SOUTHERN CALIFORNIA EDISON
POWER DELIVERY TRANSMISSION & DISTRIBUTION

Overhead Grounding Manual (OGM)

February 23, 2018

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1.0: Introduction

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1.0: Introduction

1.1 Purpose

This manual is intended to ensure consistent and practical policies for grounding de-energized conductors and equipment as required by Southern California Edison's Accident Prevention Manual (APM). Strict adherence to these policies will provide protection for employees working on normally energized high-voltage conductors and equipment that have been de-energized.

This manual addresses many questions asked and comments offered during formal training classes on grounding. Employees are encouraged to make any suggestions that will improve the Grounding Program. As questions and suggestions are received, the Grounding Committee will review, respond, and revise the manual appropriately.

This manual does not address working on energized lines and equipment, or de-energized ungrounded lines and equipment. Unless otherwise noted within this manual, it is expected that the workers intend to work without approved live-line tools or high voltage rubber gloves on the de-energized and grounded overhead lines. It is also understood that the worker shall adhere to all applicable APM rules.

The following are classifications of voltages used in this manual:

- Distribution circuits: 600 V to 33 kV
- Sub-transmission circuits: 55 kV to 161 kV
- Transmission circuits: 220 kV to 500 kV

NOTE A few 33 kV lines are under Transmission jurisdiction.

1.2 Responsibilities

Every supervisor or employee assigned to work on normally energized high-voltage lines or equipment is responsible for adhering to the policies in this manual.

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2.0: Grounding Principles and Requirements

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2.0: Grounding Principles and Requirements

2.1 Why Do We Ground?

Protect Workers from Hazards — Grounding is required for the protection of the worker when working on de-energized high-voltage lines or equipment. Use of personal grounds will minimize exposure associated with making contact with objects having hazardous difference of electrical potentials. Workers should avoid contact with applied grounds wherever possible to minimize exposure to hazardous conditions.

Properly applied grounds will protect the worker from the hazard of energizing of circuits or conductors as a result of:

2.1.1 High-Voltage Sources of Supply

- **Open Breakers, Open Switches, Open Taps, or Open Fuses:** When de-energized conductors to be worked on can be inadvertently energized by a breaker, switch, tap, or fuse, this equipment shall be considered a high-voltage source of supply. Co-Gen facilities are considered a high-voltage source of supply.
- **Crossings:** Energized high-voltage lines (above 600 V) crossing over a de-energized line shall be considered a source of supply. Unprotected energized lines that cross under a de-energized line shall also be considered a source of supply. Crossings can be attached or unattached.
- **Backfeed:** Is the reverse energizing of a high-voltage transformer from the low-voltage side to the high-voltage side. Examples of backfeed are extension cords to a neighbor's panel, motor homes, portable generators, solar panels, wind generators, and temporary power poles at a construction site.
- **Induction:** Induced voltage can be the result of high-current values in parallel lines, such as high-voltage lines parallel to de-energized conductors being worked on. When a circuit is de-energized, it may have a voltage induced in it due to current in the other circuit. Transmission lines can induce dangerously high potentials even though they may be carrying small currents. In addition, radio, TV, or microwave antennas located within close proximity could also induce voltage.
- **Static Charge:** Is an accumulated electric charge most commonly experienced when conductors are exposed to hot, dry winds. This is the same type of charge accumulated from walking on a wool rug. Static charge generated on overhead lines can become hazardous to workers when not eliminated using the grounding methods in this manual.

WARNING Work on de-energized circuits shall be discontinued with an electrical storm in the immediate vicinity.

2.2 When do We Ground?

Grounding is required when working on a circuit that is normally energized above 600 V, unless otherwise performing work with live line or other approved insulated tools.

Grounding is also required during wire stringing when high voltage sources are present.

All conductors shall be considered energized until proven de-energized by testing and grounding.

When working from a grounded and/or steel structure, additional personal grounds shall be installed between each conductor being worked on and the structure. Hazardous difference of electrical potential might exist between the structure where the work is being performed and the ground mediums used for grounding. Personal grounds are required when an Equipotential Zone (that is, workspace) is not created on grounded and/or steel structure. Approved grounds shall be used for personal grounds.

At the discretion of the supervisor in charge and following the proper procedures, Journeyman Lineman and hot apprentices (under the supervision of a journeyman lineman) are authorized to ground.

Second (2nd) Step apprentices may apply a second set of grounds on **OVERHEAD ONLY**. This can **ONLY** be done under the direct supervision of a journeyman lineman, per our Allowable Work Practices under Distribution Apprentice Manuals.

NOTE The definition of Direct Supervision is "An instructor/observer of the appropriate higher classification or journeyman lineman who is positioned in the immediate work area on the pole, tower, structure, or aerial lift." Under Observation is defined as "under the direct observation of a qualified supervisor, directing employee, or an instructor/observer of a higher classification."

Grounding is not required when constructing a new line section on wood, composite, or concrete poles where there are no high voltage sources.

Slacking back conductors, removing from dead-end clamp, or altering attachments do not eliminate grounding requirements of this manual.

Grounds shall meet the requirements, for example, (size, test, inspection, maintenance, length), of this manual, and will be considered as "Approved" grounds.

2.3 Requirements for Overhead Grounding

The general requirements for overhead grounding to achieve maximum protection are as follows:

1. All phases of a circuit shall be grounded.
2. Obtain fault-current duty of the system from the Protection Engineering website. If multiple sources can inadvertently energize the line, select the largest size of grounds that will provide protection for all sources involved.
3. See Table 3–1 of this manual and select appropriate ground conductor size.
4. Select the shortest possible length of grounds in all scenarios that will safely accomplish the task. Selecting the shortest possible length keeps the resistance values as low as possible and reduces the need to coil excess length of installed grounds and restrain the slack grounds after installation. Do not connect multiple lengths of short grounds to each other in series to make a longer ground to connect between phase-to-phase, phase-to-neutral, phase-to-structure, or

neutral-to-structure. Long grounds connected to the temporary ground rods or anchor rods may be lengthened by connecting multiple lengths together using the appropriate ground bar (SAP 10147833).

5. Inspect grounds and grounding equipment before each use, and use only those in good condition. Remove from service grounds that have been exposed to fault current and/or accidental energizing.
6. Follow proper testing requirements of conductors/equipment before applying the grounds.
7. Follow the order of priority for attaching to ground mediums, for example, (station ground grid or multi-grounded primary neutral).
8. When practical, and as configuration allows, use grounding schemes as defined in Subsection 3.6.12. Follow order of preference of grounding schemes, for example, (parallel, balanced).
9. Use approved grounding methods when applying grounds.
10. Always use approved live-line tools to install, relocate, and remove grounds.
11. Whenever possible avoid coiling of grounds when installing them. Restrain grounds installed with excessive length by securing with small ropes tied from the grounds to a secure anchorage. This limits the amount of movement that may occur during a fault and reduces the mechanical stresses imposed on the ground cable, clamps, and ferrules.
12. When working from a steel structure, all phases within minimum approach distance shall be connected to the structure/pole band to create workspace EPZ.
13. Maintain clean and solid contact pressure of the ground connections.
14. Keep resistance between de-energized conductors/equipment and ground medium(s) at a minimum.
15. When making or breaking continuity, shunts shall be installed using approved live line tools. Maintain continuity of grounded conductors at all times by means of a continuous conductor(s) between grounds or a jumper/bypass/approved ground when opening or closing conductors. Before opening or closing any conductor that may be exposed to a hazardous difference of electrical potential, when closing the first conductor, or opening the last conductor, approved jumpers shall be in place across the point to be opened or closed to ensure continuity of the conductor.
16. Use pole band(s), Equipotential Zone mat(s) (EPZ mat), Anchor rod(s), or temporary ground rods to create an Equipotential Zone (EPZ).
17. Maintain minimum approach distances and/or adequately protect exposed energized conductors/equipment.
18. Create a clearance area around temporary ground rods, steel structures, and vehicles when grounded.
19. Ensure that one set of the applied grounds is visible to at least one member of the crew unless the applied grounds are accessible only to authorized persons.
20. Remove taps completely (from line to line) when using Overhead Bracket Grounding Method for distribution circuits. For long-lead taps, see Section 4.16.
21. Work shall not be performed on downed overhead lines until they have been tested de-energized and grounded, unless they are being cut in the clear, with approved live-line tools, to protect from personal injury.
22. Previously energized aerial cable shall be worked on in accordance with an approved work method, Approved work methods described in this manual are: grounding and/or aerial cable isolation.
23. Remove grounds.

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3.0: Grounding Process

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3.0: Grounding Process

The way grounds are applied is important to maximize worker protection by maintaining all de-energized equipment, conductors, fixtures, and structures at the same electrical potential, and preventing the workers from exposure to hazardous difference of electrical potential.

The key steps in the grounding process are:

- Conduct a thorough tailboard
- Determine grounding requirements
- Inspect grounds before use
- Clean ground connections
- Test conductors de-energized
- Apply proper grounds (see Table 3–1)
- Remove grounds

3.1 Conduct a Thorough Tailboard

Before beginning any grounding procedures, the supervisor or employee in charge shall hold a tailboard briefing in accordance with Accident Prevention Manual (APM), Rule P-20. This meeting shall include these additional points:

- The status of all lines and issued clearances.
- Identification of hazards and required safeguards.
- Grounding method(s) and associated procedures to be utilized.
- The location(s) to which the personal grounds are to be applied.
- Verification of the size and number of grounds needed for the specific application.
- Requirement of testing to determine the lines or equipment are de-energized before installing grounds.
- Review the process for applying grounds.

If there is any question regarding the grounding process at the completion of the tailboard, then the employee(s) will Stop, Think, Observe, and Perform (**STOP**) accordingly. Contact Supervision, SES, or Construction Methods for assistance.

3.2 Determine the Size of Grounds

To determine the size of grounds:

1. Use the criteria in Table 3–1 to select the quantity, size, and length of grounds for the source voltage and fault-current duty at the work site or source substation(s).
2. Fault duties of various substation buses are listed in the "Redbook" available on-line on the Protection Engineering website. When utilizing the Redbook, the highest fault duty listed for the line voltage being worked on shall be used for sizing the grounds.
3. When grounding multiple circuits on one structure, determine the ground conductor size by the maximum size conductor and/or greatest fault-current duty on the structure.
4. Determine the size of grounds based on the highest fault-current duty source at each grounding location.
5. All grounds applied shall be capable of withstanding the highest fault duty. Larger size grounds than those required may be applied at any time, unless otherwise noted in Note 1 and Note 2 of Table 3–1.

❻ When the primary protection on the circuit being worked on is not in service, contact Substation Construction and Maintenance for site-specific grounding requirements.

Table 3–1: Criteria for Sizing Grounds

Table Note: See Note 1 and Note 2.

Source Voltage[1/]	MAX Fault Current Duty[2/] (A)	Quantity of Grounds per Phase[3/]	Size of Copper Grounds (AWG)	MAX Length of Grounds[4/] (ft)
2.4 – 55 kV	30,000	1	4/0	20
2.4 – 55 kV	18,000	1	2/0	20
2.4 – 55 kV	9,000	1	#2	20
66 – 161 kV	38,000	1	4/0	20
66 – 161 kV	24,000	1	2/0	20
220 – 500 kV	63,000	2	4/0	30
220 – 500 kV	37,000	2	2/0	30

Note(s):

1. When phase conductors of the line(s) being grounded is copper and its size is smaller than #2 AWG, or the phase conductor is aluminum and its size is 1/0 AWG or smaller, then #2 AWG copper grounds may be used for grounding, regardless of source voltage and fault-current duty.
2. When phase conductors of the line(s) being grounded is copper and its size is smaller than 2/0 AWG, or the phase conductor is aluminum and its size is 4/0 AWG or smaller, then 2/0 AWG copper grounds may be used for grounding, regardless of source voltage and fault-current duty.

1/ Source voltage is the voltage of the electrical power sources that could inadvertently energize the line being worked on. The electrical power sources to be considered are the sources that are normally connected to the line for which personal protective grounding is being applied.

2/ When the fault-current duty of the line to be worked on exceeds the values listed in Table 3–1 contact Construction Methods for direction. For 66 kV lines, see Paragraph 3.2.3 .

3/ For overhead transmission lines, when the line is bundled, one ground per sub-conductor is required. See Paragraph 3.2.1 for more detail regarding bundled lines. When a 220 kV line is not bundled, then two grounds per phase are generally required. See Paragraph 3.2.2 for more detail. Equal length grounds shall be used when more than one ground is applied in parallel to a single or to bundled conductors. Two equal length 4/0 grounds are required for 66 kV lines that exceed 38,000 amps fault duty. See Paragraph 3.2.3 for more details.

4/ This column presents the maximum length of grounds to be used for connecting between phase-to-phase and phase-to-neutral. Also, the lengths presented in this column apply to grounds used for parallel grounding and grounds connected between phases through a pole band. In addition, the length of grounds that connect a pole band on a wood, composite, or concrete pole to the phase or neutral is not limited by the lengths presented in this column as long as these grounds are not used as shunts to maintain continuity and are not connected to two different phases. Contact Construction Methods for direction when longer grounds than listed in this column are needed.

3.2.1 Grounding Lines Constructed with Bundled Conductors

For bundled lines, one ground per sub-conductor is required for each set of grounds. The grounds shall be the same size and equal lengths and connected from each sub-conductor to the ground medium, for example, (structure). Shorting/connecting sub-conductors to each other instead of grounding each sub-conductor is prohibited.

For quad bundled 220 kV lines, four 2/0 grounds (that is one ground per subconductor) with length of 30 feet or less may be used when the fault-current duty is 48,000 amps or less.

3.2.2 Grounding Single Conductor 220 kV Lines

When fault-current duty is between 37,000 and 63,000 amps, for each set of grounds being applied to a single conductor 220 kV circuit, two 4/0 grounds of the same length are required for each phase in accordance with Table 3–1.

