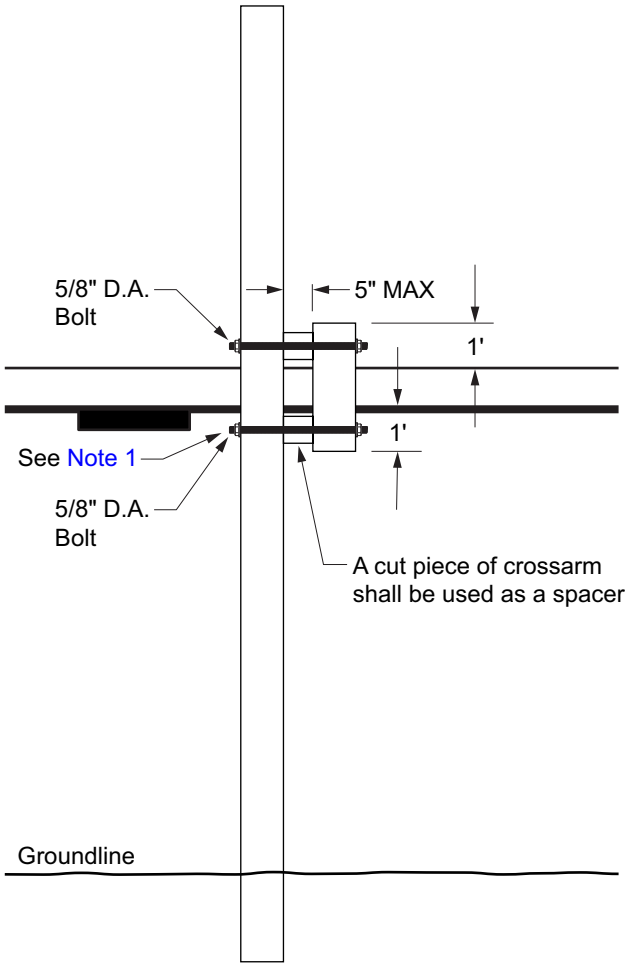
Figure PO 115–1: Wood Pole within 5 Inches of Composite Pole (No Spacers)



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)



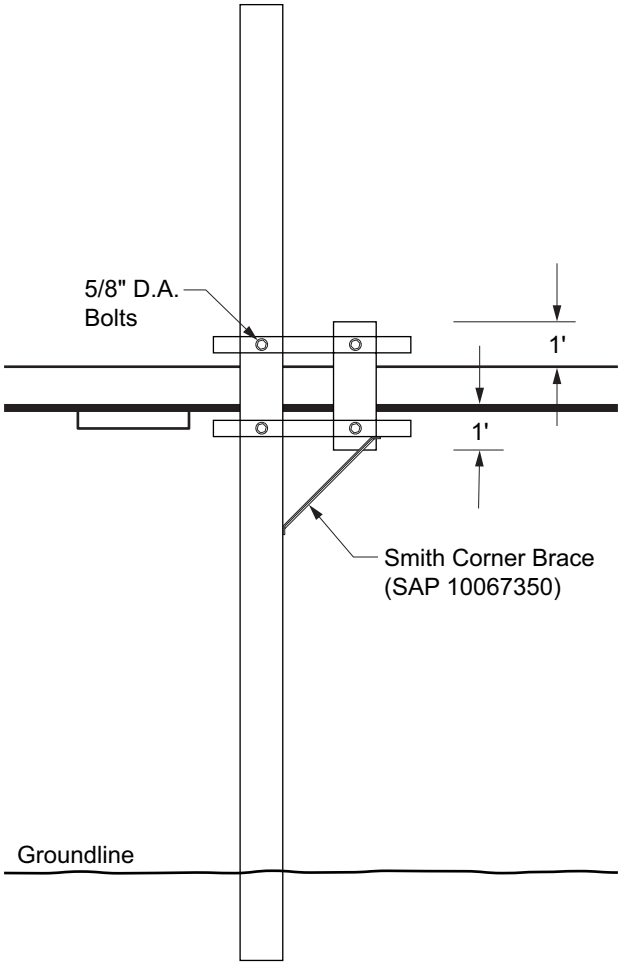
Note(s):

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).

This page intentionally left blank.

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, guy stubs and streetlight poles, should be labeled with metal pole number plates (SAP 10135278) with 7/8-inch yellow and black numbers/letters as shown in Figure 120-1 below.

Figure PO 120–1: Pole Numbering



Metal Pole Number Plate
(SAP 10135278)

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

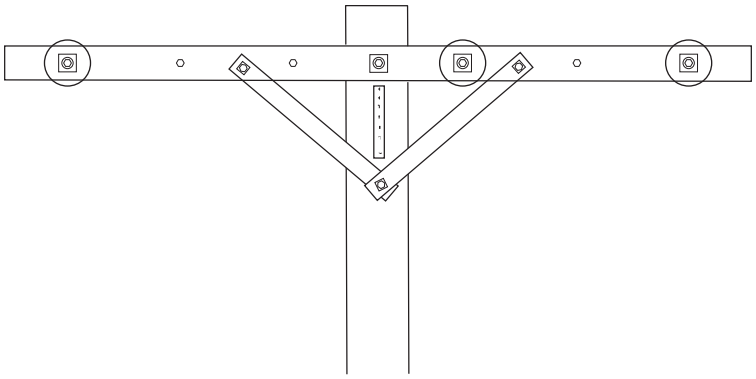
[a/] Letter “O” is the same as number “0” and thus has the same SAP number.

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 120–2). 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 120–2: Preferred Location of HFRA Pole Tag

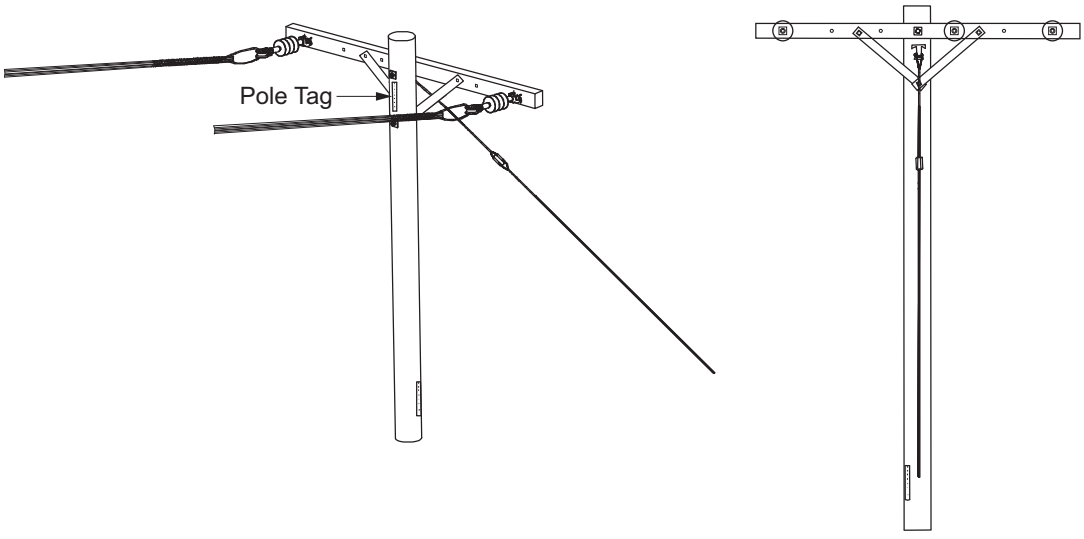


B. For cases where the area inside the V-brace is not feasible due to equipment or hardware, the rear of the pole should be considered. If this is not achievable, then the pole tag should be placed under equipment or cross arm hardware within 3 feet from the pole top and in-line with primary conductors (see Figure PO 120–3).

Figure PO 120–3: 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

B. Year-Set Nail — Locate just below and to the right of center of pole-marking plate

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).

= FOR REFERENCE ONLY

Note: ***Pole-marking nails are no longer available or maintained. Pole species, class, and length may be identified by the brands burned into the pole or medallions affixed to the pole by the manufacturer. Refer to PLM-4.***

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 120–4)

Table PO 120–3: Visibility Strip Installation

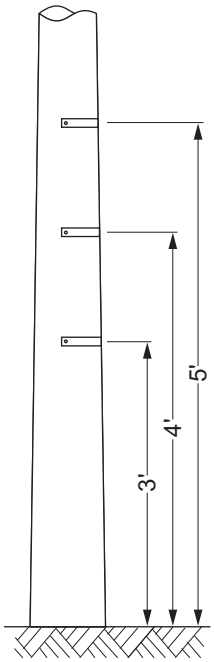
Type of Pole	Description	Quantity	Size	SAP
Wood	Visibility Strip	1	2" × 12"	10068488
	Nail	2	1-3/4"	10069984
Composite	Visibility Strip	1	2" × 12"	10068488
	Self-drilling Screw	2	#10 × 1"	10072230
Light Weight Steel	Visibility Strip Decal	1	2" × 12"	10068376

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 120–4)

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 120–4: 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 120–5)

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 120–6)

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 120–7)

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 120–8)

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 120–9)

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 120–10)

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 120–11)

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 120–12)

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 120–13)

Figure PO 120–5: Poles on Curves, with or without Curbs, Visible to Traffic in Two Directions

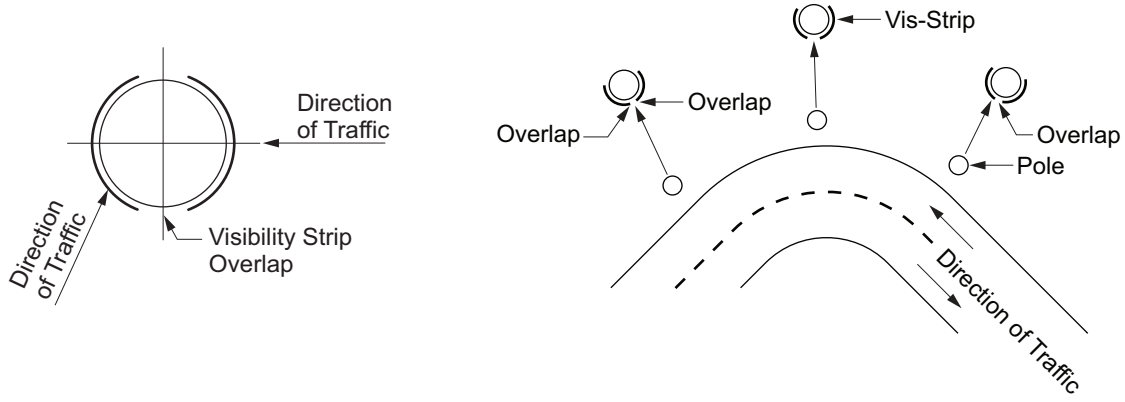


Figure PO 120–6: Poles on Curves, with or without Curbs, Visible to Traffic in One Direction

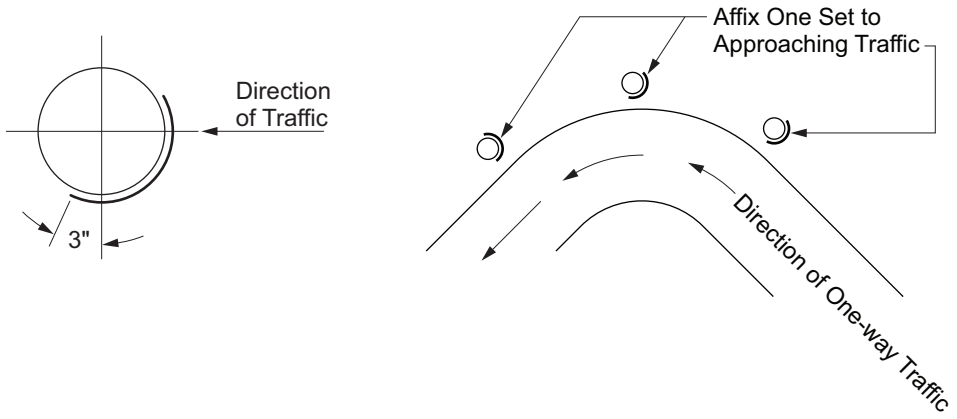


Figure PO 120–7: Poles on Offset One-Way Intersections, with or without Curbs

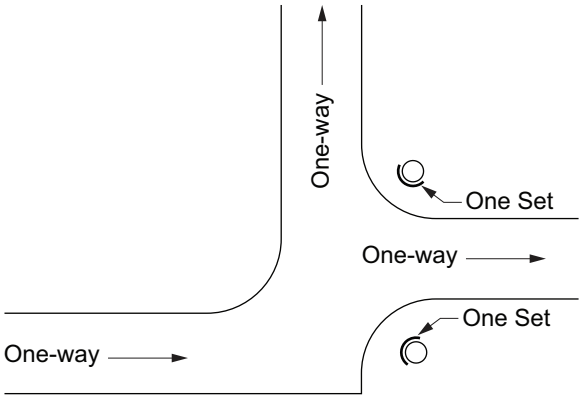


Figure PO 120–8: Poles on Offset Two-Way Intersections, with or without Curbs

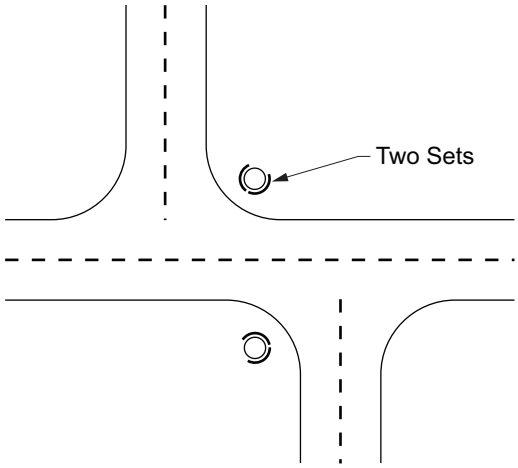


Figure PO 120–9: Poles Located within 12 Feet of Roadways, Outside of the Paved Shoulder/Curb

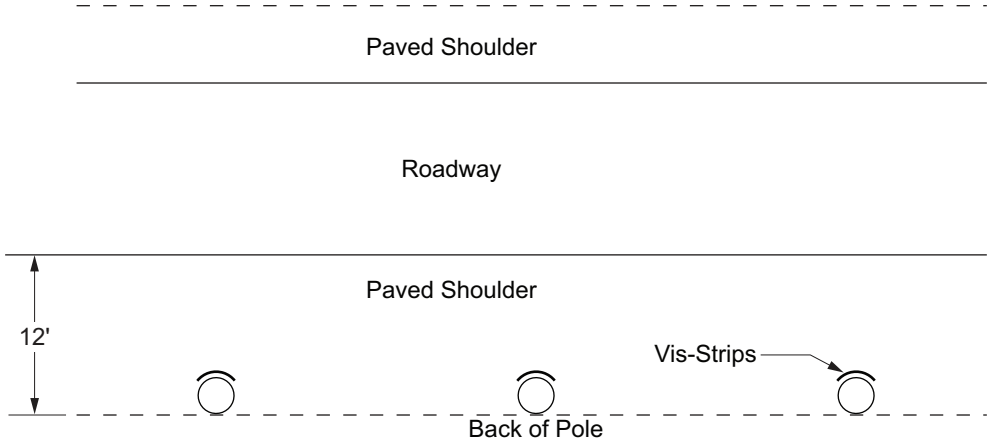


Figure PO 120–10: Poles Located in Alleys

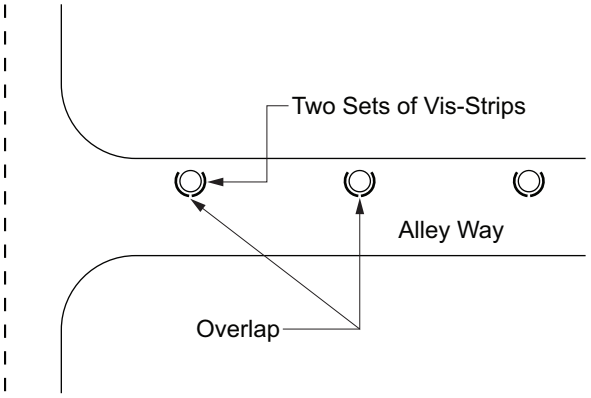


Figure PO 120–11: Poles Located in Industrial, Commercial and Public Parking Lots

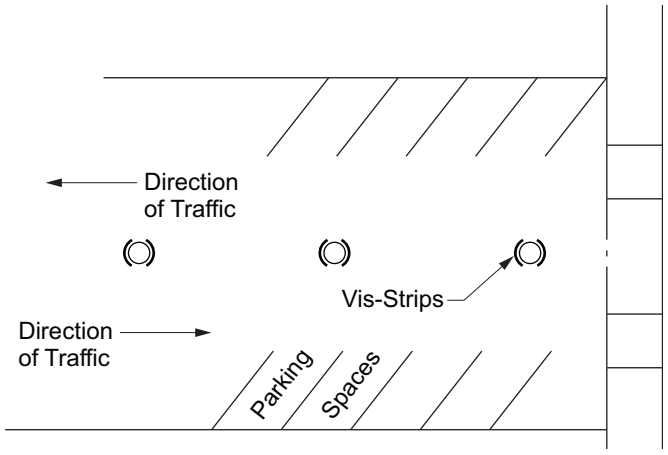


Figure PO 120–12: Poles Located near Residential Driveways

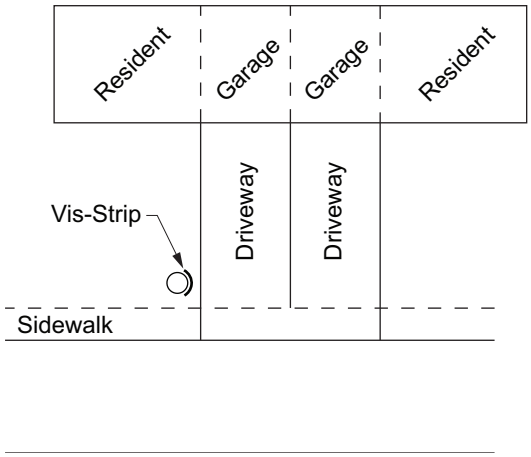
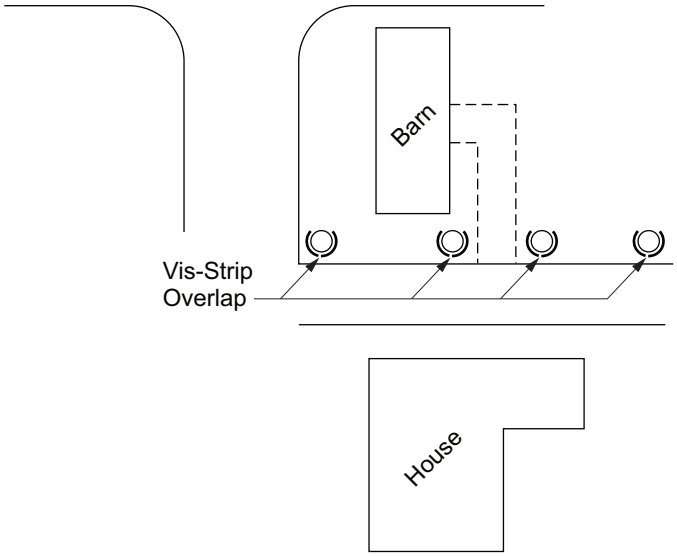


Figure PO 120–13: Poles Located on Private Agricultural, Dairy, or Farmland Property



3.0 Pole-Marking Using High Voltage Signs — General Information

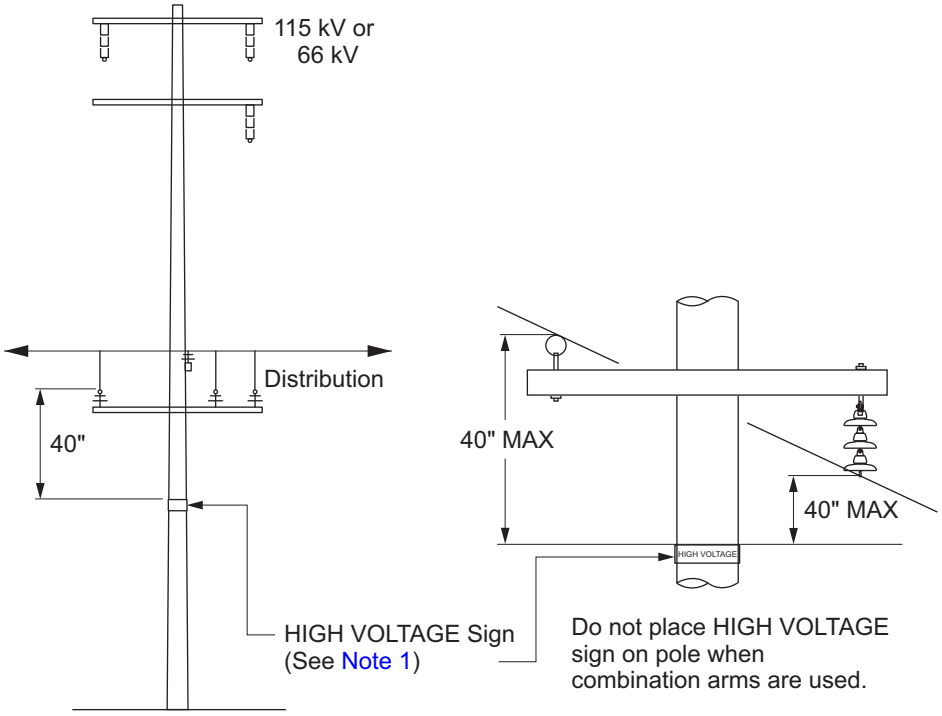
Poles or crossarms shall be marked with approved HIGH VOLTAGE signs. Wherever possible, HIGH VOLTAGE signs shall be placed on the pole at the lowest level of line conductors energized in excess of 750 V, which indicates that all circuits above that level are HIGH VOLTAGE. No additional HIGH VOLTAGE signs 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 120–14: 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.

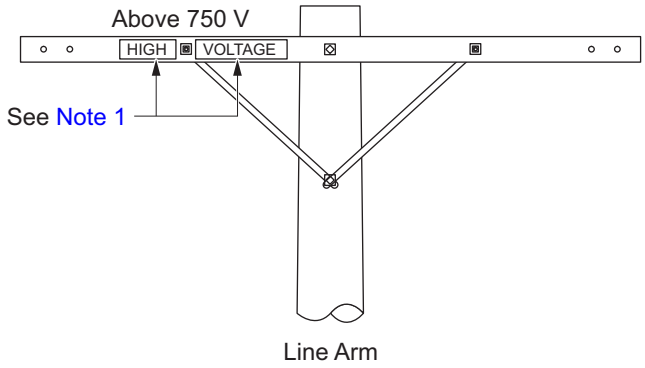
3.2 Fiberglass and Steel Poles — The standard location for marking fiberglass and steel poles is on the pole. Use the HIGH VOLTAGE sign (SAP 10135407) with yellow letters on black background with adhesive material. Wipe the pole surface with a clean rag before applying. HIGH VOLTAGE signs approximately 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 120–15: 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 120–16: Alternate HIGH VOLTAGE Sign Installation on Crossarm

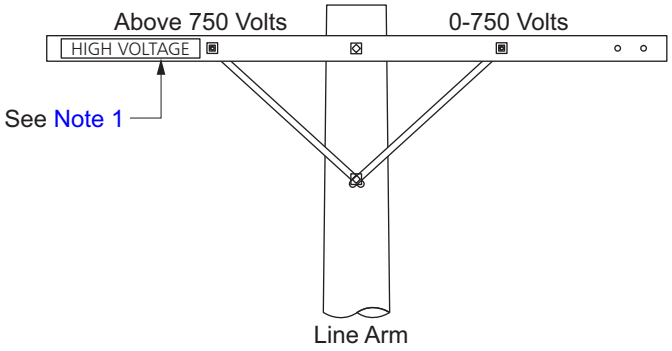


Note(s):

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 120–17: HIGH VOLTAGE Sign Installation on Combination Arm



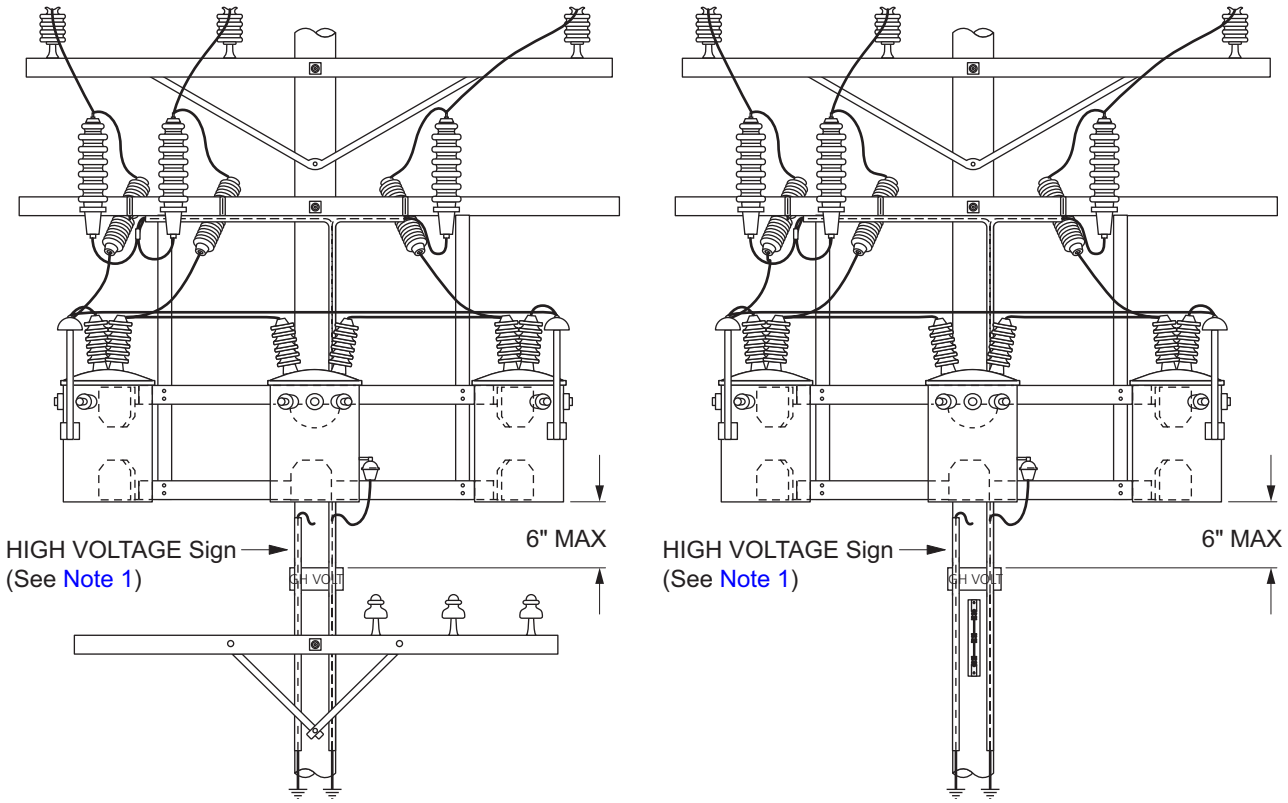
Note(s):

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 120–18: Standard HIGH VOLTAGE Sign Installation Below Equipment



Note(s):

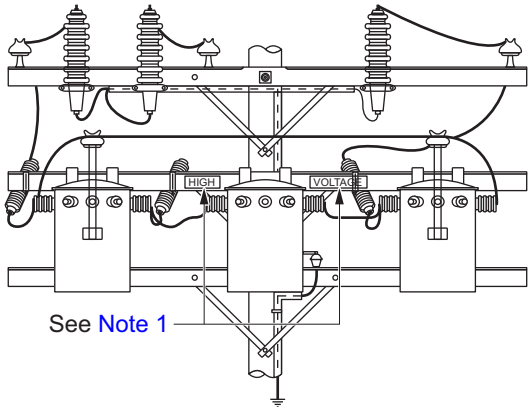
1. For new construction, High Signs can be installed on poles or arms. When replacing deteriorated High Signs, consider installing on pole so encroachment on energized equipment is not required.

