GUIDE FOR THE APPLICATION OF CLEARANCE REQUIREMENTS ON JOINT-USE POLES

Distribution Subcommittee
Overhead Work Group

TDEC

Transmission and Distribution Engineering Committee

May 2025

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FIGURES

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ABBREVIATIONS

5G	Fifth Generation Wireless Technology
ACSR	Aluminum Conductor, Steel-Reinforced
ADSS	All Dielectric Self-Supporting Fiber-Optic Cable
ANSI	American National Standards Institute
AMI	Advanced Metering Infrastructure
CATV	Community Antenna Television or Cable TV
CFR	Code of Federal Regulations
DNA	Deoxyribonucleic Acid
DPX	Duplex
DTHL	Design Tension Heavy Loading
EQ	Equation
FCC	Federal Communications Commission
IEEE	Institute of Electrical and Electronics Engineers
MAD	Minimum Approach Distance
NEC	National Electric Code
NESC	National Electrical Safety Code
OSHA	Occupational Safety and Health Administration
OET	Office of Engineering and Technology of the FCC
PUC	Public Utility Commission
QPX	Quadruplex
RF	Radio Frequency
RUS	Rural Utilities Service
SCADA	Supervisory Control and Data Acquisition
TPX	Triplex

UNITS OF MEASURE

in	inch or inches (1 inch = 2.54 centimeters = 0.0254 meters)
in-lb	inch-pounds (inch × pounds) (1 inch-pound = 0.370685 newtons)
ft	foot or feet (1 foot = 0.3048 meters)
ft-lb	foot-pounds (feet × pounds) (1 foot-pound = 4.448222 newtons)
lb-ft^2	pounds per square foot
kcmil	1,000 circular mils (1 kcmil = 5.067075 × 10^{-6} square meters)
kV	kilovolts (1 kilovolt = 1,000 volts)
MPH	miles per hour
mW/cm^2	milliwatts per square centimeter
kHz	kilohertz, a measure of frequency (1,000 Hertz or 1,000 cycles per second)
GHz	gigahertz, a measure of frequency (1 × 10^9 hertz or 1 billion cycles per second)

CONTRIBUTORS

The Distribution Subcommittee Overhead Work Group of the Transmission and Distribution Engineering Committee (TDEC) provided invaluable assistance in preparing this document.

DISCLAIMER

This guide is meant to provide a general clearance requirements on joint-use poles While every effort has been made to ensure that this document adheres to the current version of the National Electric Safety Code (NESC, currently 2023), users of this guide should always verify independently of this document that they are meeting all requirements of the current NESC and/or any other codes or requirements that may be applicable to said user.

The TDEC assumes no legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information contained in this guide. Reference herein to any specific commercial product, process, or service by trademark, name, manufacturer, or other designation does not necessarily constitute or imply endorsement, recommendation, or favoring of same by the TDEC.

Although references included in this document were accurate at the time of publication, there is no guarantee of future applicability.

INTRODUCTION

Purpose and Scope of the Guide

This user-friendly guide was developed to aid cooperative engineers, cooperative joint use coordinators, and the telecommunication companies. This guide will assist in the understanding of how to attach to cooperative's poles and to understand the proper spacings and clearances for conductors and equipment on joint-use poles as required by the National Electric Safety Code (NESC) and OSHA. References to rule numbers and/or table numbers are provided throughout the document to allow the user quick reference to the specific wording used in the NESC.

This guide addresses neither the calculation of pole rental-agreement rates nor the language of joint-use contracts which may address responsibilities and actions of the various parties to the contract. There are many reasons to forbid other parties to place cables, antennas, and other equipment in the supply space. The decision to allow communication cables and/or antennas not owned by the electric utility in the supply space is outside the scope of this guide. However, if the decision is made to permit this type of construction, this guide addresses the safety concerns (RF exposure) and NESC spacing requirements.

This guide also only addresses common RUS distribution assemblies and does not cover clearances to transmission lines, trolley lines, or spacer cables.

National Electrical Safety Code

Throughout this guide are references to rules and select data contained specifically in the 2023 Edition of the National Electrical Safety Code (NESC). The NESC is published by the Institute of Electrical and Electronics Engineers, Inc. (IEEE). At the time this guide was written, the 2023 Edition was the latest edition of the NESC. Users of this guide are strongly advised to reference the appropriate rules for complete wording and other possible exceptions not mentioned herein. The NESC is updated and revised, typically on a 5-year cycle. As such, the user should reference the actual wording of the rules as they may be revised and renumbered from the current edition of the NESC.

Other Relevant Standards and Regulations

Other standards or regulations referred to in the document were current at the time this guide was written. Users of this guide are advised to refer to the appropriate rules for complete wording and other possible exceptions not mentioned herein.

WORKER SAFETY

Communication Space and Supply Space

Often a pole supports both electric cooperative lines and communication lines, as well as equipment. The electric cooperative's lines and equipment are referred to as supply facilities (reference the NESC definition for Electric Supply Equipment). Communication lines and equipment are defined as equipment that produces, modifies, regulates, or controls communication signals. This equipment can be used by communication companies and can also be used by electric cooperatives for communication with downline devices such as Advanced Metering Infrastructure (AMI) meters, recloser controls, Supervisory Control and Data Acquisition systems (SCADA), and voltage regulator controls.

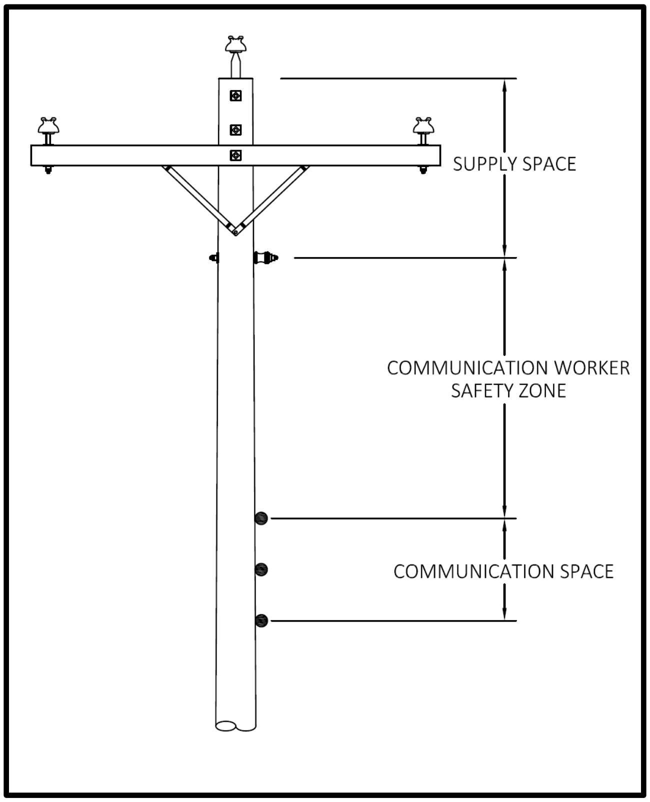

Figure 1: Supply and Communication Space

Communication companies employ individuals to install, maintain, and operate their equipment who are qualified for those tasks. However, these individuals typically are not qualified to work on electric supply lines and equipment. To provide protection for these communication workers, the NESC defines a communication space[1] and a supply space. The communication space extends from the highest communication conductor in the communication space down to the lowest communication attachments. Above the communication space is the Communication Worker Safety Zone, which is defined in NESC Rules 235C4 and 238E. Generally speaking, the Communication Worker Safety Zone starts above the communication space and extends up the pole 40 inches. The supply space is above the Communication Worker Safety Zone. This concept is shown in Figure 1.

Qualified Workers

Only qualified workers are permitted to ascend into the supply space. These are typically electric utility lineworkers. The NESC (Rule 224A1) does allow personnel to work on communication lines in the supply space, but only if these individuals are authorized and qualified to work in the supply space. To be qualified, the individuals must meet the requirements of the work rules contained in NESC Sections 42 and 44. OSHA 1920.269 defines a qualified worker as one who completed the training required by 1910.269(a)(2)(ii). This training includes being able to distinguish exposed live parts from other parts of electric equipment, the ability to determine nominal voltage of exposed live parts, understanding the minimum approach distance and skills to maintain those distances, the skills required for working on or near exposed energized parts, and the recognition of electrical hazards.

[1] Communication Space is the space on joint-use structures where communication facilities are separated from the supply space by the Communication Workers Safety Zone per Section 3 of the NESC.

A qualified worker is one who can recognize the hazards on the pole. One such hazard is the operating voltage of the lines and equipment. The Minimum Approach Distance (MAD) as shown in NESC Table 441-1 and Table 431-1 requires the worker to know the operating voltage. This can be difficult to explain when #2 ACSR, when used as a neutral conductor, operates at zero volts. However, this same conductor can be operated at 14,400 volts as a primary conductor. NESC Rule 431A requires that no communication worker approach or bring a conductive object within the minimum approach distances shown in Table 431-1. Thus, to meet these safety requirements, the NESC provides a Communication Worker Safety Zone to allow space for communication workers to safely work in the communication space.

In addition, NESC Rule 420C3 requires employees who are not required to approach or handle electric equipment and lines to stay clear of such lines.

Generally speaking, the 40-inch space permits a communication worker to access the communication lines in the communication space via an aerial lift or ladder. With the communication conductor at the worker's breastbone, there is sufficient space for the worker to perform tasks without violating the minimum approach distance. This is illustrated in Figure 2.

Only a few supply-space items are allowed in the Communication Worker Safety Zone. These include the following;

1. Supply cables guarded by conduit or U-guard (NESC Rule 239)
2. Effectively grounded street light arms/supports (NESC Rule 238C)
3. Drip loops to effectively grounded street lights/supports (NESC Rule 238D)
4. Switch handles for Gang-Operated Air Break (GOAB) Switches (NESC Rule 239I)

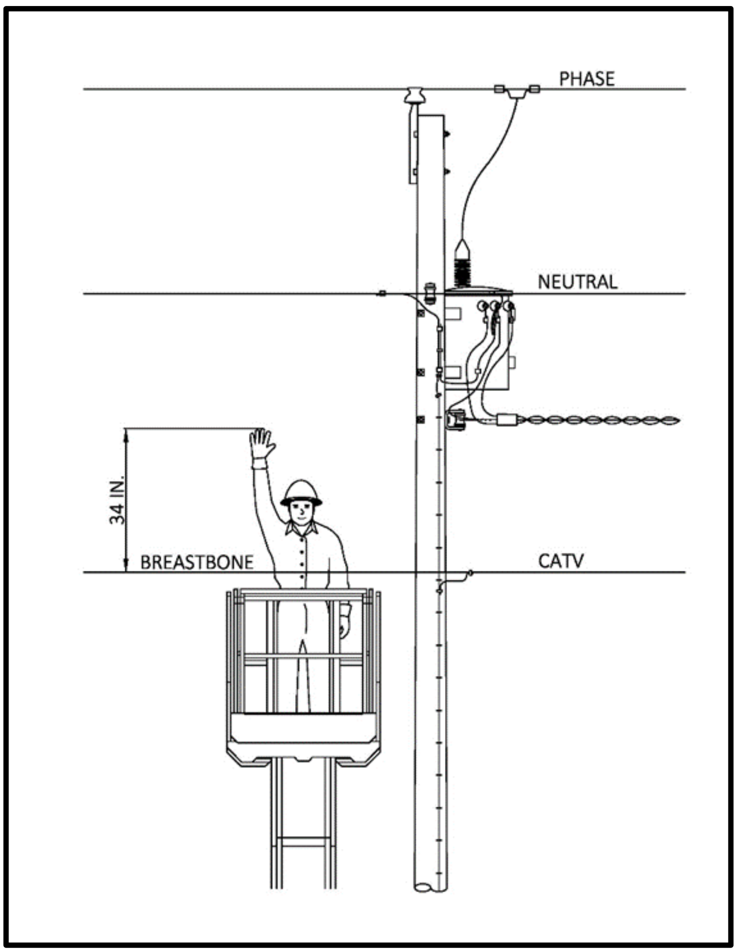

Figure 2: Working Space for Communication Workers

Antenna Radiation

Nonionizing radiation from wireless technologies can present a hazard to workers. Cellphones and other wireless devices emit radio frequency (RF) energy waves. RF energy is one type of nonionizing radiation. The RF energy waves from cellphones and other electronic devices is not strong enough to affect the structure of atoms or damage deoxyribonucleic acid (DNA). However, nonionizing radiation does cause atoms to vibrate, causing an increase in temperature. For example, nonionizing radiation is used in microwave ovens to heat food. RF energy can be dangerous at very high levels like those found near certain equipment that uses powerful long-distance transmitters.

The Federal Communications Commission (FCC) has standards for antennas that produce RF energy waves. The FCC defines two classes of exposure limits:

1. Occupational/Controlled limits, and
2. General Population/Uncontrolled limits (cell phones).

Reference Federal Communications Commission Office of Engineering and Technology (FCC OET) Bulletin 65 for more information regarding these exposure categories. OSHA Rule 1910.97, Nonionizing Radiation, provides the radiation protection guide of 10 mW/cm^2 as the average exposure level permissible over any possible 0.1 hour (6 minute) period.

Antennas that meet the FCC's General Population/Uncontrolled maximum permissible exposure limits do not require specialized clothing or specialized work rules. These types of antennas would include cell phones and low-powered radios used for AMI mesh network systems. Other antennas classified with Occupational/Controlled exposure limits that exceed the radiation protection guide set forth in OSHA 1910.97 do pose a hazard for workers and require additional precautions.

NESC Rule 410A6 requires employers to provide training to all employees who work in the vicinity of antennas operating in the range of 3 kHz to 300 GHz to recognize and mitigate exposure levels set forth by the regulatory authority having jurisdiction. In addition, NESC Rule 420Q requires employees working in the vicinity of antennas operating in the range of 3 kHz to 300 GHz to use controls to mitigate exposure to radio frequency sources that exceed permissible exposure levels at the work station.

A common method to control exposure to nonionizing radiation is to disconnect the power to the antenna when working in the vicinity of the antenna. OSHA 1910.97 requires signage (see Figure 3) near the location of the antennas indicating if the RF energy levels exceed permissible exposure levels. OSHA 1910.145, Specification for Accident Prevention Signs and Tags, also provides signage requirements. In California, the Public Utilities Commission requires certain antennas to indicate RF energy levels.

Figure 3: Example Signs for Radio Frequency Radiation

GROUNDING OF COMMUNICATION LINES AND EQUIPMENT

Effectively Grounded Neutral Conductor

Most electric cooperatives operate a wye grounded system which has a multiground neutral. In general, the neutral must be connected to ground rods (or other made electrodes) four times per mile excluding customer grounds. A neutral is considered an effectively grounded neutral conductor if it is connected to the source transformer neutral and has not less than four grounds in each mile of line (reference NESC Rule 096C). The RUS construction specifications also require the neutral to be intentionally connected to ground four times each mile. Note that butt plates and butt wraps are not considered a made electrode and generally cannot be used for meeting the four grounds per mile minimum specification unless the soil resistivity is very low (reference NESC Rule 094C3).

Communication Messengers Supporting Communication Cables

Often, communication companies use a metallic messenger to support communication cables which are lashed to this messenger. The size of the messenger is determined by the communication company based on the strength and tension required to support the weight of the communication cable along with ice and wind loading per NESC Rule 250C. This messenger is required by NESC Rule 092C1 to be grounded four times per mile. In some cases, the messenger is so small that the NESC will require eight grounds per mile (Reference NESC Rule 092C1b).

Shared Grounding Conductor

When electric cooperatives install an H1.1 pole ground, the conductor that connects the neutral to the ground rod is referred to as the grounding conductor. The communication messenger should be bonded to the electric cooperative's grounding conductor to meet NESC Rule 092C1 which requires the messenger to have four connections to ground in a mile. Butt plates and butt wraps are not considered a made electrode and generally cannot be used for meeting the four grounds per mile minimum. Because the communication worker does not know if the grounding conductor connects to a ground rod, a butt plate, or a butt wrap, the communication messenger should be bonded to each grounding conductor as shown in Figure 4.

Further, NESC Rule 097G specifically requires that, on joint-use poles with a single grounding conductor, both systems must be connected to the grounding conductor. If separate grounding conductors are used, this rule also requires the grounding conductors to be bonded to each other.

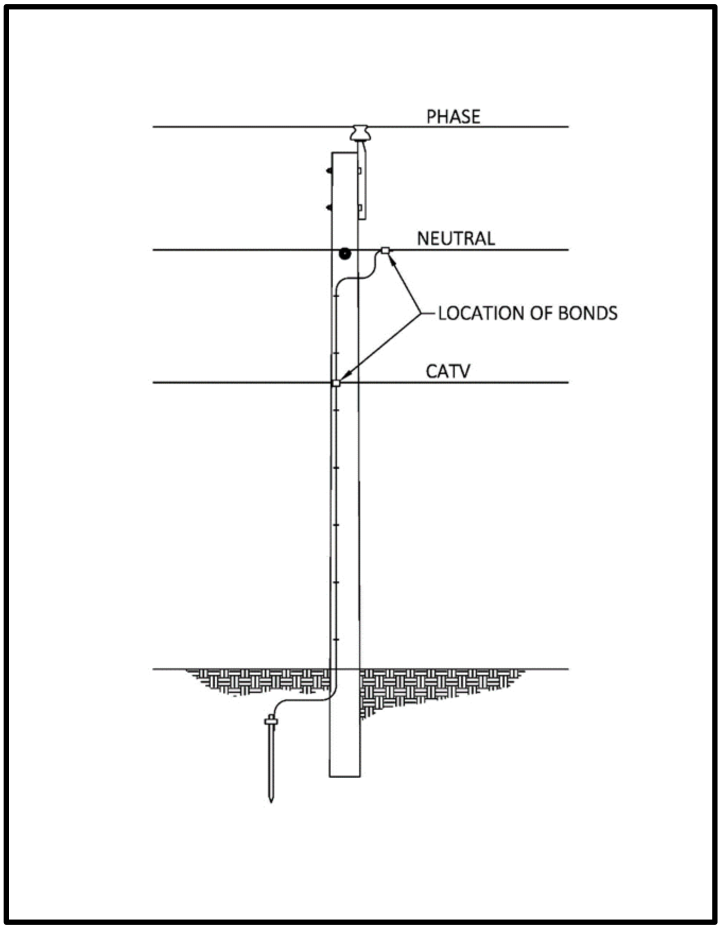

Figure 4: Common Bonding on the Pole

Separate Grounding Conductor for Communication

It is rare for the communication company to have a separate grounding conductor and separate made electrodes from the electric cooperative, despite being permitted by the NESC. In the past, copper telephone lines could experience noisy harmonics when bonded to an electric cooperative's system neutral. At that time, the telephone company would install a separate ground. In today's communication environment, this solution is rarely needed. If it is employed, all parties must recognize that the two different grounding conductors will be at different voltages and can present a hazard to the public and employees. As such, one of these grounding conductors must be insulated for 600 volts. Reference NESC Rule 097 for details.

