OREGON JOINT USE ASSOCIATION STANDARDS COMMITTEE

BEST PRACTICES GUIDE

APRIL 2009

UPDATED 2023

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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.

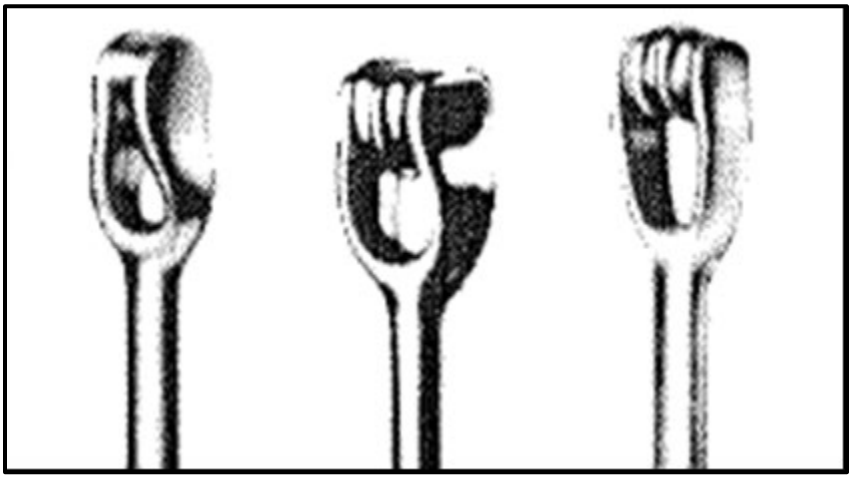
Anchors are generally placed no less than five (5) feet from an existing anchor. This is done to ensure the soil surrounding the existing anchor is not loosened while installing the new anchor.

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 optimal
- 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. <u>You must first get permission from the anchor owner prior to occupying that open eye with your guy</u>. These are "eye" bolts that are attached to an anchor rod above grade.

Figure 1.1- 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 1.2 – 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.

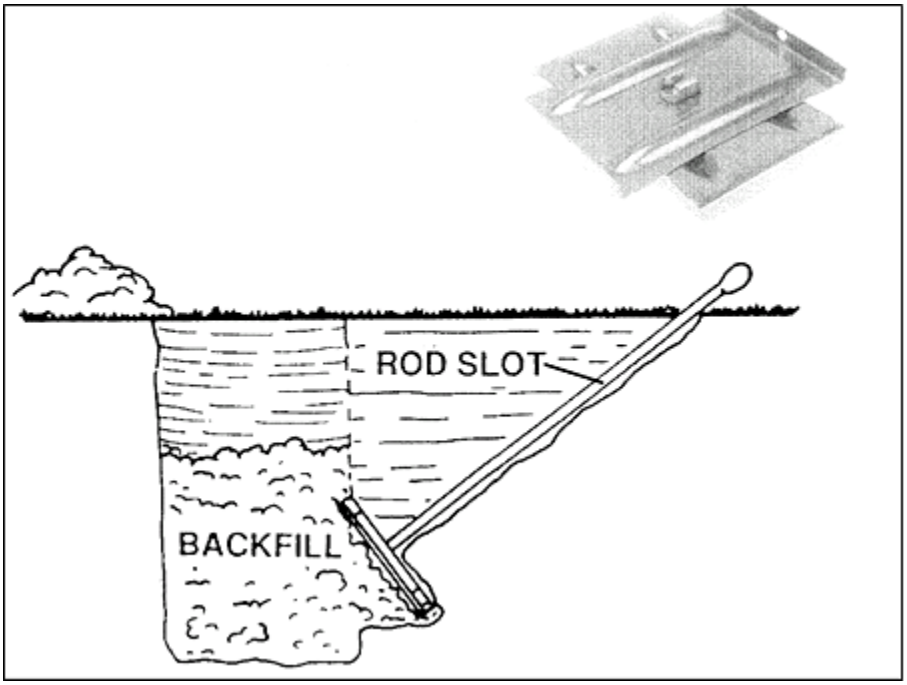
Locates: The Oregon Utility Notification Center (OUNC) is the one-call agency dedicated to safeguarding citizens and construction personnel who work around utilities, as well as safeguarding the underground infrastructure of pipes, mains, and lines which bring utilities to your community. Calling at 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.

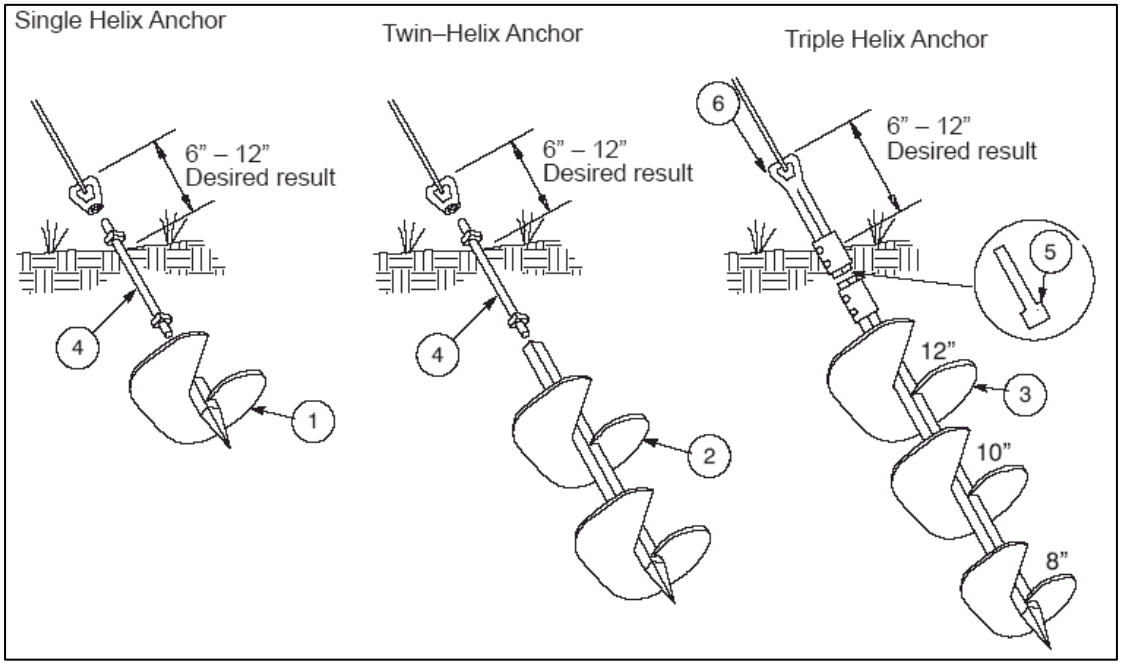
Figure 1.3 - Cross-Plate Anchor



Helix/Screw-in Anchor

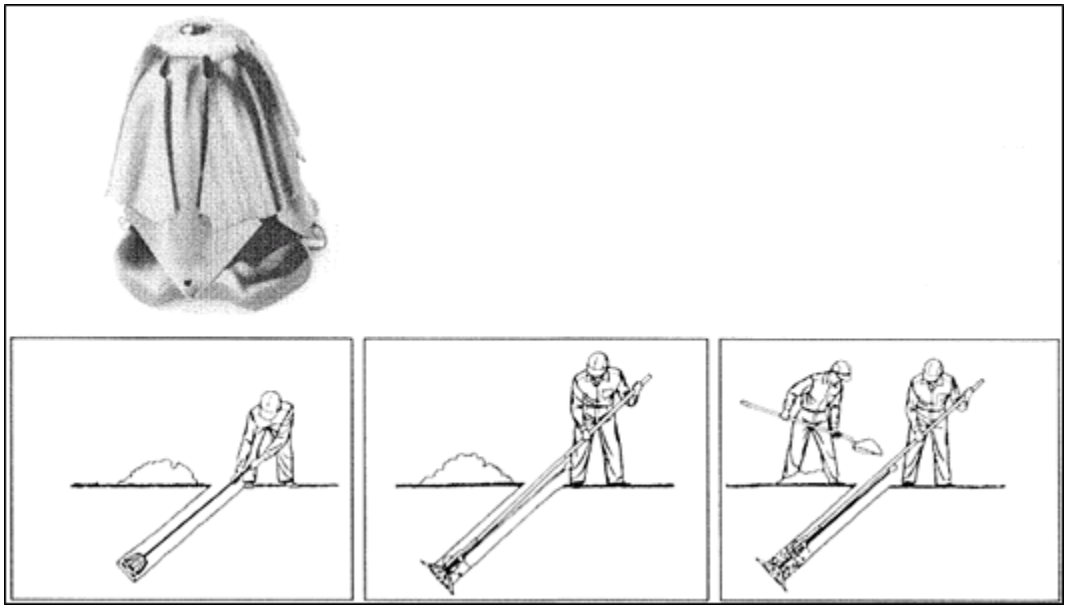
Screw-in anchors are recommended for softer soil types, including Classes 5-7 in the Soil Classification Data Chart (see Figure 1.2). They do not work well in rocky soils. Screw-in anchors are usually installed by two people rotating a log bar threaded through the eye, but may also be installed with a power drive machine. Screw-in anchors can also be used in applications where an anchor will be embedded in concrete.

Figure 1.4 - 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.

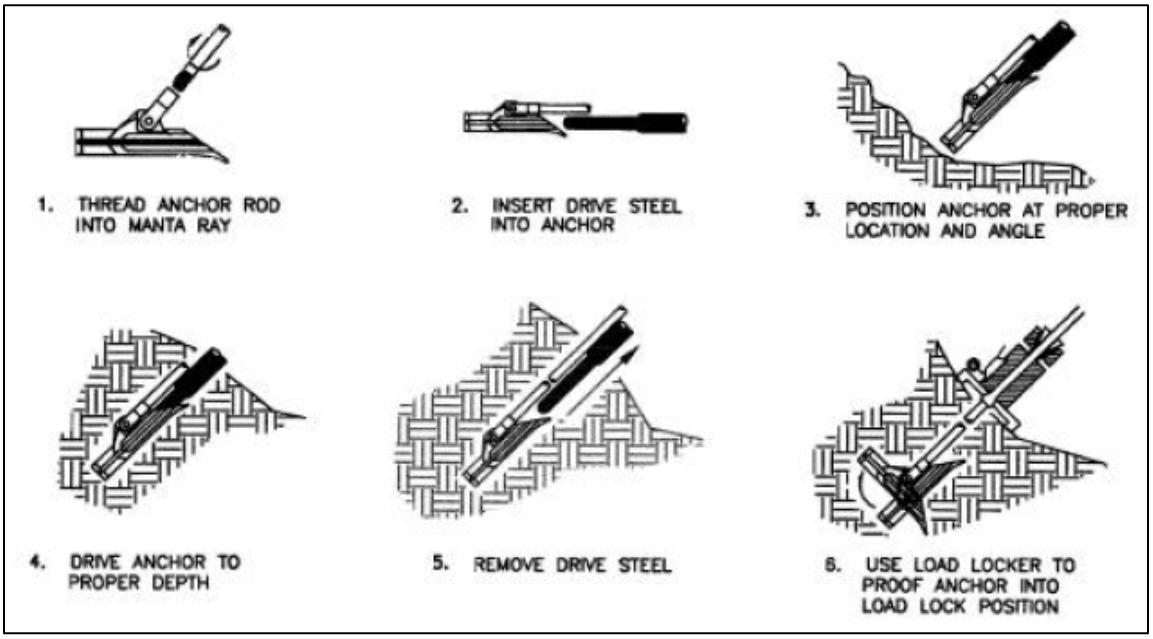
Figure 1.5 - Expanding Anchor



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 1.6 - Manta Ray Anchor

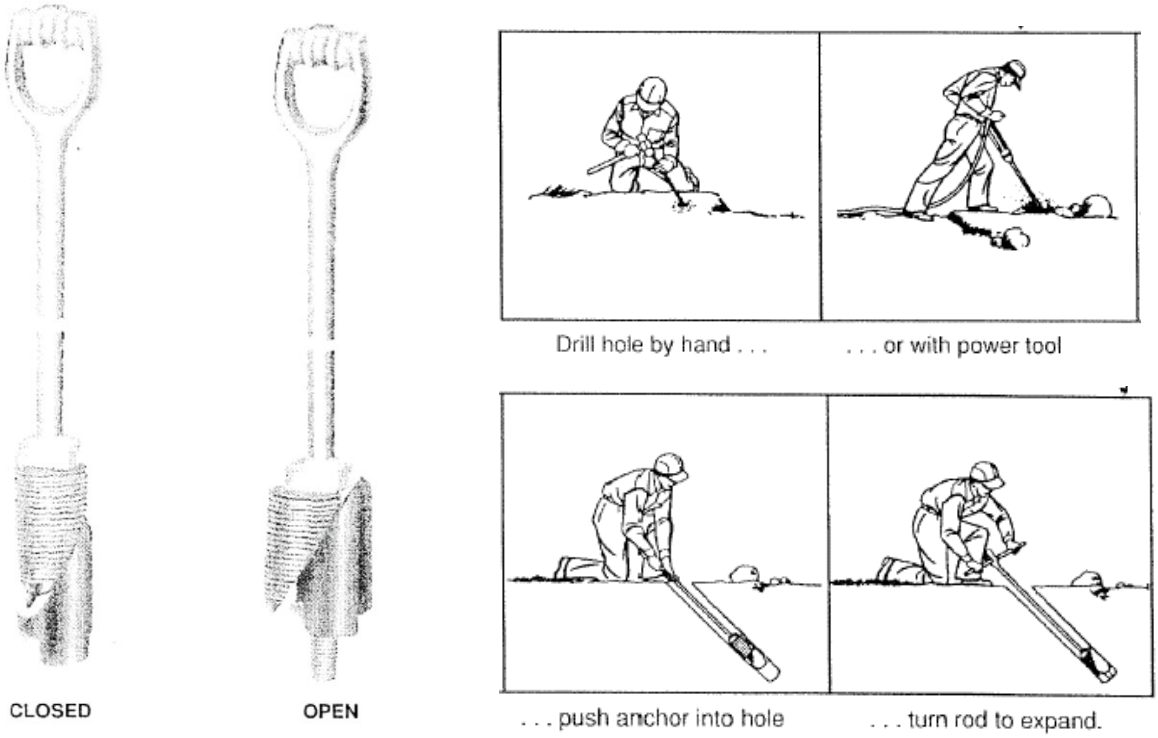


Swamp Anchor
Swamp anchors can also be buried logs that brace a wood pole and are used in marshy and swampy terrain (also called swamp brace or brace anchor).

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 1.2). 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 1.7 - 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.

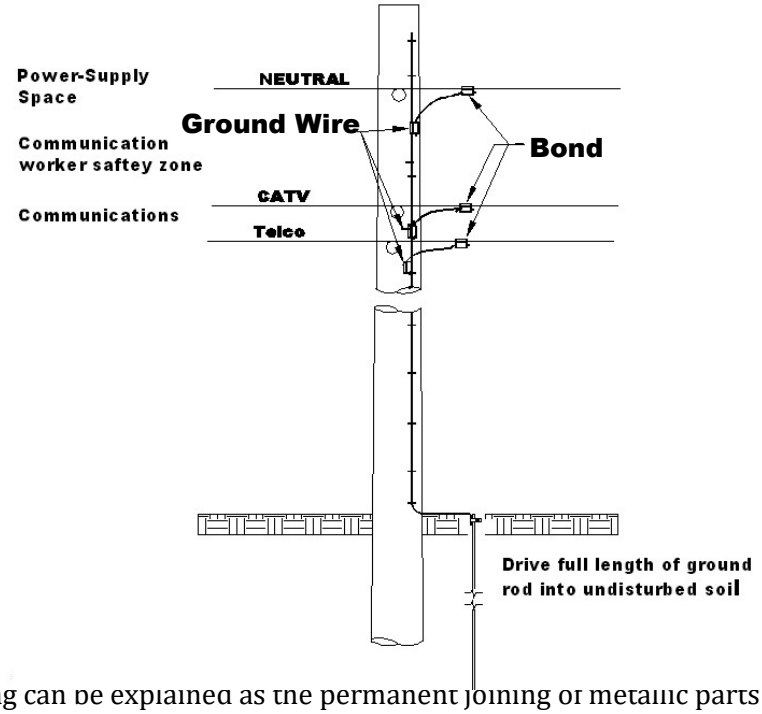
Figure 1.8 - Dynamometer

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 2.1 - Vertical Pole Ground with Bonds

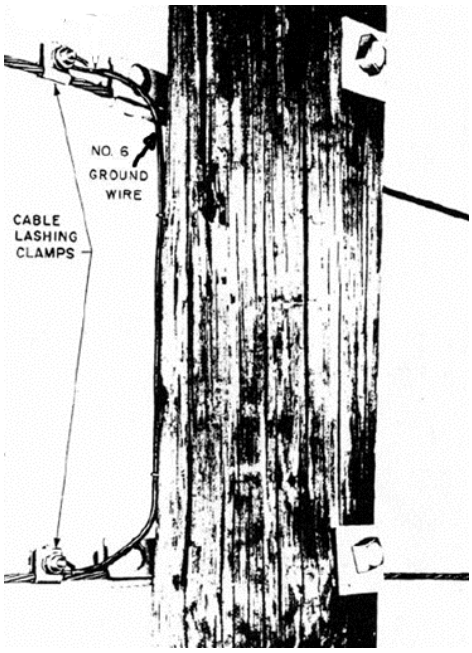


In other words, bonding can be explained as the permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity. Bonding metallic system parts together offers the capacity to safely conduct any current likely to be imposed on the grounding electrode.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

Bonding Installation Considerations

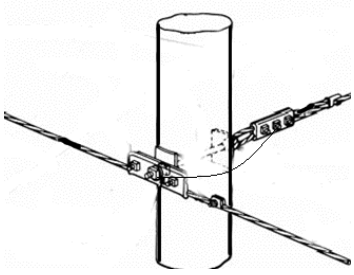
Aerial cables that include joint use construction will require common bonding. The cables must be bonded together to reduce the electrical power differences (potential).

Figure 2.2 - Common Bonding for Aerial Cables



Types of Bond Installations

Figure 2.3 - Tangent with 90° Tap Line



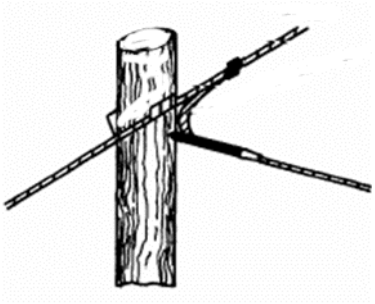


Figure 2.4 - Intersection of Messenger

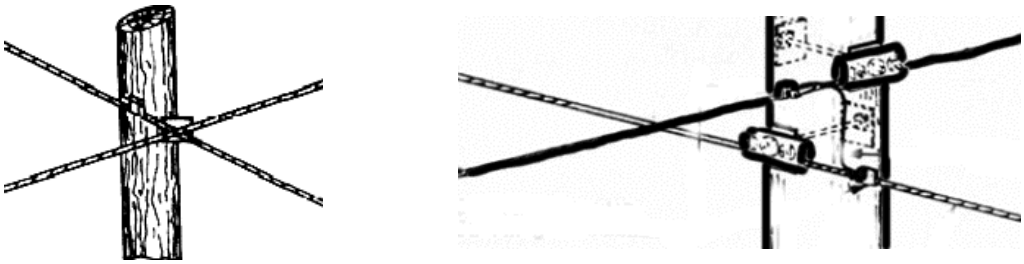
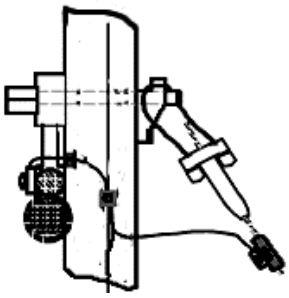


Figure 2.5 - Down Guy and Anchor



Bond is at the guy

Figure 2.6 - Parallel Messengers

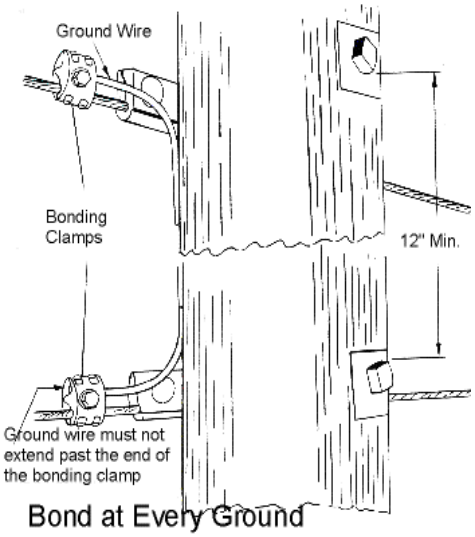
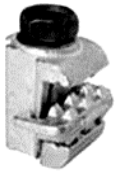
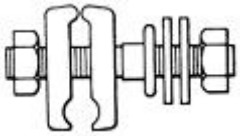


Figure 2.7 - Types of Bonding Connectors

H-2 Connector (Fargo)	C or D-Clamp	Cable Lashing Clamp (Bug Nut)
		
B-Strand Clamp	**Ground Rod Clamp**	**Ground Weaver**
		

Definition of Grounded

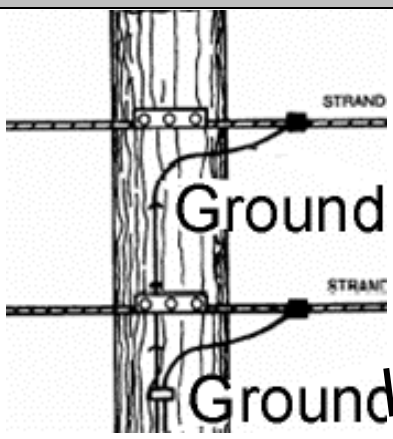
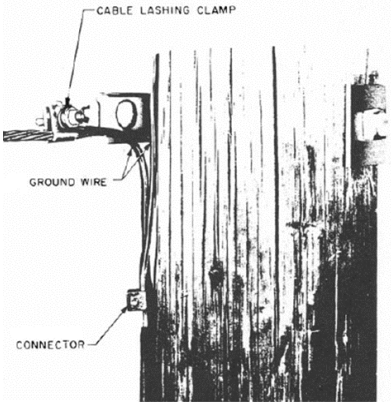
Grounded is defined by the NESC as "Connected to or in contact with earth or connected to some extended conductive body that serves instead of the earth."

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.