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 120–19: Alternate HIGH VOLTAGE Sign on Hanger Arm



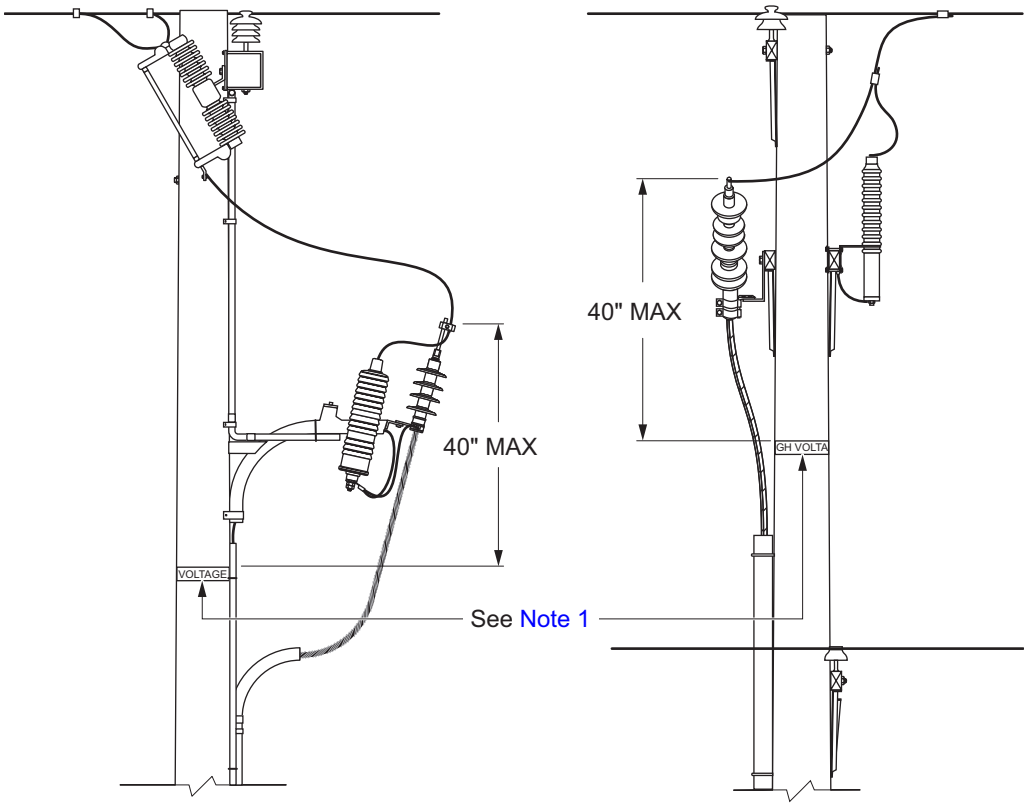
Note(s):

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 120–20: HIGH VOLTAGE Sign Installation on Riser Poles



Note(s):

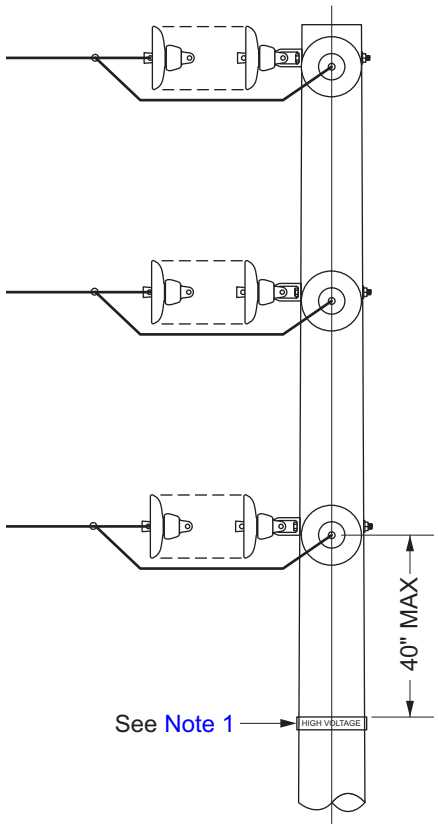
1. For new construction, High Signs can be installed on poles or arms. When replacing deteriorated High Signs, consider installing on pole so encroachment on energized equipment is not required.

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 120–21: HIGH VOLTAGE Sign Installation for Wood, Fiberglass, and Steel Pole Vertical Configuration

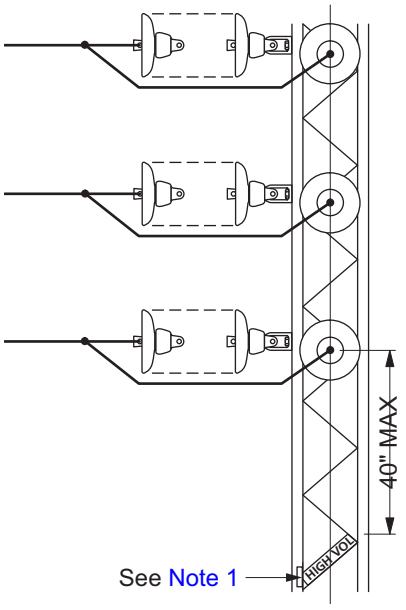


Note(s):

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 120–22: 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.

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

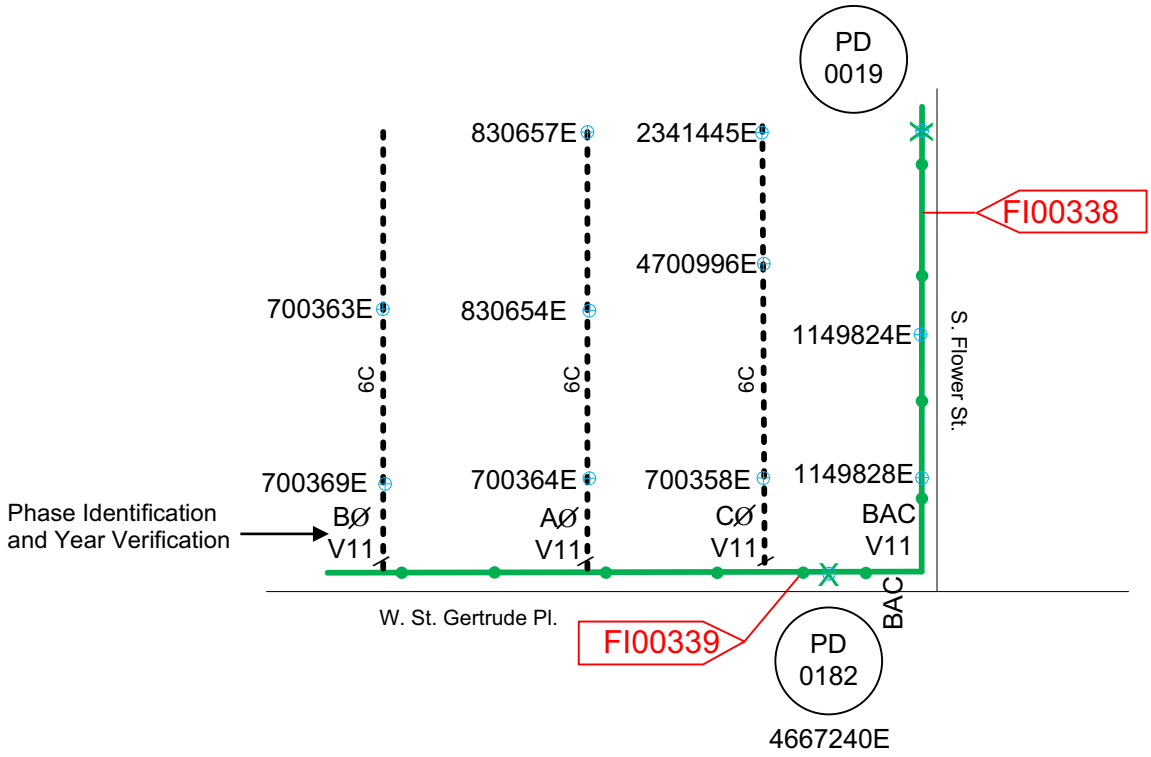


CAUTION **Whenever a pole needs to be replaced, whether it is planned, or emergency, the labels SHALL only be replaced after the Phase ID tool has been used.**

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 PO 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

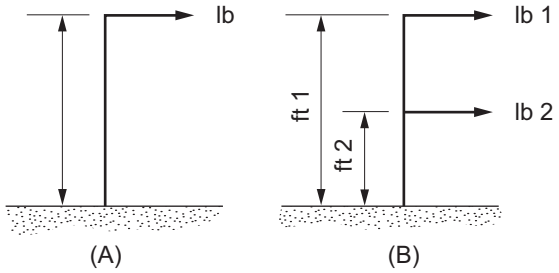
1.1 The pole key is recommended for keying wood poles used in street lighting, or as a pole reinforcement in soft soils where the load is unbalanced.

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 × 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.

1.0 Installation Instructions

1.1 Screw a 3/4-inch anchor rod into base of pole-key.

1.2 Drop the pole-key into hole, at base of pole, on opposite side of the applied strain (see Figure PO 130–2.1).

1.3 Expand pole-key with tamping bar into solid earth (see Figure PO 130–2.2).

1.4 The pole-key must be fully expanded to insure a maximum bearing surface.

1.5 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

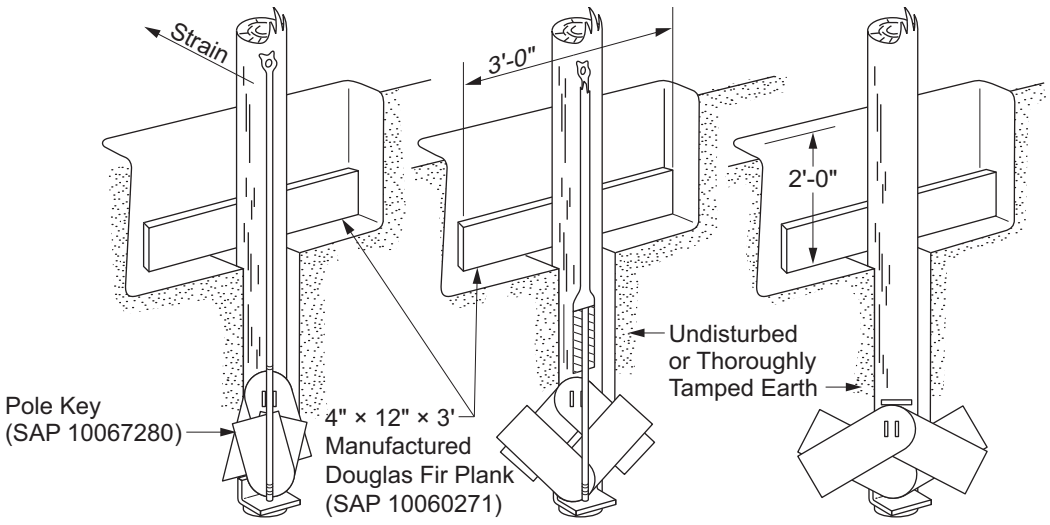


Figure PO 130–2.1 **Figure PO 130–2.2** **Figure PO 130–2.3**

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, see 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.

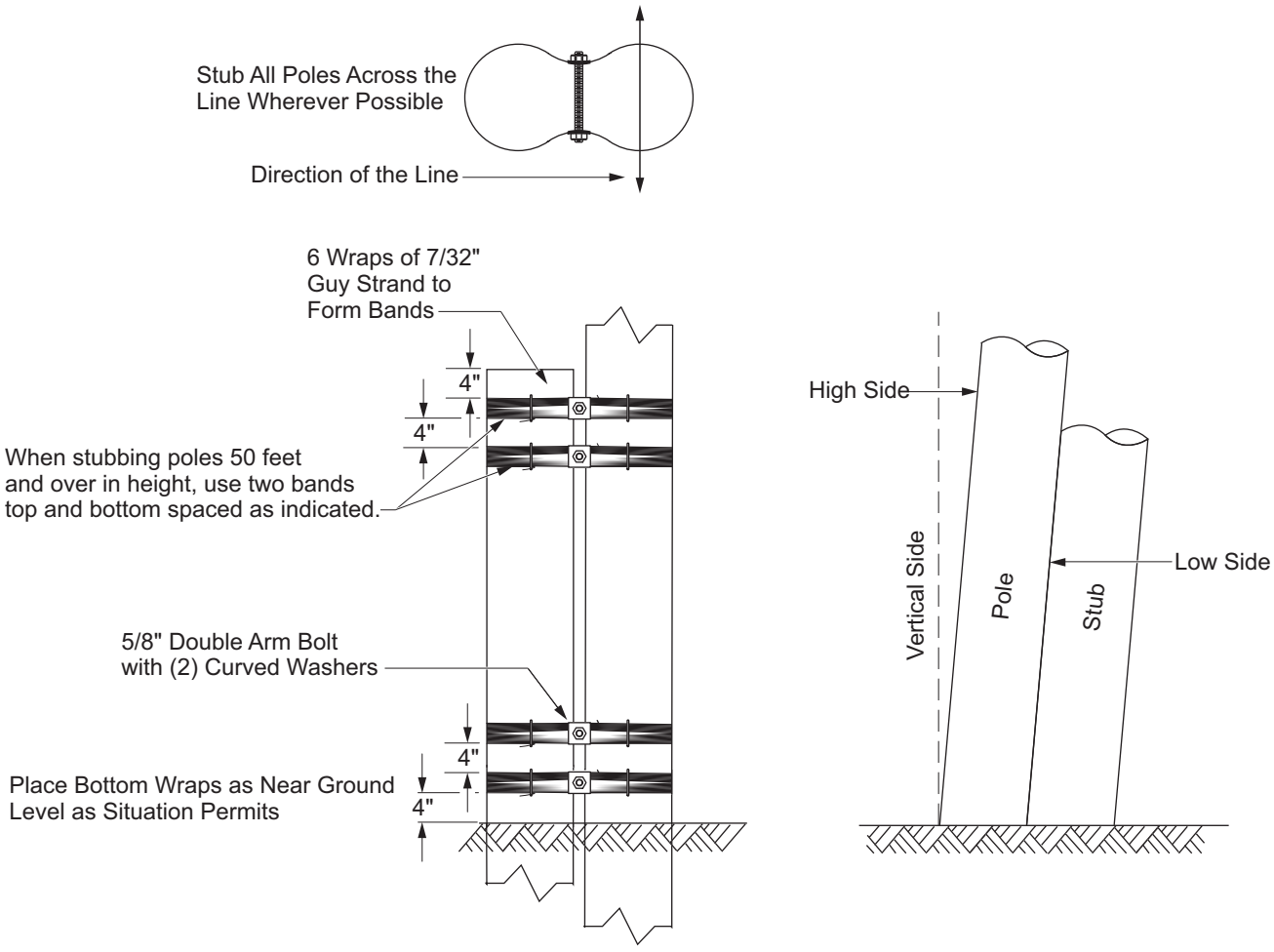
2.4 Use wood stub lengths as tabulated below:

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

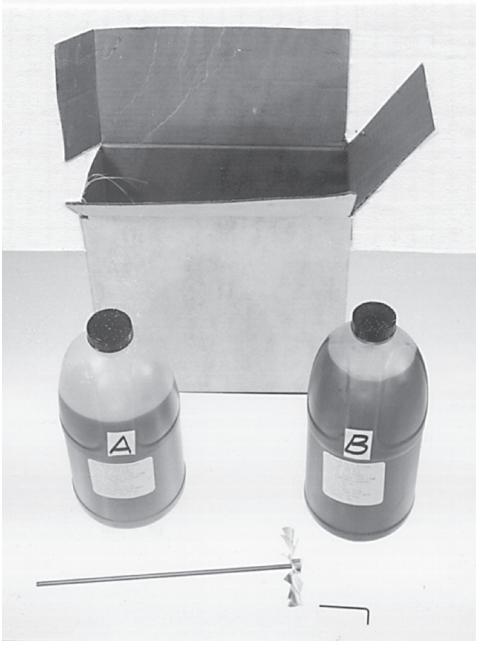
1.0 Directions

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.)

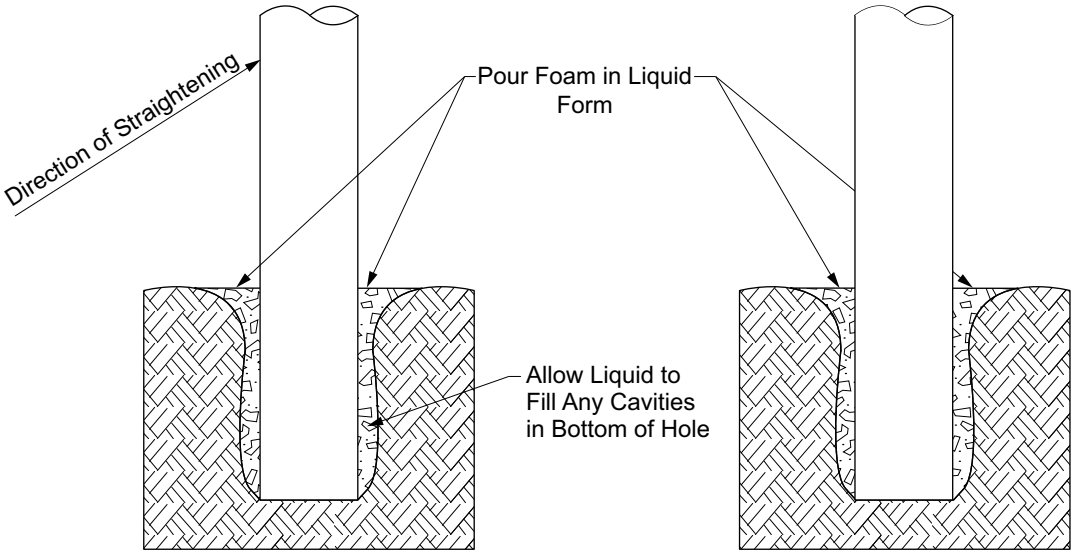
1.3 Pour chemical into hole while still in liquid state. Wait approximately 10 minutes for foam to set up before adding more compound.

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):

1. 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.

PILOT

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.

PILOT

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.

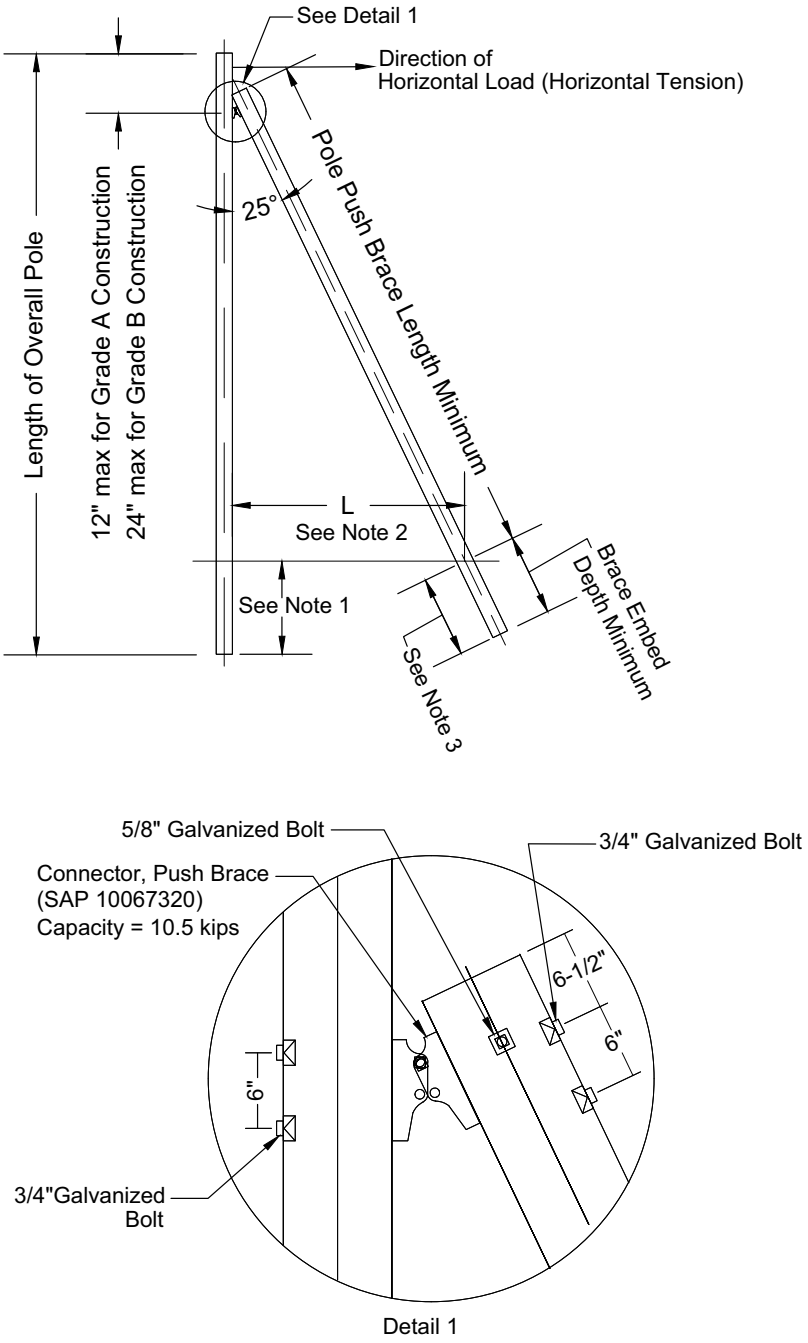
PO 142 Pole Push Brace

Scope PO 142.1 Method of Installing a Push Brace

Push brace shall be used when conventional guying is not adequate or feasible for wood poles. Conventional guying is preferred method before a push pole shall be considered. Pole load calculation and intrusive inspection is required prior to installation.

See Figure PO 142–2 for the pole push brace configuration and parameters use the Length of Overall Pole from Table PO 142–2 to determine the required minimum embed depth for the brace. With the brace embed depth minimum identified, refer to Table PO 142–3 to find the maximum horizontal force based on the pole class that the primary lines may experience with the given pole push brace. Note that this value represents the maximum total allowable horizontal tension, which is the sum of all unbalanced conductor tension for guying from primary lines.

Figure PO 142–1: Pole Push Brace



Note(s):

1. 10% of overall length of line pole + 2’ - See PO 100.
2. L per Table PO 142-2 may be ±1’.
3. See Table PO 142-2 for Line Pole and Brace Pole dimensions.

Table PO 142–1: Soil Class Descriptions

Soil Type	Description
A	Very dense sandy soil, gravel and cobbles, and soft rock. Soft rock can be identified based on site topography, such as mountain regions and hillsides. Hardpan.
B	Dense sandy soil, sand greater than 50%, or still silts and clay. Well compacted sandy soil with visible grains, typically coarse grained, often gravel and large rocks are present.
C	Medium dense, sandy soil or firm silts and clay. Soil contains a mixture of sand and clay. Sand grains are small that are barely visible. Soil moisture is medium to high.
D	Soft or loose soil consisting of clay. Clay is relatively plastic and can easily roll in hands. Soil moisture is high. Organic soil (black thin layers of soil with distinct odor) can be present.

Table PO 142–2: Line Pole and Brace Pole Length and Embedment Depth

Overall Length of Line Pole	Overall Length of Brace Pole	L (ft)	Minimum Brace Pole Emdement Depth (ft)
35	45	14	5'–6"
40	50	16	5'–6"
45	55	18	5'–6"
50	60	20	6'–0"
55	65	22	6'–0"
60	70	24	6'–0"
65	80	26	6'–6"
70	85	28	6'–6"

Table PO 142–3: Brace Pole Embed Depth/Class and Allowable Horizontal Tension Per Soil Type

Brace Embed Depth Minimum (ft)	Brace Pole Class	Allowable Horizontal Tension Per Soil Type (lb)			
		A / 1&2	B / 3&4	C / 5&6	D / 7&8
5'–6"	1	1030	2870	1480	630
6'–0"	H1	5400	3840	1990	850
6'–6"	H3	7400	4980	2590	1130

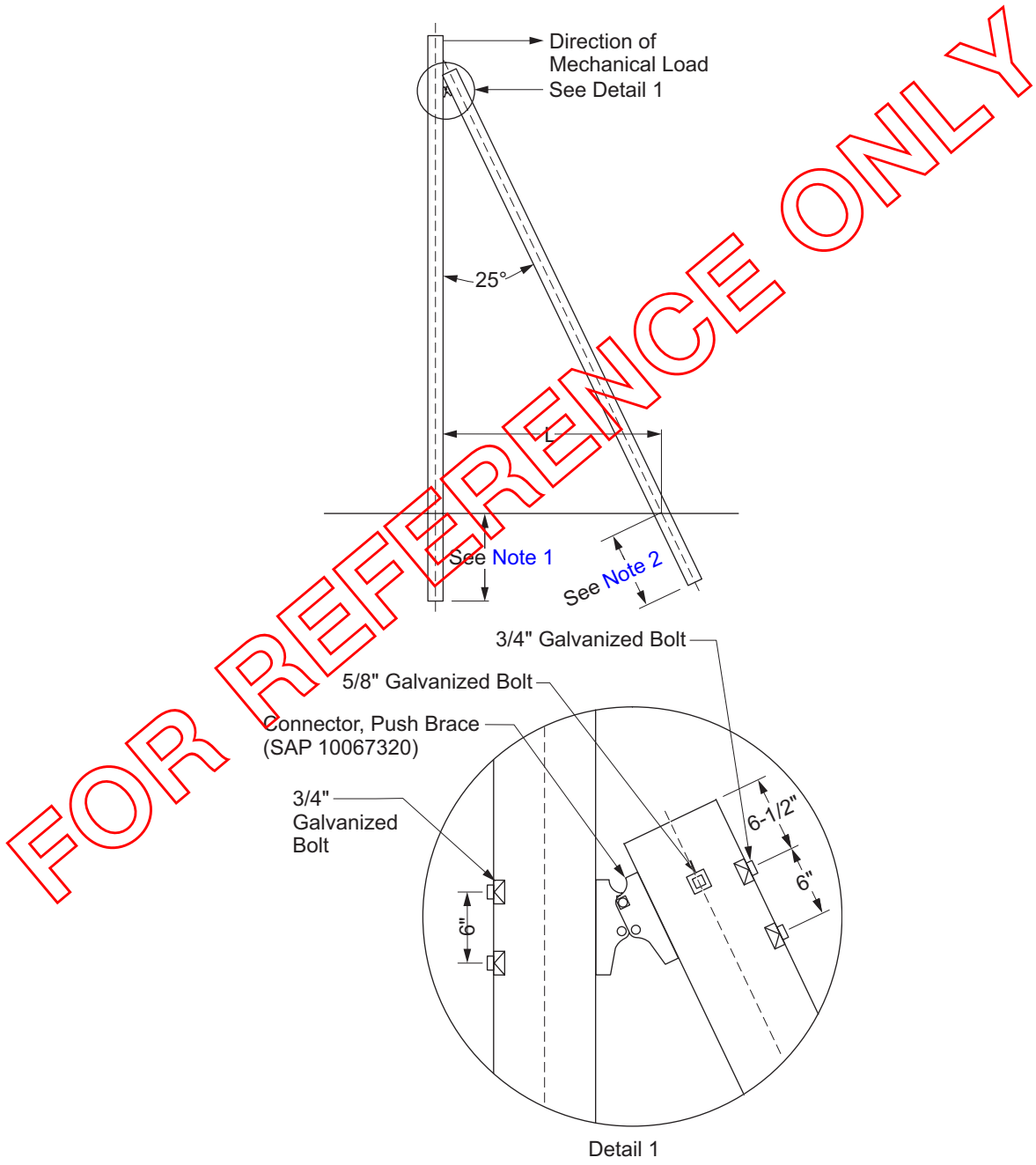
Table PO 142–4: Allowable Horizontal Tension (lb)

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

FOR REFERENCE ONLY

Figure PO 142–2: Push Brace



FOR REFERENCE ONLY

Note(s):

1. Line Pole Depth (LPD)—See PO 100.
2. Brace Pole Depth (BPD)

This page intentionally left blank.