Grounding Communication Messenger on Crossing Structure

In accordance with NESC Rule 092C3b, messengers at common crossing structures are required to be grounded and bonded with other messengers, neutrals, and guys as shown in Figure 5. The need for bonding stems from the possibility that the communication messenger is not bonded to the system neutral. If a phase conductor falls on the communication messenger, there may not be a low impedance fault for the circuit protective device to sense the presence of fault current and disconnect the faulted line.

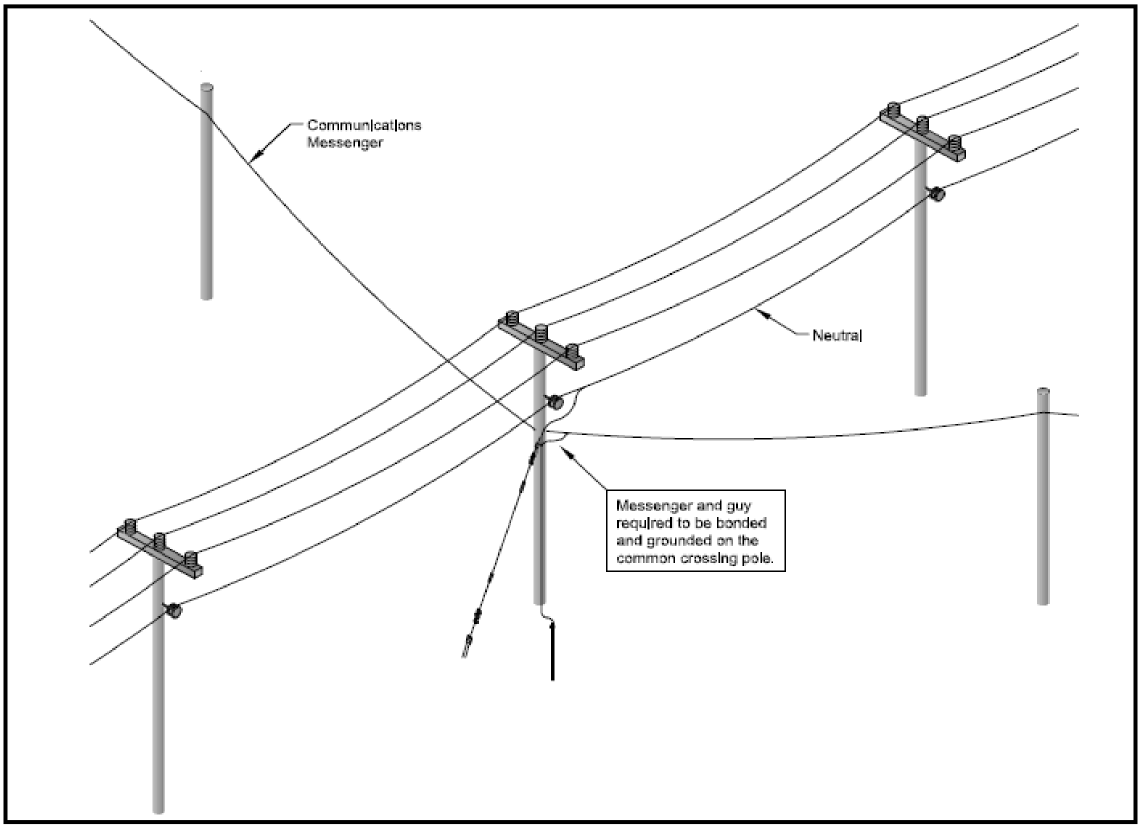

Figure 5: Grounding Communication at Crossing Structure

Grounding of Communication Equipment

Communication equipment must be effectively grounded as required by NESC Rule 215C1. Generally, this is accomplished by bonding the equipment case to an effectively grounded neutral conductor by means of the grounding conductor on the pole. This common bonding assures all the equipment, neutrals, messengers, and—in many cases—the guys, are bonded together at the pole, giving all of these components the same voltage potential. This protects all workers on the poles.

Grounding of Communication Guys

NESC Rule 215C2 requires all anchor guys to be effectively grounded. Generally, this is accomplished by bonding the communication guy to an effectively grounded neutral conductor by means of the grounding conductor on the pole or to an effectively grounded communication messenger. The rules allow communication guys to be insulated but this is rarely the case in practice.

Common Bonding of Communication Service and Electric Supply Service

The National Electrical Code (NEC) generally requires a single-point grounded system at a home or business. Therefore, a made electrode, such as a ground rod, is installed at or near the main disconnect of the service. To avoid differences of voltage between communication lines and supply lines inside homes and businesses, the NESC and NEC both require bonding of the communication service to the electric supply service ground. NESC Rule 099C requires this bonding to be accomplished using a conductor no smaller than #6 copper, as shown in Figure 6. NEC Article 800-100(D) has similar requirements. If these systems are not bonded together, it is common for lightning-induced voltage surges to damage appliances that are connected to both communication lines and electric supply lines.

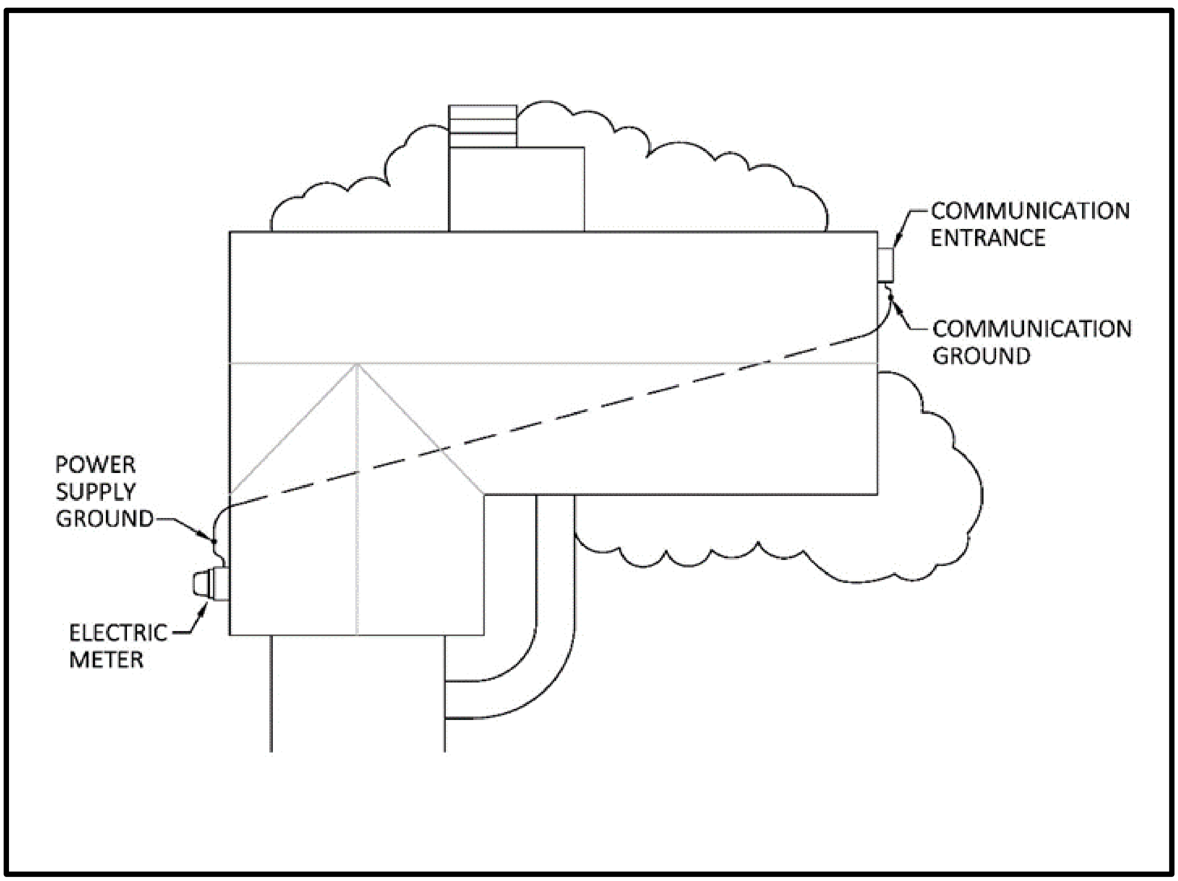

Figure 6: Common Bonding in a Home

Communication Protective Requirements

There may be times when communication equipment is located on or near transmission structures or near substations where large ground currents may flow. NESC Rule 223A suggests that these locations may need additional protection from lightning, transient rise in ground potential, and induced voltage. Ground potential rise should be evaluated and mitigated to an acceptable level. Additional information may be obtained from IEEE Standard 487, IEEE Standard for the Electrical Protection of Communications Facilities Serving Electric Supply Locations—General Considerations, and IEEE Standard 1590, IEEE Recommended Practice for the Electrical Protection of Optical Fiber Communication Facilities Serving, or Connected to, Electrical Supply Locations.

CLEARANCE OF COMMUNICATION CONDUCTORS AND EQUIPMENT ABOVE GROUND

Vertical Clearance Above Ground to Protect the Public

Ground Clearance is critical for the health, safety, and welfare of the general public as well as utility workers. Maintaining a safe distance above ground prevents the public from contacting electric supply lines and communication lines. When the communication line is the lowest conductor on a joint-use pole, maintaining a safe ground clearance should prevent contact by moving vehicles, which can possibly cause the entire structure—including the electric supply lines—to fall to the ground.

The vertical height above ground is determined based on the anticipated activity below the line.[2] The vertical clearance for communication lines, whether installed in the communication space or the supply space, is the same clearance as required for a multigrounded system neutral as defined by NESC Rule 230E1.

Communication Conductor Sags

Per NESC Rule 232A, the vertical clearance above ground needs to be maintained with the communication messenger/conductor at 120°F with no wind displacement, and when covered in ice for the Loading Zone defined in NESC Table 230-1. The Loading Zones (Zone 1, 2, 3, and 4) generally correspond to Heavy, Medium, Light, and Warm Island Loading Districts. These loading requirements on the conductors are often referred to as the largest final sag of the cable. The amount of sag will depend on the type of messenger, weight of the cables lashed, the initial tension of the messenger, as well as other factors. The communication cable owner is responsible to provide final sag data to the pole owner, upon request.

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[2] National Electric Safety Code, Appendix A, contains a detailed discussion regarding activities below communication and supply lines.

Vertical Ground Clearance Requirements

NESC Table 232-1 provides the vertical clearances above ground at the largest final sag for communication lines. In this table, communication lines are listed in the second column and described as insulated communication conductors and cables and messengers. It is rare to find noninsulated communication conductors, but the clearances of noninsulated communication cables are in the third column and have the same vertical clearance above ground as triplex secondary supply cables operating below 750 volts.

On joint use poles the common vertical clearance of communication cables are summarized in Table 1. There are exceptions in the NESC for communication cable service drops that are not covered by this guide.

Table 1: Vertical Clearance Over Land for Insulated Communication Cables, Fiber-Optic Cables, and Messengers

Activity Below the Communication Cables	Vertical Clearance at Largest Final Sag
Roads, streets, and other areas subject to truck traffic	15.5 feet
Other areas traversed by vehicles such as cultivated, grazing, forest, and orchard lands	15.5 feet
Spaces and ways subject to pedestrians	9.5 feet
Along roads where it is unlikely that vehicles will be crossing under the line	13.5 feet
Along a road located relative to fences, ditches, embankments, or other terrain features so that the ground under the line would not be expected to be traveled except by pedestrians	9.5 feet
Reference NESC Table 232-1 for details and exceptions	

Vertical Ground Clearance for Communication Equipment

NESC Table 232-2 provides the required vertical clearance for communication equipment above ground. In general, the table calls for an effectively grounded equipment case to be 15 feet above ground. In some instances, the clearance can be 13 feet or 9.5 feet depending upon the activity under the equipment. An important exception allowed in this NESC rule occurs in areas where the equipment is not above roadways and allows effectively grounded supply or communication equipment (such as control boxes, communication terminals, meters, or similar equipment cases) to be mounted at a lower level for accessibility, provided such cases do not unduly obstruct a walkway (Footnote 7 of NESC Table 232-2).

COMMUNICATION CABLES IN THE COMMUNICATION SPACE

This section address clearances for communication cables in the communication space. This section will apply to the communication cables including:

1. Communication conductors (insulated cables or fiber-optic cables) lashed to effectively grounded metallic messengers,
2. CATV cables with a metallic sheath and insulated covering lashed to an effectively grounded metallic messenger, and
3. Cable that is entirely dielectric, such as fiber-optic cable that is entirely dielectric, for example ADSS (All Dielectric Self-Supporting) cable. Reference NESC Rule 230F1.

The figure in Appendix A provides a visual summary of the clearances that apply to communication cables in the communication space.

Other sections of this guide address communication cables in the supply space and antennas in the supply space.

Generally, it is expected as a good work practice that all communication cables be installed on the same side of the pole as the neutral conductor attachment for the parallel electrical circuit, the intent being prevention of "boxing" in the pole as shown in Figure 7. Boxing a pole creates difficultly in future pole replacement as the new pole can no longer be installed from the side without cable attachments.

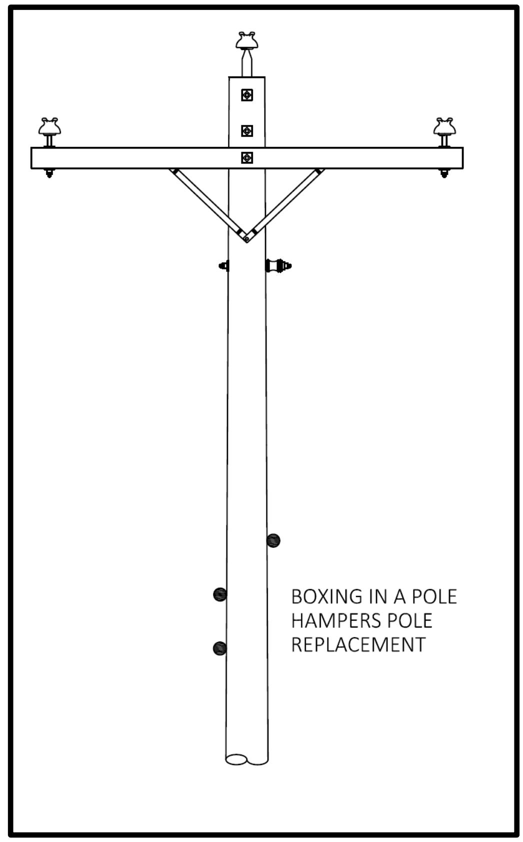

Figure 7: Boxing in a Pole

Vertical Separation at the Pole

As previously discussed, there is a Communication Worker Safety Zone which is defined in part by the NESC Rules that address vertical clearance at the pole. Specifically, NESC Rule 235C requires conductors and cables located at different levels on the same pole to have vertical clearances, as shown in NESC Table 235-5.

For communication cables in the communication space, the vertical clearance to other conductors is summarized in Table 2 below. More details and exceptions are contained in NESC Table 235-5.

Table 2: Vertical Clearance at the Pole for Communication Cables in the Communication Space

Lines and Cables in the Supply Space					
Multi-grounded Neutral Conductor	Fiber-Optic Cables on an effectively grounded messenger and entirely dielectric fiber-optic cable that meet NESC Rule 230F	Multiplex Cables with an effectively grounded bare neutral (DPX, TPX, QPX)	Open Supply Conductors operating 0 volts to 8.7 kV phase to ground (excludes neutral)	Open Supply Conductors operating over 8.7 kV to 50 kV (same utility)	Open Supply Conductors operating over 8.7 kV to 50 kV (different utilities)
40 inches*	40 inches*	40 inches	40 inches	40 inches	40 inches plus 0.4 inches per kV in excess of 8.7 kV

**In certain instances, this may be reduced to 30 inches per footnote 5 of NESC Table 235-5*
Reference NESC Table 235-5 for more details and exceptions

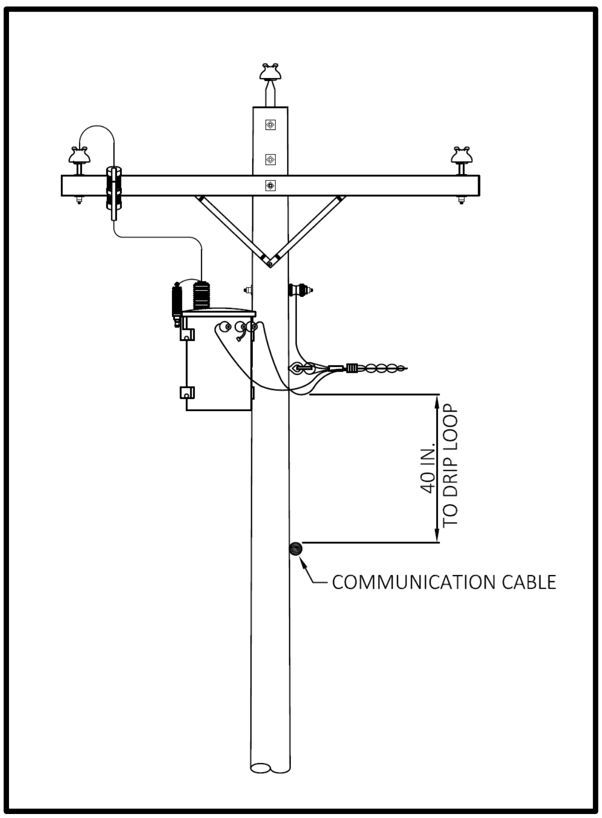

Figure 8: Clearance to Secondary Conductors

This rule is commonly referred to by communication workers as the "40-inch" rule. Although Table 235-5 allows for 30 inches between the neutral conductor and communication cable in the communication space, many electric utilities require 40 inches for this separation. Other utilities require greater separation to reserve space for future equipment to be attached to the pole.

The clearance between multiplex cables, such as triplex service cable, to communication cables in the communication space is 40 inches with no exceptions or reduction. Note also that this clearance is a surface-to-surface measurement and includes drip loops at transformers as shown in Figure 8.

If a fiber-optic supply cable with an effectively grounded messenger meeting NESC Rule 230F is installed in the supply space, the communication cables in the communication space need to maintain a minimum of 40 inches of vertical separation to the fiber-optic cable in the supply space, unless the situation meets the conditions in Footnote 5 of NESC Table 235-5 which allows for a 30-inch clearance.

The vertical separation for a 14.4/24.9 kV primary line to a communication cable is rounded up to 43 inches based on the equation provided for Different Utilities in Table 2.

The NESC Communication Workers Safety Zone typically does not provide adequate space for additional supply conductors, equipment, or appurtenances to be installed later. Care should be taken to require communication cable owners to install their cables in a designated communication space that will adequately provide supply space on the structure for the present and future.

One common practice is to require initial communication installations to be 80 or more inches below the lowest supply cable. Alternately, attachments can be authorized/licensed by a "ground up" measurement.

Additionally, some joint-use contracts require the attaching communication companies to pay for a taller pole when the electric utility needs to add more equipment.