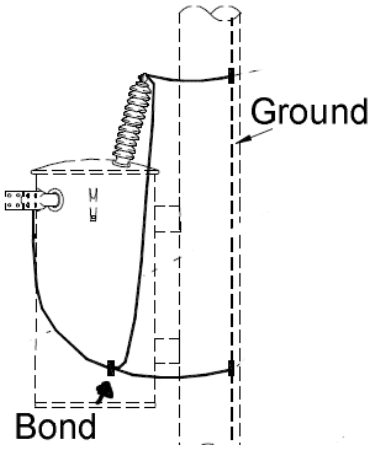
Grounding Installation Considerations

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 2.8 - Types of Grounds

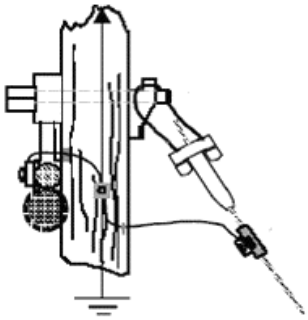
Aerial Cables	
	

Transformer and Equipment

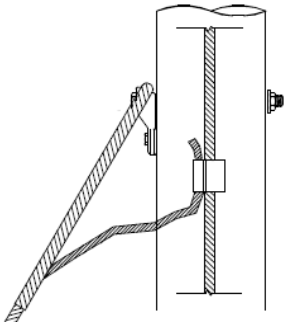


Guy Grounding

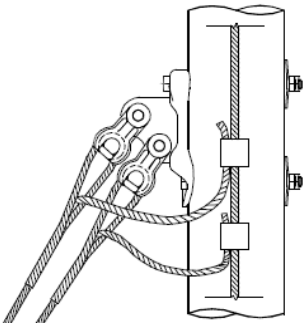
Communication Bonding



Power Supply Bonding

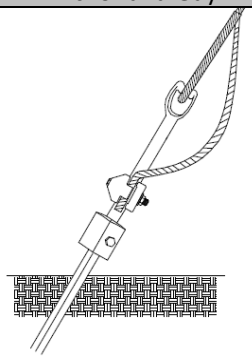


Double Down-Guy Bonding

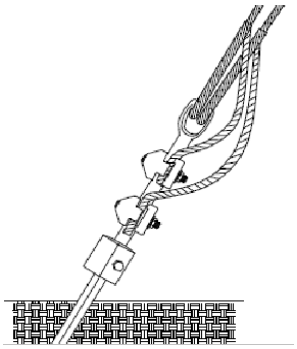


Anchor Grounding

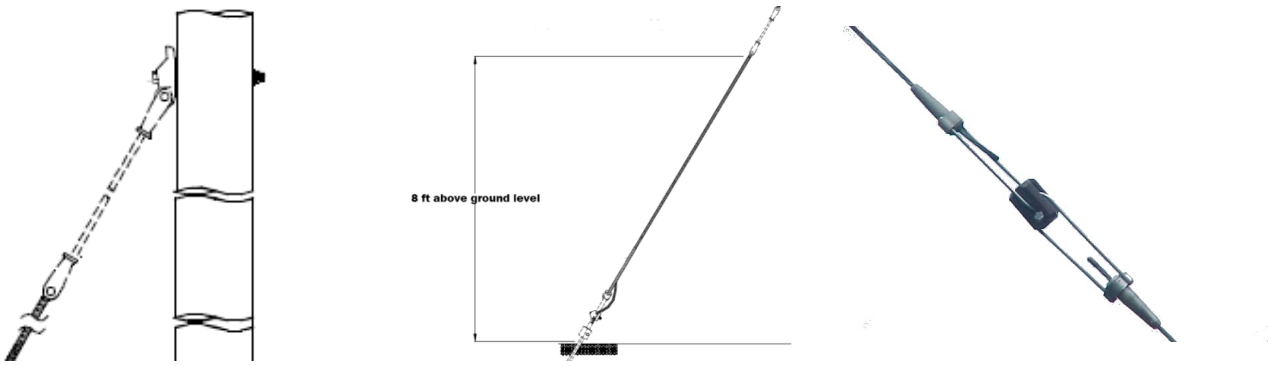
Anchor and Guy



Double Down-Guy



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

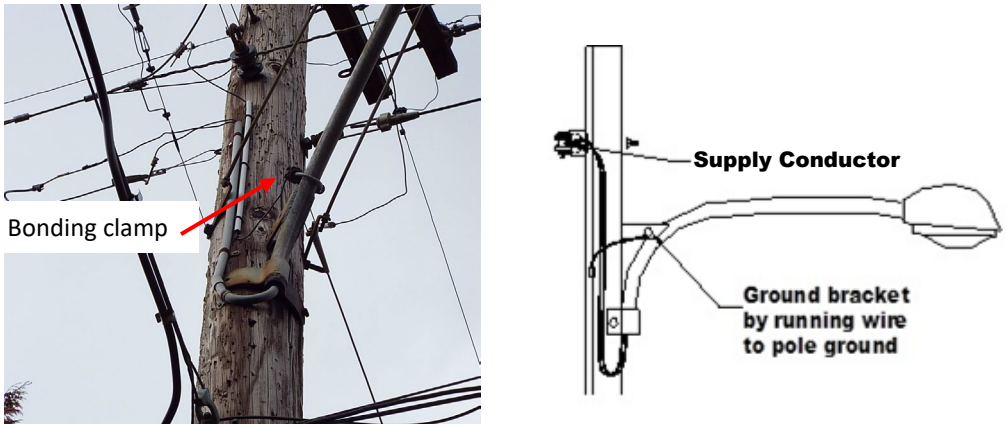


Per NESC 215 and 279, guys must be bonded unless a guy insulator is used—then exceptions apply.

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 2.9 - 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 2.10 - 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

Chapter 3 - FRAMING

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

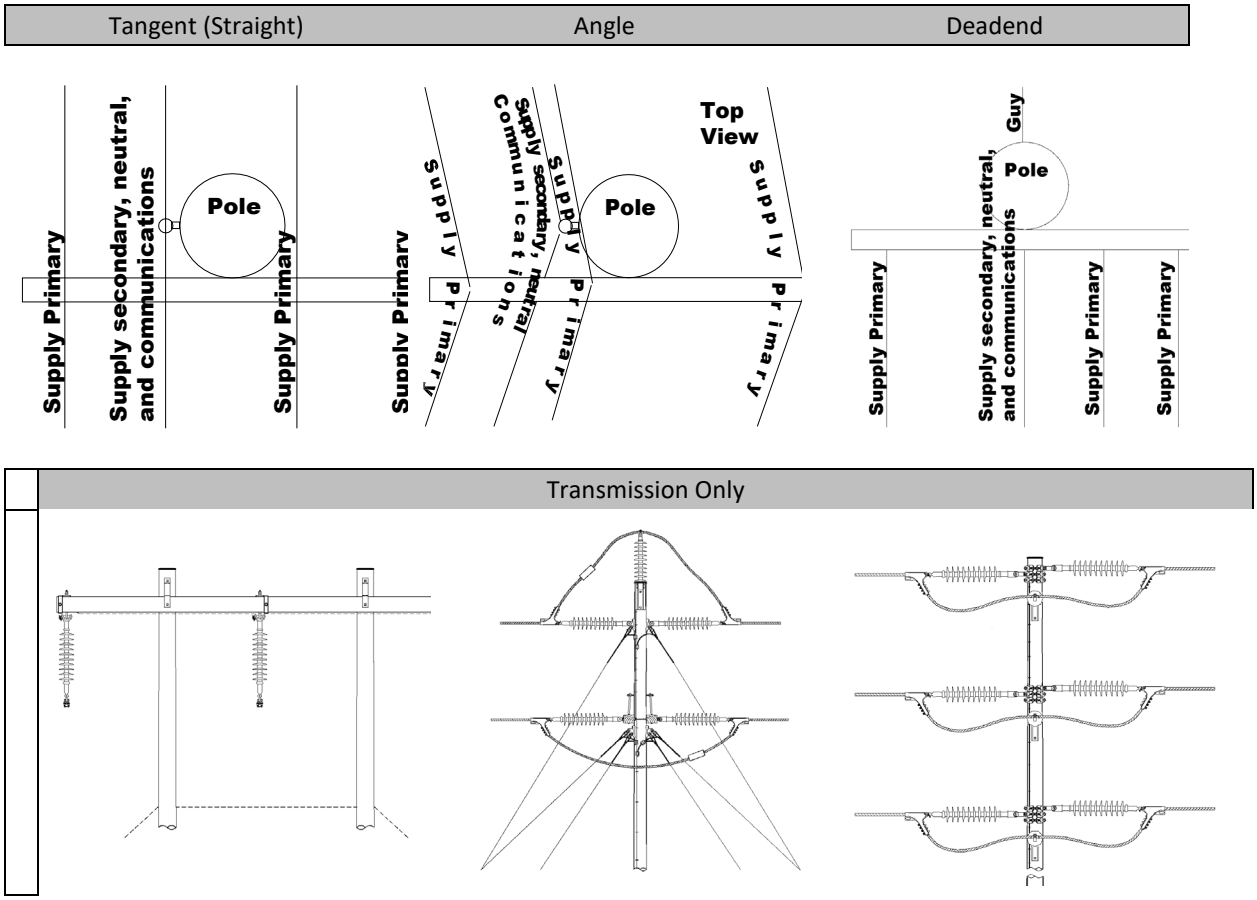
Definition of Framing

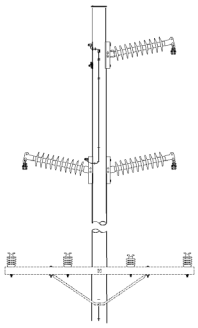
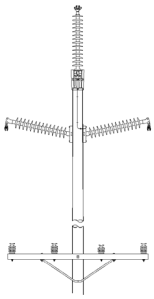
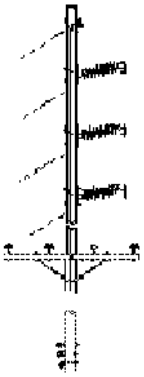
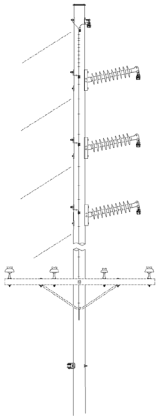
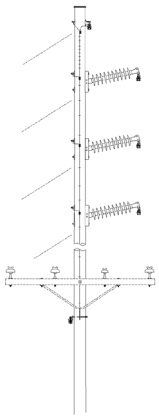
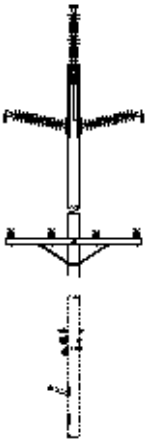
Framing is not defined in the NESC. In this document 'Framing' is referring to the overhead installations of poles and some other utility structures such as transmission H structures and the facilities attached to them. It is basically the construction style that best suits certain conditions determined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

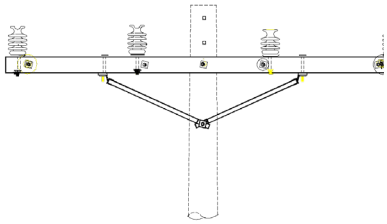
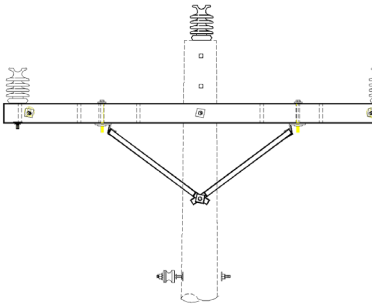
Basic Framing Terms

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

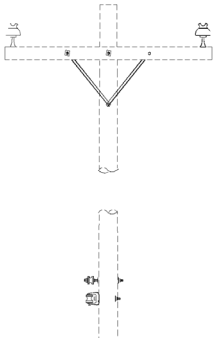
Figure 3.1 - Supply Construction Examples

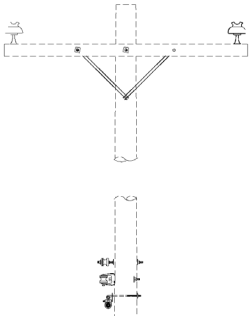


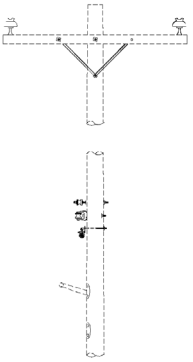
Transmission with Underbuild		
		
		

	Primary Only	
High Neutral	Low Neutral	High-Low Neutral
		

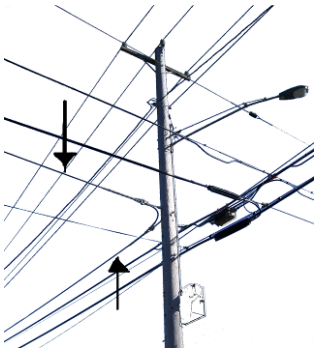
Primary with Secondary	Primary with Secondary with Supply Fiber in the Supply Space	Primary with Secondary and Communications
	Primary with Secondary	



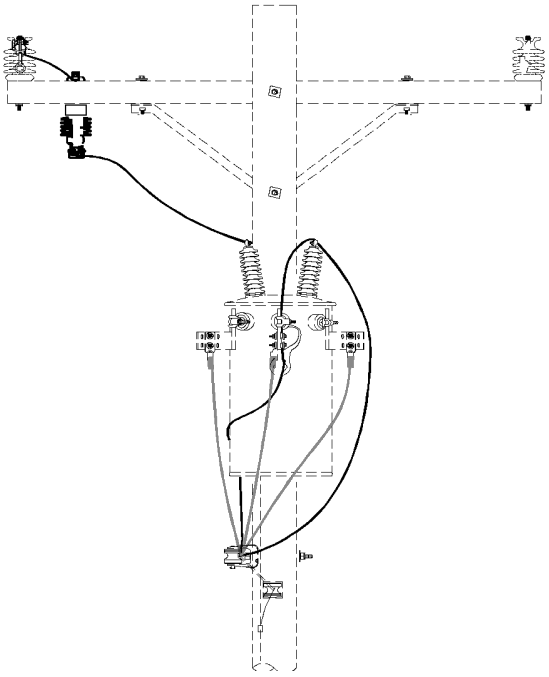


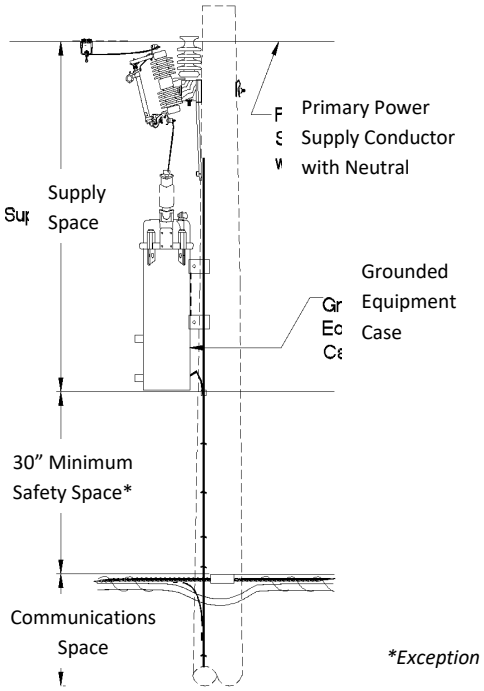


Primary with Communication Fiber in the Communication Space	Communication Fiber in Communication space on bracket
Primary with Secondary and Fiber	

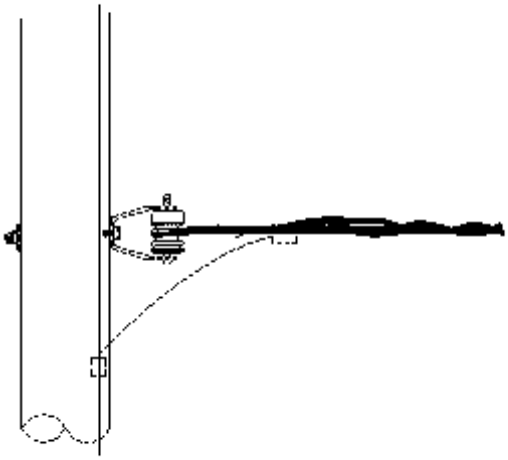


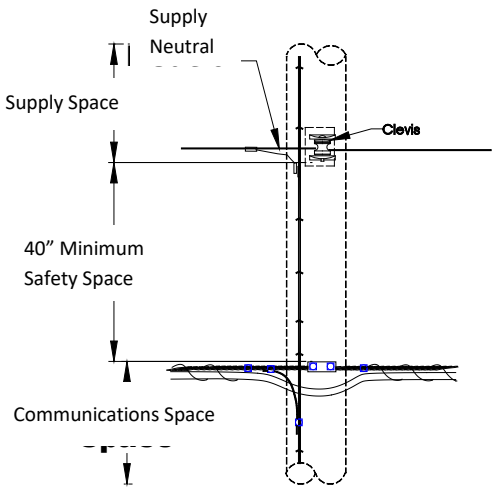
Primary with Equipment	
Transformers	Communications



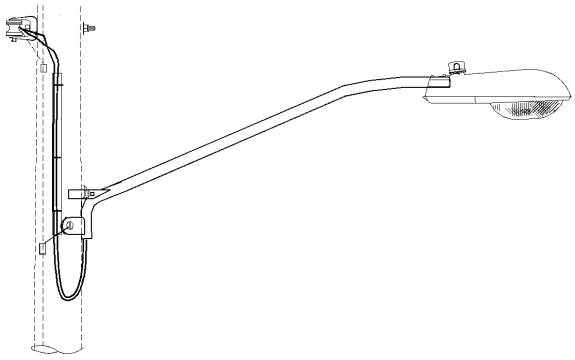


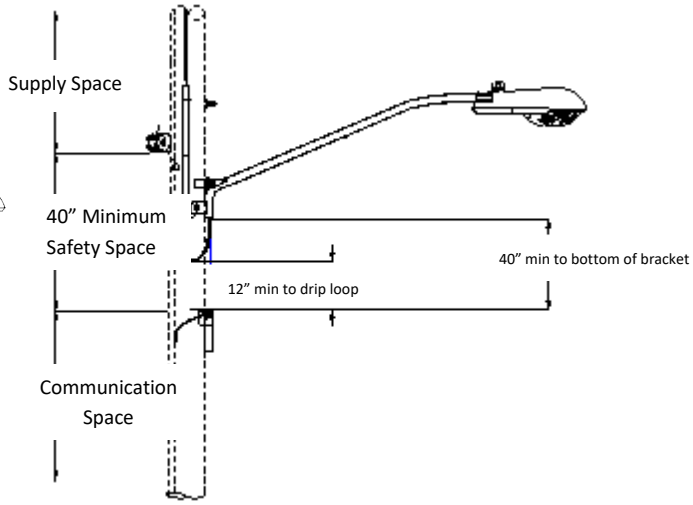
Secondary	
Secondary Only	With Communication



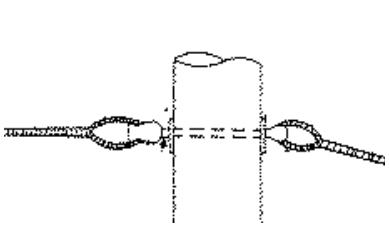


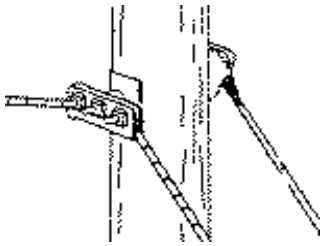
Secondary with Luminaires	Secondary with Luminaires and Communication

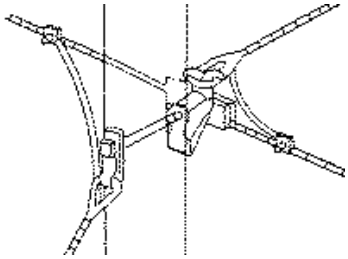


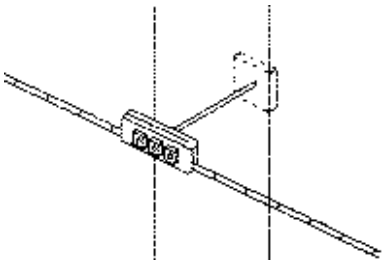


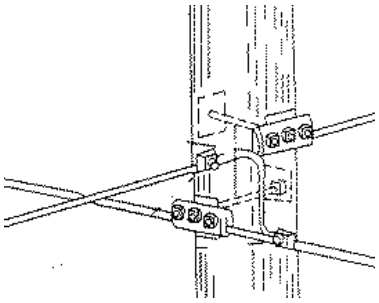
Communication Only

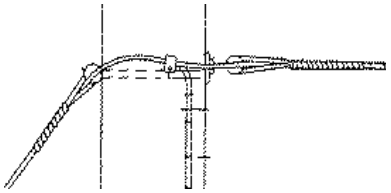


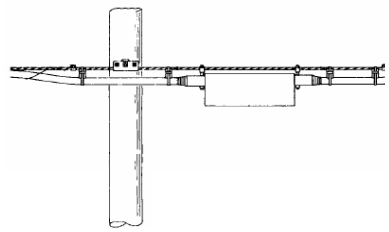


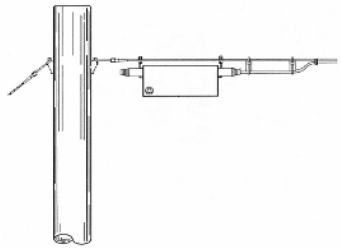


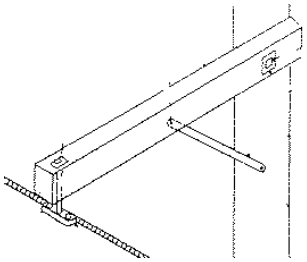




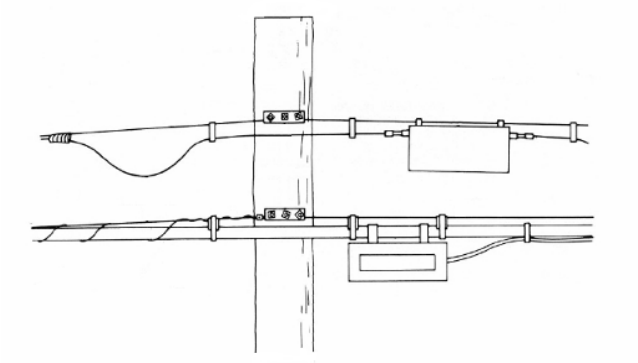








Communication to Communication



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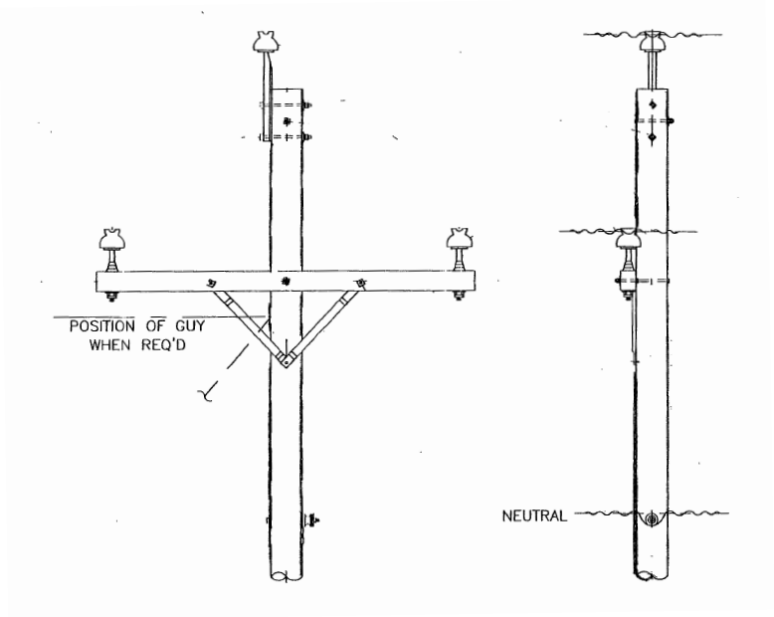
Avian Protection Construction

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 3.2 - 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.

