Prepared by: SXZO

CONSTRUCTION REQUIREMENTS FOR POLE LINE GUYS 022178

Asset Type:	Electric Distribution and Transmission	**Function:**	Construction and Maintenance
Issued by:	Sanchez, Eduardo C. (ECS4)	**Date:**	07-31-15

Rev. #07: This document replaces PG&E Document 022178, Rev. #06. For a description of the changes, see Page 26.

This document is also included in the following manual:

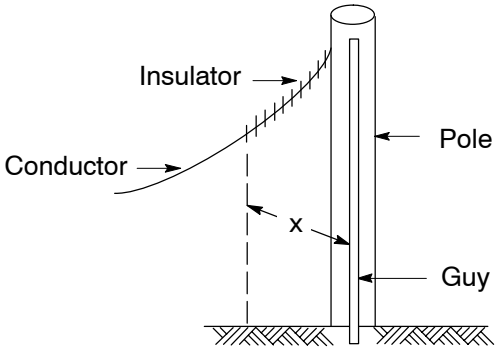
- *Electric Design Manual*

Purpose and Scope

This document describes the construction requirements for various types of pole line guys.

General Information

1. A guy is in **"proximity"** if any portion of the guy is both within a vertical distance of less than 8 feet from the level of the supply conductors, and a radial distance of less than 6 feet from the surface of a wood pole or structure.
2. A guy is **"exposed"** if any portion of the guy is less than 8 feet horizontally from the vertical plane of any supply conductor of more than 250 V.



If distance "x" is less than 8', guy is exposed.

Figure 1
Exposed Guy

If a guy is exposed to any supply conductor of 22,500 volts or more, it will not be sectionalized and shall be securely grounded. All other guys, including overhead guys and guys in the proximity (i.e., cylinder of proximity), shall be sectionalized.

3. Any two anchor or overhead guys attached to the same wood pole, which are approximately parallel to each other and act in the same direction, should be separated at the points of attachment to the pole by approximately 12 inches if either of the guys is sectionalized. The purpose of this separation is to maintain a minimum separation of 3 inches between the surface of a strain insulator in one guy and the surface of the other guy. If this minimum separation of 3 inches is not obtained by the 12-inch separation at pole, use other means, such as greater separation than 12 inches, or attachment to separate anchors. This rule does not prohibit the two guys from contacting the same strain plate, nor does it prohibit attaching guys not acting in the same direction to the same through bolt. See Figure 19 on Page 10 for another method of obtaining the 3-inch separation.
4. Not more than two guys, having a vertical separation of 18 inches or less, can be installed in any 4-foot section of climbing space.
5. Overhead guys less than 17 feet long with neither end grounded, shall be sectionalized by installing one insulator approximately midway between points of attachment, in place of two insulators between 6 and 9 feet from each end.

6. Place sectionalizing insulators in guys as high as permissible, giving due consideration to the future installation of additional supply circuits. This is necessary to prevent the grounding of the upper end of such guys by the future installation of grounded telephone cables, tree growth, etc.
7. Guys may be grounded by connecting them to a metallic anchor rod, a securely grounded steel pole, a ground rod, or another grounded guy.
8. The requirements for grounding or sectionalizing sidewalk and truss guys, and the conditions under which they may be grounded, are the same as for anchor guys. Braces for these guys which fall within cylinders of proximity (i.e., braces that are less than 8 feet below supply conductors of 0–35,500 V), must not be grounded.
9. Those portions of guys that are more than 6 inches from the surface of wood poles or crossarms (measured from the point of attachment along the guy) shall clear transformer cases and hangers by not less than 4 inches. Those portions that are less than 6 inches from the surface of wood poles or crossarms shall clear transformer cases and hangers by not less than 1-1/2 inches.
10. Guys in climbing space may not be closer than 1-1/2 inches to any through bolt that is mechanically connected to dead-end hardware. Guys and guy attachments shall clear ground wires and metal riser conduits for supply cables by 1-1/2 inches minimum.

References	Location	Document
Guy Grips, Clamps, and Splices	OH: Guys	06537
Guy Markers	OH: Guys	06542
Installation of Grounds on Wood Pole Transmission and Distribution Lines	OH: Transformers	021904
Anchors for Pole Line Guys	OH: Guys	022221
Pin, Post, and Dead-end insulators for distribution lines	OH: Guys	022088
Guy Hooks, Pole Plates, and Thimbles for Wood Pole Lines	ELS	023569
Primary Voltage Areas	EDM/EPM	054040
Miscellaneous Hardware for Overhead Line Construction	OH: Framing	058778
Adding Load to an Existing Anchor – Attachment #1	OH: Guys	

Table 1 Minimum Radial Clearance Between Guy Wires Passing Conductors Supported on the Same Poles

Voltage	Clearance
Communication	3” [1]
0–750	3”
750–7,500	6”
7,500–20,000	9”
20,000–35,000	12”
35,000–75,000	18”
75,000–150,000	27”

[1] For exception, see Note 2 on Page 6.

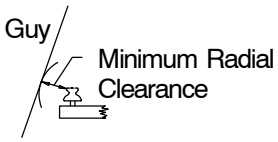


Figure 2
Radial Clearance

Note: The minimal radial clearance illustrated in Figure 2 and listed in Table 1 applies to all succeeding sketches.

Notes

1. The voltages shown in the following cases are those used in G.O. 95 to define the requirements of guys that are "in proximity" or "exposed." Except when not feasible for trolley circuits or jointly owned poles, the high voltage circuit is always carried at the higher level on the pole.
2. Dimension "X" in Figure 7 and Figure 8 on Page 5 shall not be less than 6 feet or more than 9 feet, measured along the guys, from the point of attachment to the pole, arm, or structure.
3. Depiction of various other cases can be found in Appendix G of G.O. 95, Figures 44 to 52.

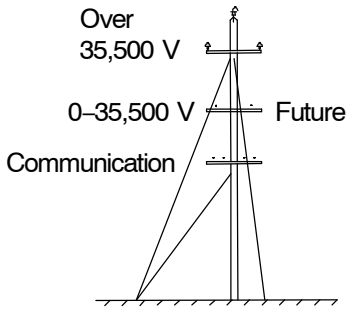


Figure 3
Case One

Case One

These guys are not in proximity to supply conductors of 0–35,500 V, but are exposed to conductors over 22,500 V. The guys shall not be sectionalized and must be grounded. If the addition of circuits less than 35,500 V is a possibility, insulators may be installed in the guys, but must be shorted out until the circuit(s) are constructed (see Figure 21 on Page 10).

Case Two

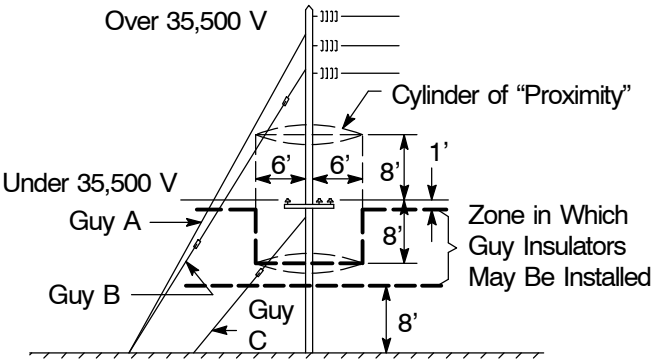


Figure 4
Case Two

Guy A is not in proximity to supply conductors of 0–35,500 V and is not exposed. Since Guy A is not in proximity and is not exposed, there is no requirement to add sectionalizing. (Note: Guy A may be sectionalized if required by permitting agency.)

Guys B and C are in proximity to supply conductors of 0–35,500 V. Install insulators as shown.

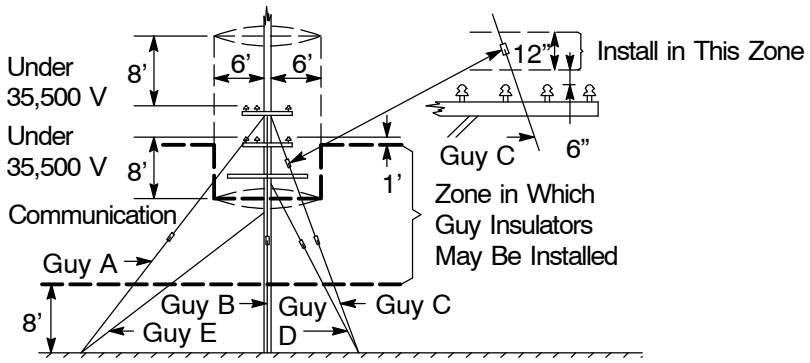


Figure 5
Case Three

Case Three

Guys A, B, C, and D are in proximity to supply conductors of 0–35,500 V.

Guy A passes through the level of communication conductors outside the outer pin position and Guy B passes through this level between pole pin positions. Install one insulator each guy.

Guy C passes through the level of communication conductors at a position other than outside the outer pin position or between pole pin positions. Install two insulators as indicated.

Guy D, install one insulator.

Guy E is not in proximity to supply conductors of 0–35,500 V and need not be sectionalized. If conductors of over 22,500 V are present, the guy **shall not** be sectionalized because it is exposed to more than 22,500 V while not in proximity.

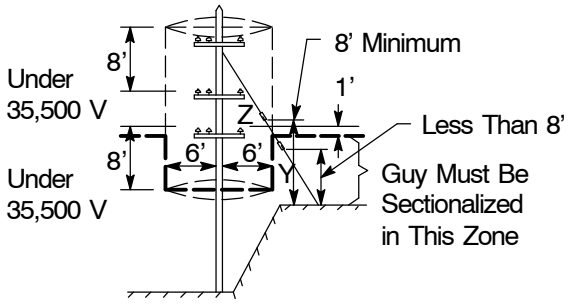


Figure 6
Case Four

Case Four

Guy is in proximity to supply conductors of 0–35,500 V.

If a guy insulator Y, installed outside the cylinder of proximity and at least 1 foot below the lowest supply conductors, is less than 8 feet above ground, install a second insulator Z, not less than 8 feet above ground.