When fault-current duty is 37,000 amps or less, two 2/0 grounds of the same length are required for each phase. Two 2/0 grounds may be replaced with one 4/0 ground.

For circuits that have maximum fault-current duty less than or equal to 23,000 amps, one 2/0 ground with length of 30 feet or less is adequate for each phase/conductor (see Figure 3–1 and Figure 3–2).

Figure 3–1: 220 kV Single Conductor and Fault-Current Duty Greater than 23,000 Amps

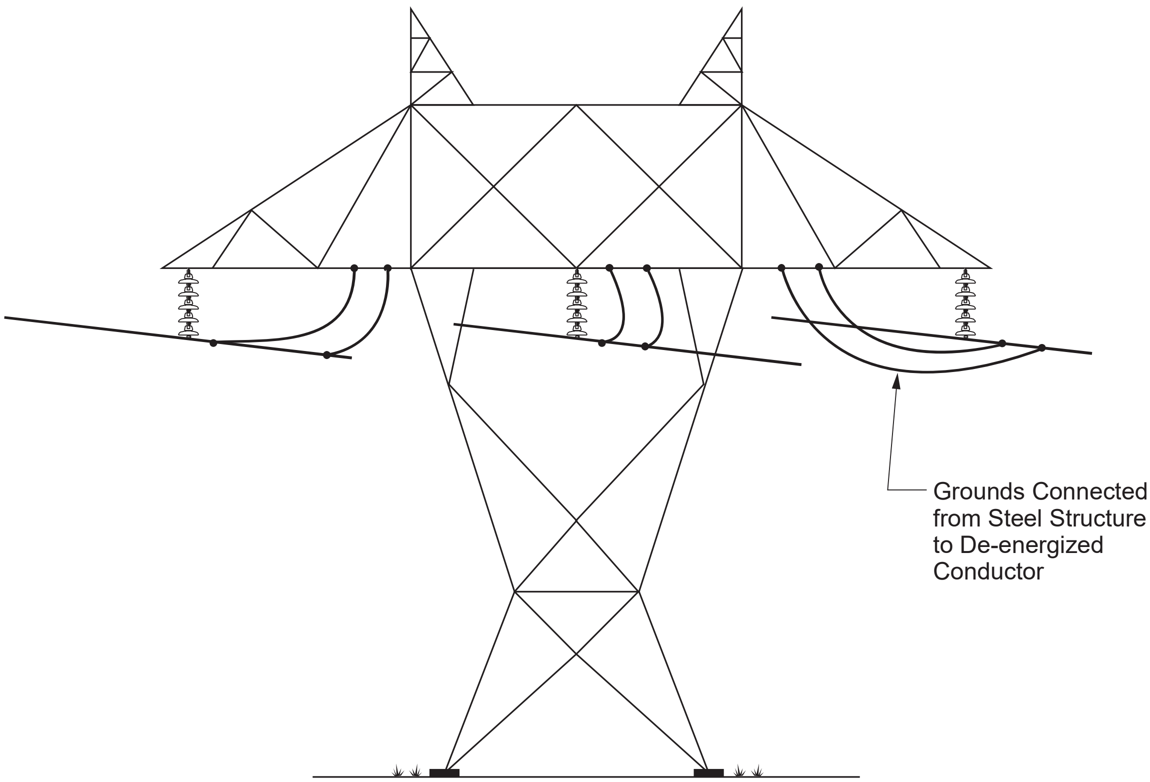
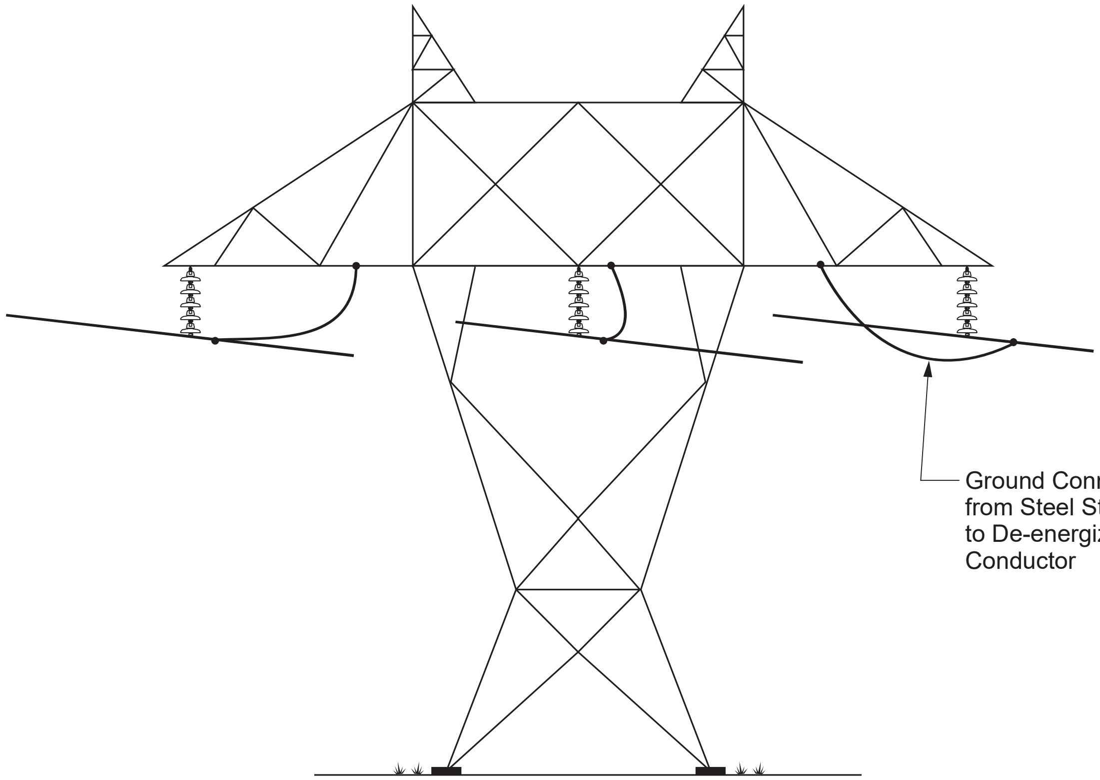


Figure 3–2: 220 kV Single Conductor and Fault-Current Duty less than 23,000 Amps



3.2.3 Grounding 66 kV Lines with More than 38,000 Amps Fault Duty

Two equal length (20 feet or shorter) 4/0 grounds per phase are required to ground 66 kV lines that exceed 38,000 amps fault duty. Two 4/0 grounds are required in these locations:

- Between phases when balanced or unbalanced grounding scheme is used; and,
- Between phases and structure when parallel grounding scheme is used.

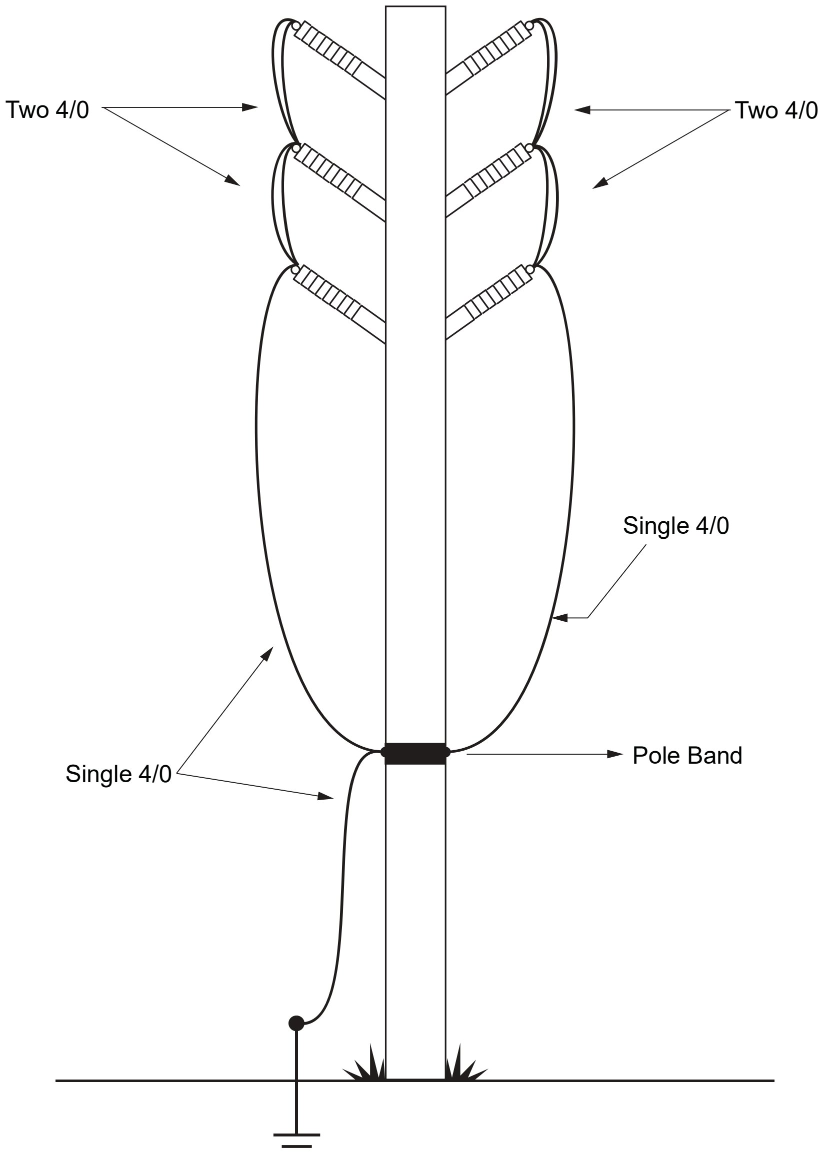
66 kV lines single phase-to-ground fault duty is less than phase-to-phase fault duty. Therefore, double grounds are only needed between phases and not between phase and ground mediums.

When grounding 66 kV lines with more than 38,000 amps fault duty with an underbuilt distribution line, use of double grounds for distribution line is not needed.

Examples of grounding 66 kV lines with more than 38,000 amps fault duty are shown in Figure 3–3 through Figure 3–7. Figure 3–3, Figure 3–4, and Figure 3–6 show a single 4/0 ground connection per circuit to the pole band. Due to limitation of a single phase to ground fault current of 66 kV system, the fault current that could pass through the single 4/0 ground and the pole band will not exceed their capability. A Flat Jaw Clamp or a copper grounding bolt can also be used in lieu of the pole band.

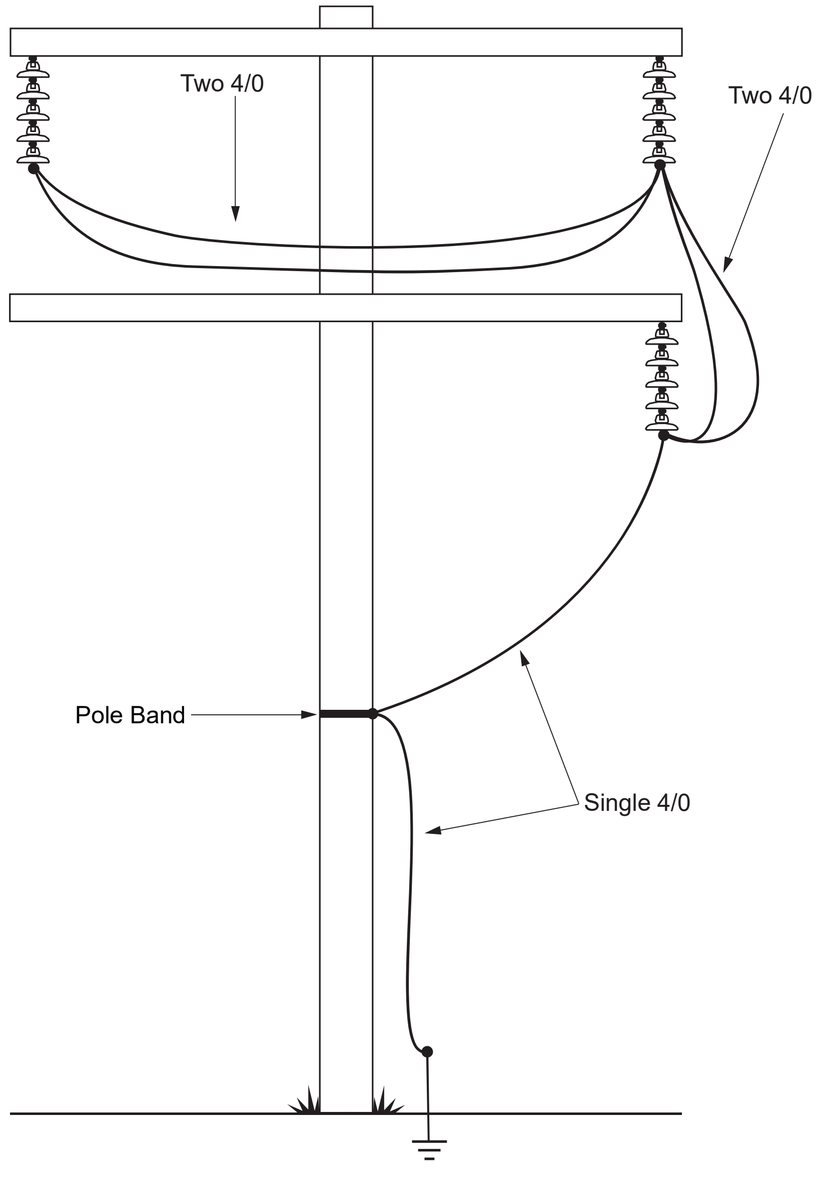
Example 1 — Double circuit 66 kV lines on a wood pole.