Voltage Clearances

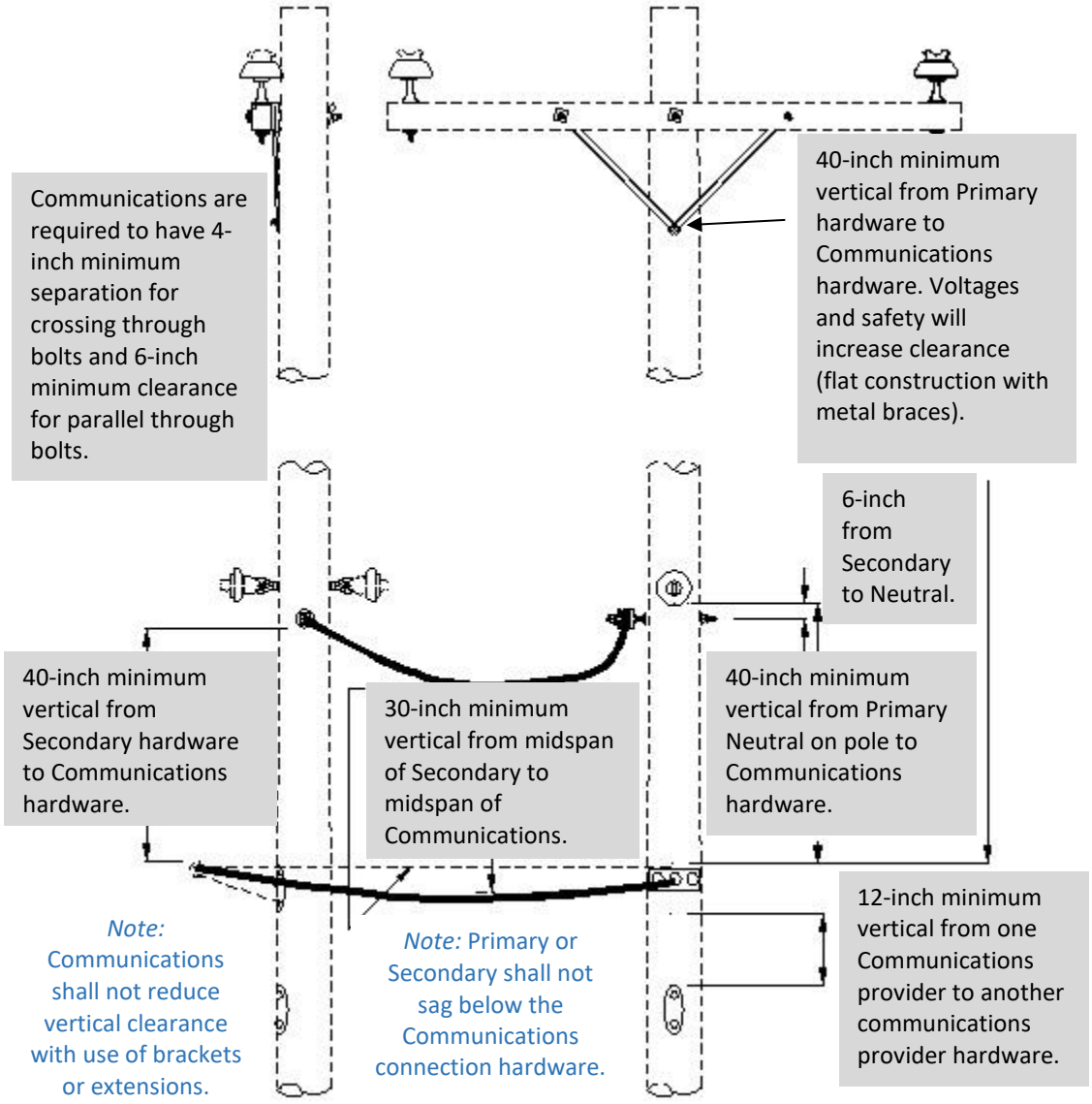
Per NESC table 235-5 the minimum height of an attachment is often the result of the voltage of the conductors above it. For example, the maximum height on a supply pole that the primary conductor can attach is dependent on the voltage of the transmission conductor above it. Similarly, the height at which 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 3.3 – 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.

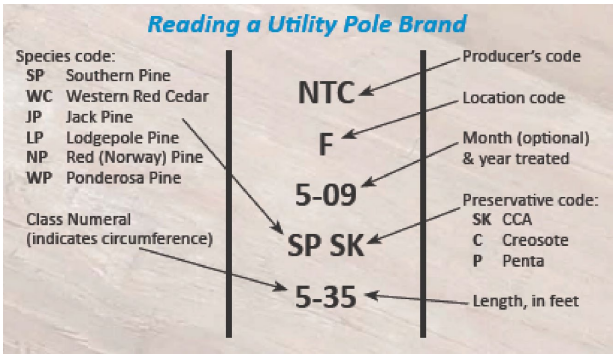
Identification

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

Figure 4.1 - Metal Tag Method of Identification

Figure 4.2 - Stamp Method of Identification

Figure 4.3 - 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 4.4 - Pole Top Extension Types

Fiberglass	4x4 (California Arm)
	

Pole Supports

Figure 4.5 - Pole Support: Swamp Brackets (Legs)

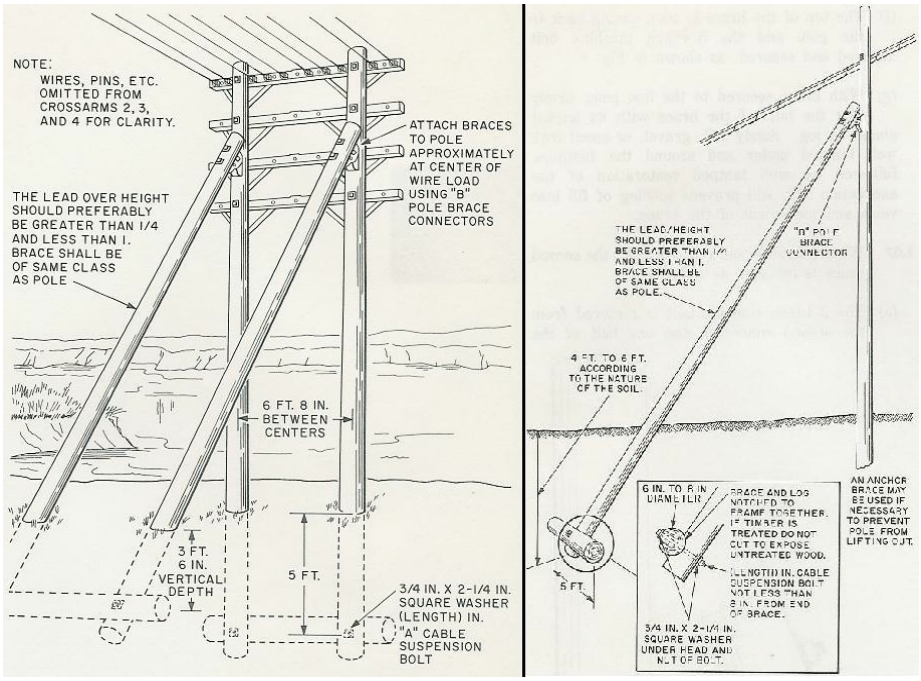
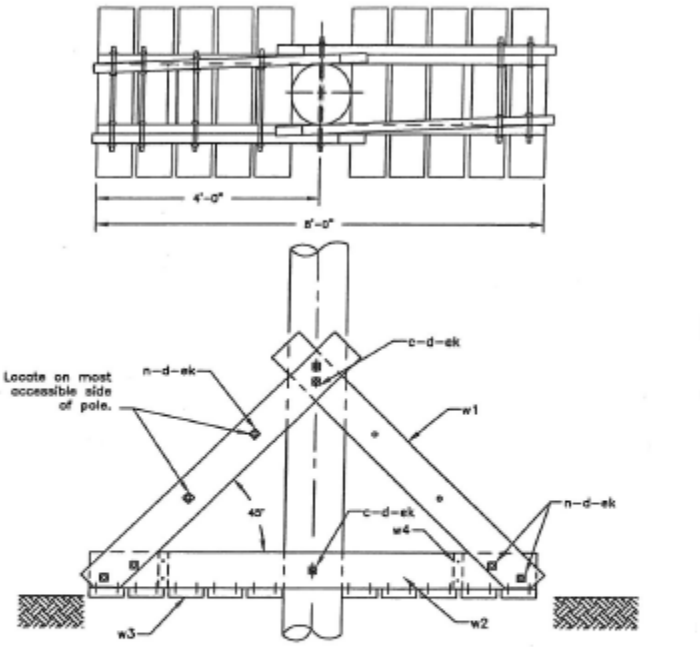


Figure 4.6 - Bog Shoes



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 4.7 - Push Pole

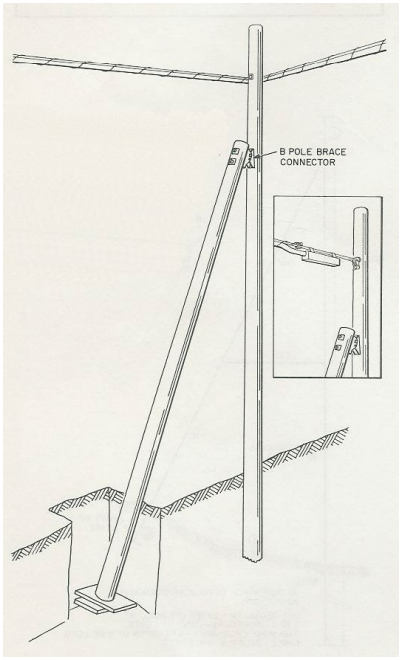
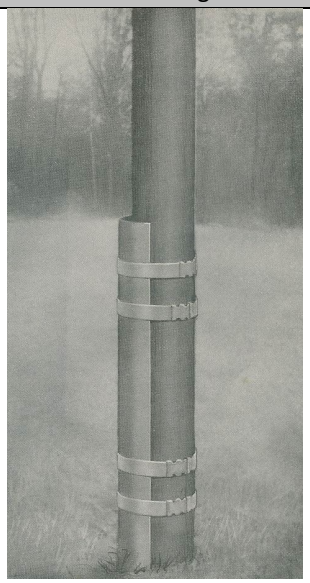
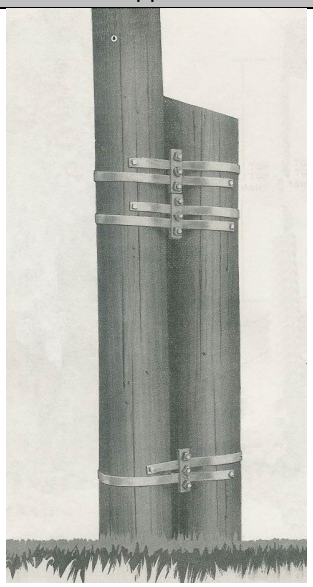


Figure 4.8 - Truss Types

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 5.1) 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 5.1 – Riser Secured to a Standoff Bracket

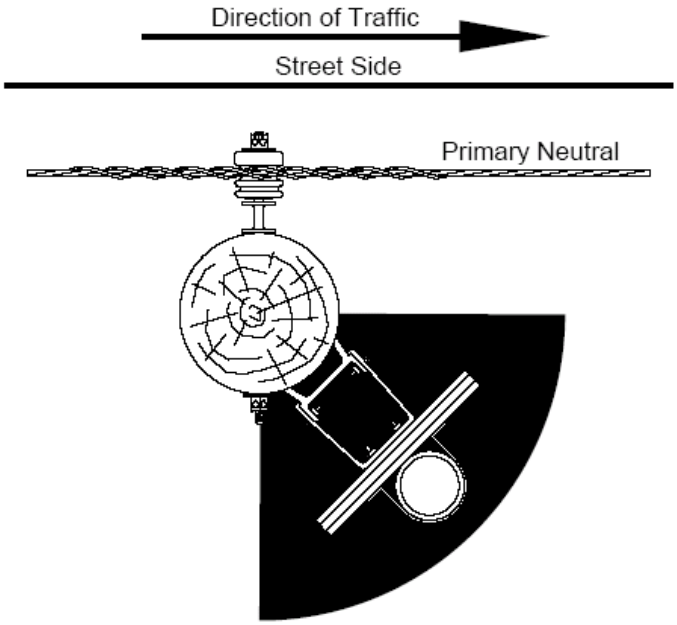


Figure 5.2 - Standoff Brackets

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 5.3 - U-Guard Protection

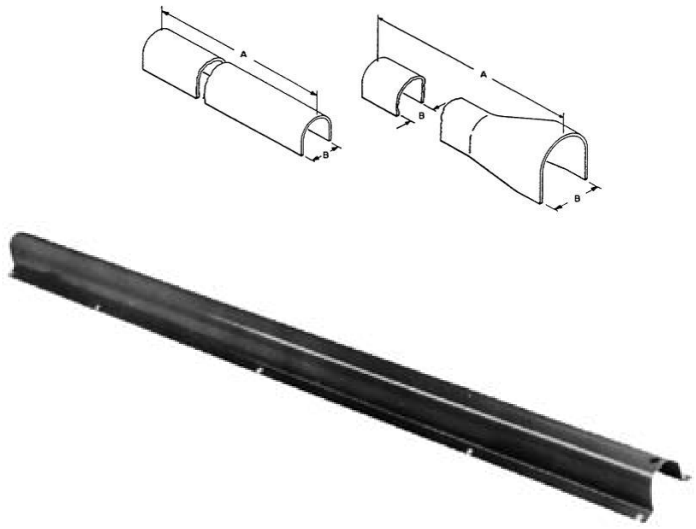
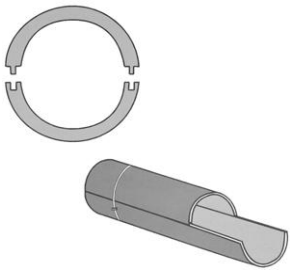


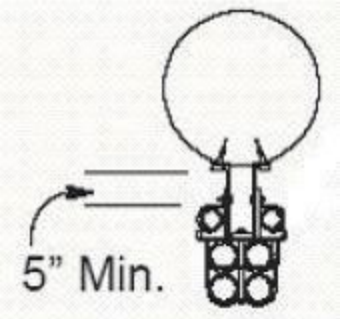
Figure 5.4 - Conduit Types

Plastic or Metal	Split	Flex	Cable in Conduit
			

<u>Installation:</u>

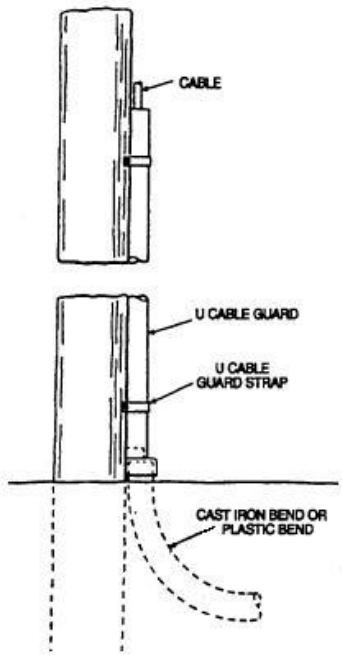
- The first riser stand-off bracket should be a minimum of 8 feet above ground or 8 feet to the next climbable surface (see NESC 217A2c).
- Maintain space requirement from the pole to facilitate a qualified worker's ability to climb and belt off on the pole (see Figure 5.5).

Figure 5.5 - 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 5.6 - Conduit Installation: Direct Attachment to Pole with Conduit Clamps



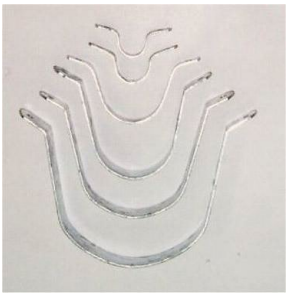
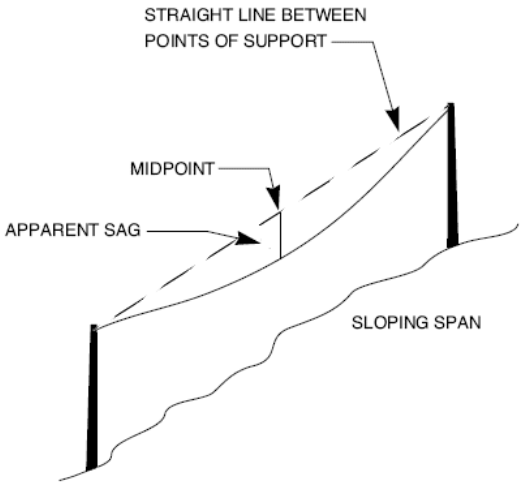


Figure 5.7 - Conduit Installation: Attachment to Standoff Brackets with Conduit Clamps

Chapter 6 - TENSION AND SAG

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

Figure 6.1 – 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 6.1).
- 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 lengths, and class of pole.

Methods of Tensioning

Figure 6.2 - DynamometerTensioning

Electronic

Dynamometers are the preferred method for testing tensioning

Mechanical

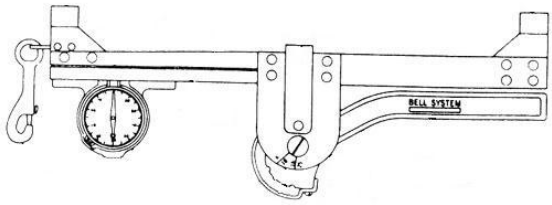
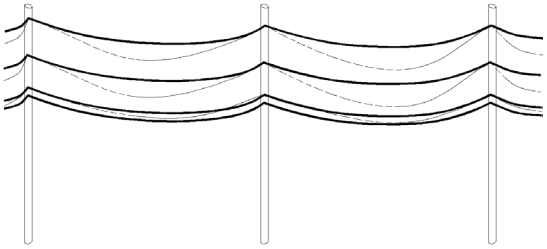


Figure 6.3 - Third Wave Return Tensioning

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 6.4 - Matching Sag Tensioning



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

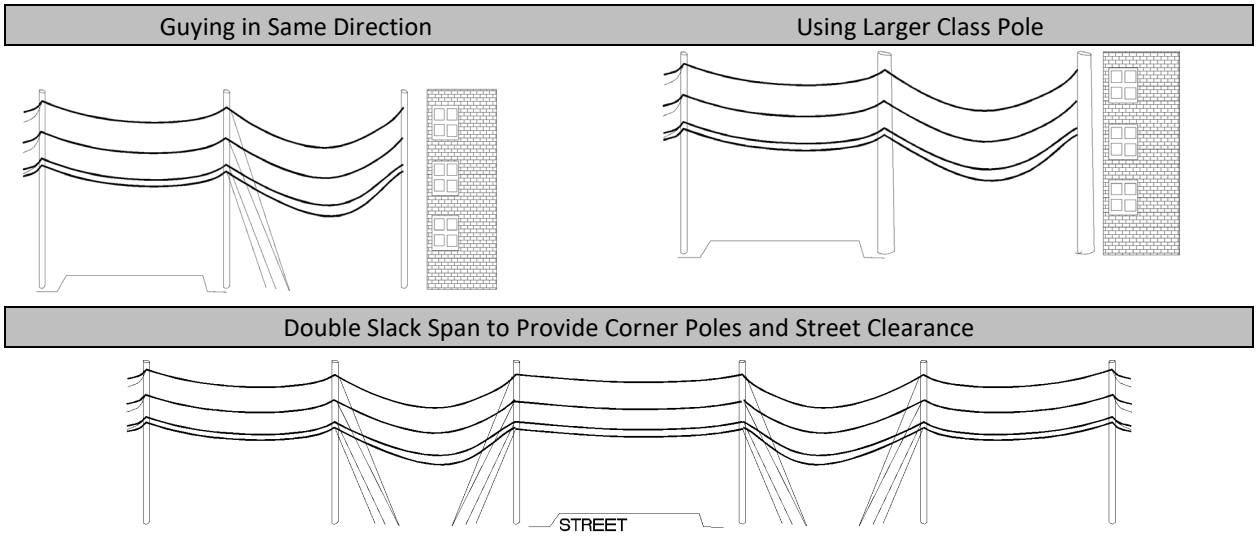
NESC clearances may not be met during different temperatures, ice, wind, etc. or over time.

