OREGON JOINT USE ASSOCIATION STANDARDS COMMITTEE

BEST PRACTICES GUIDE

APRIL 2009

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CHAPTER 1 - ANCHORS

This document is intended to provide education on common construction practices for aerial construction of power and telecommunications facilities. This is not an official codebook, nor should it be construed as a construction manual. When constructing aerial facilities, please refer to the governing codes, such as the National Electrical Safety Code, National Electrical Code, Oregon Public Utility Commission Safety Rules, Oregon Occupational Safety and Health Administration, state, county and municipal codes, and all other applicable standards, including contracts.

The National Electrical Safety Code (NESC) addresses anchors in Sections 253, 261, and 264.

Placement Considerations

The distance between the anchor and the pole is generally based on the load the anchor is required to hold and the anchor type. There are other considerations that are dealt with in this chapter.

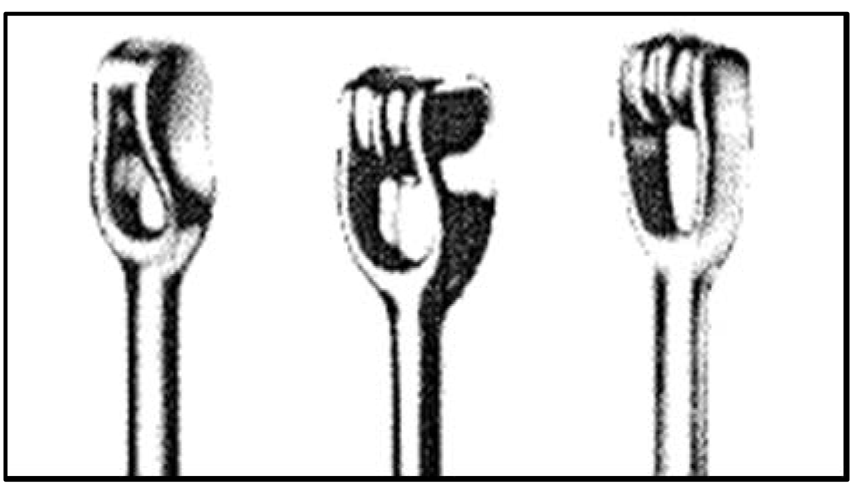
Anchors are generally placed no less than five (5) feet from an existing anchor. This is done to ensure the soil surrounding the existing anchor is not loosened while installing the new anchor.

Heights to lead ratio means that for every one foot of pole height that place your attachment, you place the anchor one foot away from the pole.

- 1:1 ratio is optimum
- 2:1 ratio is good
- 3:1 ratio is the minimum

When identifying the need to have your plant guyed at a specific location, you may observe another utility's anchor(s). This anchor may have an available open eye. You must first get permission from the anchor owner prior to occupying that open eye with your guy. These are "eye" bolts that are attached to an anchor rod above grade.

Figure 1 - Examples of Eye Bolts



When all available eyes on the rod are occupied, some utilities may allow the use of auxiliary eye attachments. This hardware is clamped to the existing rod above grade, and enables another guy to be attached to the anchor.

Newly installed anchor rods should have no more than 12 inches of exposed rod above grade.

Anchor rods should be placed in lead with the facilities they are supporting. The rod should be aimed towards the spot on the pole where the guy is attached (with the exception of sidewalk guys).

Soil Types: Soil testing is necessary to determine the proper anchor type. A soil probe is performed with a mechanical soil test probe tool that is screwed into the soil. As it displaces the soil, probe installation torque is measured in inch-pounds on a torque gauge, which is an integral part of the installing tool. Probe torque readings are then compared with the information on the Soil Classification Data Chart and translated into the appropriate soil classification.

Figure 2 – Soil Classification Data Chart

SOIL CLASSIFICATION DATA				
Class	**Common Soil-Type Description**	**Geological Soil Classification**	**Prove Values in.-lb. (NM)**	**Typical Blow Count "N" per ASTM-D1586**
0	Sound hard rock, unweathered	Granite, Basalt, Massive Limestone	N/A	N/A
1	Very dense and/or cemented sands; coarse gravel and cobbles	Caliche, (Nitrate-bearing gravel/rock)	750 – 1600 (85 – 181)	60 – 100+
2	Dense fine sands; very hard silts and clays (may be preloaded)	Basal till; boulder clay; caliche; weathered laminated rock	600 – 750 (68 – 85)	45 – 60
3	Dense sands and gravel; hard silts and clays	Glacial till; weathered shales, schist, gneiss and siltstone	500 – 600 (56 – 68)	35 – 50
4	Medium dense sand and gravel; very stiff to hard silts and clays	Glacial till; hardpan; marls	400 – 500 (45 – 56)	24 – 40
5	Medium dense coarse sands and sandy gravels; stiff to very stiff silts and clays	Saprolites, residual soils	300 – 400 (34 – 45)	14 – 25
6	Loose to medium dense fine to coarse sands to stiff clays and silts	Dense, hydraulic fill; compacted fill; residual soils	200 – 300 (23 – 34)	7 – 14
**7	Loose fine sands; alluvium; loess; medium – stiff and varied clays; fill	Flood plain soils; lake clays; adobe; gumbo, fill	100 – 200 (11 – 23)	4 – 8
**8	Peat, organic silts; inundated silts, fly ash very loose sands, very soft to soft clays	Miscellaneous fills, swamp marsh	less than 100 (0 – 11)	0 – 5
Class 1 soils are difficult to probe consistently and the ASTM blow count may be of questionable value. **It is advisable to install anchors deep enough, by the use of extensions, to penetrate a Class 5 or 6, underlying the Class or 8 soils.				

Easement Considerations: An easement is the right of use over the real property of another. It is distinguished from a license or permit that only gives one a personal privilege to do something on the land of another, usually the permission to pass over the property without creating a trespass. Easements may be considered public or private. A private easement is limited to a specific individual such as the owner of an adjoining land. A public easement is one that grants the right to a large group of individuals or to the public in general, such as the easement on public streets and highways. You must consider land use easements when placing an anchor!

Permit Considerations: There are many different agencies that may require permits related to construction activity of this type, including Oregon Department of Transportation, municipal, county, and others. Please consult the necessary agencies to ensure you are in compliance with the governing agencies.

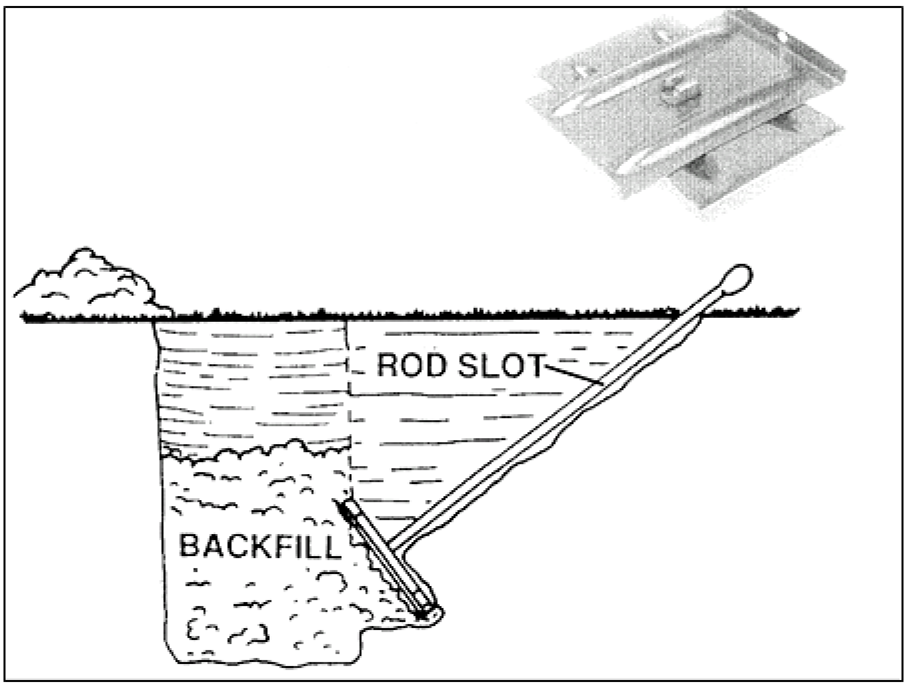
Locates: The Oregon Utility Notification Center (OUNC) is the one-call agency dedicated to safeguarding citizens and construction personnel who work around utilities, as well as safeguarding the underground infrastructure of pipes, mains, and lines which bring utilities to your community. Calling at least two working days before beginning any excavation prevents damage to underground facilities, service interruptions, and bodily injury. Submit a locate request by calling 811 or 1-800-332-2344. Online requests can be submitted at the OUNC website (www.digsafelyoregon.com).

Common Types of Anchors and Installation

Plate Anchor

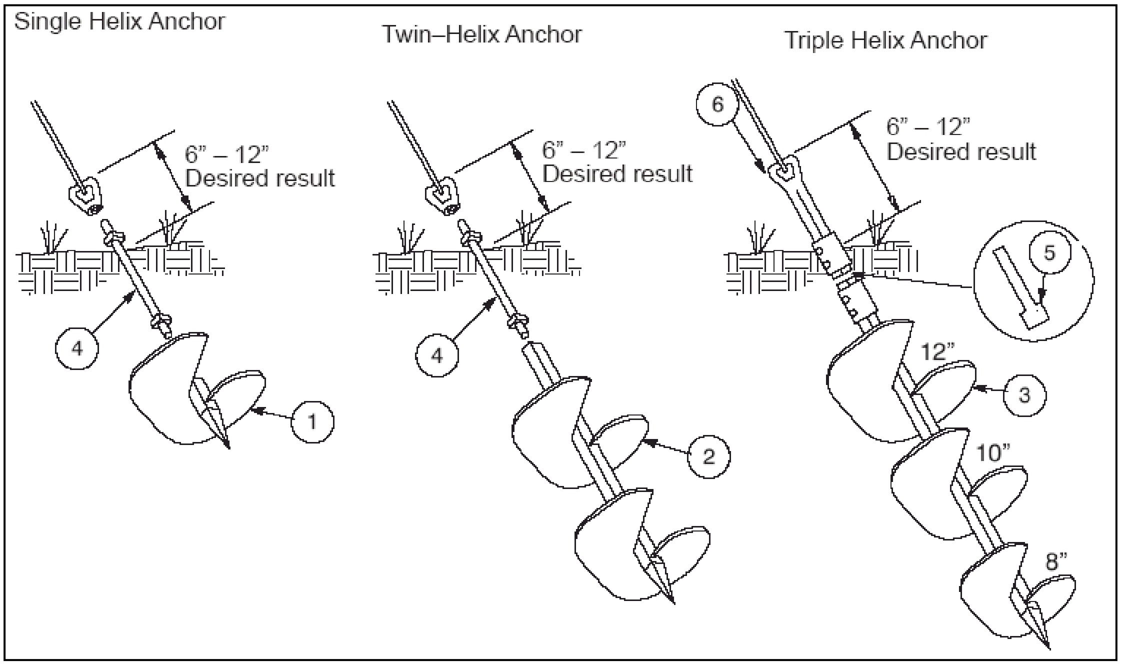
The Cross-Plate anchor is made for installation in holes drilled by power diggers. Because the size of the hole does not affect holding capacity, the same auger that is used to dig the pole holes on transmission projects can dig the hole. Cross-Plate anchors are installed in a diagonal bored hole, which is undercut so the anchor is at right angles to the guy. A rod trench is either cut with a trenching tool or drilled with a small power auger. Both anchor and rod trench should be refilled and tamped.

Figure 3 - Cross-Plate Anchor



Helix/Screw-in Anchor
Screw-in anchors are recommended for softer soil types, including Classes 5-7 in the Soil Classification Data Chart (see Figure 2). They do not work well in rocky soils. Screw-in anchors are usually installed by two people rotating a log bar threaded through the eye, but may also be installed with a power drive machine. Screw-in anchors can also be used in applications where an anchor will be embedded in concrete.

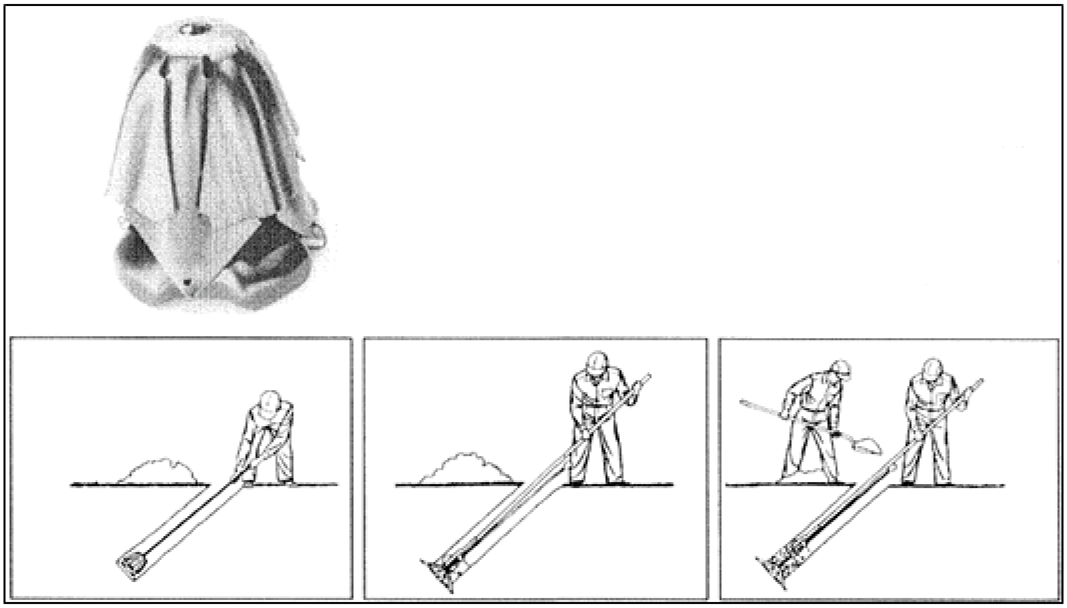
Figure 4 - Helix Anchors



Expanding/Bust Anchor

"Bust" Expanding Anchors expand to take full advantage of the available area. All eight blades wedge into undisturbed earth. There is no wasted space between blades. This anchor should be installed in relatively dry and solid soils. The effectiveness of the anchor is dependent upon the thoroughness of backfill tamping.

Figure 5 - Expanding Anchor

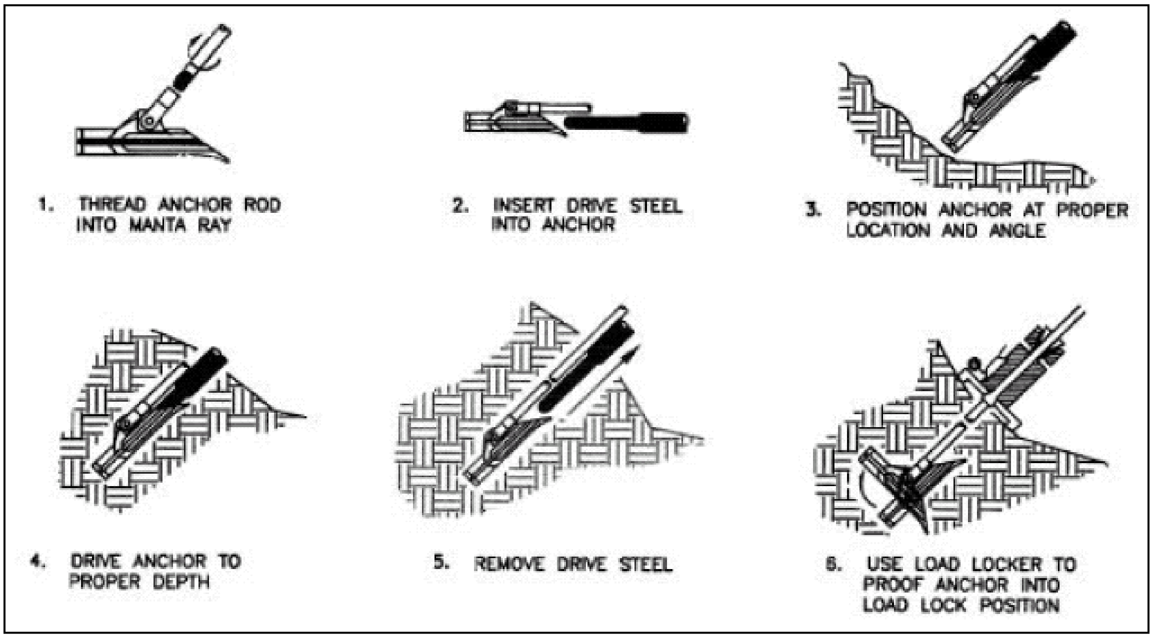


Manta Ray Anchor

Manta Rays are driven into the ground, not augured or torqued, nor is a hole dug or drilled. There is "no disturbance" or "displacement" of soil. Unlike other anchoring systems, Manta Ray actually compacts the soil around itself—a clean, safe and simple operation.