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

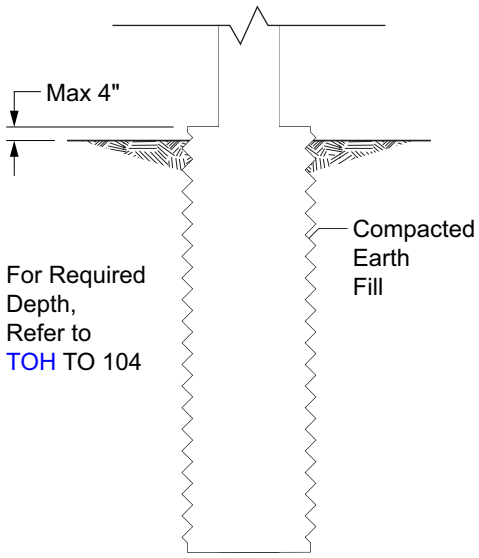
- Use Sono tubes in stable soil when setting poles with helicopters. Refer to DOM MO-4 Helicopter Pole Setting.

  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.

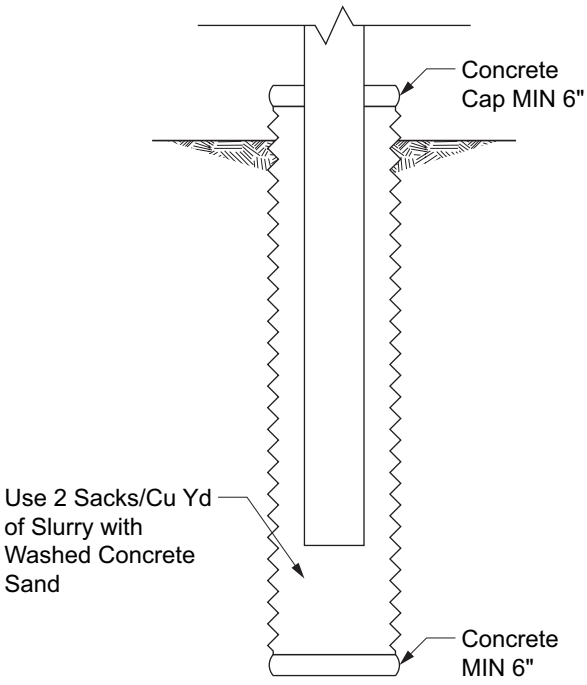
1.2 Grounding

Caissons shall not be used as a ground. Temporary ground rods shall be outside the caisson.

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.

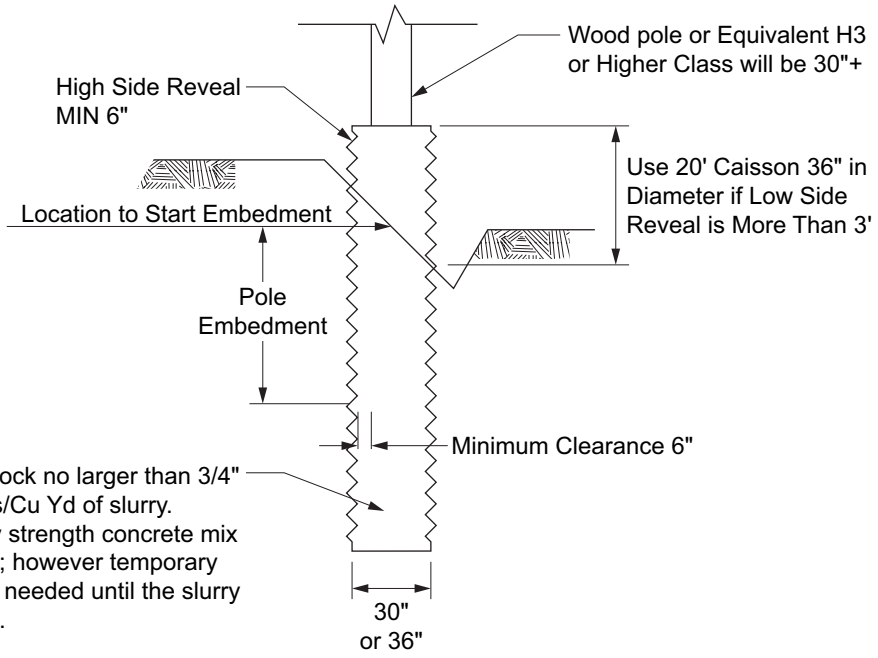
The caisson high side reveal shall be greater than 6 inches and the top of the caisson shall be higher than the highest expected water level in the ditch. If a high side reveal of more than 18 inches is required, contact Transmission Engineering.

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



This page intentionally left blank.

PO 144P Pole Cushion for Vehicle Hit Wood Poles Pilot

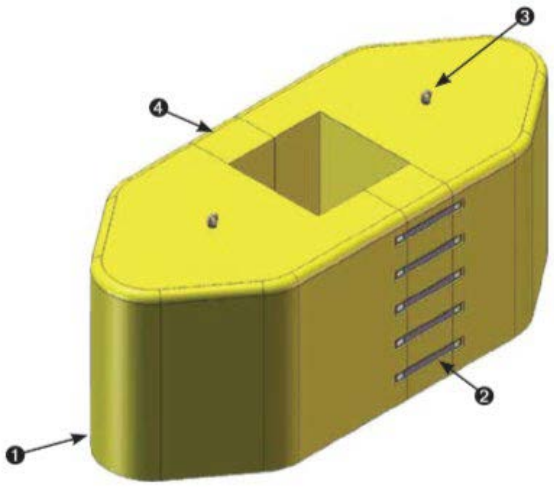
Scope PO 144P.1 Pole Cushion for Vehicle Hit Wood Poles Pilot

1.0 General Information

A Pole Cushion system consists of a 2-piece High-Density Polyethylene (HDPE) shell that can be installed around a wood pole. Pole Cushions are intended to promote public safety and mitigate against outages caused by repeated vehicle strikes. This standard will guide field personnel on the construction of Pole Cushions around distribution wood poles that have the following configurations: Bare pole, Fire Resistant (FR) wrap wood pole, pole with existing equipment (e.g. transformer, switch, or fuseholder), pole with third party attachment(s) and guy stub pole. Six (6) Pole Cushions will be piloted in the Redland district. Poles scoped for Pole Cushion installations will be determined by Enterprise Resource Management (ERM).

PILOT

Figure PO 144P–1: Pole Cushion RAPTOR™ 600



1. HDPE Shell
2. Galvanized Steel Connector
3. Integrated Lifting Point
4. HDPE Packer

Note(s):

1. Total weight of Pole Cushion system: 538 lbs. Refer to the Rigging Manual for proper rigging techniques.
2. Pole Cushion system overall dimension: 9’1” L x 3’9” W x 3’5” H.
3. Pole Cushion inside opening dimension: 24” L x 23” W.
4. Bill of Material: 2 x Shells, 2 x Packers, 10 x 430mm galvanized steel connectors and 20 x Fixings.

2.0 Pole Cushion Around Wood Pole Installation Guidelines

2.1 Pole Cushions will be installed on flat, compact, level ground. Contact Structures Asset Engineering for guidance if the Pole Cushion is to be installed on a curb or slope.

2.2 Install Pole Cushion tangent or parallel to the direction vehicles are travelling.

2.3 Use lifting equipment to install the two shells.

Note: The shell orientation will be parallel to the direction of traffic flow. Use pry bar to position the shells.

2.4 Use a 2-ton rachet tie down (or similar), bull the two shells tightly together and align vertically using a pry bar.

2.5 Install connector bars using hex head bolts and washers.

2.6 Tighten all bolts and remove the ratchet tie down.

2.7 Pole Cushions will incorporate delineation labels compliant with the requirements of the applicable local transportation agency.

PILOT

3.0 Inspection and Maintenance of the Pole Cushion

The pole cushion is maintenance free. Periodic visual inspection should be conducted to ensure that the pole cushion stays securely attached without physical damage.

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

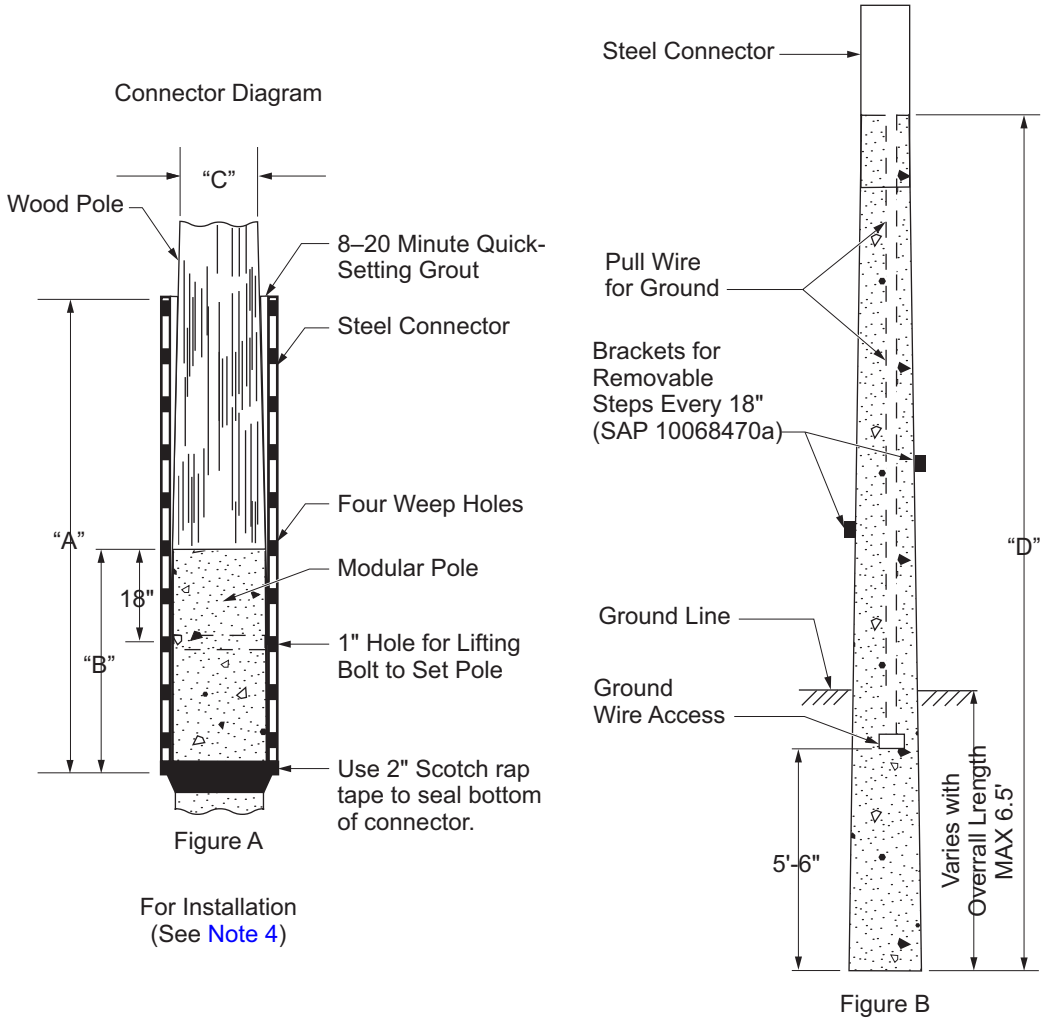


Table PO 145–1: Modular Pole Butts

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)	Circ. (in)	9-ft or 14-ft Module		18-ft Module	
		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

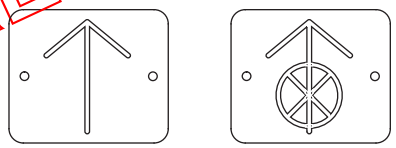
2.1 “Repol” reinforcement shall not be used under the following conditions:

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

FOR REFERENCE ONLY

This page intentionally left blank.

PO 148 Wood Pole with FR Wrap

Scope PO 148.1 Wood Pole with FR Wrap — New Construction and Rebuilds

1.0 General Information

NOTE FR Wrap is previously known as Protective Barrier.

1.1 FR Wrap Description

SCE previously installed Fire Resistant (FR) Wrap that consists of an intumescent (swelling up when heated) grid made of 23 gauge galvanized steel coated with a durable intumescent polymer. All new installation of FR Wrap on new distribution wood poles will consist of a 1/4-inch grid fiberglass mesh type which is coated with a durable intumescent polymer. The FR Wrap 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

Refer to APM Rule 209 for working in elevated positions on poles.

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 insulated staples (SAP 10221642) with staple gun (SAP 10221641) or 1-3/4" 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 insulated staples (SAP 10221642) or 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 pre-wrapped wood pole will be used on new construction and rebuilds (Refer to DDS-10, Figure 10-2 for details). 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

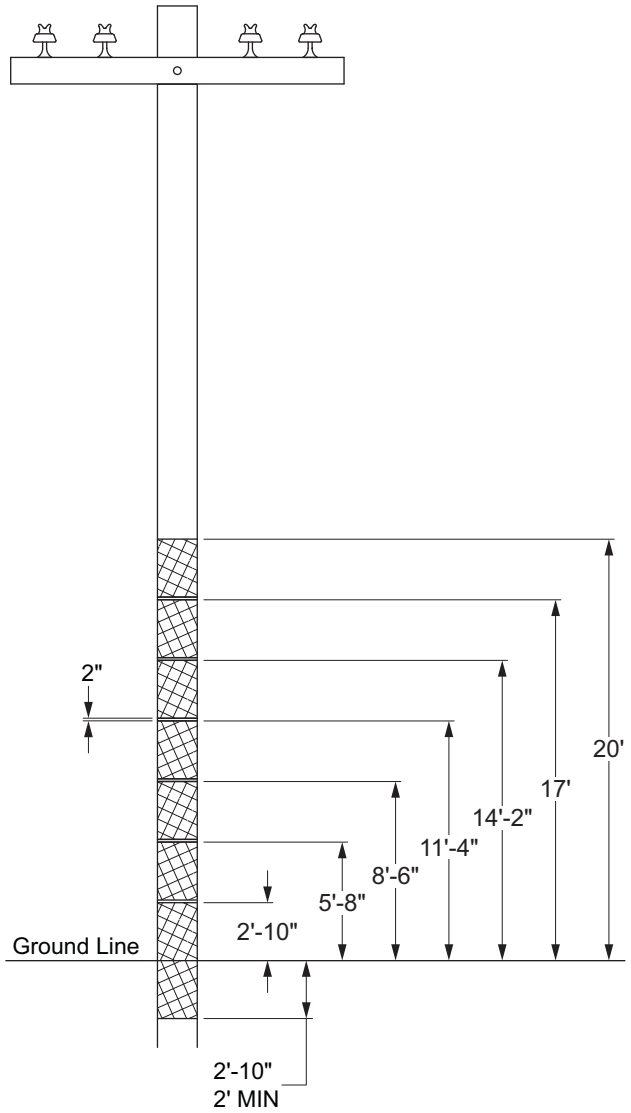


Table 148–1: Dimensions, Weights, and SAP # for Wood Poles with FR Wrap

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)			SAP
					Douglas Fir	FR Wrap	Douglas Fir with FR Wrap	
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 148–1 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 New and In-Service Wood Poles with FR Wrap

A. During installations, 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 New Wood Poles with 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) insulated staples (SAP 10221642) with staple gun (SAP 10221641) or 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 and Removal of FR Wrap

6.1 In-Service 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. Refer to Section 4.1 for FR Wrap Inspection Criteria.

6.2 Inspection and Removal of Activated FR Wrap

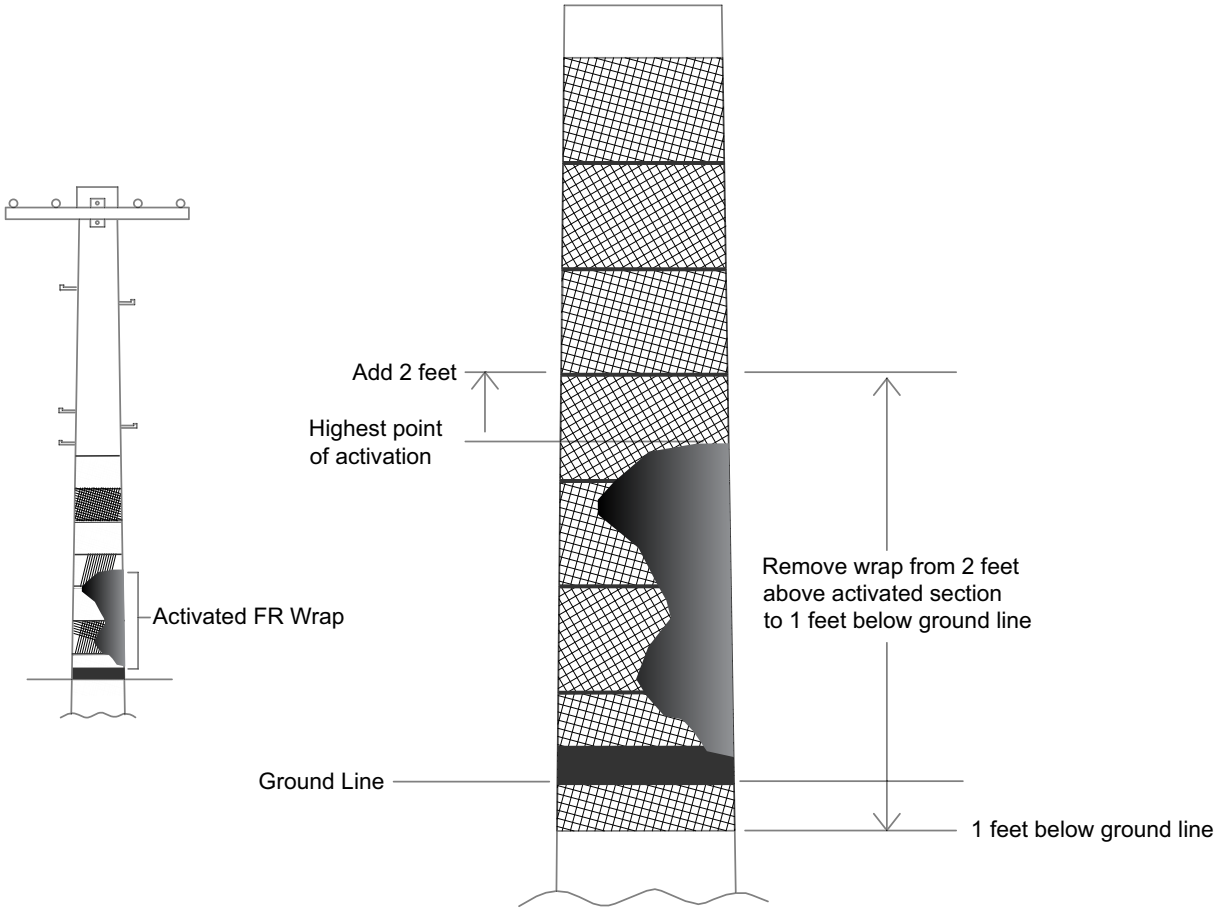
When the FR Wrap has been activated due to a fire, an inspection of the wrap shall be performed. The inspection is to assess the condition of the intumescent polymer to see if it has been activated (swelled-up creating the barrier).

If the FR Wrap has been activated (see Figure PO 148–2), remove the activated FR Wrap by cutting the mesh vertically without damaging the non-activated portion of FR Wrap. Then remove the activated FR Wrap by pulling it from the pole through the staples. Staples can be removed or hammered in flush to the wood pole. Install a new FR Wrap (see DOH PO 148.2, Section 3.0) if the pole is in good condition (see DIMP CG-1). If the two layers of the FR Wrap have been activated and the pole is in good condition (see DIMP CG-1), it should be replaced from 2-feet above the highest activated portion to 1-foot below ground line (see Figure PO 148–3).

Figure PO 148–2: Activated FR Wrap



Figure PO 148–3: Remove Activated FR Wrap from Pole



7.0 Disposal of FR Wrap

7.1 General Requirement:

Removed FR Wrap from wood poles may be characteristic of regulated hazardous waste and must be handled and disposed of in compliance with all applicable laws, regulations, and SCE policies. SCE Personnel who remove FR Wrap must complete Hazardous Waste Training shown on SCE's Portal page prior to performing FR wrap removal.

Scenario 1: Large Volume Removal

Large segments/volumes of removed FR wrap are those requiring containers larger than 55 gallons in capacity (e.g., cubic yard boxes, bins) for proper storage, transport, and disposal. If large segments or volumes of FR wrap are removed, call 844-GOT-SPIL to request and coordinate bin drop-off and disposal services.

Scenario 2: Small Volume Removal

Small segments/volumes of removed FR wrap are those that can be stored in containers of 55 gallons or less, without requiring oversized containers. Containerize small segments of removed FR wrap in closed 55-gallon drums or smaller containers.

- Mark the drums as "FR Wrap Pending Analysis".
- Return the drums of FR wrap to the appropriate District Service Center.
- Upon arrival, deliver drums to the Service Center's central waste accumulation area located in the yard.
- Notify the Service Center's Regional Environmental Advisor (REA) to initiate processing. To identify your REA, refer to the REA Job Aid.

Scenario 3: FR Wrap Attached to Wood Pole

If FR wrap remains attached and adhered to the wood pole during pole a replacement, the FR wrap may be disposed of using SCE's treated wood bin service request. Ensure the FR wrap is not removed prior to disposal.

PO 148.2 FR Wrap In-Service Wood Poles

1.0 General Information

The Fire Resistant (FR) wrap is an intumescent (swelling up when heated) fiberglass mesh grid 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.

Structures identified for the FR Wrap Expanded Deployment Program as defined in the WMP shall have FR Wrap installed on in-service wood poles with existing covered conductor located in Severe Risk Areas (SRAs) where TUG is not an option.

In-service wood poles scoped for in-field wrap per the FR Wrap Expanded Deployment Program can have equipment mounted on the pole.

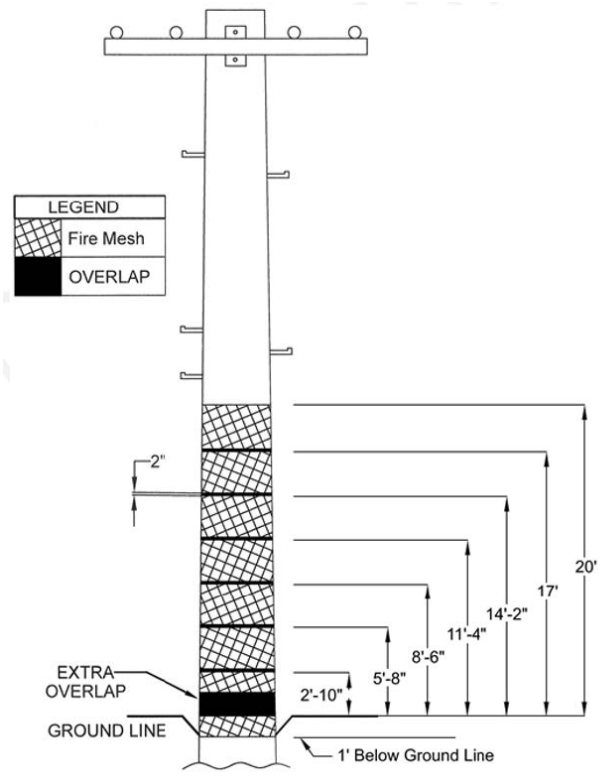
Note: ***FR Wrap can also be installed on in-service wood poles to support fire restoration.***

The FR wrap will be installed in a sequence of overlapping layers beginning at a height of 20 feet above ground level with each 3 feet wide section overlapping the previous section by 4 inches (See Figure PO 148-4). At the bottom, the lowest layer will be installed 12 inches below ground level with the excess overlapping the previous layer.

Note(s):

1. Digging or excavating around the base of the pole is a ground disturbing activity that requires an Environmental review. Complete and submit the Environmental Screening Form as shown in the Environmental page on portal prior to digging or excavating.
2. Contact Dig Alert (811) 48 hours prior to excavating.

Figure PO 148–4: Typical Fire Wrap on In-Service Wood Utility Pole



2.0 Material

FR Wrap Mesh Roll (3 feet Wide by 50 feet Length) SAP 10221593

Note: ***While on average usage per pole is approximately 1.5 rolls per pole, it is recommended to allocate 3 rolls per pole to ensure complete coverage. This allowance accounts for variations in pole size, as well as potential overlap and material waste during installation.***

Patch Kit - SAP 10215190

Insulated Staples - SAP 10221642

Battery Powered Stapler - SAP 10221641

3.0 FR Wrap In-Service Wood Pole Installation Instructions

3.1 General Instructions

STEP 1. Perform routine inspection of the wood pole and verify the pole is in good condition. Refer to DIMP CG-1 for visual inspection of wood poles.

STEP 2. If staples are present, remove or make flush by hammering in.

STEP 3. Remove the pole number, tags, equipment number and visibility strips from the pole.

STEP 4. If conduits are present, remove straps to enable installation of FR Wrap between conduit and pole.

STEP 5. Material preparation:

STEP 5.1 Measure the groundline circumference of the pole at ground line. Refer to PLM-4 for measuring ground line circumference.

STEP 5.2 Then add 2 inches to accommodate for an overlap on the seam.Length of FR Wrap section = groundline circumference + 4 inches.

STEP 5.3 Use the calculated measurement from the previous step to measure and cut the required quantity (approximately 16) of sections of FR Wrap. See Figure 148-5.

Figure PO 148–5: Measuring Sections of FR Wrap



STEP 6. Mark pole at 20 foot above ground level.

STEP 7. Remove bond molding if present.

STEP 8. Beginning wrapping the pole starting at the 20-foot level mark. The FR wrap must be positioned and wrapped beginning at this mark.

STEP 9. Two layers of FR wrap will be installed on the pole. Refer to Section 3.2A and Section 3.2B for installation of the first two layers of the FR Wrap.

STEP 10. Install subsequent layers of the FR Wrap as outlined in Section 3.2C until the FR wrap is wrapped 1 foot below the ground.

STEP 11. Cut the mesh around any hardware, making sure that the gap between the hardware and the mesh is no greater than ½ inch.

STEP 12. If bond molding is present, remove the bond molding and then pull the #4 bare copper from the pole to 18” below ground level while leaving enough intact #4 bare copper to splice on a piece of #4 copper PGW. Refer to Step 3.3 for splicing bare copper with PGW procedure.

STEP 13. Re-install ground molding (PGW) in-service wood poles with Bare #4 copper will be spliced with PGW per Step 3.3. Avoid contact between bare ground wires and the FR wrap. This can be achieved by replacing with PGW or placing the ground wire in a conduit.

STEP 14. Dig at pole base and install final section of Fire Wrap as outlined in Section 3.3.

Note: ***Complete and submit and complete the Environmental Screening Form as shown in the Environmental page on Portal prior to digging or excavating.***

STEP 15. Backfill around the pole to ground level.

STEP 16. Re-install the pole number, tags, equipment number and vis-strips in the same location on the pole prior to installing the FR wrap.

STEP 17. Provide access to medallion as outlined in Section 3.4.

3.2 Installing FR Wrap

A. First Layer of FR Wrap

STEP 1. Install the first section of FR Wrap so that top edge aligns with 20 foot mark on the pole.

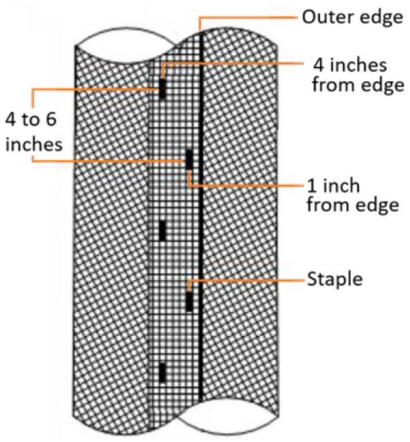
STEP 2. Install staples along the vertical edge ½ inch in from the end of the FR Wrap to secure in place.

STEP 3. Wrap FR Wrap tightly around the pole.

STEP 4. Staple the vertical overlapping section of FR Wrap using an alternating pattern. See Figure PO 148–6.

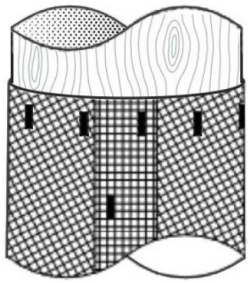
STEP 5. Cut the mesh around any hardware, making sure that the gap between the hardware and the mesh is no greater than ½ inch.