Construction Requirements for Pole Line Guys

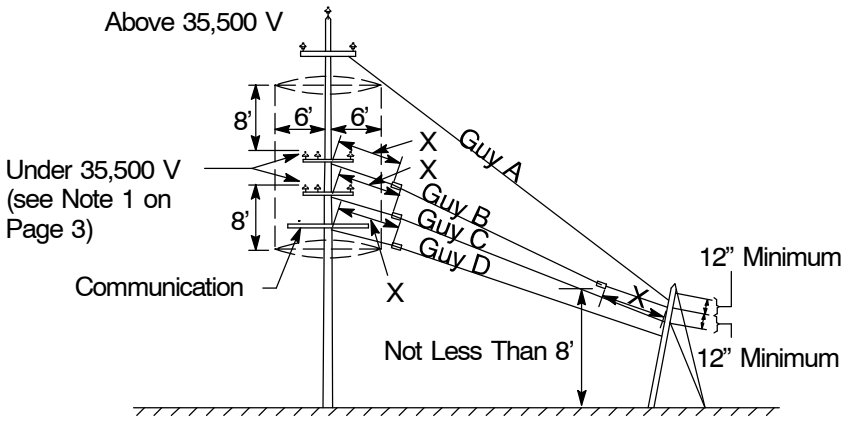


Figure 7
Case Five

Case Five

All guys are exposed to conductors of more than 22,500 V.

Guy A is not in proximity to supply conductors of 0–35,500 V. It shall not be sectionalized and shall be grounded.

Guy B is in proximity to supply conductors of 0–35,500 V and is not grounded. Install two insulators.

Guy C is in proximity to supply conductors of 0–35,500 V and is grounded. Install one insulator.

Guy D is in proximity to supply conductors of 0–35,500 V on one pole only and is not grounded but is attached at the level of communication conductors. Install one insulator.

Ground overhead guys by connecting to grounded anchor guys wherever possible to avoid unnecessary use of insulators. See Guy C above.

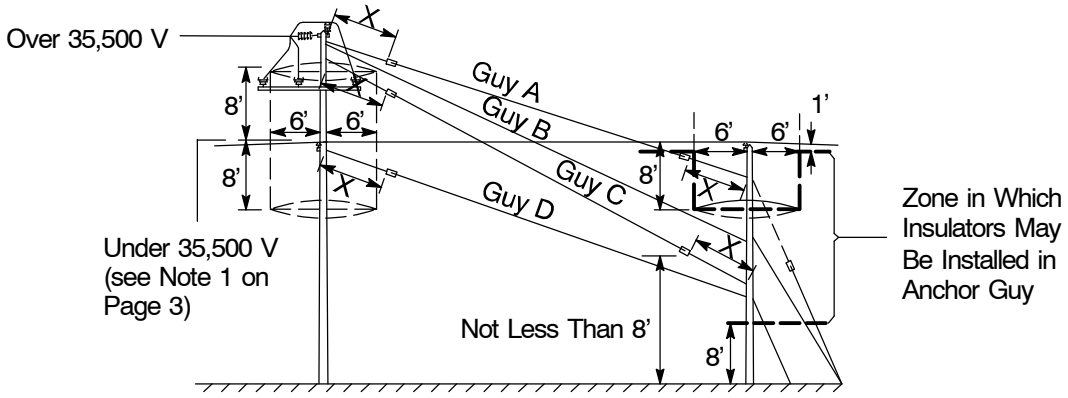


Figure 8
Case Six

Case Six

All guys are exposed to conductors of over 22,500 V.

Guy A is in proximity to supply conductors of 0–35,500 V on the pole at the right. Install two insulators in the overhead guy and one in the anchor guy.

Guy B is not in proximity to supply conductors of 0–35,500 V in either pole. The guy shall not be sectionalized and shall be grounded.

Guy C is in proximity to supply conductors of 0–35,500 V on the pole at the left and is not grounded. Install two insulators.

Guy D is in proximity to supply conductors of 0–35,500 V on the pole at the left and is grounded. Install one insulator.

Clearances

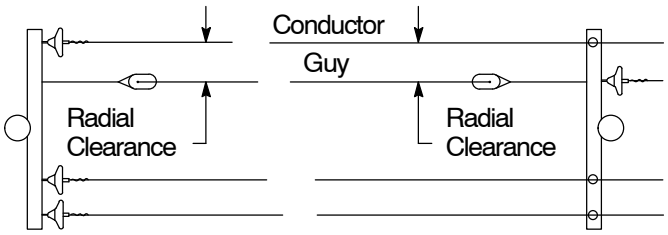


Figure 9
Radial Clearance
(see Note 1)

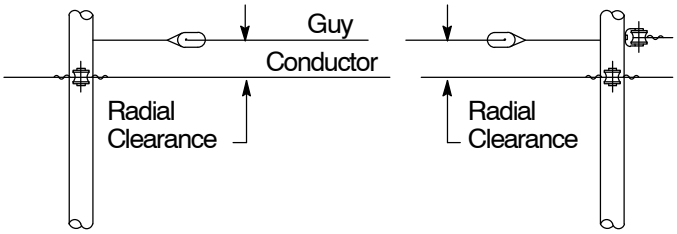


Figure 10
Radial Clearance
(see Note 1)

Notes

1. Overhead guys that are approximately parallel to conductors supported on the same poles that the guys are attached to, or passing conductors supported on other poles, shall clear such conductors by the following radial distances:

   Communications Conductors . . 3”
   0-750 V Conductors . . . . . 12”
   750-20,000 V Conductors . . . . . 18”
   20,000-35,000 V Conductors . . 24”

   For illustrations, see Figure 9 and Figure 10.

2. The 3-inch clearance between supply-line guys and the communication conductors attached to the same poles (specified in Table 1 on Page 2) shall be maintained under all conditions, including deflections of wires due to wind or to service pulloffs, etc. Where the 3-inch clearance cannot be maintained between supply line guys and the communication cables and/or messengers, all of the following requirements shall be met:

   A. The guy shall not be in proximity (see Note 1 on Page 1) to supply line conductors less than 6 feet above the communication messenger and/or cable.

   B. An approved guy insulator shall be installed in the guy, located as illustrated in Figure 11 through Figure 14 on Page 7.

   C. A suitable plastic guard shall be placed on the messenger and/or cable, or on the guy wire to prevent physical contact and resultant mechanical damage. A detail of the guard installation on a guy wire is illustrated in Figure 15 on Page 7.

Clearances (continued)

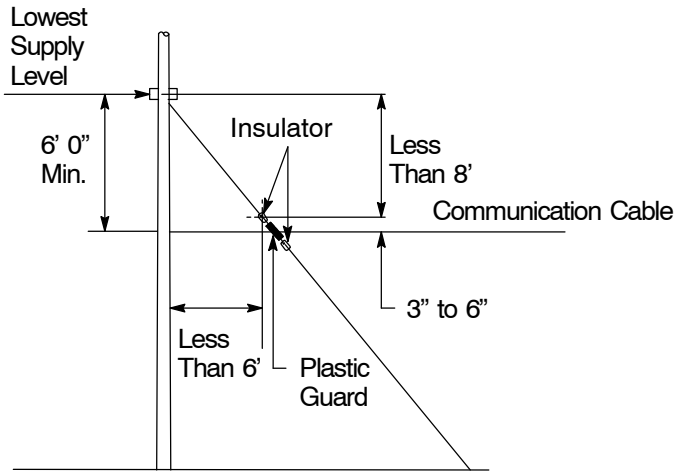


Figure 11
Guy Clearance
(see Note 2 on Page 6)

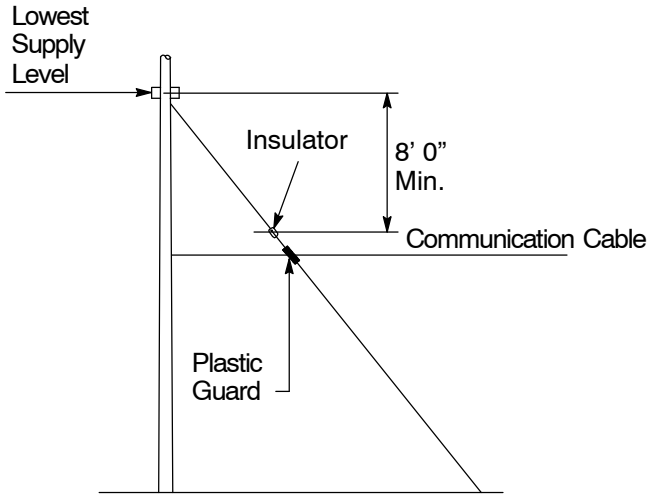


Figure 12
Guy Clearance
(see Note 2 on Page 6)

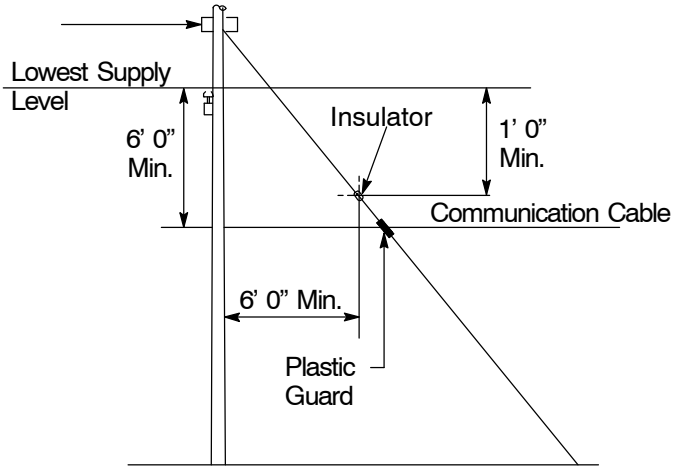


Figure 13
Guy Clearance
(see Note 2 on Page 6)

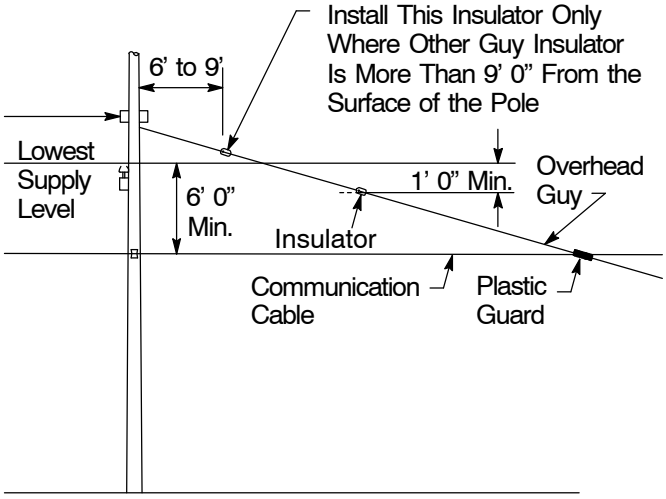


Figure 14
Guy Clearance
(see Note 2 on Page 6)