Vertical Separation at the Service Pole or House

At a service drop to a customer, the communication service drop and supply cable service drop must be separated by 12 inches or more at any point in the span. The reduction to 12 inches is permitted by NESC Rule 235C1, Exception 3. Specifically, the supply cable service drop should be a triplex service drop and the communication cable and supply cable service drop must be separated at least 12 inches along the entire length of the service drop. The 40-inch clearance must be maintained on the take-off pole.

Service drops to poles adjacent to the take-off pole can present a clearance problem. Per NESC Table 235-6, a supply cable service drop must maintain 30 inches of clearance from the communication cables as the service cable drops down to the service pole. Reference Figure 9 for an example.

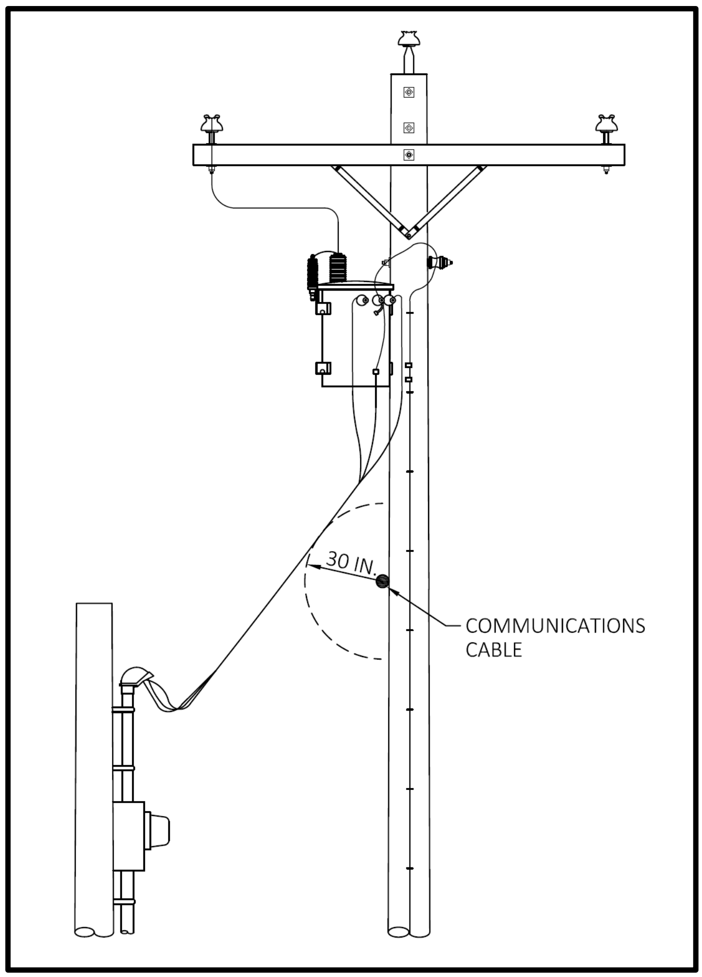

Figure 9: Separation from Lateral Conductor

Vertical Clearance Between Communication Cables in the Communication Space

NESC Rule 235H1 says that communication conductors in the communication space should have 12-inch spacing between communication cables (center-to-center measurement). Further, NESC Rule 235H2 states a clearance of 4 inches (surface-to-surface measurement) between conductors, cables, and communication equipment should be maintained, as shown in Figure 10. However, the separation can be reduced by agreement between parties involved, including the pole owner.

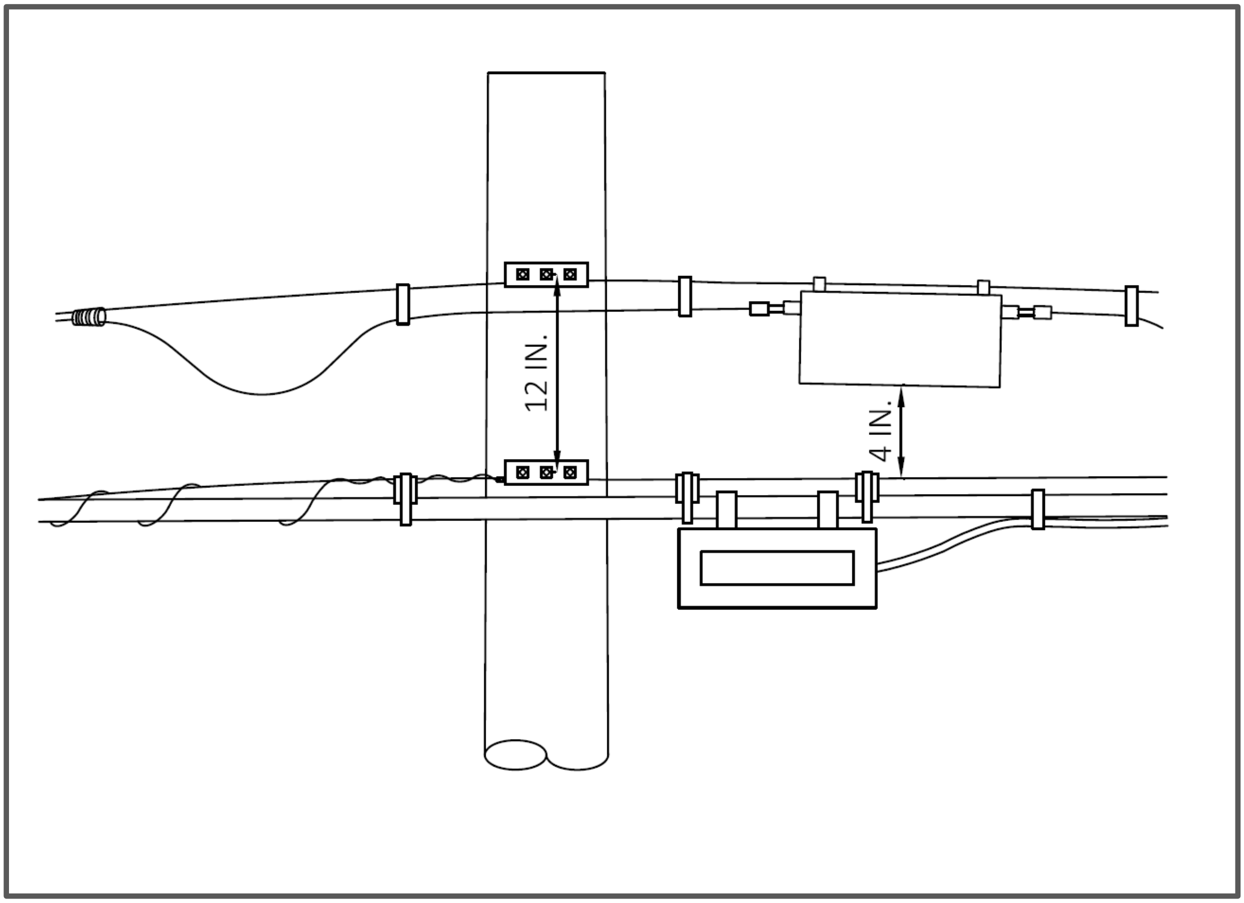

Figure 10: Spacing Between Communication Cables

Sag-Related Clearances

For wires, conductors, and cables supported at different levels on the same structure, NESC Rule 235C2b specifies the vertical clearances at the structure shall be adjusted if necessary such that clearance at any point in the adjacent span(s) shall not be less than 75% of that required at the supports as specified by Table 235-5 when voltages are less than 50 kV between conductors. There is an exception in the footnotes of NESC Table 235-5 for the separation of the multigrounded neutral conductor to a communication cable and certain fiber-optic cables installed in the supply space (see NESC Rule 230F). Table 3 summarizes the clearance at any point in the span between supply conductors and communication cables located in the communication space. Figure 11 illustrates some of the clearance requirements.

Table 3: Clearance at Any Point in the Span Between Supply Conductors and Communication Cables in the Communication Space

Cables in the Supply Space					
Multi-grounded Neutral Conductor	Fiber-optic cables on an effectively grounded messenger and entirely dielectric fiber-optic cable meeting NESC Rule 230F	Multiplex cables with an effectively grounded bare neutral (DPX, TPX, QPX)	Open supply conductors operating 0 volts to 8.7 kV phase to ground (excludes neutral)	Open supply conductors operating over 8.7 kV to 50 kV (same utility)	Open supply conductors operating over 8.7 kV to 50 kV (different utilities)
12 inches	12 inches	30 inches	30 inches	30 inches	75% of the total of 40 inches plus 0.4 inches per kV in excess of 8.7 kV

Reference NESC Rule 235C2b and Table 235-5 for more details and exceptions

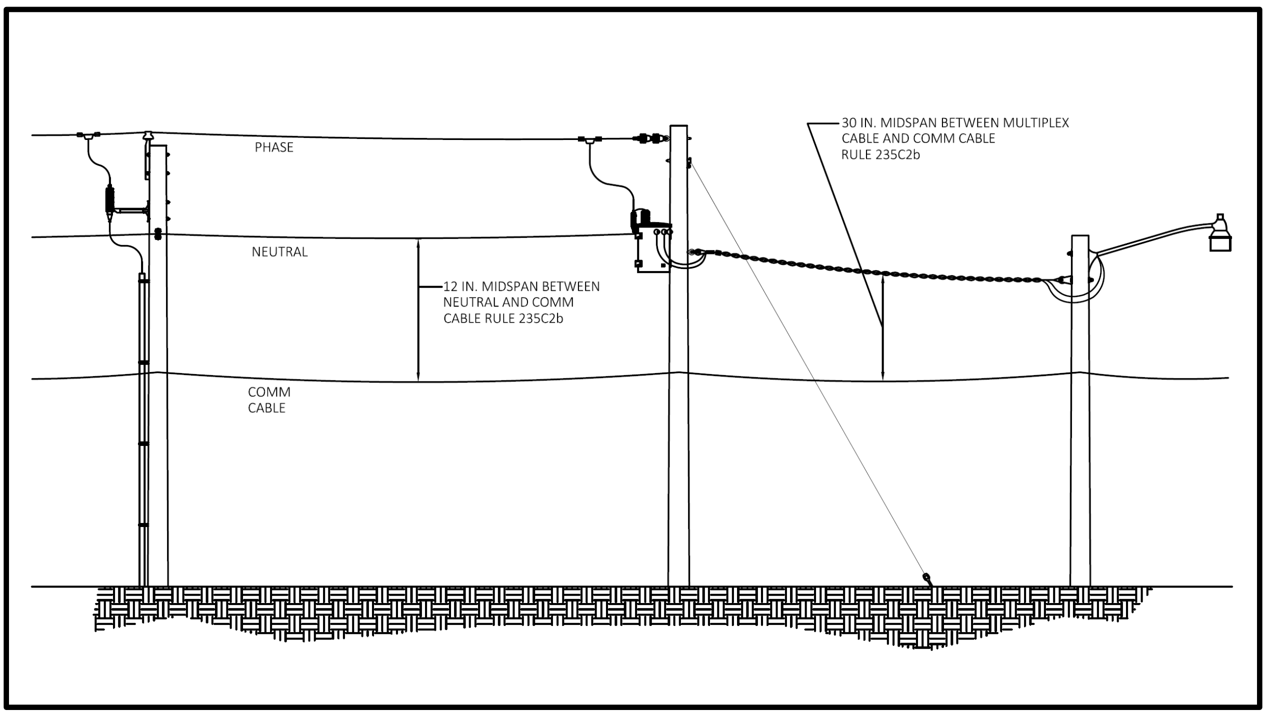

Figure 11: Clearance at Any Point in the Space Between Supply Conductors and Communication Cables in the Communication Space

The clearance at midspan is based on the concept of closest approach. NESC Rule 235C2c sets forth the parameters. These clearances must be maintained at final sag when the top conductor has ice loading but no wind, and the lower conductor is at the same ambient temperature of 32°F. The separation at midspan must also be maintained at final sag when the top conductor is at 120°F (or its maximum operating temperature) and the lower conductor is at the same ambient temperature as the upper conductor.

A common violation of this midspan requirement occurs when a duplex or triplex cable is installed from pole to pole with a communication cable in the communication space. If 40 inches of separation is used at the poles, it is difficult to maintain 30 inches at midspan. Often the solution is to have greater spacing at the poles.

Another sag-related clearance violation is addressed by NESC Rule 235C2b(3) which requires that the final sag of the primary conductors at 60°F should not cross a straight line between the communication cable attachment points. The concern is that if the communication cable had to be replaced or installed after the primary conductors are installed, the messenger would be initially installed in almost a straight line which could result in a contact between the messenger and the primary conductor.

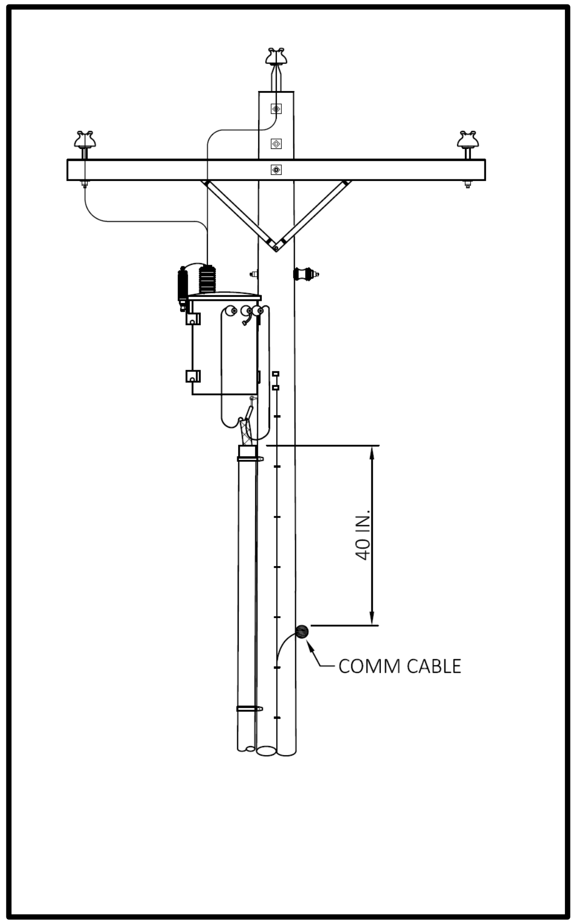

Figure 12: Secondary Conduit Clearance to Communication Cables

Clearances on Riser Poles

NESC Rule 239G provides guidance on the clearance for supply cables that pass through the communication space. This normally happens on riser poles and includes both primary and secondary risers. This rule requires that the vertical conductor(s) be guarded. This can be accomplished with plastic conduits, rigid metal conduits, or U-guard. However, regardless of the material guarding the conductors, the guarding should extend 40 inches above the highest communication attachment located in the communication space. The 40 inches applies to both secondary and primary cables as shown in Figures 12 and 13. Note that if the cables sag below the top of the conduit (i.e., drip loop), the 40-inch rule shown in Table 2 would apply to the lowest point of the cable.

Vertical Clearance to Equipment

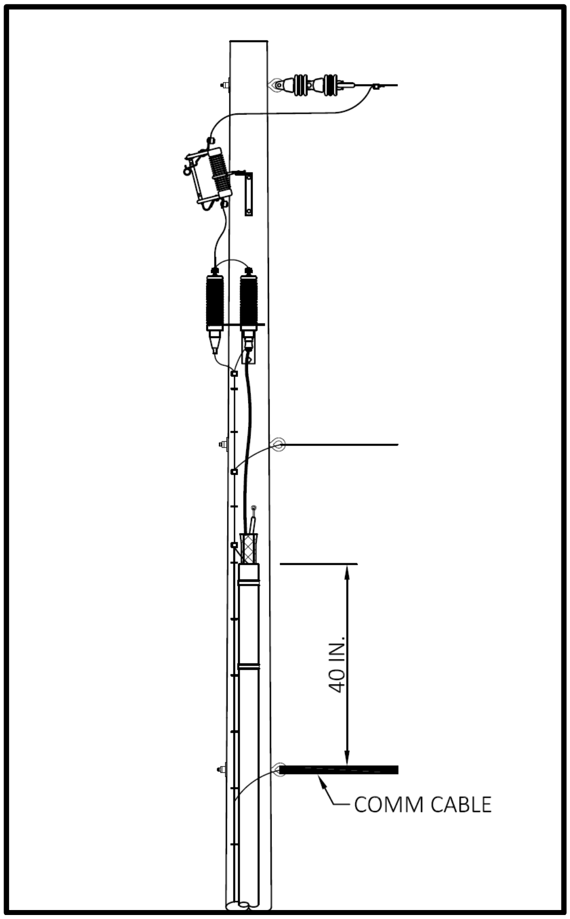

Figure 13: Primary Riser Clearance to Communication Cables

When communication and supply facilities are installed on the same supporting structure, NESC Rule 238 specifies vertical clearance requirements for communication lines to supply equipment and from supply conductors to communication equipment. Per NESC Rule 238A for determining these clearances, equipment is considered non-current-carrying metal parts—including metal supports for cables or conductors, metal support braces that are attached to metal supports, and metal or nonmetallic supports or braces associated with communication cables or conductors.

Vertical clearances between supply conductors and communication equipment, communication conductors and supply equipment, and between supply and communication equipment in the communication space are specified in NESC Table 238-1. If the communication facilities are installed in the supply space per NESC Rule 235C, they must meet the vertical clearances set forth in Table 235-5 which are similar to the clearances for a system neutral. Keep in mind that communication cables in the supply space can only be worked upon by qualified personnel/workers.

Assuming the supply equipment is effectively grounded (bonded to the system neutral) and the system neutral is bonded to the metallic messengers of communication conductors over a well-defined area (e.g., the entire county or the entire electric system), the vertical clearance is permitted to be 30 inches (Reference Table 238-1, Footnote 1). Effectively grounded supply equipment can include transformer tanks, regulator tanks, some recloser tanks, capacitor tanks, etc. Some equipment may not have a grounded case and, therefore, would need to maintain a 40-inch separation from communication conductors.

For span wires or brackets carrying luminaires, traffic signals, or trolley conductors, Table 238-2 specifies the vertical clearances from communication lines and equipment. This table was modified in 2017 to provide different clearances to effectively grounded street light arms (bonded to an effectively grounded system neutral). If the street light arm is effectively grounded, the vertical clearance is 4 inches; otherwise 40 inches must be maintained. Reference Figure 14 for examples. Although not specifically stated, a best practice for the bonding of the street light arm is an external bond.