Figure PO 148–6: Staple Vertical Overlapping Section



STEP 6. Staple the top edge of the first section of the FR Wrap. Staples can be oriented vertically or horizontally (See Figure PO 148–7). Place staples 4 inches to 6 inches apart.

Figure PO 148–7: Staple Top Edge of First Section



B. Second Layer of FR Wrap

STEP 7. Install the second layer so that the vertical edge is offset from the starting point of the first layer by at least 6 inches.

STEP 8. Wrap the second layer around the pole in the opposite direction of the first layer.

STEP 9. Follow the same staple pattern as used for the first layer.

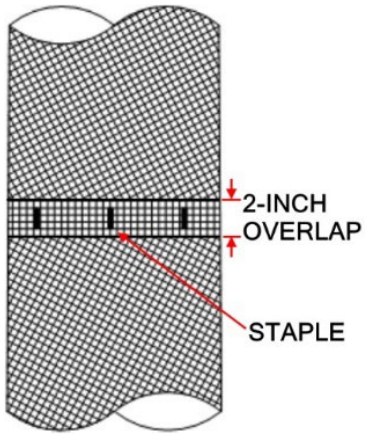
C. Subsequent Layers of FR Wrap

STEP 10. Install the next layer of FR Wrap with not less than a 2-inch overlap over the previously installed layer.

STEP 11. Continue the installation of this layer using the steps shown in Section 3.2A.

STEP 12. Staple the horizontal overlapped layer with the staples aligned vertically, and spaced 4 inches to 6 inches apart. See Figure PO 148–8.

Figure PO 148–8: FR Wrap Horizontal Overlap Section



STEP 13. Install the second layer of FR Wrap offset from the starting position of the first layer.

STEP 14. Wrap the second layer of FR Wrap in the opposite direction of the first layer.

STEP 15. Follow the same staple pattern as shown in Section 3.2A.

STEP 16. Repeat the steps outlined Section 3.2A and Section 3.2B for all methods of accessing the pole (e.g. bucket, on pole, or on the ground) until the wrap is near the ground level.

D. Final Layer of FR Wrap

STEP 17. Dig or excavate around the base of the pole to a depth that will permit the FR Wrap to be installed 12 inches below the ground level. For spliced bare copper with PGW, excavate an additional 6 inches below the fire wrap for a total of 18 inches below ground level.

STEP 18. The bottom edge of the final section of the FR Wrap must be installed in the excavated area at the base of the pole at 12 inches below ground level. For spliced bare copper with PGW, the excavated areas at the base of the pole must be 18 inches below ground level.

STEP 19. The remaining 2 feet of this section of FR Wrap will overlap the last section that was installed on the pole.

STEP 20. Final layer: Follow the steps outlined in Sections 3.2A and 3.2B for the installation of the two layers of FR Wrap.

3.3 Re-installation of Pole Ground (if present)

Note: ***Bare copper will not be in contact with FR Wrap. This can be achieved by replacing with PGW or placing the ground in a conduit.***

STEP 1. At the location of the pole ground, excavate to a depth of 18 inches below ground level for the PVC conduit to be installed.

STEP 2. Install the bare ground in a 10-foot section of 1-inch PVC conduit.

STEP 3. The bottom end of the PVC will sit 18 inches below ground level with the bare copper ground conductor.

STEP 4. At the top end of the PVC, cut the bare ground approximately 12 to 18 inches from the end of hte conduit. The #4 PGW splice to #4 bare copper will be concealed within the 3-foot section of PVC conduit.

STEP 5. Strip one end of the PGW and feed the stripped end of the PGW through the 3-foot section of PVC. Splice the PGW and bare copper.

STEP 6. Connect the 3-foot section of PVC conduit to the top end of the 10-foot section of PVC conduit.

STEP 7. Place the bottom end of the PVC conduit 18 inches below ground level. Secure the PVC conduit to the pole.

3.4 Access to Medallion

STEP 1. Two cuts will be made in the FR Wrap, one vertical and one horizontal, to allow a section of the wrap to be folded back (See Figure PO 148–9).

STEP 2. A staple will be placed in one corner to keep the FR Wrap in place. (See Figure PO 148–10).

Figure PO 148–9:
Cut Mesh for Medallion Access



Figure PO 148–10:
Staple Mesh to Secure FR Wrap



4.0 Inspection and Maintenance of FR Wrap

For in-service inspection and maintenance, see PO 148-1 Section 4.0 and Section 6.0.

For inspection and removal of activated FR Wrap, see PO 148-1, Section 6.0.

5.0 Disposal of FR Wrap

Refer to PO 148.1 Section 7.0 for disposal procedures of the FR Wrap.

PO 150 Pole Top Extensions

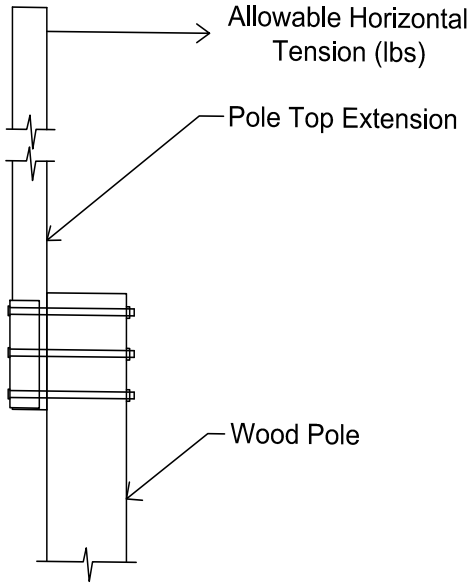
Scope PO 150.1 Applications for Pole Top Extensions

1.0 Wood 5-Foot and 7-Foot Extensions

The wood pole top extension (PTX) is composed of a galvanized bracket with square block wood extension. The extension sizes consist of two sizes, 5-Foot and 7-Foot lengths. The following table lists the maximum horizontal loading and SAP numbers:

Figure PO 150–1: Wood 5-Foot and 7-Foot Extensions

Extension Size	Allowable Horizontal Tension (lbs)	SAP
5-Foot	1300	10224249
7-Foot	1100	10224281



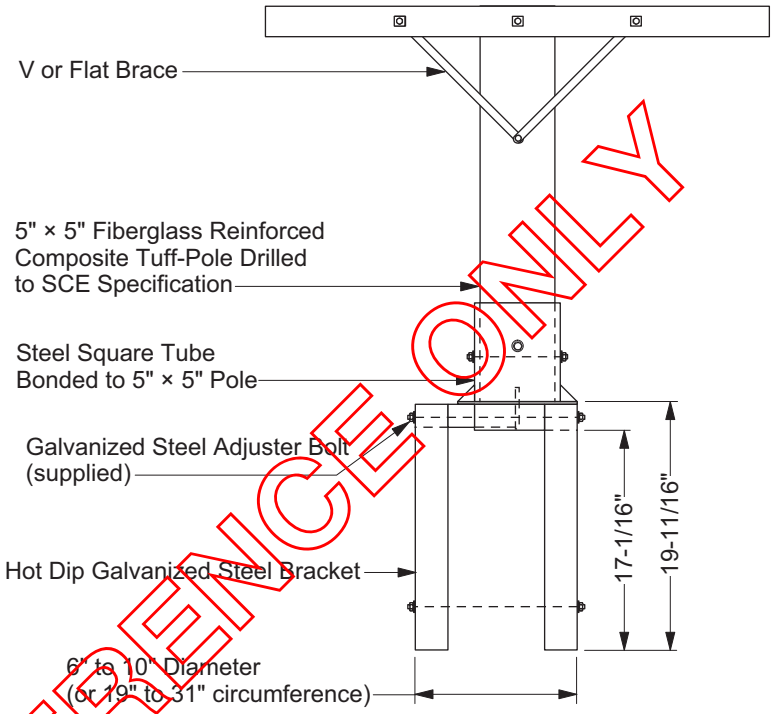
Note(s):

1. SCE equipment is not approved to be installed on a wood PTX. Composite fiberglass PTXs are not approved for use and PTX per Section 1 are for use for wood only. Refer to DDS-10, Section 5.2 D for information on PTXs applications.

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

FOR REFERENCE ONLY

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.

FOR REFERENCE ONLY

Figure PO 150–3: Old Pole Top Extensions

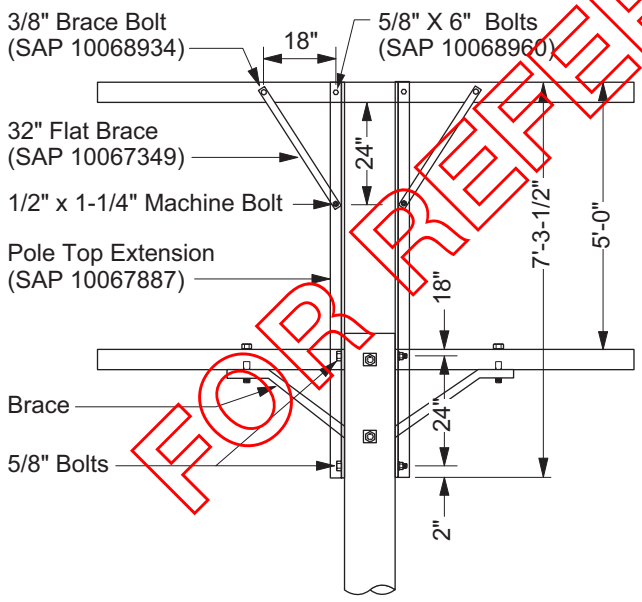


Figure PO 150–3.1

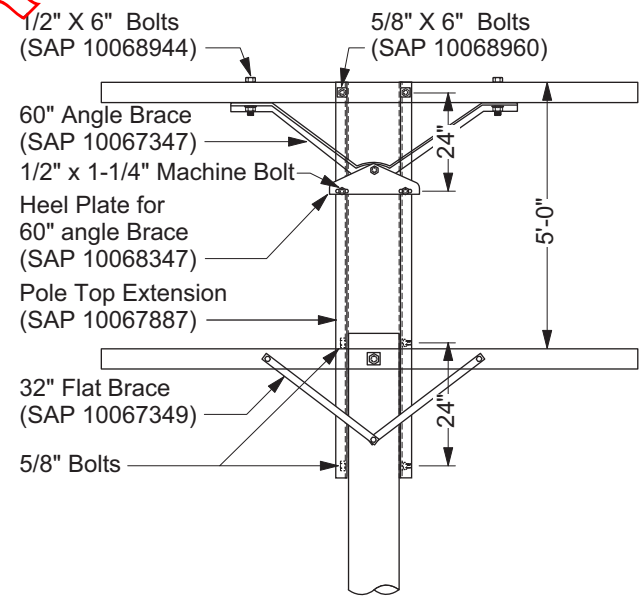


Figure PO 150–3.2

This page intentionally left blank.

PO 151P Woodpecker Wood Pole Damage Repair

Scope PO 151P.1 Woodpecker Damage Repair

1.0 Epoxy and Foam Filler

Damage along the spans of wood poles, typically caused by woodpeckers, trigger a pole replacement process for the wood pole. To mitigate the wood poles replacement with minimal damage due to wood peckers, an epoxy or foam filler may be used to repair holes due to woodpeckers until the next inspection cycle. Epoxy and foam fillers may be also used for crown and pole top decay. Once identified, cavities, starter holes, and crown damage should be filled as soon as possible to cease further deterioration and reduce the chances of additional decay.

1.1 Repair Criteria

Once a pole a pole qualifies for epoxy or foam filler repair, the pole is capable of remaining in service for 5 years or the next inspection. For additional attachments onto pole, there shall be minimum 3" of clearance from any epoxy filler applications.

A starter hole is defined as a preliminary or exploratory hole, generally early stages of damage (Figure PO 151-1). An entrance hole is a fully developed hole that typically leads to a nesting cavity (Figure PO 152-2).

The following lists are potential scenarios that may be inspected from the field from woodpecker damage. See the decision tree per Figure PO 151-3 for a more in depth layout of criteria.

Scenario 1 - If any of the items are present on wood pole, epoxy/foam fill all holes and initiate pole replacement process.

General

- There are existing wood fillers.
- The wood pole is a deadend or angled structure.

PILOT

Figure PO 151P–1: Starter Hole

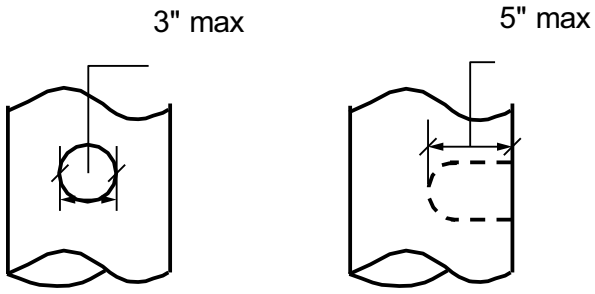
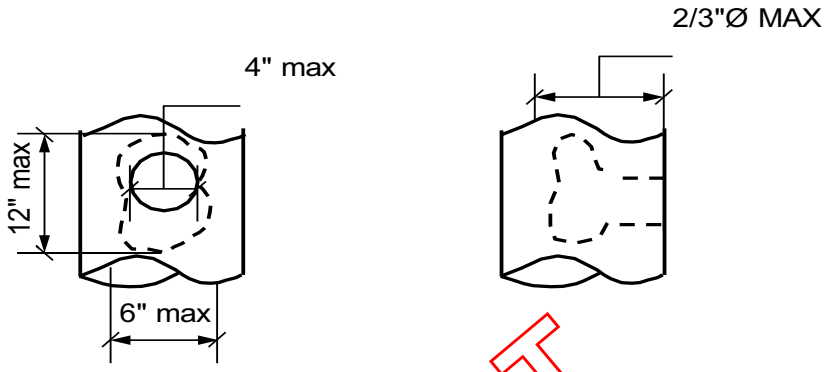


Figure PO 151P–2: Entrance Hole with Cavity



PILOT

Scenario 2 - If any of the items are deviated on wood pole, epoxy/foam fill all holes and continue/initiate pole replacement process.

A. Entrance Holes with Cavity

- Spacing of entrance holes with cavities are 3' minimum.
- Internal cavity is less than 12" high and 6" across.
- Entrance hole diameter is less than 4".
- Holes cover less than 50% of pole surface and less than 18 holes in a 3 feet section.
- There is a minimum of 6" horizontal and/or 12" vertical from critical attachments (guy fixtures, crossarm through bolts, or equipment that use a through bolt).

B. Starter Holes

- Spacing of starter holes are 1 foot minimum.
- There are 3 or less entrance holes that are maximum 3 inches in diameter and 5 inches deep in every 1 foot section.
- Starter holes are minimum 6 inch clearance from adjacent.
- There are less than 10 total holes along the pole.

C. Pole Top Crown Damage

- Damage extends less than 12 inches from top of pole.

1.2 Woodpecker Relocation

If an epoxy or foam filling is scheduled during the nesting season (March 31 to October 1), contact Environmental Services at EnvironmentalRequirements@sce.com to obtain clearance before beginning any epoxy/foam filling.

1.3 Installation and Inspections

For the installation and inspection instructions, refer to epoxy or foam filler manufacturer then job and if applicable.

1.4 Pole Steps

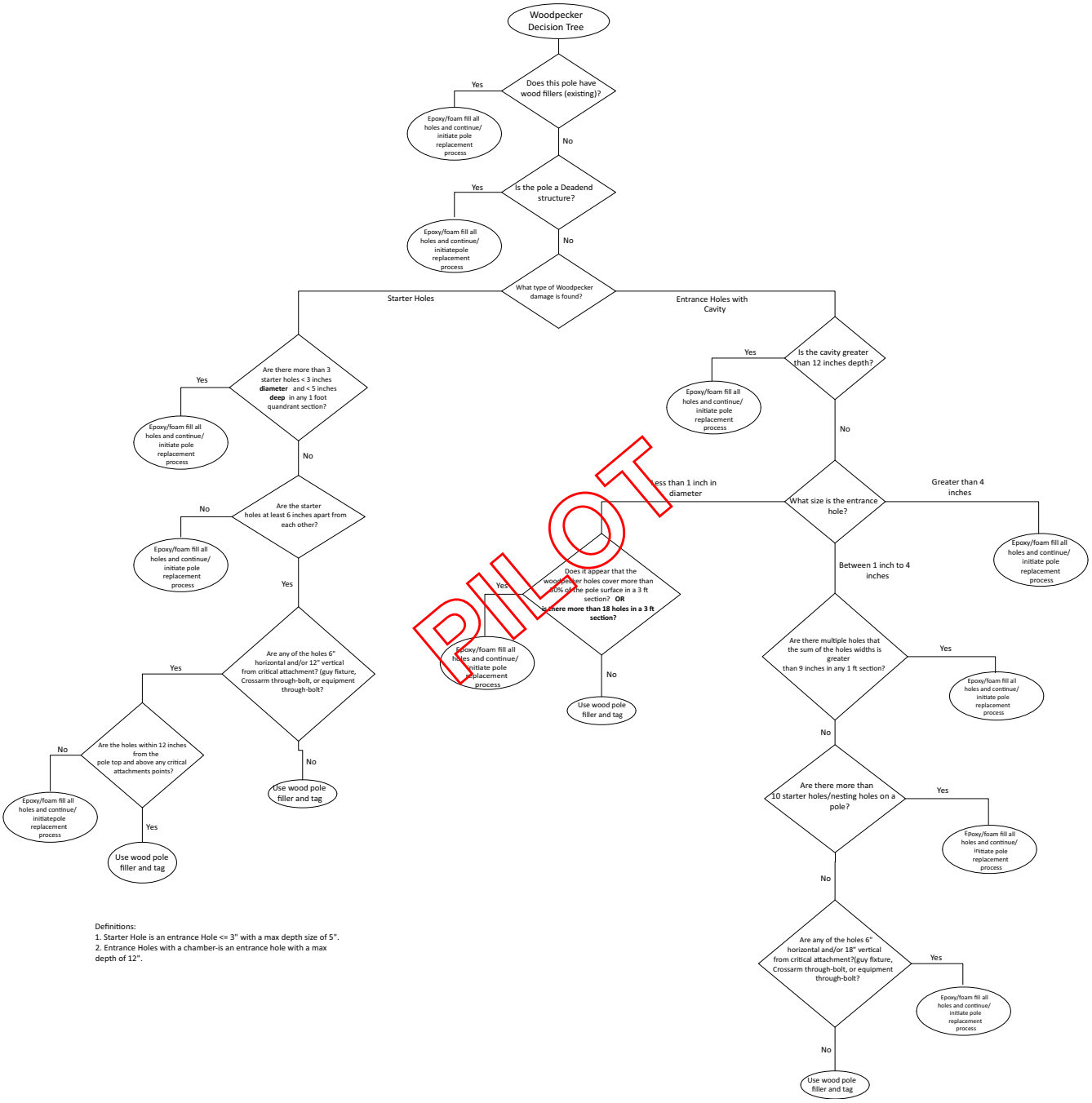
New or existing pole step placements to be installed a minimum of 12 inches from all epoxy or foam filler applications.

1.5 Material

Foam Filler Manufacturer:
Polywater (SAP 10222096)
(651) 430-2270

PILOT

Figure PO 151P–3: Woodpecker Wood Pole Damage Repair Decision Tree



Definitions:
1. Starter Hole is an entrance Hole <= 3" with a max depth size of 5".
2. Entrance Holes with a chamber-is an entrance hole with a max depth of 12".

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.

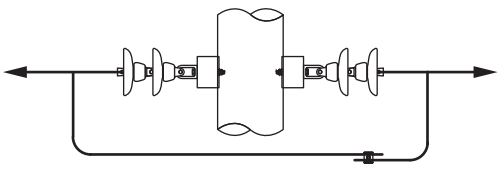
2.0 Splices

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

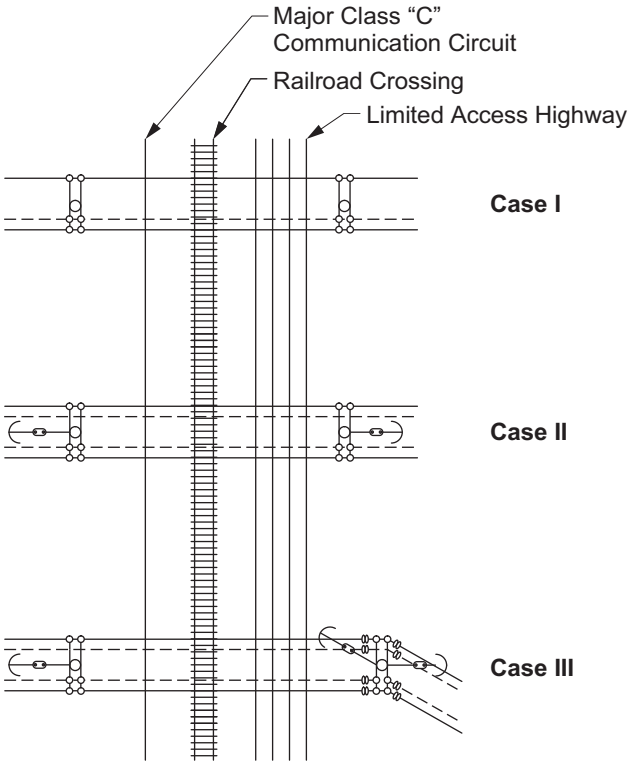
Conductor Size		Straddle Span Length (ft)	
Copper	**ACSR**	**Light Loading**	**Heavy Loading**
No. 6	No. 4[a/]	300	150
No. 4	No. 2	Normal Span Length of Line	Normal Span Length of Line
and Larger			

[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.

This page intentionally left blank.

PO 300 Guying — General Information

Scope PO 300.1 Guying — General Information

1.0 Guying Requirements for Distribution and Transmission Lines

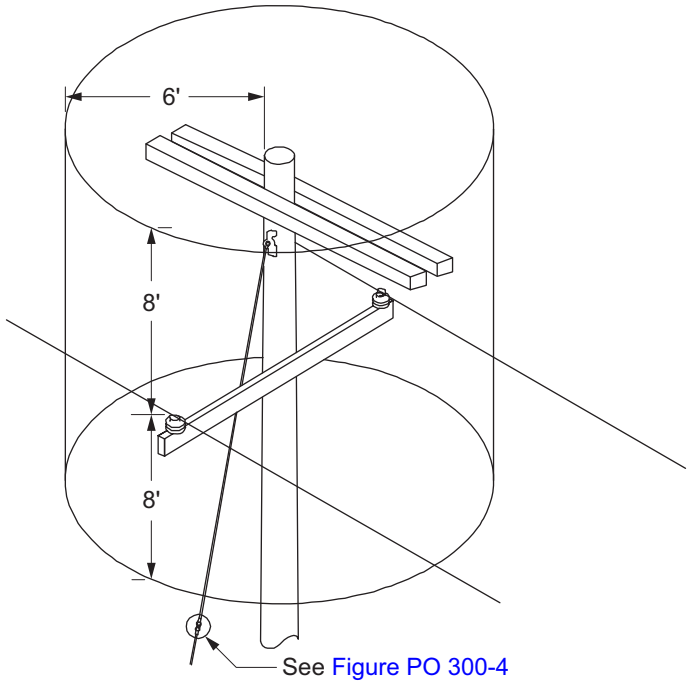
1.1 When the mechanical loads to be imposed upon the poles are greater than can be safely supported by the poles, use guys to provide additional strength. This applies particularly to angles and dead-ends when the conductor stresses are sufficiently unbalanced to make guying necessary.

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 300–1). When using fiberglass guy strain insulators (FGSI), porcelain guy strain insulators are not required (see Section 3.0 (Sheet 2) for additional requirements).

Figure 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.

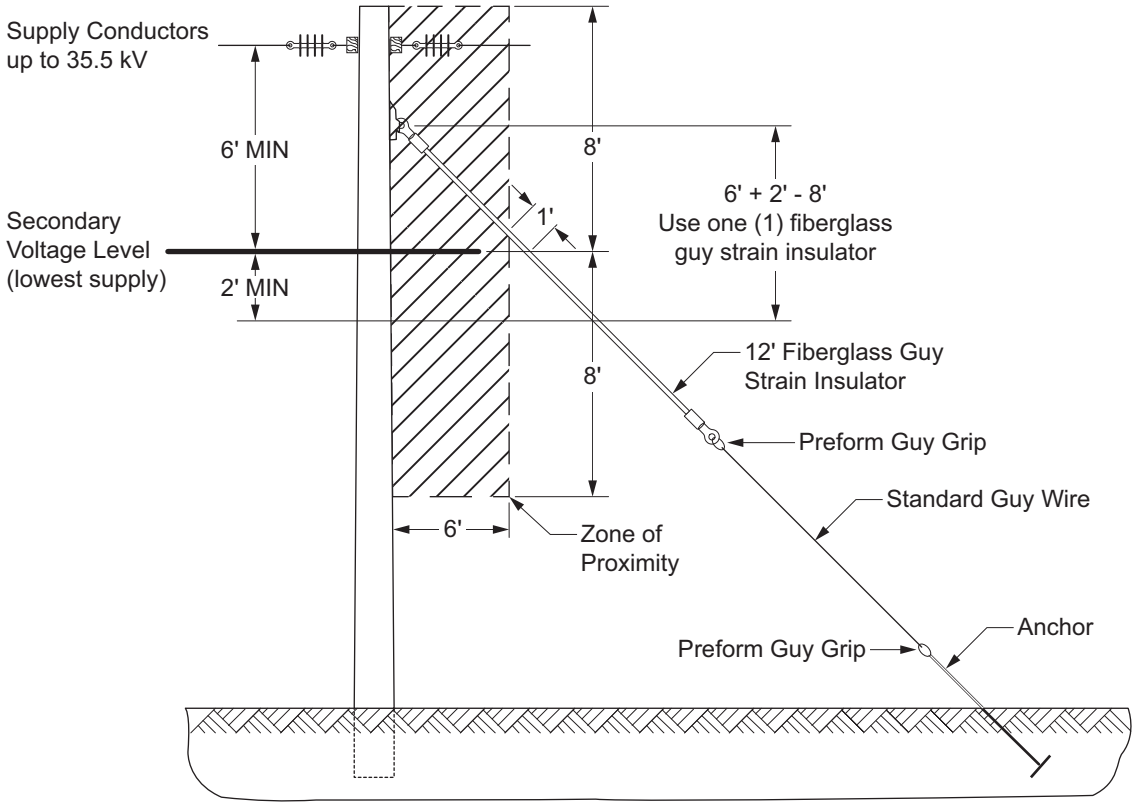
3.2 For new guy installations, guy remediation, and/or pole replacements that require guying in High-Fire Risk Areas (HFRAs), the fiberglass guy strain rod shall be used. Total length of fiberglass guy strain insulators shall meet the following requirements as measured from the connection point on the 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:

3.3 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.

3.4 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 300–2). For other guying examples, see PO 300.2.

Figure 300–2: Example for Determination of Fiberglass Guy Strain Insulator Length



3.5 The remaining distance of the guying installation shall use standard guy wire applicable to the strength requirements of the installation.

3.6 Two or more fiberglass guy strain insulators can be linked together utilizing a chain link (SAP 10068258).

Figure 300–3: Two Fiberglass Guy Strain Insulators Linked



Link together with Chain link SAP 10068258

3.7 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 300–4).