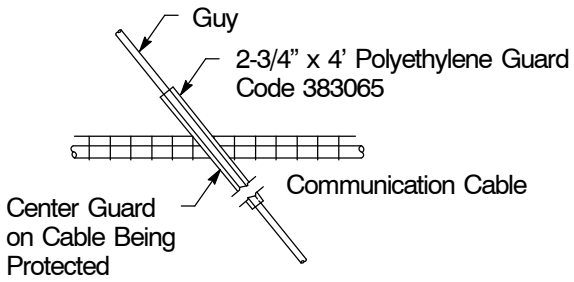


Figure 15
Guy Clearance
(see Note 2 on Page 6)

Anchors and Guy Strands

Table 2 Maximum Allowable Load for Non-PISA Anchors and Anchor Rods

Max. Allowable Load (lbs.)	Class of Soil	Anchors (see Note 1 on Page 9)		Anchor Rods-Steel		Number and Size of Guy Strand 7 Strand (except as noted)	
		Size	Code	Size	Code	Galvanized Steel Extra High Strength	Alumoweld (see Note 4 on Page 9)
2,500	A	16” Cross Plate	185103	5/8” x 6’ 0”	185050	One 7/32” 3-Wire	One 5M3
	B	8” Expanding	185012				
	D	8” Swamp	185109	See Note 3 on Page 9			
4,000 [2]	A, B	Manta Ray MR-4	180041	5/8” x 8’ 0”	185051	One 5/16”	One 10M
6,000	A	16” Cross Plate	185103	5/8” x 8’ 0”	185051	One 5/16” or One 10M (to 5,000 lbs. max.) One 3/8” or One 16M (over 5,000 lbs.)	
	B	8” Expanding	185012				
	D	13-1/2” Swamp	185110	See Note 3 on Page 9			
7,500 [2]	A, B	Manta Ray MR-3	180042	5/8” x 8’ 0”	185051	One 3/8”	One 16M
7,500	A	16” Cross Plate	185103	3/4” x 9’ 0”	185065		
	B	8” Expanding	185012				
	D	13-1/2” Swamp	185110	See Note 3 on Page 9			
10,000 [2]	A, B	Manta Ray MR-2	026823	3/4” x 7’ 0”	185143	One 7/16”	One 20M
10,000	A	16” Cross Plate	185103	3/4” x 9’ 0”	185065		
	B	8” Expanding	185012				
	D	13-1/2” Swamp	185110	See Note 3 on Page 9			
2,500 to 10,000	E	3/4” x 30”	185081	Included (see Note 2 on Page 9)		Size as Above Per Tension Requirements	
		3/4” x 53”	185107				
		3/4” x 72”	185115				
12,000 [2]	C	Manta Ray MR-SR	180038	3/4” x 7’ 0”	185143	Two 3/8”	Two 16M
15,000	A	20” Cross Plate	185091	1” x 10’ 0”	185067	Two 3/8”	Two 16M
	B	10” Expanding	185014				
15,000 [2]	B	Manta Ray MR-1	026822	3/4” x 7’ 0”	185143		
15,000 to 18,000	E	1” x 30”	185154	Included (see Note 2 on Page 9)		Two 3/8” or Two 16M (15,000) Two 7/16” or Two 20M (18,000)	
		1” x 53”	185155				
		1” x 72”	185156				
20,000 [1]	A	24” Cross Plate	185094	1-1/4” x 10’ 0”	185999	Two 7/16”	Two 20M
	B	12” Expanding	185015				
20,000 [2]	B	Manta Ray MR-SR	180038	1” x 7’ 0”	185144		
25,000 [1]	A	24” Cross Plate	185094	1-1/4” x 10’ 0”	185999	Three 7/16”	Three 20M

[1] The anchors listed on this sheet shall not exceed a combined working load of 18,000 pounds if jointly owned, unless it is impractical for each party to furnish its own anchorage.

[2] The holding capacity can vary depending on the soil and shall be verified with the anchor load locker. The ratings given are for average soil.

Class of Soil

A = Not suitable for installing expanding anchors (too hard, rocky, sandy, etc.).

B = Suitable for installing expanding anchors.

C = Loose or wet soils.

D = Under water or too soft for auger.

E = Solid rock.

Anchors and Guy Strands (continued)

Table 3 Guy Strand

Galvanized EHS Steel Strand		Preformed Galvanized Grips		Alumoweld [1]				Guy Insulator Code	Turnbuckle (if used)		Through Bolt Items 9 and 10 Table 6
				Strand		Preformed Grips			Size	Code	
Size	Code	Size	Code	Size	Code	Size	Code				Diameter
7/32" 3w	101041	7/32"	186149	5M3	101043	5M3	186170	315006	None	–	5/8"
5/16"	101014	5/16"	186118	10M	101044	10M	186171		5/8"	186067	
3/8"	101015	3/8"	186119	16M	101045	16M	186172		3/4"	186063	3/4"
7/16"	101016	7/16	186122	20M	101046	20M	186173				

[1] See Notes 4 and 5.

Table 4 Guy Assemblies

Distribution Guy Assemblies [1]				Transmission Guy Assemblies [2]			
Galvanized Steel		Alumoweld		Galvanized Steel		Alumoweld	
Guy Wire	Down Guy	Guy Wire	Down Guy	Guy Wire	Down Guy	Guy Wire	Down Guy
7/32"	160075	5M3	160082	–	–	–	–
5/16"	160076	10M	160083	5/16"	160000	10M	160092
3/8"	160053	16M	160084	3/8"	160090	16M	160093
7/16"	160064	20M	160085	7/16"	160091	20M	160094

[1] Guy assemblies come with 50 feet of wire. All assemblies include the required attachment hardware and guy insulators.

[2] Transmission down guy assemblies come without any guy insulators (order as needed). The assemblies come with 100 feet of guy wire. All assemblies include the required attachment hardware.

Notes

1. Power-installed screw anchors (PISAs) specified in Document 022221 are preferred for construction. Use anchors listed in Table 2 on Page 8 only in locations where it is not practical to install PISAs.
2. Rock anchors are expanding anchors for straight pulls and require a drilled hole, minimum 12 inches deep, in line with the guy, 1-7/8 inches in diameter for 3/4-inch rods or 2-3/8 inches in diameter for 1-inch rods.
3. See Document 022221 for rod extension data for Code 185109 and 185110 swamp anchors.
4. Use Alumoweld guy strand only for installations in severe corrosion areas. See Document 032911 for severe corrosion boundaries. Copperweld guy strand was formerly specified for this application. Do not install Alumoweld guy strand on existing anchor rods with Copperweld guy strand.
5. **Caution:** Guy grips for Alumoweld guy strand are not interchangeable with guy grips for steel guy strand.

Requirements for Adding Load to an Existing Anchor

1. The existing and proposed combined total load shall not exceed the published maximum allowable load of the anchor and anchor rod assembly. See Table 2 on Page 8 of Document 022178 for Non-PISA anchors and Table 6 on page on 12 in Document 022221 for PISA anchor maximum allowable load.
2. The total number of attachments shall not exceed the number of available slots of the eyelet to the anchor rod. Auxiliary eyes are not permitted.
3. If the installation is 10 years or older, the anchor rod assessment for corrosion shall be performed per Document 025998.
4. New procedure for electric estimator whenever additional load is planned to be added to an existing anchor. See Adding Load to an Existing Anchor – Attachment #1.

   Contact Names:
   Gilbert Martinelli; CSD Business Technology, Phone Number:(925-270–2239),
   Steven Grimes, Joint Utilities Group, Phone Number: (925-270-2280).

Attachment of Guy to Pole

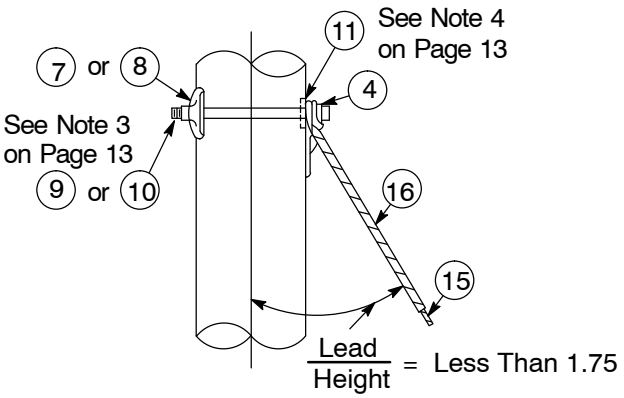


Figure 16
Guy Strain – 7,500 Pounds or Less
Angle of Guy Less Than 60°
(typical for anchor guys)

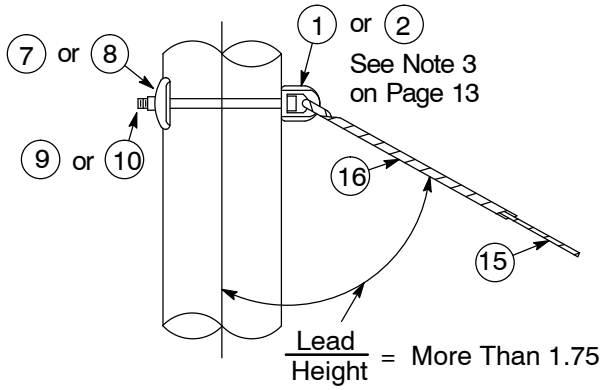


Figure 17
Guy Strain – 7,500 Pounds or Less
Angle of Guy More Than 60°
(typical for overhead and span guys)

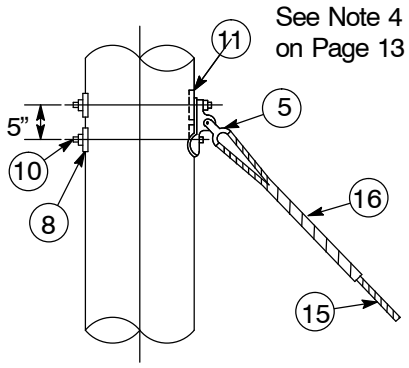


Figure 18
Guy Strain: 7,501–10,000 Pounds

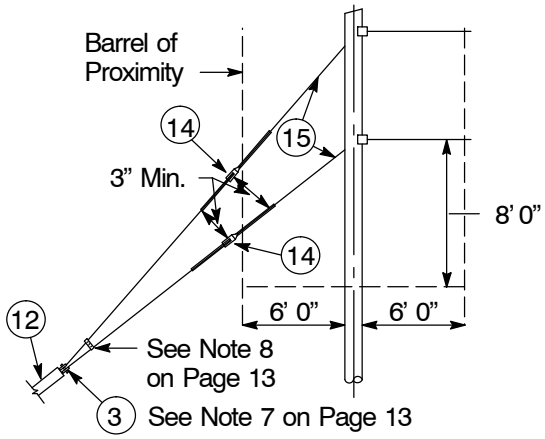


Figure 19
Attachment of Two or More Guys
to the Same Anchor Rod

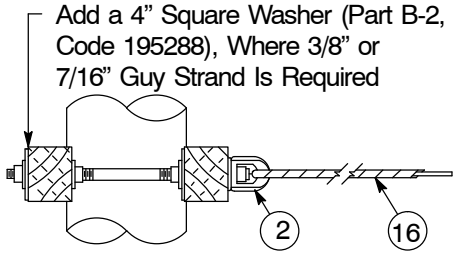
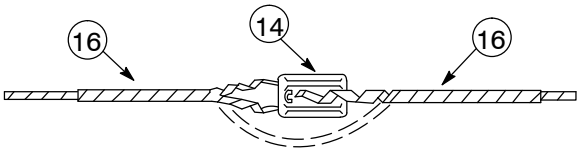


Figure 20
Attachment of Arm and Bridle Guys



When “shorting-out” insulator (as required in Case 1 on Page 3), install the guy wire in one continuous piece as shown by dashed lines.