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 6.5 - Slack Span Construction



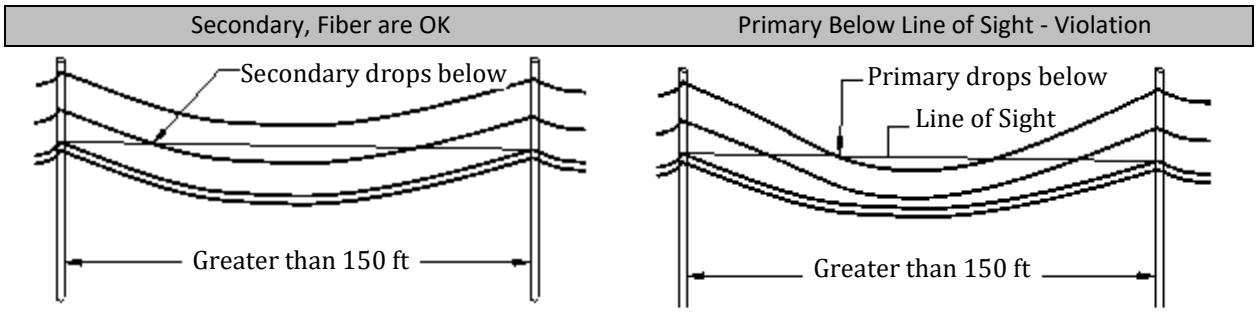
Guy Tension

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 6.6 - 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 6.7 - Loading Zones in the United States

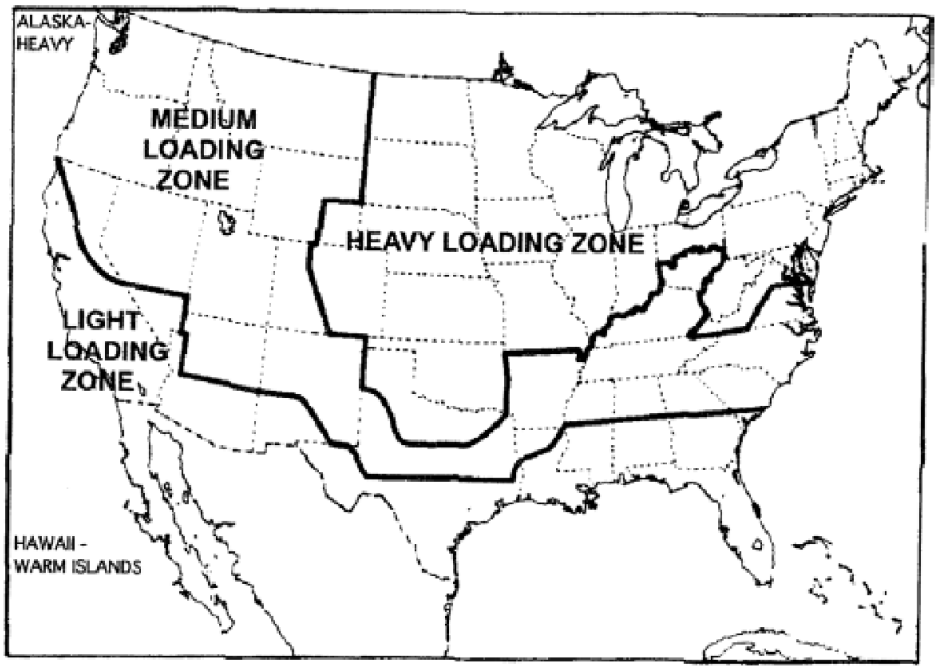
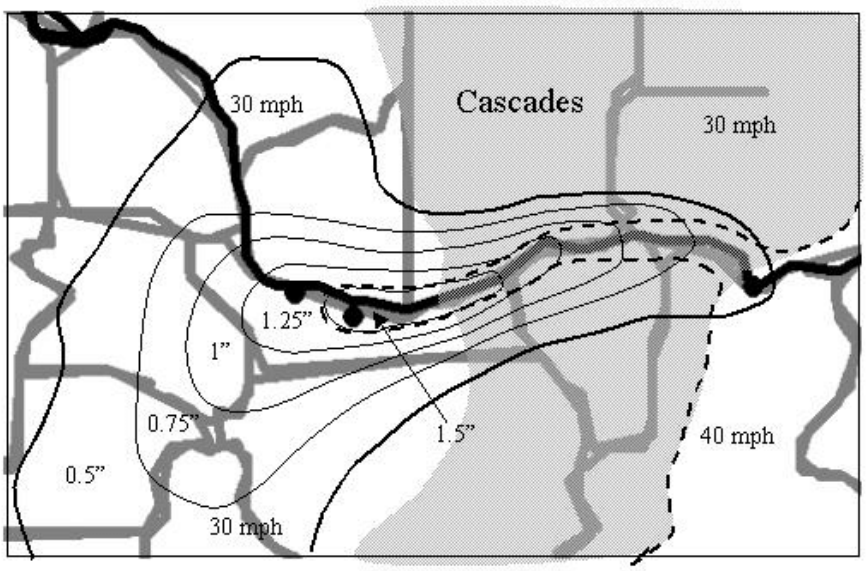


Figure 6.8 - Extreme Loading Zones in Oregon



Oregon can typically expect 85-mph 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:

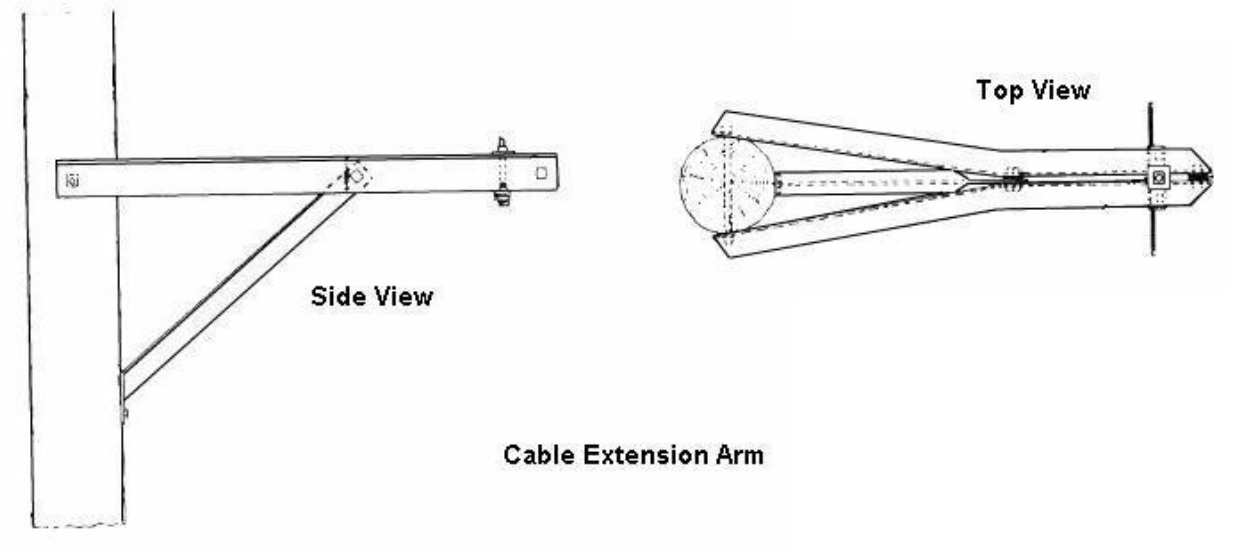
- Establish or maintain clearances
- Maintain the lead or tangent (eliminate the necessity to guy a pole)
- Create space to accommodate multiple attachments
- Create climbing space

Placement Considerations

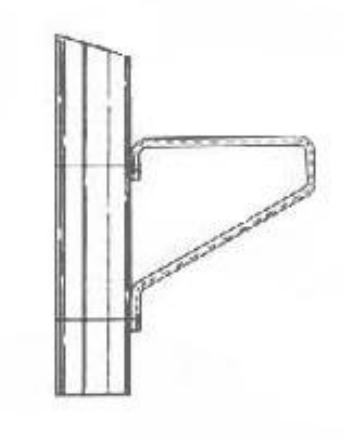
Considerations include length, weight of facilities, angle, type and size of arm, clearance from the pole and ground, and space on the pole. (*Note: Communication operators typically will not place a support guy on a support arm.)*

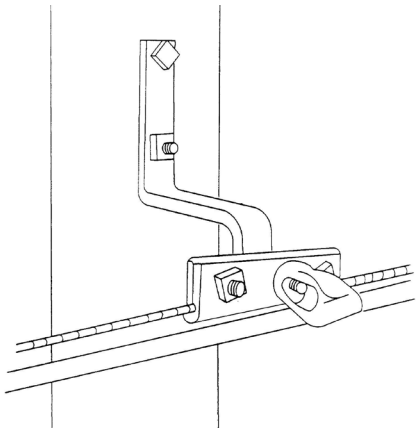
Figure 7.1 - Support Arms

Metallic Communication Alley Arm
(aka: B-metal arm; Seattle brace)

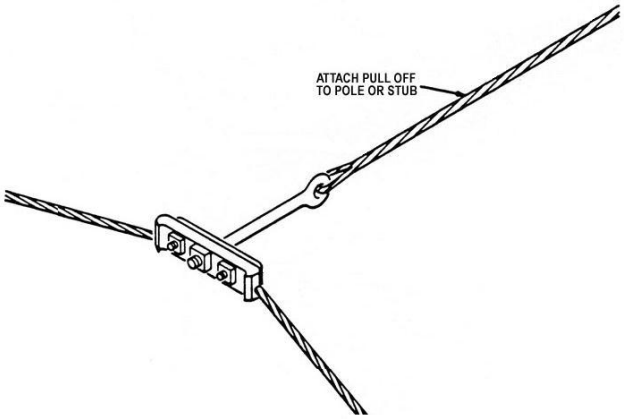


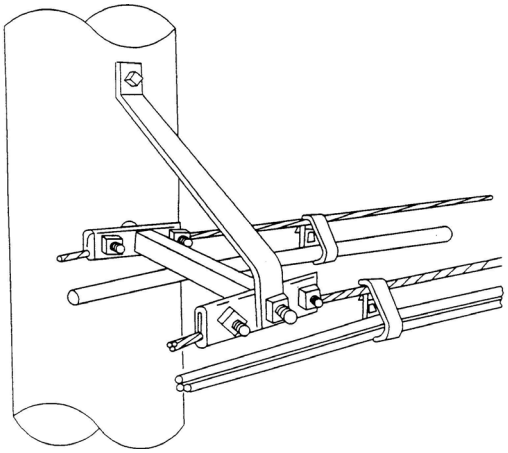
Seattle Bracket (Extension Bracket)	T-Alley Bracket



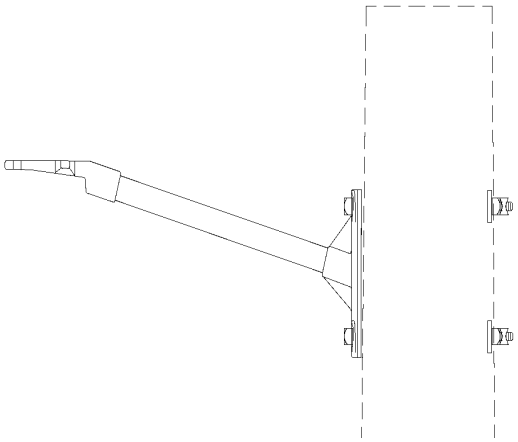


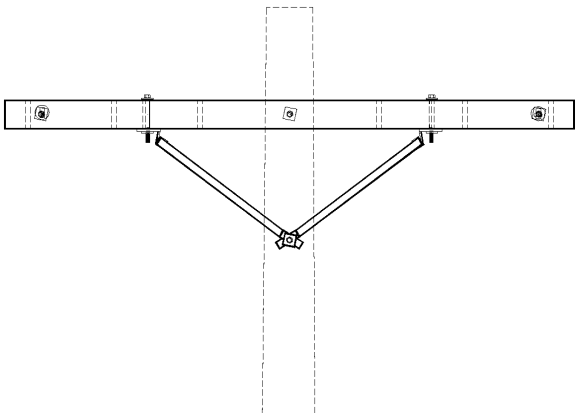
Flying Mary (Support Made Of Strand - aka Flying Dutchman)	Illinois Bracket (9" Extension Bolt)





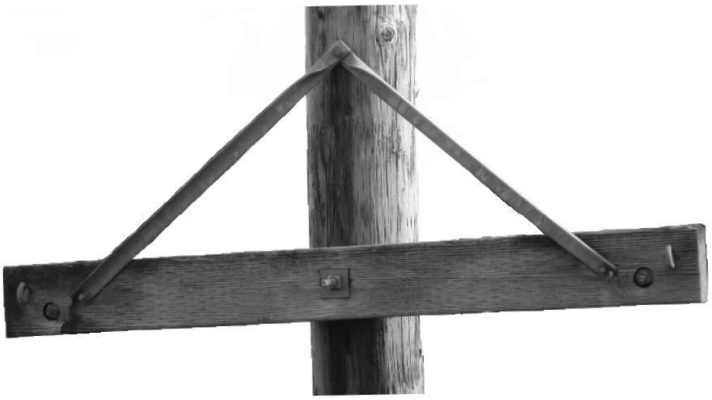
Fiberglass (Epoxy Rod) Stand-off	Power Cross Arm



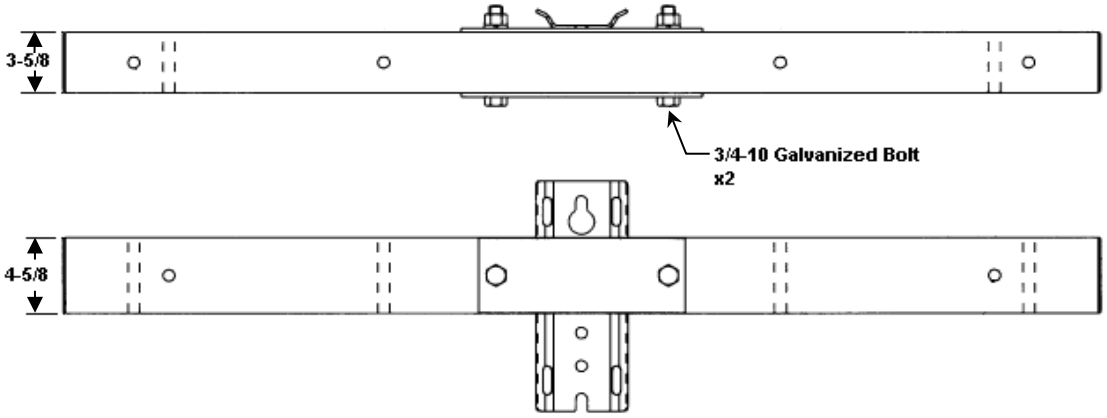


"E" Arm or "F" Arm (4x4 or 4x6 which can support facilities on both ends)

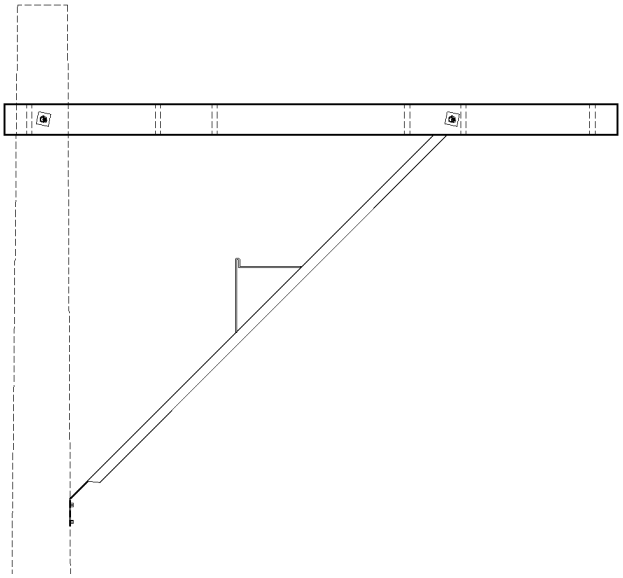
Note: When installed as pictured below, the top of the braces becomes the highest point for clearance purposes.



Braceless Cross Arm (Fiberglass)



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



Double Arms

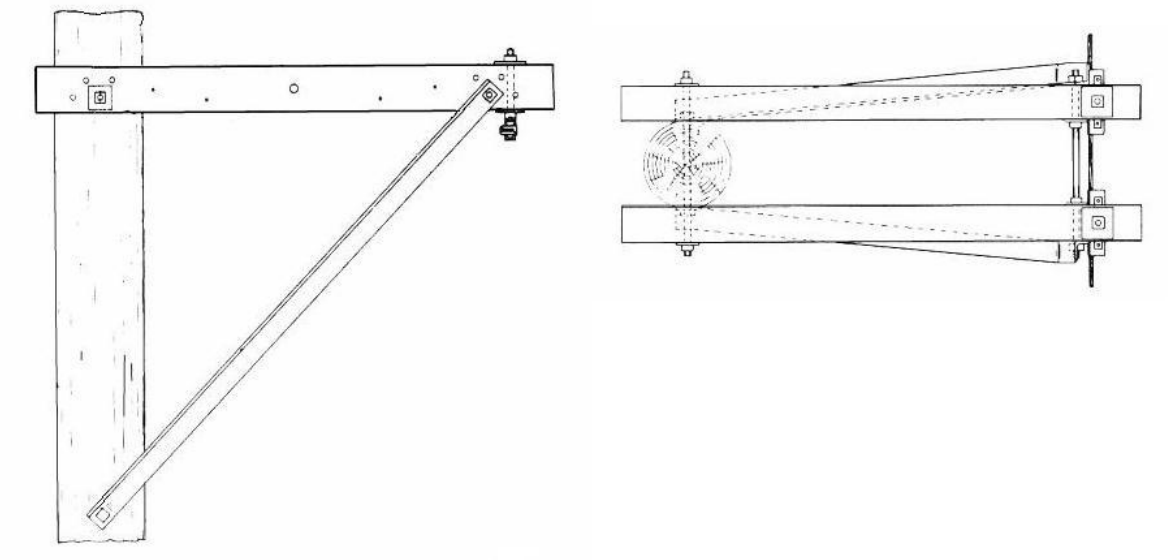
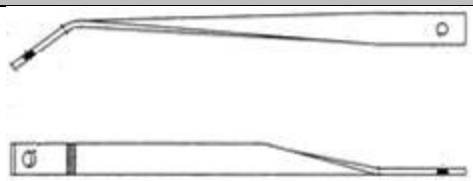


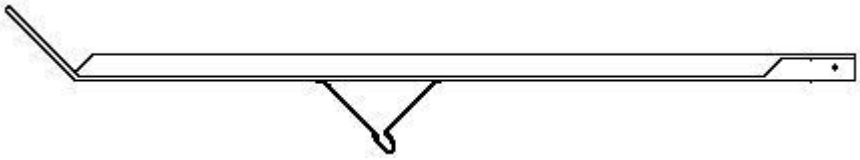
Figure 7.2 - Braces

Flat

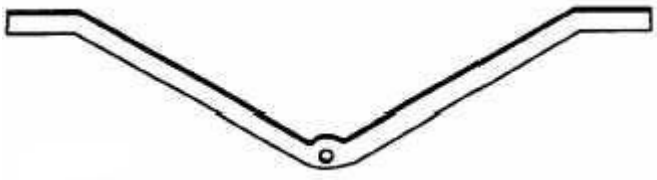
Curved



Angle Iron with 4” Brace



V Brace (aka Steerhorn)



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”)

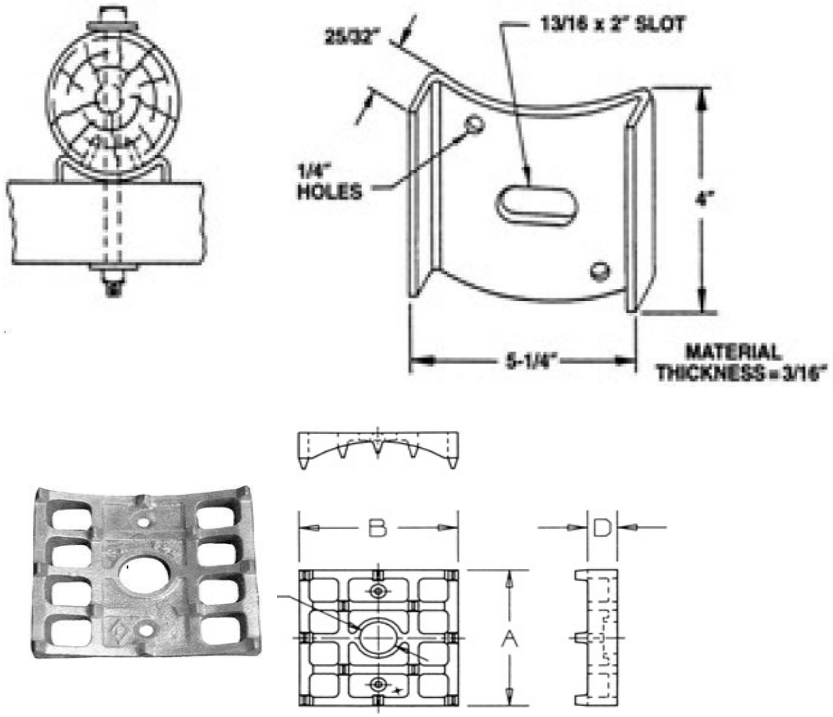
Pole Gains

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 7.3 - 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 manufacturer’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.

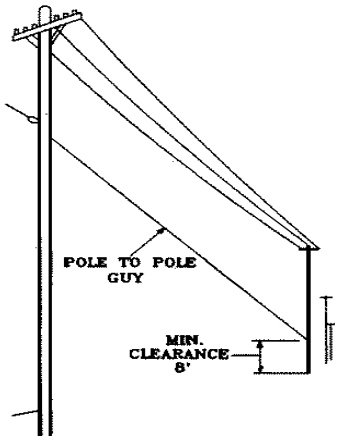
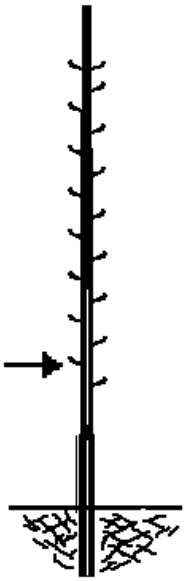
Definition of Equipment

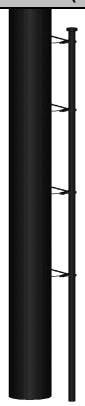
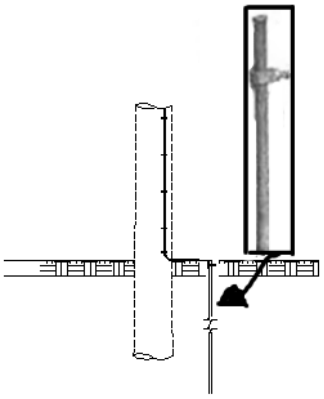
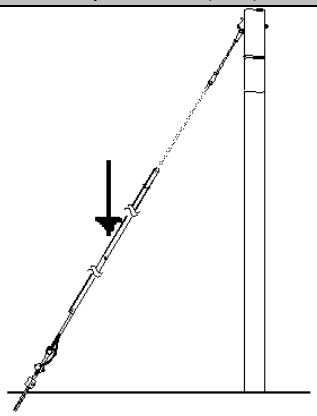
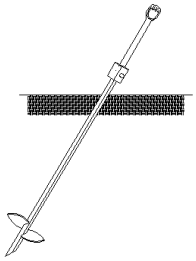
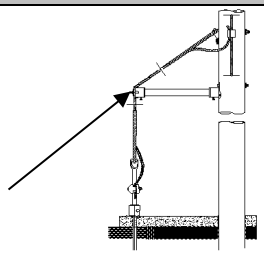
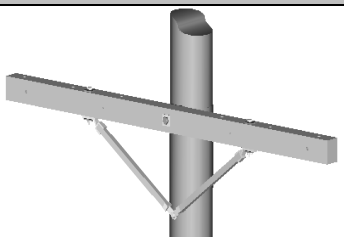
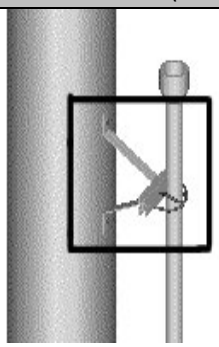
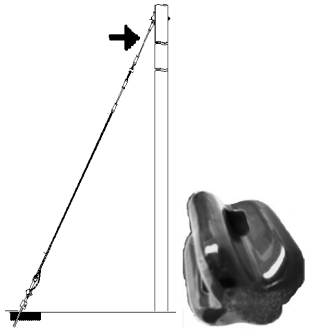
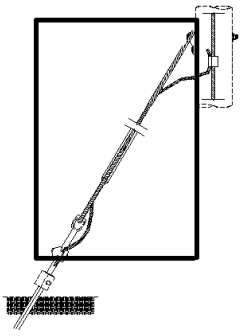
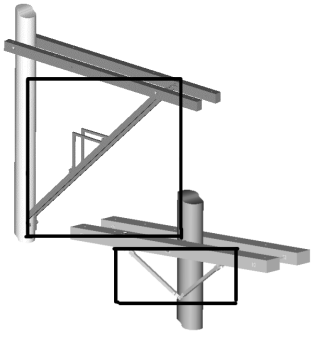
Equipment is defined in the NESC as "A general term and includes equipment installed for the operation of the electric supply and communications systems and auxiliary equipment installed incidental to the presence of the supply or communications system." In this section, Equipment is used to define a 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 8.1 - General Equipment Types & Codes

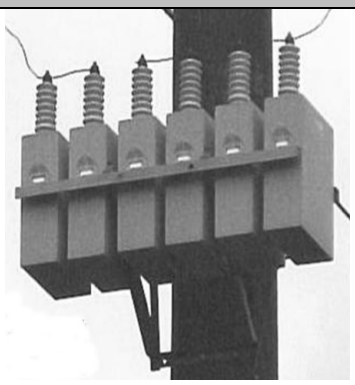
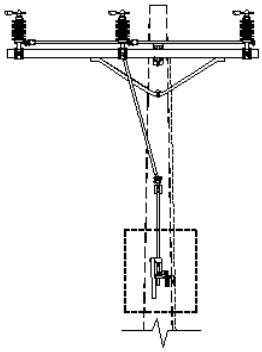
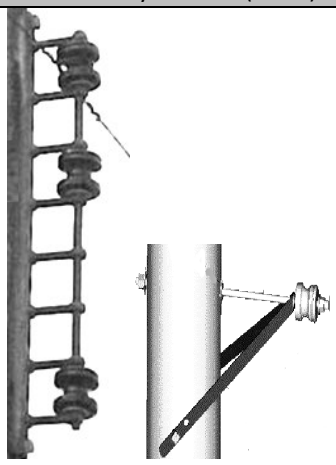
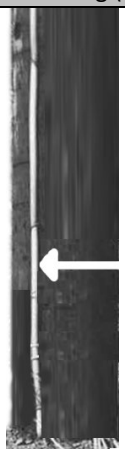
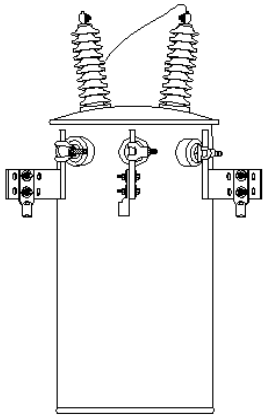
Pole to Pole Guy (PPG)	Pole Step (STEP)	Anchor (auxiliary) (AANC)
		
A Pole-to-Pole Guy (PPG) exists on poles where no anchor room is available. The guy attaches at a lower location on the next pole. That pole acts as the anchor for the pole-to-pole guy.		