Figure 300–4: Angle Deviation of Fiberglass Guy Strain Insulator

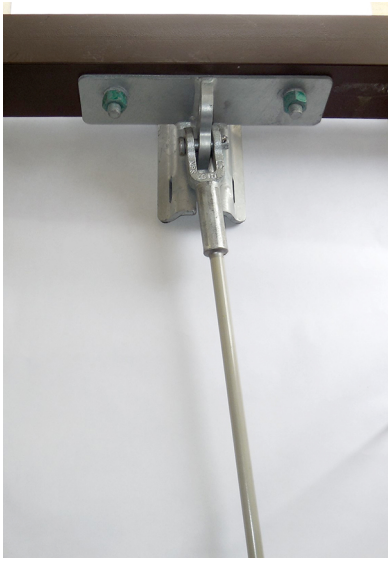


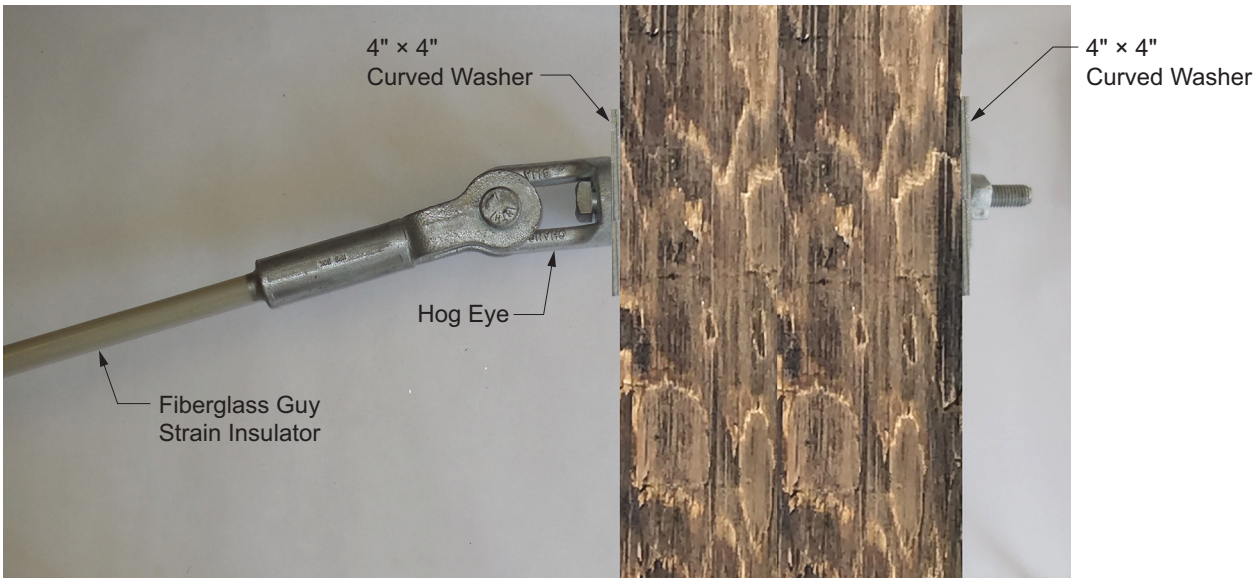
Figure 300–4.1: : Composite Arm Dead-end Bracket



Figure 300–4.2: : Guying Tee

3.8 Span guys utilizing the fiberglass guy strain insulator shall be installed per the details in Figure 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 300–5: Span Guy Using Fiberglass Guy Strain Insulator (Preferred)



3.9 All other guying requirements described in Section 1.0 (Sheet 1) shall apply.

4.0 Types of Guying

Figure 300–6: Overhead Guy Across Streets and Roadways

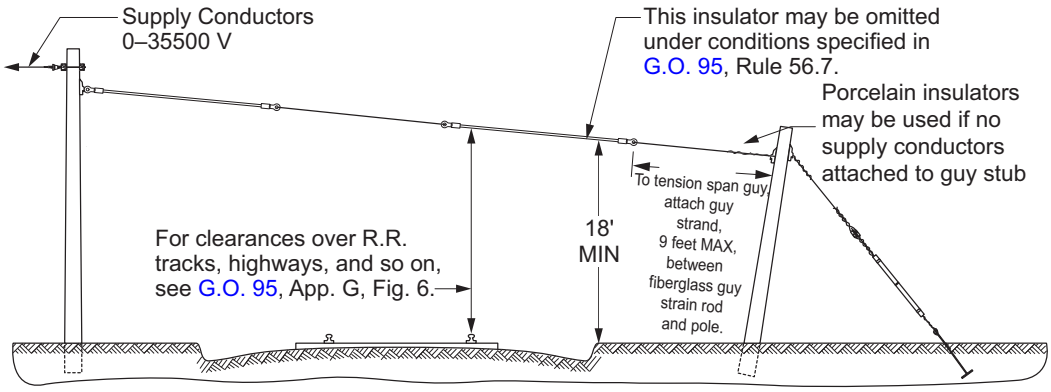
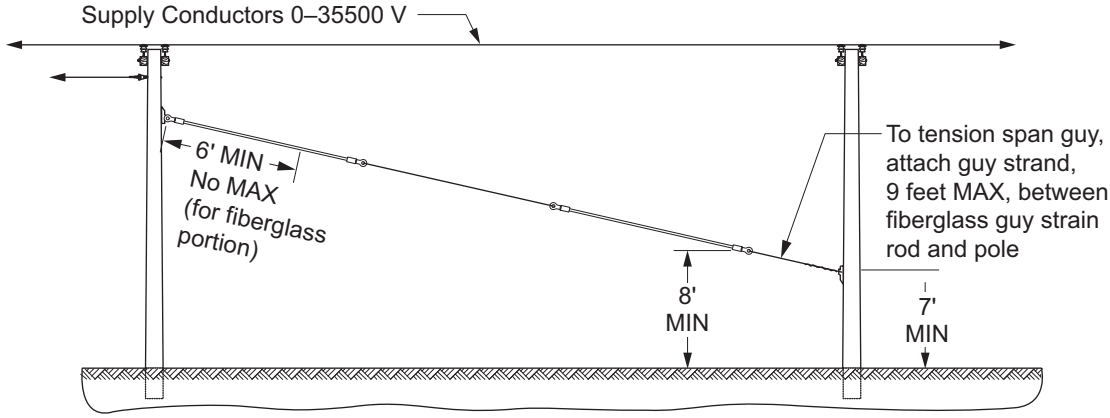


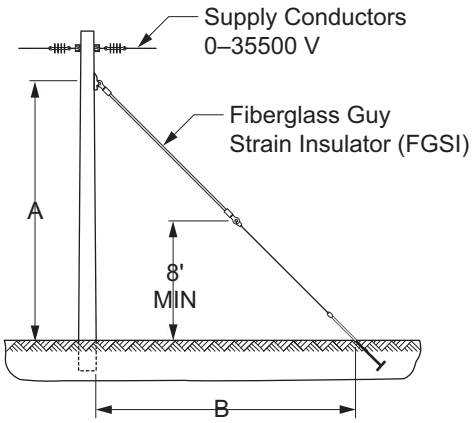
Figure 300–7: Overhead Span Guy Parallel to Streets and Roadways



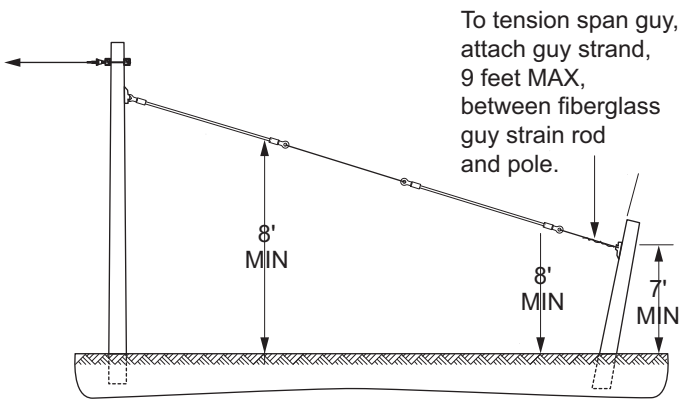
NOTE

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 300–8: 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. 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 300–9: Types of Guying

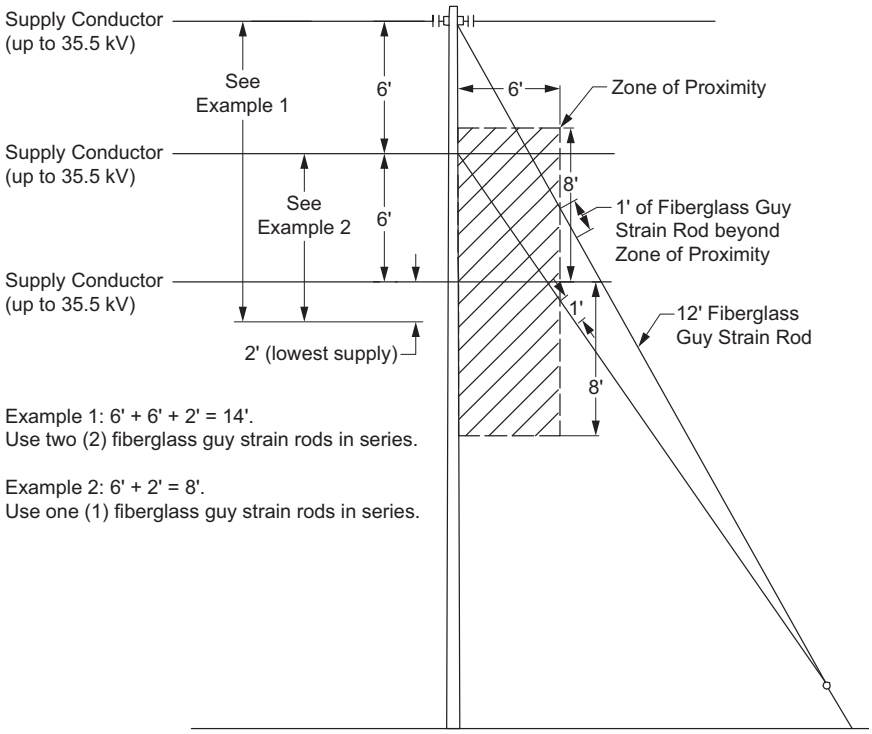


Figure 300–9: Types of Guying *(continued)*

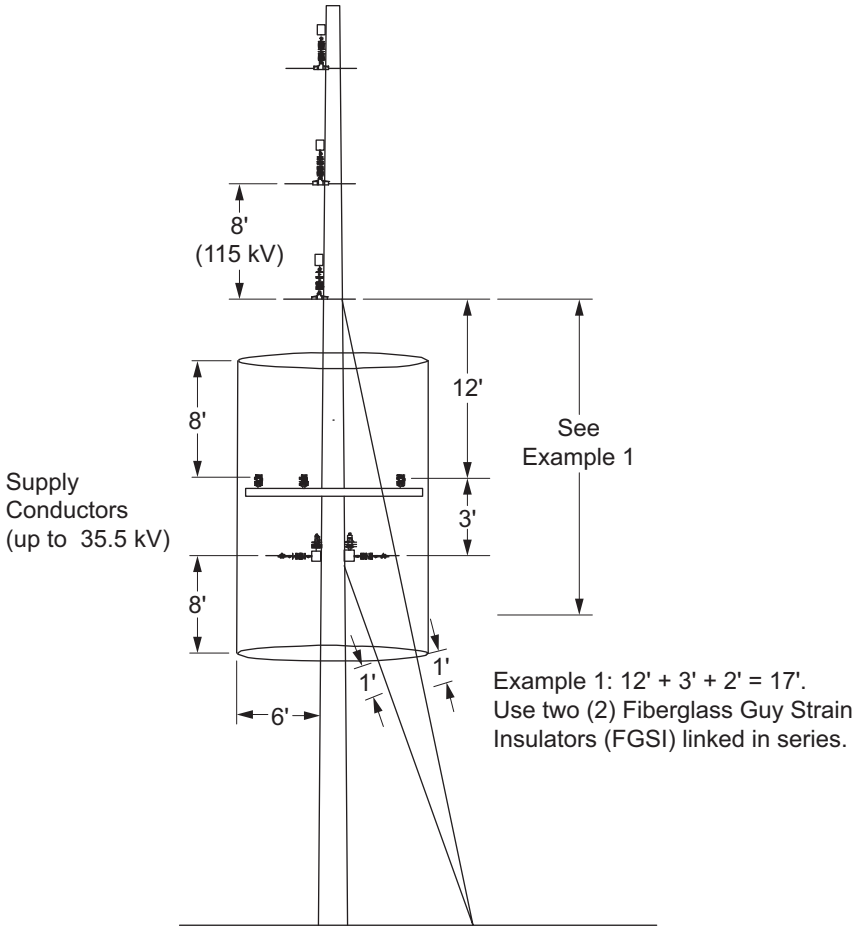


Figure 300–9: Types of Guying *(cont'd)*

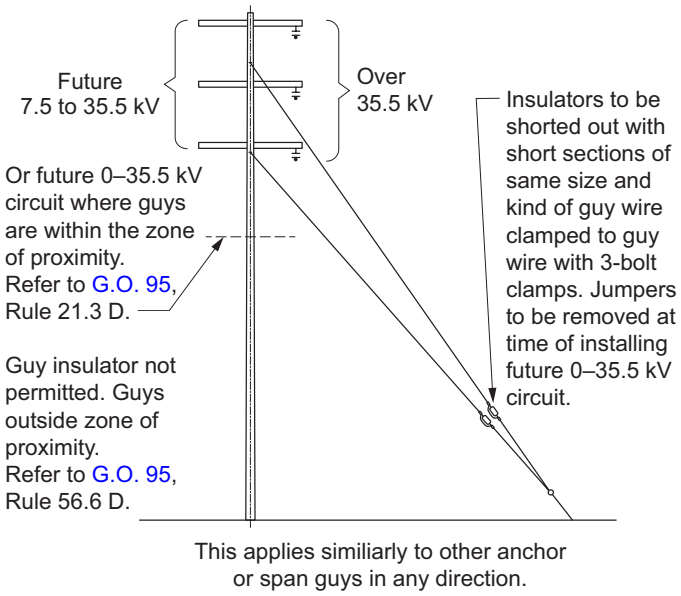


Figure 300–9.1:

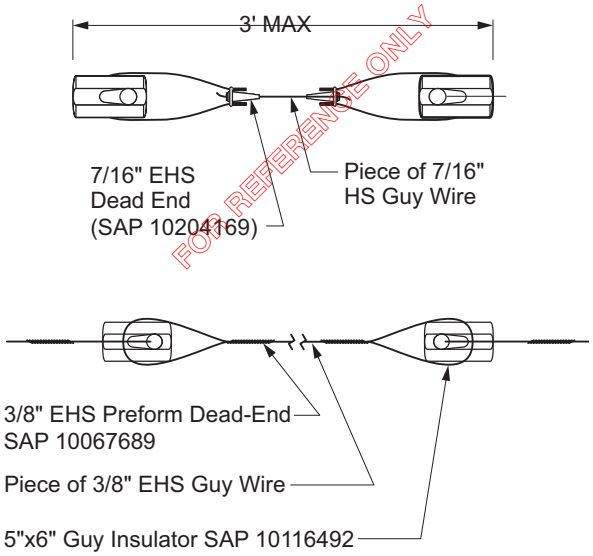


Figure 300–9.2:

Note(s):

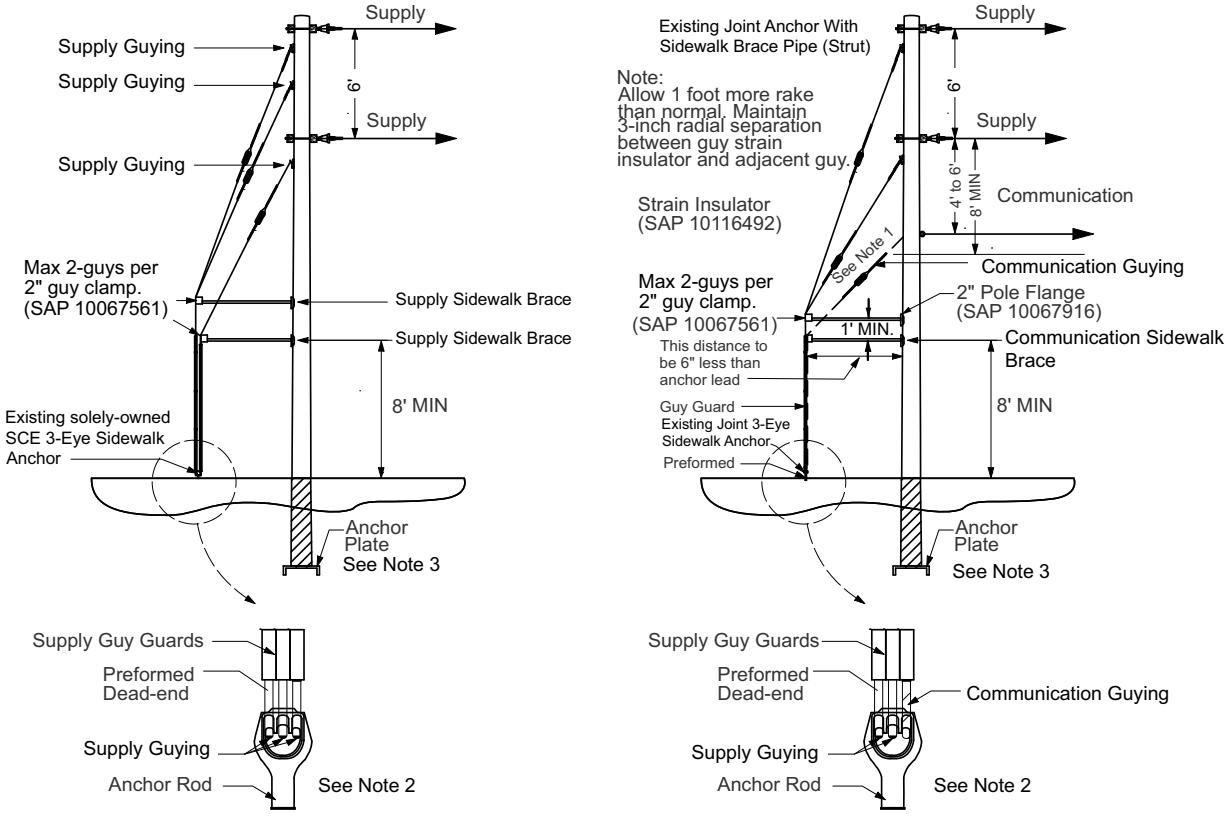
1. If dimension "X" is less than 8 feet, a second insulator located at a minimum of 8 feet vertically above ground is required.
2. One guy insulator required on circuits from 0 to 22.5 kV. Two insulators in series required from 22.5 kV to 35.5 kV, G.O. 95, Rules 56.8 and 86.8
3. If FGSI does not meet installation requirements per PO 300, utilize double FGSI configuration as detailed in Figure 300–9.2.

5.0 Typical Installation of Rock Anchor Guying and Sidewalk Anchor Guying

5.1 For sidewalk anchor with sidewalk braces—whether solely by SCE or jointly owned—no more than three (3) down guys shall be attached to a single SCE anchor. Reference Table PO 310–7 for guying options. The design shall be verified in SPIDACalc to verify required safety factors are met, however, SPIDACalc does not check anchor capacity.

Where an existing joint anchor and sidewalk brace are present, installation of a second sidewalk brace is recommended. Connection to an existing Joint Pole Owner's brace shall be avoided. Refer to Figure 300–10.

Figure 300–10:
Sidewalk Anchor with Sidewalk Brace Solely Edison Ownder Sidewalk Anchor (Left)
Sidewalk Anchor with Sidewalk Brace Joint Sidewalk Anchor (Right)

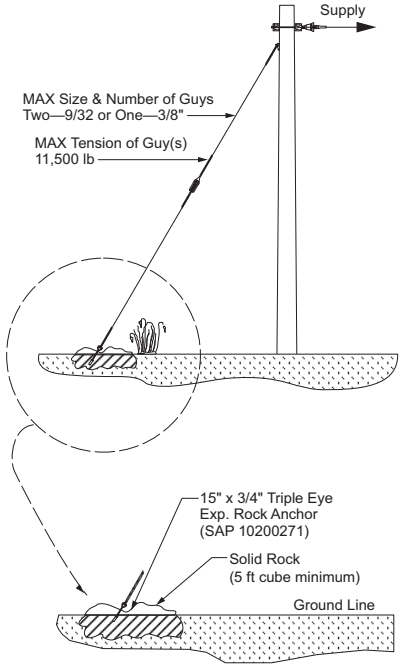


Note(s):

1. When holding capacity allows attaching three down guys to an exisiting 3-eye jointly owned sidewalk anchor, communication guying shall not share a sidewalk brace with two SCE down guys, nor shall SCE attach its guys to a solely owned communication brace. In these cases, a new SCE sidewalk brace must be installed per Figure 300–10.
2. See DOH PO 310 for anchor selection and holding capacities.
3. For new pole sets or pole replacements with sidewalk anchor with sidewalk brace, crews shall install an anchor plate under the butt of the pole to increase soil bearing capacity and to minimize pole settlement. See Table PO 310–6 for anchor plate material code.
4. Follow GO95 for supply guy guards.
5. To construct a 3-guy sidewalk assembly, order two quantities of the sidewalk guy assembly, if upgrading an exisiting 2-guy configuration to include a third guy, order one additional sidewalk guy assembly.

5.2 Rock Anchor Guying

Figure 300–11: Typical Installation of Rock Anchor Guying

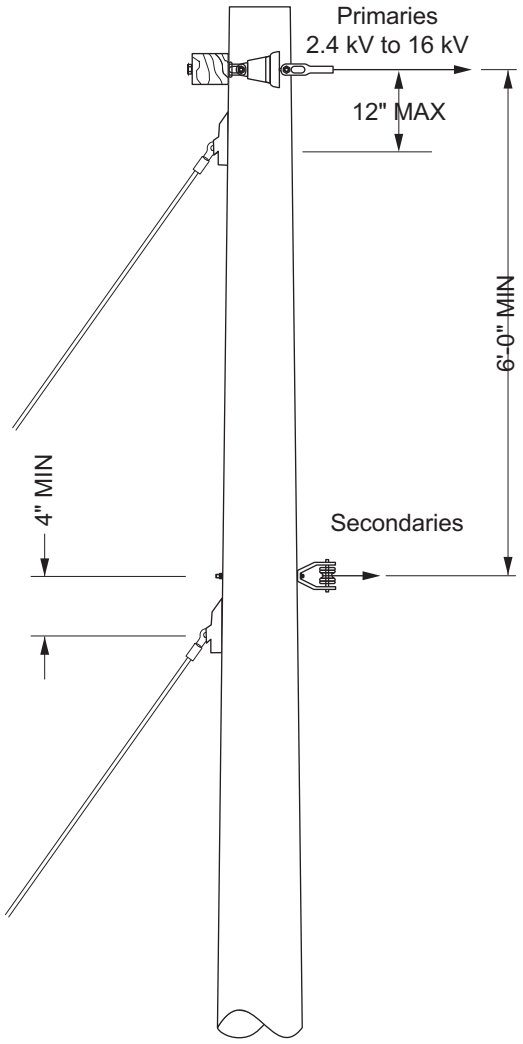


Note(s):

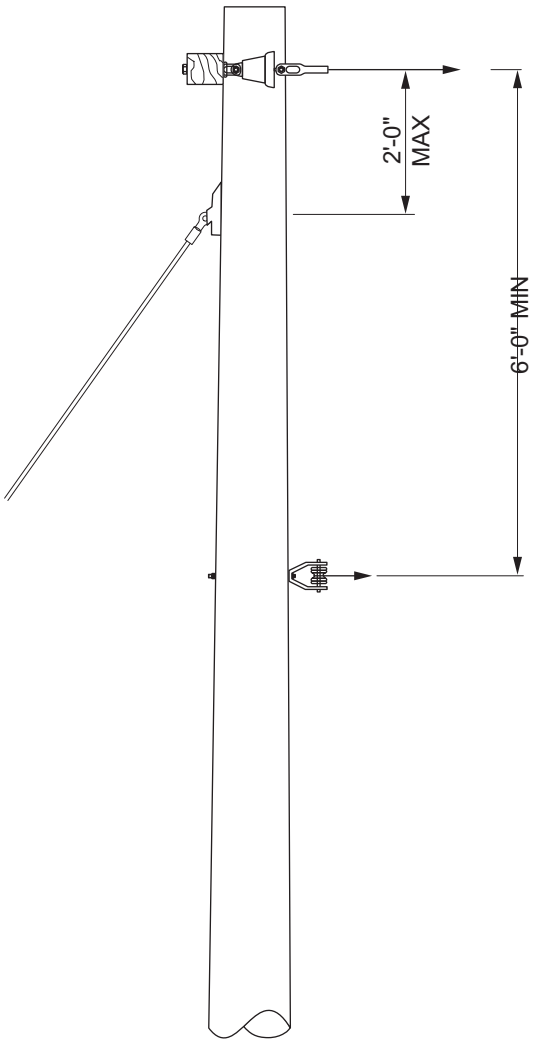
1. Rock anchors should only be installed in solid hard rock. Hard rock requires a minimum of 5 cu. Ft of solid mass that can either be partially exposed to a maximum of 20 inches below ground. Never in decompose or crumbly rock.
2. Drill a 1-7/8 inches diameter into the solid hard rock to a minimum depth 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. Rock anchor shall be installed in the same direction as the guy wires.
6. The bottom of the eye of the rock anchor shall be 4 inches above the rock, measured along the rod.
7. For new installations, if solid hard rock is found 20 inches below and meet the 5 cubic feet minimum volume requirement, anchor extension with identification tag can be installed (See Figure PO 310–2).

6.0 Typical Guying for Grades A and B Construction

Figure 300–12: 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.

7.0 Maximum Conductor Tension for Guy Wires - Grade B Construction

Table 300–1: 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

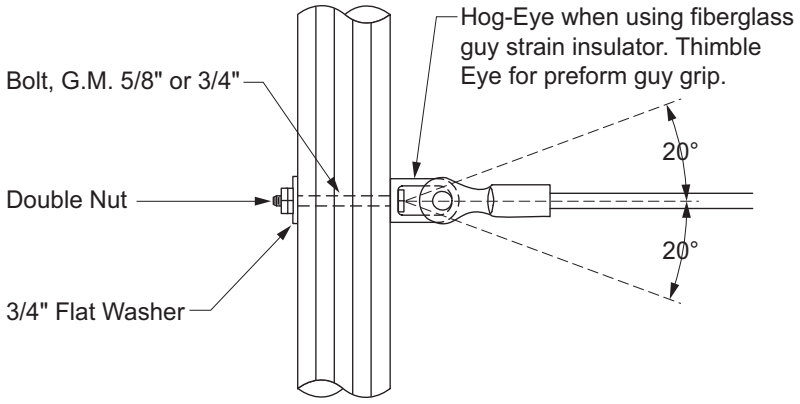
[a/] Ultimate conductor tension divided by safety factor (from Table 24, G.O. 95). The 1/4", 5/16", and 7/16" entries are listed for reference only. The Maximum number of guys for a sidewalk anchor is two.

EXAMPLE:

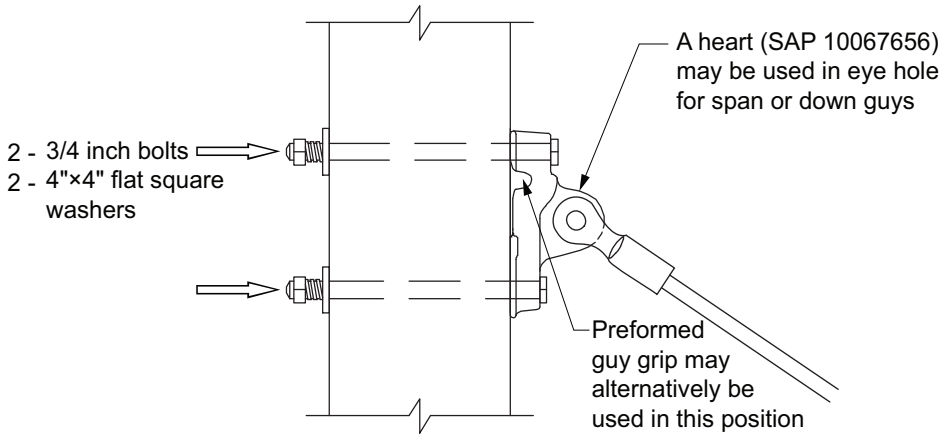
A single 3/8" guy wire installed at a 40 degree angle, between the pole and guy, is capable of supporting a conductor tension of 4,949 pounds in Grade B construction.

Scope PO 300.1 Guying Subtransmission Lightweight Steel Poles

Figure 300–13: Installation of Guy Hardware on Light weight Steel Poles



Span Guy



Guying Tee Detail
(SAP 10181650)

Note(s):

1. Follow the guying criteria for wood poles, including poles with communication and third party attachments, except as shown in these figures.

This page intentionally left blank.

PO 310 Anchors for Guys

Scope PO 310.1 Anchors for Guys

1.0 General

The table below shall be used to select appropriate anchor material based on the type of soil at the project location.