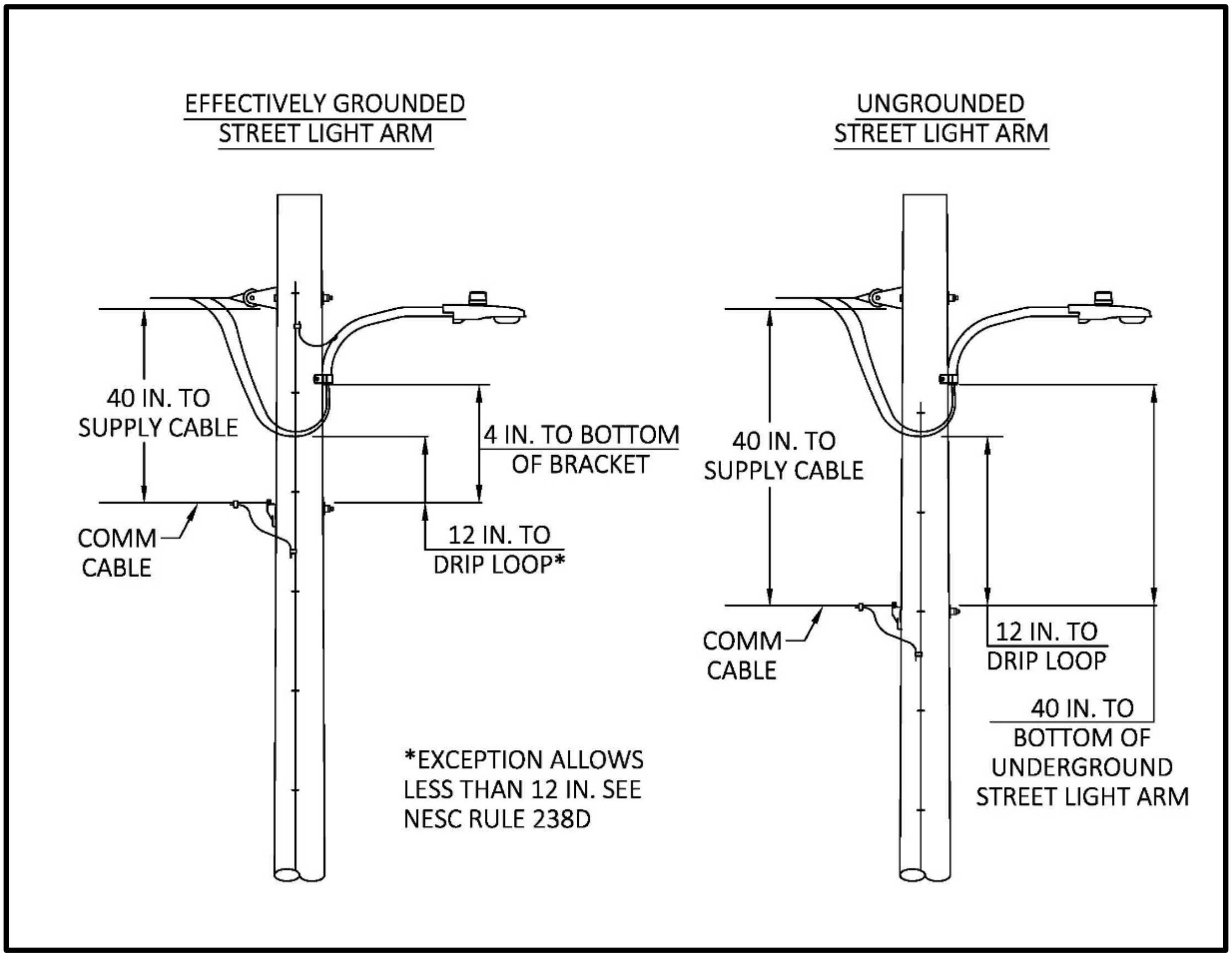

Figure 14: Clearance for Effectively Grounded and Ungrounded Street Light Arm

For drip loops associated with luminaires and traffic signals, the lowest point of the loop shall meet the requirements of NESC Rule 238D, which calls for a vertical clearance of 12 inches. Vertical clearance can be reduced to 3 inches if the loop is covered with a suitable nonmetallic covering that extends at least 2 inches beyond the loop.

Allowing street light equipment to be in the Communication Worker Safety Zone is a rare exception in the NESC.

Clearance between Communication Cables and Electric Cooperative Anchor Guys

It is necessary to maintain proper clearances between communication cables and an electric cooperative's anchor guy wires (also referred to as down guys). NESC Table 235-6 covers required clearances between communication cables and span or anchor guy wires. This table requires 6 inches of separation between an effectively grounded anchor guy wire and a communication cable on a joint-use pole as shown in Figure 15. If a guy insulator link is used, this clearance can be reduced by 25% to 4.5 inches, which—according to NESC Rule 018—should be rounded to 5 inches. For insulated guys[3] that pass within 12 inches of supply conductors and within 12 inches of communication cables, guy insulator links are required. Reference Table 235-6, Footnote 1, for further details.

COMMUNICATION CABLES IN THE SUPPLY SPACE

This section address clearances for communication cables in the supply space. This section will apply to the communication cables including:

1. Communication conductors (insulated cables or fiber-optic cables) lashed to effectively grounded metallic messengers, and
2. Cable that is entirely dielectric, such as fiber-optic supply cable that is entirely dielectric (ADSS cable, for example). Reference NESC Rule 230F1.

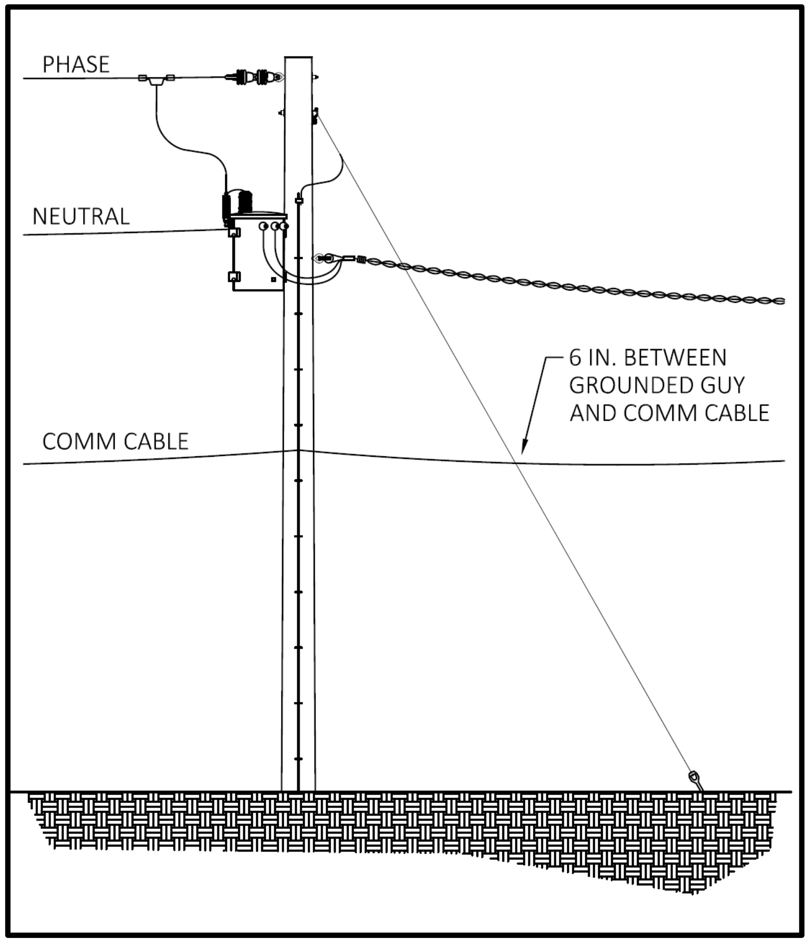

Figure 15: Clearance from Effectively Grounded Anchor Guy and Communication Cable

Other sections of this guide address communication cables in the communication space and antennas in the supply space.

As stated in the section above on the purpose of communication cables in the communication space, generally it is expected as a good work practice that all communication cables shall be installed on the same side of the pole as the neutral conductor attachment for the parallel electrical circuit, the intent being prevention of "boxing" in the pole as shown in Figure 7.

[3] NESC Rule 215C2 provides requirements for insulated guys (i.e., guys which are not effectively grounded).

Vertical Separation at the Pole

In most cases, communication cables are installed in the communication space on a pole. However, there may be specific reasons why communication wires or cables are installed in the supply space. A typical example would be fiber-optic supply cables owned and operated by the electric cooperative used for applications that support electric operations, such as SCADA communication. In some cases, the electric cooperative may agree to allow a communication company to install fiber in the supply space (also referred to as fiber-optic supply cable). Regardless of who owns the fiber-optic supply cable in the supply space, the workers who must ascend into the supply space to install or work on the fiber-optic cable must be qualified as defined in NESC Rule 224A1. Reference the section of this guide regarding qualified workers (under worker safety).

There are different types of fiber-optic supply cables as defined by the NESC in Rule 230F. These are summarized in Table 4, although, for this guide, the clearances will focus on fiber-optic cables discussed in Rows 1, 2, and 5 of Table 4.

Table 4: Treatment of Certain Fiber-Optic Supply Cables in the Supply Space

Row	Cable Type	Space	Description	Treatment for Clearances
1	Fiber-Optic	Supply Space	Supported by messenger that is effectively grounded	Same clearances as multigrounded neutral to communication cables in communication space
2	Fiber-Optic	Supply Space	Entirely dielectric or supported on a messenger that is entirely dielectric	Same clearances as multigrounded neutral to communication cables in communication space
3	Fiber-Optic	Supply Space	Supported on messengers not effectively grounded nor entirely dielectric	Same clearances as conductor operating 0–8.7 kV to communication cables in communication space
4	Fiber-Optic	Supply Space	Supported on or within conductor or containing a conductor or cable sheath with the fiber-optic cable	Same clearances as required for the such conductors
5	Fiber-Optic	Comm. Space	In supply space then transition to comm. space per Rule 224A4	Considered to be communication cables in the communication space

Adapted from NESC Rules 230F and 224A4

NESC Rule 235C addresses clearance requirements when wires, conductors, or cables are carried on the same supporting structure as shown in NESC Table 235-5. When consulting Table 235-5, keep in mind that certain fiber-optic supply cables in the supply space often have the same clearances as a multigrounded neutral (see NESC Rule 230F), as shown in Rows 1 and 2 in Table 4 above.

For communication cables in the supply space, the vertical clearance to other conductors is summarized in Table 5. More details and exceptions are contained in NESC Table 235-5.

Table 5: Vertical Clearance Between Conductors at the Pole

	Comm. Cables in the Comm. Space	Multi-grounded Neutral Conductor	Multiplex Cables with an effectively grounded bare neutral (DPX, TPX, QPX)	Open supply conductors operating 0 volts to 8.7 kV phase to ground (excludes neutral)	Open supply conductors operating over 8.7 kV to 50 kV (same utility)	Open supply conductors operating over 8.7 kV to 50 kV (different utilities)
Fiber-Optic Supply Cable on Effectively Grounded Messenger in the Supply Space	40 inches	Reference Rule 235G	16 inches	40 inches	40 inches	40 inches plus 0.4 inches per kV in excess of 8.7 kV
Fiber-Optic Supply Cable entirely dielectric or supported by a dielectric messenger in the Supply Space	40 inches	No Require-ment at the Pole	No Require-ment at the Pole	No Requirement at the Pole	No Require-ment at the Pole	40 inches plus 0.4 inches per kV in excess of 8.7 kV
Fiber-Optic Supply Cable in the Communication Space	12 inches	30 inches	40 inches	40 inches	40 inches	40 inches plus 0.4 inches per kV in excess of 8.7 kV

Reference NESC Rules 230F, 235C, and Table 235-5 for more details and exceptions

The clearance between fiber-optic supply cables in the supply space and communication cables in the communication space can be 30 inches if the requirements of Footnote 5 in NESC Table 235-5 are met. The instances in Table 5 that state "No Requirement at the Pole" are explained in Footnotes 9 and 10 of NESC Table 235-5.

If the fiber-optic supply cable is supported by an effectively grounded messenger, then no clearance is required for a multigrounded neutral. However, the NESC requires in Footnote 9 of Table 235-5 that fiber-optic cable must be positioned away from the neutral to prevent abrasion damage.

If the fiber-optic supply cable is entirely dielectric or supported by a dielectric messenger, then no clearance is specified between the fiber-optic supply cable and supply cables and conductors. Hence, Table 5 notes "No Requirement at the Pole." However, the NESC requires in Footnote

10 of Table 235-5 that fiber-optic cable must be positioned away from the supply conductor to prevent abrasion damage.

Sag-Related Clearances

Often when installing a fiber-optic supply cable, electric cooperatives will elect to install the fiber-optic supply cable close to the system neutral. The placement could be above or below the neutral attachment but far enough from the neutral attachment to prevent abrasion. In addition, there is the concern of maintaining the mid-span clearance between conductors.

NESC Rule 235C2b specifies that for wires, conductors, and cables supported at different levels on the same structure, the vertical clearances at the structure shall be adjusted if necessary so that clearance at any point in the span shall not be less than 75% of that required at the supports by Table 235-5 when voltages are less than 50 kV between conductors. Table 6 provides the clearance at any point in the span for the situation of a fiber-optic supply cable.

Table 6: Clearance at Any Point in the Span Between Conductors and Fiber-Optic Supply Cable

	Comm. Cables in the Comm. Space	Multi-grounded Neutral Conductor	Multiplex cables with an effectively grounded bare neutral (DPX, TPX, QPX)	Open supply conductors operating 0 volts to 8.7 kV phase to ground (excludes neutral)	Open supply conductors operating over 8.7 kV to 50 kV (same utility)	Open supply conductors operating over 8.7 kV to 50 kV (different utilities)
Fiber-Optic Supply Cable on Effectively Grounded Messenger in the Supply Space	12 inches	Reference Rule 235G	12 inches	30 Inches	30 Inches	75% of the total of 40 inches plus 0.4 inches per kV in excess of 8.7 kV
Fiber-Optic Supply Cable entirely dielectric or support by a dielectric messenger in the Supply Space	12 inches	Reference Rule 235G	Reference Rule 235G	Reference Rule 235G	Reference Rule 235G	75% of the total of 40 inches plus 0.4 inches per kV in excess of 8.7 kV
Fiber-Optic Supply Cable in the Communication Space	12 inches	12 inches	30 inches	30 inches	30 inches	75% of the total of 40 inches plus 0.4 inches per kV in excess of 8.7 kV

Reference NESC Rules 230F, 235C, and Table 235-5 for more details and exceptions

The clearance at midspan is based on the concept of closest approach, meaning the top conductor at final sag will sag down due to ice or temperature and the lower conductor at final sag would have no ice and would be operating at ambient temperature as the top conductor. According to NESC Rule 235C2c, these clearances must be maintained when the top conductor at final sag has ice loading but no wind and the lower conductor at final sag is at the same ambient temperature of 32°F. The separation at midspan must also be maintained when the top conductor at final sag is at 120°F (or its maximum operating temperature) and the lower conductor at final sag is at the same ambient temperature as the upper conductor.

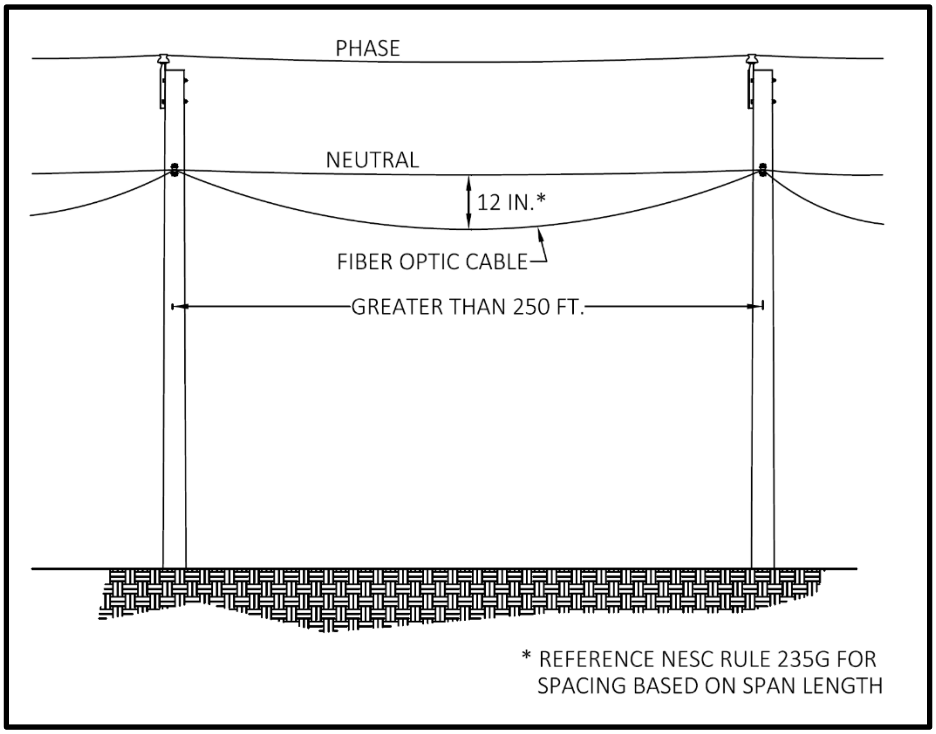

Figure 16: Vertical Clearance for Fiber-Optic Supply Cable Attached Near Neutral

Table 6 has multiple references to NESC Rule 235G. Since there is no specified vertical clearance between some fiber-optic supply cables and supply conductors, the 75% requirement cannot be applied. Therefore, in Footnotes 9 and 10 of Table 235-5, the NESC requires the midspan spacing to meet spacing defined in NESC Rule 235G unless the fiber-optic cable is attached to the neutral in the middle of the span.

NESC Rule 235G requires midspan vertical clearances as shown in NESC Table 235-8, which for spans greater than 250 feet is 12 inches as shown in Figure 16. These clearances must be maintained for the closest approach as previously discussed.

Transition Between Communication Space and Supply Space

If the fiber-optic supply cable is to transition from the communication space to the supply space or vice versa, then NESC Rule 224A4c would apply, which requires the transition to occur on a single pole and not in between structures. Figure 17 shows how the transition must occur.

An exception to NESC Rule 224A4c allows communication service drops from fiber-optic supply cables which may originate in the supply space on a pole to terminate in the communication space on the building being served.

Vertical Clearance to Equipment

For fiber-optic supply cables with a multigrounded messenger or entirely dielectric cables, the clearance to equipment is the same as the clearance of a multigrounded neutral to equipment.

Note that there are no clearance requirements for neutral conductors to equipment in the supply space. In fact, the cases of the equipment are required to be bonded to the system neutral.