Figure 21
Assembly of Strain Insulator

Attachment of Overhead and Anchor Guys

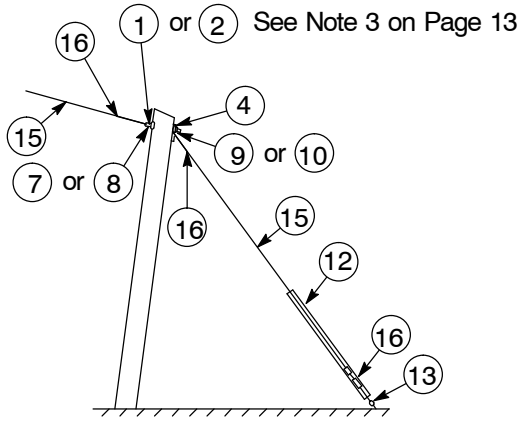


Figure 22
Guy Strain 7,500 Pounds or Less

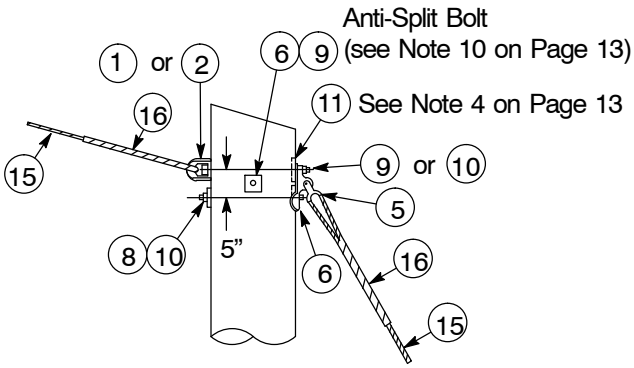


Figure 23
Overhead Guy 7,500 Pounds or Less and Anchor Guy More Than 7,500 Pounds

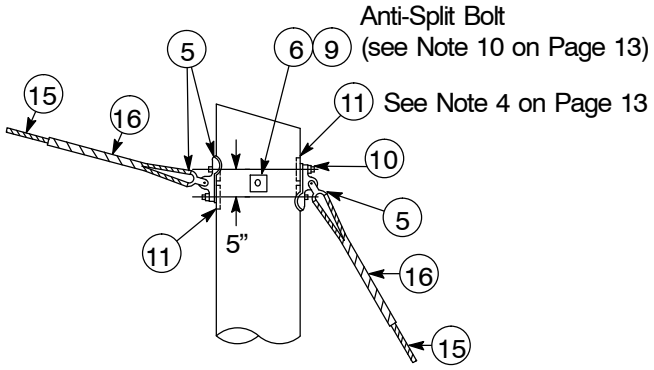


Figure 24
Guy Strain More Than 7,500 Pounds

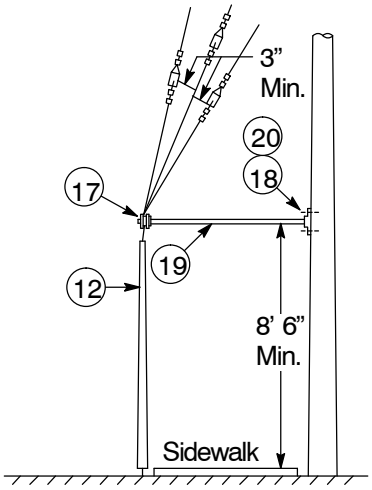


Figure 25
Sidewalk Guy

Attachment of Overhead and Anchor Guys (continued)

Table 5 Sidewalk Guy Fittings – Approved for Purchase

Combined Load lbs.	Pipe Size Std. Galv.	Fitting	Manufacturer and Catalog Number				Code
			Inwesco	Lindsey	Line-Way	Hubbell	
Up to 25,000	2-1/2”	End Fitting (see Note 9 on Page 13)	60A11	R4625	H-19	DG5D1	186120
		Pole Plate	—	2142	H-9	–	186121

Table 6 Material for Figure 16 (Page 10) - Figure 25 (Page 11)

Item	Description	Document	Code
1	Strand Eyelet, 5/8”	058778	195307
2 [1]	Strand Eyelet, 3/4”		195310
3	U-Bolt Type Guy Clamp	06537	186104
4	Guy Hook 7,500 lbs.	023569	186180
5	Guy Pole Plate and Thimble Assembly		188017
6	Washer, Square, 2-1/4” for 5/8” Bolt	058778	195286
7 [2]	Washer, Curved, 3” x 3”, Part No. D-1, 5/8”		195297
8 [1]	Washer, Curved, 4” x 4”, Part No. D-2, 3/4”		195298
9	Bolt, Machine, 5/8”		As Required
10 [1]	Bolt, Machine, 3/4”		
11 [3]	Shear Plate, TECO 143F, 2-5/8”	–	199017
12	Guy Marker	06542	–
13	Anchor Rod (see Table 2 on Page 8)	022178	As Required
14	Insulator, Strain		315006
15	Guy Wire (see Table 2 on Page 8 and Table 3 on Page 9)		As Required
16	Guy Grip (see Table 3 on Page 9)	06537	–
17	End Fitting, Sidewalk Guy (see Table 5)	–	186120
18	Pole Plate, Sidewalk Guy (see Table 5)	–	186121
19	Pipe, Galvanized Steel, 2-1/2”, 10’ Length or Less	–	010251
20	Lag Screws, 1/2” x 5”	058778	196033

[1] Use 3/4” diameter bolt hardware for 3/8” and 7/16” guy strand construction.
[2] Substitute 3” x 3” washer, Part C-1, Code 195293 for 2,500 pound guy strain assembly.
[3] See Note 4 on Page 13 concerning the use of Item 11 for construction at or above 44 kV.

Attachment of Overhead and Anchor Guys (continued)

Notes

1. Guy attachments shall be as close as practical to the strain.
2. Where the total resultant guy tension is in excess of 10,000 pounds, it will be necessary to install multiple guys. The distance between multiple guy attachments shall be kept to a minimum while still maintaining all hardware and guy wire clearances (see Note 3 on Page 1).
3. Where a 5/8-inch through bolt is specified (see Pages 10, 11, and 12), use the corresponding fittings, Items 1 and 7, as applicable. For a 3/4-inch through bolt, use the corresponding fittings, Items 2 and 8, as applicable.
4. For construction at or above 44 kV only, install a TECO Shear Plate (Item 11, Table 6 on Page 12), on the load end of 3/4-inch size bolt(s) as shown in Figure 16 and Figure 18 (on Page 10) and Figure 23 and Figure 24 (on Page 11).
5. Guy through bolts in the climbing space shall not project more than 1 inch beyond the nut.
6. No more than one guy wire is to be attached to each position on an anchor eyenut.
7. Two or more guys attached to the same anchor rod shall be clamped together as shown in Figure 19 on Page 10 unless the angle between them is too large to permit such construction. On joint anchor installations, the last party on the job shall clamp the guys together and attach the guard in accordance with Document 06542.
8. Install a 3-bolt clamp (Document 06537) where required, to maintain a 3-inch separation between the guy insulator and the guy, as illustrated in Figure 19 on Page 10.
9. Sidewalk guy end fittings accommodate one, two, or three 5/16-inch to 7/16-inch diameter guy wires. Do not use one 7/32-inch guy wire as it is too small to be clamped by the fitting.
10. Install anti-split bolts at pole top construction only.