The anchors are driven with conventional hydraulic/pneumatic equipment that is readily available worldwide. Once driven to the proper depth, the rod/tendon attached to the anchor is pulled to rotate the anchor into undisturbed soil—like a toggle bolt. This is called "anchor locking" the anchor (using the Manta Ray anchor locker). The anchor is pulled upon to reach the holding capacity required which is measured by a gauge on the "anchor locker." Each anchor is immediately proof loaded to the exact capacity required.

Figure 6 - Manta Ray Anchor



Swamp Anchor

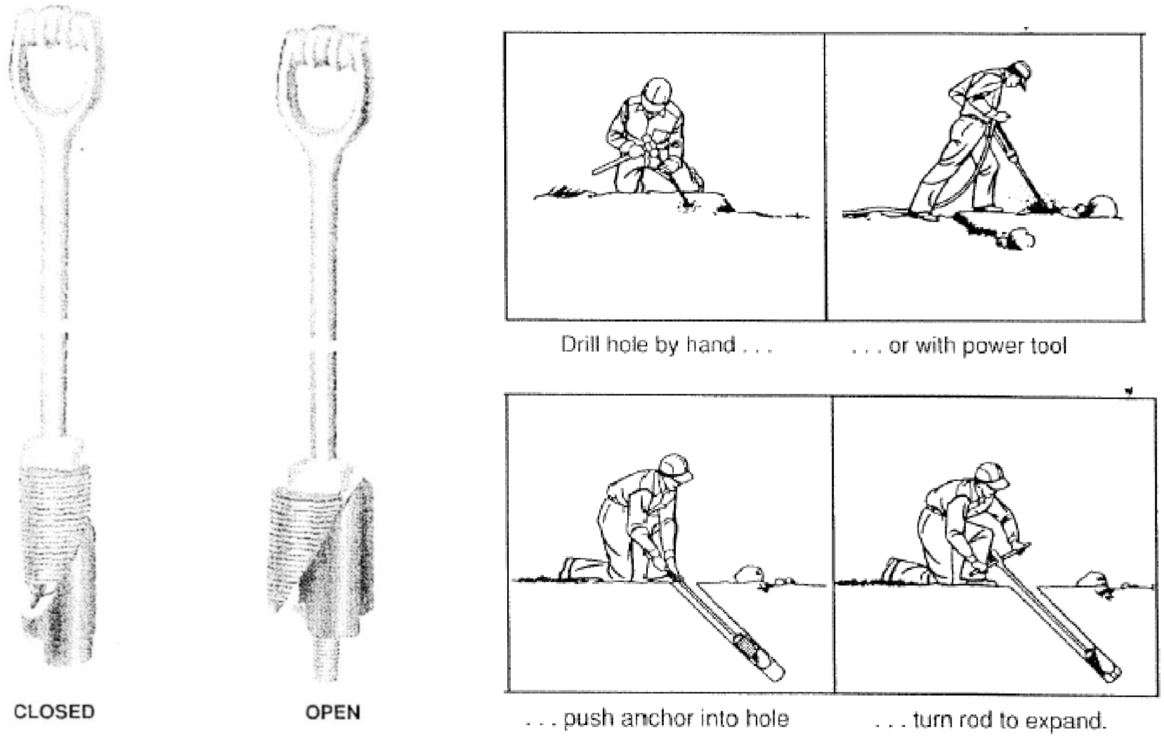
Swamp anchors can also be buried logs that brace a wood pole and are used in marshy and swampy terrain (also called swamp brace or brace anchor).

Rock Anchor

Rock anchors are standard in the construction industry for rocky areas. They are appropriate for soil Classes 0-1 in the Soil Classification Data Chart (see Figure 2). They require drilling a hole for insertion of a threaded rock anchor. The anchor can then be cemented into place if desired. Grouting is necessary with soft, crumbling rocks or if weathering is expected.

The hole is bored with a hand or power drill to a diameter larger than the diameter of the unexpanded anchor. The anchor is then dropped into the hole and the eye is threaded with a bar and rotated until the anchor has expanded firmly against the sides of the hole. The anchor must be aligned with the guy loads and should be installed at least 12 inches into solid rock. The anchor wedges and expands against walls of solid rock. Once it is set, the more pull on the rod, the tighter it wedges.

Figure 7 - Rock Anchor



Testing the Anchor

A dynamometer is used to test the holding capacity of an anchor or messenger strand (as illustrated below). One end is attached to the anchor eye, and the other to a chain hoist that is temporarily attached to the pole. Tension is placed on the dynamometer by ratcheting the chain hoist until the desired holding capacity is observed.

Figure 8 - Dynamometer

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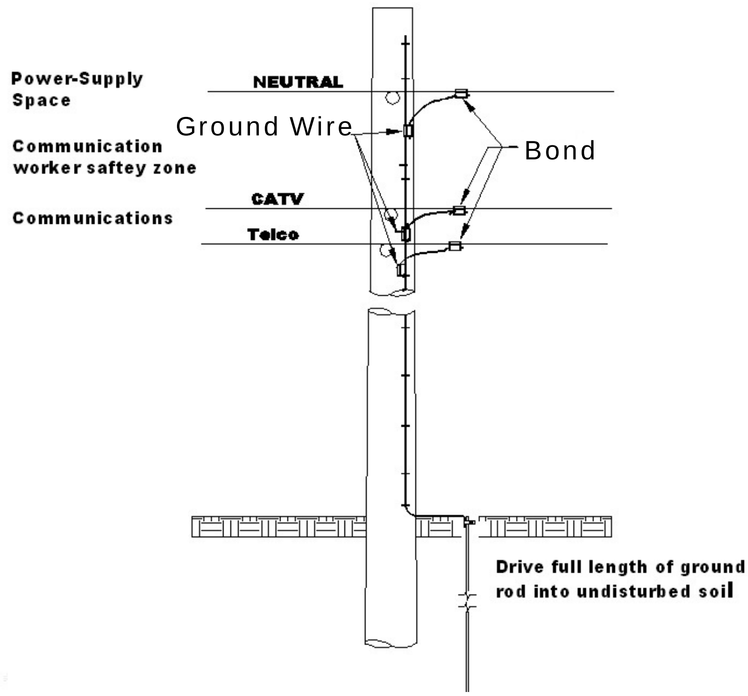
CHAPTER 2 - BONDING AND GROUNDING

Definition of Bonding

Bonding is defined in the NESC as "The electrical interconnecting of conductive parts, designed to maintain a common electrical potential."

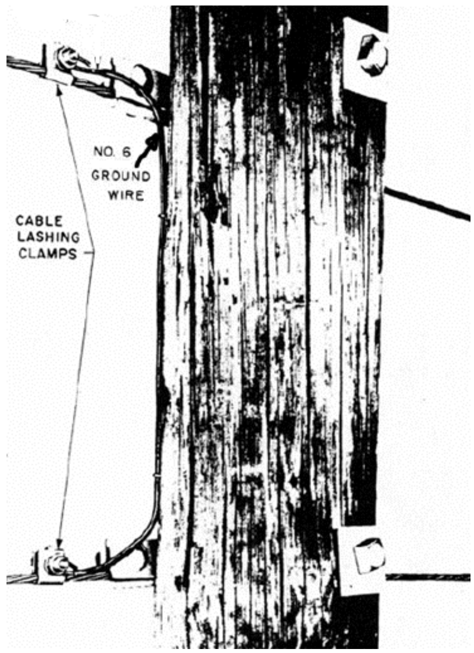
Figure 9 - Vertical Pole Ground with Bonds



In other words, bonding can be explained as the permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity. Bonding metallic system parts together offers the capacity to safely conduct any current likely to be imposed on the grounding electrode. Bonding maintains the continuity of the facilities to provide protection of personnel and equipment.

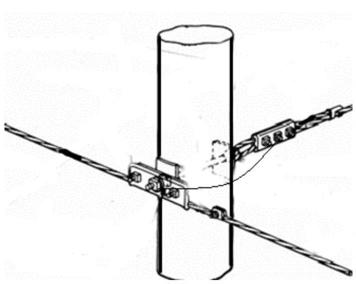
Bonding Installation Considerations
Aerial cables that include joint use construction will require common bonding. The cables must be bonded together to reduce the electrical power differences (potential).

Figure 10 - Common Bonding for Aerial Cables



Types of Bond Installations

Figure 11 - Tangent with 90° Tap Line



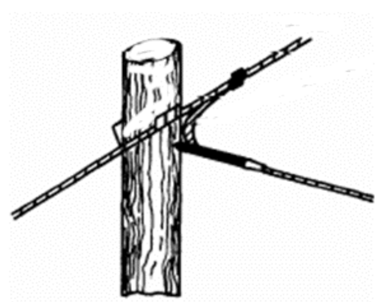
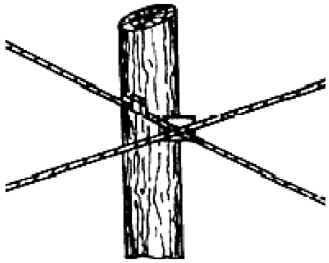


Figure 12 - Intersection of Messenger



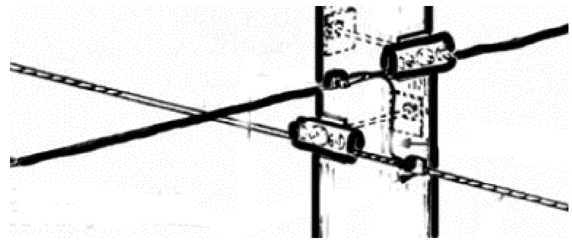
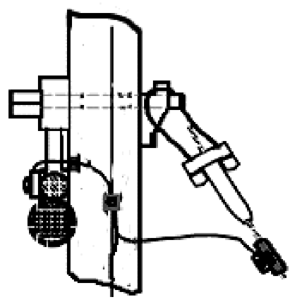


Figure 13 - Down Guy and Anchor



Bond is at the guy

Figure 14 - Parallel Messengers

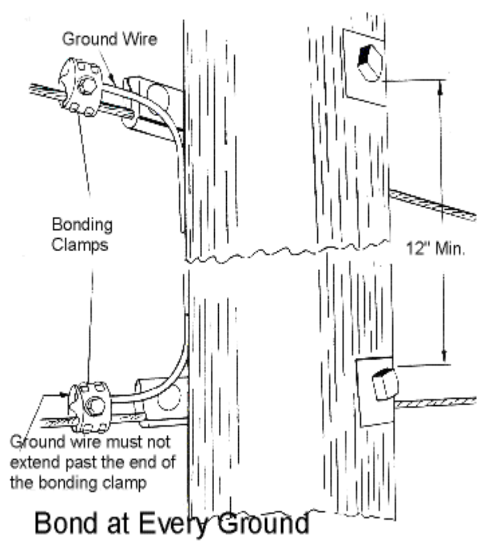
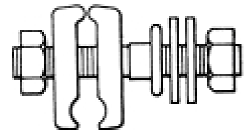
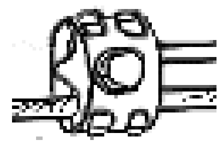


Figure 15 - Types of Bonding Connectors

H-2 Connector (Fargo)	C or D-Clamp	Cable Lashing Clamp (Bug Nut)
		

B-Strand Clamp	Ground Rod Clamp	Ground Weaver
		

<u>Definition of Grounded</u>

Grounded is defined by the NESC as "Connected to or in contact with earth or connected to some extended conductive body that serves instead of the earth."

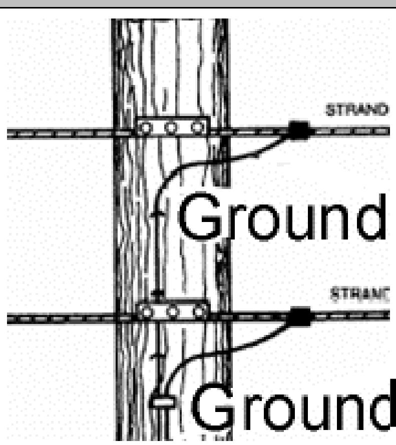
In other words, facilities are grounded when they are purposefully connected by conductive parts to a grounding electrode (ground rod) that is in direct contact with soil—preferably undisturbed. Grounding of facilities is needed for the protection of personnel and equipment.

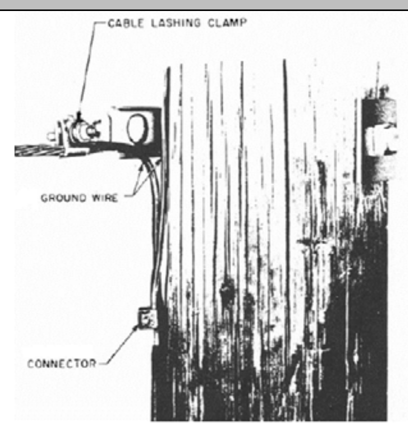
Grounding Installation Considerations

The NESC requires all joint utility occupants to ground whenever a vertical ground (pole ground) exists. Use care to avoid blocking climbing space when routing the bond wire to the vertical pole ground.

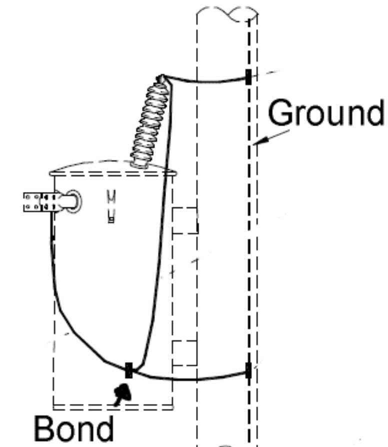
Figure 16 - Types of Grounds

Aerial Cables

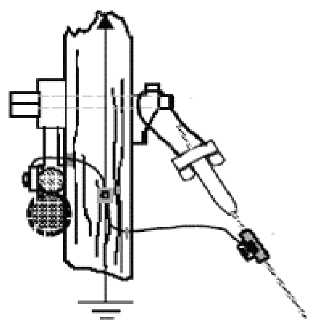


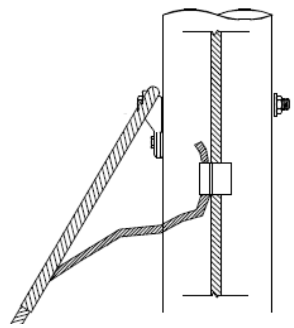


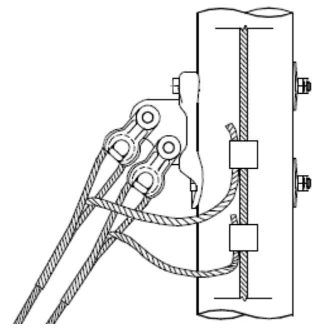
Transformer and Equipment



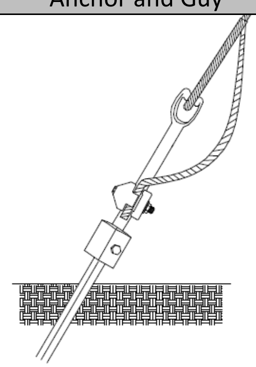
	Guy Grounding	
Communication Bonding	Power Supply Bonding	Double Down-Guy Bonding

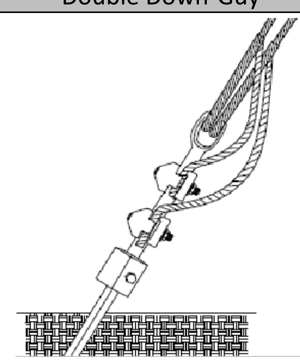




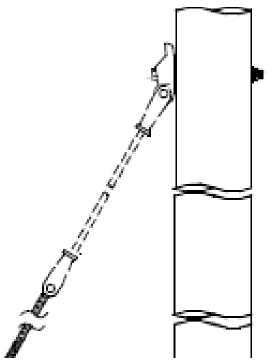


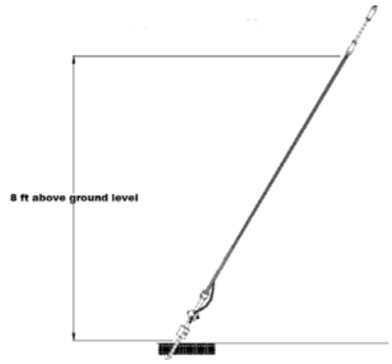
Anchor Grounding	
Anchor and Guy	Double Down-Guy





Guy Strain Insulator		
Insulated Guy, Not Bonded	Insulated Guy 8-ft minimum above Ground, Bonded	Porcelain Insulator or "Johnny Ball"



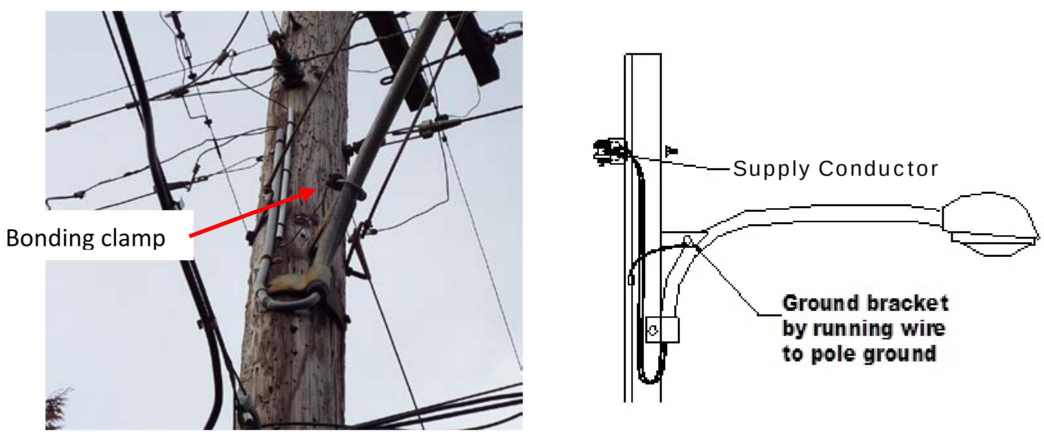


Per NESC 215 and 279, guys must be bonded unless a guy insulator is used—then exceptions apply.