Heavy-Duty Power-Installed Screw Anchors (PISA) provide minimal ground disturbance, fast installation, and reliable performance in many types of soil. Proper installation requires digger-derrick/line truck access and the use of power-driven equipment/tools to install PISA. PISA's shall NOT be dropped in a pre-dug hole. Plate anchors will continue to be used in extremely loose soils and in inaccessible areas. The project will determine anchor best suited for soil and/or physical restrictions at the site.

Table PO 310–1: Anchor Selection

Soil Per Table PO 310–2	Suitable Anchors To Achieve Higher Holding Capacity			Power Installed Screw Anchor (PISA) [a/]				Plate Anchor		Expanding Rock Anchor	
Type	PISA[a/]	Plate[b/]	Rock	Max. Allowable Guy Load (lbs)	Min. Anchor Spacing (ft) [c/] 4'Ø Double Helix	8'Ø Helix	10'Ø Helix	Max. Allowable Guy Load (lbs)	Min. Anchor Spacing (ft) [c/]	Max. Allowable Guy Load (lbs)	Min. Anchor Spacing (ft)[c/]
A	8" Single Helix (SAP 10217543) 4" Single Helix (SAP10067289) 8" Double Helix (SAP 10200272) 10" Double Helix (SAP 10200180)	17" x 17" (SAP10067304) 23" x 23" (SAP 10210268)	-	See Table PO 310–3	1.5	3	3.5	See Table PO 310–7	6	-	-
B	8" Single Helix (SAP 10217543) 8" Double Helix (SAP 10200272) 10" Double Helix (SAP 10200180)	17" x 17" (SAP10067304) 23" x 23" (SAP 10210268)	-	See Table PO 310–3	1.5	3	3.5	See Table PO 310–7	6	-	-
C	8" Single Helix (SAP 10217543) 8" Double Helix (SAP 10200272) 10" Double Helix (SAP 10200180)	17" x 17" (SAP 10067304) 23" x 23" (SAP 10210268)	-	See Table PO 310–3	1.5	3	3.5	See Table PO 310–7	6	-	-
D	8" Double Helix (SAP 10200272) 10" Double Helix (SAP 10200180)	17" x 17" (SAP 10067304) 23" x 23" (SAP 10210268)	-	See Table PO 310–3	-	-	-	See Table PO 310–7	6	-	-
E	-	-	3/4" x 30" SAP 10215681 1" x 30" SAP 10215682	-				-		See Table PO 310–9	3

a/ When truck access is possible, use digger-derrick/line truck or other power-driven equipment/tools to install PISA. PISA shall NOT be dropped in a pre-dug hole.
b/ All types of plate and PISA anchors are available to be used depending on site conditions and allowable maximum capacity based on soil type. See Table PO 310–3, Table PO 310–6 and Table PO 310–7.
c/ When minimum spacing cannot be achieved, see Table PO 310–4 for PISA and Table PO 310–8 for Plate Anchors, for reduced holding strength capacity.

1.1 Soil Type

The type of soil play a critical role in the holding capacity of anchors. Dense to very dense soils will have higher holding capacity compared to other types of soils. This soil table shall be used for determining anchor holding capacity.

Table PO 310–2: Soil and Types

Soil Type[1]	Description
A	Very dense sandy soil, gravel and cobbles, and soft rock. Soft rock can be identified based on site topography, such as mountain regions and hillsides. Hardpan.
B	Dense sandy soil, sand greater than 50%, or still silts and clay. Well compacted sandy soil with visible grains, typically coarse grained, often gravel and large rocks are present.
C	Medium dense, sandy soil or firm silts and clay.Soil contains a mixture of sand and clay. Sand grains are small that are barely visible. Soil moisture is medium to high.
D	Soft or loose soil consisting of clay. Clay is relatively plastic and can easily roll in hands. Soil moisture is high. Organic soil (black thin layers of soil with distinct odor) can be present.
E	Sound and unweathered hard rock.

Note(s):

1. Soils based on USGS Shear Wave Velocity (V30), which measures the average shear in the top 98 feet of soil and rock. Obtained through geophysical methods such as seismic refraction, downhole, and surface wave techniques.
2. Use SCEGeoView and turn on layers Landbase 3rd Party and Soil Type Layer.

2.0 Screw Anchors

Heavy-Duty Power-Installed Screw Anchors (PISA) provide minimal ground disturbance, fast installation, and reliable performance in many types of soil. Digger-derrick/line truck access is needed to install screw anchors. Use power-driven equipment/tools to install PISA. PISA's shall NOT be dropped in a pre-dug hole. When PISA is not possible due to physical site limitations, plate anchors are acceptable for use.

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 at least 4 inches above ground, measured along the rod. Maximum projection above ground depends on PISA type:

- 36 inches for 4 inch double helix and 8 inch single/double helix
- 30 inches for 10 inch double helix

For new installations, measurements are taken along the rod relative to the finished grade. For specific PISA installation method and requirements, see Scope PO 310.2. If an extension is required, a 1" × 3-1/2' anchor extension with coupler (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. See Section 7.0 for PISA ID Tagging.

Figure PO 310–1: PISA Assembly with Extension

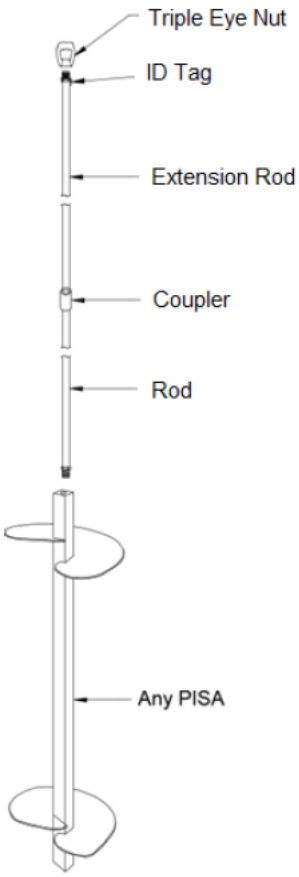


Figure PO 310–2: Projection Above Ground

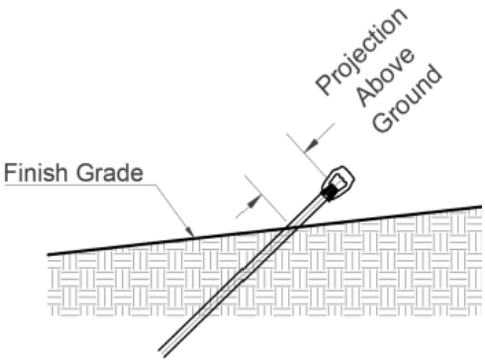


Table PO 310–3: Maximum Allowable Holding Capacity for PISA Guys Anchors

Anchor Rod	SAP Number	Photo	Anchor	1-1/2" Anchor Hub	SAP Number	Photo	Soil Type	Torque (in minimum pins sheared)	Maximum Allowable Guy Anchor Load (lbs)		Guying Options[a/]
									New Install (S.F. = 1.5)	In-Service (S.F.=1.33)	
1" x 7' Triple Eye Galvanized Steel	10185605 (Medium Strength)		Power Installed Screw Anchors (PISA)	4" Double	10067289		A	12	24,000	27,000	**New Install:** 2-7/16", or 2-3/8", 2-3/8" &1-9/32", or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32" **In-Service:** 2-7/16", or 2-3/8" & 1-9/32", or 1-3/8" & 2-9/32", or 2-3/8" & 1-7/16", or 3-3/8", or 3-9/32"

Table PO 310–3: Maximum Allowable Holding Capacity for PISA Guys Anchors *(Continued)*

Anchor Rod	SAP Number	Photo	Anchor	1-1/2" Anchor Hub	SAP Number	Photo	Soil Type	Torque (in minimum pins sheared)	Maximum Allowable Guy Anchor Load (lbs)		Guying Options[a/]
									New Install (S.F. = 1.5)	In-Service (S.F.=1.33)	
1" x 7' Triple Eye Galvanized Steel	10185605 (Medium Strength)		Power Installed Screw Anchors (PISA)	8" Single Helix (Tough One and Turbo Drive)	10217543		A	12	24,000	27,000	**New Install:** 2-7/16", or 2-3/8", 2-3/8" &1-9/32", or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32" **In-Service:** 2-7/16", or 2-3/8" & 1-9/32", or 1-3/8" & 2-9/32", or 2-3/8" & 1-7/16", or 3-3/8", or 3-9/32"
							B	9	18,000	20,000	**New Install:** 2-3/8", or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32" **In-Service:** 2-7/16", or 2-3/8", or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32"
							C	7	14,000	15,000	**New Install:** 2-9/32", or 1-3/8", or 1-7/16" **In-Service:** 2-9/32", or 1-3/8", or 1-7/16"

Table PO 310–3: Maximum Allowable Holding Capacity for PISA Guys Anchors *(Continued)*

Anchor Rod	SAP Number	Photo	Anchor	1-1/2" Anchor Hub	SAP Number	Photo	Soil Type	Torque (in minimum pins sheared)	Maximum Allowable Guy Anchor Load (lbs)		Guying Options[a/]
									New Install (S.F. = 1.5)	In-Service (S.F.=1.33)	
1" x 7' Triple Eye Galvanized Steel	10185605 (Medium Strength)		Power Installed Screw Anchors (PISA)	8" Double Helix	10200272		A	10	24,000	27,000	**New Install:** 2-7/16", or 2-3/8", 2-3/8" &1-9/32", or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32" **In-Service:** 2-7/16", or 2-3/8" & 1-9/32", or 1-3/8" & 2-9/32", or 2-3/8" & 1-7/16", or 3-3/8", or 3-9/32"
							B	8	20,000	22,000	**New Install:** 2-7/16", or 2-3/8", or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32" **In-Service:** 2-7/16", or 2-3/8", or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32"
							C	5	13,000	15,000	**New Install:** 2-9/32", or 1-3/8", or 1-7/16" **In-Service:** 2-9/32", or 1-3/8", or 1-7/16"
							D	2	6,000	7,000	**New Install:** 1-9/32" **In-Service:** 1-9/32"

Table PO 310–3: Maximum Allowable Holding Capacity for PISA Guys Anchors *(Continued)*

Anchor Rod	SAP Number	Photo	Anchor	1-1/2" Anchor Hub	SAP Number	Photo	Soil Type	Torque (in minimum pins sheared)	Maximum Allowable Guy Anchor Load (lbs)		Guying Options[a/]
									New Install (S.F. = 1.5)	In-Service (S.F.=1.33)	
1" x 7' Triple Eye Galvanized Steel	10185605 (Medium Strength)		Power Installed Screw Anchors (PISA)	10" Double Helix	10200180		A	9	24,000	27,000	**New Install:** 2-7/16", or 2-3/8", 2-3/8" &1-9/32", or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32" **In-Service:** 2-7/16", or 2-3/8" & 1-9/32", or 1-3/8" & 2-9/32", or 2-3/8" & 1-7/16", or 3-3/8", or 3-9/32"
							B	7	20,000	22,000	**New Install:** 2-7/16", or 2-3/8", or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32" **In-Service:** 2-7/16", or 2-3/8", or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32"
							C	4	13,000	15,000	**New Install:** 2-9/32", or 1-3/8", or 1-7/16" **In-Service:** 2-9/32", or 1-3/8", or 1-7/16"
							D	2	7,000	8,000	**New Install:** 1-9/32" **In-Service:** 1-9/32"

[a/] Guy recommendations are guidelines to ensure that the anchor can support the full strength capability of the guys. For in-service installations or 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.

Note(s):

1. When the minimum number of pins sheared is achieved and the PISA rod exceeds the maximum projection above ground, continue driving the PISA until maximum projection is achieved. Projection is measured along the rod. If that is not possible, install a smaller diameter PISA.
   - For 4 inch double helix, 36 inches maximum projection above ground
   - For 8 inch single and double helix, 36 inches maximum projection above ground
   - For 10 inch double helix, 30 inches maximum projection above ground
2. New install safety factors for maximum allowable guy anchor load shall be used when replacing poles. In-Service safety factors for maximum allowable guy anchor load shall be used when equipment or components are added or removed on in service poles. Safety factors shown are for anchors only, **not** for guying.
3. Determine the maximum loading of each guy wire from SPIDA results and use the sum to compare the total maximum allowable anchor holding strength from Table PO 310–3. The sum of multiple guying in one anchor shall not exceed the maximum values shown in Table PO 310–3.
4. When infield soil conditions do not match the soil type in the work order, the field shall mark the work order with the revisions and construction must use the standard DOH 310 to follow the equivalent holding capacity for the revised anchor or consult with Planning/Tech Planning.
5. When installing anchor, ensure the installation will hit bedrock or dense soil. Verified by the minimum number of pins sheared as shown in Table PO 310–3. Use PISA extension if bedrock or dense soil is not achieved in the initial installation to reach the minimum shear pins or contact designer/planner to obtain a design for plate anchor.
6. If an existing SCE anchor rod with a diameter of less than 1 inch is discovered during a project that requires pole replacement, it must be replaced with a standard approved anchor.

Table PO 310–4: Reduced Maximum Allowable Holding Capacity for PISA Guy Anchors

PISA	Spacing Between PISA Anchors	Reduced Maximum Load Allowed When Minimum Spacing Cannot Be Achieved
4” diameter helix	<1.5 feet	The anchors are limited to the holding capacity of one anchor. See Note 1.
8” diameter helix	<3.0 feet	The anchors are limited to the holding capacity of one anchor. See Note 1.
10” diameter helix	<3.5 feet	The anchors are limited to the holding capacity of one anchor. See Note 1.

Note(s):

1. New installations with two or more using PISA anchors with spacing less than the minimum spacing as listed on Table 310-1, the anchors are limited to the holding capacity of one anchor. The new allowable holding capacity is the Maximum Holding capacity (Table PO 310–3) divided by the number of anchors.
   - Example #1, two 4" dia. helix with allowable holding capacity of 6,000 lbs (based on Table PO 310–3) each anchor shall have a maximum holding capacity of 3,000 lbs. (6,000 lbs divided by the # of anchors)
   - Example #2, three 10" dia. helix with allowable holding of 18,000 lbs. (based on Table PO 310–3) each anchor shall have a maximum holding capacity of 6,000 lbs. (18.000 lbs divided by the number of anchors)
2. When the minimum number of pins sheared is achieved and the PISA rod exceeds an 18-inch maximum projection above ground, continue driving the PISA until 18 inches is achieved. If not possible, try installing a smaller diameter PISA.

3.0 Plate Anchors

Plate anchors are to be used when PISA is not possible due to physical site limitations such as: utilities (telecom, water, storm drain, gas, fibers) are within 24 inches horizontally away from anchor, permanent structures obstructions such as foundations, poles, buildings and inaccessible bucket truck access.

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. Other methods of excavation is acceptable when soil conditions are not feasible for digger-derrick/line truck.

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.

Backfill the hole with native materials and compact using mechanical means. When native back fill material is not practical due to underground utilities, back fill with the hole with 2-sack concrete slurry. 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 unapproved standard material shall not be connected to the cross plate.

3.1 Only approved anchor rods listed Table PO 310–5 are allowed for use. The anchor rods shall be attached directly to the appropriately sized cross plate anchors listed below and identified in Table Table PO 310–6.

3.2 For multiple anchor installations, it is necessary for the plate anchors to be properly spaced to prevent failure. The standard spacing is shown in Table PO 310–1. If the standard spacing cannot be achieved, then the holding capacity will be reduced as shown in Table PO 310–8.

Table PO 310–5: 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	

For Reference Only

Table PO 310–6: Plate Anchors

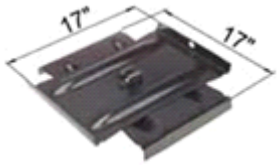
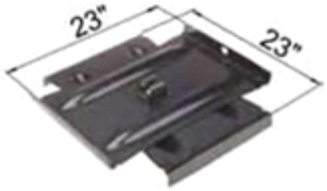
Size	SAP	Remark
17" × 17" Cross Plate	10067304	
23" × 23" Cross Plate	10210268	

Table PO 310–7: Allowable Holding Strength for Plate Guy Anchors

Cross Plate Anchors	SAP	Soil Type	Anchor Inclination Angle (Degrees), φ				
			90° (Sidewalk Anchor) (90° - 67.51°)	60° (67.50° - 52.51°)	45° (52.50° - 37.51°)	30° (37.50° - 22.51°)	15° (22.50° - 15°)
17" x 17"	10067304	A	Max. Allowable Load: **New Install (SF=1.5)**: 18,000 lbs Guying Options [a/]: 1-7/16", 2-3/8", or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32" **In-Service (SF=1.33)**: 20,000 lbs Guying Options [a/]: 2-7/16", or 2-3/8" & 1-9/32", or 1-3/8" & 2-9/32", or 2-3/8" & 1-7/16", or 3-9/32"	Max. Allowable Load: **New Install (SF=1.5)**: 18,000 lbs Guying Options [a/]: 1-7/16", 2-3/8", or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32" **In-Service (SF=1.33)**: 20,000 lbs Guying Options [a/]: 2-7/16", or 2-3/8" & 1-9/32", or 1-3/8" & 2-9/32", or 2-3/8" & 1-7/16", or 3-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 14,000 lbs Guying Options [a/]: 1-7/16", 1-3/8", or 1-3/8" & 1-9/32", or 3-9/32" **In-Service (SF=1.33):** 15,500 lbs Guying Options [a/]: 1-7/16", or 2-3/8" & 1-9/32", or 1-3/8" & 2-9/32", 3-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 13,000 lbs Guying Options [a/]: 1-7/16", 1-3/8", or 1-3/8" & 1-9/32", or 2-9/32" **In-Service (SF=1.33):** 14,500 lbs Guying Options [a/]: 1-7/16", or 1-3/8" & 2-9/32", or 3-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 12,000 lbs Guying Options [a/]: 1-7/16", 1-3/8", or 2-9/32" **In-Service (SF=1.33): 13,500 lbs** Guying Options [a/]: 1-7/16", or 1-3/8" & 2-9/32", or 3-9/32"
		B	Max. Allowable Load: **New Install (SF=1.5): 14,000 lbs** Guying Options [a/]: 1-3/8", or 1-3/8" & 1-9/32", or 1-7/16", or 3-9/32" **In-Service (SF=1.33):** 15,500 lbs Guying Options [a/]: 1-7/16", or 2-3/8" & 1-9/32", or 1-3/8" & 2-9/32", 3-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 13,000 lbs Guying Options [a/]: 1-7/16", or 1-3/8", or 1-3/8" & 1-9/32", or 2-9/32" **In-Service (SF=1.33):** 14,500 lbs Guying Options [a/]: 1-7/16", or 1-3/8" & 2-9/32", or 3-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 12,000 lbs Guying Options [a/]: 1-7/16", or 1-3/8", or 2-9/32" **In-Service (SF=1.33):** 13,500 lbs Guying Options [a/]: 1-7/16", or 1-3/8" & 2-9/32", or 3-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 11,000 lbs Guying Options [a/]: 1-7/16", or 1-3/8", or 2-9/32" **In-Service (SF=1.33):** 12,500 lbs Guying Options [a/]: 1-7/16", or 1-3/8" & 1-9/32", or 2-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 9,000 lbs Guying Options [a/]: 1-3/8", 2-9/32" **In-Service (SF=1.33): 10,000 lbs** Guying Options [a/]: 1-7/16", or 1-3/8" & 2-9/32"
		C	Max. Allowable Load: **New Install (SF=1.5):** 13,000 lbs Guying Options [a/]: 1-7/16", or 1-3/8", or 1-3/8" & 1-9/32", or 2-9/32" **In-Service (SF=1.33):** 14,500 lbs Guying Options [a/]: 1-7/16", or 1-3/8" & 2-9/32", or 3-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 10,000 lbs Guying Options [a/]: 1-7/16", or 1-3/8", or 2-9/32" **In Service (SF=1.33):** 11,000 lbs Guying Options [a/]: 1-7/16", or 1-3/8", or 2-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 9,500 lbs Guying Options [a/]: 1-3/8", or 2-9/32" **In Service (SF=1.33):** 10,500 lbs Guying Options [a/]: 1-7/16", or 1-3/8", or 2-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 9,000 lbs Guying Options [a/]: 1-3/8", or 2-9/32", **In Service (SF=1.33):** 10,000 lbs Guying Options [a/]: 1-7/16", or 1-3/8", or 2-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 8,000 lbs Guying Options [a/]: 1-3/8", or 1-9/32" **In Service (SF=1.33):** 9,000 lbs Guying Options [a/]: 1-3/8", or 2-9/32"

Table PO 310–7: Allowable Holding Strength for Plate Guy Anchors *(Continued)*

Cross Plate Anchors	SAP	Soil Type	Anchor Inclination Angle (Degrees), φ				
			90° (Sidewalk Anchor) (90° - 67.51°)	60° (67.50° - 52.51°)	45° (52.50° - 37.51°)	30° (37.50° - 22.51°)	15° (22.50° - 15°)
17" x 17"	10067304	D	Max. Allowable Load: **New Install (SF=1.5):** 7,000 lbs Guying Option a/: 1-9/32" **In-Service (SF=1.33):** 8,000 lbs Guying Options a/: 1-3/8", or 1-9/32	Max. Allowable Load: **New Install (SF=1.5):** 6,000 lbs Guying Option a/: 1-9/32" **In-Service (SF=1.33):** 6,500 lbs Guying Option a/: 1-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 5,500 lbs Guying Option a/: 1-9/32" **In-Service (SF=1.33):** 6,000 lbs Guying Option a/: 1-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 5,000 lbs Guying Option a/: 1-9/32" **In-Service (SF=1.33):** 5,500 lbs Guying Option a/: 1-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 4,500 lbs Guying Option a/: 1-9/32" **In-Service (SF=1.33):** 5,000 lbs Guying Option a/: 1-9/32"
23" x 23"	10210268	A	Max. Allowable Load: **New Install (SF=1.5):** 21,000 lbs Guying Options a/: 2-7/16", or 2-3/8" & 1-9/32", or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32" **In-Service (SF=1.33):** 23,000 lbs Guying Options a/: 2-7/16", or 1-7/16" & 2-9/32", or 2-3/8" & 1-9/32", or 3-3/8", or 1-3/8" & 2-9/32", or 3-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 20,000 lbs Guying Options a/: 2-7/16", or 2-3/8" & 1-9/32", or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32" **In-Service (SF=1.33):** 22,500 lbs Guying Options a/: 2-7/16", or 1-7/16" & 2-9/32", or 2-3/8" & 1-9/32", or 1-3/8" & 2-9/32", or 3-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 16,000 lbs Guying Options a/: 2-3/8", or 1-3/8" & 1-9/32", or 1-9/32" & 1-7/16", or 3-9/32" **In-Service (SF=1.33):** 18,000 lbs Guying Options a/: 1-7/16", 2-3/8", or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16", or 3-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 15,000 lbs Guying Options a/: 1-7/16", or 1-3/8", or 1-3/8" & 1-9/32", or 3-9/32" **In-Service (SF=1.33):** 17,000 lbs Guying Options a/: 1-7/16", 2-3/8", or 1-3/8" & 2-9/32", or 3-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 14,000 lbs Guying Options a/: 1-7/16", 1-3/8", or 1-3/8" & 1-9/32", or 3-9/32" **In-Service (SF=1.33):** 16,000 lbs Guying Options a/: 1-7/16", 2-3/8", or 1-3/8" & 2-9/32", or 3-9/32"
		B	Max. Allowable Load: **New Install (SF=1.5):** 15,000 lbs Guying Options a/: 1-7/16", or 1-3/8", or 1-3/8" & 1-9/32", or 3-9/32" **In-Service (SF=1.33):** 17,000 lbs Guying Options a/: 1-7/16", 2-3/8", or 1-3/8" & 2-9/32", or 3-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 13,000 lbs Guying Options a/: 1-7/16", or 1-3/8", or 1-3/8" & 1-9/32", or 2-9/32" **In-Service (SF=1.33):** 14,500 lbs Guying Options a/: 1-7/16", or 1-3/8", or 1-3/8" & 2-9/32", or 3-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 12,500 lbs Guying Options a/: 1-7/16", or 1-3/8", or 1-3/8" & 1-9/32", or 2-9/32" **In-Service (SF=1.33):** 14,000 lbs Guying Options a/: 1-7/16", or 1-3/8", or 1-3/8" & 2-9/32", or 3-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 12,000 lbs Guying Options a/: 1-7/16", or 1-3/8" or 2-9/32" **In-Service (SF=1.33):** 13,500 lbs Guying Options a/: 1-7/16", or 1-3/8", or 1-3/8" & 2-9/32", or 3-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 11,000 lbs Guying Options a/: 1-7/16", or 1-3/8", or 2-9/32 **In-Service (SF=1.33):** 12,500 lbs Guying Options a/: 1-7/16", or 1-3/8", or 1-3/8" & 2-9/32", or 2-9/32"
		C	Max. Allowable Load: **New Install (SF=1.5):** 13,000 lbs Guying Options a/: 1-7/16", or 1-3/8", or 1-3/8" & 1-9/32", or 2-9/32" **In-Service (SF=1.33):** 14,500 lbs Guying Options a/: 1-7/16", or 1-3/8", or 1-3/8" & 2-9/32", or 3-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 11,000 lbs Guying Options a/: 1-7/16", or 1-3/8", or 2-9/32" **In-Service (SF=1.33):** 12,500 lbs Guying Options a/: 1-7/16", or 1-3/8", or 1-3/8" & 2-9/32", or 2-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 10,500 lbs Guying Options a/: 1-7/16", or 1-3/8", or 2-9/32" **In-Service (SF=1.33):** 11,500 lbs Guying Options a/: 1-7/16", or 1-3/8", or 2-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 10,000 lbs Guying Options a/: 1-7/16", or 1-3/8", or 2-9/32", or 1-7/16" **In-Service (SF=1.33):** 11,000 lbs Guying Options a/: 1-7/16", or 1-3/8", or 2-9/32"	Max. Allowable Load: **New Install (SF=1.5):** 9,000 lbs Guying Options a/: 1-3/8", 2-9/32" **In-Service (SF=1.33):** 10,000 lbs Guying Options a/: 1-7/16", or 1-3/8", or 2-9/32"
		D	Max. Allowable Load: **New Install (SF=1.5):** 7,000 lbs Guying Option a/: 1-9/32" **In-Service (SF=1.33):** 8,000 lbs Guying Option a/: 1-3/8", or 1-9/32	Max. Allowable Load: **New Install (SF=1.5):** 6,500 lbs Guying Option a/: 1-9/32" **In-Service (SF=1.33):** 7,000 lbs Guying Option a/: 1-9/32	Max. Allowable Load: **New Install (SF=1.5):** 6,000 lbs Guying Option a/: 1-9/32" **In-Service (SF=1.33):** 6,500 lbs Guying Option a/: 1-9/32	Max. Allowable Load: **New Install (SF=1.5):** 5,500 lbs Guying Option a/: 1-9/32" **In-Service (SF=1.33):** 6,000 lbs Guying Option a/: 1-9/32	Max. Allowable Load: **New Install (SF=1.5):** 5,000 lbs Guying Option a/: 1-9/32" **In-Service (SF=1.33):** 5,500 lbs Guying Option a/: 1-9/32

a/ Guy recommendations are guidelines to ensure that the anchor can support the full strength capability of the guys. For in-service installations or 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.