Attachment of Overhead and Anchor Guys for Circuits 44 kV and Above

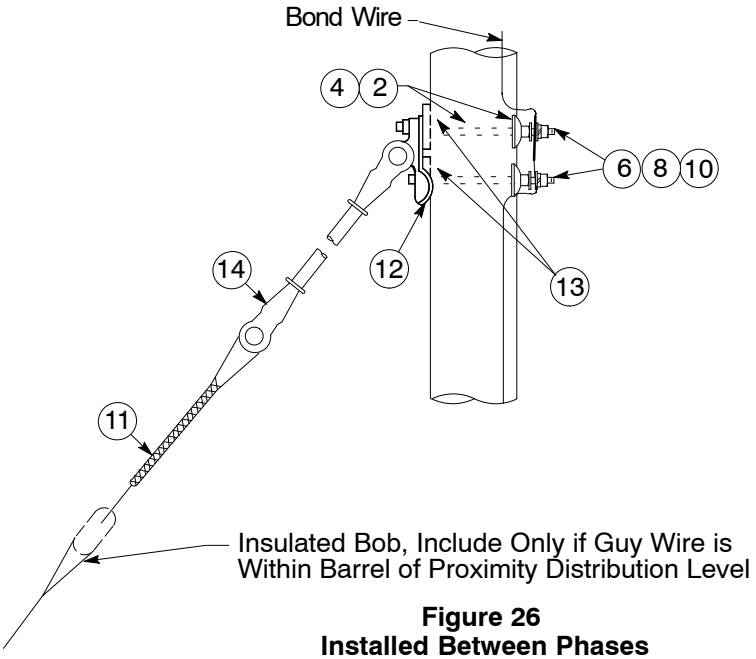


Figure 26
Installed Between Phases

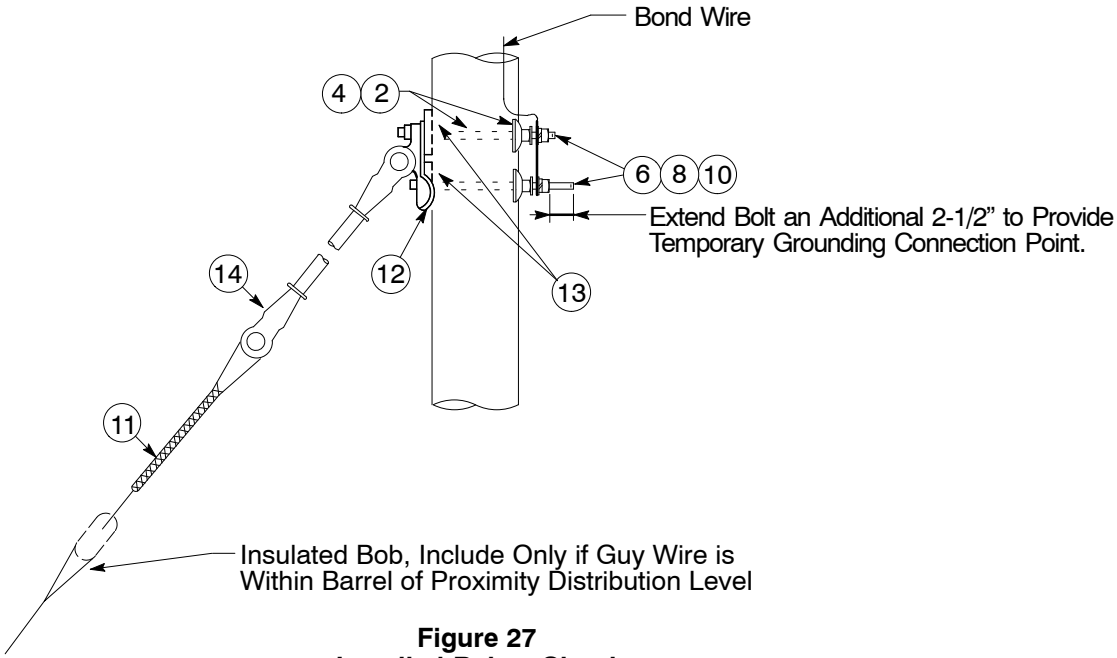


Figure 27
Installed Below Circuit

Note:
When grounded and unsectionalized down guys create a condition where a bird can contact an energized conductor and a grounded down guy simultaneously, install a fiberglass guy link at the pole end of the down guy. In this case, the guy fixture hardware should be tied into the bonding scheme. Subsequently there is no potential for the bolt to become "hot" and cause a pole fire.

Attachment of Overhead and Anchor Guys for Circuits 44 kV and Above (continued)

Table 7 Material for Figure 26 through Figure 27

Item	Description	Code	Document	
			Number	Part
1	Bolt, Machine, 5/8” x Length as Required	–	058778	–
2	Bolt, Machine, 3/4” x Length as Required	–		–
3	Washer, Curved, 3”, for 5/8” Bolt	195297		D-1
4	Washer, Curved, 4”, for 3/4” Bolt	195298		D-2
5	Washer, Round, 1-3/4” OD, for 5/8” Bolt	195274		A-3
6	Washer, Round, 2” OD, for 3/4” Bolt	195275		A-4
7	Washer, Lock, for 5/8” Bolt, Galvanized	195229	–	–
8	Washer, Lock, for 3/4” Bolt, Galvanized	195232	–	–
9	Nut, Square, 5/8” American Standard Regular Galvanized	195060	–	–
10	Nut, Square, 3/4” American Standard Regular Galvanized	195061	–	–
11	Guy Materials, as Required	–	022178	–
12	Guy Pole Plate and Thimble Assembly	188017	023569	–
13	Shear Plate, TECO 143F, 2–5/8”	199017	058778	–
14	Insulator, Guy Strain, Fiberglass, Length 78”	310066	–	–

Guy Tension

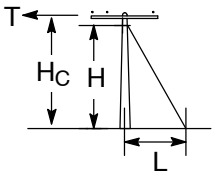


Figure 28
Level Ground

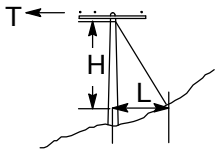


Figure 29
Uphill Guy

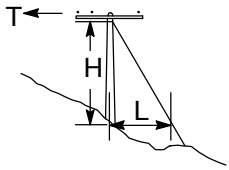


Figure 30
Downhill Guy

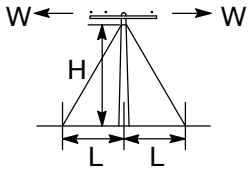


Figure 31
Storm Guy, Wind Only
See Note 3

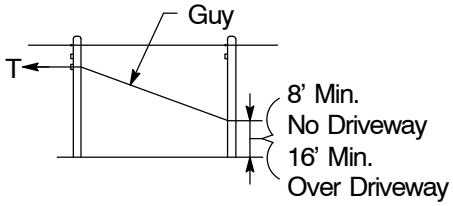


Figure 32
Overhead Guy, No Down Guy
Light Circuit Dead End

T = 1,000 Pound, Max. 8' Attachment
T = 500 Pound, Max. 16' Attachment

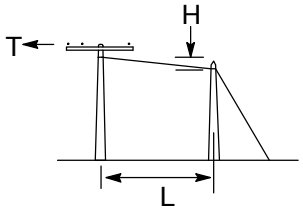


Figure 33
Overhead Guy

H is the difference in height between the overhead guy attachments at the pole and stub. For in-field use, a 1.2 guy factor can be assumed.

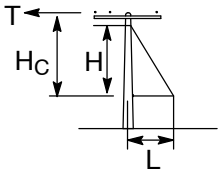


Figure 34
Sidewalk Guy

Heights are measured from the strut level. Lead is the strut length.

T = Resultant Horizontal Tension for All Conductors

Notes

1. For a dead-end guy, the resultant tension T is the maximum conductor tension times the number of conductors. Maximum conductor tensions are listed in Document 015221 (Document 057877 for aerial cable). For convenience, maximum conductor tensions for standard sizes are also listed in Table 8 on Page 17. For side guys, the resultant tension T is the sum of the individual side strains. Use Figure 38 and Figure 39 on Page 19 and Figure 40 on Page 20, or the formula shown in Note 4B below.
2. Line angles may be measured or determined by measuring "pull." Figure 35 on Page 17 converts between "pull" and angles. Mathematically, pull ft. = 100 x sin ∅/2; ∅=2 x arc sin (pull ft./100).
3. Where storm guys are required, the conductor wind loading W should be used in the same manner as R is used in the example shown on Page 18. Calculate W from the wind load factors (P) given in Document 015203.
4. Tension Determination
   A. By use of charts:

      Figure 38 – Figure 41 on Pages 19 through 20 are provided for convenience in calculating tensions on the pole and in the guy. These charts have assumptions built in for span lengths and for the distance the guy is attached below the conductor. For average construction, these charts should give slightly conservative answers.

      Guy tension equals total tension on the pole (T) times the guy factor, per Figure 41 on Page 20.

   B. By use of formula:

      For exact calculation of tensions, use the following formulas:

      Side Strain for one Wire, $R = (2 \times T_I \times \sin \varnothing/2) + (P \times S \times \cos \varnothing/2)$

      Guy Tension, $T_G = T \times (H_C/H) \times [1+(H/L)^2]^{1/2}$

      Where: T_I = individual maximum dead-end conductor tension; T = total resultant horizontal tension of all individual maximum dead-end or side-strain conductor tensions at the pole; ∅ = angle in line, in degrees; P = wind load per lineal foot of wire; S = average span length; H = height of guy attachment; H_C = height of conductor above ground at pole; L = lead, pole to anchor.

Guy Tension (continued)

Table 8 Maximum Dead-End Tension - Document 015221 (see Note 1 on Page 16)

Conductor		Pounds per Wire or Cable Light Loading District		Pounds per Wire or Cable	
Type	Size	Short Span Urban	Rural [3]	Intermediate Loading District	Heavy Loading District
ACSR	4 (6/1)	282	708	[4]	[4]
	2 (7/1)	473	1,067	1,540	1,690
	1/0 (6/1)	570	1,455	1,875	2,000
Bare Al.	1/0	475	[4]	[4]	[4]
	4/0	811	1,520	1,875	–
	397.5	1,335	2,640	3,150	3,440
	715.5	2,195	2,700	2,700/3,500 [1]	2,700/3,500 [1]
Bare Copper	6	275	405	[4]	[4]
	4	420	635	[4]	[4]
	2	625	940	–	1,185
	1/0	950	1,430	–	1,560
	3/0	1,460	2,230	–	2,030
	250	2,150	3,300	–	2,670
Tree Wire	4 ACSR	[4]	775	775	777
	2 ACSR	[4]	1495	1642	1625
	1/0 Al	[4]	785	785	785
	4/0 Al	[4]	1450	1450	1450
	397 Al	-	2780	2780	2780
AWAC Aerial Cable	1/0, 4/0	6,000 [2]	6,000	6,000	6,000
ACSR Aerial Cable	1/0 (6/1) Tri	1,260	1,260	–	1,957
	1/0 (6/1) Quad	1,496	1,496		2,182
	4/0 (6/1) Tri	2,145	2,145		3,161
	4/0 (6/1) Quad	2,617	2,617		3,620

1 2,700 pounds for a 300-foot ruling span, 3,500 pounds for longer spans.
2 Use 3,600 pounds maximum conductor tension for aerial cable when midspan services in any span do not exceed four and conductor is strung at reduced tension, per Document 057877.
3 Maximum dead-end tension is based on the longest ruling span as shown in Document 015221.
4 Not applicable.