Streetlight Grounding

Many utilities use ungrounded street lights and you must be aware of the hazard—it is always best to assume that the street light is not bonded and grounded unless the grounding and bonding are clearly visible. The mast may be bonded at several different locations.

Figure 17 - Grounding and Bonding on Streetlights



Bonding Risers

Metal risers must be bonded and grounded if the cables contain supply conductors. Visual confirmation of bonded supply risers is recommended. Below are some examples of bonding to metal risers.

Figure 18 - Examples of Bonding to Metal Risers

Bond to pole ground when riser is adjacent to pole using industry-accepted components designed for such use

Wire is bonded to top of metal riser and pole ground

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CHAPTER 3 - FRAMING

The NESC addresses framing in Sections 232, 235, and 238.

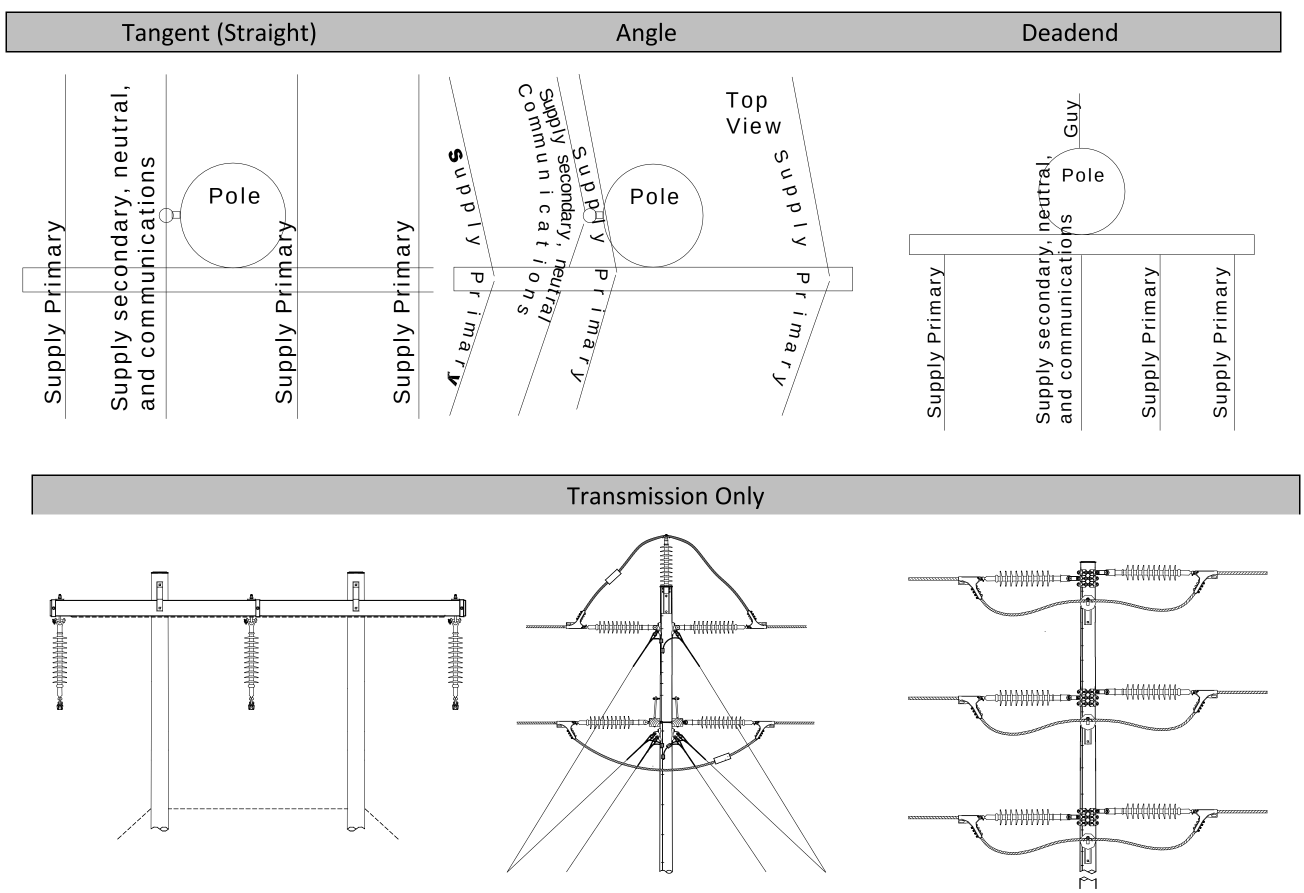
Definition of Framing

Framing is not defined in the NESC. In this document 'Framing' is referring to the overhead installations of poles and some other utility structures such as transmission H structures and the facilities attached to them. It is basically the construction style that best suits certain conditions determined by generally accepted practices.

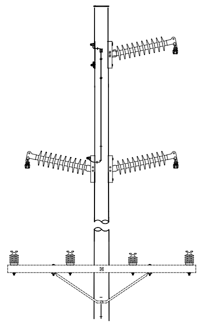
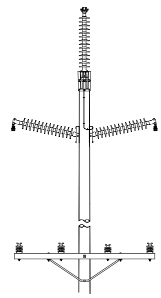
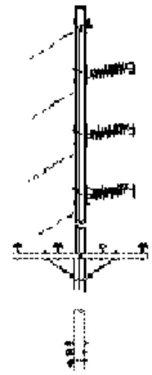
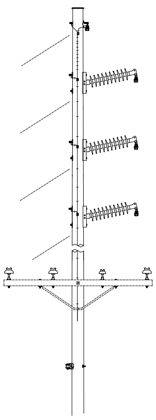
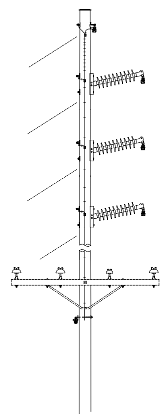
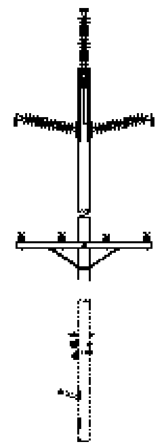
Basic Framing Terms

All types of supply construction cannot be listed here. The examples given represent a generally accepted preference of construction.

Figure 19 - Supply Construction Examples

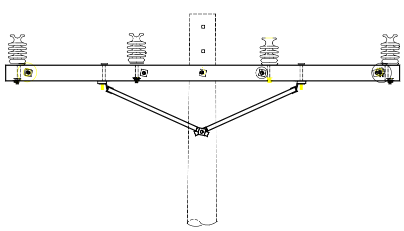
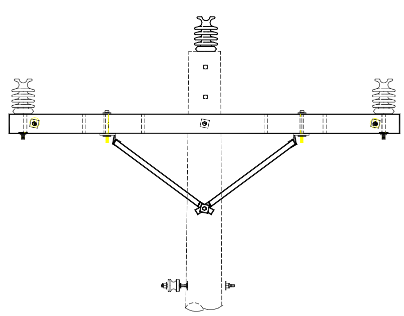
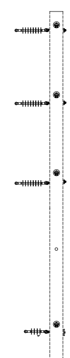


Transmission with Underbuild

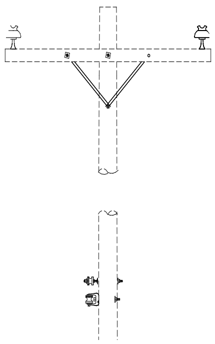







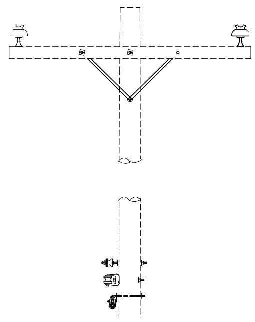
Primary Only

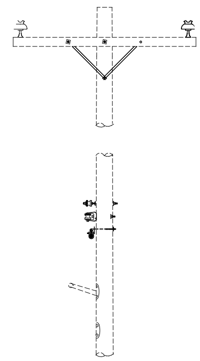
High Neutral | Low Neutral | High-Low Neutral

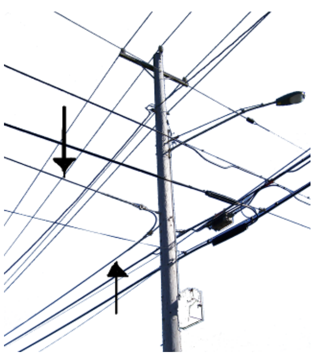
Primary with Secondary		
Primary with Secondary	Primary with Secondary with Supply Fiber in the Supply Space	Primary with Secondary and Communications



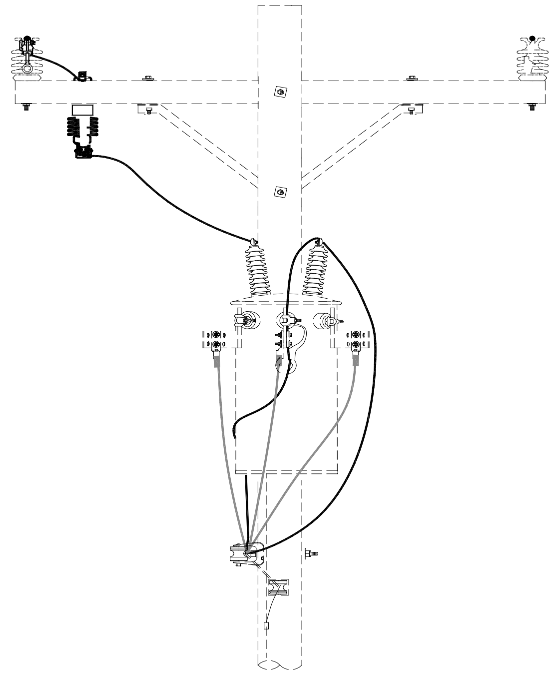


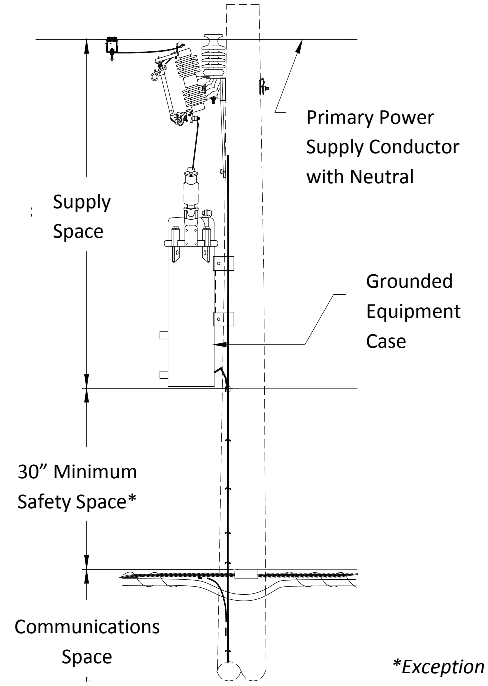


Primary with Secondary and Fiber	
Primary with Communication Fiber in the Communication Space	Communication Fiber in Communication space on bracket

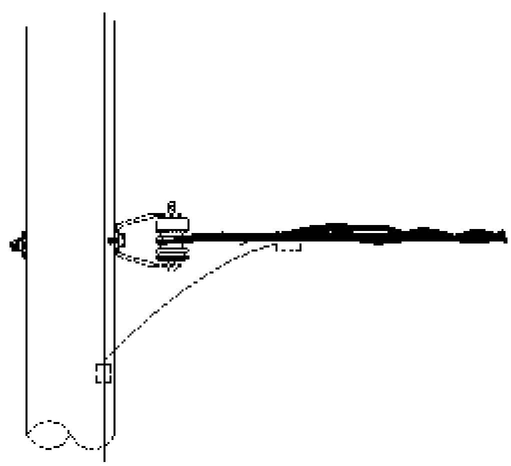


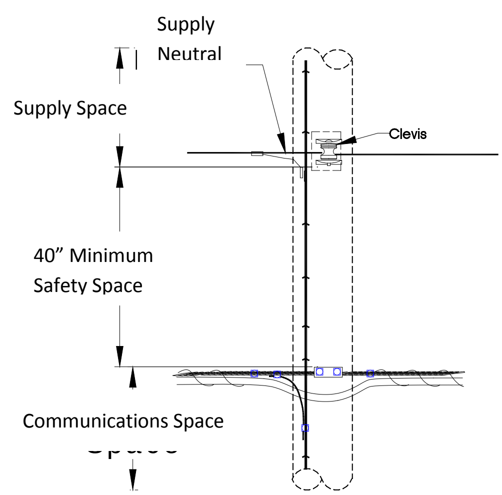
Primary with Equipment	
Transformers	Communications



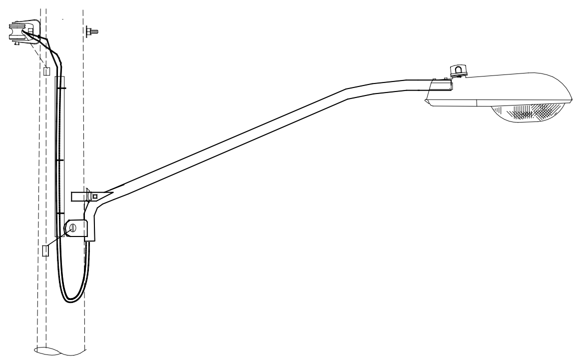


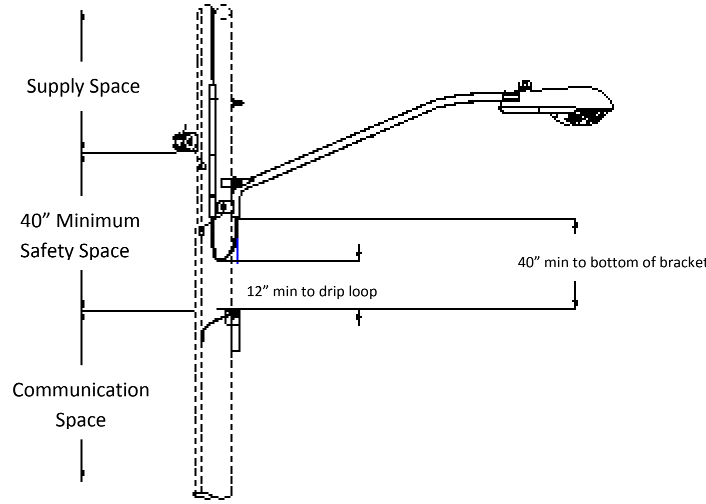
Secondary	
Secondary Only	With Communication



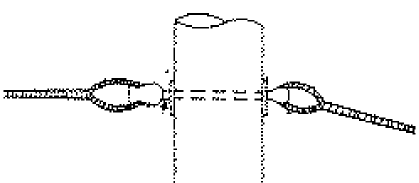


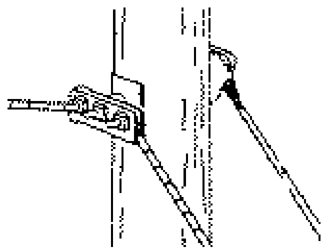
Secondary with Luminaires	Secondary with Luminaires and Communication