Figure 3–3: Grounding 66 kV Lines with More than 38,000 Amps Fault Duty — Example 1



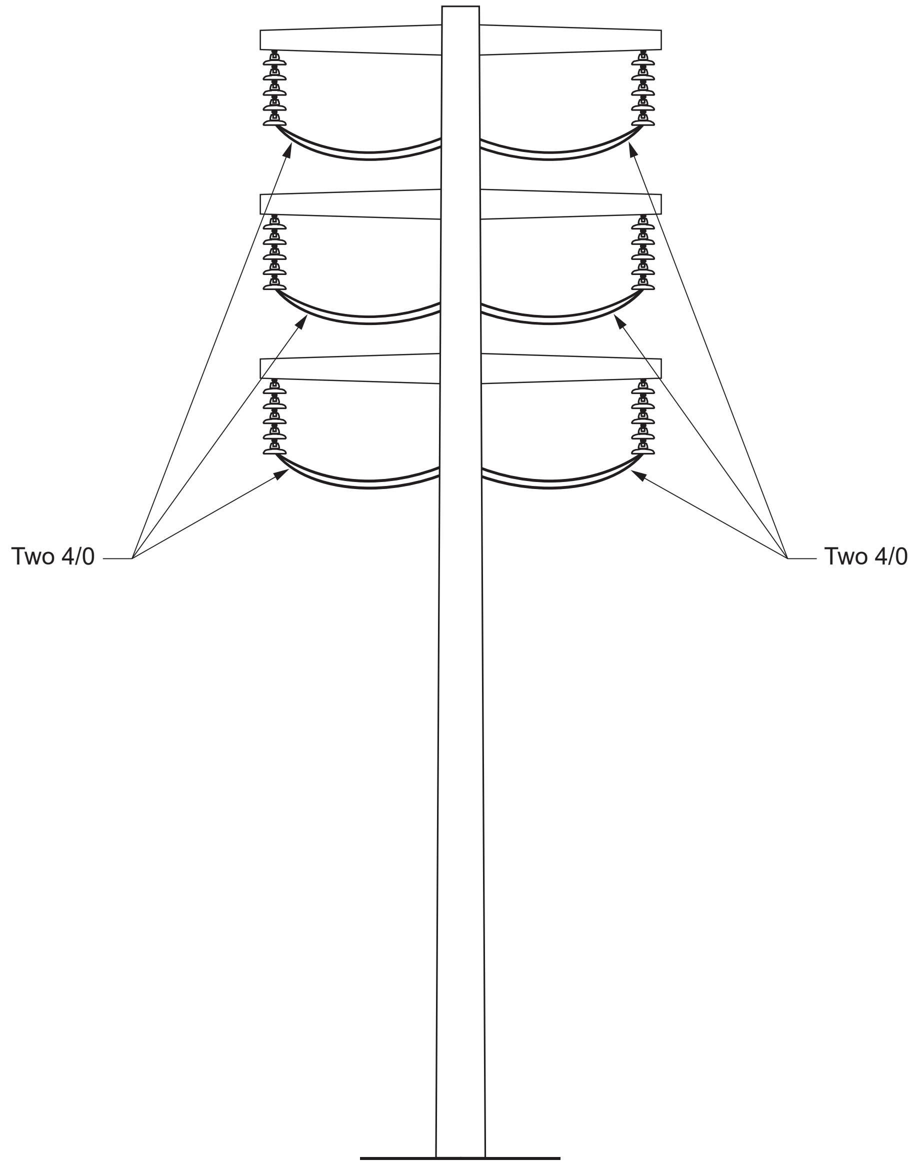
Example 2 — Single circuit 66 kV line on a wood pole.

Figure 3–4: Grounding 66 kV Lines with More than 38,000 Amps Fault Duty — Example 2



Example 3 — Double circuit 66 kV lines on a Tubular Steel Pole (TSP).

Figure 3–5: Grounding 66 kV Lines with More than 38,000 Amps Fault Duty — Example 3

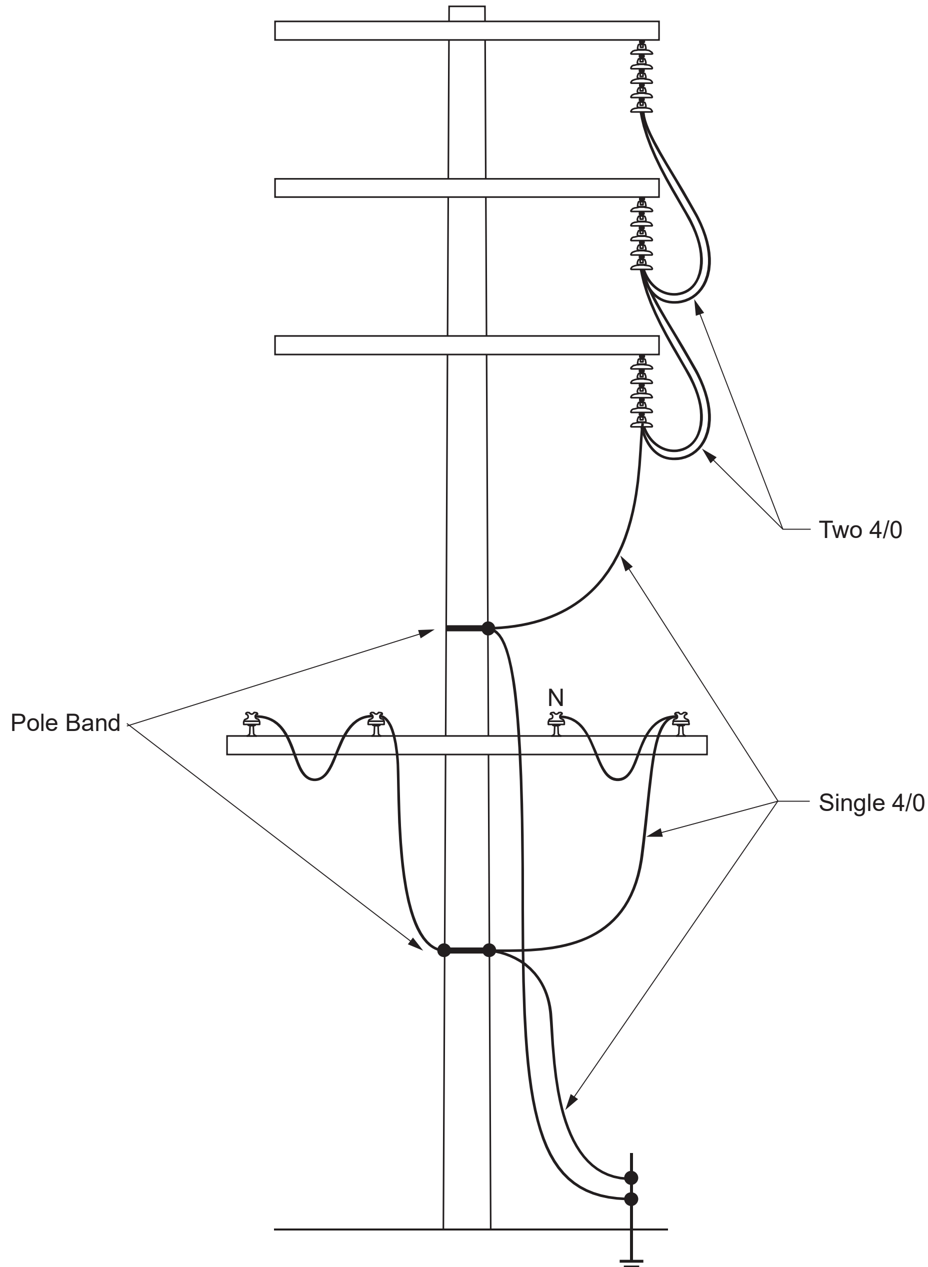


Note(s):

1. Grounding attachments to the pole shall be approved step bolts or copper grounding bolts.

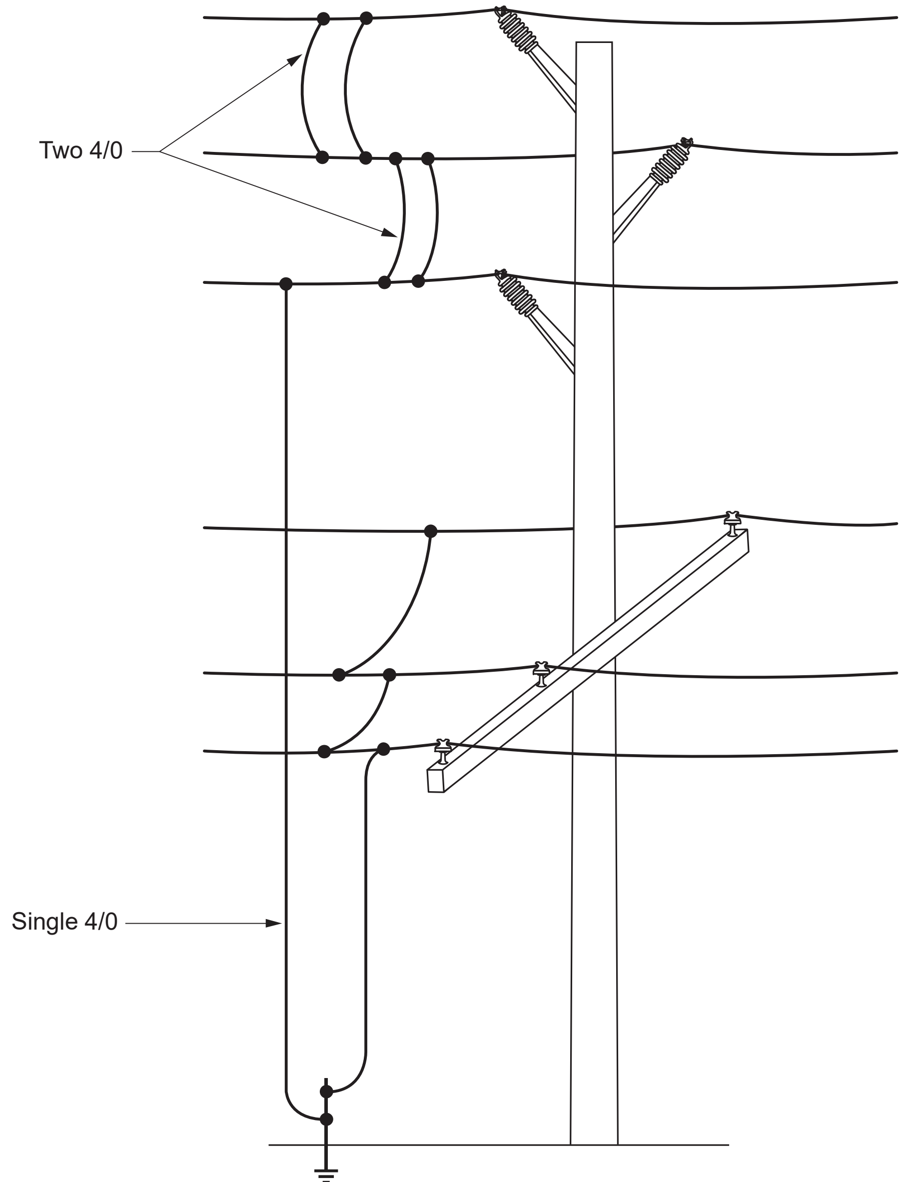
Example 4 — Single circuit 66 kV line and a distribution line on a wood pole.

Figure 3–6: Grounding 66 kV Lines with More than 38,000 Amps Fault Duty — Example 4



Example 5 — Single circuit 66 kV line and a distribution line on a wood pole.

Figure 3–7: Grounding 66 kV Lines with More than 38,000 Amps Fault Duty — Example 5



3.3 Inspect Grounds Before Use

The supervisor or employee in charge is responsible for determining the serviceability and condition of ground assemblies.

3.3.1 Visually Inspect All Ground Assemblies Before Each Use

Include the following in each inspection:

3.3.1.1 Ground Cable Inspection

- ☐ Inspect the ground cable for cuts, nicks, and abrasions that may have penetrated through the jacket into the conductor and, if suspect, inspect the conductor for broken strands or visual signs of corrosion.
- ☐ Inspect for kinks that could possibly damage the strands.
- ☐ Ensure ground cable is not damaged, for example, (flattened).
- ☐ Inspect for swollen cable jacket or soft spot for indication of internal corrosion or damage to strands.
- ☐ Verify the GARP test date is current (that is, within 24 months of test date).

NOTE Ground cable jacket is not considered insulation; it is for mechanical protection only.

3.3.1.2 Ground Clamp Inspection

- ☐ Ensure all components are in place and tight.
- ☐ Loose threaded ferrule connections to the clamp assembly shall be tightened before use.
- ☐ Ensure ferrules and clamps are not cracked or broken.
- ☐ Visually inspect the crimped ferrule on the end of the conductor for broken strands or visual signs of corrosion.
- ☐ Inspect for indications of corrosion at the threaded connection, hinge points, or any other surfaces of the clamp.

3.3.1.3 Ground Accessory Inspection, for example, (Pole Bands, Flat Jaw Clamp)

- ☐ Ensure the accessories are clean and in good working condition.

3.3.1.4 EPZ Mat

- ☐ Visually inspect EPZ mat and ensure it is clean and in good working condition.
- ☐ The braids shall be intact.
- ☐ Holes in the canvas are acceptable.
- ☐ EPZ mat can be cleaned, washed off with mild soap and water, towel and air dried.
- ☐ Verify that the grounding stud connection to the EPZ mat is clean and functional.
- ☐ Verify that the bonding conductor clamps and connections are clean.
- ☐ Check for broken strands on the bonding conductor or damage to the protective covering which has migrated to the inner conductor.

3.3.1.5 When a ground cable, clamp, EPZ mat, or accessory is found to be in unsatisfactory condition, remove from service.

3.4 Clean Ground Connections before Installing Grounds

3.4.1 Cleaning Conductors

Clean conductors as follows:

STEP 1. **Always** clean the line conductors and overhead ground wires before testing and attaching grounds.

STEP 2. Use a wire brush to clean conductors with approved live-line tool.