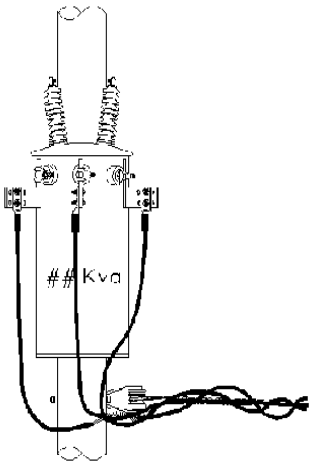
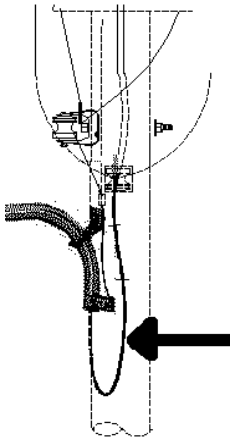
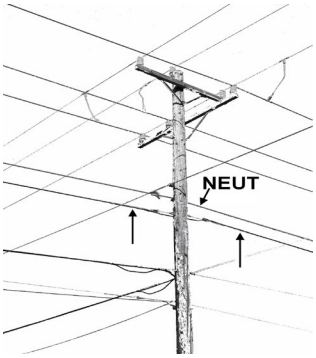
Risers (RIS)	Ground Rod (GRND)	Guy Markers (GM)
		
Anchor (ANC)	**Sidewalk Fixture (SWF)**	**Cross Arm (XARM)**
		
Ground Wire (GRWR)	**Stand-off Bracket (SOB)**	**Insulator Guy (INS)**
		
Down Guy (GUY)	**Cross Arm Brace (XARB)**	**Cross Arm (Fiberglass) XARF**
		

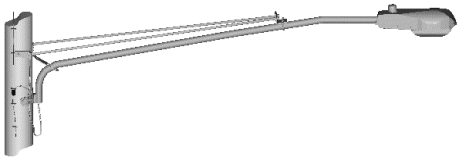
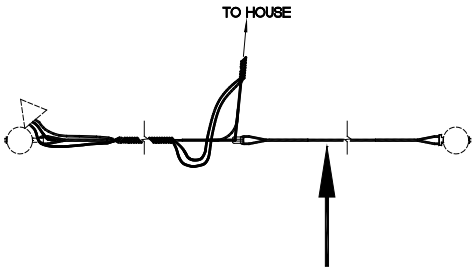
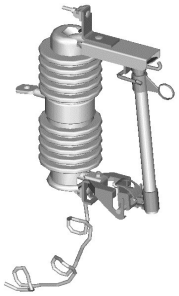
Supply Equipment

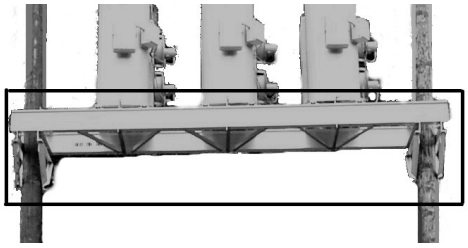
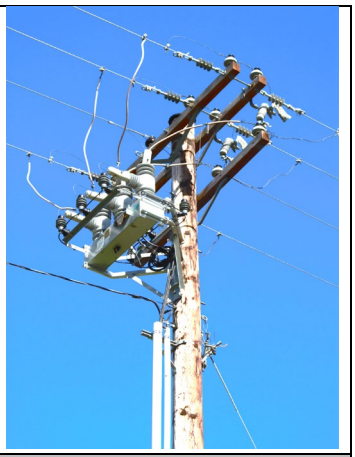
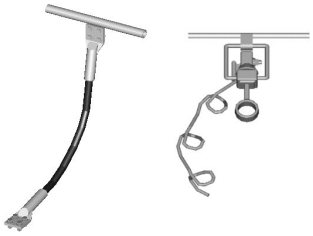
All types of Supply Equipment cannot be listed here. The examples given represent a general overview.

Figure 8.2 - 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)
		

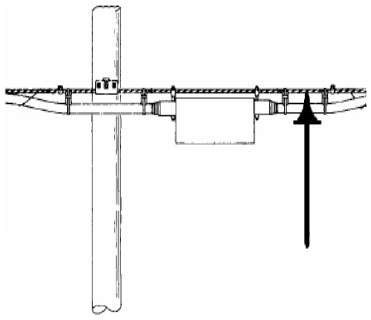
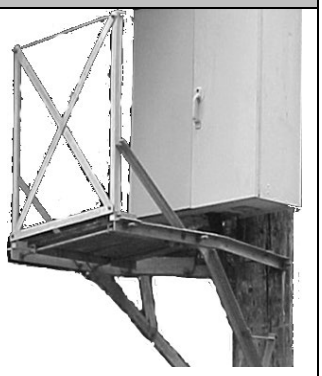
Streetlight (SLT)	Pedestal (PED)	Padmount Equipment (PAD)
		
Power Service Support Wire (PSSW)	Power Cutout (PCO)	Power Single Phase Voltage Regulator (PSVR)
		
Platform (PF)	Power 3 Voltage Regulator Bank (P3VR)	Power 3 Phase Recloser (P3RC)

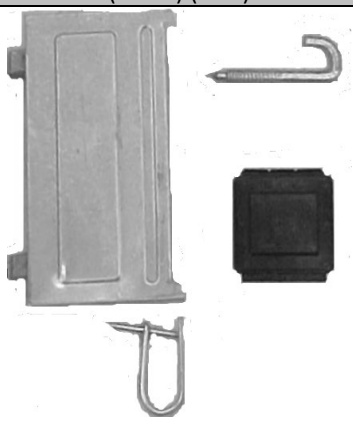
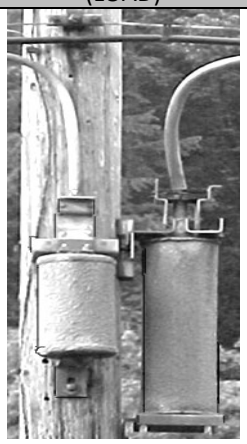
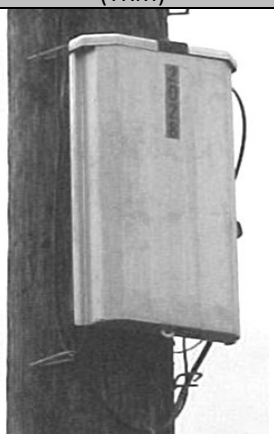
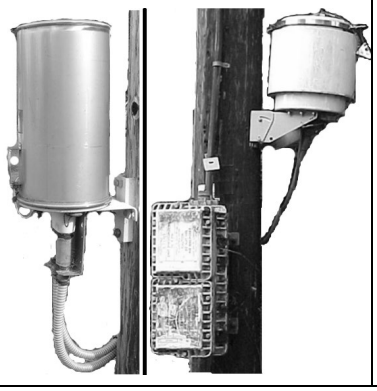
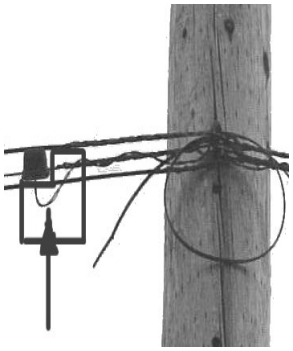
		
Power Jumper (JUMP)		
		

Telco Equipment

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

Figure 8.3 - Telco Equipment

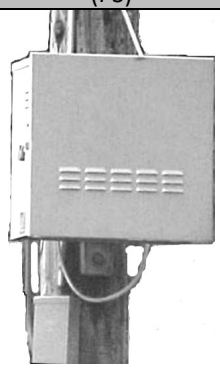
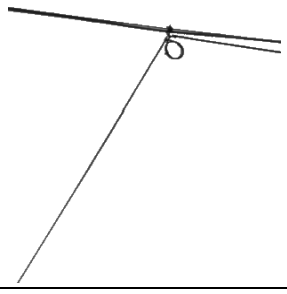
Communication Mainline (COML)	Communication Cross-Connect (XBOX)	Platform (PF)
		

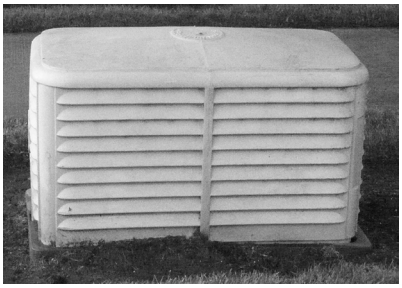
Communication Equipment (other) (CEO)	Communication Load Coil (LOAD)	Communication Terminal (TRM)
		
Communication Repeater (REP)	**Communications Bridle Wire (BRW)**	**Communications Pedestal (PED)**
		

Cable Equipment

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

Figure 8.4 - Cable Equipment

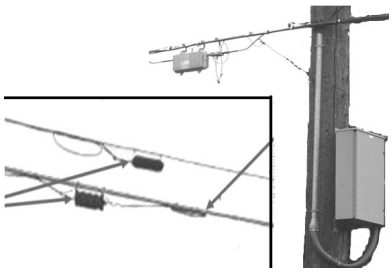
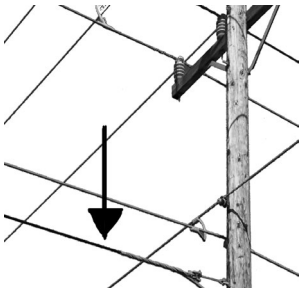
Communication Mainline (COML)	Communication Power Supply (PS)	Communication Drop (COMD)
		

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 8.5 - Fiber Equipment

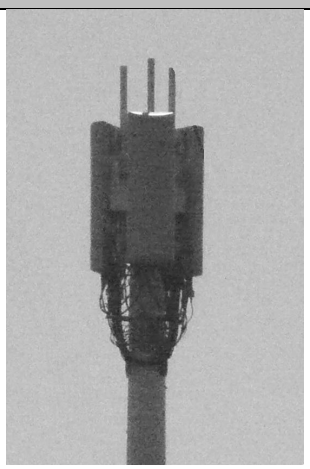
Fiber Equipment (other) (FEO)	Communications Fiber-optic (COFO)	Supply Fiber Optic (SPFO)
		

Wireless Equipment

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

Figure 8.6 - Wireless Equipment

Antennas (ANT)



Wireless Equipment (WEO)

Chapter 9 – WIRELESS CHAPTER

Definitions and Glossary

Most Common Wireless Terminology
New generations of cellular standards have appeared approximately every tenth year since 1G (Analog) systems were introduced in 1979. Every advance in technology is characterized by new frequency bands and higher data rates. The first commercial 3G networks were introduced in mid-2001 enabling the transition to all digital communications. Cellular telephone service is divided into small geographical areas called cells.

3G: Third Generation wireless technology allowed for the jump of higher transmission rates to voice, data, and wireless devices. It also allowed greater bandwidth and security protocols to be implemented including increased digital transmission. All US Wireless carriers will have deprecated and replaced 3G networks by the end of 2022.

4G: 4G does not support traditional circuit-switched telephone service (systems traditionally used to provide local phone services). Instead, it relies on all-Internet Protocol (IP) based communication such as IP telephony. 4G wireless technologies provide at least 100 Mbps transfer rates.

5G: The main advantage of the new 5G networks is that they will have greater bandwidth giving higher download speeds, eventually up to 10 gigabits per second. 5G can support up to a million devices per square kilometer, while 4G supports only one tenth of that capacity. It relies on a mix of low-, medium-, and high-power systems depending on configuration and frequencies utilized.

Femtocell: Small low-power device used to extend a cellular network to small areas such as a house, shop, or office. Utilizes local customers Internet service provider (ISP) network fed by copper or fiber optic.

Picocell: Low-power system used in public areas, such as shopping malls, airports, train stations, and high rises buildings. Extends coverage to indoor areas where outdoor signals do not reach well or to add network capacity in areas with very dense phone usage.

Microcell (Small Cell): Low-power system used in urban areas to fill gaps in service. Will allow greater urban 5G service by providing more sites with the higher data rates required for smart devices or autonomous vehicle navigation. Can be mounted on poles, buildings and other structures.

Macrocell: The most common type of cellular site, each instance is a high-powered cell that provides radio coverage by use of a large tower, antenna, or mast that covers a wide area. Typically located on high elevation sites or tall structures. Can contain a mix of technology (3G, 4G, 5G) depending on local need or existing coverage.

General Definitions

Analog: Method of modulating radio signals so that they can carry information such as voice or data. These voice signals can be heard and understood by any types of devices that can receive the signal.

Antenna: Device, or part of a device, that facilitates the transmission and reception of radio signals

Authentication: Feature used to reduce fraud by electronically confirming the identity of a phone to the wireless network

AWS (Advanced Wireless Service): A wireless spectrum band in the 1700 MHz and 2100 MHz frequency ranges

Backhaul: Connection of a cell site to and from a carrier's core network. The connection may be by copper, fiber optic or microwave and may be supplied by a company other than the wireless carrier.

Bandwidth: Transmission capacity of a medium in terms of a range of frequencies. A greater bandwidth indicates the ability to transmit a larger amount of data over a given period of time.

Bluetooth: Short range wireless protocol that allows mobile and IOT devices to share information and applications

Broadband: A communications medium capable of transmitting a relatively large amount of data over a given period of time

Carrier: Companies that provides telecommunications services

Carrier Aggregation: Wireless data transmission technique that ties separate frequency bands together to effectively create wider channels. Used in LTE networks, wider channels allow more data to be transferred at higher speeds.

CDMA (Code Division Multiple Access): Digital communication technology used by specific carriers to provide mobile phone service

Cell: An area surrounding a cell site. The area in which calls are handled by a particular cell site.

Cell Site: Transmission and reception equipment, including the base station antenna, that connects a cellular phone to the carrier's network

Cellphone: Cellphone or Cellular Phone. Equipment used to transmit and receive data and voice signals over a cellular network, including the ability to do so while in motion.

Cellular: The wireless communication that is most familiar to mobile phones users. Called 'cellular' because the system uses many base stations to divide a service area into multiple 'cells'. Cellular calls are transferred from base station to base station as a user travels from cell to cell.

Central Office: Connection point between a carrier's wireless phone system and the landline phone system

Digital: Encoding information using a binary code of 0s and 1s. Most modern wireless phones and networks use digital technology.

EME (Electromagnetic energy): Electrical equipment, mobile devices and wireless communications networks all emit EME. EME comes from a variety of sources in the natural environment. It's emitted by the sun, the earth's atmosphere and even the human body.

ESN (Electronic Serial Number): A unique serial number of a cellular phone that identifies it to the cellular system for the purpose and placing and receiving calls

FCC (Federal Communications Commission)**:** US government agency responsible for regulating communications industries

G: Stands for 'generation' and designates a certain minimum level of reliability and transfer speed for a wireless network technology. The Use of 'G' for marketing purposes is not regulated.

IP (Internet Protocol): The primary data transmission technology of the Internet. Increasingly used for wireless transmissions. (IP may also be used to refer to a device's address on the network)

Landline: Traditional wired telephone service

LTE (Long Term Evolution, 4G): An evolution of the wireless network data communications standard. Its improvements include faster data transmission rates and seamless call handoffs with older technology cell sites.

Mbps: A data transfer rate of 1,000,000 bits per second. May also be written as Mbit/s or Mb/s.

NAM (Number Assignment Module): component of a wireless phone that holds the telephone number and ESN of the phone

NFC (Near-Field Communications): Very short range (less than 4 inches) one or two-way radio communication between devices. Typically used with mobile device payment apps (i.e. Applepay, Google Pay, etc) and next generation credit cards that can utilize "tap to pay".

NIR (Non Ionizing radiation): RF energy given off by electronic devices used by cellular industry

NOC (Network Operations Center): a central location from which network administrators manage, control and monitor one or more networks. Commonly used to monitor remote sites.

OTA (Over-The-Air): A remote update of a device's operating system or other system software through the cellular network

PCS (Personal Communication Services): A class of wireless communications services authorized by the FCC through licensing. PCS systems use the 1.9 GHz radio frequency band. Digital technology was first used in the PCS band.

POTS (Plain-Old-Telephone-Service): Name for traditional wired, land-based telephone service

PSTN (Public Switched Telephone Network): Formal name for the world-wide telephone network

RF (Radio Frequency): A radio signal

RFI (Radio Frequency Interference): An undesired radio signal that interferes with communication signals causing noise and/or signal dropouts

Roaming: Using your wireless phone in an area outside its home coverage area

SAR (Specific Absorption Ratio): SAR provides a means for measuring the RF exposure characteristics of cell phones to ensure that they are within the safety guidelines set by the FCC

SIM (Subscriber Identity Module or Subscriber Identification Module): A microchip mounted on a flat plastic card which contains the data needed to uniquely identify a

subscriber and connect a device to a wireless network. In newer devices a SIM may be embedded in a device.

Smartphone: Device with capabilities inclusive of and extended beyond that of a cellphone to include those of a mobile computer

SMR (Specialized Mobile Radio): Land based mobile communications service using handsets with 'direct connect' features

Spectrum: The entire range of electromagnetic frequencies

Spread Spectrum: Communications technology where a signal is transmitted over a broad range of frequencies and then re-assembled when received

Telecommunications Act of 1996: Federal legislation passed in 1996 intended to increase competition among wireless and wireline carriers for the benefit of consumers

TDMA (Time Division Multiple Access): Deprecated digital communication technology that was used by some carriers to provide wireless phone service

UMTS (Universal Mobile Telecommunications System): Third generation (3G) of the GSM standard for mobile network systems

VOIP (Voice Over Internet Protocol): Transmission of voice as data using the packet switching of an IP (Internet Protocol) network

VoLTE (Voice Over LTE): Voice transmission over an LTE data network. Calls are packet switched versus circuit switched.

WCDMA (Wideband CDMA): 3G wireless communications standard. Uses wider 5 MHz channels (vs. 1.25 MHz for CDMA) for increased voice traffic capacity and peak data rates of 384 kbps.

WiFi: A wireless data networking protocol generally used to connect any type of device to a network over relatively short distance. The most common means of wireless networking.

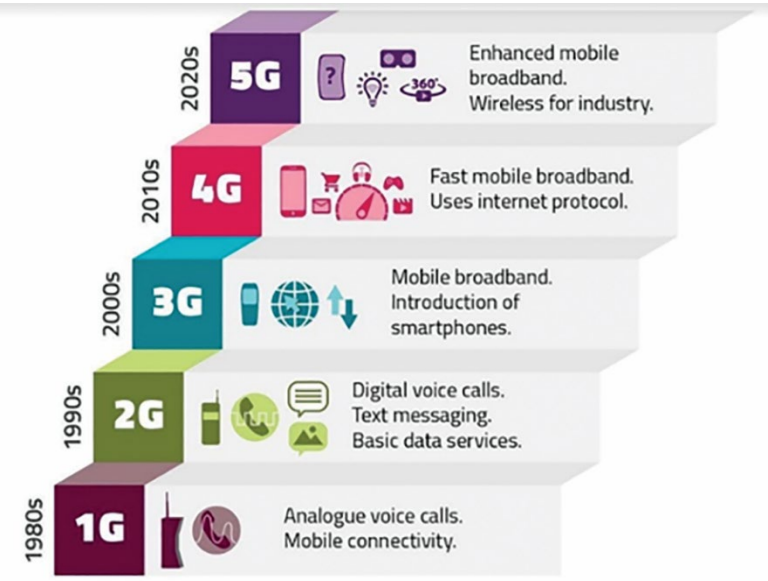
Wireless: Transmission and/or reception of signals between devices using radio waves and without the use of any physical connection

Wireless Carrier: Companies that provide wireless telecommunications services

Evolution of Wireless Technology

Nothing has made more impact on our global society than Wireless technology. It has affected how we communicate, learn, and socialize with one another. It has even changed how we interact with our household appliances, lights, automobiles, banks, healthcare providers, and more. Entertainment that once was confined to the home is now mobile. We stream movies, enjoy gaming, and can play virtual tennis with anyone in the world. So, what are the roots of Wireless and how long has it been around? According to Wikipedia, Wireless "is the electromagnetic transfer of information between two or more points that are not connected by an electrical conductor." The term "wireless communication" came about in the late 1800s with the advent of wireless telegraphy, the use of radio waves in place of wires. An early example of this was the proliferation and use of Morse Code. Radio wave transmission is widely in use today, as it is the main communication means for all our wireless technologies that we use in our daily lives.