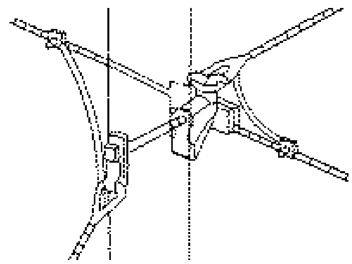


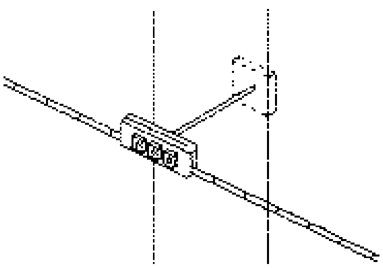


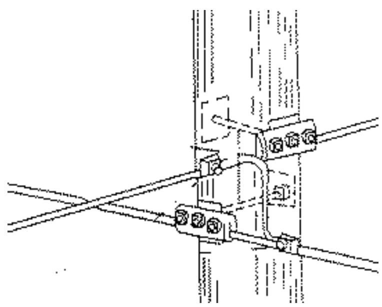
Communication Only

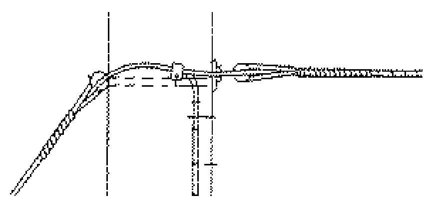


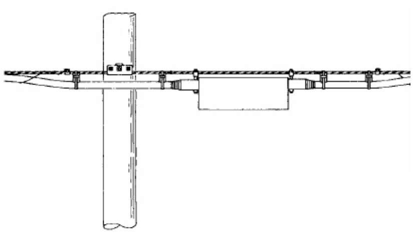


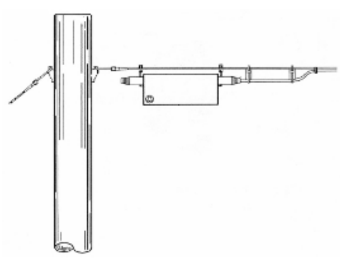


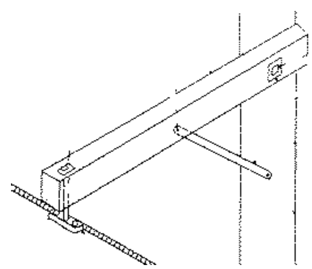




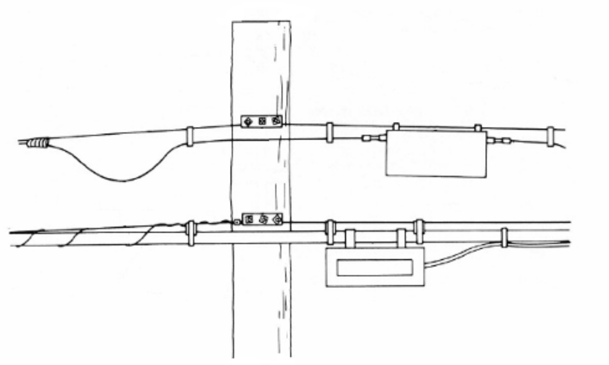








Communication to Communication



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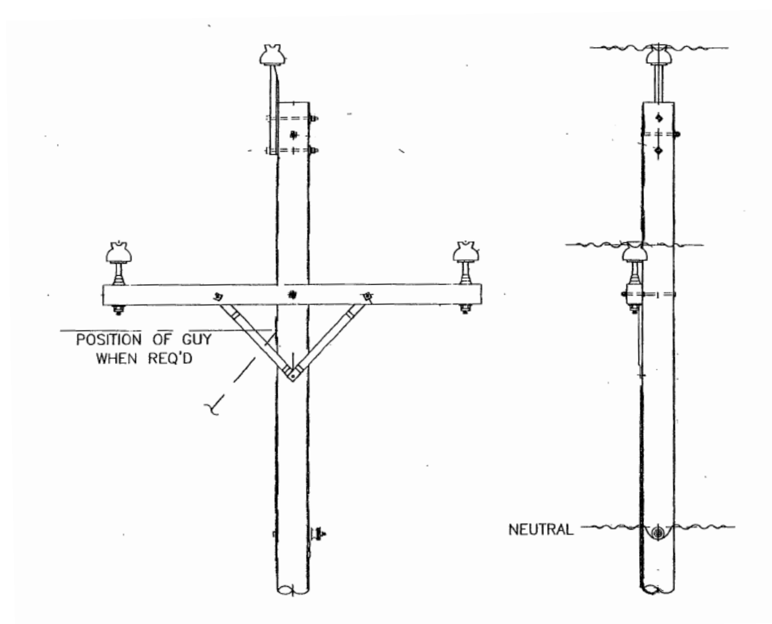
Avian Protection Construction

In recent years there has been a growing concern regarding the protection of migratory birds. The U.S. Department of Fish and Wildlife has required all electric utilities to have an Avian Protection Plan. This plan may require greater spread between conductors, as illustrated below.

Figure 20 - Three-Phase Raptor Framing



Construction Practices

There are some generally accepted rules based on the NESC as to where supply and communication attach to structures (poles). As with all construction, there are exceptions.

Normally the attachments for new construction are (from top to bottom) as follows:

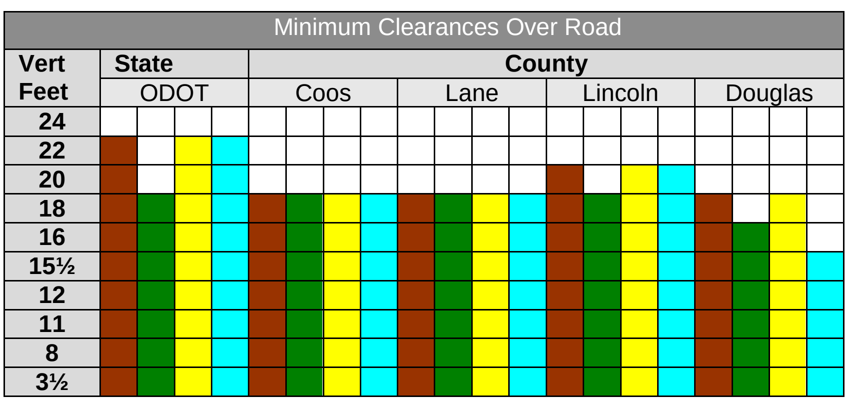
- Supply Transmission
- Supply Primary - 10 feet minimum below Transmission
- Supply Secondary – 6 feet minimum below Primary
- Supply Fiber – can be anywhere in the supply space
- Communication Attachments
  - Communication to Communication 12-inch separation

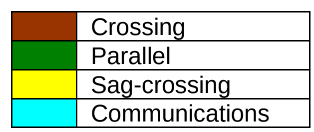
    Note: Suggested practice is to follow the existing framing for new attachments and construction. Climbing space must be maintained.

Ground Clearances

Clearances of attachment heights vary depending on the clearance of the cable or conductor to ground. NESC table 232-1 gives detailed minimum ground clearances for both supply and communications. However, there are other jurisdictions that may require greater heights. Below is an example of road districts that require more clearance than the minimum NESC code.

Figure 21 - Road Districts Requiring More than NESC Minimum Clearances





Clearances are measured from surface to surface and subject to change. Check local jurisdiction for required clearances.

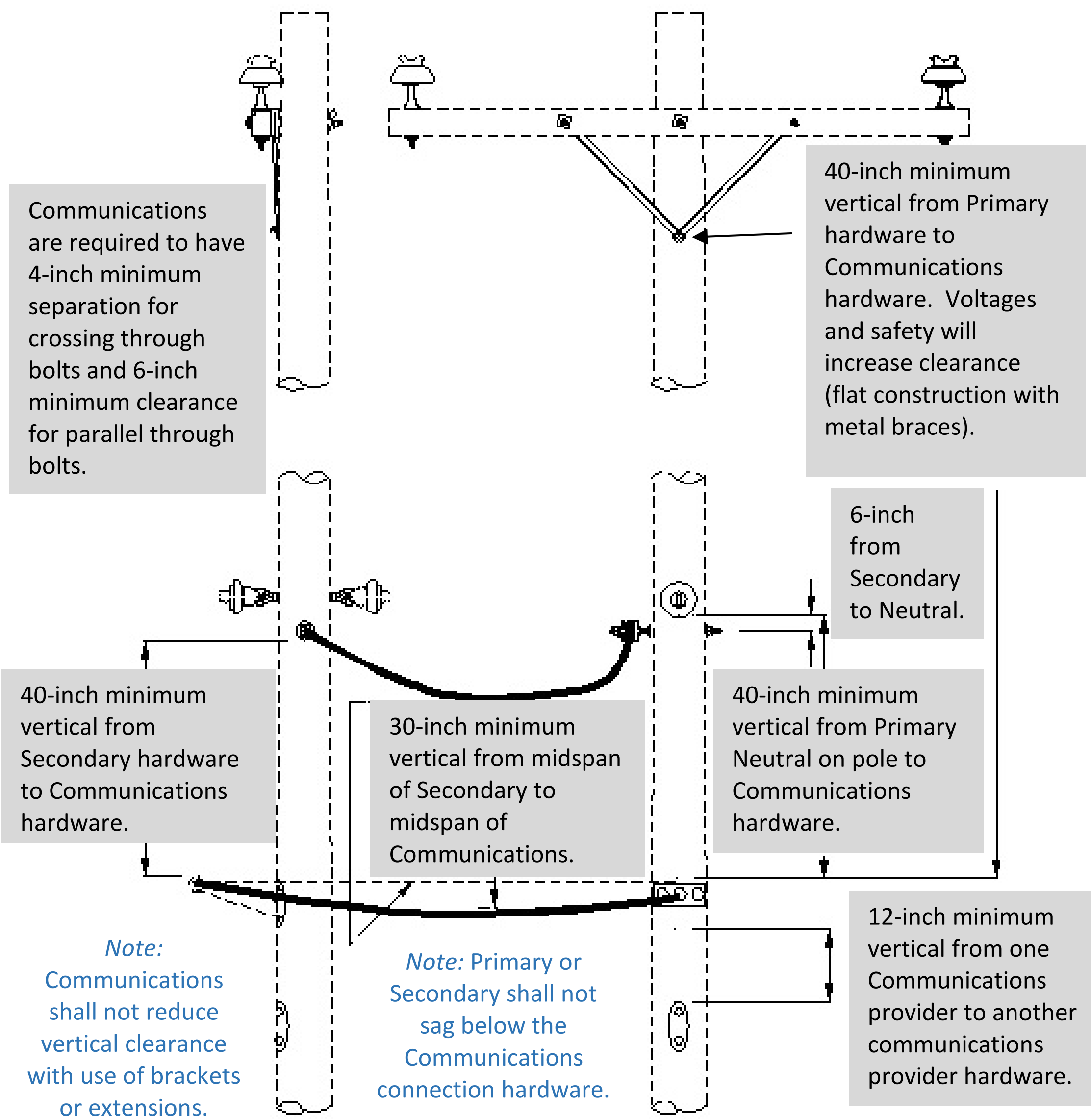
Voltage Clearances

Per NESC table 235-5 the minimum height of an attachment is often the result of the voltage of the conductors above it. For example, the maximum height on a supply pole that the primary conductor can attach is dependent on the voltage of the transmission conductor above it. Similarly the height at which a communication cable may be attached is dependent on the voltage of the supply cable above it. This voltage is not determined simply by a visual observation.

Here are some different methods for determining attachment heights:

- Inquire to the supply utility as to the voltage and use NESC table 235-5
- Request permit attachment height from supply utility
- Pole is marked or banded to show communications maximum attachment height

Figure 22 – Voltage Clearances



Note: Mid-span clearances are a controlling factor—see Chapter 6.

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CHAPTER 4 - POLES

The NESC addresses poles throughout the code.

Definition of a Pole
A pole is a structure used to support supply and or communication conductor cables and associated equipment."

Placement
The placement of poles is subject to numerous conditions such as the general location and proximity to the street, buildings, fire hydrants, driveways or easements and other aerial or buried utilities. Additional factors to consider are the weight loading for the pole, the depth the pole is to be set, protective barriers that may be needed, foliage in the vicinity that may need to be trimmed, and local climate (snow and or wind loads). As with any excavation, utility locates must be called for.

Types

- **Wood:** The most predominate species of wood used for poles consists of Douglas Fir,Western Red Cedar, various species of Pine, and Western Larch. Typically wood poles are treated to prevent deterioration and rot. The species of wood and the original manufacturer's treatment used can usually be found on the brand or tag that the supplier places on the pole.
- **Metal:** Tubular metal poles are typically made from galvanized steel or ductile iron aluminum.
- **Concrete:** Designs for concrete poles include tapered structures and round poles made of:
  - Solid Concrete
  - Pre-Stressed Concrete
  - Hybrid – Concrete and Steel Poles
- **Fiberglass:** Poles are hollow and similar to the tubular metal poles with a typical fiberglass thicknesses of ¼ to ½-inch.
- **Laminate:** An engineered product comprised of assemblies of specifically selected and prepared wood laminates bonded with adhesives and treated with preservatives.

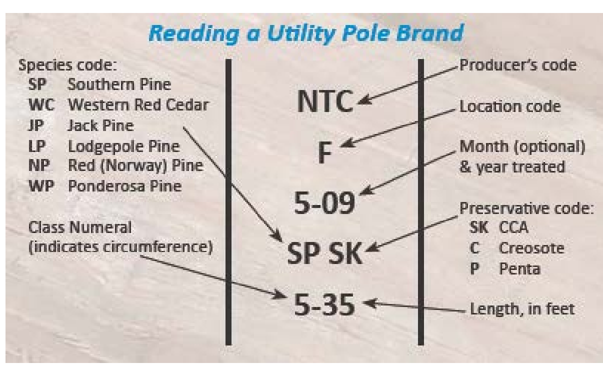
Identification

Poles can be identified with metal tags (also known as bellybuttons) or stamps (also referred to as burned or branded).

Figure 23 - Metal Tag Method of Identification

Figure 24 - Stamp Method of Identification

Figure 25 - Utility Pole Brand Legend



Grades of Construction

The grade of construction will determine the appropriate size (strength) pole to withstand wind and ice storms to meet basic safety requirements. Three grades of construction are defined by the NESC related to pole lines:

- Grade B—the highest grade; typically corresponds to crossings (highway, railroad, pole lines carrying varying power supply voltage levels)
- Grade C—lower grade of construction than Grade B; typical power or joint use (telecommunications and power) distribution pole applications
- Grade N—lowest grade of construction; typically only used on poles with sole use of communication facilities

Pole Class

Wood Pole Class	Horizontal Load (lb)	Length Range (ft)	Minimum Top Circumference (inch)
H6	11,400	45-125	39
H5	10,000	45-125	37
H4	8,700	40-125	35
H3	7,500	40-125	33
H2	6,400	35-125	31
H1	5,400	35-125	29
1	4,500	35-125	27
2	3,700	20-125	25
3	3,000	20-90	23
4	2,400	20-70	21
5	1,900	20-50	19
6	1,500	20-45	17
7	1,200	20-35	15
9	740	20-30	15
10	370	20-25	12

Utility poles are divided into classes. The class's definition specifies a minimum circumference that depends on the species of tree and the length of the pole. This circumference is measured 6 feet from the butt of the pole. There is also a minimum top circumference that is the same for all species and lengths.

Pole Top Extensions

Figure 26 - Pole Top Extension Types

Fiberglass	4x4 (California Arm)
	

Pole Supports

Figure 27 - Pole Support: Swamp Brackets (Legs)

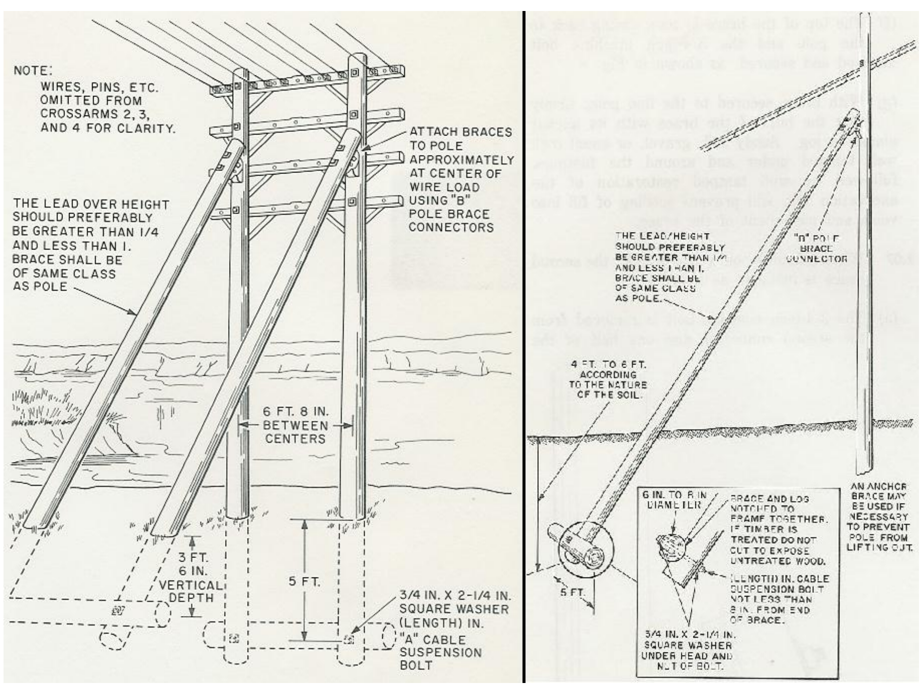
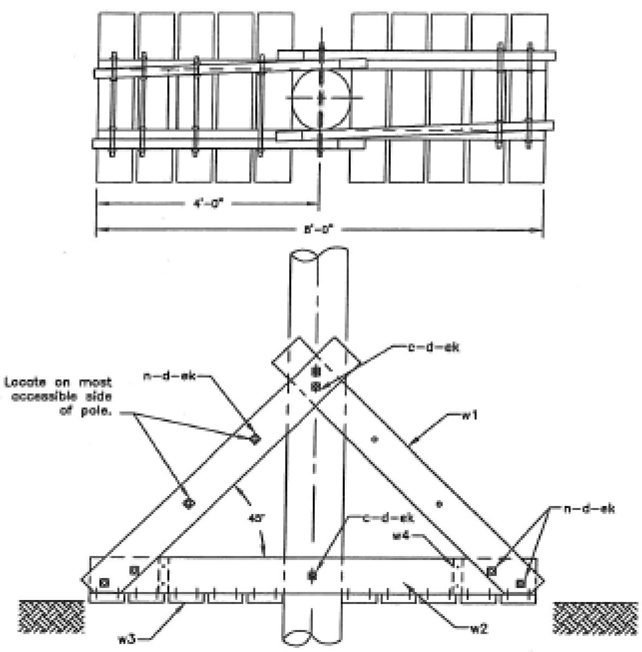


Figure 28 - Bog Shoes



NOTES:

1. Trim length of w4 to diameter of Pole at ground level.
2. Use 3/4" minus crushed rock as necessary to provide a level base for bog shoe.
3. See W3.1GX for drilling guide for wood members.