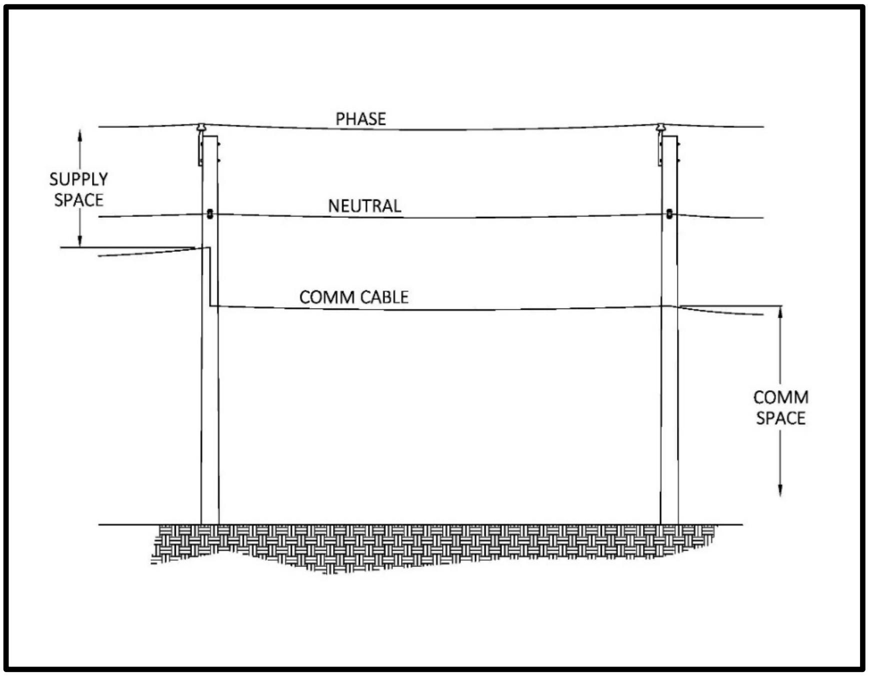

Figure 17: Transition from Supply Space to Communication Space

ELECTRIC COOPERATIVE OWNED ANTENNAS IN THE SUPPLY SPACE

This section address clearances for antennas used by electric utilities when installed in the supply space. This section assumes that these antennas meet the FCC's General Population/ Uncontrolled maximum permissible exposure limits. Reference OET Bulletin 65 for more information regarding maximum permissible exposure limits. Examples of antennas that meet these exposure limits include cell phones and radios used for AMI radio mesh systems, including repeaters on poles.

Other sections of this guide address communication cables in the communication space and the supply space as well as antennas in the supply space operated by third parties.

Vertical Clearance from Antennas and Equipment Cases that Support Antennas in the Supply Space

NESC Rule 238F1 states, "These clearances apply to communication antennas operated at a radio frequency of 3 kHz to 300 GHz, including any associated conductive mounting hardware. Communication antennas located in the supply space shall be installed and maintained only by personnel authorized and qualified to work in the supply space in accordance with the applicable work rules." NESC Rule 224A provides information regarding qualified workers.

NESC Rule 238F2a provides guidance on the clearance between antennas and equipment cases that support or are adjacent to a communication antenna and a supply conductor or communication conductor in the communication space. Sometimes, the equipment case supports the antenna; in other instances, the equipment is located near the antenna. In both situations, the distance to supply conductors is provided in NESC Table 238-3. Table 7 summarizes these clearances.

Table 7: Vertical Clearance from Antennas and Equipment Cases Supporting Antennas in the Supply Space

Communication Cables in the Communication Space	Multi-grounded Neutral Conductor	Multiplex Cables with an effectively grounded bare neutral (DPX, TPX, QPX)	Supply Lines Circuit phase-to-phase voltage 0 to 8.7 kV	Supply Lines Circuit phase-to-phase voltage 8.7 to 50 kV
40 inches (may be reduced to 30 inches if equipment cases are effectively grounded)	16 inches (may be reduced to 3 inches if all parties agree)	16 inches (may be reduced to 3 inches if all parties agree)	16 inches (may be reduced to 6 inches if all parties agree)	16 inches plus 0.4 inches per kV in excess of 8.7 kV (may be reduced to 6 inches plus 0.4 inches per kV in excess of 8.7 kV if all parties agree)

Reference NESC Table 238-3

It is important to recognize that antennas are not permitted in the Communication Worker Safety Zone. A communication antenna in the supply space that points down, such as one attached to a street light arm or a recloser case, is not permitted to extend into the Communication Worker Safety Zone. Therefore, it is possible for the lower limits of the antenna to define the lower limits of the supply space.

While street light arms are permitted to be in the Communication Worker Safety Zone, antennas are not. Thus, when an antenna is mounted on a street light arm, the street light arm and the antenna must be 40 inches from the communication space (an exception permits 30 inches if the equipment case is effectively grounded).

It is also important to note that these clearances are not intended to protect personnel working in the vicinity of communication antennas from nonionizing radiation.

Also, NESC Rule 236D1 requires that antennas located below conductors or other attachments shall be mounted outside of the climbing space. This provides room for a lineman to ascend the pole to work.

Clearance to Vertical and Lateral Communication Conductors Attached to an Antenna in the Supply Space

The clearance from the conductor or cable attached to an antenna in the supply space must maintain clearances to other conductors in the supply space. These clearances are required by NESC Rule 238F3a, which references NESC Table 235-6, Row 1. Table 8 summarizes the clearances for antennas installed in the supply space.

For systems operating at 7.2/12.5 kV, use the phase-to-phase voltage numbers for clearance to the antenna, which results in a clearance of 7.5 inches, which rounds up to 8 inches. A similar calculation for 1.4/2.49 kV results in a clearance of 12.5 inches, which rounds up to 13 inches.

Table 8: Clearance to Vertical and Lateral Conductors Attached to a Communication Antenna in the Supply Space

Comm. Cables in the Comm. Space	Comm. Cables in the Supply Space	Multi-grounded Neutral Conductor	Multiplex Cables with an effectively grounded bare neutral (DPX, TPX, QPX)	Supply Lines Circuit phase-to-phase voltage 0 to 8.7 kV	Supply Lines Circuit phase-to-phase voltage 8.7 to 50 kV
40 inches	3 inches	3 inches	3 inches	6 inches	6 inches plus 0.4 inches per kV in excess of 8.7 kV
Reference NESC Rule 238F3a and Table 235-6, Row 1, for more details and exceptions					

It is also important to note that these clearances are not intended to protect personnel working in the vicinity of communication antennas from nonionizing radiation.

Good engineering practice for the placement of antennas should attempt to minimize damage by a flashover from an energized conductor. Overvoltages, such as lightning surges, can flash over an insulator (pin, post, or suspension insulator), resulting in an electrical path to ground. If the antenna is electrically closer than the insulator, the overvoltage may flash over to the antenna. This may damage the antenna and the accompanying communication equipment.

Also, NESC Rule 236D1 requires that antennas located below conductors or other attachments be mounted outside of the climbing space. This provides room for a lineworker to ascend the pole to work.

Figures 18, 19, and 20 are examples of the clearance requirements for communication antennas in the Supply Space.

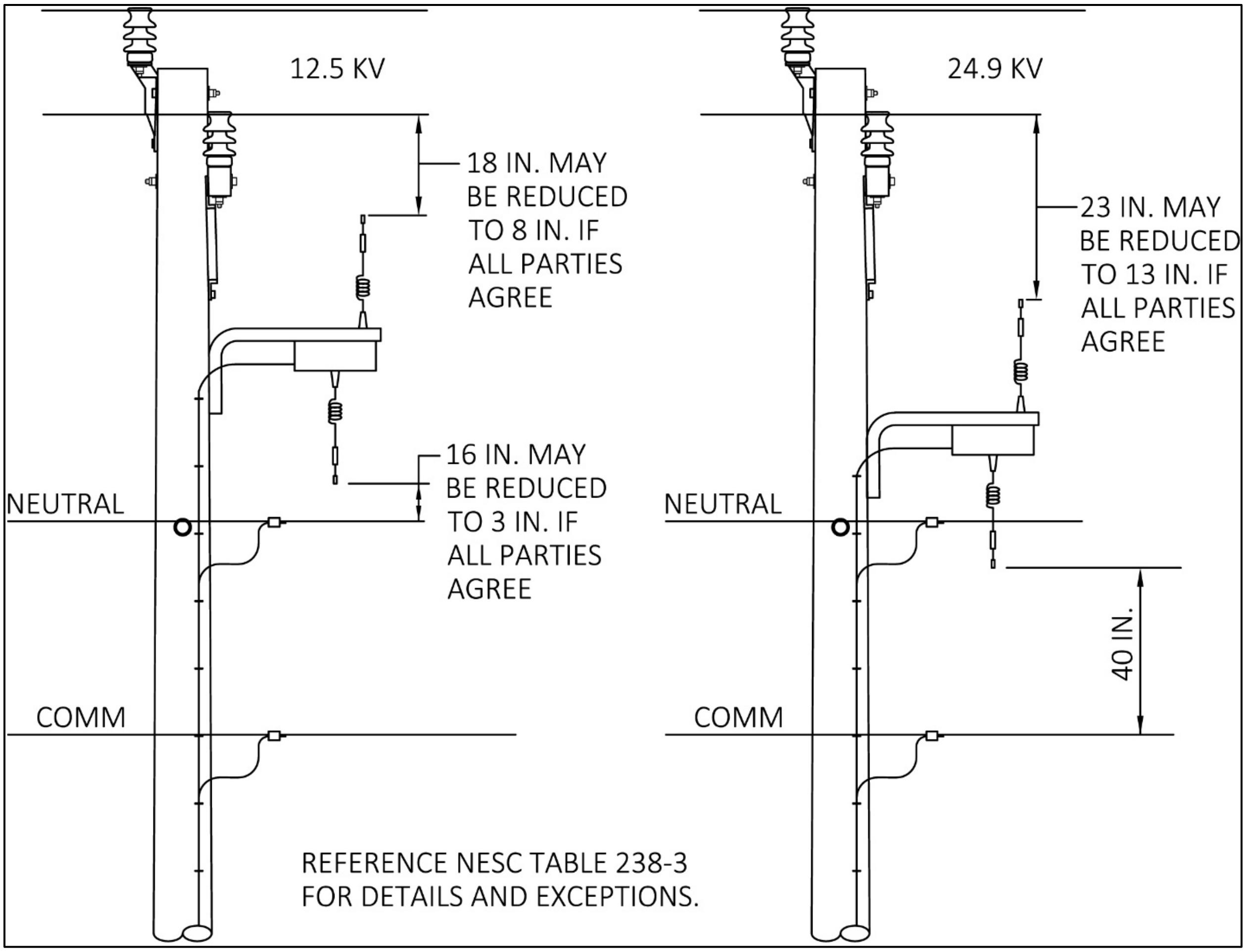

Figure 18: Antenna in the Supply Space

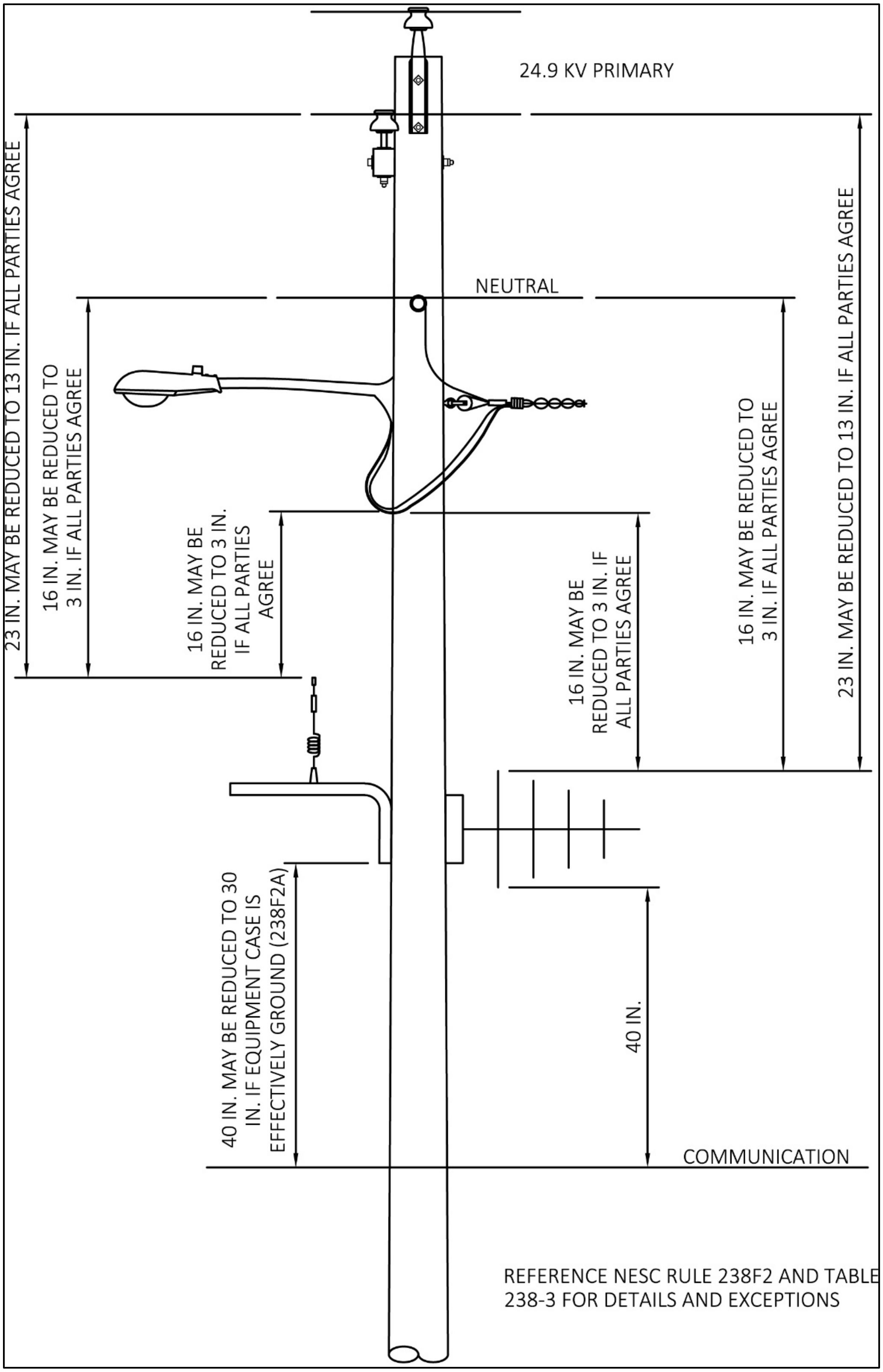

Figure 19: Antennas in Supply Space

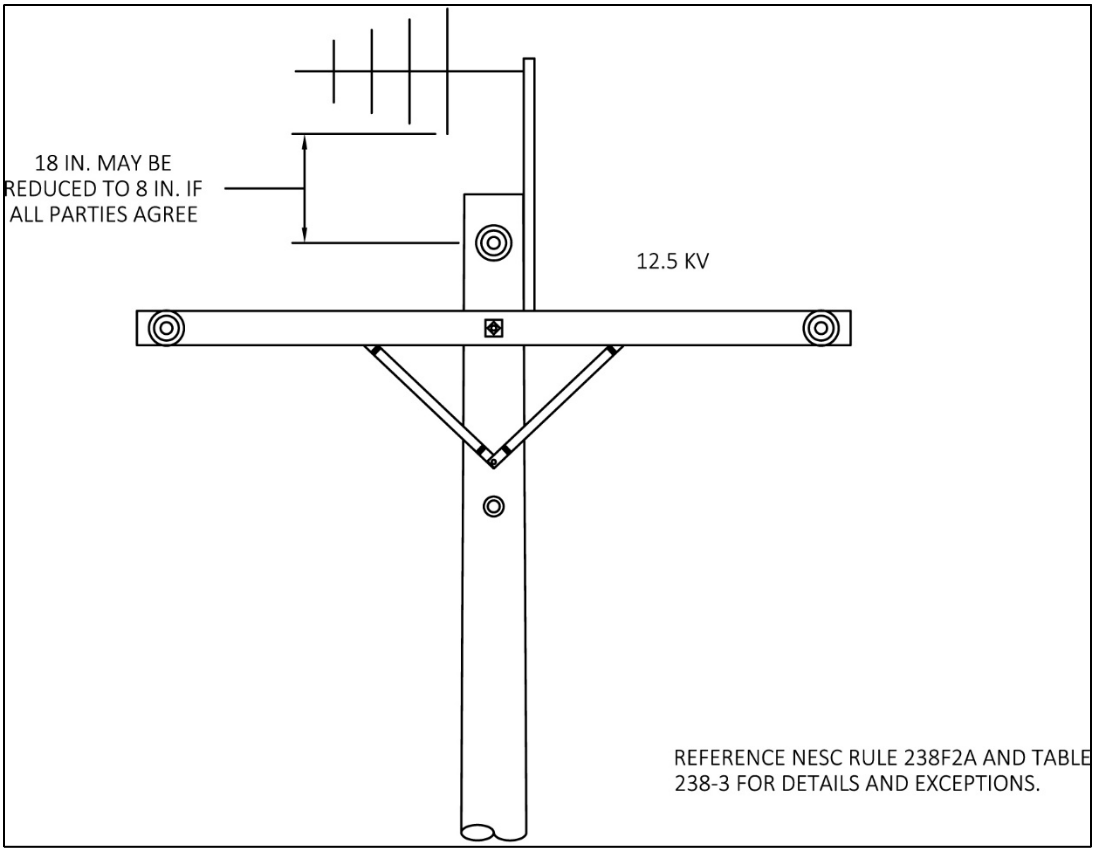

Figure 20: Supply Antenna Above 12.5-kV Primary

THIRD PARTY ANTENNAS IN THE SUPPLY SPACE

This section addresses clearances for antennas owned and operated by a third party when installed in the supply space. Small cell antennas, such as 5G antennas, for economics in the communication system design often need to be mounted higher on the pole in supply space. This section assumes these antennas do not meet the FCC's General Population/Uncontrolled maximum permissible exposure limits. Reference OET Bulletin 65 for more information regarding maximum permissible exposure limits. An example of antennas that may not meet the General Population/Uncontrolled standard can be 5G antennas.

Other sections of this guide address communication cables in the communication space and the supply space, as well as antennas used by electric utilities in the supply space.

Radiation Protection

NESC 410A6 requires employers to provide training to all employees who work in the vicinity of antennas operating in the range of 3 kHz to 300 GHz to recognize and mitigate exposure levels set forth by the regulatory authority having jurisdiction. More information regarding maximum permissible exposure levels can be found at OSHA 1910.97 and in FCC OET Bulletin 65. A recommended method of mitigating exposure to radio frequency radiation is to de-energize the antenna.

Electric utilities are requiring communications companies to install signage at all antenna sites on joint-use poles. The signage includes the identification of the antenna operator, the 24-hour contact number of the antenna operator for emergency information, and the unique identifier for the antenna site. Antenna owners are responsible for the installation and upkeep of all signs. This requirement for signage is also contained in California PUC General Order 95, Rules for Overhead Electric Line Construction, Rule 94.5.

Additional signage is required when the RF energy exceeds General Population/Uncontrolled levels (see FCC OET Bulletin 65 and OSHA 1910.97). There are examples of signs in both FCC OET Bulletin 65 and OSHA 1910.97. Electrical workers should be trained to watch for and heed these warning signs.

For these third-party antennas, it is suggested that a disconnect switch be made readily available and marked with a permanent sign indicating that it is to be used to disconnect power to the radio frequency source, so that, when the disconnect is opened, the radio frequency is no longer generated and exposure levels are now safe. A disconnect switch may be required for both AC services and backup DC power. The antenna owner must provide a satisfactory on-site means to verify the antenna is de-energized.

For example, an electric cooperative may come to an agreement with the antenna owner stipulating that, after providing 24 hours of advanced notice, the cooperative may disconnect service to antenna installations for the purposes of performing routine or nonemergency operational or maintenance activities when that work is in the vicinity of the antenna or RF signals which exceed the permissible limits.[4] For emergency working conditions, the electric cooperative will attempt to contact the antenna owner and, if unable to make contact, shall de-energize the antenna by any means necessary.[5]

5G Antennas Mounted Above the Primary

Typically, 5G antennas have a limited coverage area of less than 1,500 feet. Because 5G coverage areas are subject to line-of-sight propagation, communication companies prefer to mount these antennas as high as possible to increase coverage. Placing the antennas above the primary conductors has the benefit of limiting exposure to linemen working below the antennas.