Let's examine the mobile network advancements a little closer. Although in the US Motorola was the first company to mass produce mobile phones in 1973 (Zero Generation or 0G radio telephone), it was Nippon Telegraph and Telephone (NTT) who introduced the first-generation cellular mobile network in Tokyo, Japan, in 1979. In 1983, the US embraced this technology. Every decade since then has brought large advancements in technology. Today, 5G technology promises close to 600 times more speed than the typical 4G connection. For carriers to achieve this unbelievable speed, it will be necessary for them to move to the less reliable mmWave technology. Not only is it finicky about obstacles in its path, such as trees, but it also misbehaves over long distances. To counter these undesirables, the carriers must deploy a vast number of small cells.



Types of Wireless Sites

Content about macros; micros, aka small cells; distributed antenna systems; strand mounted

Figure 9.1 - 2G-5G Bands Frequencies

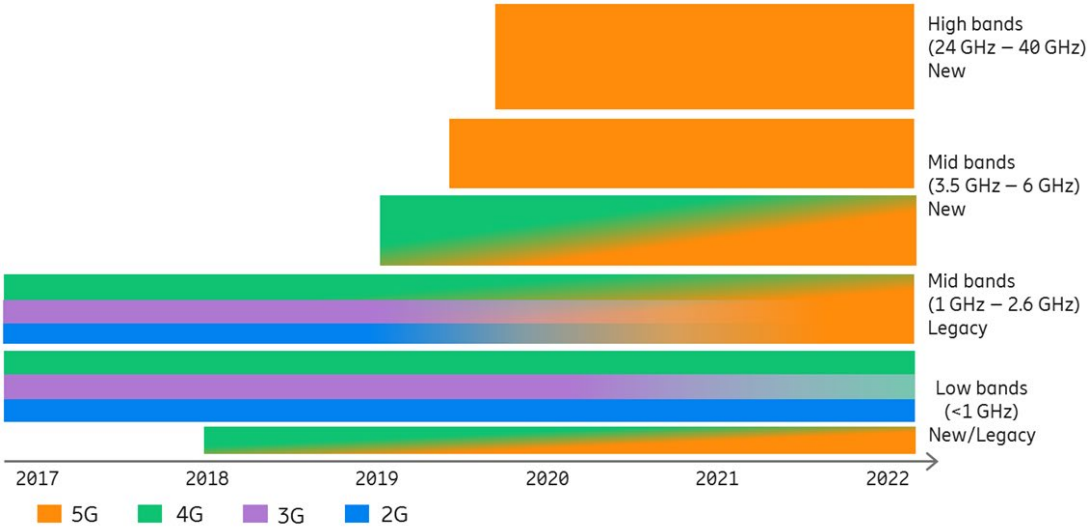


Figure 9.2 – 3G-4G Frequencies

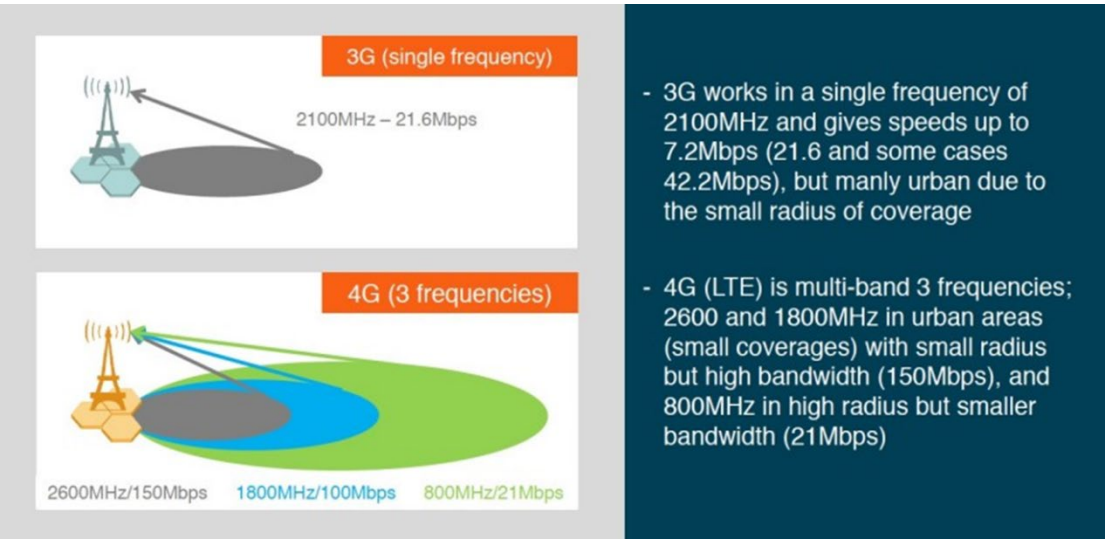


Figure 9.3 – Radio Wave Spectrum

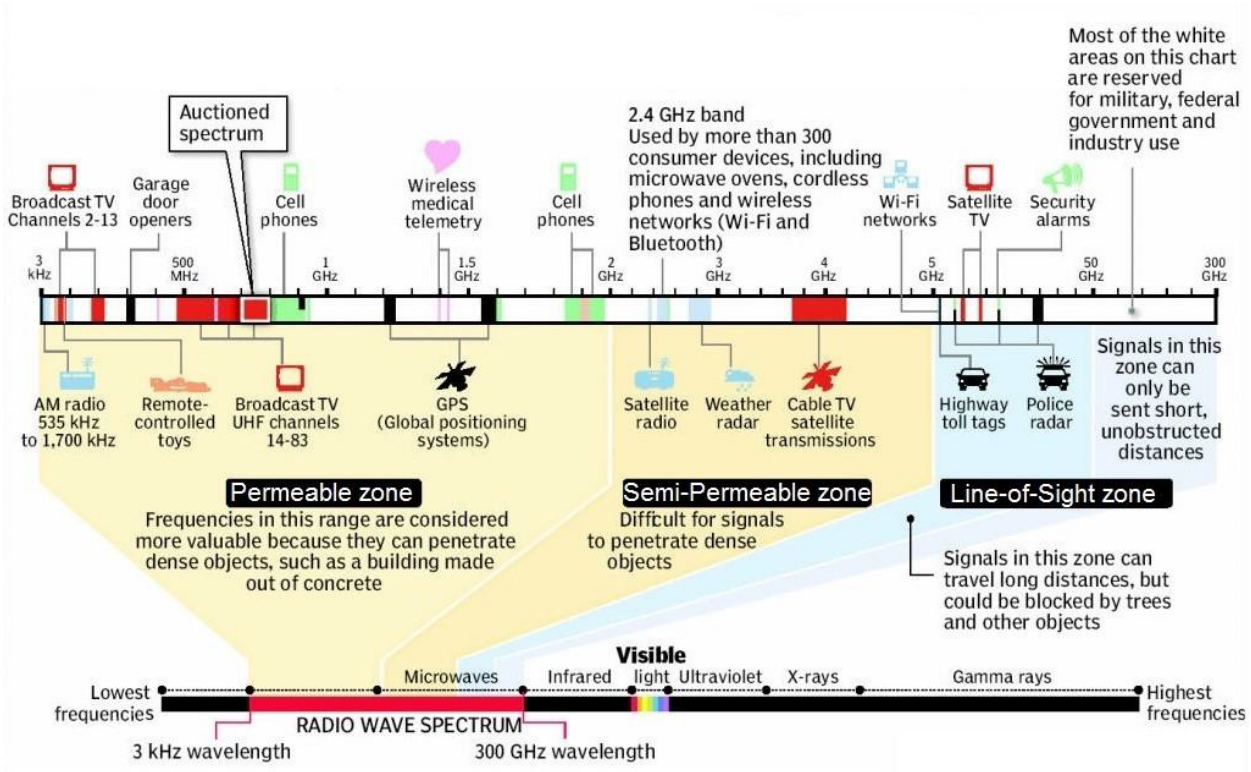


Figure 9.4 - Joint Use W-Arrows

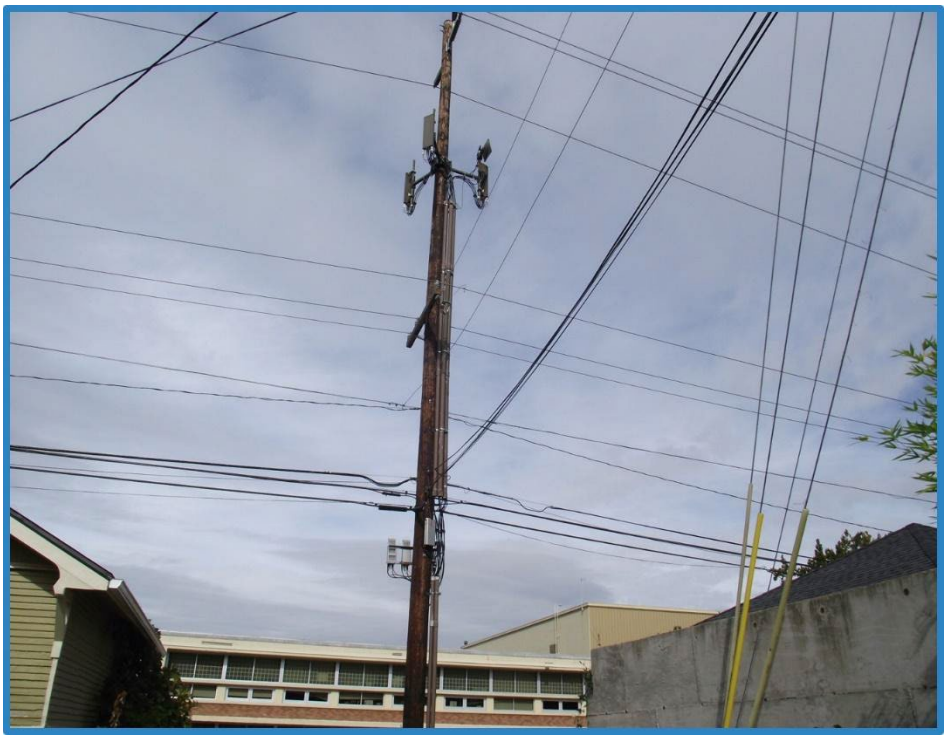


Figure 9.5 - Comm Space Small Cell

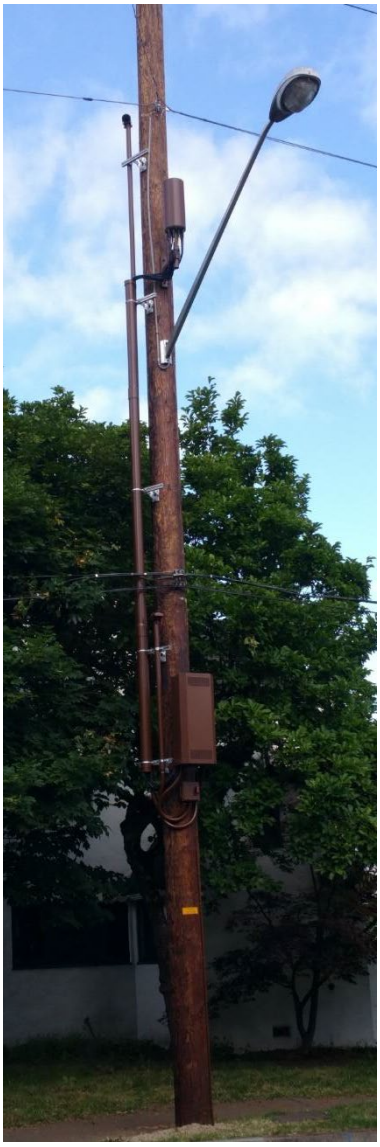


Figure 9.6 - Strand Mount Comm Space

Figure 9.7 - Dual 2

Figure 9.8 - Strand 8

Figure 9.9 - Strand 9

Site Selection

The selection of joint use structures for co-locating wireless attachments requires cooperative consideration of all factors involved, including the character of existing equipment, the total number, diameter and weight of existing conductors, the number and location of service drops, the size and configuration of proposed new wireless equipment, and other structure conflicts.

The following section is intended to provide general guidelines for utility operators and wireless vendors as they evaluate the suitability of structures for co-location of various forms of wireless attachments and related equipment.

Included are common examples of candidate structures that are generally considered by industry as "good" and others that are considered "poor" for wireless co-location.

Also included are figures showing basic configurations intended to meet NESC clearance requirements between wireless equipment and other pole-mounted equipment.

This is by no means a comprehensive examination of all candidate site possibilities, nor is any attempt being made with this section or these guidelines to limit a pole-owner's rights to reject usage as a wireless co-location site.

National Electrical Safety Code (NESC) Rules
NESC requirements related to wireless co-locations.

American National Standards Institute (ANSI)
ANSI Standard Section.

Federal Communications Commission (FCC)
FCC Regulations related to wireless co-locations.

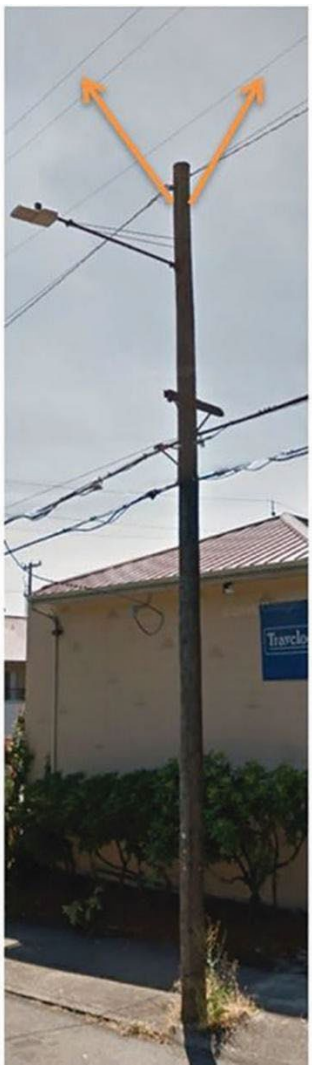
Institute of Electrical and Electronics Engineers (IEEE)
IEEE requirements related to wireless co-locations.

Figure 9.10 - Suitable (Good) Candidates for Wireless Co-Location

Minimal loading, tangent pole, minimal transformers, at least 6-8” available on top of the pole.

Figure 9.11 - Poles Not Suitable (Poor) for Wireless Co-Location

Cluttered with Cutouts | *Switch on Pole* | *Metal Lightpole* | *3 Transformers on Pole*