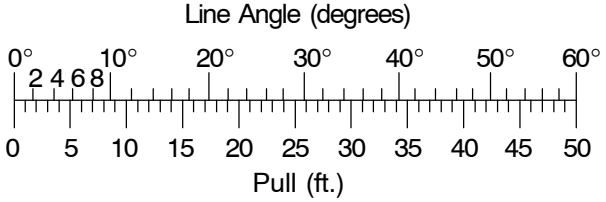


Figure 35
Scale for Changing Line Angles in Degrees to "Pull"

Guy Tension (continued)

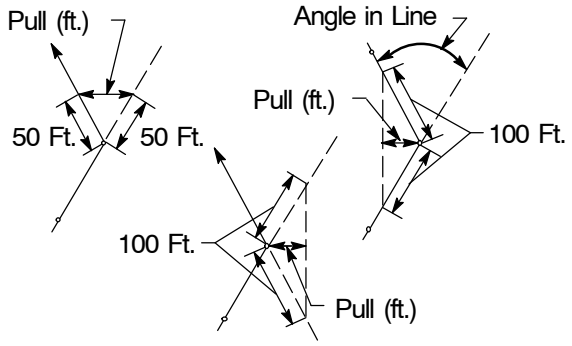


Figure 36
Methods of Determining Pull

Example

For Guy on Split of Angle (light loading district)
Given:

3 Copper Conductors (bare) . . . . . Size #2/0
2 Telephone Conductors (bare) . . . . . Size #8
Pull (ft.) (determined in field) . . . . . 22 ft.
Height (ground to guy fastenings) . . . . . 47 ft.
Lead (pole to anchor rod) . . . . . 33 ft.

By use of the charts:

From Figure 38 on Page 19 (see line marked example)

R = 870 lbs., for 1-#2/0, Therefore 3-#2/0= 2,610 lbs.
R = 200 lbs., for 1-#8, Therefore 2-#8 = 400 lbs.
T = (total resultant horizontal tension) 3,010 lbs.

From Figure 41 on Page 20 (see line marked example)

When Height = 47 ft., Lead 33 ft., Guy Factor = 1.8
Tension in Guy = 1.8 x 3,010 = 5,420 lbs.

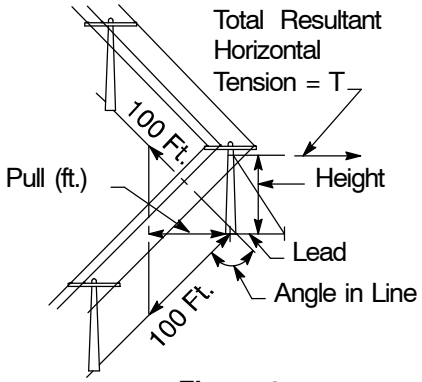


Figure 37
Example Illustration

Guy Tension (continued)

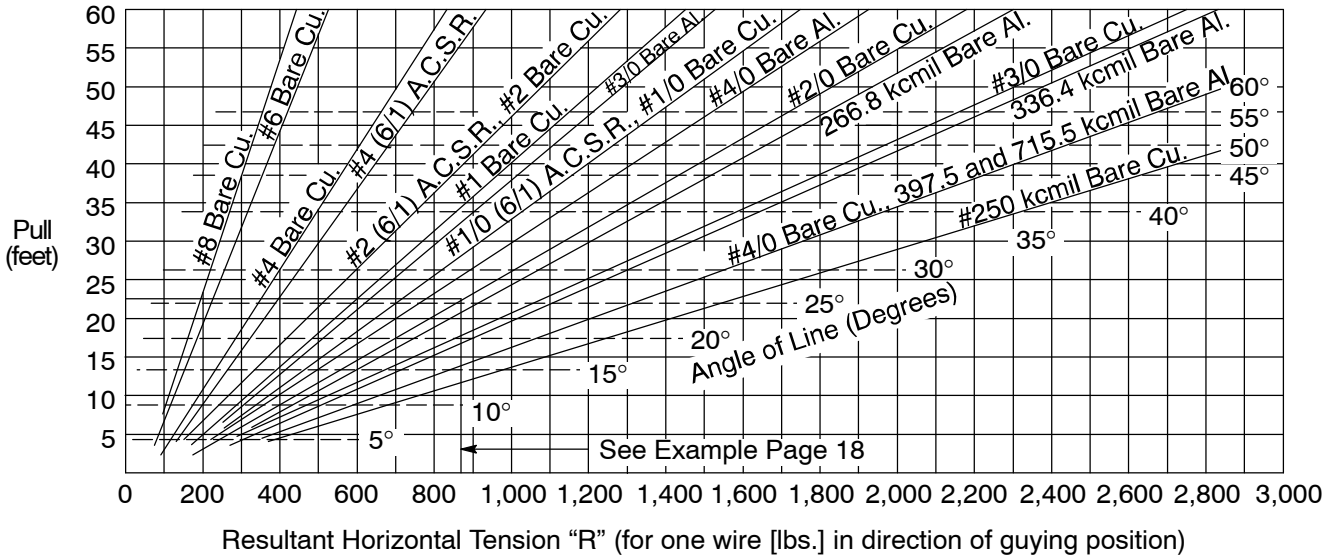


Figure 38
Resultant Tension "R," Light Loading
(sag and tension Document 015221)

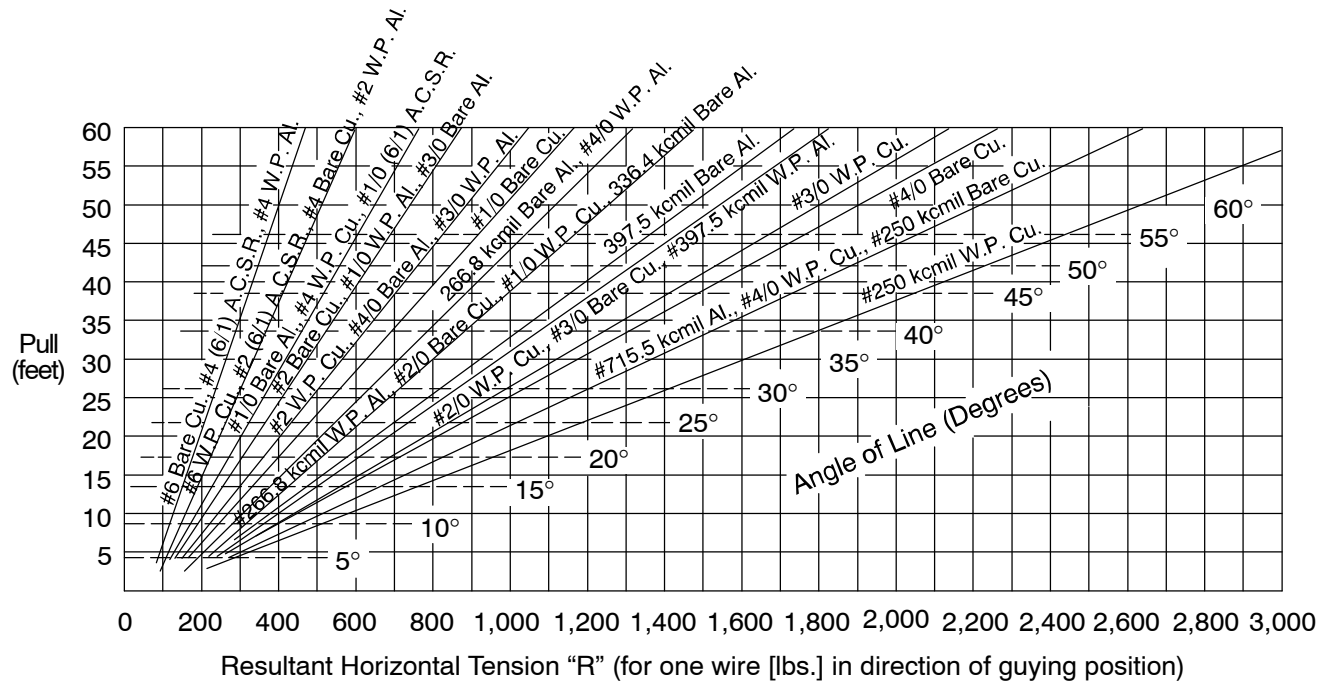


Figure 39
Resultant Tension "R," Light Loading
For Short Span Urban-Type Construction Only
(sag and tension Document 015221

Guy Tension (continued)

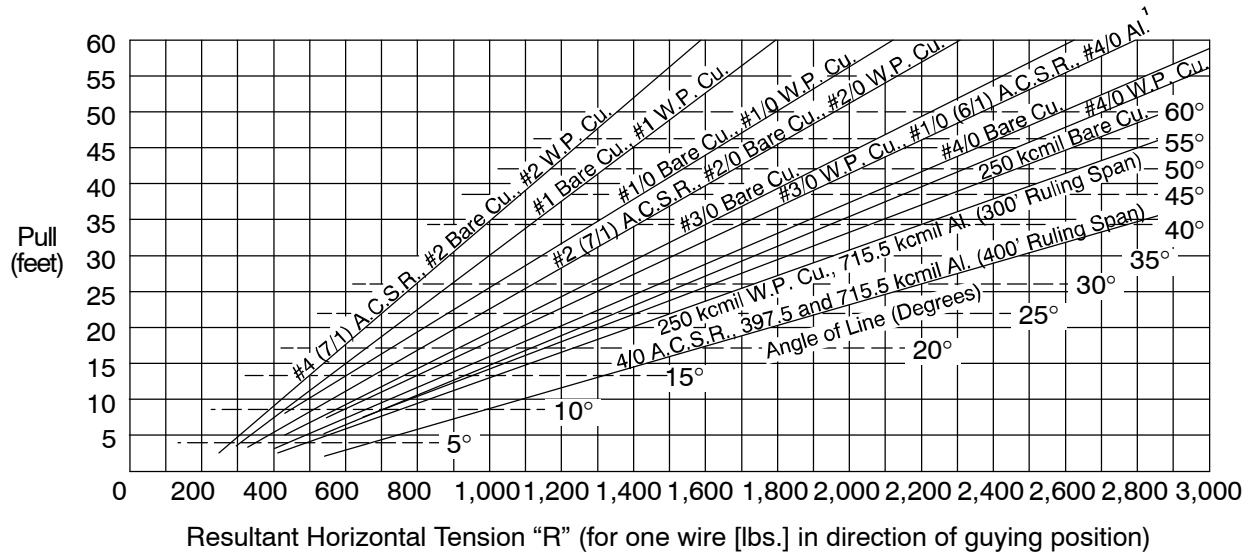


Figure 40
Resultant Tension "R," Heavy or Intermediate Loading

[1] 4/0 Al. is listed in Figure 40 for use in the intermediate loading district only.