[4] California General Rule 95, Rule 94.9, Appendix H, Exhibit B
[5] California General Rule 95, Rule 94.9, Appendix H, Exhibit C

In this instance, the bottom of the antennas and the bottom of the antenna support need to meet the requirements of NESC Rule 230F2. These clearances are summarized in Table 7 and Table 8 of this guide. The given clearance above a primary conductor is only 13 inches.

Many electric cooperatives are requiring more vertical clearance to the bottom of the antenna. This provides space for the qualified individual installing and maintaining the antenna to have space to position a bucket above the phase conductors, as shown in Figure 21. Vertical clearances of 36 inches to 72 inches are commonly used. As an example, California General Order 95, Rule 94.4, requires 72 inches. This additional space of 6 feet (72 inches) plus the typical height of a 5G anternna of 5 feet adds 11 feet to the pole height. This added height may cause some poles to be subject to extreme wind loading (NESC Rule 250C) and extreme ice loading (NESC Rule 250D). This is especially true if antennas are added to existing poles which were not designed for extreme wind.

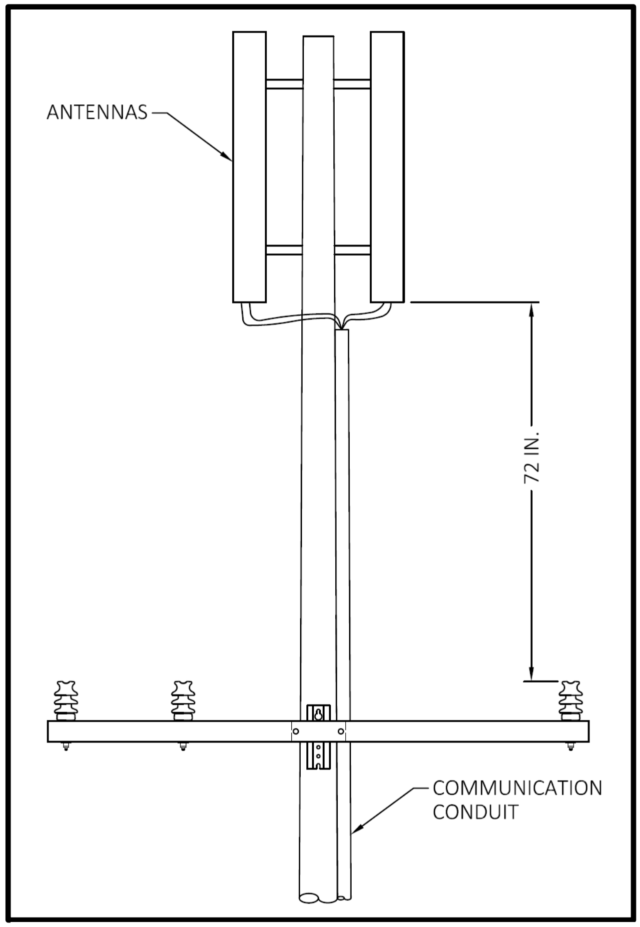

Figure 21: Antennas 72 Inches Above Primary Provides Working Space

Regardless, the additional loading will normally require strengthening the pole through appropriate means up to and including replacement, which will result in costs that are passed on to the telecom provider. See the section in this guide on joint-use structure strength.

5G Antennas Mounted Above Street Light Facilities

Street light poles and lighting-only poles may be another option for 5G antennas because there are no primary conductors to conflict with the antenna. It is important to note that only qualified workers are permitted in the supply space on street light poles. Street light poles and lighting-only poles are not designed for as much wind and ice loading as distribution poles supporting primary lines and may not be strong enough for equipment to be mounted on them.

When mounting above a street light arm, the vertical clearance required from the bottom of the antennas to a secondary cable operating less than 750 volts is 16 inches and, if all parties agree, this distance can be reduced to 3 inches. This is illustrated in Figure 22. Reference Tables 7 and 8 of this guide for clearance values and details.

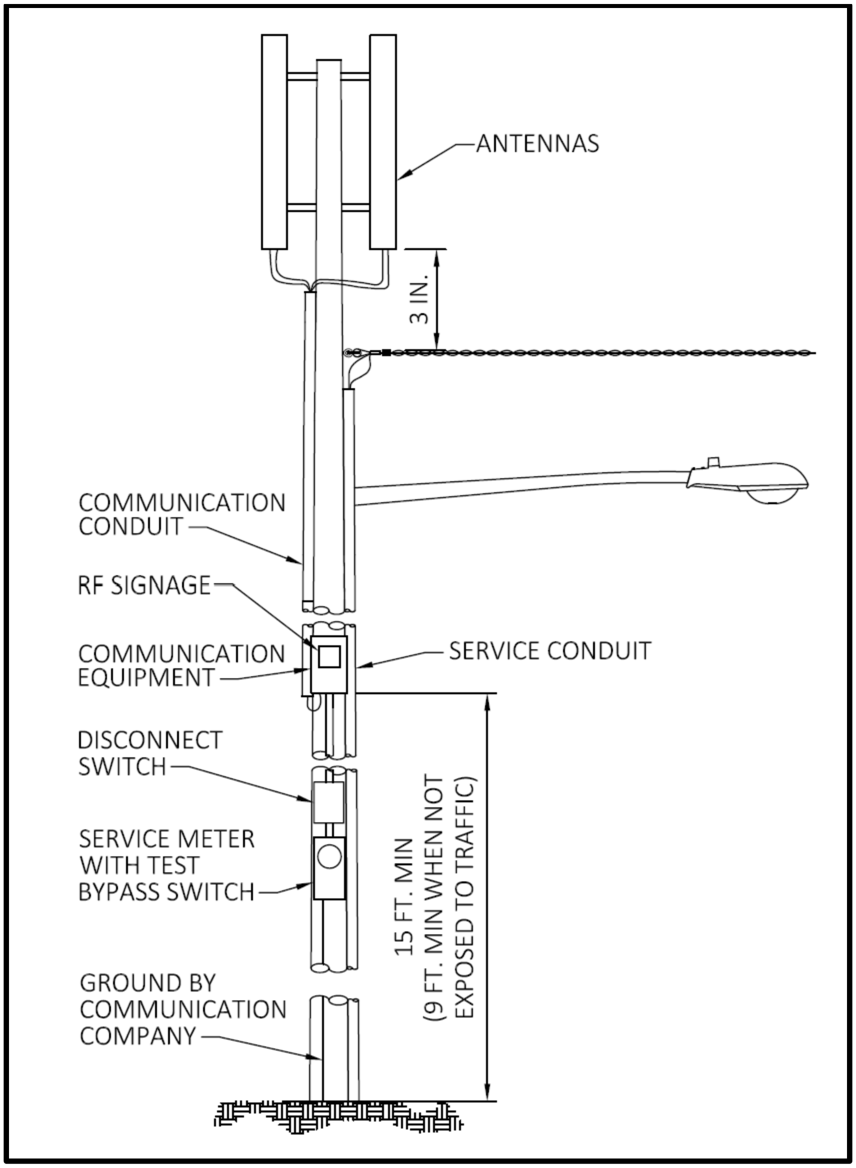

Figure 22: Antenna Above Secondary on Street Light Pole

Communication Cables Passing through the Supply Space

Communication cables passing through the supply space are required by NESC Rules 239H1 and 239H2 to have nonmetallic covering. This nonmetallic covering needs to extend 40 inches above the highest supply conductor and extend 72 inches below the lowest supply conductor as seen in Figure 23. However, if the communication cable terminates at an antenna in the supply space, the nonmetallic covering need only extend to the antenna. Thus, the antenna equipment case can be 6 inches above the primary and the nonmetallic covering need only extend to the antenna.

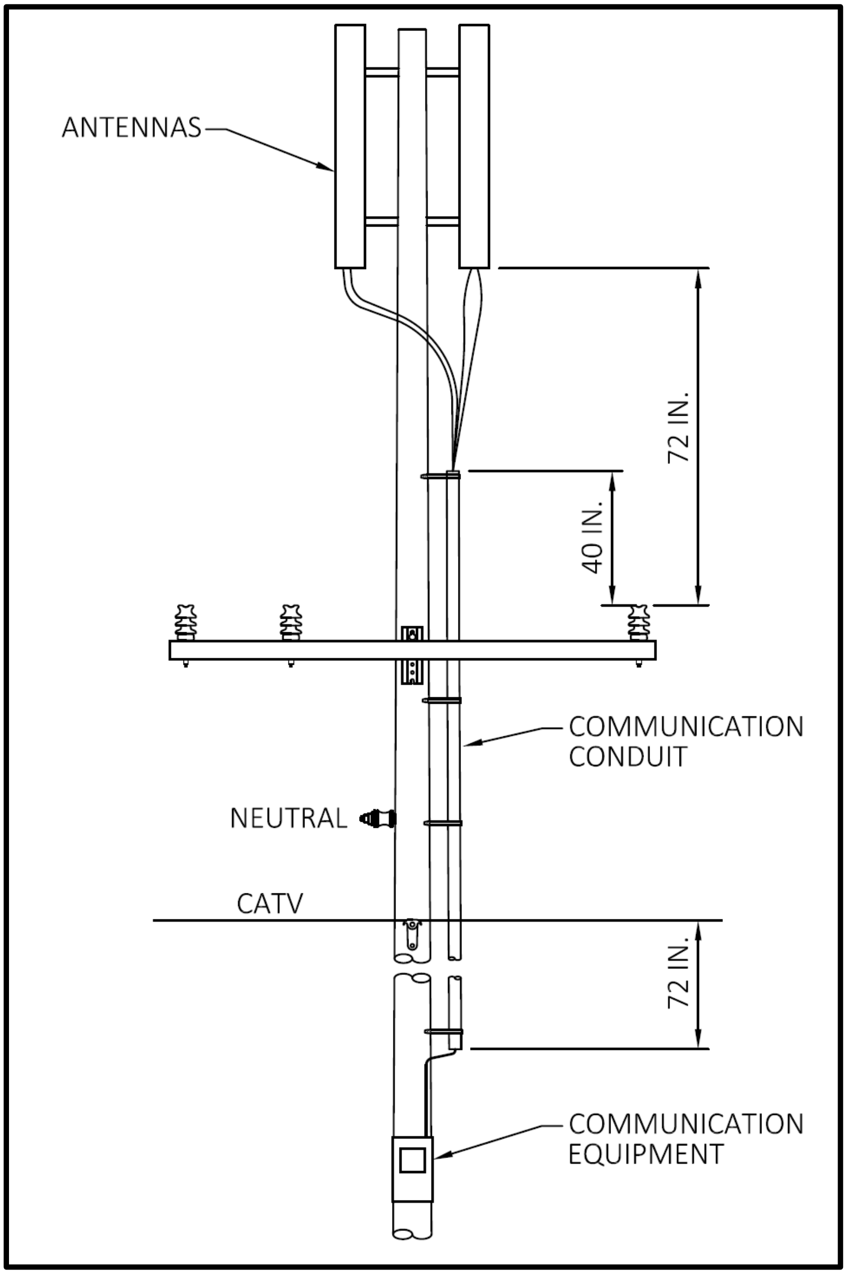

Figure 23: Conduit from Supply Space to Extend 72 Inches Below Lowest Communication Cable

As suggested by NESC Rule 239B, the placement of the conduit should not obstruct the climbing space. In addition, NESC Rule 239H4 requires vertical runs of communication conductors to have a clearance of one eighth of the pole circumference and not less than 2 inches from exposed through-bolts and other exposed metal objects associated with the supply line. However, if the communication cable is effectively grounded, this clearance maybe reduced to 1 inch.

COMMUNICATION ANTENNA IN THE COMMUNICATION SPACE

This section addresses clearances for antennas installed in the communication space. These antennas may or may not meet the FCC's General Population/Uncontrolled maximum permissible exposure limits. Reference OET Bulletin 65 for more information regarding maximum permissible exposure limits. If these antennas do not meet General Population/Uncontrolled maximum permissible exposure limits, a disconnect switch and warning signs are advisable, as detailed in the section in this guide on Radiation Protection.

Other sections of this guide address communication cable in the communication space and the supply space as well as antennas in the supply space.

Clearance to Supply Conductors and Supply Equipment

When an antenna is installed in the communication space, the vertical clearance between communication equipment and supply facilities located on the same structure is addressed in NESC 238F2b and Table 238-1.

The vertical distance from the top of an antenna in the communication space to a multigrounded neutral is 30 inches. For supply conductors such as triplex and duplex conductors, the clearance is 40 inches. For supply conductors operating from 0 to 8.7 kV (phase-to-ground), the clearance from the top of the antenna is 40 inches. For supply conductors operating over 8.7 kV (phase-to-ground), the clearance from the top of the antenna is 40 inches plus 0.4 inches per kV in excess of 8.7 kV.

Per NESC Rule 238F2 and Table 238-1, the top of an antenna can be 30 inches below the effective ground tanks of supply equipment.

Clearances on Riser Poles

NESC Rule 239G requires power cables that pass through the communication space to be guarded with suitable conduit or covering from 40 inches above the highest communication attachment. Measurement would be from the attachment point of the antenna, which is the location at which a communication worker would access the pole.

5G ANTENNAS ON NON-JOINT-USE POLE

This section addresses clearances from antennas on poles owned by the communication company but installed near the electric cooperative's power lines. In dense urban areas, it is common to have multiple poles in a street right-of-way, including power poles, traffic signals, decorative street poles, and now, 5G antenna poles. This congestion can present clearance problems which are addressed in NESC Rule 234C.

Clearance to Pole Supporting Antennas

Poles that are equipped with 5G antennas—as well as other devices, such as cameras and sensors—are becoming more typical. These "smart" poles allow data gathering of the surrounding area for various uses. These can include decorative poles with the antennas and sensors concealed within the pole. These third-party-owned poles that support antennas need to meet the clearance requirements in NESC Rule 234C and NESC Table 234-1. Specifically, third-party-owned poles with an antenna will have the clearances shown for "radio and television antennas" in Row 2 of NESC Table 234-1.

The horizontal clearance to antennas is 7.5 feet from supply conductors operating at 750 volts to 22 kV (phase-to-ground) with no wind blowing. Footnote 10 of NESC Table 234-1 requires additional clearance when the supply conductors are displaced by a 50 MPH wind (6 lb/ft^2) at a temperature of 60°F. These clearances are 4.5 feet for open supply conductors operating at 750 volts to 22 kV (phase-to-ground). Reference Figure 24 for an illustration of this clearance.

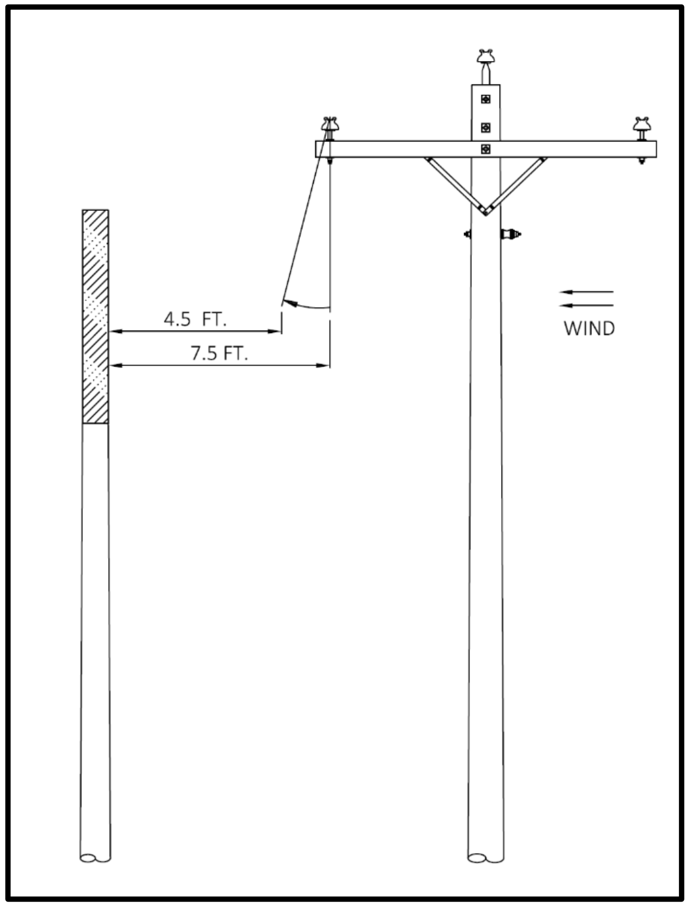

Figure 24: Horizonal Clearance of 750 volts-22 kV to Third-Party-Owned Poles Supporting Antennas

The required horizontal distance from the antenna and its support pole to a multigrounded neutral is 3 feet, assuming the pole is not readily accessible to pedestrians. "Readily accessible" is defined as having casual access, which in case of a pole supporting a communication antenna would be a permanently mounted ladder. For multiplex supply cables with a bare messenger (duplex, triplex, or quadraplex secondary cable) operating at less than 750 volts, the clearance is 3.5 feet, assuming the pole is not readily accessible to pedestrians. Reference NESC Table 234-1 for more details and exceptions.

These third-party-owned poles supporting a communication antenna could be placed closer than this horizontal distance specified in NESC Table 234-1 as long as vertical clearance at largest final sag as defined by NESC Rule 234B2 is maintained. As shown in Figure 25, the vertical clearance is 8 feet from supply conductors operating from 750 volts to 22 kV (phase-to-ground). This clearance assumes the third-party-owned antenna pole will not have sufficient space to allow personnel to walk at or near the top of the pole. Reference NESC Table 234-1 for exceptions and details.

Assuming personnel will not be walking at or near the top of the pole, the vertical clearance to a multiground system neutral is 3 feet and the vertical clearance to a multiplex supply cable (duplex, triplex, or quadraplex secondary cable) operating at less than 750 volts is 3.5 feet. These clearances are based on largest final sag of these conductors. Reference NESC Table 234-1 for exceptions and details.