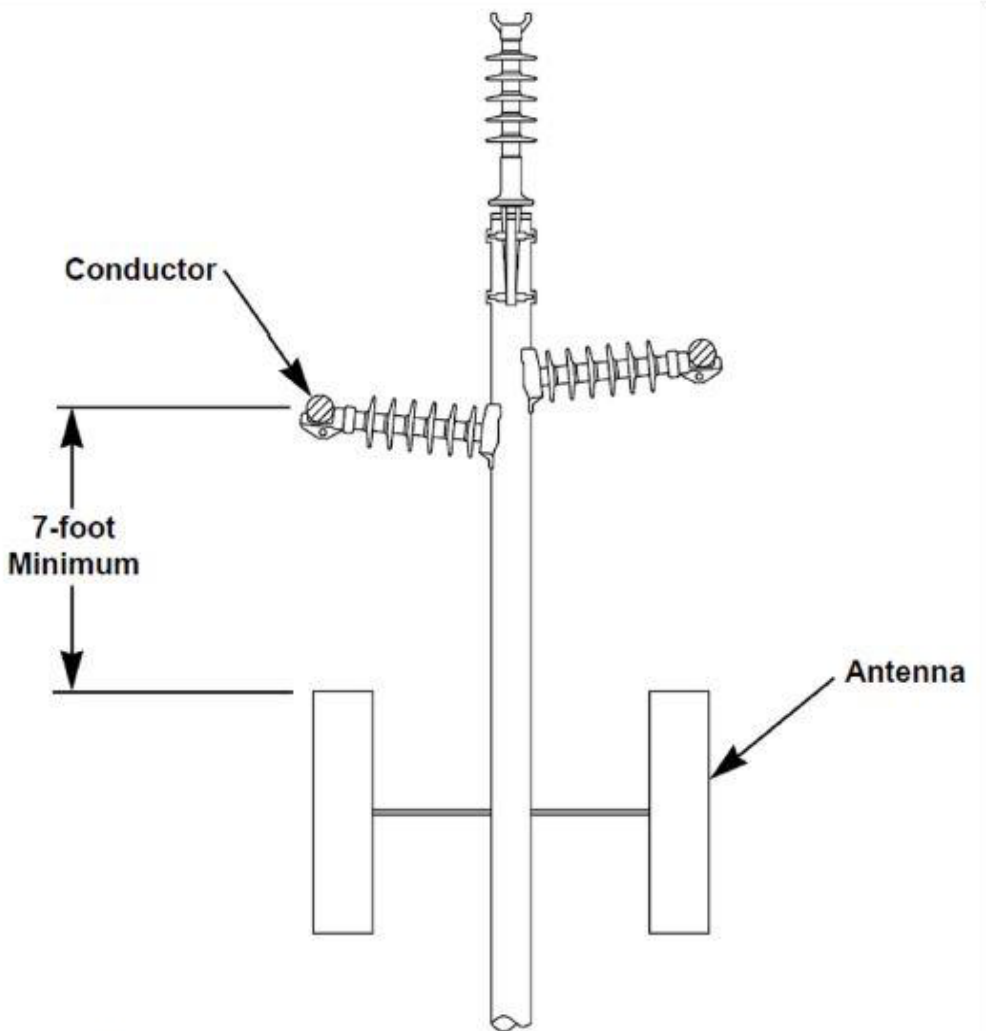


Conductors Overhead

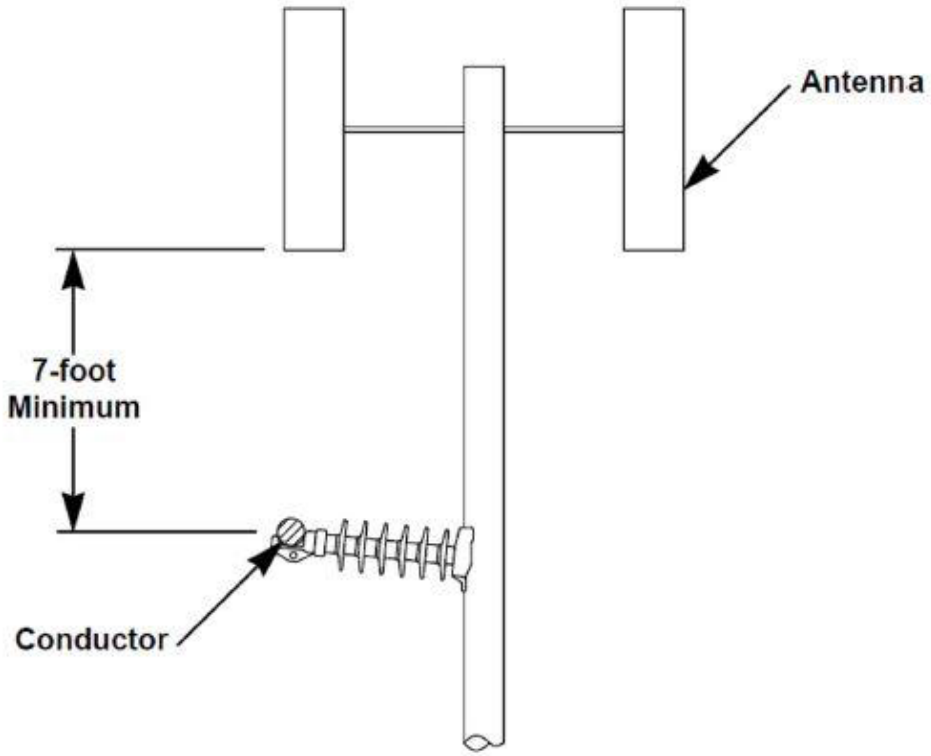
Transmission Pole

Line and Buck Crossarms

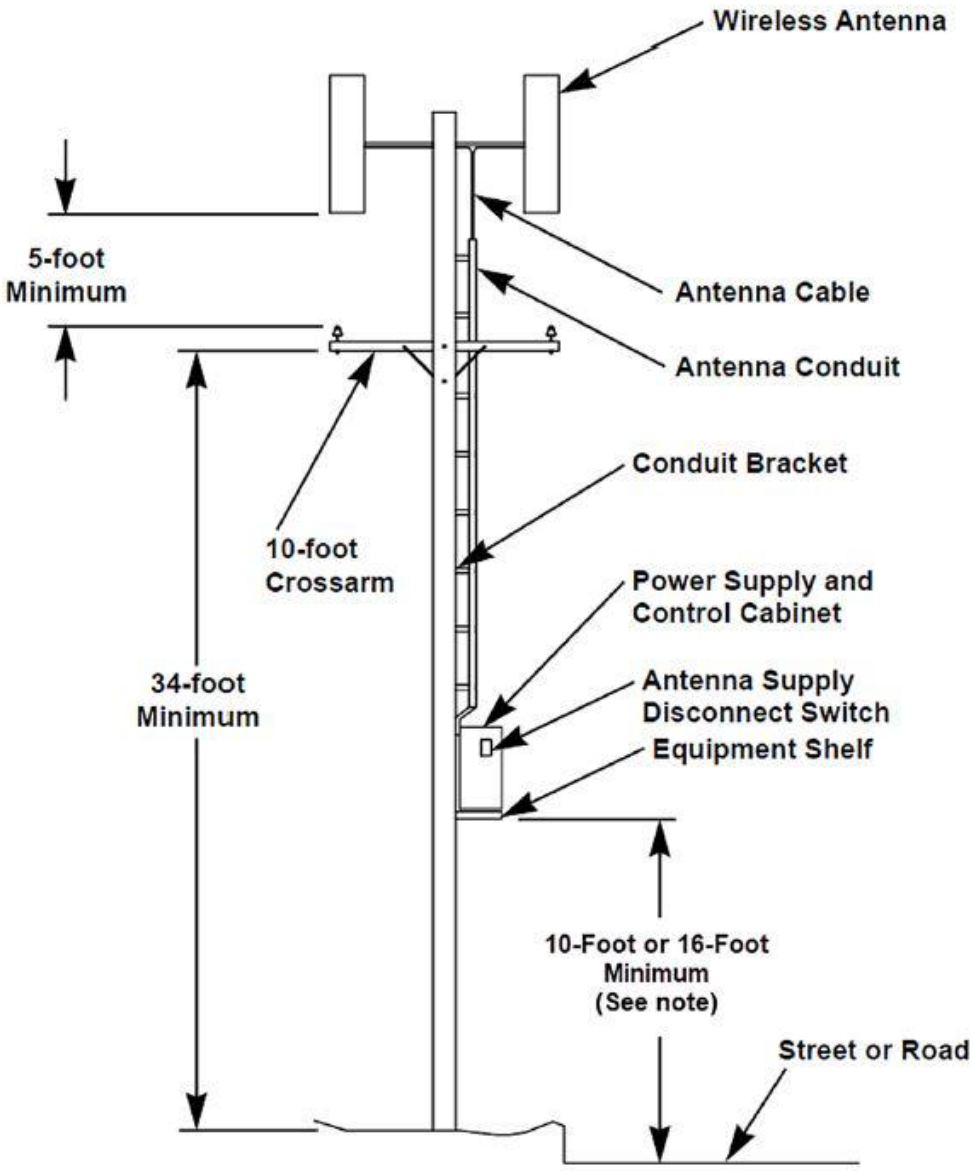
Double Alley Arms



Transmission Pole with Antennas Installed Below the Transmission Line

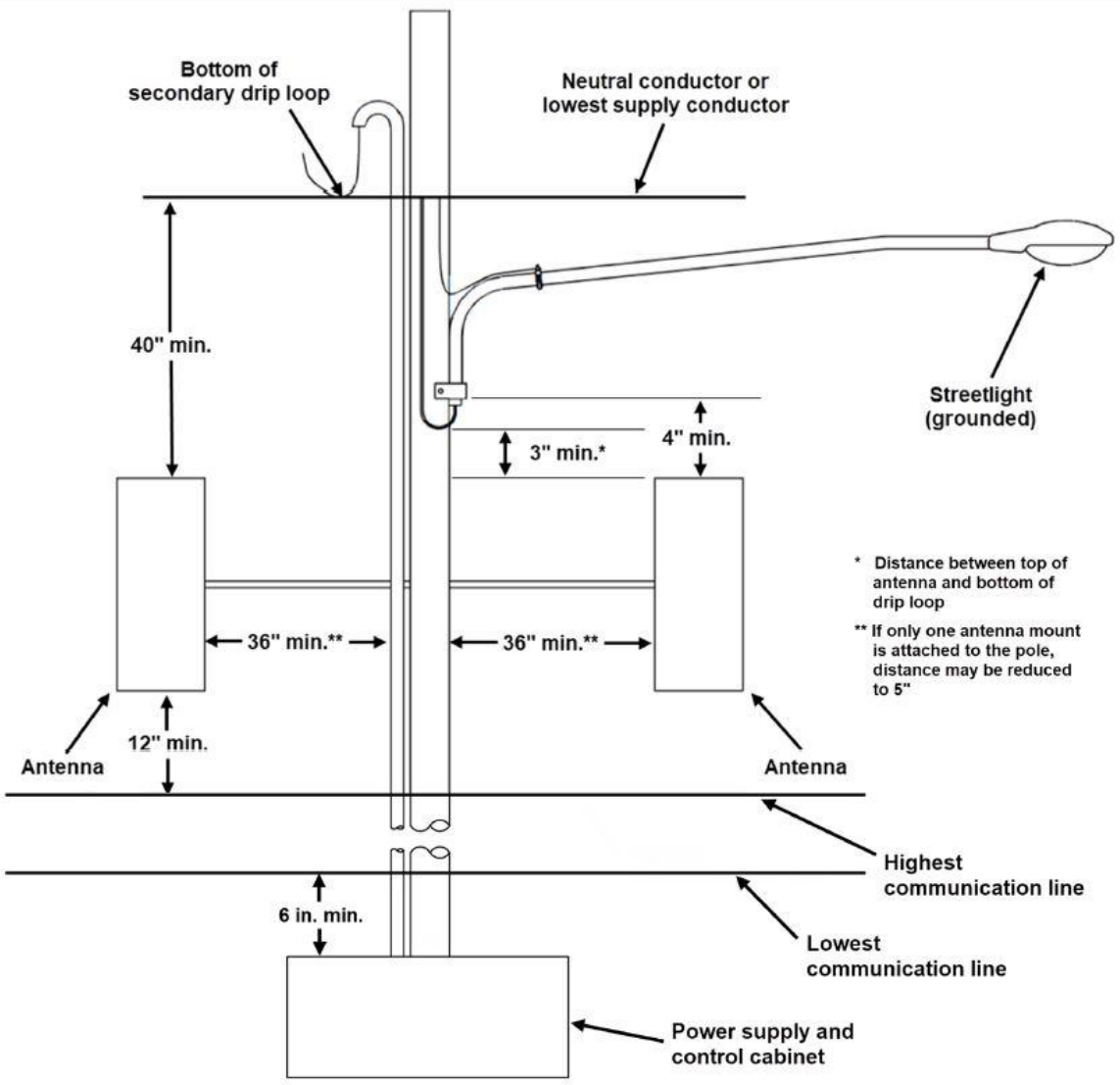


Transmission Pole with Antennas Installed Above the Transmission Line

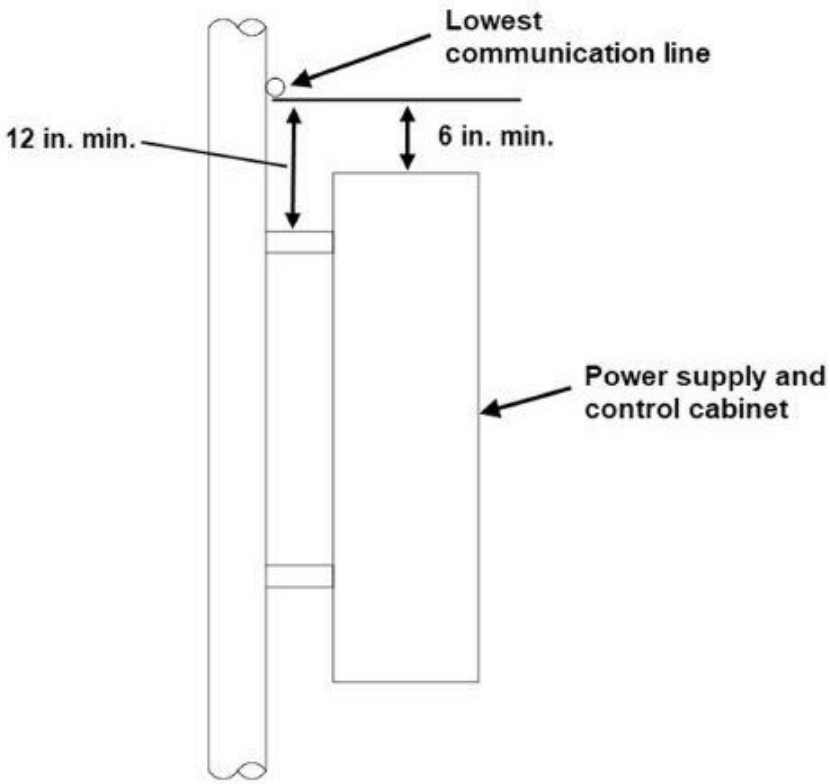


Distribution Pole with Antennas

Note: The bottom of the equipment shelf on a distribution pole must be at least 10 feet above pedestrian sidewalks or restricted-traffic roads, and at least 16 feet over roads, streets, and alleys.

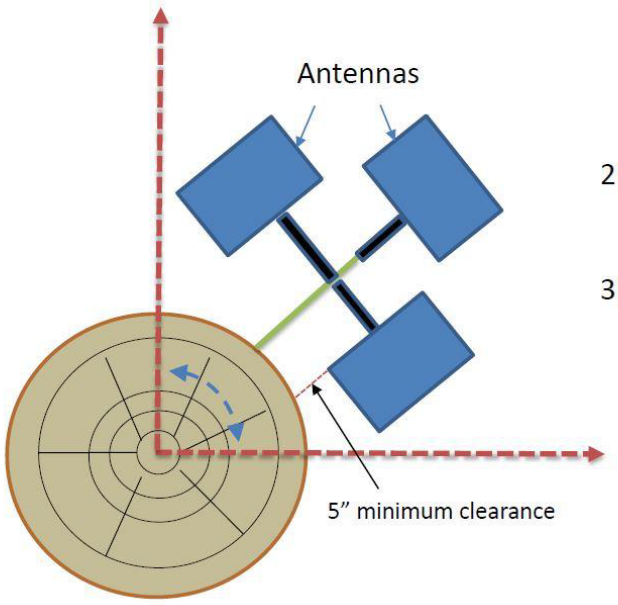


Minimum Clearances on a Pole with Antennas



Clearances Between Equipment Cabinet and Lowest Communication Line

Horizontal space allowed per pole (top-down view)



1) All Comm space mounted antennas and their supporting structures must fit within the confines of one-quadrant (90deg)

2) Minimum 5" poleface to antenna clearance must be maintained

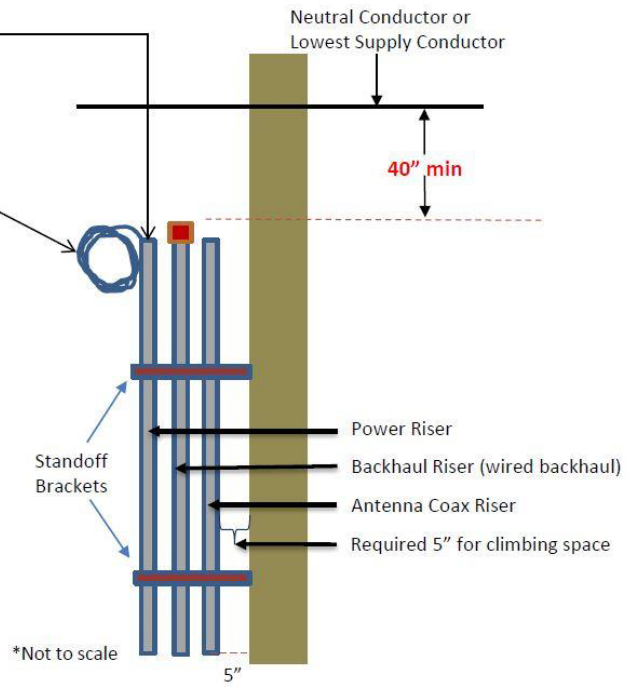
3) If more than 1 standoff arm is attached, the minimum clearance requirements are increased to 36"

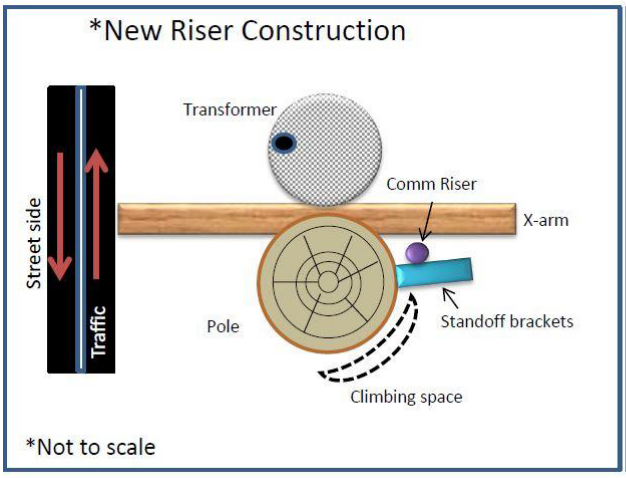
Riser Construction

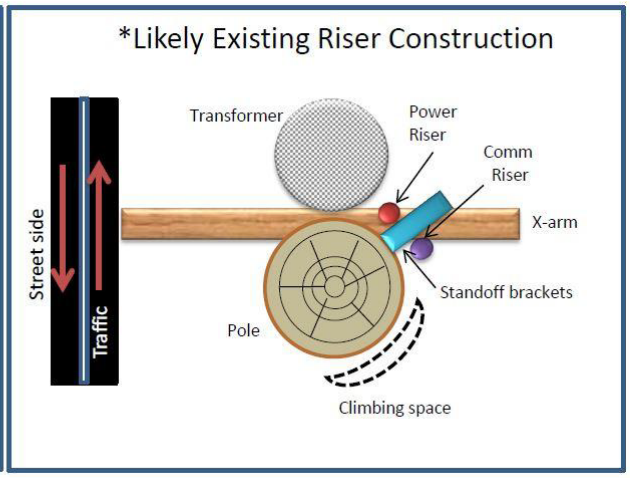
Riser Construction (Non-Journeyman Lineman)

- **Build risers no closer than 40" to Neutral conductor or lowest Supply conductor**
- **Allow sufficient conductor to connect to power source.**
- **PGE will complete riser/Weatherhead install**
- **Wireless construction crew must provide materials. (Additional conduit, Weatherhead, etc.)**
- ***Note: Work may be performed by a *qualified worker near the secondary conductor if <u>BOTH</u> of the following conditions are met:***
  1) The Secondary Conductor is insulated <u>AND</u>
  2) Secondary Conductor is the <u>ONLY</u> source of power on the pole

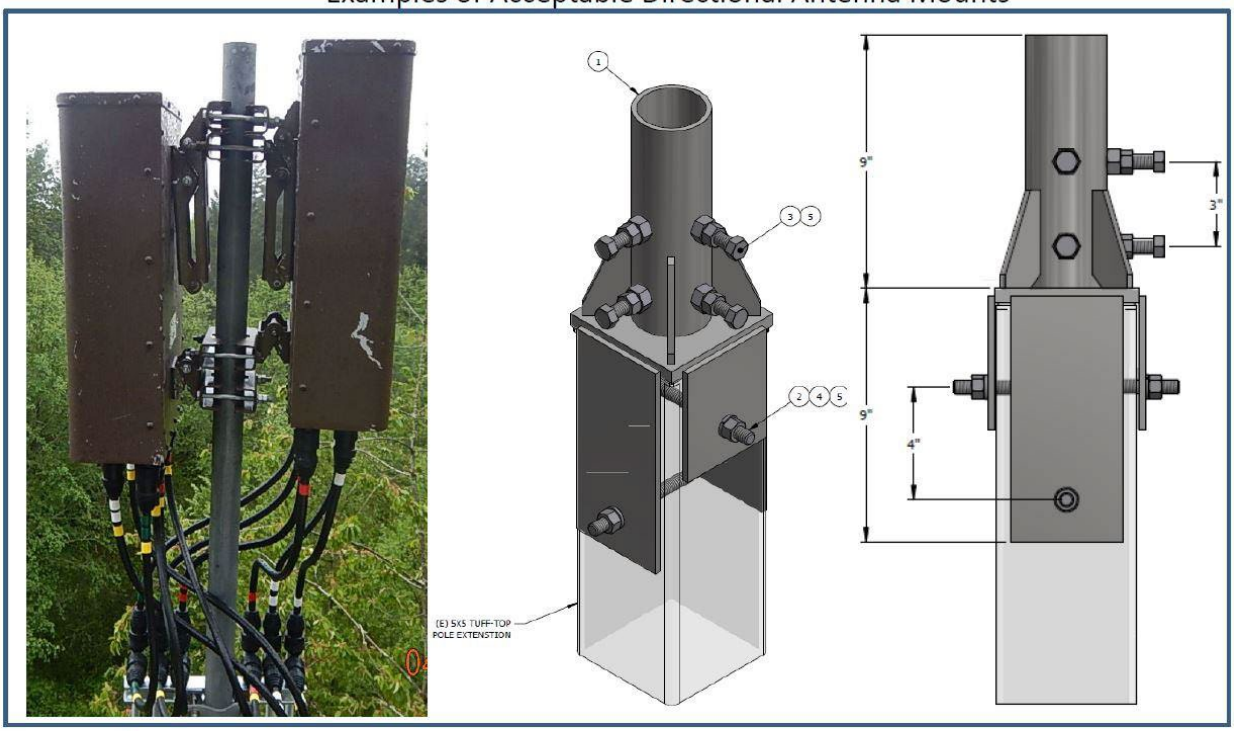
* Qualified workers are expected to know and follow all applicable OSHA, NESC and Industry Safety Standards







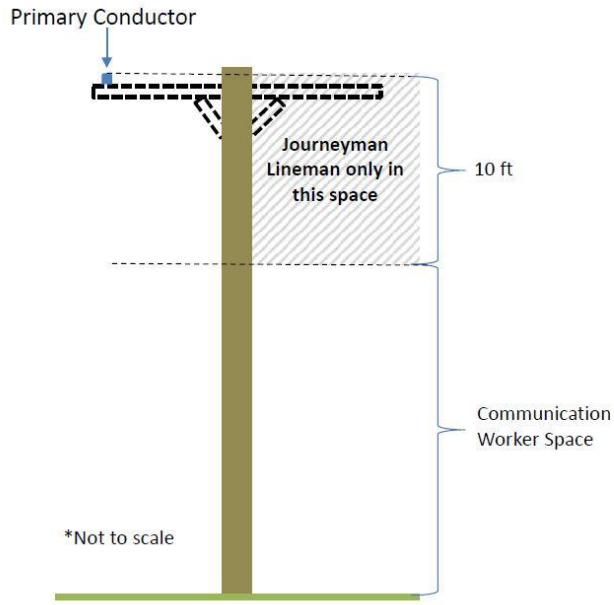
Examples of Acceptable Directional Antenna Mounts



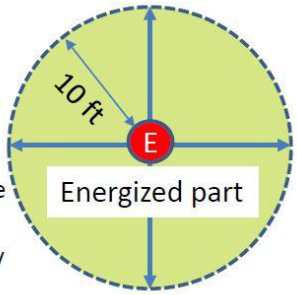
SIDE VIEW

Comments:

- Mounting Brackets Must allow 360 degrees Freedom of Movement



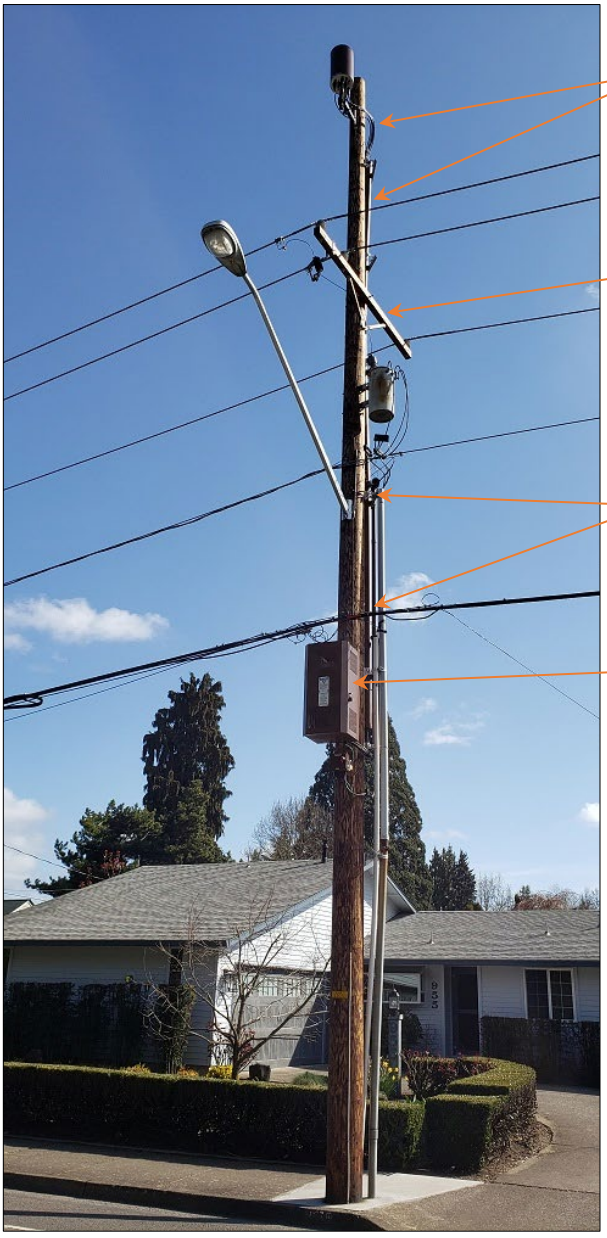
Communication workers are required to maintain a minimum approach distance of 10 feet from energized Primary lines



Configurations on Joint Use Poles

Figure 9.12 – Types of Small Cell Configurations on Joint Use Poles

Pole Top – Above Primary (3 PH)



7’ clearance from bottom of hardware to primary conductor.

Refer to NESC 238-1 for minimum clearance.

Underbuild framing—10’ cross-arm.

Refer to your utility’s standards.

Minimum 40” from lowest energized conductor.

Refer to NESC 235-5.

Cabinet installed over roadway—minimum 15’ (bottom of cabinet).

Refer to NESC 232-2.

Mid-Pole – Below Primary

Maintain your utility's standard framing; Pole height gets adjusted based on utility standard and wireless request for RAD center height.

Example: This utility frames neutral 9' from top of pole. Required 60' pole to be installed.

Streetlight placement may require the conductor to be covered and the light mast to be bonded.

Refer to NESC 238-2.

Cabinet and associated equipment height may vary between utility.

Example: This utility requires equipment to be minimum 9' and maximum 16' unless over a roadway in which case minimum for the cabinet is 15' and maximum is 19'.

Refer to NESC 232-2.

Mid-pole – Below Primary with Underground Fiber

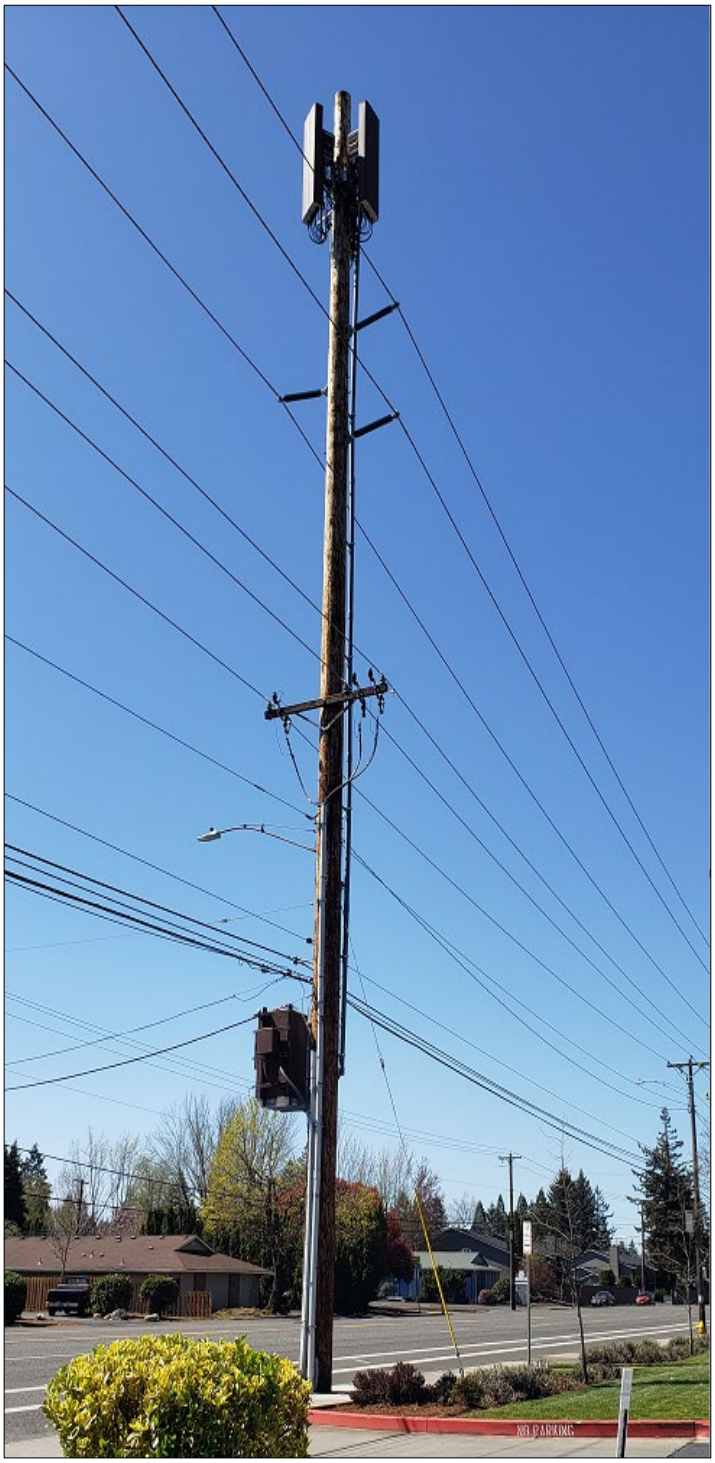
Streetlight installed in the worker safety zone.