ITEM	NO.	MATERIAL	ITEM	NO.	MATERIAL
c	3	Bolt, machine, 5/8" x req'd length	w2	2	2" x 8" x 8'-0" D.F. (treated)
d	30	Washer, curved 3" x 3"	w3	10	2" x 8" x 3'-0" D.F. (treated)
n	6	Bolt, D A, 5/8" x req'd length	w4	2	2" x 8" x 1'-6" D.F. (treated)
ek	27	Locknuts, 5/8"		48	Nails, 10d galv.
w1	4	2" x 8" x 6'-4" D.F. (treated)			3/4" minus crushed rock (as req'd)

Figure 29 - Push Pole

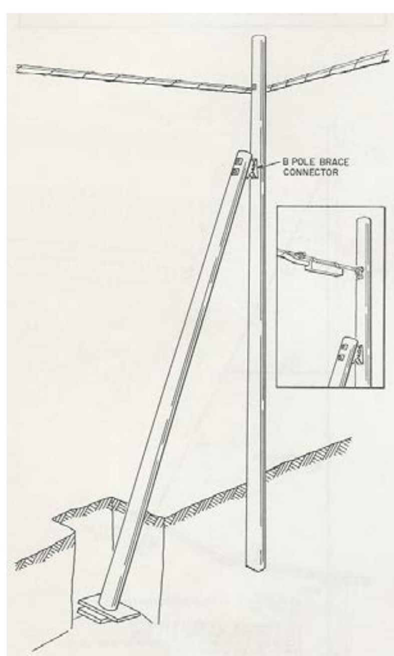
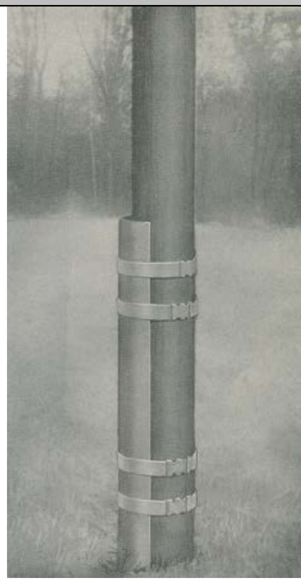
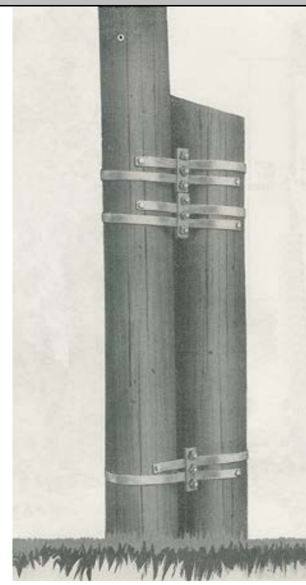


Figure 30 - Truss Types

C Trussing	Pole Strapped to Pole
	

CHAPTER 5 - RISERS

The NESC addresses Risers in Sections 239D, 360, 361, and 362.

Definition of Riser

The term "riser" references cable or the mechanical protection (conduit, u-guard, etc.) of the cable. It is a vertical installation of a cable or conductor that is directly or indirectly (stand-off brackets) attached to a pole for the purpose of transitioning between aerial and underground systems. Vertical grounds are not considered to be risers.

Placement Considerations

- Mechanical protection for supply conductors or cables is required by NESC Rule 239D. This protection should extend at least one foot below ground level.
- Communication cables and armored cables that are firmly secured to the pole do not require guarding.
- For mechanical protection, risers should be installed on the pole quadrant away from the flow of traffic and in the safest available position with respect to climbing space (see Figure 31) and subject to pole owner standards.
- Observe climbing space. The number, size, and location of risers shall be limited to allow adequate access for climbing. Vertical runs physically protected by suitable conduit and securely attached to the surface of the line structure are not considered to obstruct the climbing space.
- Existing risers should not obstruct other equipment or prevent the attachment of additional facilities.
- Supply cable (Secondary or Primary) conduits should extend far enough above communication facilities to provide for at least a 40-inch clearance from exposed supply conductor to communication facilities.
- Exposed conductive pipes or guards containing supply conductors or cables shall be grounded in accordance with Rule 314 (grounding of circuits and equipment).
- Common sharing of a single set of standoff brackets by both Supply and Communications is preferable subject to pole owner standards. Sharing makes future pole transfers easier and helps reduce risk of climbable structure standoff spacing.
- The pole owner should determine what type of standoff bracket can be used and what construction standards must be met.

Figure 31 – Riser Secured to a Standoff Bracket

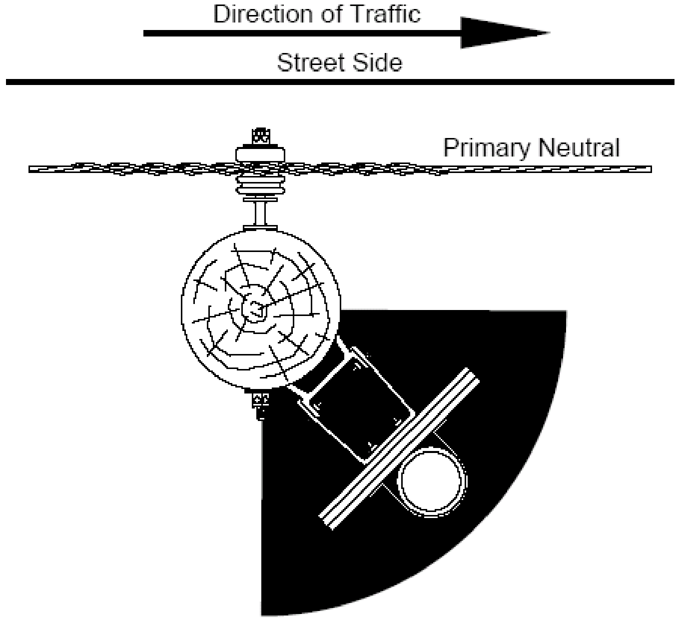


Figure 32 - Standoff Brackets

12-inch Standoff Bracket

15-inch Standoff Bracket

Pole View with 15-inch Brackets

Types of Mechanical Protection

U-Guard protection can be formed of plastic, metal, or wood.

Figure 33 - U-Guard Protection

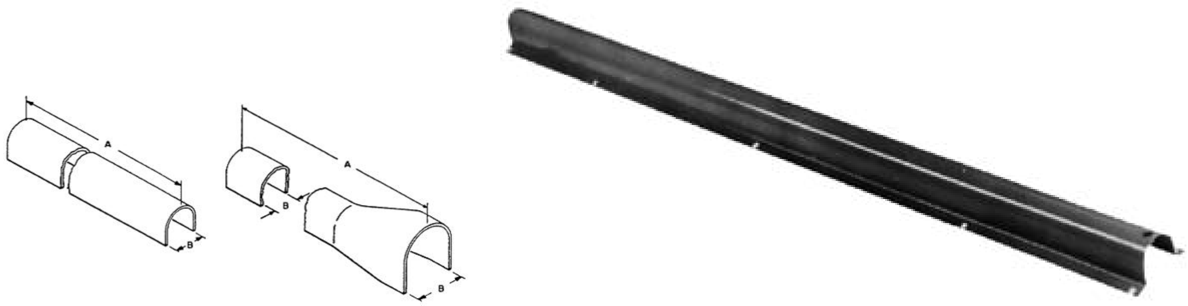
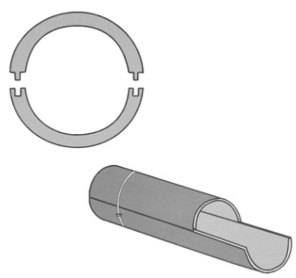


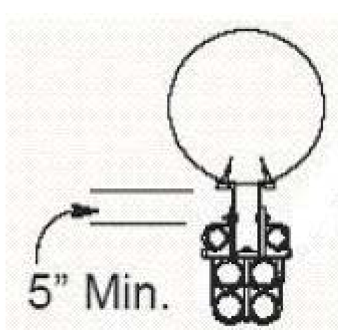
Figure 34 - Conduit Types

Plastic or Metal	Split	Flex	Cable in Conduit
			

Installation:

- The first riser stand-off bracket should be a minimum of 8 feet above ground or 8 feet to the next climbable surface (see NESC 217A2c).
- Maintain space requirement from the pole to facilitate a qualified worker's ability to climb and belt off on the pole. (see Figure 35).

Figure 35 - Climbing Space Requirement



Riser conduits can be directly affixed to the pole by utilizing one of the following devices spaced in a manner to maintain its installed position.

Figure 36 - Conduit Installation: Direct Attachment to Pole with Conduit Clamps

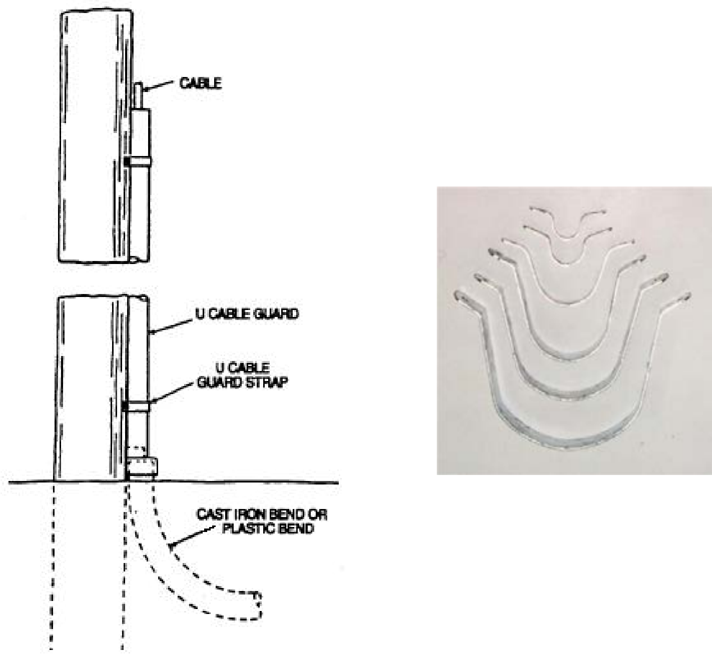
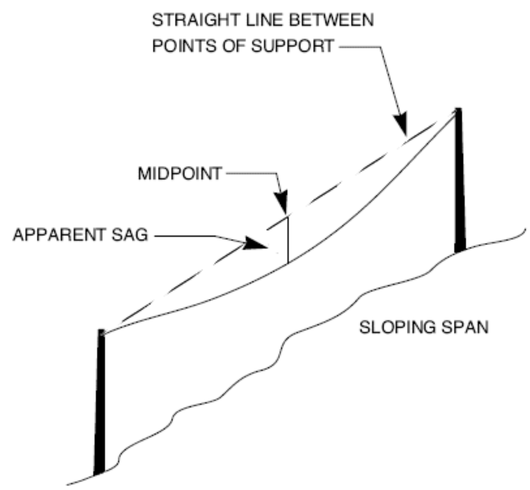


Figure 37 - Conduit Installation: Attachment to Standoff Brackets with Conduit Clamps

CHAPTER 6 - TENSION AND SAG

The NESC addresses Tension and Sag in Sections 235, 251, 252, 253, 260, 261, 263, and 277.

Figure 38 – Illustration of Sag



Definition of Tension

The NESC defines two types of tension:

- Initial—The tension in a conductor prior to the application of any external load.
- Final—The tension in a conductor under specified conditions of loading and temperature applied after it has been subjected for an appreciable period to the loading specified for the loading district (zone) in which it is situated, or the equivalent loading, and this loading removed. Final tension includes the effect of inelastic deformation (creep).

In other words, tension can be explained as force pulling the cables or wires at either end by what they are attached to or the weight of the cable itself. Tension is also applied to insulators.

Definition of Sag

The NESC provides the following definition of Sag:

- The distance measured vertically from a conductor to the straight line joining its two points of support. Unless otherwise stated in the rule, the sag referred to is the sag at the midpoint of the span (see Figure 38).
- Initial Sag—The sag of a conductor prior to the application of any external load.
- Final Sag—The sag of a conductor under specified conditions of loading and temperature applied, after it has been subjected for an appreciable period to the loading specified for the clearance zone in which it is situated or equivalent loading, and this loading is then removed. Final sag includes the effect of inelastic deformation.

Engineering Design

The appropriate sag and tension is determined by several factors, including span lengths, strand size, load, storm loading area, temperature, vertical clearances above grade, vertical clearances from other utilities, pole length~~s~~, and class ~~of pole~~.

Methods of Tensioning

Figure 39 - DynamometerTensioning

Electronic

Dynamometers are the preferred method for testing tensioning

Mechanical

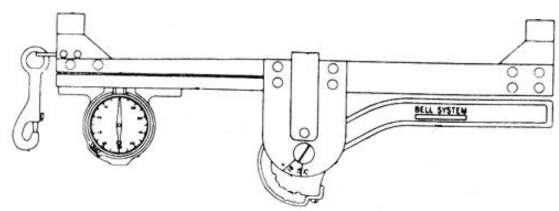
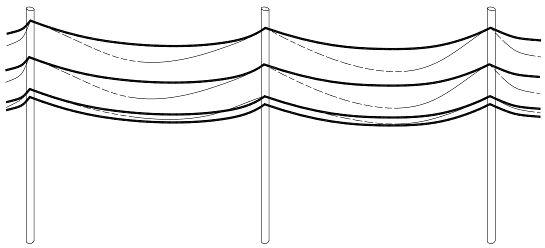


Figure 40 - Third Wave Return Tensioning

A light rope tossed over the conductor near one end of a span and give it a good hard jerk down. At the same instant press the button on the watch to start it. You then feel for return pulses in the rope as the shock wave you created runs up and down the conductor. At the instant you feel the third or fifth return you stop the watch. Read the number on the appropriate scale on the face of the watch and you have your sag in feet. The scales are direct reading and no math is needed.

Figure 41 - Matching Sag Tensioning



The smaller cables represent the difference in sag after environmental changes- notice how the sag between conductors differs.