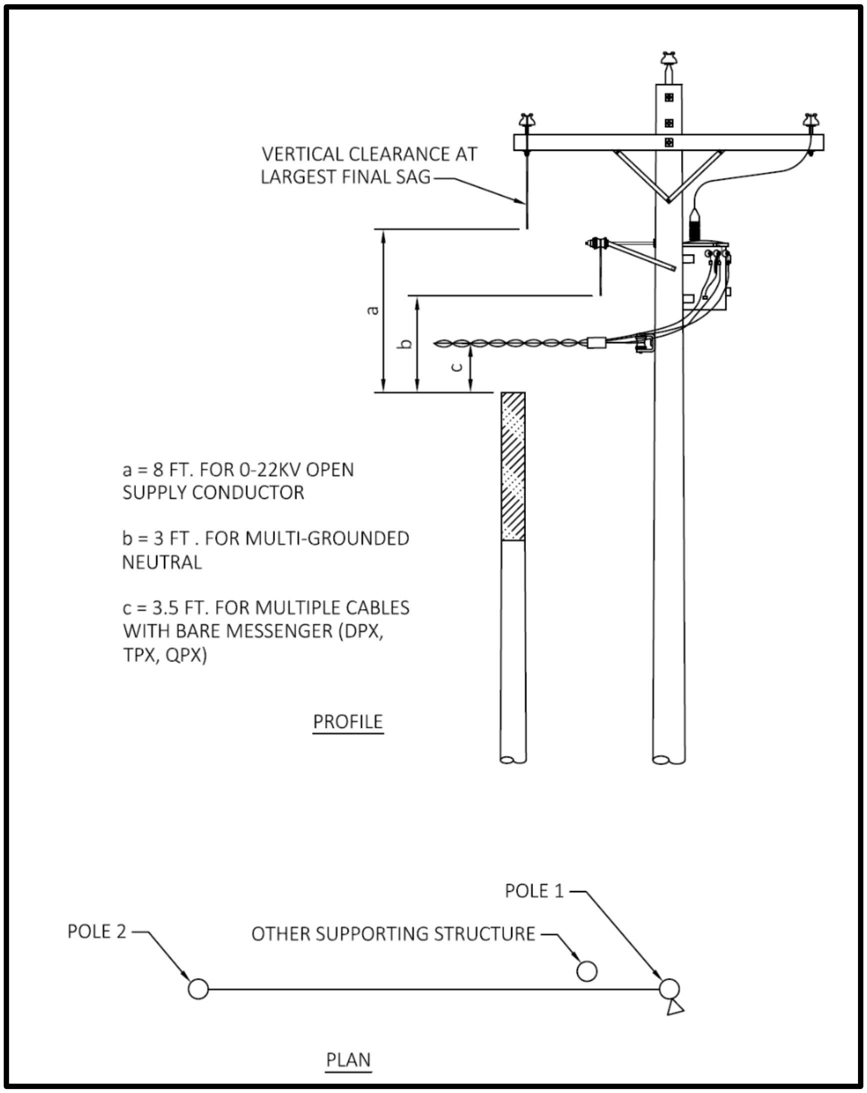

Figure 25: Vertical Clearance from Supply Conductors to Third-Party-Owned Poles that Support Antennas

ELECTRIC SERVICE TO COMMUNICATION FACILITIES

Communication facilities require electric service to boost signals and to provide power to antennas, boosters, or other related equipment. For the purpose of this section, communication equipment will be defined as equipment that produces, modifies, regulates, or controls communication signals mounted to an electric utility pole. The cost for electric service and electric energy is usually separate from any pole attachment fee.

Point of Service

The Point of Service is usually defined by the electric utility and marks the location where the scope and rules of the NESC end and the scope and rules of the NEC begin. For a typical home served by an overhead service drop, the point of service is at the top of the weatherhead. The weatherhead needs to meet the clearance requirements of the NEC but the height of the triplex service drop over the roof needs to meet the rules of the NESC.

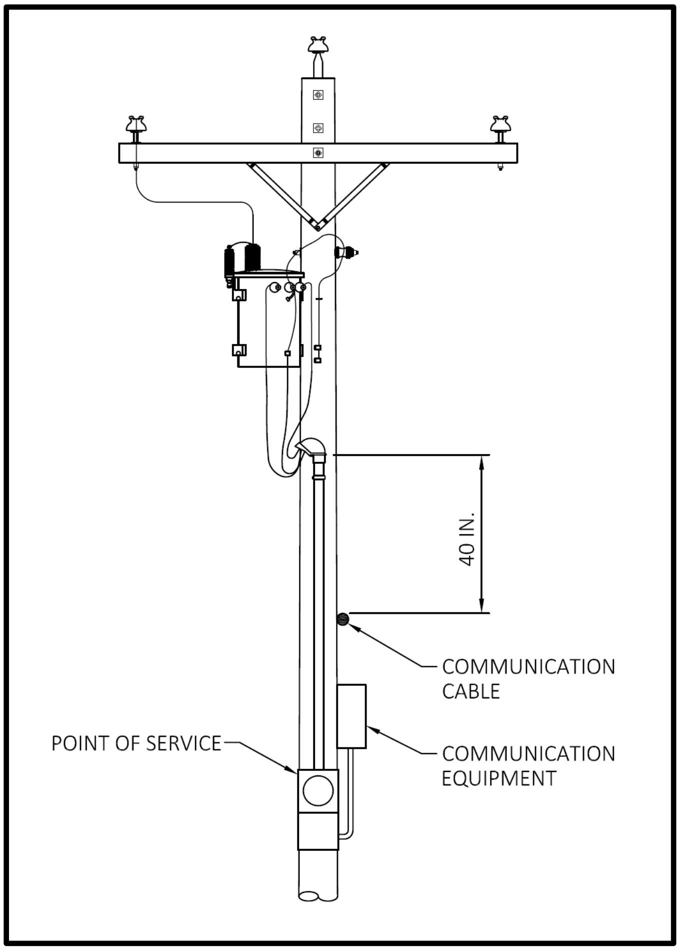

Figure 26: Point of Service to Communication Equipment

When providing electric service to communication equipment, it is advisable to document and define the point of service, as shown in Figure 26.

Measuring Energy Use

The two most common ways of providing electric service are metered and flat fee. State and/or local code enforcement may have requirements for both methods. Installing a meter at each equipment cabinet will be the most accurate way to be certain all energy use is recorded and billed. However, having a meter at each location will require an additional investment in equipment and the associated increased operation and maintenance costs which may not be feasible in every instance.

A flat fee will require the electric cooperative to know what equipment is/will be installed and that the same or very similar equipment is installed at each location. A calculated cost of energy and a quantified operation and maintenance cost should be included in the flat fee. If communication equipment in an area has different energy loads that vary from location to location, this may not be the best option. Additionally, the electric cooperative may need to inspect the cabinets from time to time to verify the same equipment is still installed. The communication company may upgrade to equipment that has a larger load than the load that was used to calculate the original flat fee.

Another option is to meter a percentage of the usage of the communication facilities and use that information to estimate the energy use on the nonmetered location.

Placing the Service

Several options exist for where to install the electric service, each with its own advantages and disadvantages. Of the available options, the electric utility pole is certainly the easiest location for the communication company to accept electric service. This may, however, present the most problems to the electric cooperative as it limits climbing space and creates an issue for transferring meters when a pole is replaced. Installing the electric service on a lift pole, service pole, or meter pedestal would be more desirable to the electric cooperative, particularly in small cell (5G or similar technology) applications.

It is advantageous if the communication company installs the antenna on the lift pole or service pole because the meter and antenna would not be on a joint-use pole.

Setting a meter pole entirely separate from the electric cooperative primary pole is another option. This pole would be owned by the communication company and, depending on state and local laws, can be required to be off the right-of-way and could require an easement. If the electric cooperative allows meter poles to be set within power line rights-of-way, NESC Rule 234B requires clearances both horizontal and vertical from supply conductors to the meter pole.

If the meter base is to be located on the primary pole, NESC 239G requires the supply conductors to be in conduit and that conduit must extend 40 inches above the highest communication attachment. Note that the vertical electric service conductor is subject to NESC 239G, meaning it must be guarded with suitable conduit or covering. Extending the conduit 40 inches above the communication attachment places the weatherhead in the supply space. Unless the communication worker is authorized and qualified to work in the supply space, these workers cannot install the weatherhead. Alternatively, as shown in Figure 21, if the point of service is where the electric service cables connect to the meter, then the electric cooperative can install the conduit, service conductors, and weatherhead. Another option is to provide overhead service to a meter pole owned by the communication company or an underground feed to a meter pedestal.

Some electric utilities allow the communication company to install a meter, a disconnect, and the communication company equipment on the primary pole. If this done, the communication equipment must be installed in a manner to meet NESC 236D, with a clear climbing space of at least 24 inches.

Bonding of all communication equipment frames and enclosures within reach is required by NESC 093C7. Bonding of communication system grounds and electric supply system grounds is required on joint-use poles by NESC Rule 097G, although there are rare exceptions.

CROSSING WHEN NOT A JOINT-USE POLE

Crossings of power lines and communication lines are often required when dealing with the layout of aerial attachments. Per NESC Rule 233, it is considered a good practice to cross a communication line with a power line on a common supporting structure as shown in Figure 5. However, when it is not possible to use a common supporting structure and the lines must cross one another without a common structure, NESC Rule 233 addresses the clearances between the conductors at the point of crossing.

Clearance at Crossings

Whenever practical, crossings should be made on a common structure. Otherwise, the clearance between any two crossing or adjacent wires, conductors, or cables carried on different supporting structures must be not less than that required by NESC Rules 233B and 233C at any location in the span; it also must be not less than the clearance envelope specified in NESC Rule 233A2, the horizontal clearance specified in Rule 233B, and the vertical clearance specified in NESC Rule 233C. NESC Table 233-1 shows the actual distance required between the two lines as well as clearance for span guys crossing over communication lines at the point of closest approach.

The clearance envelope defines the movement of the conductor due to ice, temperature, and wind loading throughout the life of the conductor. The point of crossing is based on the closest approach of the conductors when subjected to the same ambient air temperatures and wind loading conditions and subjected individually to the full range of icing conditions and electrical loading. This requires knowledge of the movement of the communication cables passing below the power line.

Strength of Supply Line at Crossings

Due in part to the safety concern of a supply line falling on a communication line, the strength of the supply line must be increased "at crossings." At these crossing points, the messenger of the communication line may not have a common ground with the supply line neutral which, in the event of a contact with the supply line, may result in a high-impedance fault. Thus, greater strength is required to reduce the occurrence of a difficult-to-clear high-impedance fault.

Per NESC Rule 241C1, a conductor is considered "at crossing" if it crosses over another line regardless of its presence on a common supporting structure as shown in Figure 5. Note that colinear lines such as communication cables attached below supply lines on joint-use poles are not considered "at crossing."

Three grades of construction are defined in the NESC: Grades B, C, and N, with Grade B being the highest or strongest. Grade N applies only in very limited cases and mostly for communication facilities. RUS requires electric cooperatives to construct lines using a minimum of Grade C. Grade B is required where lines cross railroads, limited-access highways, and most navigable waterways.

Per NESC Table 242-1, Grade B construction is required for an open supply conductor operating at 750 volts to 22 kV (phase-to-ground) over a communication conductor. However, an exception is provided in Footnote 7 that allows Grade C construction if certain conditions are met including clearing of faults if the phase conductor contacts the communication cable or its messenger. For colinear lines with multigrounded neutrals and messengers meeting NESC Rule 092C1 (four grounds per mile) which are bonded as required by NESC Rule 097G, there is a clear low impedance path to allow a fault from the phase conductor to the communication line to clear. However, at crossings, the electric cooperative needs to determine if a fault can be cleared if the supply line contacts the communication line. The key to this determination is often the proximity of the bonding of the communication plant and supply facilities. If the system cannot clear the fault, then Grade B construction is required.

If Grade B is used for the “at crossing” structures, keep in mind that NESC Rule 252C has requirements for adjacent structures when transitioning from Grade B to Grade C.

It is important to remember that the load factors for structures, guys, and anchors are increased for “at crossing” structures. So even though Grade C construction is permitted for “at crossing,” a higher load factor is used that, in effect, makes the structures on either side of the crossing stronger.

JOINT-USE STRUCTURE STRENGTH

Weather-related events create some of the greatest challenges for any overhead line. Wind and ice are the most extreme trials facing most systems. Such events are frequently encountered in combination, such as wind and heavy rainfall in hurricanes, or ice and wind in ice storms. Also, the elements affect trees and can carry wind-blown debris which can exacerbate the direct weather effects on an electric utility’s lines. While it is not generally realistic to design overhead lines in such a way that they can withstand the impact of extensive wind-blown debris, the NESC serves as a baseline of what should be considered as realistic weather-related load. Further, if an electric utility sees the need to use greater wind or ice loading as design criteria based on experience or for storm hardening, there is no prohibition against doing so. However, from a joint-use structure perspective, the loading criteria should be consistently applied to all parties.

The loading criteria in the NESC is defined partly as a means to improve public safety. Public safety is fortified by maintaining power lines at the vertical and horizonal clearances defined in the NESC, and structures that can withstand defined weather events help to meet those safety goals.

Adding communication cables and equipment to poles adds more stress on the structures and must be considered when analyzing pole strengths.

Grade of Construction for Joint-Use Poles

As previously discussed in the above section on strength of supply line at crossings, NESC Table 242-1 defines the grade of construction to be used for supply and communication lines. Grade B is required where lines cross railroads, limited-access highways, and most navigable waterways. Grade C is the minimum required for all RUS borrowers.

Grade B construction is required for an open supply conductor operating at 750 volts to 22 kV (phase-to-ground) over a communication conductor. However, an exception is provided in Footnote 7 that allows Grade C construction if certain conditions are met, including clearing of faults if the phase conductor contacts the communication line. For colinear lines with multigrounded neutrals and messengers meeting NESC Rule 092C1 (four grounds per mile) which are bonded together as required by NESC Rule 097G, this requirement for clearing faults is often met.

The upper line must have the grade of construction as required by NESC Table 242-1, while the lower line needs only to have the grade of construction that would be required if the line at the higher level were not present. However, per NESC Rule 243A, the strength of the *structure*—including all communication and supply guys and anchors—must be based on the highest grade of construction required for the conductors attached to the supporting structure. Failure of these guys and anchors puts the structure at risk of failing and, therefore, even the communication-owned guys and anchors must meet this requirement.

Tangent and Unguyed Joint-Use Poles

A tangent pole and unguyed angle wood poles must have sufficient strength to withstand the forces of ice and wind blowing on the pole and conductors as defined by NESC Rule 261A2. When a communication cable is added to a tangent pole or unguyed angle pole, it is important to verify that the pole has sufficient strength for the additional loads.

At a minimum, distribution lines must be designed in accordance with the loads defined in NESC Rule 250B. This is also known as the Combined Ice and Wind District Loading, which divides the U.S. into Heavy, Medium, Light, and Warm Island districts (NESC Figure 250-1). Some electric utilities are using loading criteria greater than required by the NESC for storm hardening or increased reliability. The requirements of NESC Rule 250B are summarized in Table 9.

Table 9: Summary of NESC Table 250B

	Heavy	Medium	Light	Warm Islands (Sea level to 9,000 ft)
Radial Ice	0.5 inches	0.25 inches	0.0 inches	0.0 inches
Wind	4 lb/ft^2	4 lb/ft^2	9 lb/ft^2	9 lb/ft^2
Temperature	0°F	15°F	30°F	50°F

Adapted from NESC Table 250-1

RUS Bulletin 1724E-150, *Unguyed Distribution Poles—Strength Requirements*, provides details on how to calculate pole loading. The loading calculations include wind load per unit length of conductor (Wc). The wind load per unit length is based the diameter of the conductor (in inches) and the amount of radial thickness of ice. Note that because it is a radial thickness, the ice is applied all the way around the conductor as shown in Figure 27. The value is divided by 12 to convert the diameter value from inches to feet. This final number is multiplied by the wind load in pounds per square feet to yield:

$$W_c = \frac{[D + (2 \times ICE)]W}{12}$$

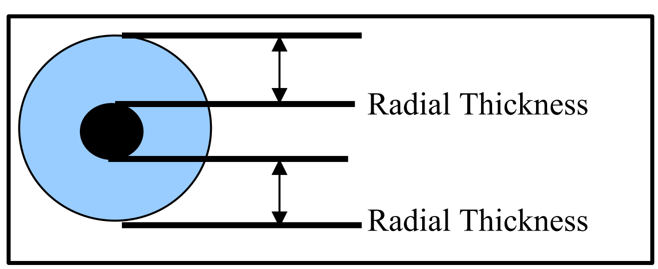

Figure 27: Model for Icing of Bare Conductor

Where:

W_c = Wind load per unit length of each conductor (lb/ft)
D = Diameter of wire (inches)
ICE = Radial thickness of ice on conductor (inches)
W = Wind force acting on conductor (pounds per square foot)

NESC Rule 251A3 describes the method to calculate ice loads on lashed cables by modeling the ice as a coating on a hollow cylinder touching the outer strands of the outer circumference of the lashed cable. Figure 28 illustrates this model for icing lashed communication cables.

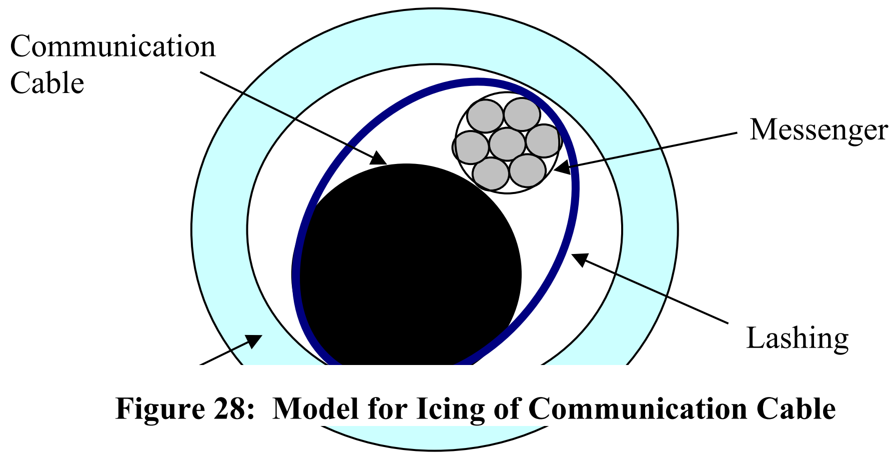

Figure 28: Model for Icing of Communication Cable

$$W_c = \frac{[D_c + D_M + 2 \times D_L + (2 \times ICE)]W}{12}$$

Where:
W_C = Wind load per unit length of each conductor (lb/ft)
D_C = Diameter of communication cable (inches)
D_M = Diameter of messenger wire (inches)
D_L = Diameter of lashing (inches)
ICE = Radial thickness of ice on conductor (inches)
W = Wind force acting on conductor (pounds per square foot)

For 1/2" or 3/4" CATV wires, the messenger wire is typically 1/4" in diameter. For 1", 1.5", or 2" phone wires, the messenger wire is typically 3/8" in diameter. Generally, the lashing diameter is ignored ($D_L = 0$) because of its small relative size.

Table 10: Wind Load Per Unit Length of Conductor

Conductor	Diameter (Inches)	Wind Load for One Foot of Conductor (lb/ft)			
		Heavy	Medium	Light	Warm Island
2 ACSR	0.316	0.439	0.272	0.237	0.329
1/0 ACSR	0.398	0.466	0.299	0.299	0.350
4/0 ACSR	0.563	0.521	0.354	0.422	0.391
336 ACSR	0.684	0.561	0.395	0.513	0.421
1/2 CATV*	0.750	0.583	0.417	0.563	0.438
3/4 CATV*	1.000	0.667	0.500	0.750	0.500
1" Phone*	1.375	0.792	0.625	1.031	0.594
1.5" Phone*	1.875	0.958	0.792	1.406	0.719
2" Phone*	2.375	1.125	0.958	1.781	0.844
**Diameters include messenger but ignores the lashing*					

The calculated loads of W_C in Table 10 can be used in the equations found in RUS Bulletin 1724E-150 to determine the horizontal wind loading on the pole. Note that the wind load per unit length of communication cables is significantly higher than that of the standard overhead conductors used by electric utilities.