NOTE Additional cleaning is provided by the serrated jaws of the clamps when the clamp is rocked on the conductor during the installation of the ground.

3.4.2 Cleaning Ground Mediums

Clean ground mediums as follows:

STEP 1. Clean the ground mediums for suitable electrical connection before making the ground connection.

STEP 2. Remove any rust or paint.

STEP 3. Clean station ground grid pigtails using a wire brush, file card or emery paper.

STEP 4. After removal of grounds, re-paint and/or apply cold galvanizing to the disturbed surfaces of all structures.

3.5 Test Conductors De-Energized before Installing Grounds

Test conductors de-energized using an approved testing device before applying grounds in the following sequence:

WARNING Always consider conductors energized until they are tested de-energized and grounded.

STEP 1. Clean conductors at the location where the testing device is to be applied.

STEP 2. Set the testing device on the proper voltage range for the circuit to be tested.

STEP 3. Before testing the conductors de-energized, test the testing device on an energized conductor or by means of the test switch to determine that the testing device is working properly.

STEP 4. Test each conductor/phase on the circuit as de-energized before applying grounds.

STEP 5. After testing all conductors de-energized, retest the testing device on an energized conductor or by means of the test switch to re-verify proper operation of the device.

3.6 Apply Grounds

Key steps of grounding are:

- Ground Medium(s)
- Minimizing personnel and public exposure
- Proper workspace
- Grounding Schemes
- Grounding Methods
  - — Overhead Equipotential Bracket Grounding
  - — Overhead Bracket Grounding
- Leaving Grounds Overnight

3.6.1 Ground Mediums in Order of Priority

1. Approved ground mediums in order of priority are:

   a. Substation ground grid (see Subsection 3.6.2)

   b. Multi-grounded primary neutral (see Subsection 3.6.3)

   c. Grounded steel structures (see Section 4.2 and Section 4.3), steel structures ground lugs (see Subsection 3.6.4), steel structures step bolts (see Subsection 3.6.5), steel structures copper grounding bolts (see Subsection 3.6.6)

   d. Anchor rods (see Section 4.8)

   Exception: Anchor rods within 10 feet of marked high pressure pipelines, carrying flammable liquids or gases, shall not be used as a ground medium.

2. When none of the foregoing is available, use approved temporary ground rod(s) (see Subsection 3.6.7).

NOTE Temporary driven ground rods shall not be installed within 10 feet of marked high pressure pipelines, carrying flammable liquids or gases.

3. When a primary neutral is used as a ground medium, the circuit shall be grounded to an additional ground medium (see Subsection 3.6.3).

4. When grounding a transmission circuit on a transmission wood riser pole, in addition to the above ground mediums; the 4/0 bare copper ground continuity conductor shall also be included in the grounding scheme.

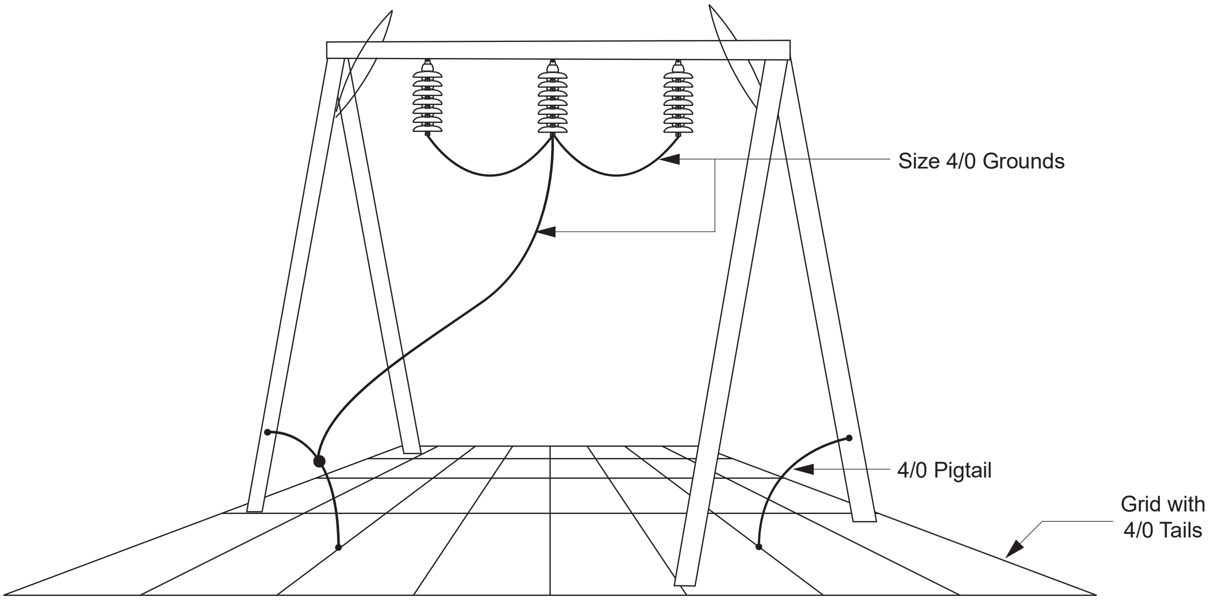
3.6.2 Substation Ground Grid as Ground Medium

Substation ground grid is the priority ground medium to be used for grounding. When grounding within 40 feet of substation ground grid, the fault current, if the line is inadvertently energized, will be as high as the fault-current duty of the substation bus. Therefore, the substation ground grid shall be used as a ground medium when grounding within 40 feet of the substation ground grid and proper locations shall be selected for routing and attaching grounds to the substation ground grid.

Substation ground grids are constructed using mostly #2, 2/0, 4/0, or 350 size copper conductors. The substation ground grid pigtails that are used to ground various equipment and structures within substations are also mostly #2, 2/0, 4/0, or 350 size copper conductors. Using these substation ground grid pigtails for attaching grounds is preferred. See Figure 3–8. Structures such as racks may be used for grounding.

However, the size of pigtails grounding these structures should be verified for adequacy. Building structures such as fence posts shall not be used for attaching grounds.

Figure 3–8: Proper Pigtail Size for Grounding — Example 1



Procedure

STEP 1. Ensure that the size of substation ground grid pigtails meets the requirements of Table 3–1.

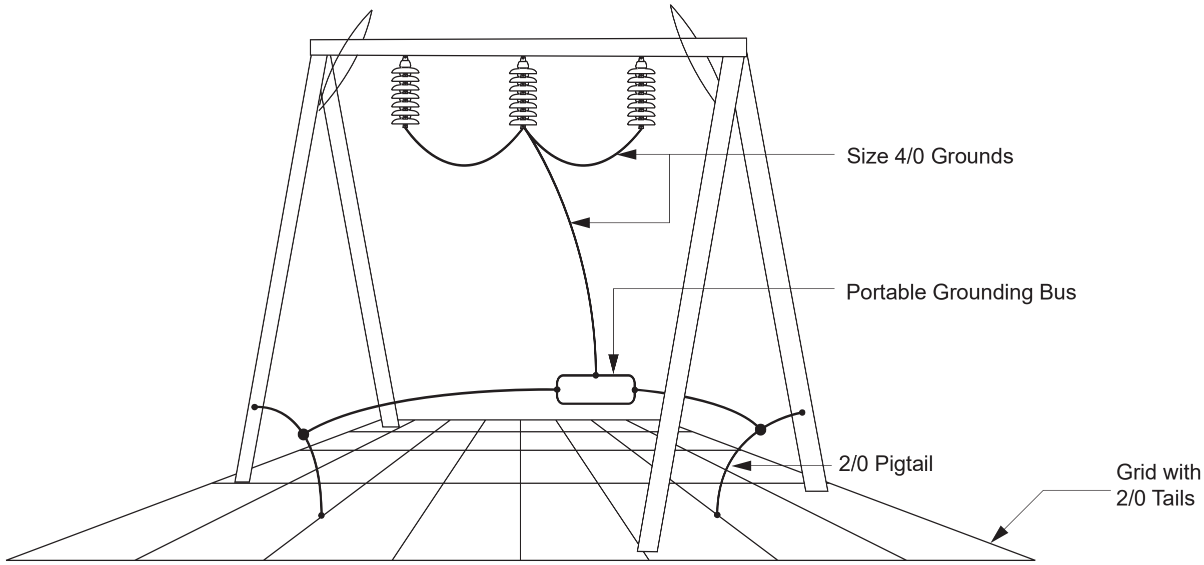
STEP 2. When the size of substation ground grid pigtail is smaller than what is required, use multiple pigtails electrically in parallel. Two 2/0 pigtails are equivalent to one 4/0.

STEP 3. Use an apparatus that is capable of carrying the maximum fault current to distribute the fault current to multiple pigtails. A portable grounding bus, as described in the Substation Grounding Manual, is an example of such apparatus.

STEP 4. Ensure that equal lengths of grounds are used to distribute fault current to multiple pigtails (see Figure 3–9).

STEP 5. Contact the appropriate SC&M maintenance crew for use of the portable grounding bus and the proper connections to the substation ground grid. The SC&M crew will provide the portable ground bus and any grounds necessary for connection to the ground grid.

Figure 3–9: Proper Pigtail Size for Grounding — Example 2



3.6.3 Multi-Grounded Primary Neutral as Ground Medium

A multi-grounded primary neutral, as opposed to a "floating" neutral, is defined as a neutral conductor on a primary circuit that has grounds attached to it at intervals of up to 1,200 feet and is also tied to the substation ground grid. When a multi-grounded primary neutral does not have grounds attached to it at intervals of up to 1,200 feet, it should be reported. However, it shall still be incorporated into the grounding scheme as a ground medium.

When a multi-grounded primary neutral conductor is incorporated into the grounding scheme, ensure that an additional approved ground medium is also utilized (see Section 4.6 for additional details).

WARNING

1. Secondary neutrals that are not part of a common neutral system shall not be utilized as a ground medium; and,
2. Foreign utility neutrals shall not be used as a ground medium.

WARNING

Isolated/Floating neutrals beyond distribution Automatic Reclosers (ARs) shall not be used as a ground medium; the floating neutral shall be opened between the AR and the bracket grounds. Floating neutrals that are not part of the line being grounded, should not be incorporated into the grounding scheme because that connection could cause an unplanned operation, for example, (AR tripping).

3.6.4 Steel Structures, Ground Lugs

Welded ground lugs on engineered TSP arms are designed to provide the least resistive connection to ground. When available, use approved welded ground lugs as the preferred ground medium connection points for grounding. Ground lugs are capable of carrying fault duties equivalent to one 4/0 ground.

3.6.5 Steel Structures, Step Bolts

Three quarter inch diameter threaded step bolts are approved for grounding on engineered TSP. Remove, clean, and grease step bolt threads before each use for grounding. The maximum fault currents these step bolts can carry are as follows:

System Voltage (kV)	MAX Fault Current (A)
2.4–55	20,000
66–161	30,000
220–500	36,000

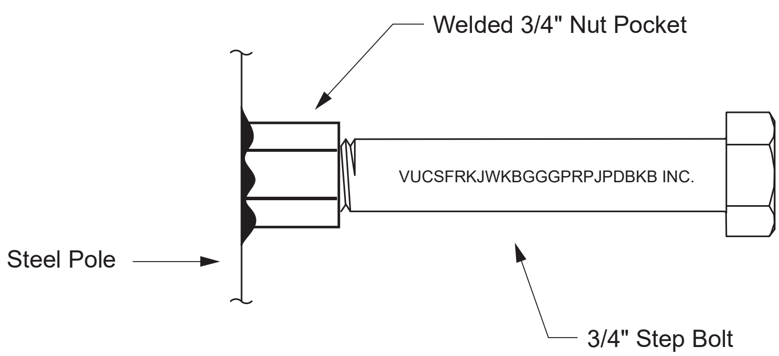
Use only step bolts that can carry the anticipated fault current for grounding. Copper grounding bolts can be used when the fault current of the system exceeds the values indicated above (see Subsection 3.6.6 for copper grounding bolts).

Two step bolts in parallel can also be used when the fault current of the system exceeds the values indicated in the above table. When using step bolts in parallel, grounds connected between each phase and these step bolts shall be the same size and length. When using two step bolts in parallel, the maximum fault current that these two step bolts can carry are as follows:

System Voltage (kV)	MAX Fault Current of Two Step Bolts (A)
2.4–55	32,000
66–161	48,000
220–500	56,000

Approved 3/4-inch step bolts are SAP 10068467 (see Figure 3–10).

Figure 3–10: Approved Step Bolt to be Used in Grounding



Do not attach grounds to a temporary or portable-type step bolt. These include the pull out, push in type, and the portable steps that slide into a pocket welded to the face of the pole.

Welded step bolts on contemporary and portal structures may be used for grounding. In addition, the welded-type ladder rungs on contemporary towers that are normally found at the arm transition may be used for grounding.

When a Light Weight Steel Pole (LWS) has 3/4-inch welded pocket nuts an approved step/grounding bolt can be used to establish the Equipotential Zone in lieu of a pole band. These bolts cannot be used as a grounding medium on LWS poles.

Step bolts on lattice structures, concrete or composite structures shall not be used for grounding. Likewise, ladders that are bolted onto the face of contemporary towers shall not be used for grounding purposes.s

3.6.6 Steel Structures, Copper Grounding Bolts

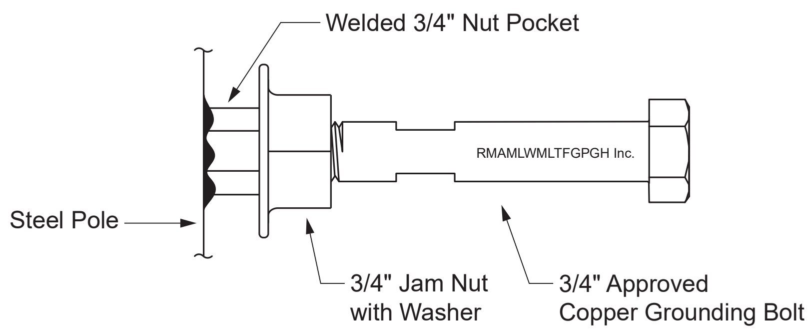
Copper grounding bolts are approved for grounding on engineered TSP. Clean and grease copper grounding bolt threads before each use for grounding. The maximum fault currents these copper grounding bolts can carry are as follows:

System Voltage (kV)	MAX Fault Current (A)
2.4–55	30,000
66–161	38,000
220–500	42,000

Use only grounding bolts that can carry the anticipated fault current for grounding. When the fault current of the system exceeds the values indicated above, contact Construction Methods.