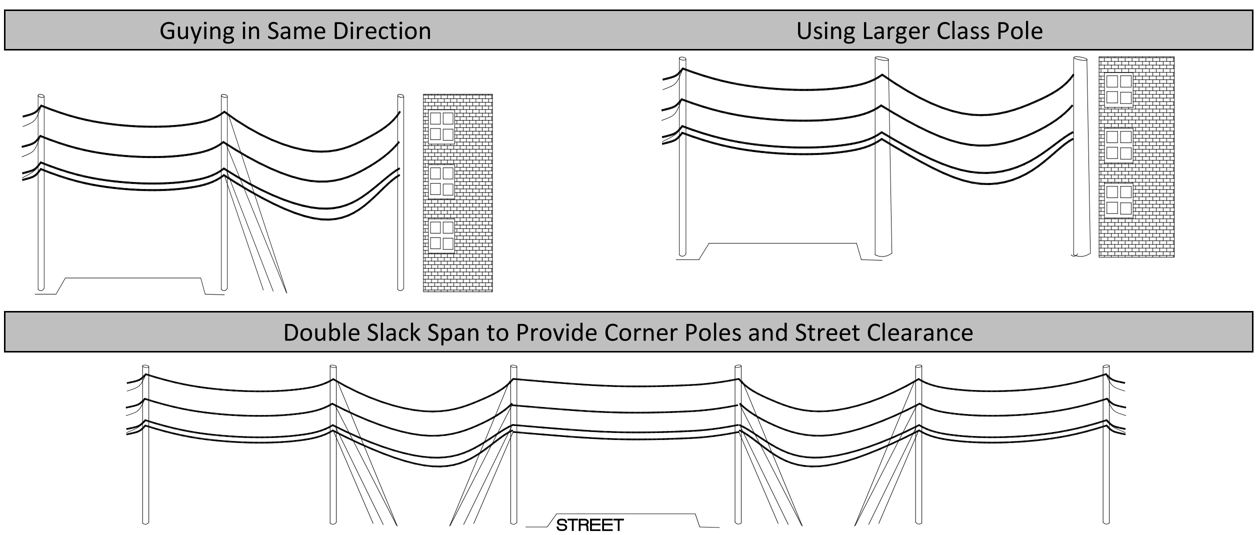
NESC clearances may not be met during different temperatures, ice, wind, etc. or over time.

This method is not recommended.

Slack Span (Reduced Tension Construction)

Slack spans are used when traditional guying is not practical. This should be avoided if possible. The slack spans are typically limited to one span and sags of joint users are matched. Guying can also be avoided with the use of stronger poles.

Figure 42 - Slack Span Construction



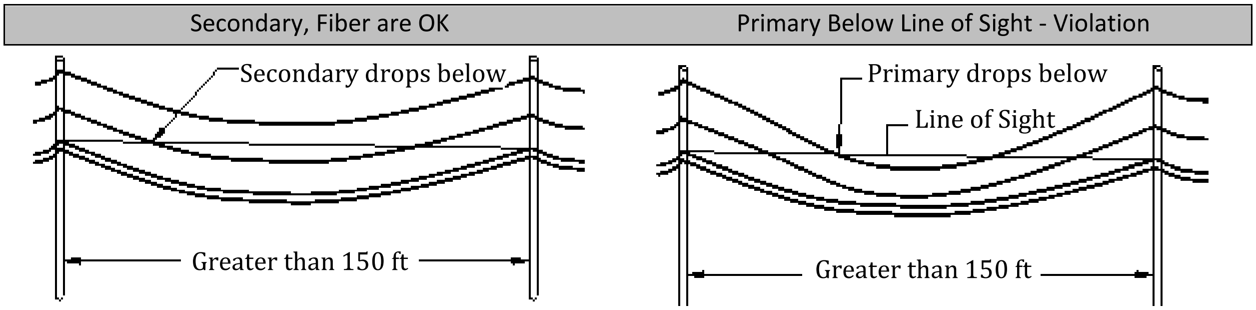
Guy Tension

Per NESC 261C2 (in layman's terms) the guy should be considered a part of the structure and designed and installed with the proper tension to support the tension of the attachments it supports. The guy can create an imbalance in tension if installed too tight. The note for this section also clarifies that guys must not be "loose".

Line of Sight

Per NESC 235C3 (in layman's terms) primary power cables cannot sag below the attachment points of the highest communication cable in spans over 150 feet.

Figure 43 - Line of Sight



Sag Charts

Sag Charts are used by most aerial utilities in one form or another to determine how much tension to use to pull the wire up to the appropriate sag. They come in many forms based on a variety of formulas. Some are commercially provided like those mentioned in the Resources section of this chapter; some are created in house. They typically include the following information:

- Wire Diameter
- Span Length
- Wire Weight
- Supporting Cable Characteristics
- Temperature
- Rated Breaking Strength
- Tension

Loading District

Varying environmental conditions create hazards that effect aerial cables differently. When looking at the loading zone map of the United States, it appears that all of Oregon has a “Medium” loading zone. However, special wind regions change the standard “Medium” loading zone to “Extreme”. There are four types of loading zones:

- **Heavy** loading district is generally in the central and northeast U.S. states. There is an assumption of lower temperatures and greater ice buildup on cables and conductors. This may require adjustments made such as open-wire conductors having breaking strength reduced by 50 percent. Where there are copper or steel cables or conductors, span lengths should be kept to a minimum

- **Medium** loading district covers much of the northwestern states, including Oregon. Where the standard for ice in the heavy loading district is ½ inch, in the Medium zone it is assumed ¼ inch. This may require adjustments. One example is an open-wire conductors having breaking strength reduced by 33 percent. Where a limiting span length in the Heavy zone is 150 feet, it may be increased to 175 feet in a Medium or Light zone.

- **Light** loading district covers most of the southern states. It is the lightest, most flexible loading zone. Where the Medium loading district assumes ¼ inch of ice, the Light loading district assumes no ice.

- **Extreme** loading district covers the entire coast, Columbia Gorge and some other areas of Oregon. This zone does not have ice but has higher than usual winds. The current code assumes wind above 60 feet must withstand extreme wind.

Figure 44 - Loading Zones in the United States

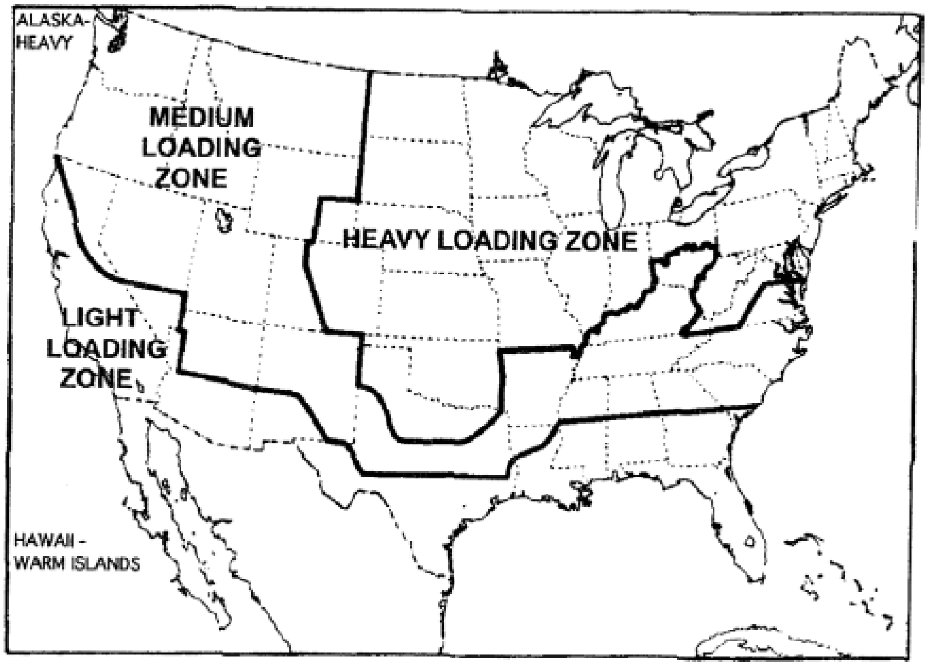
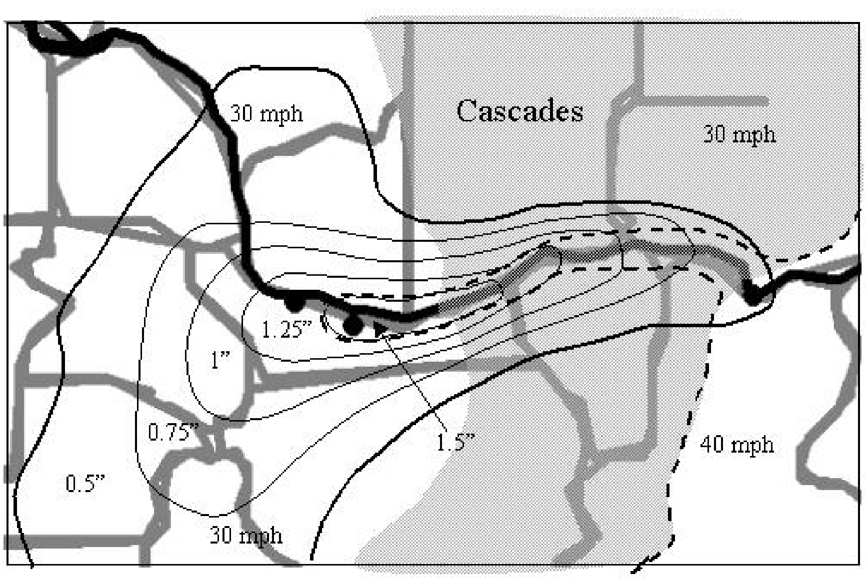


Figure 45 - Extreme Loading Zones in Oregon



Oregon can typically expect 85 mile winds; however, in “Extreme” areas those winds may increase to 120 miles or more. The Loading Zone or district determines some of the overload factors used for engineering. Reference the current NESC and local pole owner for additional information and guidelines.

Grades of Construction

There are three types of grades of construction; above ground utility construction must meet one of the three depending on environmental concerns.

- **Grade N** construction per NESC 263 is the most reduced type. Per NESC 014A2 grade N may be used for emergency construction. This construction must be upgraded to Grade C or above as soon as possible. Construction must always meet the minimum of grade N. A planned Grade N construction may be required when installing and removing facilities overlap. Planned Grade N requires approval of the OPUC. Grade N does not usually apply to communication facilities where no supply facilities exist. (NESC 263G)

- **Grade C** construction is the most common type of construction. Grade C provides the standard of minimum requirements for items such as strength of poles, structures, hardware, cross-arms, guys, anchors, foundations and sizes and sag for supply conductors. Grade C also provides the overload factors needed to meet the minimum standard.

- **Grade B** is the highest or most stringent type of construction. Grade B provides the standard of minimum requirements at greater values then Grade C. This type of construction is the minimum for installations crossing over railroads, communication lines or limited access highways. It is also used when the high voltage of the supply conductor will not be de-energized during breaker operations. Grade B may be used in Extreme Wind loading areas. Grade B has more stringent strength and overload factors than either grade N or C. Engineering for Grade B may require doubling cross-arms, brackets, ties and pins.

Resources

- Alcoa Sag 10 (Supply Cables)
- CommScope (Communication Cables)
- NESC

CHAPTER 7 - SUPPORT ARMS

The NESC addresses Support Arms in Sections 232B, 243B; 72, 160

Definition of Support Arm

Apparatus may be made of wood (which may require bracing), fiberglass, steel or other material that is bolted directly to the pole for the purpose of attaching equipment, messengers or conductors. Support arms can be used to:

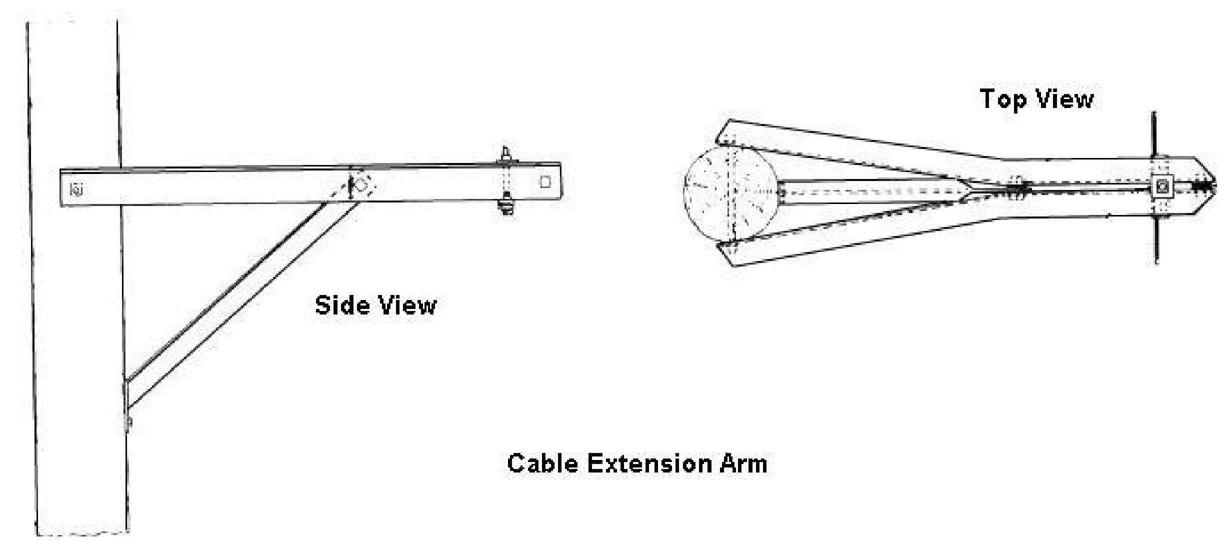
- Establish or maintain clearances
- Maintain the lead or tangent (eliminate the necessity to guy a pole)
- Create space to accommodate multiple attachments
- Create climbing space

Placement Considerations

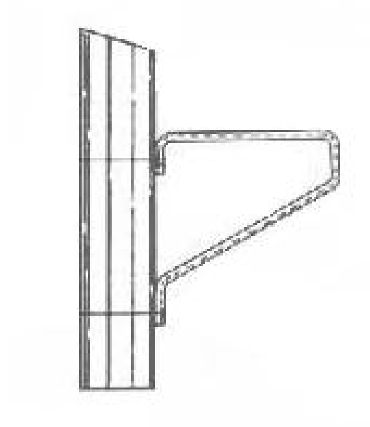
Considerations include length, weight of facilities, angle, type and size of arm, clearance from the pole and ground, and space on the pole. (*Note: Communication operators typically will not place a support guy on a support arm)*

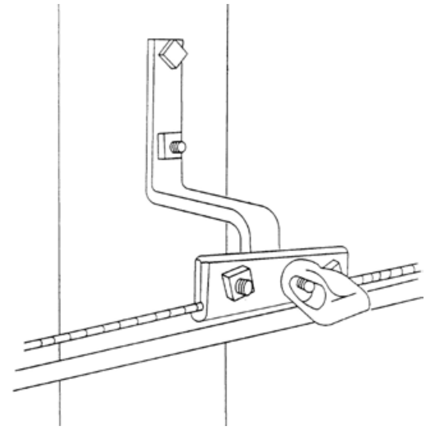
Figure 46 - Support Arms

Metallic Communication Alley Arm

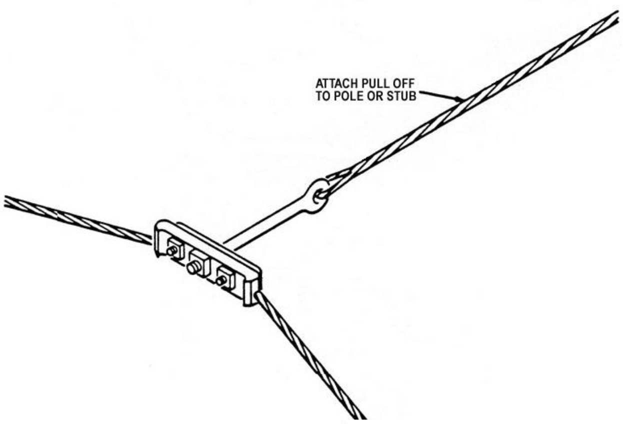


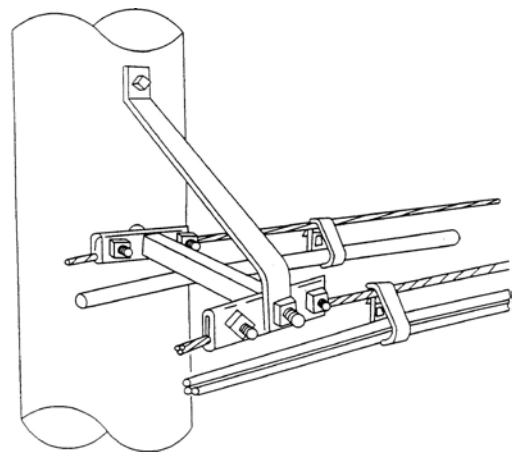
Seattle Bracket (Extension Bracket)	T-Alley Bracket