Refer to NESC 238-2.

Minimum 3 inches see Rule 238F 2b

Feed with underground fiber and installed in same quarter as communication and power riser.

Pole Top Macro Cellular Site – Above Transmission



Maintain your utility's standard requirements from transmission.

This utility requires 7' minimum between conductor & bottom of antenna/cable.

Refer to NESC 238-1 for vertical clearance between supply conductors and communication equipment.

Power supply and control cabinet mounted on the pole with brackets

This utility requires 12" minimum separation from lowest communication line to bracket (6" minimum to top of cabinet), and minimum 16' over roadway.

Refer to NESC 232-2.

Metered/Unmetered Installations

Contact the Electric Utility that serves the location for information regarding their current Metering Standards and Electric Service Requirements for service installations. Metering requirements of each Electric Utility Service provider as well as equipment requirements of each Right of Way (ROW) or Public Utility Easement (PUE) entity can be quite different.

Many factors may drive the electric utilities' ability to provide the service. Locations of requested Wireless services may not have existing electric infrastructure or capacity to serve the site. The electric utility will need to know what service voltage and service size is needed.

Contacting the serving utility early in the planning process will help in the design and construction. The Utility can share information on rate schedules and may have unmetered service options.

Some factors that may steer Electric Service Providers metering requirements:

- Like the wireless industry, metering technology is also constantly evolving. Many providers do have automated metering infrastructure (AMI) but not all. Manual read meters are still quite common, which require regular unobstructed access.
- Acceptable meter sockets and mounting requirements.
- Sealing provisions.
- Other local electrical jurisdiction requirements. Metering equipment typically is customer owned equipment which falls under the National Electric Code (NEC).
- Pole owners may have limitations on equipment attach to poles.
- Municipal or ROW owners may also have equipment placement standards.

Contacting the Electric Service Provider early in the process may help avoid issues that could cause a delay in service.

Radio Frequency (RF)
Considerations Regarding Cellular Antennas

The basic factors to consider when we talk about worker safety and RF are the frequency, transmitter power level, distance from the antenna, location in relation to the antenna (in its pointing path), and the duration of exposure. Regarding health effects, RF emissions are a non-ionizing form of radiation, very different from the ionizing energy (radioactive) of X-Rays and Gamma Rays which can cause severe damage to tissue and even DNA. RF energy, however, has been linked to extreme heating of the body tissue and temperature causing eye and testicular damage due to the low blood flow to both. RF exposure is not cumulative and has not been found to cause cancer. It is important to note that not all antennae are RF emitting. Some are just receivers.

Macro Cell Sites (Base Stations)
Macro sites are the large tower antennas typically located on a rooftop, on the side of a building or behind a fence. In all instances, these are secured access sites. The antenna height ranges from 50' to 200'. These antennas cover vast rural areas or smaller city areas. Due to their higher power, in order to get greater coverage, their RF output is the greatest among telecommunications facilities.

Small Cell Sites and Distributed Area Systems (DAS)
Small cell sites are mounted at much lower levels than macro sites and can be found on utility poles, light poles, telecom poles or on buildings. Their height can be anywhere from 10' to 50'. The small cells help facilitate the broadcast of macro cells and, because of their small size, their power is small as well. Thus, their RF output pales compared to the macro sites. Because of their low power, they cannot transmit very far and rely on other small cells nearby to continue their work.

Exposure Guidelines
There are many governmental agencies that have published RF exposure standards and guidelines. In the US, the FCC has been updating their RF guideline since 1985. According to the FCC website page titled RF Safety FAQ:

> "The FCC guidelines for human exposure to RF electromagnetic fields were derived from the recommendations of two expert organizations, the National Council on Radiation Protection and Measurements (NCRP) and the Institute of Electrical and Electronics Engineers (IEEE). Both the NCRP exposure criteria and the IEEE standard were developed by expert scientists and engineers after extensive reviews of the scientific literature related to RF biological effects. The exposure guidelines are based on thresholds for known adverse effects, and they incorporate prudent margins of safety. In adopting the current RF exposure guidelines, the FCC

consulted with the EPA, FDA, OSHA and NIOSH, and obtained their support for the guidelines that the FCC is using."

The FCC provides a greater level of protection in its RF exposure limits: Occupational or Controlled Limits uses a "10 times safety factor" below known biological effects, per the Utilities Technology Council.

Carrier Requirements

When any licensee builds a new facility or renews a permit for an existing facility that has the potential to emit high RF, the FCC assesses their compliance with the RF exposure guidelines. Additionally, carriers are required to post signage at all RF sites that provides information about the RF risk, who the carrier is, and contact information.

Signage

Introduction

Many forms of signage may be associated with wireless pole attachments for various purposes. This section will identify some of the most common types of signs and their intended use.

It is also important to acknowledge the varying terminology that is used throughout the industry when discussing signage. Some of the most common terms are:

- Signs
- Signage
- Labels
- Stickers
- Notices
- Placards

Regulations – starting page 85

- NESC
- ANSI
- FCC

Signage examples – starting page 87

Entity examples – starting page 92

- PGE
- PacifiCorp
- Seattle City
- Kansas City
- Crown Castle

Current Regulations

National Electrical Safety Code (NESC) Rules

There are currently no NESC requirements related to wireless antenna signage. All NESC references to required signage defer to ANSI Standard requirements.

Rule 411D - Signs and tags for employee safety

Safety signs and tags required by Part 4, when installed or replaced, shall comply with the provisions of the current editions of ANSI Z535.1 through ANSI Z535.5, inclusive.

American National Standards Institute (ANSI)

ANSI Standard Section Z535 sets basic standards for occupational signage (color, size, minimum information, wording [caution, warning, notice, etc.]). However, there are no specific standards for wireless antenna signs. There is a general RF Hazard sign available, which is shown in the Signage Examples section of this manual.

Federal Communications Commission (FCC)

What is the FCC's Policy on Radiofrequency Warning Signs? For Example, when should signs be posted, where should they be located, and what should they say?

Radiofrequency warning or alerting signs should be used to provide information on the presence of RF radiation or to control exposure to RF radiation within a given area. Standard radiofrequency hazard warning signs are commercially available from several vendors. Appropriate signs should incorporate the format recommended by the Institute for Electrical and Electronics Engineers (IEEE) and as specified in the IEEE standard: IEEE Std C95.2-1999 (Web address: http://www.ieee.org). Guidance concerning the placement of signs can be found in the IEEE Standard: IEEE Std C95.7-2005 (available for free through the IEEE Get Program). When signs are used, meaningful information should be placed on the sign advising affected persons of: (1) the nature of the potential hazard (i.e., high RF fields), (2) how to avoid the potential hazard, and (3) whom to contact for additional information. In some cases, it may be appropriate to also provide instructions to direct individuals as to how to work safely in the RF environment of concern. Signs should be located prominently in areas that will be readily seen by those persons who may have access to an area where high RF fields are present.

Institute of Electrical and Electronics Engineers (IEEE)
IEEE has a Local Area Network Standards Committee referred to as IEEE 802 (based on the section number of the IEEE Standards related to wireless networks), which has several working groups. IEEE 802 develops and maintains networking standards and recommended practices for local, metropolitan, and other area networks. Currently, the IEEE 802 family of standards consists of 71 published standards with 54 under development. IEEE 802 coordinates with other national and international standards bodies, including ISO and for this reason, has not adopted its own independent standards related to wireless signage.

International Organization for Standardization (ISO)
ISO Standard Section 7010 sets technical standards for graphical hazard symbols on hazard and safety signs. However, there are no specific standards for wireless antenna signs.

Signage Examples - Public and Worker Notices

Figure 9.13 - ANSI General Notice

Figure 9.14 - Customized Worker "May Exceed" Notice

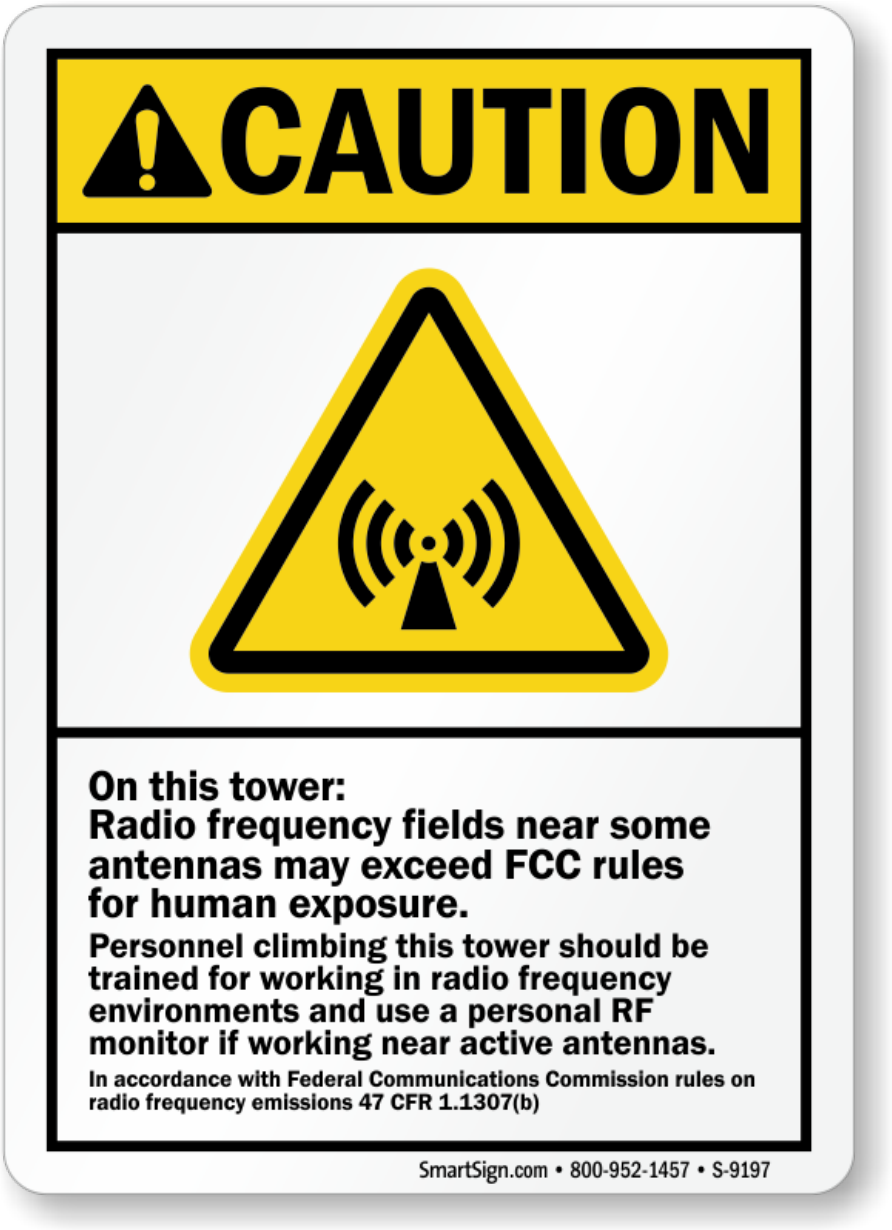


Figure 9.15 - Customized Public "May Exceed" Notices

Figure 9.16 - Customized Public "Excessive RF" Notices

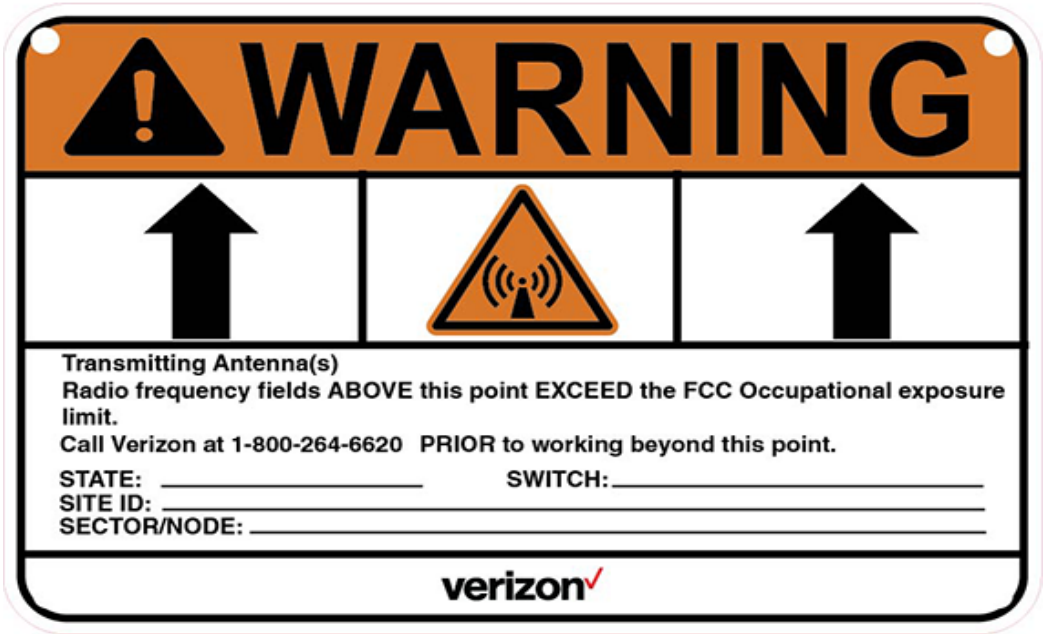


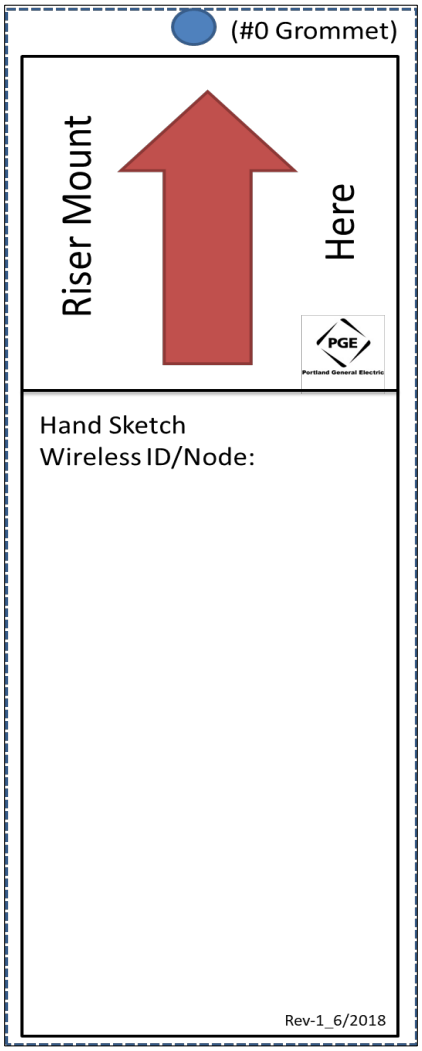
Figure 9.17 - Examples of Installed Signage

Entity-Specific Standards Examples

PGE Wireless Signage Standards

No signage is required for PGE-owned weather stations; there is no harmful RF.
The image below shows a weather-resistant sticker made to attach to the front of the equipment box.

The Riser Mount sticker below is used in the case of…



PacifiCorp Construction Standard Requirements

Requester shall clearly and conspicuously post signs indicating:

- Safe working distance (approach distances) from the device
- Contact information for field workers, including information for temporary disabling of antenna at the site.

At PacifiCorp's request, the telecommunications company shall provide a sign affixed to the pole nearest the shutoff box reading "High Energy Field—RF Monitors Must Be Worn."

Seattle City Requirements:

E5. Radio Frequency (RF) equipment disconnect and warning labels on the poles

E5a. The small wireless facility shall comply with applicable federal laws, rules, regulations, and standards regarding radio frequency exposure.

E5b. Radio frequency equipment shall have a disconnect that meets or exceeds the pole owner's requirements.

E5c. If required, radio frequency warning labels shall be mounted to the exterior of the small wireless facility. Labels shall be placed facing toward the street and away from the adjacent buildings and windows, and located on or near the site disconnect. Labels shall contain a site identification number, carrier name, and emergency phone number.

E5d. Signage and warning stickers shall be no larger than 5 inches by 7 inches (or as otherwise required by applicable Federal, State, or local laws). Other signs, logos, or advertising devices are prohibited, except for certification and warning signage required by law or allowed by the city.

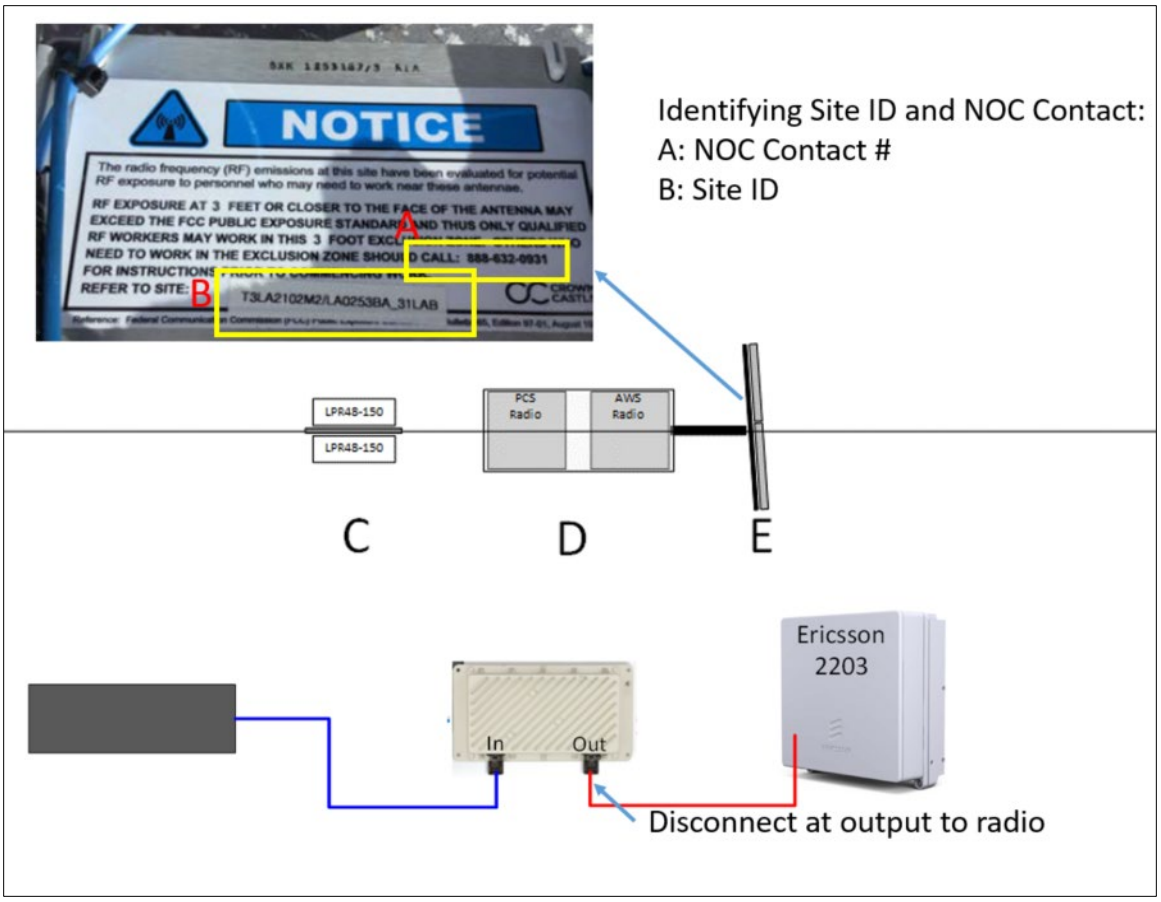
Kansas City Requirements:

STICKERS Any on-pole cabinet and ground mounted utility box should be labeled with (1) a RF warning sticker, background to match pole color, no larger than 4 x 6 inches, and facing the street near the elevation of the antennae, (2) a 4-inch by 6-inch (maximum) plate with the provider's name, location identifying information, and 24-hour emergency telephone number, and (3) no advertising, logos, or decals.

Crown Castle Strand Mount Requirements:

Emergency Shutoff Procedure

1) Contact Crown Castle National Operations Center (NOC) at
   a) 888-632-0931 (see Appendix A)
2) Identify and provide Site ID (see Appendix A to identify ID)
   a) Provide estimated down time
3) Proceed with steps to identify and disconnect power at DC down convert (See Illustration A)
4) When work is completed contact NOC and notify of completed
5) Connect & Secure power cables back onto DC down converters



Crown will implement a tagging system on strand mount equipment for new deployments moving forward to help line workers identify which power source the node is connected to. Crown will add a label next to the EME signage located behind the antenna plate to display the Power Source ID and Pole ID on the strand mount installation. Additionally, Crown will add a label to existing equipment as operations visits sites for maintenance and outages.

Jurisdictional Requirements

Disclaimer: For your convenience, OJUA is providing the following links to certain local governmental wireless communications facilities co-location standards, land use regulations, and ordinances ("wireless permitting requirements"). However, the responsibility to determine the appropriate jurisdiction for a proposed wireless communications facility, as well as compliance with that jurisdiction's wireless permitting requirements (including any changes to wireless permitting requirements implemented after the publication of this OJUA standards manual), are and will remain with the applicant for the wireless communications facility. OJUA makes no representations with regard to the completeness of the information contained in the following links, nor shall OJUA bear any responsibility for an applicant's failure to comply with the wireless permitting requirements of the applicable jurisdiction.

For additional information, click the links below to be directed to specific city resources:

City of Gresham (Section 10.0600)

City of Portland

City of Salem

City of Happy Valley (Chapter 16.44.020)

City of Eugene (specific for ROW wireless sites)

City of Tualatin (Chapter 73F) Municode Library

City of Tualatin Cell Towers and Wireless Communication Facilities

.

Chapter 10 - 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

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

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

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

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

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

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

Raise Other
Raise Power
Raise Secondary
Raise Telco
Refer to Engineering
Relocate/Move
Remove
Repair
Replace
Re-Tension
Shorten
Tighten
Transfer
Trim