Approved copper grounding bolts are SAP 10176181 (see Figure 3–11).

Figure 3–11: Approved Copper Grounding Bolt



When a LWS pole has 3/4 inch welded nut pocket, an approved step/grounding bolt can be used to establish the Equipotential Zone in lieu of a pole band. These bolts cannot be used as a ground medium on LWS poles.

Grounding bolts shall be tightened to the 3/4 inch welded nut until the bottom of the bolt is in contact with the surface of the pole. Then, the 3/4 inch jam nut (with welded washer) shall be tightened to the welded nut.

3.6.7 Approved Temporary Ground Rods

Temporary ground rod(s) may be used as an approved ground medium when priority ground mediums are not available. Temporary ground rods are 5/8-inch copper clad steel material. The two approved ground rod(s) configurations are as follows:

1. One single ground rod buried a minimum of seven feet deep, maximum 45-degree angle from center (see Figure 3–12).
2. Two parallel ground rods driven to a minimum of 30-inches deep and a minimum distance of six feet apart (see Figure 3–13). These two ground rods shall be jumpered to each other with an approved ground that is equivalent to the grounds being used.

Figure 3–12: Single Temporary Ground Rod

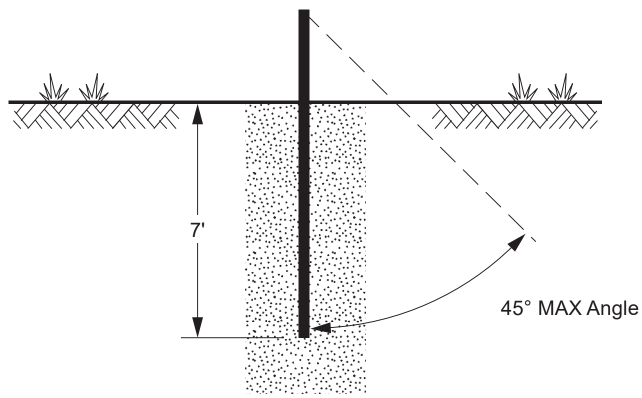
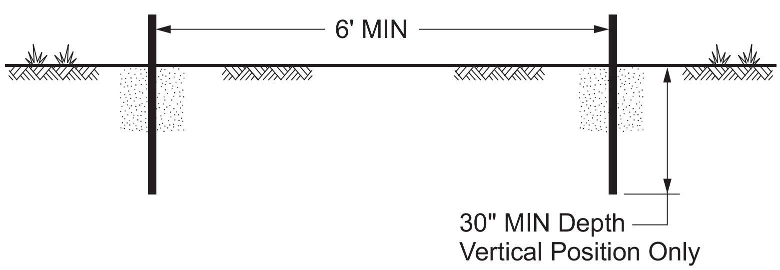


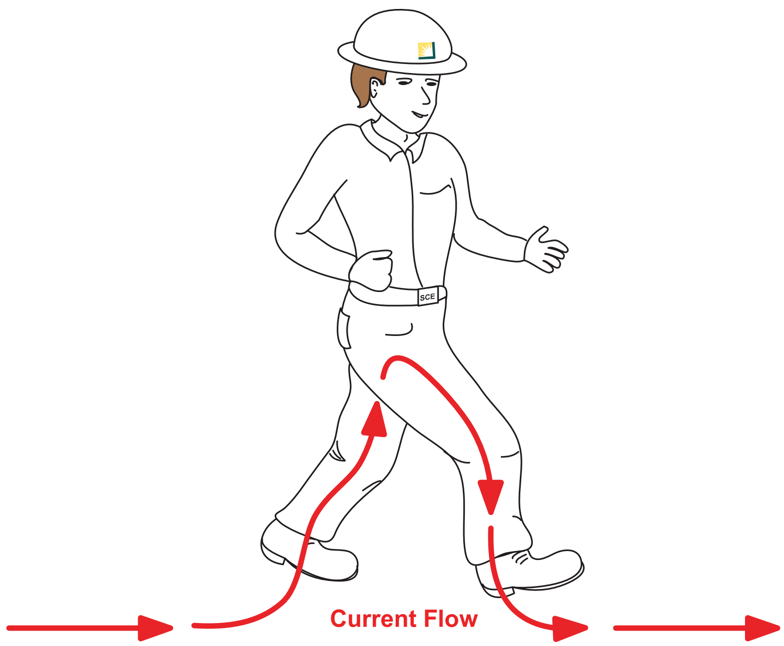
Figure 3–13: Two Temporary Ground Rods



3.6.8 Step and Touch Potential

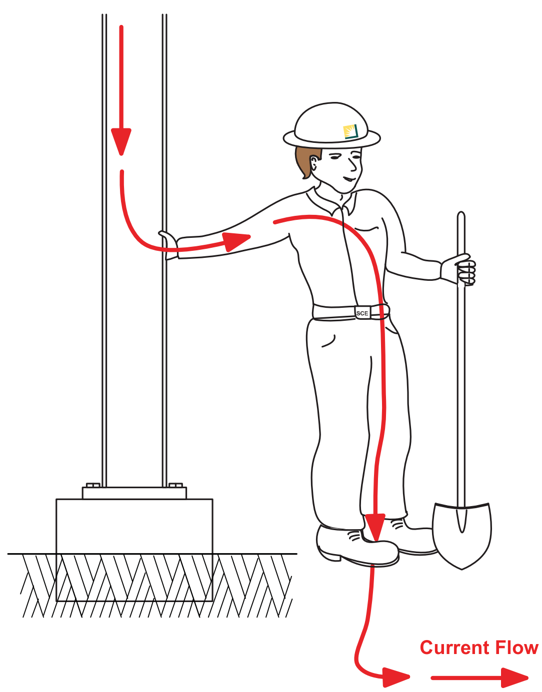
Step Potential — Is the electrical potential difference between two points on the earth's surface, separated by distance of one pace.

Figure 3–14: Step Potential



Touch Potential — Is the electrical potential difference between a grounded metallic structure and a point on the earth's surface separated by a distance of a typical reach.

Figure 3–15: Touch Potential



3.6.9 Minimizing Personnel and Public Exposure (Clearance Area)

Step and touch potential hazards may occur in the immediate vicinity of a ground medium, for example, (a ground rod), during a fault. To minimize exposure, perform the following:

Techniques for Protection:

1. Position grounds and temporary ground rods so that personnel and public exposure is kept to a minimum.
2. Where practical, maintain a ten foot minimum working clearance area around ground level ground connections where de-energized conductors are connected to ground mediums.
3. Ensure connections at ground level mediums, for example, (anchor rods, temporary ground rods), are not accessible to the general public.
4. When public access to the work area cannot be avoided, use appropriate work area protection techniques to minimize public exposure.
5. Minimize personnel and public exposure to grounded vehicles and steel structures.
6. Consider step and touch potential hazards when working near the base of a grounded vehicle or steel structure. Similar techniques, as described above, should be employed to protect from hazardous step and touch potential that could exist in the immediate vicinity of a grounded vehicle or steel structure. An EPZ can be utilized for work protection.
7. To minimize public and personnel exposure from contacting objects located within Equipotential Zone, install pole bands a minimum of 12 feet elevated from the ground level.

3.6.10 Workspace on a Structure

Workspace is needed when working on de-energized conductor(s) from a structure while using Overhead Equipotential Bracket Grounding Method. The workspace should be an Equipotential Zone to minimize exposure to hazardous difference of electrical potentials. For grounding purposes, the workspace on a structure will vary depending on the type of material the structure is made of and the application of pole band(s) and/or structure grounds on the structure. Workspace on various structures is described below. To minimize exposure hazards, workers located outside the workspace, should avoid contacting installed pole bands and grounds in the grounding scheme.

It is imperative that transitioning in or out of the Equipotential Zone be performed quickly and safely to minimize exposure to step and touch potential.

3.6.10.1 Workspace on LWS Pole — Use of the Pole Band or Approved Step/Grounding Bolt

Workspace on a LWS pole is established after applying grounds to a pole band or approved step/grounding bolt. The Equipotential Zone on a LWS pole is the entire surface of the structure. The location of the pole band or step/grounding bolt is not critical since the pole is conductive. However, the pole band shall be a minimum of 12 feet above ground level to prevent easy access to the public (see Figure 3–16 and Figure 3–17).

Figure 3–16: Workspace on a LWS Pole — Example 1

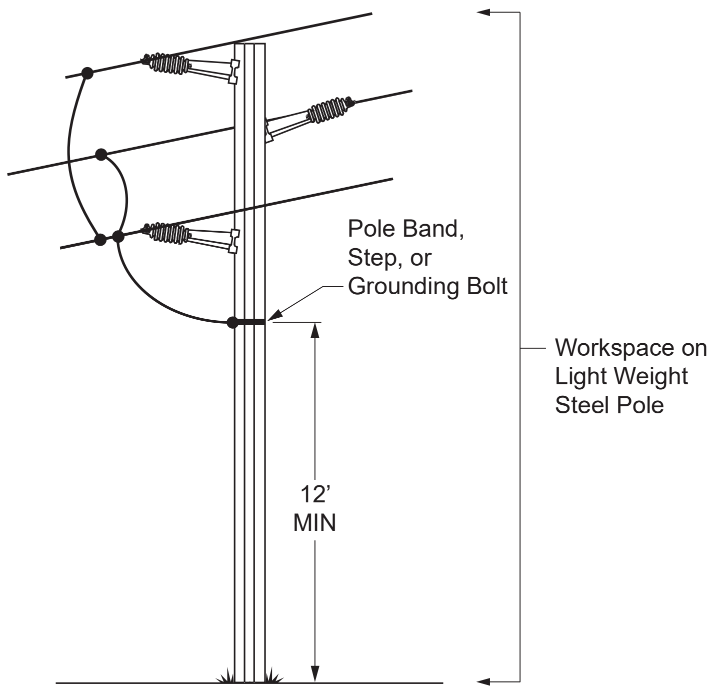
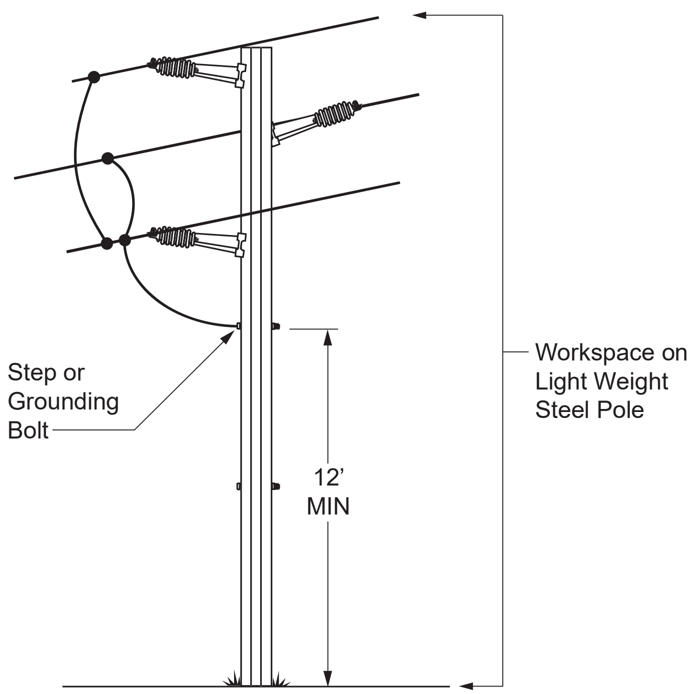


Figure 3–17: Workspace on a LWS Pole — Example 2



3.6.10.2 Workspace on Steel Structures

Workspace on a steel structure is established after applying grounds. Since steel is an electrically conductive metal, difference of electrical potential on a steel structure is minimal. Therefore, the Equipotential Zone on a steel structure is the entire surface of the structure.