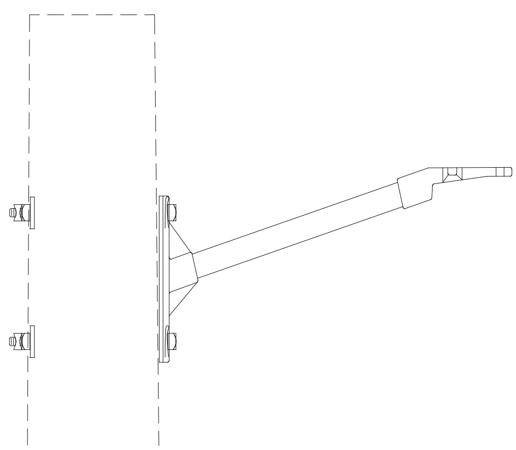


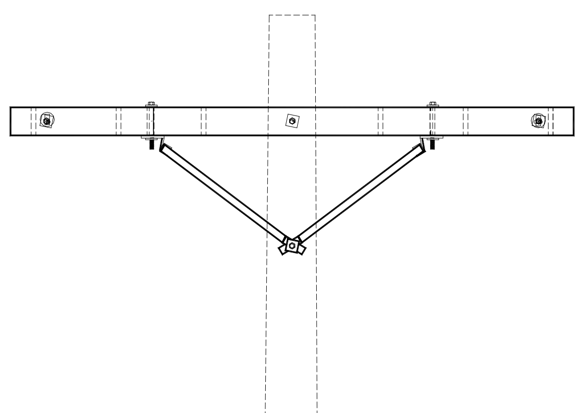
Flying Mary (Support Made Of Strand - Also Known as Flying Dutchman)	Illinois Bracket (9" Extension Bolt)





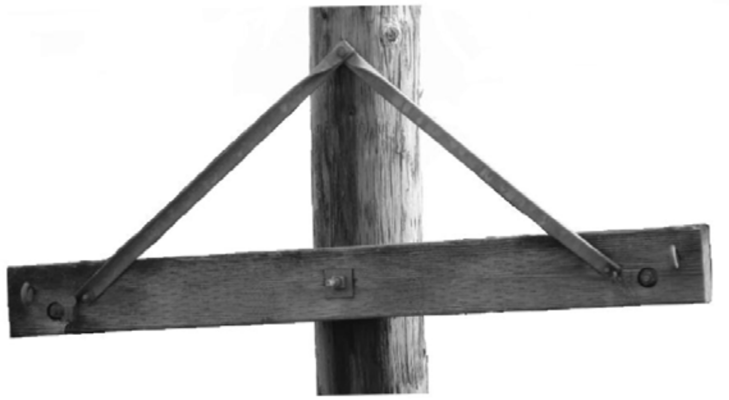
Fiberglass (Epoxy Rod) Stand-off	Power Cross Arm



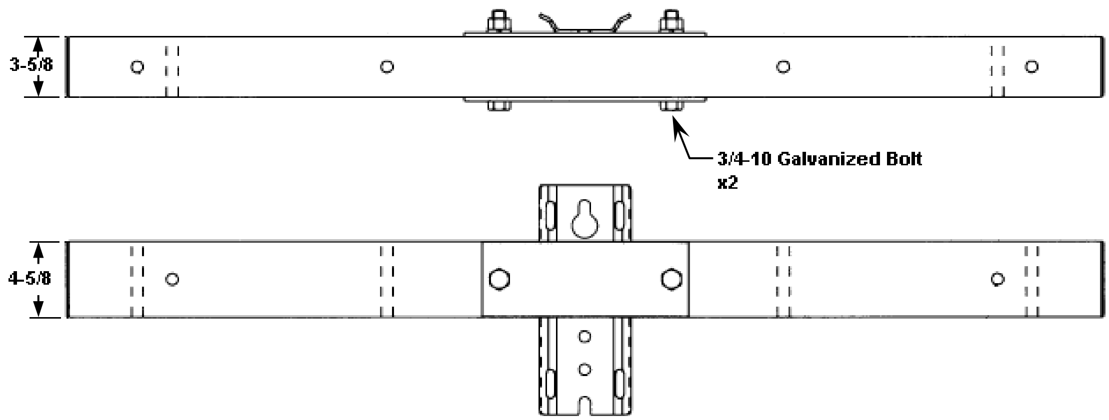


“E” Arm or “F” Arm (4x4 or 4x6 which can support facilities on both ends)

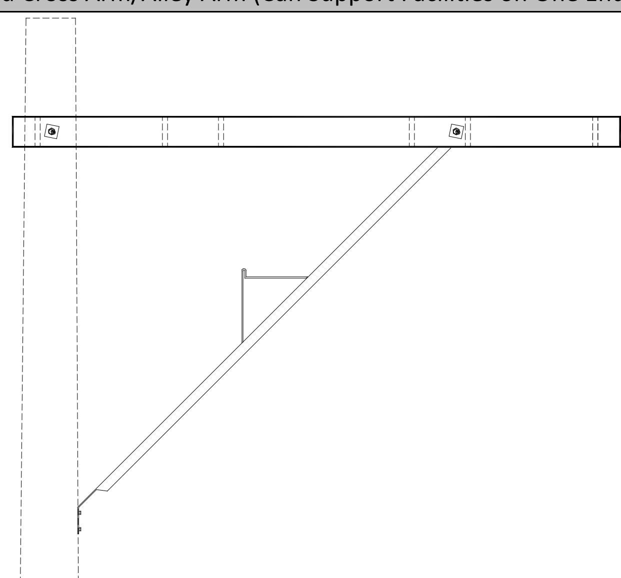
Note: When installed as pictured below, the top of the braces becomes the highest point for clearance purposes.



Braceless Cross Arm (Fiberglass)



Wood Cross Arm/Alley Arm (Can Support Facilities on One End)



Double Arms

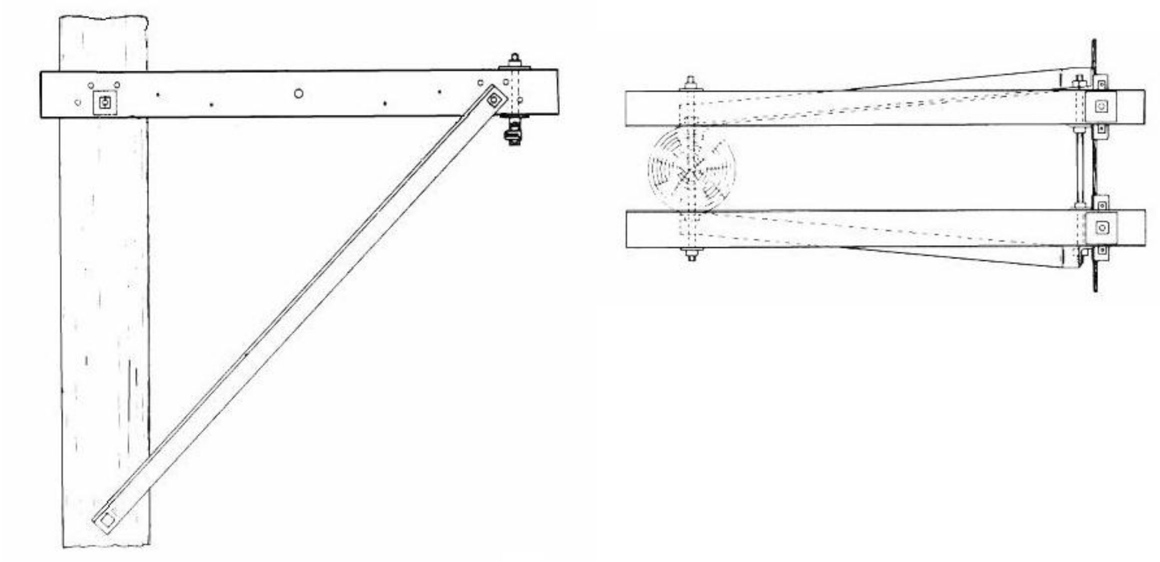
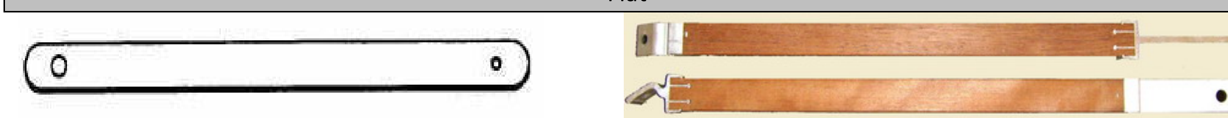
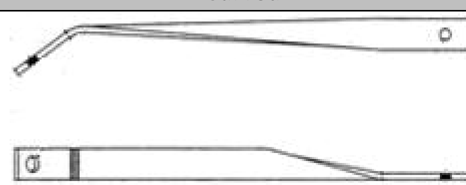


Figure 47 - Braces

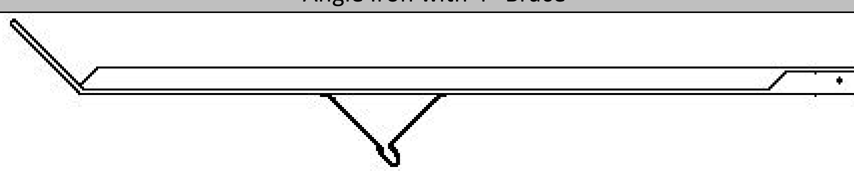
Flat



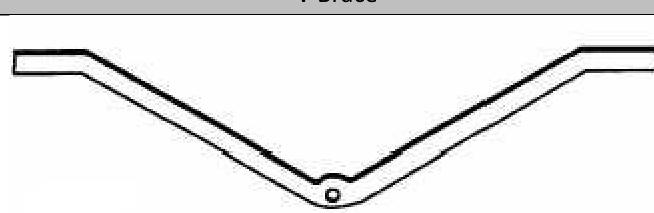
Curved



Angle Iron with 4” Brace



V Brace



Lengths of Arms

- Fiberglass (6" increments ranging from 6" to 36")
- Wood arms (6" increments ranging from 3' to 12')
- Metal arm sizes (24" and 48")

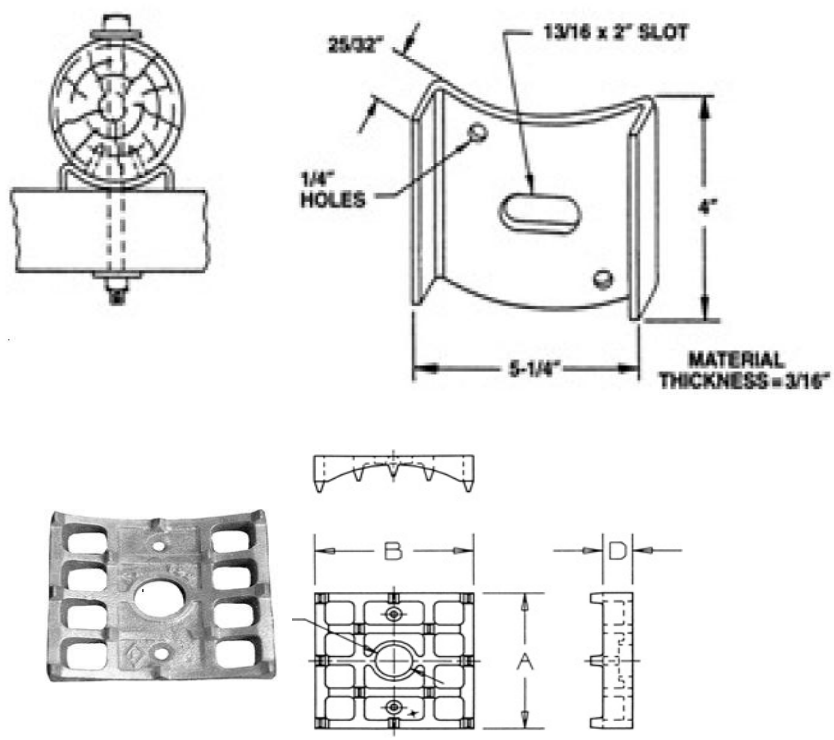
Pole Gains

There are two methods to "gain" a pole (create a flat surface on the round wooden pole):

- "Pre-notched" flat surface that is performed by the pole manufacturer
- Pole gain hardware that is bolted to the pole to create a flat surface to which the wood arm or structure is then attached

(*Note:* Gains can be "manually" cut into the pole in the field. This is no longer a common practice and should only be performed with the pole owner's permission.)

Figure 48 - Pole Gain Hardware



Installation

- Keep the wood arms perpendicular to the lead whenever possible
- Keep wood arms level
- Use pre-drilled holes whenever possible
- Use the appropriate length of bolt to avoid climbing hazard
- Position based on manufacture's specifications
- Select appropriate accompanying brace(s)
- Observe climbing space

- Place cross-arms to be centered on the pole
- Treat drilled holes with preservative prior to mounting
- Arms should be placed on the same face of the pole for all utilities if possible

CHAPTER 8 - EQUIPMENT PICTORIAL

The NESC addresses equipment in Section 38.

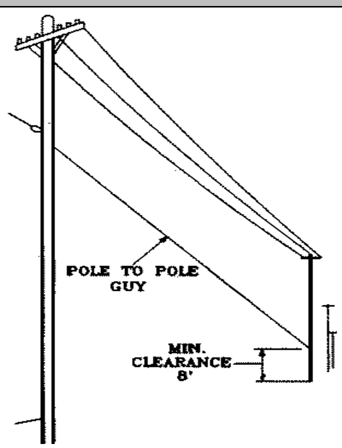
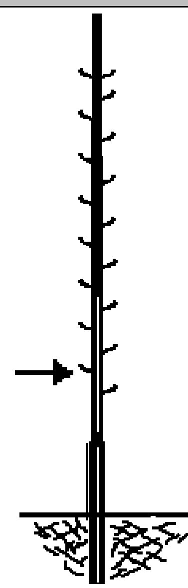
Definition of Equipment

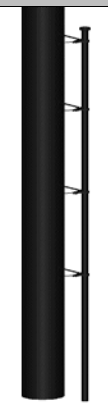
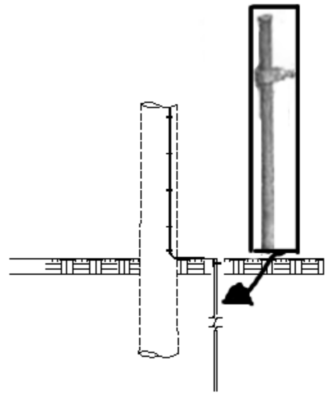
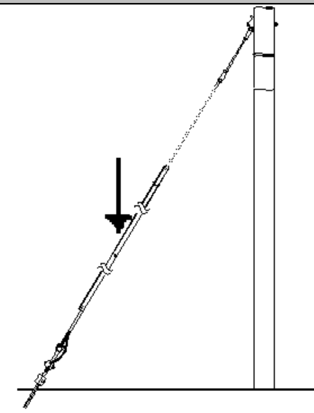
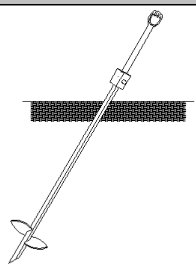
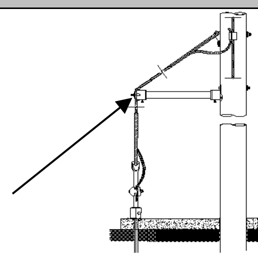
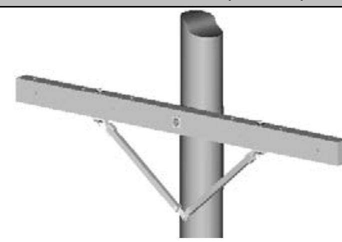
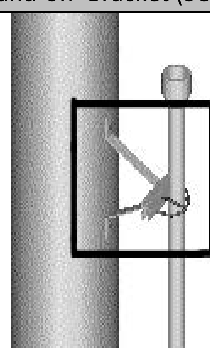
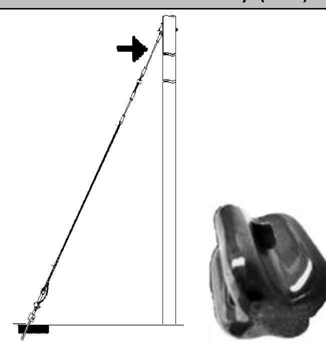
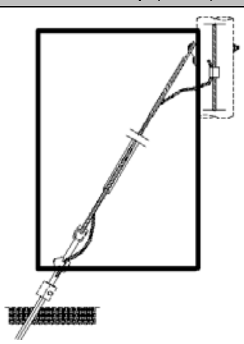
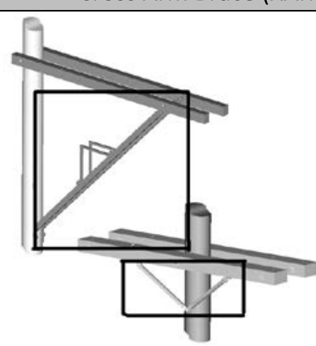
Equipment is defined in the NESC as "A general term and includes equipment installed for the operation of the electric supply and communications systems and auxiliary equipment installed incidental to the presence of the supply or communications system." In this section, Equipment is used to define a common language for the different parts of the aerial utilities facilities on poles, structures and towers, and shows the OJUA accepted abbreviations.