If any portion of the structure or its supported facilities exceeds 60 ft above ground or water, the structure is also required to meet the loading of NESC Rule 250C, *Extreme Wind Loading*, and NESC Rule 250D, *Extreme Ice with Concurrent Wind Loading*. The NESC provides an equation in Rule 250C for determining the load in pounds. For conductors, the area (A) in the equation should be based on one foot of conductor to yield W_C for extreme wind. For bundled conductors, such as cables lashed to a messenger, use the hollow cylinder model to determine the diameter of the cable. Similarly, use the hollow cylinder model for the calculation of loading for extreme ice.

The volume of ice around the hollow cylinder can yield the weight of ice for vertical strength calculations. Note that NESC Rule 250B sets the weight of ice to be 57 lb/ft^2.

Wind Loading on Antennas and Communication Equipment

Just as wind blows on the conductors causing a groundline moment on the pole, wind on the communication equipment and antennas will also result in groundline moments on the pole. The basic equation is the area in squared feet (height and width) of the equipment times the wind in pounds per feet squared, which yields a force in pounds. This force times the distance to ground line is the resulting groundline moment on the pole, which is in addition to the forces caused by wind on the conductors and wind on the pole.

RUS Bulletin 1724E-150 provides the method to calculate the wind force on equipment. Often the pole loading of the equipment, such as a transformer, is small compared to wind on the conductors but this loading should be considered. This is especially true with antennas at the top of the pole which have a long fulcrum, thereby increasing pole loading. Meters, disconnects, and modulation equipment are generally mounted lower on the pole and likely have less impact to pole loading.

Adding the antenna at the top of the pole can increase the effective height of the pole by as much as 11 feet. This added height may cause some shorter poles to become subject to significant additional loading when exposed to extreme wind (NESC Rule 250C) or extreme ice (NESC Rule 250D).

Pole Strength

Adding joint-use facilities, including cables and equipment, subjects the pole to additional forces that can overload the strength of the pole. Pole strength is required to be derated in accordance with Strength Factors in NESC Table 261-1. For example, wood pole strength must be derated to 85% for Grade C and 65% for Grade B.

Wood structures must be designed to withstand the loads multiplied by the appropriate load factor from NESC Table 253-1 without exceeding the derated strength of the wood pole. When designing a new structure for supply facilities and joint-use facilities, this application is straightforward in determining the appropriate strength (class) of the pole.

However, when joint-use facilities are to be added to an existing pole, the NESC has a prescribed method of determining if the pole has sufficient strength, as described in Footnote 7 of NESC Table 261-1:

> *When new or changed facilities add loads to existing structures,*
>
> *(a) the strength of the structure when new shall have been great enough to support the additional loads, and*
> *(b) the strength of the deteriorated structure shall exceed the strength required at replacement.*
>
> *If either (a) or (b) cannot be met, the structure must be replaced, augmented, or rehabilitated.*

The "strength required at replacement" is determined by reviewing the footnotes of NESC Table 261-1. For wood structures, Footnote 2 requires structures to be replaced or rehabilitated when deterioration reduces the structure strength to two-thirds of that required when installed. Note that the value is based on the loading of the structure and not the strength of the structure.

For example, a wood pole supporting supply facilities has a calculated ground line moment of 48,000 ft-lb including all NESC load factors. A pole was selected that has a groundline strength rating of 79,000 ft-lb. This rating must be reduced by 85% since the structure is built for Grade C. The resulting derated strength of the pole is 68,000 ft-lb.

To continue this example, a communication company wishes to attach to the pole. The additional groundline moment due to the new communication cable with the appropriate load factor is calculated to be 12,000 ft-lb. Now the total load on the pole is 48,000 ft-lb plus 12,000 ft-lb or 60,000 ft-lb, which is less than the derated strength of the pole. Thus, part (a) of the test is passed.

The calculation of the deteriorated strength of two-thirds of that required would be two-thirds times 60,000 ft-lb or 40,000 ft-lb. This means the original strength of the pole can deteriorate from 79,000 ft-lb to 40,000 ft-lb before replacement or rehabilitation is required. Note that, for this example, the deteriorated strength of the poles was actually 50% of the original strength of the pole. The designer needs to determine through inspection if the pole strength exceeds the 40,000 ft-lb for this structure to pass test (b).

The difficulty lies in determining when a structure has deteriorated to two-thirds of the strength required. There are numerous testing methods on the market to aid in this determination. Another resource is a document published by the U.S. Bureau of Reclamation entitled *Wood Pole Maintenance*.[6] This document provides calculations based on the volume of wood lost due to decay.

Guyed Structures

Guys and anchors are installed at distribution line deadends, line angles, and at points of unbalanced conductor tensions. These loads include the tension in the conductor caused by the loading requirements (NESC Rules 250B, 250C, and/or 250D). A guy assembly must be designed to hold the entire horizontal component of the load being applied on the structure in the opposite direction of the guy assembly. The horizontal component could be longitudinal pull on a deadend structure or the bisect angle of a line angle structure. When a pole is guyed, the pole acts as a strut (Reference NESC Rule 261C2) meaning the pole does not normally contribute to hold horizontal loads such as conductor tensions.

RUS Bulletin 1724E-153, *Electric Distribution Line Guys and Anchors*, provides methods and equations for determining proper selection of guys and anchors.

Typically, those responsible for installing communication cables under tension will be responsible for designing and installing guy and anchor assemblies needed to support the horizontal loading of the communication plant. Essentially, each pole user is responsible for designing and installing the appropriate guys and anchors to support its plant.

The tension of communication messengers can vary from 2,000 lb to 5,000 lb with even greater tensions for long spans and larger communication cables. Since the messenger is installed first, followed by the lashing operation, it is important that the guys and anchors are in place prior to stringing the messenger. If not, existing poles will be deflected at the point of attachment of the messenger and appear as a bow in the pole. Most joint-use contracts specifically require the installation of guys and anchors prior to installing the messenger.

In most cases, separate anchors are used to support the communication plant. However, it is possible to share anchors between pole users. If this practice is followed, the total resultant force on the anchor (communication facilities and supply facilities) must be less than the holding power of the anchor. Since the designs for power and communication facilities are prepared by different parties, each party would not know the resultant force of the other party's facilities.

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[6] Bureau of Reclamation, Wood Pole Maintenance and can be found at https://www.usbr.gov/power/data/fist/fist_vol_4/vol4-6.pdf.

If an electric utility is installing a fiber-optic cable in the supply space, there is no prohibition that excludes the guys associated with the fiber-optic cable from being installed on an anchor used to support supply facilities. Again, the total resultant force on the anchor (fiber-optic cable facilities and supply facilities) must be less than the holding power of the anchor.

Vertical Loading of Structures

Poles need to support the vertical load on the pole which includes both the weight of the conductor when iced and the equipment on the pole. Long spans with ice loading may require a larger pole class to support this weight. Adding communications to these long spans will add even more vertical loading to the pole.

Normally, in the design of distribution lines, the weight of transformers, regulators, and oil circuit reclosers are the largest equipment on the poles. The newer equipment needed for some communication equipment can exceed 500 pounds. This weight includes processing equipment, uninterruptible power supply (UPS) equipment, and battery backup systems. While communication equipment is mounted lower on the pole, this weight should be factored into the analysis of the structure strength.

UNDERGROUND POWER LINES AND COMMUNICATION FACILITIES

If a power line is placed underground, many of the concerns of protecting a communication worker within the communication worker safety zone are negated. However, since the communication facilities and the electric power facilities can be at different voltage potentials, NESC safety rules focus on bonding of underground facilities to limit the voltage differences. This section will address NESC safety rules that apply to underground facilities.

Buried Supply Cables

The NESC has two sets of rules relating to underground systems. One system is direct-buried, and the other system is a conduit system. A conduit system is any combination of duct, conduit, manholes, handholes, and/or vaults joined to form an integrated whole. Single-phase or three-phase pad-mounted transformers fed by primary cable in conduit is not a conduit system (Reference NESC Rule 350G). If manholes, handholes, and vaults are added, this creates a conduit system. Therefore, many underground residential distribution systems are direct-buried systems and would need to adhere to the rules contained in NESC Section 35–*Direct-Buried Cable and Cable in Duct Not Part of a Conduit System*.

Direct-Buried Supply Cables with Deliberate Separation from Communication Cables

Where direct-buried cable and cable in duct are not part of a conduit system and are deliberately separated from communication cables, the radial separation is 12 inches, as detailed in NESC Rule 353A. Radial separation means that the communication cables can be above, beside, or underneath the supply cables. NESC Rule 353A2 suggests that the separation should provide adequate space for maintenance of either cable system. This generally includes crossing of two cable systems. It is permissible to install a cable system directly over and parallel to another underground cable, provided all parties are in agreement (Reference NESC Rule 353C). Adequate vertical separation shall be maintained to permit access to and maintenance of either facility without damage to the other cables.

Direct-Buried Supply Cables with Random Separation from Communication Cables

The application of joint trenching (random separation with communication cables) is complicated with many different rules which require detailed review of NESC Rule 354.

Random separation is defined as a separation of less than 12 inches between communication cables and supply cables. The rule regarding random separation only applies to direct-buried cables and applies regardless if the cables are in a duct or not (Reference NESC Rule 350G). The concern with communication cables in close proximity to supply cables is the chance of dangerous touch and step potential voltages for any worker doing maintenance in a ditch that has random separation between communication cables and power cables.

There are numerous requirements for random separation set forth in NESC Rule 354. First, all parties must agree to random separation (per NESC Rule 354D) and second, the supply circuits operating above 300 volts to ground or 600 volts between conductors must promptly be de-energized when faulted. Then, the following requirements of NESC Rule 354D1 must be complied with, based on the assumption the system is operating as a multigrounded wye system:

1. Supply cables must operate below 22 kV (phase-to-ground).
2. Ungrounded supply cables operating above 300 volts (phase-to-ground) must be shielded (concentric neutral).
3. Communication cables and communication service cables having metallic conductors must have a continuous metallic shield under the outer jacket.
4. Communication protective devices must be adequate for the voltage and currents expected to be impressed on them in the event of contact with supply conductors.
5. There must be bonding every 1,000 ft between a multigrounded supply conductor and the communication shield.[7]
6. In the vicinity of supply stations where there may be large ground currents, the effect of these currents on communication circuits should be evaluated for joint trenching.

There are safety rules (NESC Rules 354D2, 354D3, or 354D4) that are different depending on the type of underground supply cable used. RUS requirements for primary underground cable requires all underground primary cable to have a jacket over the concentric neutral.[8] This jacket can be an insulating material or a semiconducting material. Cables with semiconducting jackets may be used where soil resistivity is greater than 25 ohmmeters in lieu of using cables with an insulating jacket to help improve the effectiveness of system grounding in locations of high soil resistivity.

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[7] Reference the NESC Rule 354D1g for an exception allowing increased bonding interval.

[8] Reference 7 CFR 1728.204 (Formerly RUS Specification U-1)

For supply cables with semiconducting jackets to have safe random separation with communication cables, the supply cable and its neutral must be adequate for the expected magnitude and duration of the fault current that may be imposed (Reference NESC Rule 354D2). In addition, semiconducting materials need to have a stable resistivity as required by NESC Rule 354D2c.

For supply cables with insulating jackets, the electric utility has two options to safely have random separation with communication cables. One option is defined in NESC Rule 354D4 which requires cables with insulating jackets to be installed in nonmetallic duct. The second option is defined in NESC Rule 354D3 which requires the cable concentric neutral to be adequate for the expected magnitude and duration of the fault current that may be imposed and have at least eight grounds per mile.

Bonding of Adjacent Equipment

Pad-mounted equipment should be bonded together to reduce voltage potential differences. This is similar to common bonding on a pole to protect line personnel. NESC Rule 384C states that bonding should be provided between all above-ground metallic supply and metallic communication apparatus when they are separated by six (6) feet or less. Beyond six feet, it is unlikely that an individual could touch both the electrical case and the metallic communication enclosure. This bonding can be difficult since the pad-mounted transformers are normally installed first and the communication facilities at a later date. The communication workers do not have access to the ground rod in the electric utility's pad-mounted equipment. Even so, these facilities need to be bonded.

One common solution is for the electric utility to install a grounding conductor that extends from underneath the transformer pad to allow access to the communication workers.

Riser Poles

In general, communication cables should be guarded by a separate conduit or a U-guard from the supply conductors. However, NESC Rule 239A2 allows communication conductors and supply conductors operated by the same utility to be installed together in the same duct or U-guard. NESC Rule 239A2e allows communication cables to be installed together in same duct or U-guard, provided all utilities involved are in agreement.

Underground Conduit Systems

A conduit system is any combination of duct, conduit, manholes, handholes, and/or vaults joined to form an integrated whole. The conduit system does not need to be concrete-encased conduits, but often is encased.

In a conduit system, the separation between communication conduits and supply conduits are defined in NESC Rule 320B2. The separation when encased in concrete is 3 inches and 12 inches in well-tamped earth.

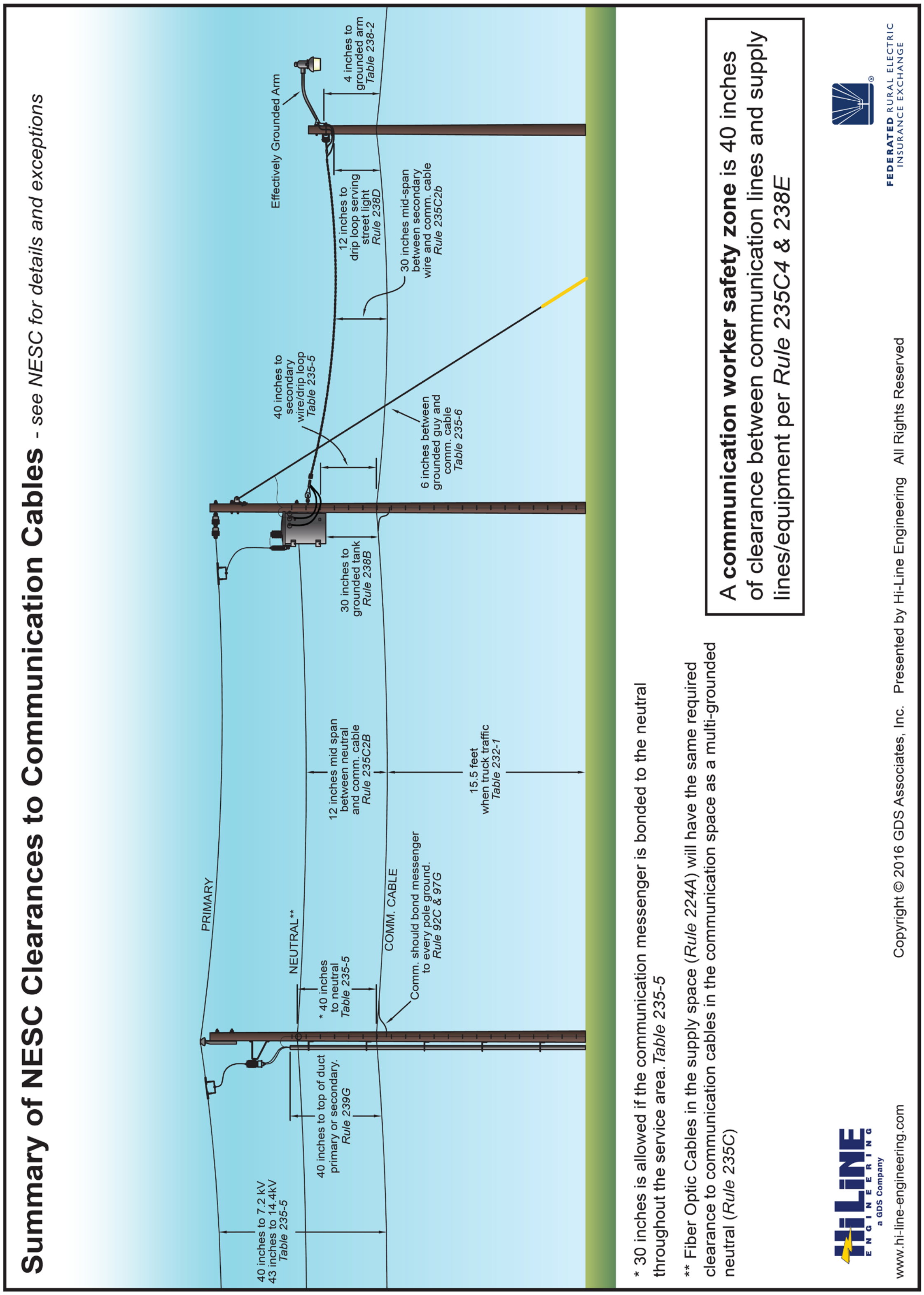
Per NESC Rule 341A6, supply cables shall not be installed in the same duct as communication cables unless all cables are operated and maintained by the same utility.

Manholes and Vaults

It is permissible for communication cables to pass through manholes/vaults that contain supply cables. Workers accessing manholes/vaults with supply cable must be authorized and qualified to be in these spaces close to supply conductors.

Working space in manholes and vaults must be in accordance with NESC Rule 323B: 3 feet horizontal and 6 feet vertical. Refer to NESC Table 341-1 for surface-to-surface clearances between supply and communication facilities in manholes and vaults. All cables shall be permanently identified by tags made of corrosion-resistant material (NESC Rule 341B3a). Bare metallic sheaths, shields, or concentric neutrals must be effectively bonded to a common ground (NESC Rule 342) when exposed to personal contact.

APPENDIX A



Summary of NESC Clearances to Communication Cables - see NESC for details and exceptions
40 inches to 7.2 kV
43 inches to 14.4kV
Table 235-5
PRIMARY
NEUTRAL**
COMM. CABLE
40 inches to top of duct primary or secondary.
Rule 239G
* 40 inches to neutral
Table 235-5
Comm. should bond messenger to every pole ground.
Rule 92C & 97G
12 inches mid span between neutral and comm. cable
Rule 235C2B
15.5 feet when truck traffic
Table 232-1
30 inches to grounded tank
Rule 238B
40 inches to secondary wire/drip loop
Table 235-5
6 inches between grounded guy and comm. cable
Table 235-6
30 inches mid-span between secondary wire and comm. cable
Rule 235C2b
12 inches to drip loop serving street light
Rule 238D
Effectively Grounded Arm
4 inches to grounded arm
Table 238-2
* 30 inches is allowed if the communication messenger is bonded to the neutral throughout the service area. Table 235-5
** Fiber Optic Cables in the supply space (Rule 224A) will have the same required clearance to communication cables in the communication space as a multi-grounded neutral (Rule 235C)
A communication worker safety zone is 40 inches of clearance between communication lines and supply lines/equipment per Rule 235C4 & 238E
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