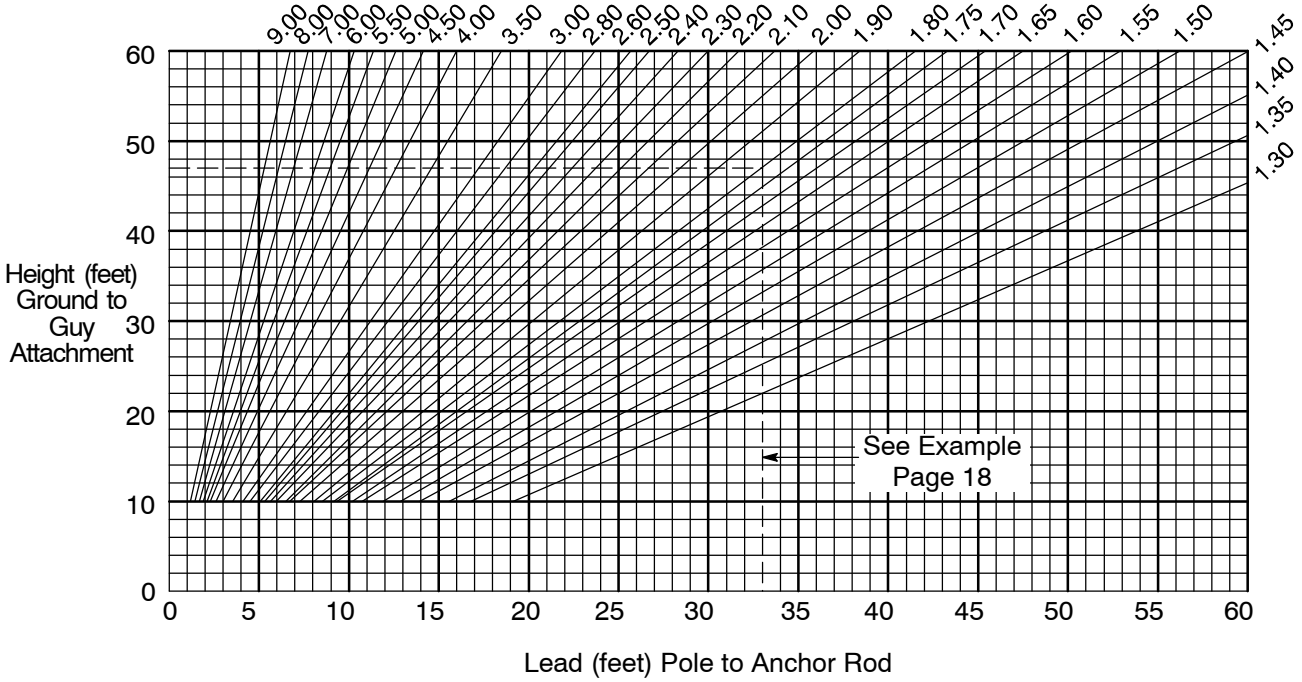


Figure 41
Guy Factor

Combination Primary and Secondary Guy

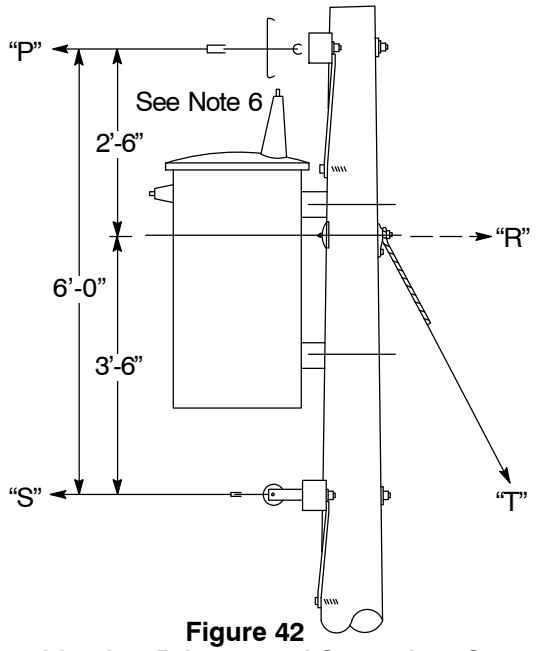


Figure 42
Combination Primary and Secondary Guy

Notes

1. The combination primary and secondary guy illustrated on this page is intended for use only in urban short span construction, subject to the following limitations:
   A. The physical spacing between conductors, guy attachment, and transformer (if any) shall conform to Figure 42.
   B. Pole loading shall not exceed the values shown below:

      Total Primary Conductor Tension, P = 1,190 pounds maximum (shall be reduced to 1,000 pounds on a transformer pole).

      Total Secondary Conductor Tension, S = 2,520 pounds maximum.

      Horizontal Guy Reaction, R = 3,690 pounds maximum.

      Transformer Weight, 1,000 pounds maximum.
2. The above values are based on zero deflection of the pole at the point of guy attachment. The guy tension shall be adjusted (within practical limitations) to obtain zero deflection at that point.
3. Guy reactions for other combinations may be computed by the method illustrated in Note 5. The values obtained from the formula provide a minimum safety factor of 4 with a Class 5 pole.
4. The values of guy reaction, calculated from the formula given in Note 5, are based on a vertical separation of 6 feet between the primary and secondary levels.

   When the level separation is *less* than 6 feet, the values of guy reaction obtained from the formula may be used directly, provided the guy is attached a proportionate distance below the primary level.

   When the level separation is *greater* than 6 feet, separate primary and secondary guys shall be used.
5. Guy reactions for conductor combinations may be computed from the formula R = 1.12P + 0.84S. Where: R = horizontal reaction of guy, P = total primary conductor tension, and S = total secondary conductor tension.

   Example: Calculate the horizontal reaction (R) of a combination guy for use with 2-#6 BC primary and 2-#2 and 1-#4 BC secondary.

   P = 2 x 275 = 550 pounds (from Document 015221)

   S = (2 x 625) + (1 x 420) = 1,670 pounds (from Document 015221)

   R = (1.12 x 550) + (0.84 x 1,670) = 2,018 pounds (which is less than 3,690 pounds allowable)

   Guy Tension (T) pounds = 2,020 x Guy Factor (approximately)
6. The spacing of the guy below the primary level must be increased to 2' 7" on transformer poles with a crossarm primary, to provide the required 1-1/2 inch minimum clearance between guy attachments and the transformer supporting lugs and mounting bolts.

Guy Strand Cattle Guard Installation

Notes

1. A cattle guard must fit freely on the guy wire.
2. The cattle guard clamp base prevents cattle guards from unwrapping guy grips and allows the guard to rotate freely.
3. Cattle guards should be installed only on down guys that are exposed to livestock.
4. A guy marker shall be installed above the cattle guard to ensure that there is a minimum of 8 feet of total marker on the guy. To allow the cattle guard to move freely, install an additional marker as follows. Using the plastic guy guards listed in Document 06542, cut the guard just above the flanged portion (approximately 2 feet). Take the remaining round section and install it upside down just above the cattle guard. The section can be cut to adjust for the sectionalizing insulator as long as the total length (including the cattle guard) is at least 8 feet.

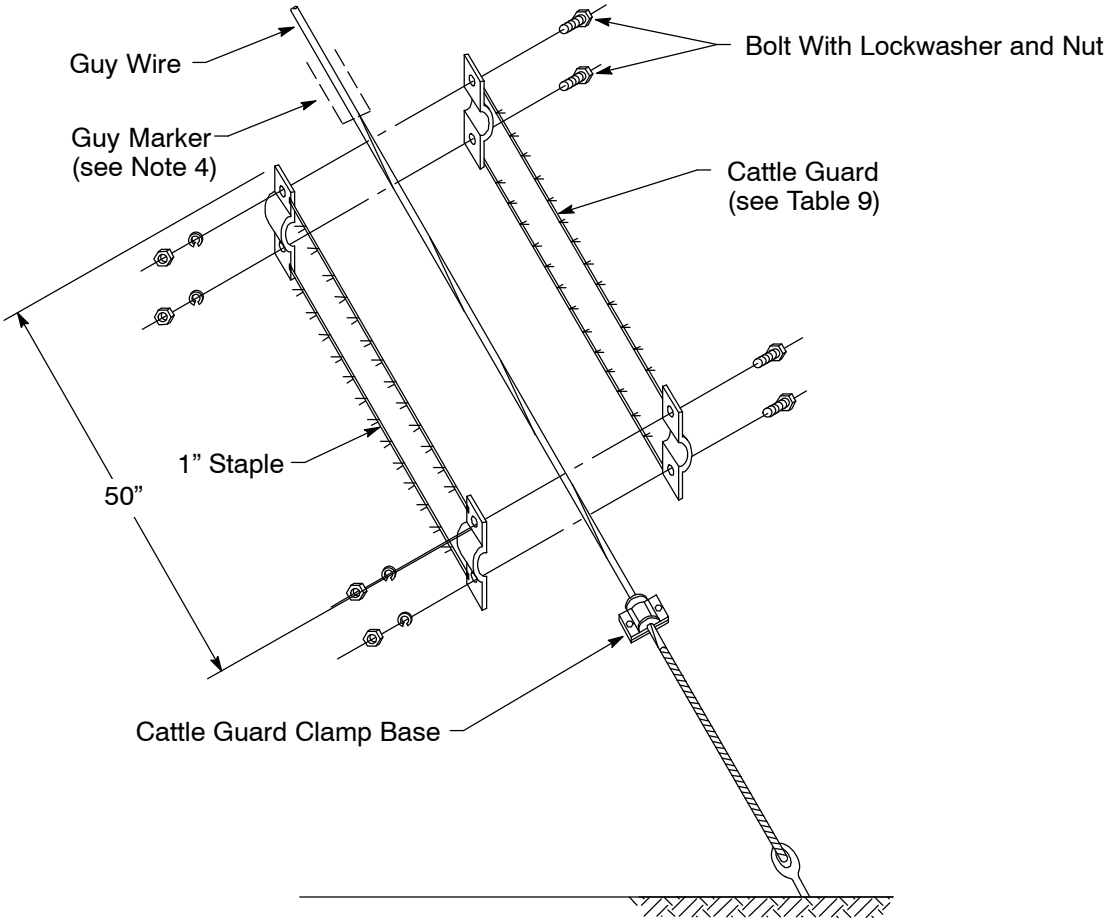


Figure 43
Guy Strand Cattle Guard Installation

Table 9 Cattle Guards

Guy Wire Size	Color	Cattle Guard Catalog Number [1]	Code [1]
Under 1/2"	Yellow	CG103A	186186
1/2"	Yellow	CG104A	186187

[1] Catalog and code number includes two halves of cattle guard, connecting bolts, and clamp base.