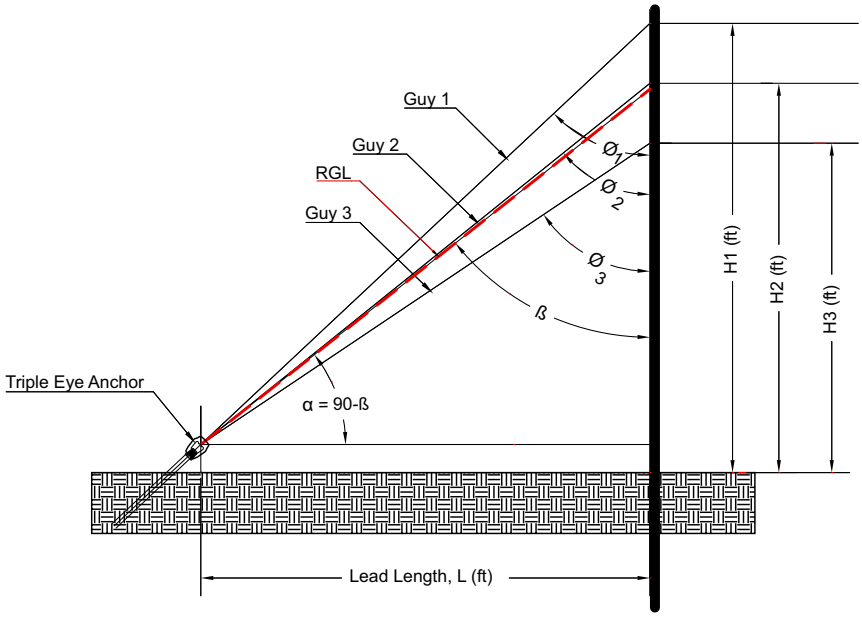
Note(s):

1. Minimum size guy strand for anchor guys is 9/32".
2. 5/16" and 7/16" high-strength guy strand may be substituted for 9/32" and 3/8" EHS guy strand, respectively.
3. 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. For existing anchors, see Section 7.0.
5. New install safety factors for maximum allowable guy anchor load shall be used when replacing poles. In-service safety factors for maximum allowable guy anchor load shall be used when equipment or components are added or removed on in-service poles. Safety factors shown in this table are for anchors only, NOT for guying.
6. Guy angle (β) is the angle or resultant angle that guy wire(s) make with the pole. Complementary angle (α), which is the difference between 90° and β, is the angle to be used to compare with the anchors angle of inclination (φ). Phi (φ), measured from the ground, shall not be less than 15°.
7. Plate anchors shall be backfilled with selected native material fully compacted or tamped. For native soil backfill, compaction or tamping shall be done in layers of backfill. After placing the plate anchor, fill the hole with native materials up to 18 inches, compact or tamp the initial layer, fill the hole again up to 12 inches of backfill materials, compact or tamp this layer. This step shall be repeated at every 12 inches of backfill until reaching the ground line. Alternately, concrete slurry shall be used as backfill by filling the hole with 3-sacks concrete slurry after placing the plate anchor.

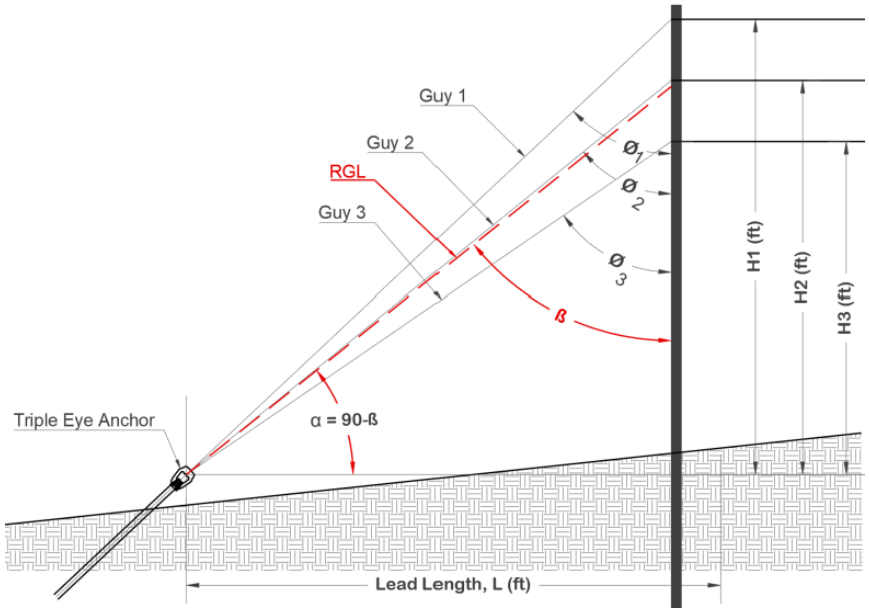
When a single guy is attached to the anchor, the load of a single guy shall not exceed the maximum allowable load. When two or three guys are attached to the anchor, the resultant guying load (RGL) shall not exceed the maximum allowable load. To calculate the resultant guying load (RGL), use the Anchor Calculator. Resultant guying load (RGL) and resulting guy angle ONLY applies to plate anchors.

Figure PO 310–3: Resultant Guying Load (RGL) Calculation



The guy height is the vertical distance from the point on the pole where the guy is attached and the anchor rod eye. This measurement should account for any slope in the finished grade to ensure accurate calculation. See Figure PO 310–4 and Figure PO 310–5.

Figure PO 310–4: Height Calculation with Pole Base Higher Than Anchor Eye

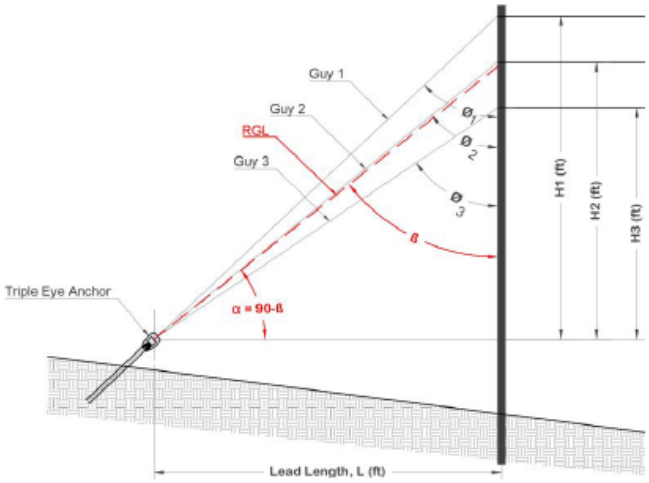


Height = Height of Guy - (Height of Anchor Eye below Pole Base)

Example: If the anchor is installed 10 ft **below** the ground line of the pole and the guy is attached 40 ft above the pole groundline, the Guy Height input the anchor tool should be 60 ft.

Height = (40’ - (-10’)) = 50’

Figure PO 310–5: Height Calculation with Pole Base Lower Than Anchor Eye



Height = Height of Guy - (Height of Anchor Eye above Pole Base)

Example: If the anchor is installed 20 ft **above** the ground line of the pole and the guy is attached 40 ft above the pole groundline, the Guy Height input the anchor tool should be 20 ft.

Height = (40’ - (20’)) = 20’

A. How to calculate Resultant Guying Load (RGL) and Guy Angle (β)

1. RGL when two guys are attached to an anchor

a. Calculate the horizontal (Fx) and vertical (Fy) components of each guy load

Fx_1 = Guy 1 Load x sin Ø1 Fy_1 = Guy 1 Load x cos Ø1

Fx_2 = Guy 2 Load x sin Ø2 Fy_2 = Guy 2 Load x cos Ø2

b. Sum of Horizontal and Vertical Forces

$$\Sigma Fx = Fx_1 + Fx_2$$
$$\Sigma Fy = Fy_1 + Fy_2$$

c. Resultant Guying Load (RGL)

$$RGL = \sqrt{(\Sigma Fx)^2 + (\Sigma Fy)^2}$$

d. RGL Guy Angle (β)

$$\beta = \arctan\frac{\Sigma Fx}{\Sigma Fy}$$

e. Calculate guy complementary angle (α). This is also the anchor angle of inclination (φ).

$$\alpha = \varphi = (90 - \beta)$$

f. Compare RGL guy complementary angle (α) to anchor angle of inclination (φ) from Table 14 to determine maximum allowable load to be used in the design. RGL guy complementary angle (α) shall be 7.50° < φ < 7.50°.
Phi (φ) is the guy angle per Table PO 310–7: For inclined angles: Min φ = 15°, Max φ = 67.50°; For sidewalk anchors, φ = 90° or 90°-7.50

2. RGL when three guys are attached to an anchor.

a. Calculate the horizontal (Fx) and vertical (Fy) components of each guy load



NOTE Guy load is the applied load from SPIDAcalc Analysis Results.

Fx_1 = Guy 1 Load x sin Ø1 Fy_1 = Guy 1 Load x cos Ø1
Fx_2 = Guy 2 Load x sin Ø2 Fy_2 = Guy 2 Load x cos Ø2
Fx_3 = Guy 3 Load x sin Ø3 Fy_3 = Guy 3 Load x cos Ø3

b. Sum of Horizontal and Vertical Forces

$$\Sigma Fx = Fx_1 + Fx_2 + Fx_3$$
$$\Sigma Fy = Fy_1 + Fy_2 + Fy_3$$

c. Resultant Guying Load (RGL)

$$RGL = \sqrt{(\Sigma Fx)^2 + (\Sigma Fy)^2}$$

d. RGL Guy Angle (β)

$$\beta = \arctan\frac{\Sigma Fx}{\Sigma Fy}$$

e. Calculate guy complementary angle (α). This angle is also the anchor angle of inclination (φ).

$$\alpha = \varphi = (90 - \beta)$$

f. Compare RGL guy complementary angle (α) to anchor angle of inclination (φ) from Table 14 to determine maximum allowable load to be used in the design. RGL guy complementary angle (α) shall be 7.50° < α < 7.50°.
Phi (φ) is the guy angle per Table PO 310–7: For inclined angles: Min φ = 15°, Max φ = 67.50°; For sidewalk anchors, φ = 90° or 90°- 7.50.

Table PO 310–8: Reduced Maximum Allowable Holding Capacity for Plate Guy Anchors

Plate Anchors	Spacing Between Anchors	Reduced Maximum Load Allowed When Spacing Cannot Be Achieved (lbs.)
17” x 17”	<4 ft	The anchors are limited to the holding capacity of one anchor. See Note 1.
	4 ft to < 5 ft	10,000
	5 ft to < 6 ft	15,000
	> 6 ft	18,000
23” x 23”	<4 ft	The anchors are limited to the holding capacity of one anchor. See Note 1.
	4 ft to < 5 ft	10,000
	5 ft to < 6 ft	15,000
	> 6 ft	21,000

Note(s):

1. New installations with two or more anchors spacing less than four feet, the anchors are limited to the holding capacity of one anchor. The new allowable holding capacity is the Maximum Holding capacity (Table PO 310–5) divided by the number of anchors.
   a. Example #1, two 17" x 17" plate anchors with soil type A at an anchor inclination angle (φ) of 45 degrees have a holding strength of 14,000 lbs (based on Table PO 310–7). Each anchor shall have a maximum holding capacity of 7,000 lbs. (14,000 lbs divided by the # of anchors).
   b. Example #2, two 23" x 23" plate anchors with soil type B at an anchor inclination angle (φ) of 15 degrees have a holding strength of 11,000 lbs (based on Table PO 310–7). Each anchor shall have a maximum holding capacity of 5,500 lbs. (11,000 lbs. divided by the number of anchors).

3.0 Rock Anchor

Rock anchors should be used when anchoring to solid rock. See PO 300 for guidance on criteria and requirements for rock anchor and anchor extensions.

Figure PO 310–6: Rock Anchor

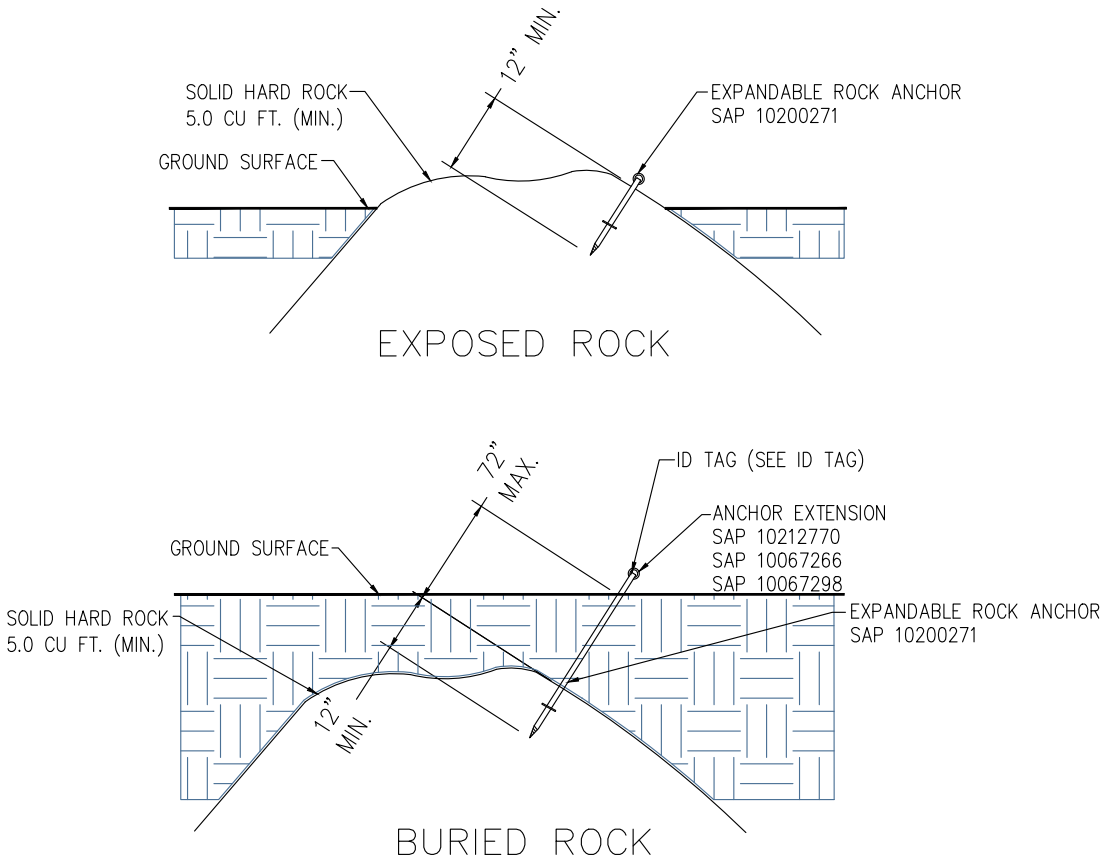


Table PO 310–9: Expanding Rock Anchor

Expanding Rock	SAP	Photo	Maximum Allowable Guy Anchor Load (lbs)		Guying Options
			New Installations (S.F.=1.5)	In-service (S.F.=1.33)	
3/4″ x 30″ Triple Eye	10215681		15,000	17,300	3-9/32", or 1-3/8" & 1-9/32″, or 1-7/16" & 1-9/32″
1″ x 30″ Triple Eye	10215682		24,000	27,000	2-3/8" & 1-9/32”, or 1-3/8" & 2-9/32", or 1-3/8" & 1-7/16”, or 2-7/16", or 3-9/32"

For Reference Only

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:

- For plate anchor extensions, the bottom of the eye shall be 4 inches minimum to 18 inches maximum above grade, measured along the rod. See Figure PO 310–2 for illustration.
- For PISA extensions, the bottom of the eye shall be 4 inches minimum above grade, with a maximum projections as follows:
  - 36 inches for 4 inch single helix and 8 inch single/double helix
  - 30 inches maximum for 10 inch double helix

Table PO 310–10: 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.

NOTE

To avoid risk of liability, it is important that all personnel be instructed to follow these requirements.

If an existing SCE anchor with a diameter of less than 1 inch is discovered during a project that requires pole loading, it must be removed and replaced with a standard approved anchor.

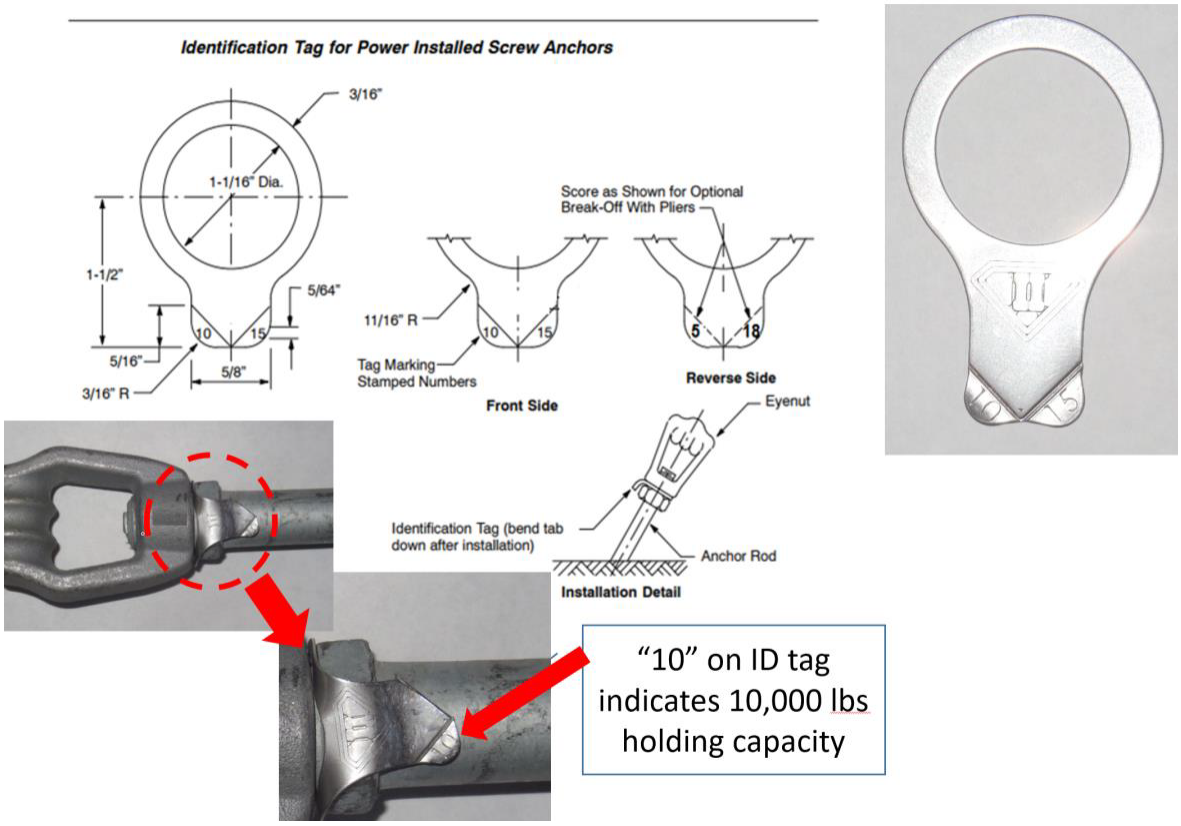
7.0 ID Tagging

Based on the soil type and installation method the anchor is tagged with the maximum capacity.

Based on the soil type and number sheared pins, the holding capacities can be 5,000 lbs, 10,000 lbs, 15,000 lbs, and 18,000 lbs, see Scope PO 310.2 Steps 9 through 15.

Figure PO 310–7: PISA ID Tag

PISA ID Tag (SAP 10214166)

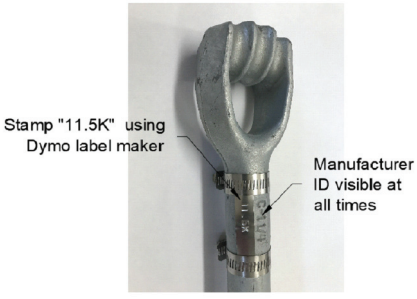


For rock, plate, and extensions, tag with the maximum holding capacity based on soil type and installation methods. See Table PO 310–7, Table PO 310–8: , and Table PO 310–9: .

Figure Note: Use this ID tagging method when the holding capacity of the anchor is 5, 10, 15 & 18kips. Otherwise, use method below.

Figure PO 310–8: Rock, Plate, and Extension Anchor ID Tag

Figure Note: When tagging PISA, use this ID tagging method when the holding capacity of the anchor is not listed in the four (4) available options shown in DOH Fig 310-3 above.



ID Tag

Scope PO 310.2 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), and Torque indicator pins (SAP 10148739) 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 310–8).

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 310–8).

STEP 5. Determine the minimum torque value needed for anchor installation. See examples for calculating holding strength Scope PO 310.3.

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 310–3).

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 310–3).

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 four of the pins that equal 10,000 lb holding capacity based on the number and diameter of the helices (single or double helix) (see Table PO 310–3).

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 310–3).

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 310–3 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.

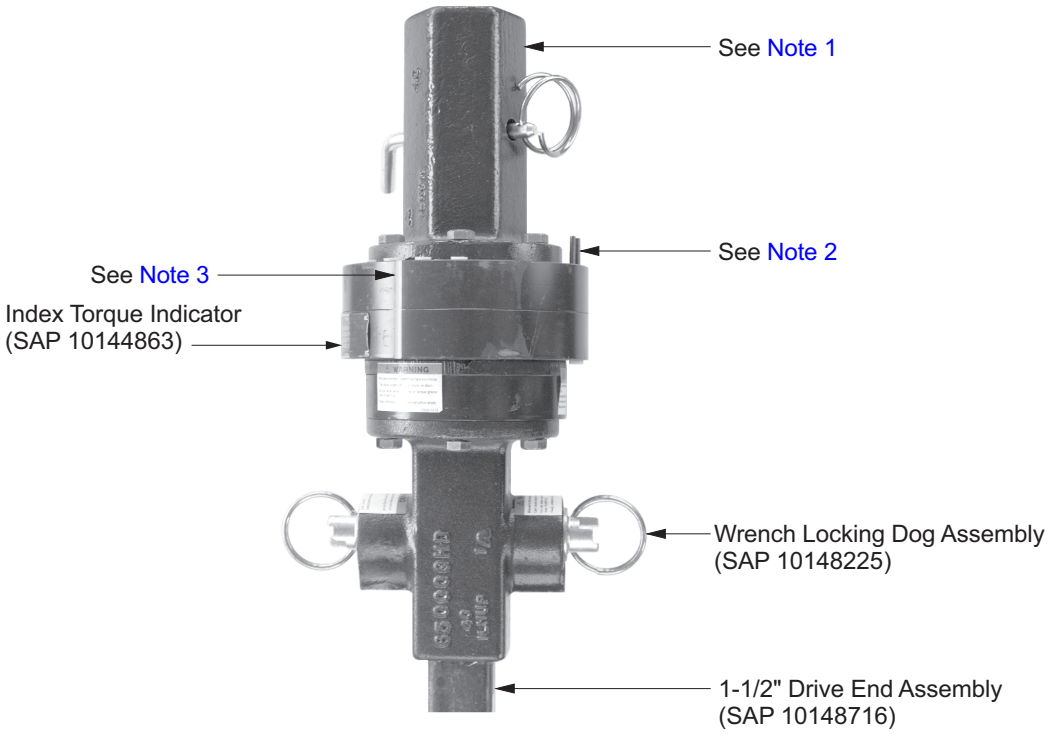
STEP 18. Withdraw Kelly bar adapter, Torque indicator and Drive end assembly.

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.

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 310–9: Power Installed Screw Anchors



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.)

Scope PO 310.3 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 310–3).

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 310–3, 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 insta

This page intentionally left blank.

PO 315 Anchor and Guying Components

Scope PO 315.1 Anchor and Guying Components

Table PO 315–1: Anchors and Guying Components

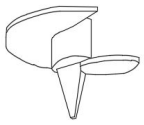
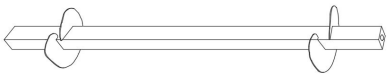
SAP	Description	
10200593	Pisa Anchor, Single 8" Helix	
10217543	8" Single Helix "Tough One or Turbo Socket" 10,000 FT-LBS Takes ¾" and 1" Anchor	
10217544	8" Single Helix "Tough One or Turbo Socket" 15,000 FT-LBS Takes ¾" and 1" Anchor	
10067289	Pisa Anchor, Double 4" Helix	
10200272	Pisa Anchor, Double 8" Helix	
10200180	Pisa Anchor, Double 10" Helix	
10067293	Anchor Rod, Single 4" Helix, Hand Installed, 5'6" × 3/4", Thimble Eye, Galvanized Steel*.(Key 10) * For temporary/emergency application ONLY, max. of 12 months. Maximum 2,000 lb working load limit.	

Table PO 315–1: Anchors and Guying Components *(Continued)*

SAP	Description	
10200271	Expanding Rock Anchor, 15" × 3/4" dia. Triple Eye, 1-3/4" to 2-3/8" Expanded, Galvanized Steel Expanded, Galvanized Steel	
10215681	Expanding Rock Anchor 30" x 3/4" dia. Triple Eye, Galvanized Steel	
10215682	Expanding Rock Anchor 30" x 1" dia. Triple Eye. Galvanized Steel	
10200179	Expanding Pole Key Anchor, 7" to 27-1/4" Expanded, Steel	
10067304 10210268	Cross Plate, Anchor, 17" x 17", Steel, is used with 1" Rod Cross Plate, Anchor, 23" x 23", 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 10210269 10067254	Rod, Anchor, 10' × 1" Triple Eye Rod, Galvanized Steel Rod, Anchor, 10' × 1-1/4", Triple Eye, Galvanized Steel Rod, Anchor, 10' × 1", Triple Eye, Stainless Steel, is used with Concrete Anchor Plate (SAP 10067305)	

Table PO 315–1: Anchors and Guying Components *(Continued)*

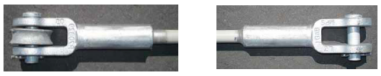
SAP	Description	
10212770	Anchor Extension, 1-1/4" × 2', 40,000 lb, is used when existing anchor is covered with soil due to grade change and does not meet the 4" to 36" distance in PO 310 and PO 350.	
10067266	Anchor Extension, 1-1/4" × 3'	
10067298	Anchor Extension, 1-1/4" × 6'	
10215705	Anchor Extension, 3/4" x 2'	
10067299	PISA Anchor Extension, 1" × 3-1/2' with Coupler	
10217791	PISA Coupler for 1" Dia.rod size ONLY	
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.	

Table PO 315–1: Anchors and Guying Components *(Continued)*

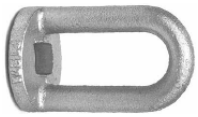
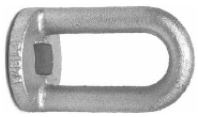
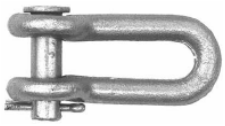
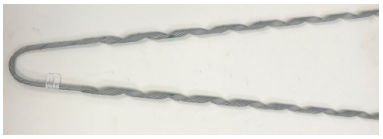
SAP	Description	
10181650	Guying Attachment, 35,000 lb, also known as a Guying Tee, is used to make attachments at the pole. The stem mounting hole can be used to attach guy rod insulators and preformed type guy grips attach directly through the seat on the pole side of the guy attachment.	
10067854	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.	
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.	

Table PO 315–1: Anchors and Guying Components *(Continued)*

SAP	Description	
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 10067958 10067961 10067959 10067845	7/32" Preformed Dead-End Guy Grip (Green) 9/32" Preformed Dead-End Guy Grip (Blue) 7/16" Preformed Dead-End Guy Grip (Green) 3/8" Preformed Dead-End Guy Grip (Orange) 3/8" Preformed Dead-End Guy Grip (Orange)[a/]	
10212698 10212697 10212658 10212657	5/16" Preformed Dead-End Shunt Guy Grip (Green) 9/32" Preformed Dead-End Shunt Guy Grip (Blue) 7/16" Preformed Dead-End Shunt Guy Grip (Green) 3/8" Preformed Dead-End Shunt Guy Grip (Orange)	
10110468 10110471 10110475 10110473	7/32" Guy Wire, E.H.S 9/32" Guy Wire, E.H.S 7/16" Guy Wire, E.H.S. 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

This page intentionally left blank.

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	
	350	19	3,260	
	500	37	3,260	
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.