3.6.10.3 Workspace on Wood, Composite, and Concrete Structures — Use of the Pole Band

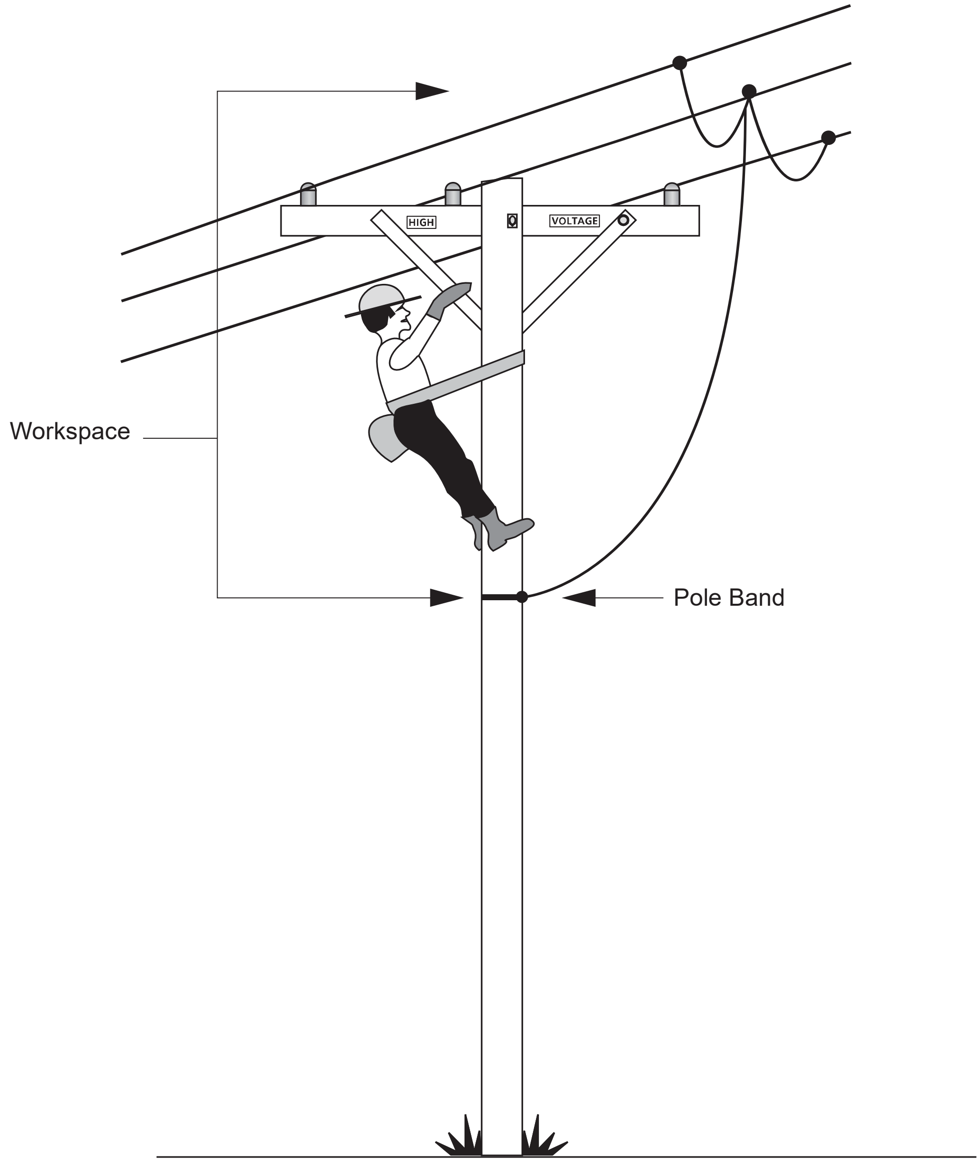
After application of a pole band and grounds on wood, composite, and concrete poles, an Equipotential Zone (that is, workspace) is established. See Table 3–2 and determine number of phases that shall be connected to the pole band in order to create a workspace EPZ. At the work site, attach approved ground(s) from the pole band or structure to required number of phases using approved live-line tools. This creates a workspace EPZ on the structure.

The workspace EPZ is the area on the pole above the pole band including the conductor(s) or equipment connected to the pole band to be worked on and extends to the top of the pole. In addition, the other phases of the grounded circuit are within the workspace EPZ when only one continuous phase between bracket grounds is connected to the pole band per Table 3–2.

However, the workspace EPZ does not extend inside the minimum approach distance of other energized or de-energized circuits not being worked on (see Figure 3–18).

In cases where workers have installed two pole bands, the workspace EPZ will be the area on the pole between the two pole bands.

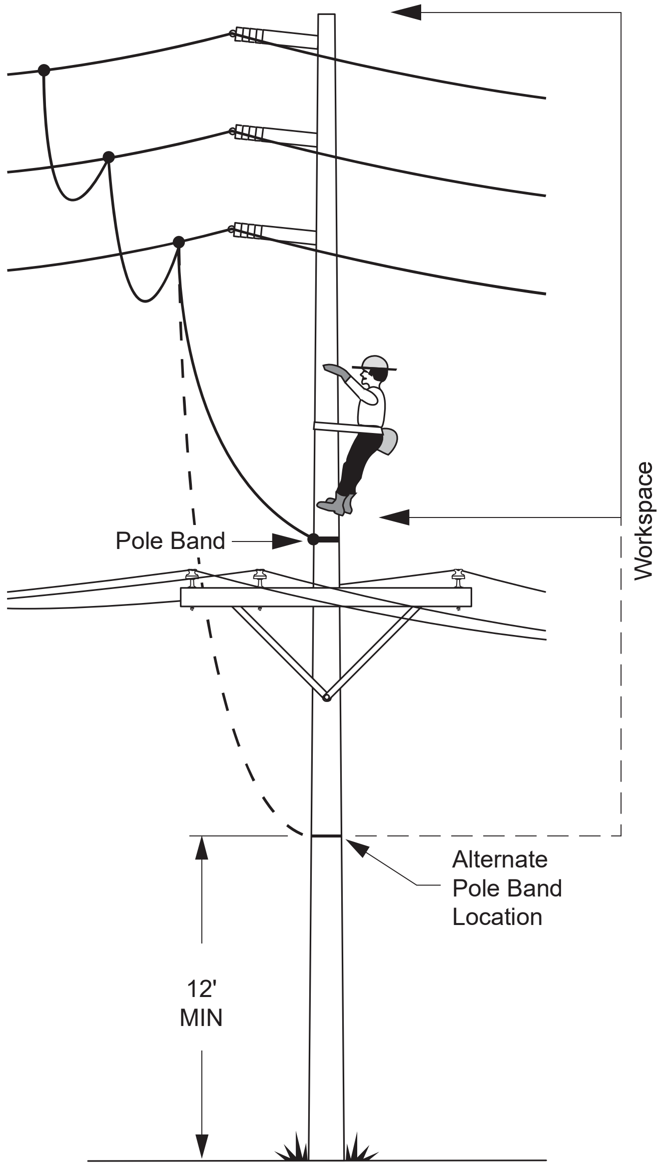
Figure 3–18: Workspace on a Wood, Composite, and Concrete Pole



3.6.10.4 Multiple Circuits on the Same Structure

In some cases when a circuit is grounded and being worked on, there may be other circuit(s) on the same structure. The pole band may be installed above or below the lower circuit(s) (see Figure 3–19).

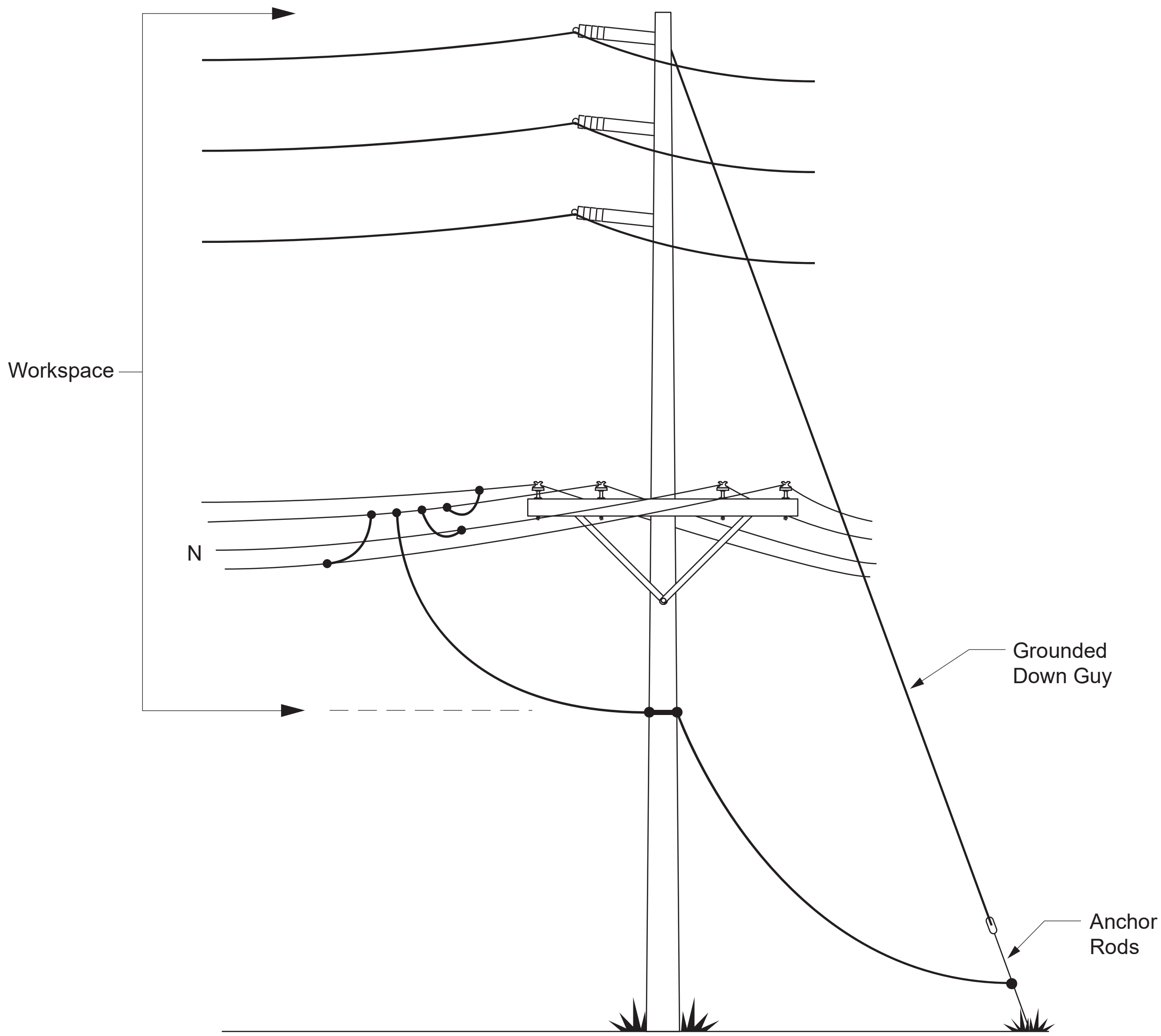
Figure 3–19: Workspace for Multiple Circuits on a Structure



3.6.10.5 Down Guy or Span Guy

When a down guy or span guy is attached to a wood, composite, or concrete structure above the pole band, the pole band should be connected to the anchor rod of the guy wire, if accessible. The conductor used to connect the pole band to the anchor rod shall be an approved ground conductor of the equivalent size used for other grounds on the structure being worked on (see Figure 3–20).

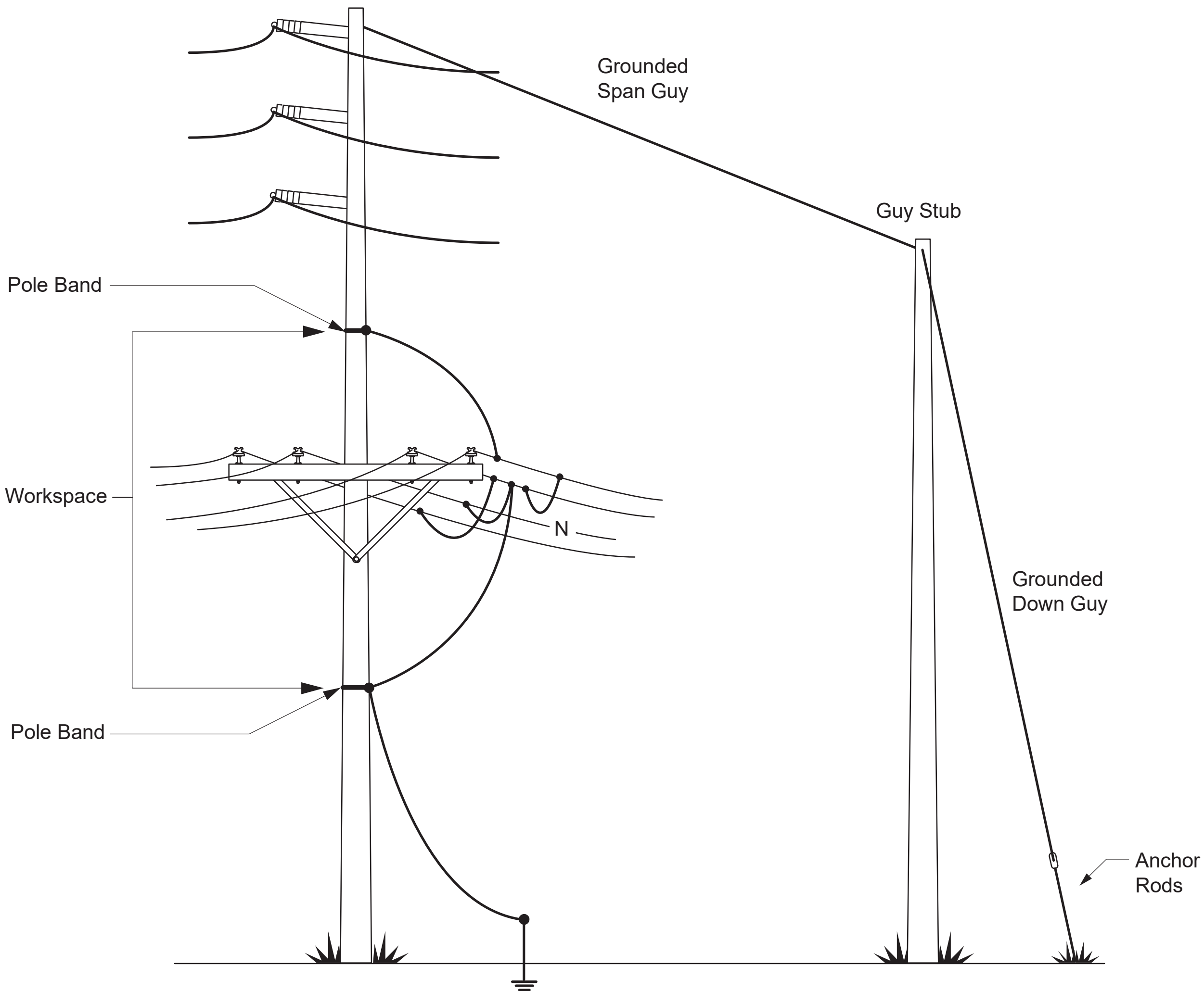
Figure 3–20: Workspace using Anchor Rod with Down Guy (Grounds Elsewhere)



3.6.10.6 Two Pole Bands

The application of two pole bands, as described below, applies to wood, concrete or composite poles. In some cases when de-energized distribution conductors are grounded and being worked on, there may be grounded down or span guys attached to the structure at the sub-transmission level. When it is not practical to connect the anchor rod to the pole band, or bond the guy wire to the pole band or grounded conductor, the worker shall install another pole band above the level of the distribution circuit being worked on. This pole band shall be bonded to the grounded conductors in a similar manner as the lower pole band. The workspace EPZ on a structure with two pole bands is the area between the two pole bands. Attached grounds located within the workspace shall be bonded to the grounding scheme (see Figure 3–21).