General Equipment

This equipment is used by all factions of aerial utilities. These types include, but are not limited to:

Figure 49 - General Equipment Types & Codes

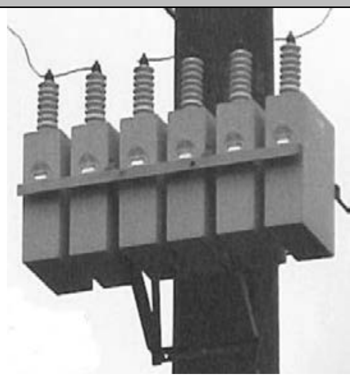
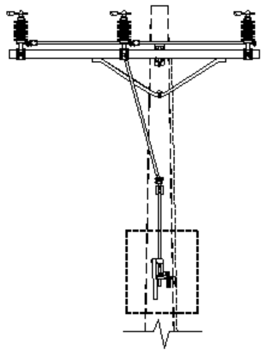
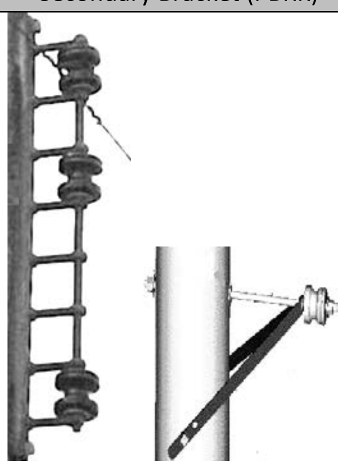
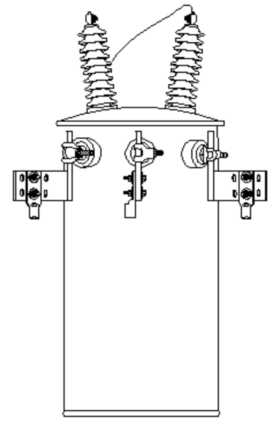
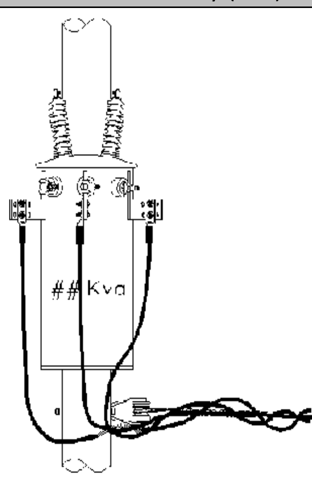
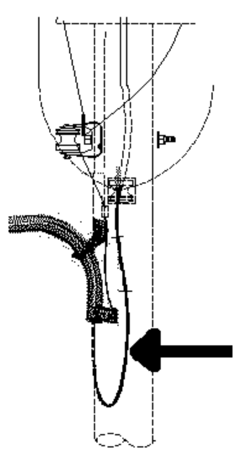
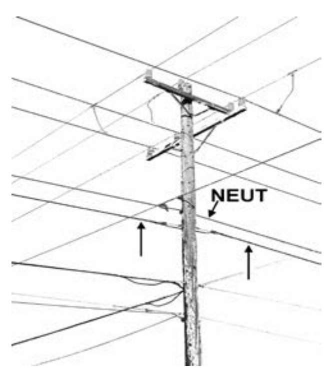
Pole to Pole Guy (PPG)	Pole Step (STEP)	Anchor (auxiliary) (AANC)
 A Pole-to-Pole Guy (PPG) exists on poles where no anchor room is available. The guy attaches at a lower location on the next pole. That pole acts as the anchor for the pole-to-pole guy.		

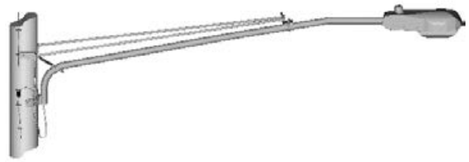
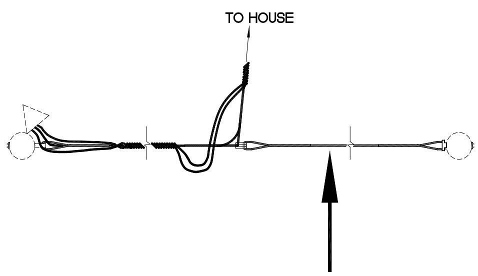
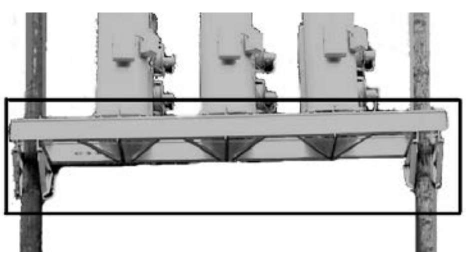
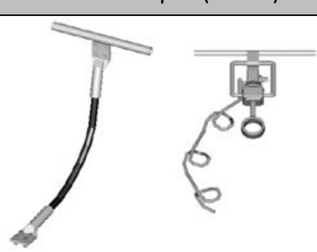
Risers (RIS)	Ground Rod (GRND)	Guy Markers (GM)
		
Anchor (ANC)	Sidewalk Fixture (SWF)	Cross Arm (XARM)
		
Ground Wire (GRWR)	Stand-off Bracket (SOB)	Insulator Guy (INS)
		
Down Guy (GUY)	Cross Arm Brace (XARB)	Cross Arm (Fiberglass) XARF
		

Supply Equipment

All types of Supply Equipment cannot be listed here. The examples given represent a general overview.

Figure 50 - Supply Equipment

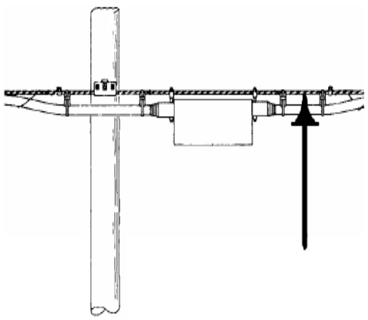
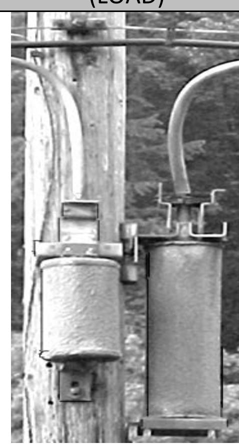
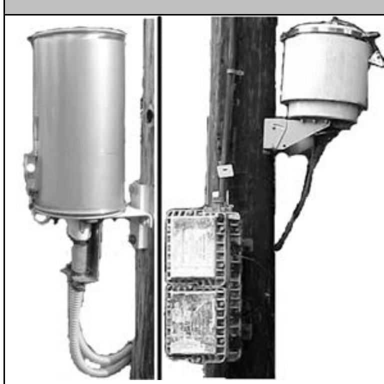
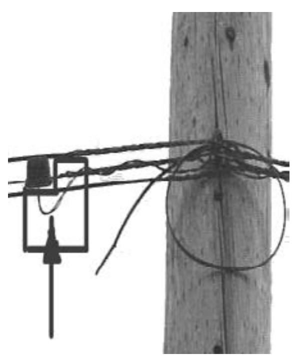
Power Capacitor (PCAP)	Power Switch Handle (SWCH)	Power Meter (PMR)
		
Secondary Bracket (PBRK)	Ground Molding (UGRD)	Power Transformer (XFMR)
		
Power Secondary (SEC)	Drip Loop (PDLP)	Supply Fiber (SPFO)
		

Streetlight (SLT)	Pedestal (PED)	Padmount Equipment (PAD)
		
Power Service Support Wire (PSSW)	**Power Cutout (PCO)**	**Power Single Phase Voltage Regulator (PSVR)**
		
Platform (PF)	**Power 3 Voltage Regulator Bank (P3VR)**	**Power 3 Phase Recloser (P3RC)**
		
Power Jumper (JUMP)		
		

Telco Equipment

All types of Telco Equipment cannot be listed here. The examples given represent a general overview.

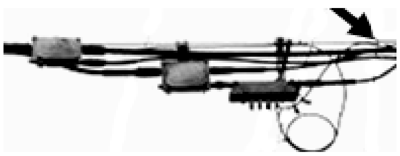
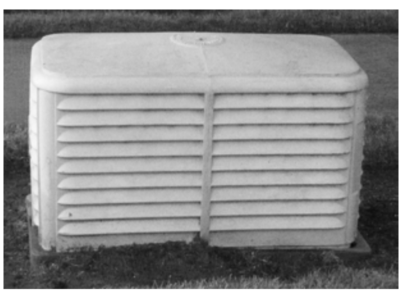
Figure 51 - Telco Equipment

Communication Mainline (COML)	Communication Cross-Connect (XBOX)	Platform (PF)
		
Communication Equipment (other) (CEO)	Communication Load Coil (LOAD)	Communication Terminal (TRM)
		
Communication Repeater (REP)	Communications Bridle Wire (BRW)	Communications Pedestal (PED)
		

Cable Equipment

All types of Cable Equipment cannot be listed here. The examples given represent a general overview.

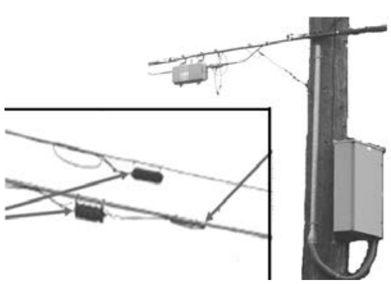
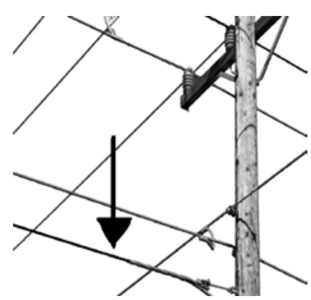
Figure 52 - Cable Equipment

Communication Mainline (COML)	Communication Power Supply (PS)	Communication Drop (COMD)
		
Pedestal (PED)	Pedestal (PED)	Cable Flush Mount Pedestal (PED)
		

Fiber Equipment

All types of Fiber Equipment cannot be listed here. The examples given represent a general overview.

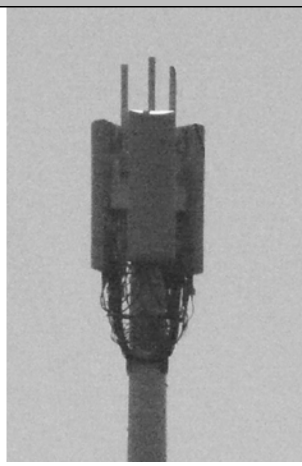
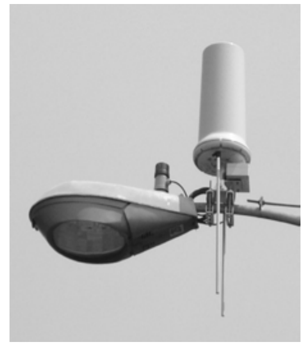
Figure 53 - Fiber Equipment

Fiber Equipment (other) (FEO)	Communications Fiber-optic (COFO)	Supply Fiber Optic (SPFO)
		

Wireless Equipment

All types of Wireless Equipment cannot be listed here. The examples given represent a general overview.

Figure 54 - Wireless Equipment

Antennas (ANT)		
		
Wireless Equipment (WEO)		
		

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APPENDIX – OJUA CODES

Attachments

Attachment Type (Type)	Code
Antennas	ANT
Communication Cross-Connect	XBOX
Communication Drop	COMD
Communication Equipment (other)	CEO
Communication Fiber-optic	COFO
Communication Load Coil	LOAD
Communication Mainline	COML
Communication Messenger	COMM
Communication Power Supply	PS
Communication Repeater	REP
Communication Terminal	TRM
Conduit-metal	MCON
Conduit-PVC	CON
Cross-arm	XARM
Cross-arm (fiberglass)	XARF
Down Guy	GUY
Fiber Equipment (other)	FEO
Others Mainline	OTML
Others Messenger	OTMM
Overhead Guy	OGUY
Pedestal	PED
Platform	PF
Pole to Pole Guy	PPG
Power 3 Phase Recloser	P3RC
Power 3 Voltage Regulator Bank	P3VR
Power Capacitor	PCAP
Power Cut Out	PCO
Power Meter	PMR
Power Neutral	NEUT
Power Primary	PRI
Power Secondary	SEC
Power Service Drop	PDRP
Power Service Support Wire	PSSW
Power Single Phase Volt Regulator	PSVR
Power Street Light	SLT
Power Switch	SWCH
Power Transformer	XFMR
Private Party Attachment	PVT
Riser	RIS
Signs	SIGN
Stand Off Brackets	SOB
Supply Fiber-optic	SPFO
Traffic Signal Bracket	TRSB
Traffic Signals	TRS
Wireless Equipment (other)	WEO

Violations

Deviation Code (DEV.)	Code
Abandoned	AB
Building	BD
Building/Horizontal clearance	BH
Building/Vertical clearance	BV
Damaged/Broken	DB
Mid-span/Horizontal clearance	MH
Mid-span/Vertical clearance	MV
Missing	MS
Out of Lead	OL
Pole Leaning	PL
Pole/Climbing/working space	PC
Pole/Grounding	PG
Pole/Horizontal clearance	PH
Pole/Marking	PM
Pole/Riser	PR
Pole/Structure	PS
Pole/Vertical clearance	PV
Underground	U

Violations

Equipment (EQUIP. 1 & 2)	Code
Anchor	ANC
Anchor (auxiliary)	AANC
Antennas	ANT
Bridge	BR
Communication Bridle Wire	BWR
Communication Cross-Connect	XBOX
Communication C-Wire	CWR
Communication Drop	COMD
Communication Equipment (other)	CEO
Communication Fiber-optic	COFO
Communication Load Coil	LOAD
Communication Mainline	COML
Communication Messenger	COMM
Communication Power Supply	PS
Communication Repeater	REP
Communication Terminal	TRM
Conduit-metal	MCON
Conduit-PVC	CON
Cross-arm	XARM
Cross-arm (fiberglass)	XARF
Cross-arm Braces	XARB
Curb	CURB
Down Guy	GUY
Drivable Surface	DRSR
Fence	FENC
Fiber Equipment (other)	FEO
Fire Hydrant	HYD
Ground Molding	UGRD
Ground Rod	GRND
Ground Wire	GRWR
Guy Marker	GM
Hardware	HDWR
Insulator	INS
Lashing Wire	LWR
Multi-grounded Neutral	MGN
Others Mainline	OTML
Others Messenger	OTMM
Overhead Guy	OGUY
Padmount Equipment	PAD
Pedestal	PED
Pedestrian Surface	PEDS
Platform	PF
Pole	POLE
Pole Step	STEP
Pole to Pole Guy	PPG
Pole-Metal	MPOL
Power Bracket	PBRK
Power Capacitor	PCAP
Power Drip-loop	PDLP
Power Jumpers	JUMP
Power Mast	PMST
Power Meter	PMR
Power Neutral	NEUT
Power Primary	PRI
Power Secondary	SEC
Power Service Drop	PDRP
Power Service Support Wire/Bridle	PSSW
Power Street Light	SLT
Power Switch	SWCH
Power Transformer	XFMR
Private Party Attachment	PVT
Railroad	RR

Equipment (continued)	Code
Riser	RIS
Roof	ROOF
Sidewalk Fixture	SWF
Signs	SIGN
Stand Off Brackets	SOB
Stencils/Pole Tag	STN
Subscriber Network Interface	SNI
Supply Fiber-optic	SPFO
Traffic Signal Bracket	TRSB
Traffic Signals	TRS
Trees/Vegetation	TREE
U-Guard	UGRD
Inaccessible Surface	UNSR
Water Surface	WSR
Weather Head	WH
Window	WIN
Wireless Equipment (other)	WEO

Base Pole Info

Timber Species (Material)	Code
Douglas fir	DF
Concrete	CC
Fiberglass	FG
Jack Pine	JP
Laminated	LM
Lodgepole Pine	LP
Metal/Steel	ST
Ponderosa Pine	WP
Red Pine	NP
Southern Pine	SP
Southern Yellow Pine	SYP
Western Larch	WL
Western Red Cedar	WC

Base Pole Info

Directional Information	Abbrev
North	N
South	S
East	E
West	W
North East	NE
South East	SE
North West	NW
South West	SW
North Side	N/S
South Side	S/S
East Side	E/S
West Side	W/S
Field Side	F/S
Road Side	R/S
North Of	N/O
South Of	S/O
East Of	E/O
West Of	W/O
Rear Of	R/O
Across From	A/F

Suggested Action
Attach
Attach Mid-span
Bury
Contact Jump Pole
Ground/Bond
Guard
Lengthen
Lower
Lower CATV
Lower Fiber
Lower Neutral
Lower Other
Lower Power
Lower Secondary
Lower Telco
Make Ready
Move 1st attachment
Move Mid-span
Move to Span
Place
Place BSW (buried service wire)
Place California Top
Place Clearance Pole
Place Cross-arm
Place Mid-set Pole
Place Split Duct
Place Taller Pole
Raise
Raise CATV
Raise Fiber
Raise Neutral
Raise Other
Raise Power
Raise Secondary
Raise Telco
Refer to Engineering
Relocate/Move
Remove
Repair
Replace
Re-Tension
Shorten
Tighten
Transfer
Trim