FOR REFERENCE ONLY

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	Deviation Angles (Degrees)											
			5	10	15	20	25	30	35	40	45	50	55	60
			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

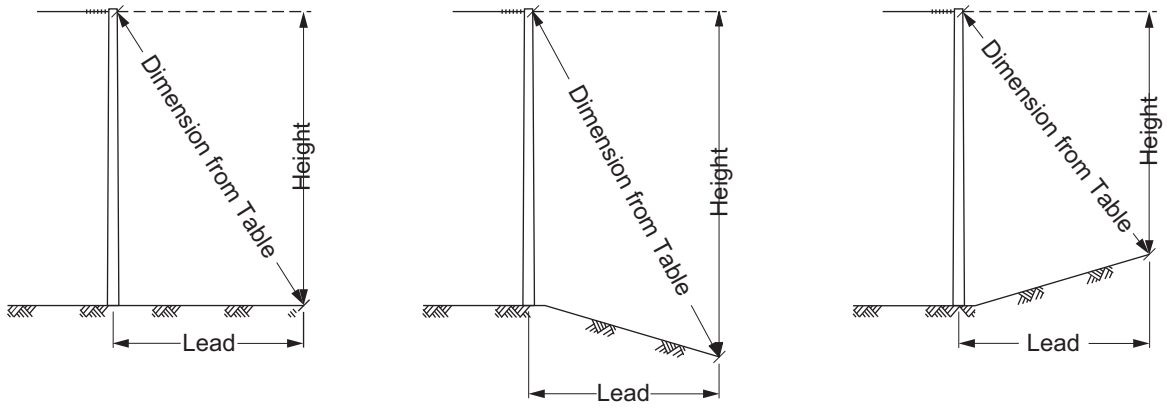
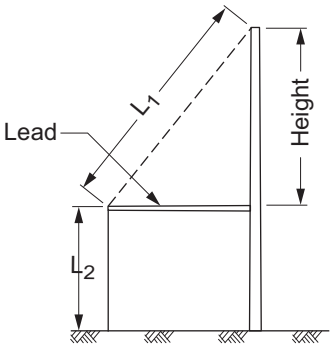


Table PO 320–8: Length of Guy Wire

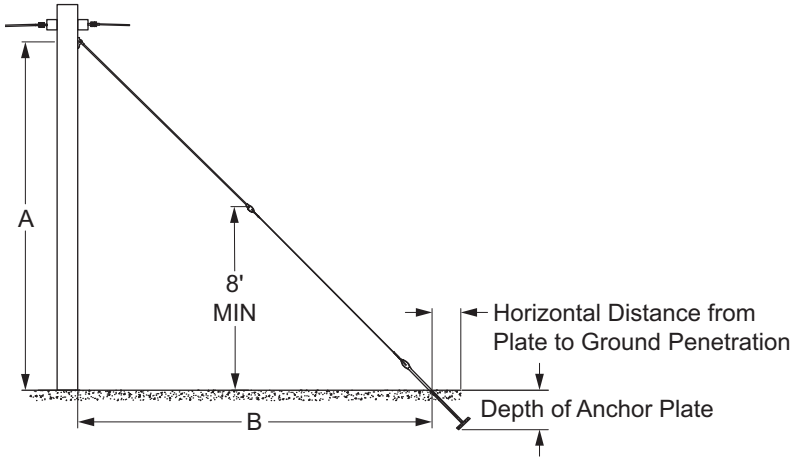
Height (ft)	Lead (ft)																
	10	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**
10	14	18	23	27	32	37	42	46	51	56	61	66	71	76	81	86	92
15	18	21	25	30	34	39	42	48	53	58	62	67	72	77	82	87	92
20	23	25	28	33	36	41	45	50	54	59	64	68	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

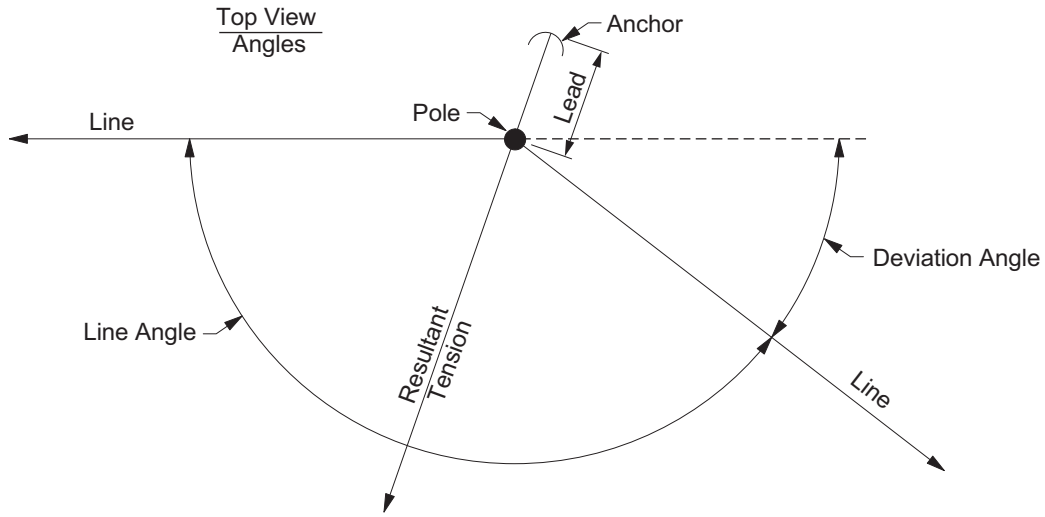
PO 330 Determination of Anchor Deviation Angle

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



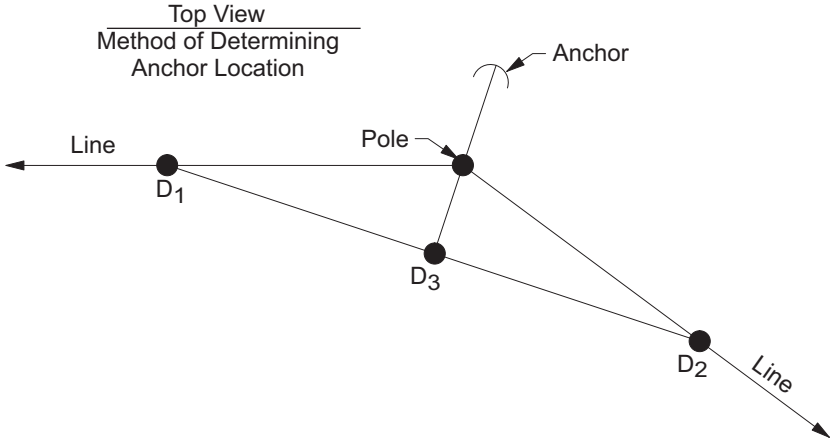
2.0 Determination of Side Anchor Location

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. $\left(D_3 = \frac{1/2}{D_1 D_2}\right)$

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

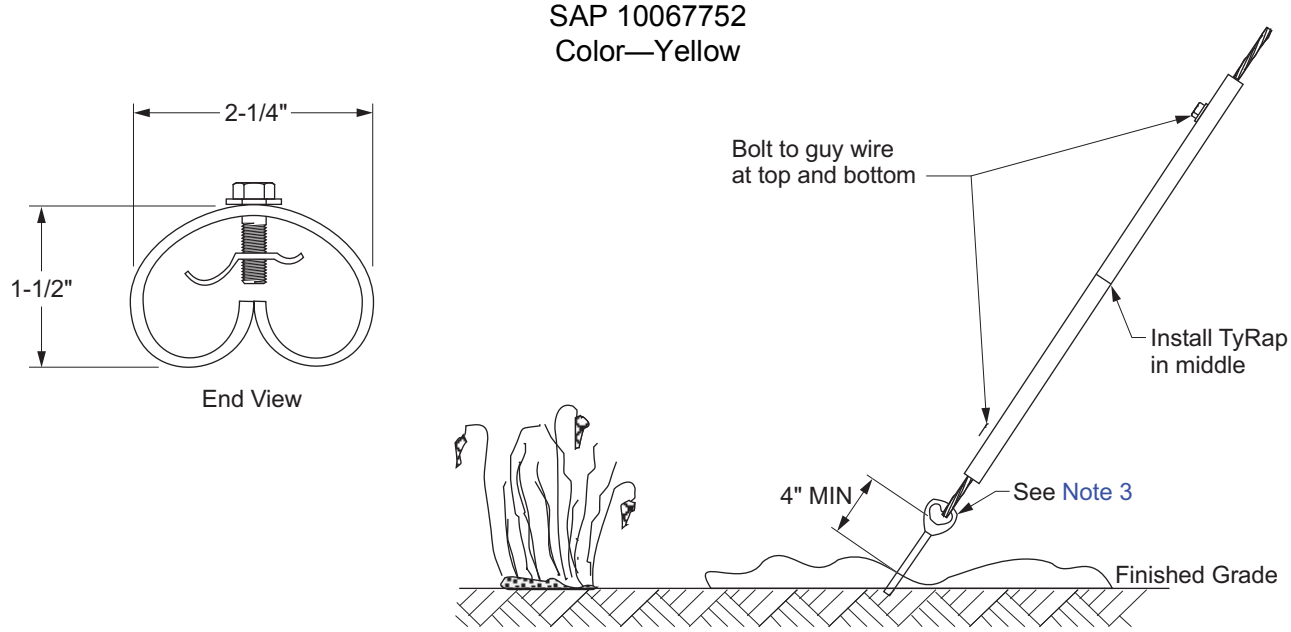


PO 350 Guy Guards

Scope PO 350.1 Approved Guy Guards, Application, and Installation Information

Figure PO 350–1: Plastic "Snapper" Guy Guard

SAP 10067752
Color—Yellow

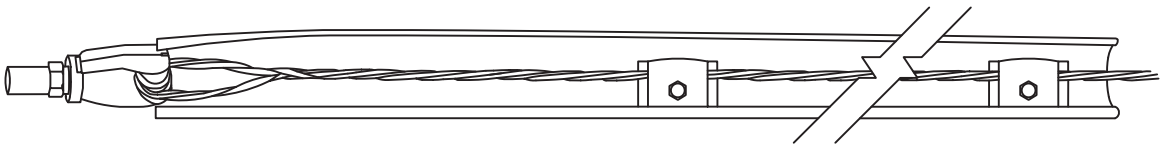


Application

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

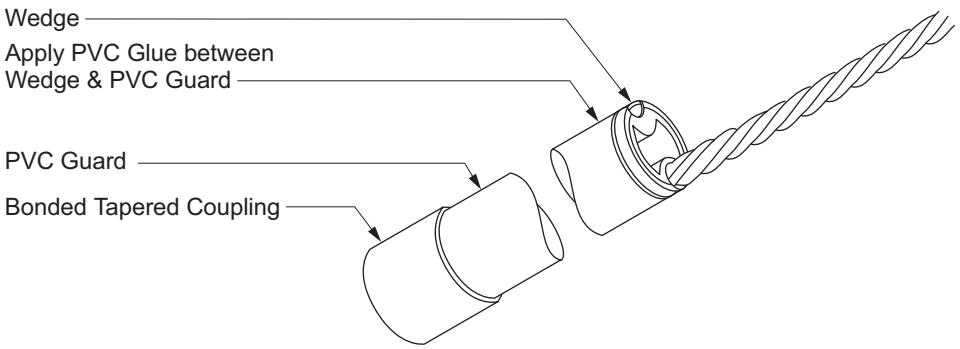


Application

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.

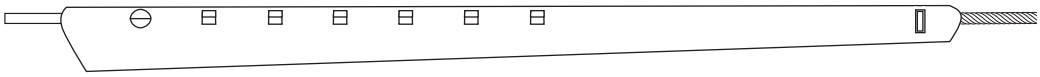
Install PVC wedge after guard is in place.

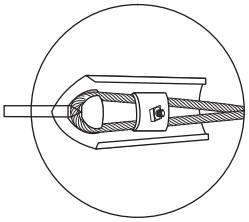
Note(s):

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.

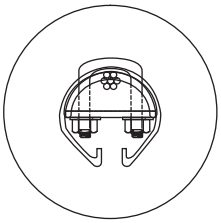
Figure PO 350–4: Half Round Steel Guy Guard

SAP 10067971





Bottom Clamp Detail



Top Clamp Detail

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

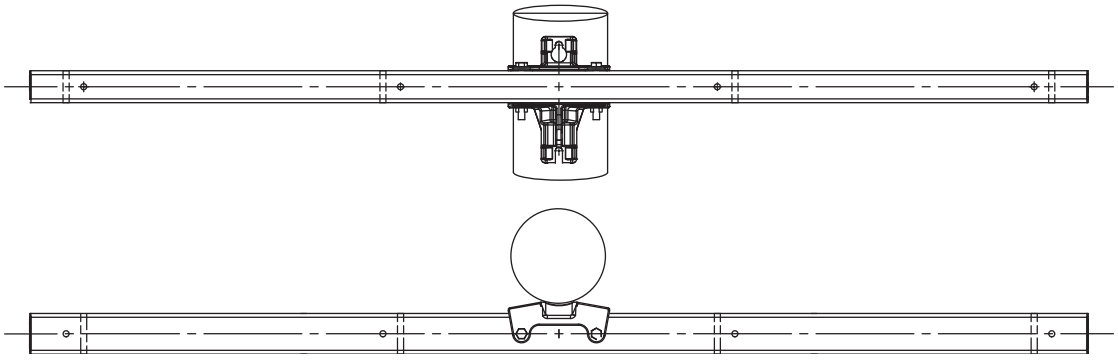


Table PO 370–1: Heavy Duty Crossarm SAP Numbers

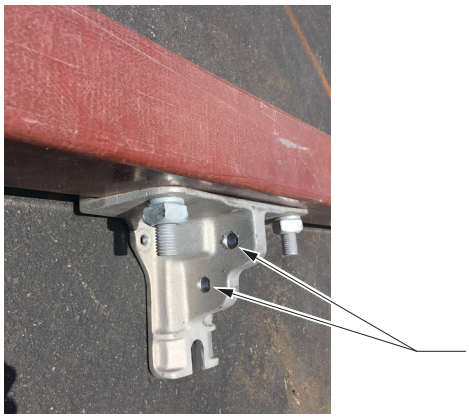
Type	Size (ft)	SAP
Tangent	5	10211425
Tangent	8	10060793
Tangent	10	10060794
Tangent	12	10060795
Tangent	20	10208033
Dead-End	8	10060796
Dead-End	10	10060797
Dead-End	12	10060798
Dead-End	20	10208513
Tangent Alley Arm	10	10211423
Tangent Alley Arm	12	10211424

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. 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 Composite Crossarm Hardware

2.1 Flat Washers

Flat square washers shall be used on all composite crossarm installations. **Washer size is determined by the size of the crossarm face on which the washer will be mounted.** Refer to Table PO 370-2 for appropriate washer sizing.

Table PO 370–2: Appropriate Washer Sizing for Composite Crossarm Faces.

Composite Crossarm Length (ft)	Crossarm Face	Required Flat Washer
10’ and below	Smaller face (3-5/8”)	3-1/2” x 3-1/2”a/
	Larger face (4-5/8”)	4” x 4”
12’ and below	Smaller face (4”)	4” x 4”
	Larger face (6”)	6” x 6”

a/: 4” x 4” washer is acceptable when 3-1/2” x 3-1/2” washer is not available.

Table PO 370–3: SAP Numbers for Flat Square Washers

Washer Size	SAP No.
3-1/2” x 3-1/2”	10217099
4” x 4”	10071859
6” x 6”	10217613

2.2 Additional Hardware

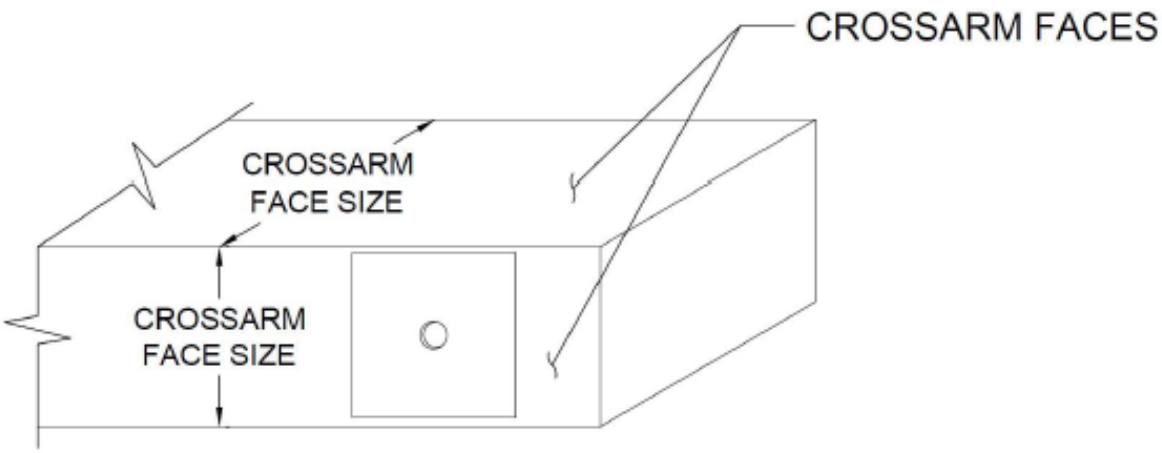
For 12 feet composite crossarm deadend configuration where the distance between V-Brace washer and jumper support washer is less than 1-1/2” inches, utilize 6”x6” washer on the V-Brace and 4”x4” washer on the jumper insulator support.

Refer to PO 370 2.1 for more details regarding washer size requirements. Fuse holder, pot head, and lightning arresters do not require washers on the “L” bracket side.

Steel straight pin insulators require flat square washers installed on the topside of the composite crossarm if mounted on the 4”, 4-5/8”, and 6” crossarm faces. Flat square washers are not required on the 3-5/8” face. Washers are required on the underside of the composite crossarm for all steel straight pin insulator installations. Refer to Table PO 370-2 for washer sizing.

Angle pins and post-type insulators will not require washers when installed on the topside of the composite crossarms. Washers are rquired on the underside of the composite crossarm for all angle pin and post-type insulator installations.

Figure PO 370–3: Composite Crossarm Diagram



Note(s):

1. Washer size is determined by the size of the crossarm face on which the washer will be mounted. See Table PO 370-2.

3.0 Riser Support

Figure PO 370–4: Riser Support



Table PO 370–4: Riser Support

Size	SAP
24” Extended	10073393

Table Note: Attach risers as described in PO 112, and refer to the Distribution Underground Construction Standards (DUG) Section CR 110.

4.0 Pole Hole Plug

4.1 Pole hole plugs shall be installed in open composite pole holes per Table PO 370–6 to prevent bugs and moisture intrusion. Only use High Temperature plugs in Bulletin 322 and/or High Fire Risk Areas (HFRA).

Table PO 370–5: 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 370–6: 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
5/8 – 1-1/2	10222066

= For Reference Only

5.0 Insulated Clamp for Ground Wire

For use on composite poles, use (2) #10 × 2" self-drilling screws (SAP 10071503).

Figure PO 370–5: Insulated Clamp and (2) Self-drilling Screws

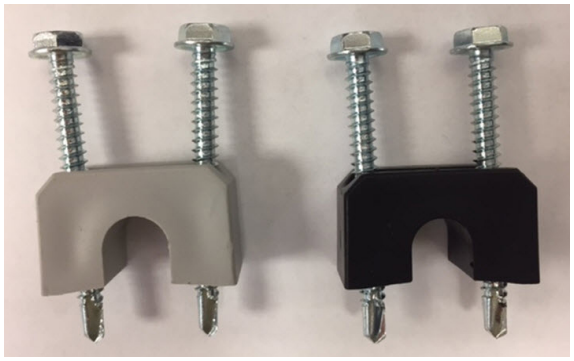


Table PO 370–7: Insulated Clamp and (2) Self-drilling Screws

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

6.0 Bonding Clip

Figure PO 370–6: Bonding Clip



Table PO 370–8: Bonding Clip

Description	Quantity	Size	SAP
Bonding Clip	1	1/8"	10113253
Self-drilling Screw	1	#10 × 1"	10072230

7.0 Thimble Eyelet

Figure PO 370–7: Thimble Eyelet



Table PO 370–9: Thimble Eyelet

Type	Application	Size	SAP
Standard	Span Guys	5/8"	10068524
		3/4"	10068525

8.0 Pole-Top Cap

Pole-top caps (see Figure PO 370–8) 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 370–8: 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 370–10: 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.

9.0 Spring Washer

Hardware for composite poles shall be tightened until the spring washer has been compressed to where the springs just touch.

Figure PO 370–9: Spring Washer



Table PO 370–11: Spring Washer

Size	SAP
3/8"	10072344
1/2"	10072345
5/8"	10072346
3/4"	10072347

10.0 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 370–10: Composite Pole Guying Tee

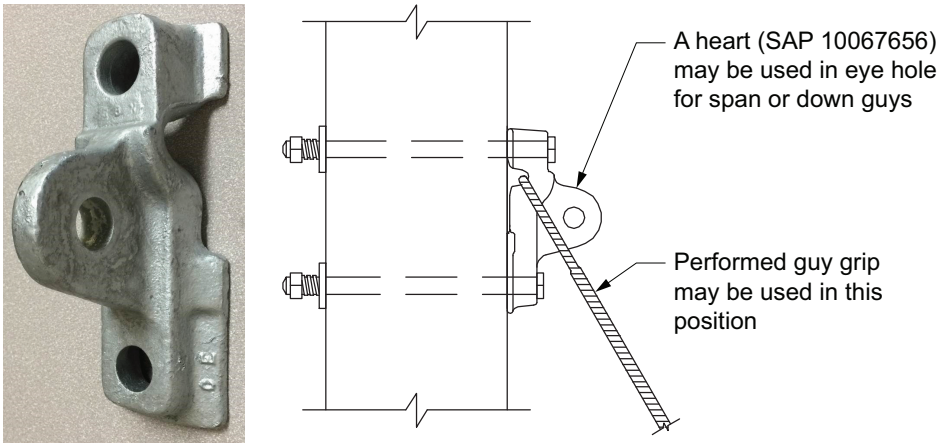


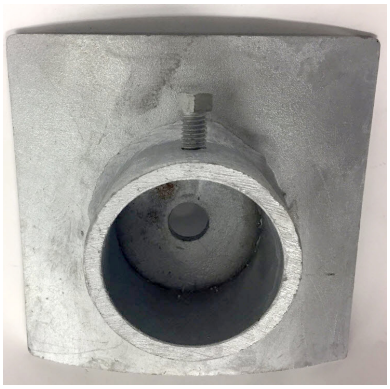
Table PO 370–12: Composite Pole Guying Tee

Maximum Working Load (lb)	SAP
10,400	10181650

11.0 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 370–16 for details).

Figure PO 370–11: Pole Plate



12.0 Thimble Eye Bolt

Straight thimble eye bolts are to be used for span guys.

Figure PO 370–12: Thimble Eye Bolt, Straight Type



Table PO 370–13: 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

13.0 Pole Band

Figure PO 370–13: Stainless Steel Pole Band

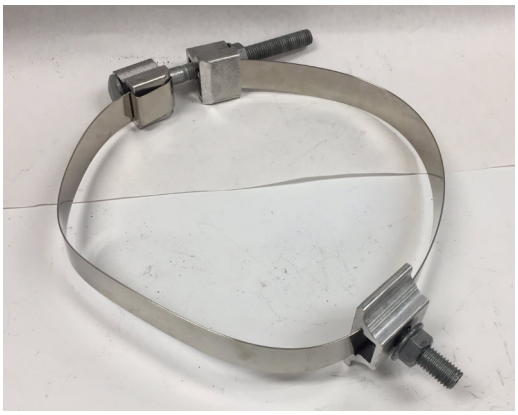


Table PO 370–14: Stainless Steel Pole Band

Size (in)	SAP
1-1/4	10209449

14.0 Flat Square Washer

Figure PO 370–14: Flat Square Washer

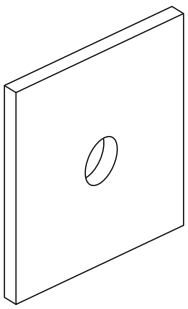


Table PO 370–15: Flat Square Washer

Size	Bolt Hole	SAP
3-1/2” x 3-1/2” x 1/4”	13/16"	10217099
4" × 4" × 1/4"	13/16"	10071859
6” x 6” x 1/4”	13/16"	10217613

15.0 Standoff Bracket

Figure PO 370–15: Standoff Bracket



Note(s):

1. Standoff bracket shall be used only with composite crossarms and V-Braces.

Table PO 370–16: Standoff Bracket

Size	SAP
4” x 4”, R 4-1/2”	10214167

16.0 Curved Square Washer

Figure PO 370–16: Curved Square Washer

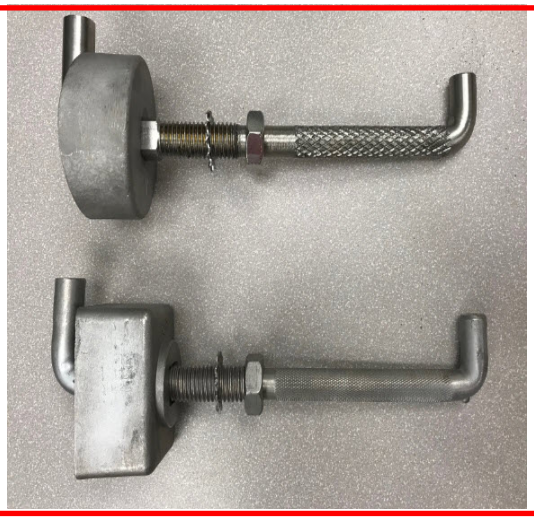


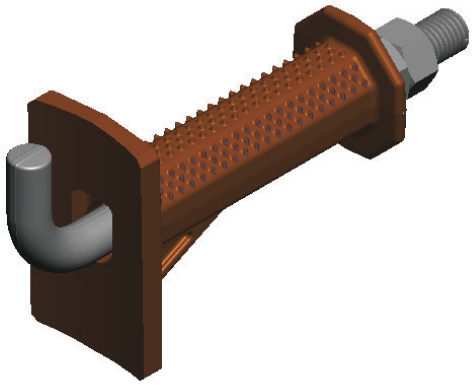
Table PO 370–17: Curved Square Washer

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

17.0 Permanent/Temporary Climbing Step

Figure PO 370–17: Permanent/Temporary Climbing Steps





= FOR REFERENCE ONLY

Table PO 370–18: Permanent/Temporary Climbing Steps

Table Note: For installation, application or, assembly details, see PO 112.

Pole	SAP
Round	10068660 (Key 6)
Round	10221248

18.0 Temporary Pole Step Plate

Figure PO 370–18: Temporary Pole Step Mounting Assembly



Table PO 370–19: Temporary Pole Step Mounting Assembly

Table Note: For installation, application or, assembly details see PO 112.

Pole	Washer	SAP
Round	Curved	10068609

19.0 Detachable Temporary Pole Step

Figure PO 370–19: Detachable Temporary Pole Step



Table PO 370–20: Detachable Temporary Pole Step

Table Note: For installation, application or, assembly details, see PO 112.

Size	SAP
5-1/2"	10068470

= FOR REFERENCE ONLY

20.0 Mast Arm

Figure PO 370–20: Mast Arms



Table PO 370–21: Mast Arm

Size	SAP
30"	10118514
6'	10118515
16'	10200181

21.0 Insulator Pin

Figure PO 370–21: Insulator Pin



Table PO 370–22: 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

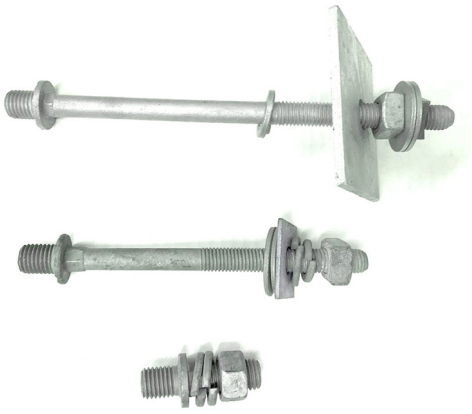
NOTE Install 4" × 4" flat square washer (SAP 10071859) on the underside of composite arms with straight steel pins and angle pins.

22.0 Insulator Studs

Table PO 370–23: 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 370–22: Insulator Studs



23.0 Ridge Pin Bracket

Figure PO 370–23: Ridge Pin Bracket



Table PO 370–24: Ridge Pin Bracket

Size	SAP
Universal	10067373

24.0 Protected Ground Wire

Figure PO 370–24: Protected Ground Wire



Table PO 370–25: Protected Ground Wire

Size	SAP
4 AWG	10109304
6 AWG	10109302

25.0 No Drill Zone Decal for Intelli-Pole

Figure PO 370–25: No Drill Zone Decal



Table PO 370–26: 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.

26.0 Visibility Strip

Figure PO 370–26: Visibility Strip



Table PO 370–27: Visibility Strip

Description	Quantity	Size	SAP
Visibility Strip	1	2" × 12"	10068488
Self-drilling Screw	2	#10 × 1"	10072230