Figure 3–21: Workspace with Two Pole Bands (Grounds Elsewhere)



3.6.11 Equipotential Zone (EPZ) using Mat, Temporary Ground Rod(s), or Anchor Rod(s)

3.6.11.1 EPZ Mat Creates a Workspace

The EPZ mat is a tool with electrical characteristics similar to a pole band. The purpose of an EPZ mat is to protect the worker if the line becomes inadvertently energized. Use of an EPZ mat creates a workspace in which the worker will be at the same electrical potential as the grounded conductor, equipment, or vehicle.

Workspace EPZ can also be created by ground rod(s) or anchor rod(s) within ten feet of work area (see Figure 3–22 and Figure 3–23).

Figure 3–22: EPZ with One Single Ground Rod Driven to a Minimum of Seven-Feet Deep

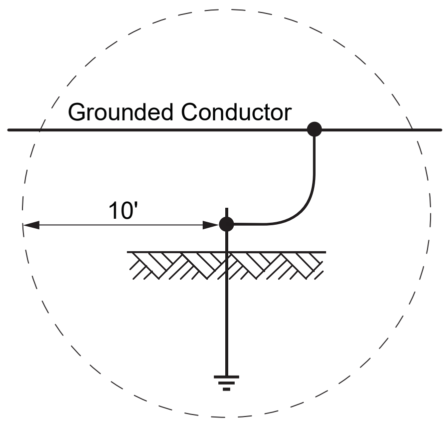
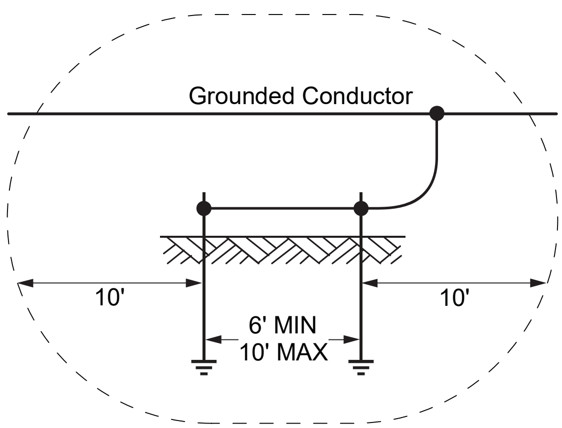


Figure 3–23: EPZ with Two Ground Rods Driven to a Minimum of 30-Inches Deep, and a Minimum Distance of 6 Feet and Maximum of 10 Feet Apart



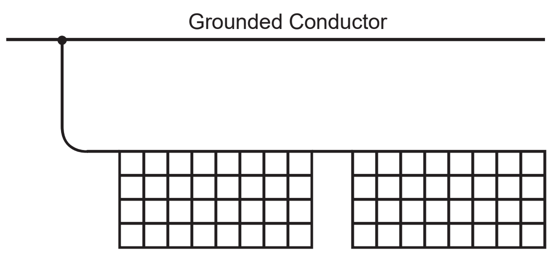
Note(s):

1. 10 feet maximum distance is to minimize step potential.

Do not install the EPZ mat(s) in such a manner as to conduct electrical current. Always connect the mat(s) at a single point to the de-energized and grounded conductor, equipment, or vehicle. Mats can be connected to each other to create a larger workspace. Connect mats to each other by hand prior to connecting to the conductor using approved live-line tools (see Figure 3–24).

Quickly and safely transition on or off the EPZ mat to minimize exposure to step and touch potential.

Figure 3–24: EPZ Mat Usage



3.6.12 Grounding Schemes for a Three-Phase Circuit

The three basic schemes to ground a three-phase circuit are as shown in Figure 3–25 and Figure 3–26.

Figure 3–25: 3-Wire Grounding Schemes

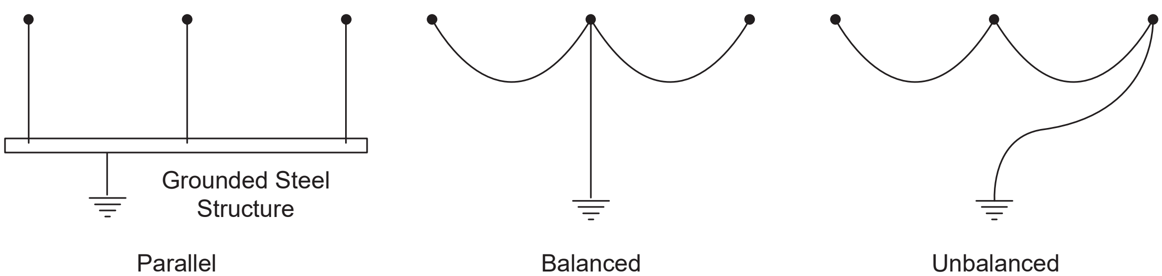
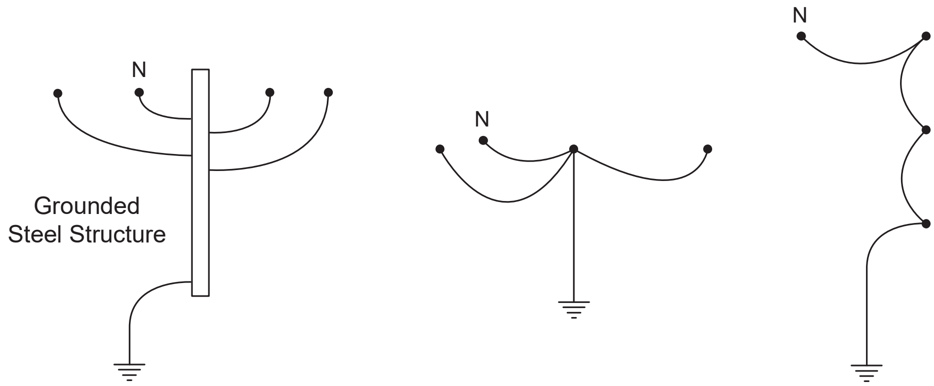


Figure 3–26: 4-Wire Grounding Schemes



Parallel Balanced Unbalanced

The order of preference for grounding schemes is:

- Parallel
- Balanced
- Unbalanced

WARNING Do not use an unbalanced scheme when grounding to or within close proximity, for example, (within 40 feet), of a substation ground grid.

Parallel and Balanced are the Preferred Grounding Schemes — With these preferred grounding schemes one or a maximum of two length(s) of grounds connect any two conductors that a worker might be in contact with. If the line is inadvertently energized, the generated exposure voltage to the worker could be less when a parallel or balanced grounding scheme is used compared to the unbalanced grounding scheme. Therefore, avoid use of the unbalanced grounding scheme for better protection whenever possible.

For each grounding scheme no more than three grounds/shunts in series is permitted (see Figure 3–27 and Figure 3–28).

Figure 3–27: Proper Grounding of Multiple Circuits

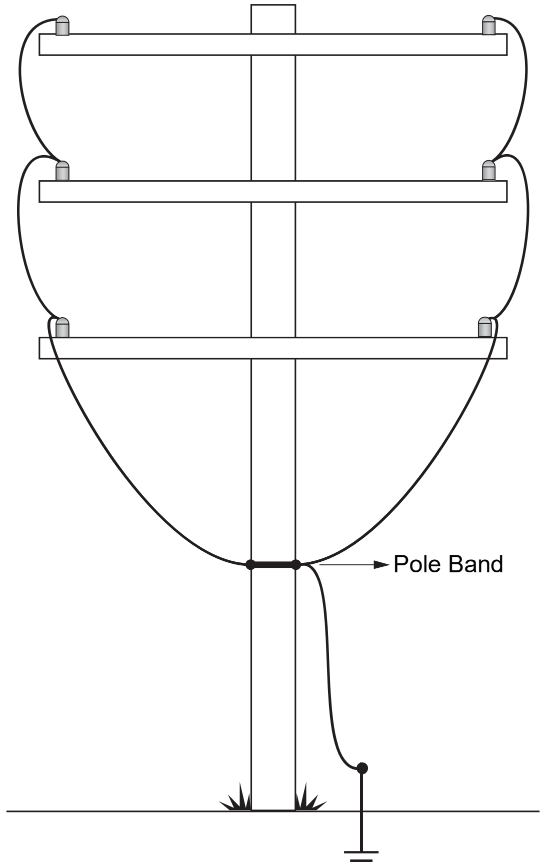
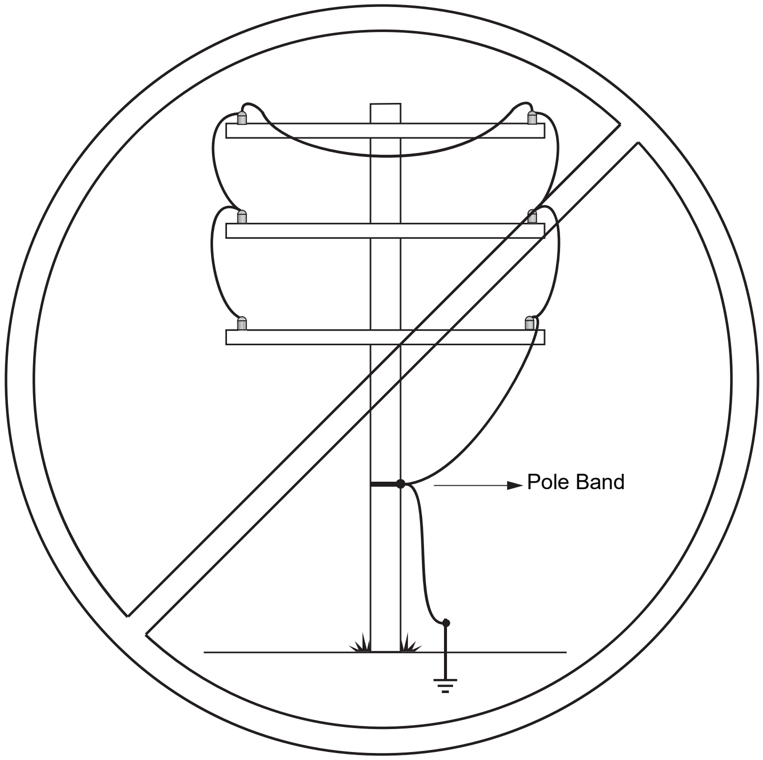


Figure 3–28: Improper Grounding of Multiple Circuits



3.6.13 Approved Overhead Grounding Methods

Overhead grounding shall be accomplished using one of the following approved grounding methods as described below:

- Overhead Equipotential Bracket Grounding
- Overhead Bracket Grounding

3.6.13.1 Overhead Equipotential Bracket Grounding Method

Overhead Equipotential Bracket Grounding is the Preferred Method and can be Applied in Any Situation

This method is achieved by applying a set of grounds (grounding all phases) between the work location and each source with a workspace EPZ created at the work location. The workspace EPZ shall be created with ground(s) connected between the pole band and the grounded phase(s) in accordance with Table 3–2.

Equipotential bracket grounding method applies to any type of structure.

This method may also apply to single source distribution tap lines with only one set of grounds (grounding all phases) between the work location and the source; a workspace EPZ shall be created at the work location. In addition, backfeed shall be eliminated.

This method will also apply to 4-wire systems with the neutral opened or in service. Unless neutral is taken out of service, an electrical path for neutral current shall be maintained.

The size of grounds used for bracket grounds and workspace EPZ shall be determined from Table 3–1 based on the highest fault-current duty source. All grounds applied shall be capable of withstanding the highest fault duty. Larger size grounds than those required may be applied at any time. Grounds shall be applied between all sources and the work site.

When using this method, perform the following:

Procedure

STEP 1. Install a set of approved grounds between the work site and every source of supply. When working on a source pole, install grounds as close as practicable to the source pole, for example, (next structure).

STEP 2. When there is a multi-grounded primary neutral on the structure being grounded, attach an additional approved ground from the multi-grounded primary neutral to a grounded conductor, to the structure, to the pole band, or to the same ground medium used for grounding the circuit. When using this method always make the connection to the ground medium first, for example, (anchor rod or temporary driven ground rod), and then connect to the conductors to be grounded using approved live-line tools.

STEP 3. At the work site create a workspace EPZ as follows:

- Table 3–2 shows minimum number of phases to be connected to the pole band when working on distribution circuits, provided the work site is not on a steel structure. When the work site is on a steel structure, all phases within minimum approach distance shall be connected to the structure.

STEP 4. At the work site, connect attached pole grounds located within the workspace EPZ to the pole band as described in Section 4.7.

STEP 5. When handling downed conductors on the ground, an Equipotential Zone (EPZ) shall be created using EPZ mat(s) or temporary ground rods. The minimum number of phases to be connected to the EPZ shall follow Table 3–2.

STEP 6. Downed and grounded distribution conductors can be moved, inspected, and transferred to workers using high voltage rubber gloves or approved live-line tools with no EPZ required. High voltage rubber gloves may be used when adding wire or splicing on the ground (see Section 4.11). However, the workers shall not contact the conductor with any part of their body.

STEP 7. When crossing(s) exist between bracket grounds, then a set of approved grounds sized in accordance with Table 3–1 is required between the work site and the crossing.

NOTE A protected distribution undercrossing is not considered a source.

STEP 8. When working directly under/over a crossing, a set of approved grounds sized in accordance with Table 3–1 shall be installed at the work site or as close as practicable to the work site. In addition, a workspace EPZ shall be created per Table 3–2.