Push Brace

Notes

1. Size the push brace pole for the vertical load on it. Calculate the load the same as a down guy using the height (H) and lead (L) as shown. The lead of the brace should not be less than 1/3 of the height of the line pole (e.g., for a 45-foot pole, use a minimum 15-foot lead).
2. Set the push brace pole the same depth as it would be for a line pole.
3. In soft soil, it may be necessary to rock key the push brace pole.

Table 10 List of Materials for Push Brace Installations

Item	Description	Code	Document
1	Pole (length and class as required)	–	–
2	Bracket, Push Brace Connector	180061	–
3	Bolt, Machine, 3/4” Diameter (length as required)	–	058778
4	Washer, Spring Clip, 3/4” Bolt Size	033501	
5	Bolt, Machine, 5/8” Diameter (length as required)		
6	Washer, 2-1/4” Square, 5/8” Bolt Size	195286	
7	Washer, Spring Clip, 5/8” Bolt Size	033320	

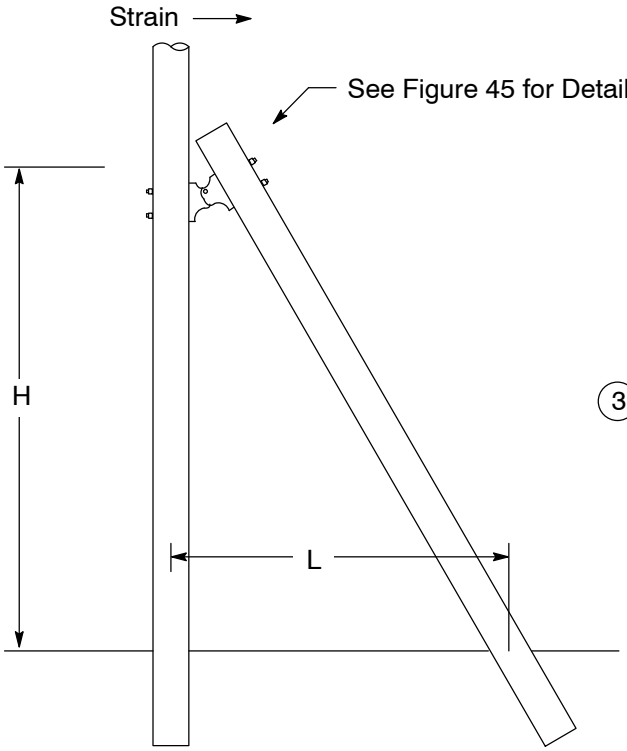


Figure 44
Push Brace Installation

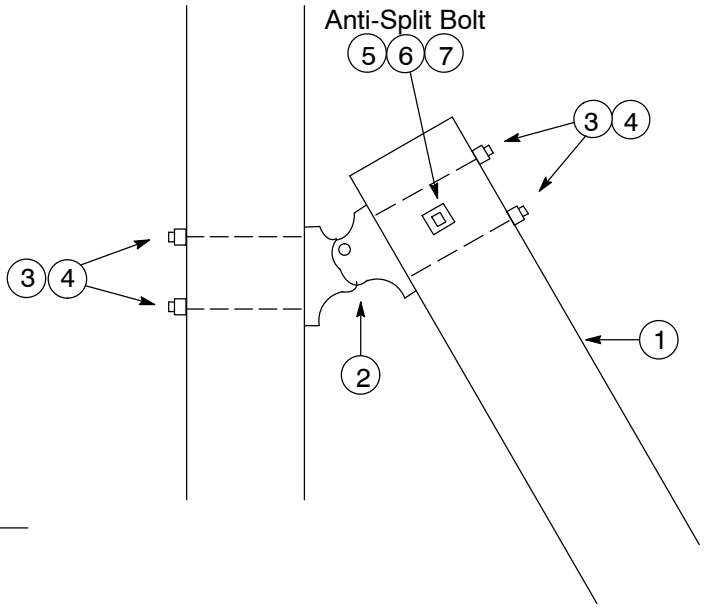


Figure 45
Detail of Connector Installation

Truss Guy

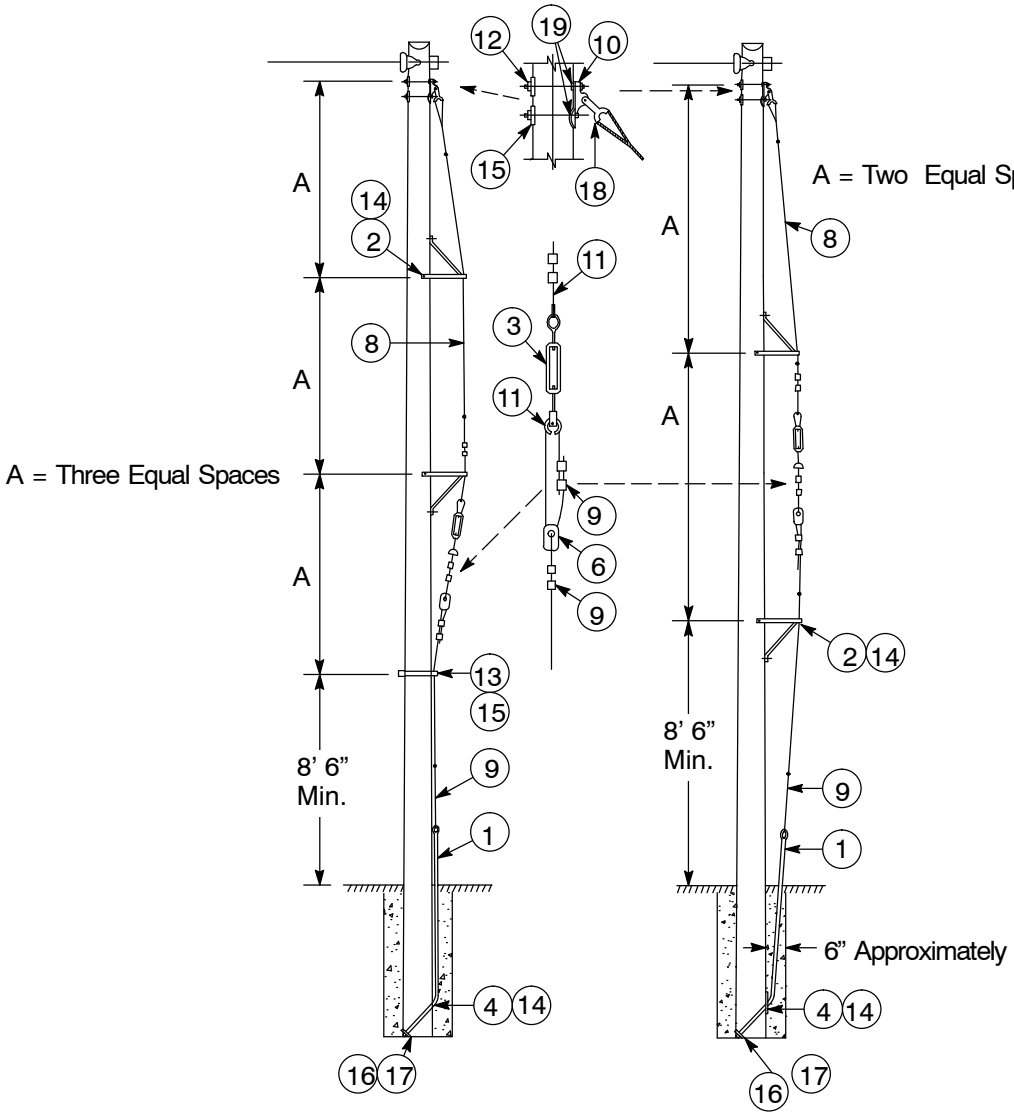


Figure 46
Alternate Methods

Figure 47
Alternate Methods

Truss Guy (continued)

Notes

1. Use this construction for very light loads only. Do not use this construction when other methods of guying are available. The maximum total horizontal load for Figure 46 on Page 24 is 1,325 pounds for a 45-foot pole, and 1,145 pounds for a 50-foot pole. For Figure 47 on Page 24, the maximum load is 890 pounds for a 45-foot pole, and 765 pounds for a 50-foot pole. The vertical load is 10,000 pounds.
2. The requirements for sectionalizing and grounding truss guys are the same as the requirements for any anchor guy (see Note 8 on Page 2).
3. Truss guys installed on poles supporting conductors of over 35,500 V (under the conditions illustrated by Case 1 on Page 3) shall not be sectionalized and **shall** be grounded. If such a pole is set in concrete, a ground rod shall be installed and the truss guy grounded thereon.
4. Set pole 1 foot deeper than standard.
5. For construction at or above 44 kV only, install TECO Shear Plates, Item 19, as shown in Table 11.

Table 11 Material For Truss Guy

Item	Quantity		Description	Document	Code
	Figure 46 (on Page 24)	Figure 47 (on Page 24)			
1	1	1	Rod, Anchor, 3/4” x 9’ 0”	022222	185065
2	2	2	Strut, 15”, Joslyn J0502	–	186998
3	1	1	Turnbuckle, 3/4” x 9” Galvanized, Eye and Clevis	–	186063
4	1	1	Plate, Strain, 5/16” x 2-1/2” x 9”, Kortick K3523	–	186040
5	1	1	Guard, Guy	06542	–
6	1	1	Insulator, Strain	–	315006
7	As Required		Grounding Materials (if required - see notes)	021904	–
8			Wire, Guy, 7/16” HS (length as required)	–	101016
9	14	14	Grips, Clamps, Guy (as required)	06537	–
10	1	1	Guy Pole Plate	023569	188671
11	2	2	Thimble, Guy, 1/2”	058778	186058
12	2	2	Bolt, Machine, 3/4” x Length (as required)		–
13	1	–	Eyebolt, 5/8” x Length (as required)		–
14	9	9	Lag Screw, 1/2” x 5”		196033
15	3	2	Washer, 3” Square, Curved, Galv., Part C-1		195293
16	1	1	Washer, 5-3/16” Round, Cast Iron, Part E-2	022221	195369
17	1	1	Washer, 3-3/4” Round, Cast Iron, Part E-1		195248
18	1	1	Guy Thimble	023568	186213
19 [1]	2	2	Shear Plate, TECO 143F, 2-5/8”	–	199017

[1] See Note 5.

Revision Notes

Revision 07 has the following changes:

1. Revised catalog number in Table 5 on Page 12.
2. Revised Table 8, Page 17, added “Tree Wire.”
3. Added Note 4 on Page 9.
4. Modified requirements for transmission guying. Figures 26, 27, 28, and 29 were affected.
5. Added requirements for “Adding Load to an Existing Anchor” on Page 9.