STEP 9. For single source tap lines, one set of approved grounds sized in accordance with Table 3–1 is required between the work site and the source. A workspace EPZ shall also be created per Table 3–2.

STEP 10. Backfeed shall be eliminated per APM, Rule 149.

STEP 11. When working on a source pole, for example, (installing/removing conductors), a set of approved grounds sized in accordance with Table 3–1 shall be installed as close as practicable to the source pole. The conductors shall be brought up to the source pole while maintaining minimum approach distance to energized conductors. In addition, adequate protective devices shall be applied to the source when required such that there are no exposed energized conductor(s). Additionally, a workspace EPZ shall be created on the source pole. The minimum number of phases to be connected to the EPZ shall follow Table 3–2.

STEP 12. Before opening/closing any distribution conductor that may be exposed to a hazardous difference of electrical potential approved jumpers shall be in place across the point to be opened/closed to ensure continuity of the conductor.

When opening/closing conductors that are grounded, and when the distance of grounds to the work site is within 1,250 feet with no parallel lines or 300 feet with parallel lines, one conductor shall remain continuous between grounds in order to maintain continuity and to eliminate hazardous difference of electrical potential. Therefore; to close the first conductor an approved shunt shall be used. Opening/closing additional distribution conductor(s) would not require a shunt when the above conditions are met.

When the distance of grounds to the work site is more than1,250 feet with no parallel lines or 300 feet with parallel lines, or one side is not grounded, a hazardous difference of electrical potential might exist. Therefore, opening/closing of any conductor would require a shunt.

When opening/closing conductors while working on distribution lines with transmission induction present, equipotential bracket grounding method shall be used utilizing two sets of grounds (see Figure 3–32).

Table 3–2: Minimum Number of Phases to be Connected to the Pole Band on Wood, Composite, and Concrete Poles Only

Table Note: See Note 1.

Presence of Hazardous Induction	Distance from Work Site to Bracket Grounds	MIN Number of Phases to be Connected to the Pole Band
No Induction	One set of bracket grounds within 1,250 feet of the work site	One phase (continuous between bracket grounds)[1/ 2/]
No Induction	Bracket grounds more than 1,250 feet from work site	All phases within minimum approach distance
Induction[3/]	One set of bracket grounds within 300 feet of the work site	One phase (continuous between bracket grounds)[1/ 4/]
Induction[3/]	Bracket grounds more than 300 feet from work site	All phases within minimum approach distance

Note(s):

1. This table is for Distribution only. For Transmission circuits all phases within minimum approach distance shall be connected to the pole band to create workspace EPZ.

1/ In a double dead-end or similar situations, when a shunt is used to make a phase continuous between bracket grounds, the shunt shall be an approved ground and sized adequately in accordance with Table 3–1.

2/ Workspace EPZ can be created by shunting one phase to the pole band when the other phases being worked on are also continuous to the same bracket grounds that are within 1,250 feet.

3/ Induction will cause a hazardous difference of electrical potential when conductors are being worked on, and are located within transmission/sub-transmission corridors, or support energized line(s) which are in parallel with the circuit being worked on for more than 600 feet.

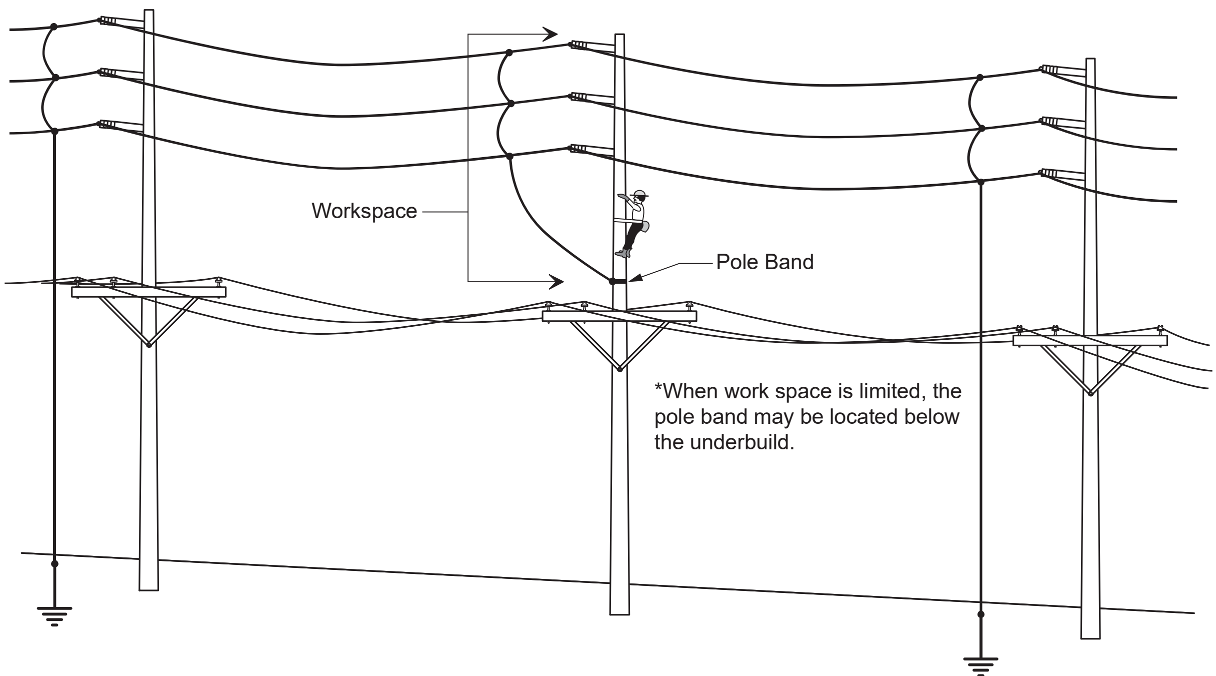
4/ Workspace EPZ can be created by shunting one phase to the pole band when the other phases being worked on are also continuous to the same bracket grounds that are within 300 feet.

Overhead Equipotential Bracket Grounding Method examples are shown in Figure 3–29 through Figure 3–44.

Example 1 — Overhead Equipotential Bracket Grounding

Sources are open. There are parallel line(s) and hazardous induction exists. Bracket grounds are installed between the work site and every source. The distance between the work site and bracket ground(s) is more than 300 feet. A workspace EPZ shall be created at the work site. Phase(s) being worked on and other phases within minimum approach distance are shunted to the pole band.

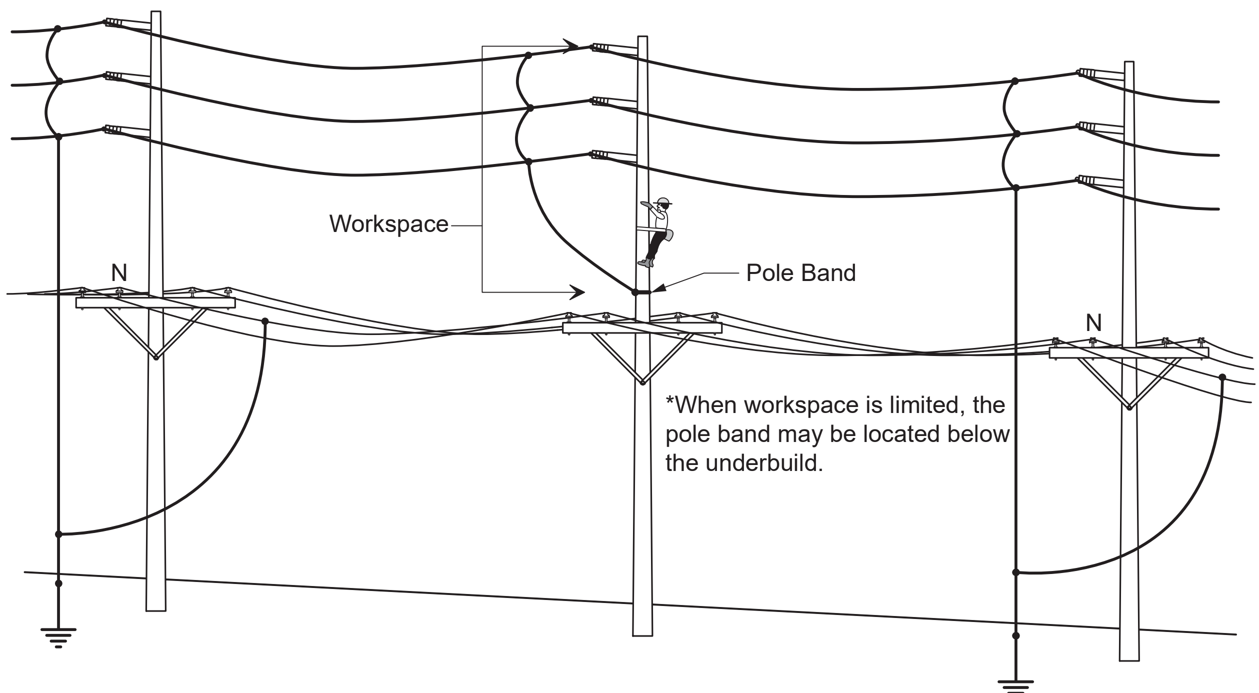
Figure 3–29: Overhead Equipotential Bracket Grounding — Example 1



Example 2 — Overhead Equipotential Bracket Grounding

Sources are open. There are parallel line(s) and hazardous induction exists. Bracket grounds are installed between the work site and every source. Neutral is used as priority of ground medium. The distance between the work site and bracket ground(s) is more than 300 feet. A workspace EPZ shall be created at the work site. Phase(s) being worked on and other phases within minimum approach distance are shunted to the pole band.

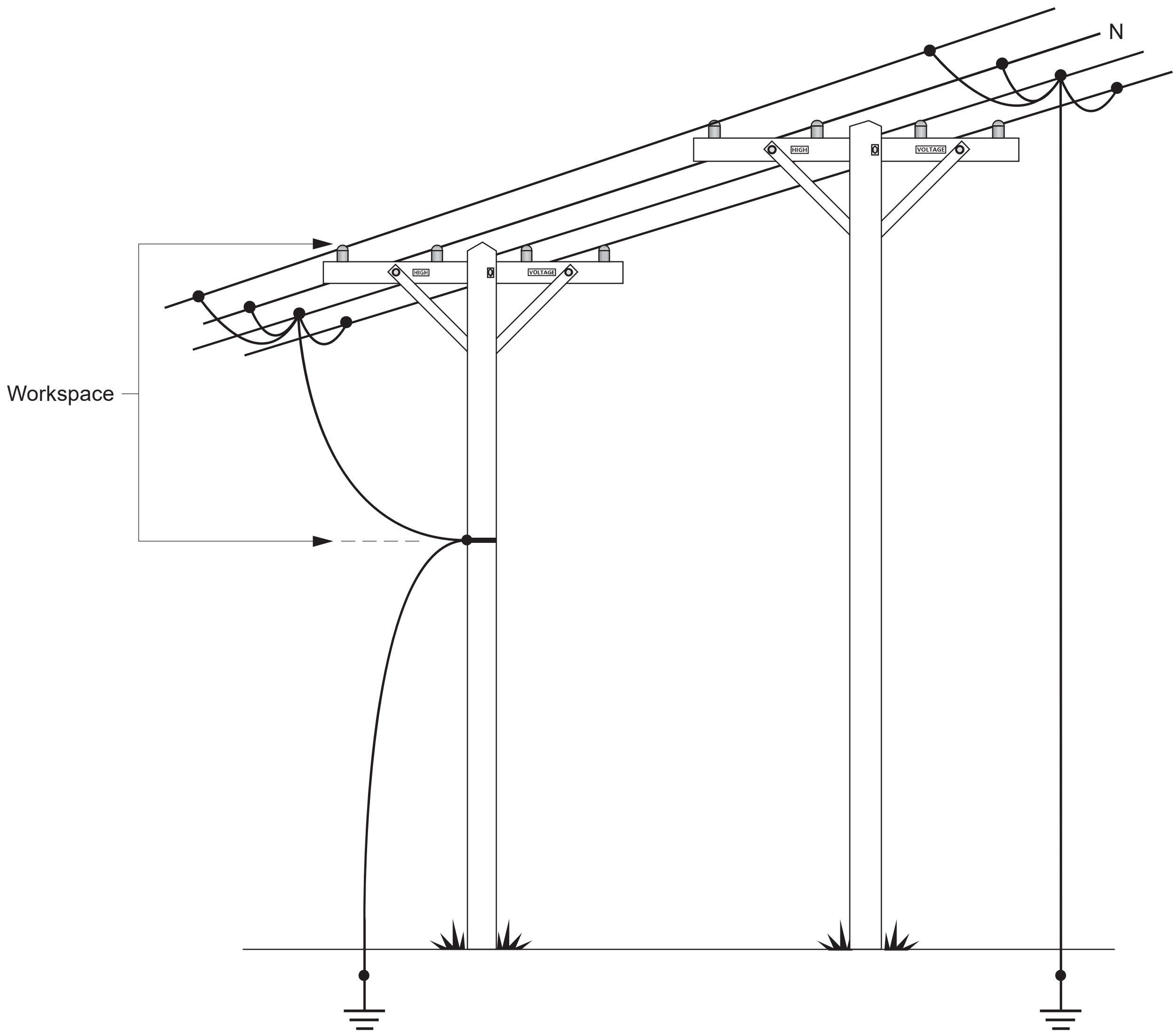
Figure 3–30: Overhead Equipotential Bracket Grounding — Example 2



Example 3 — Overhead Equipotential Bracket Grounding

Sources are open. There are no parallel line(s) and therefore no hazardous induction exists. Bracket grounds are installed between the work site and every source. One set of the bracket grounds is installed at the work site. All phases are grounded and are shunted to the pole band at the work site creating a workspace EPZ. The distance between the bracket grounds is more than 2,500 feet.

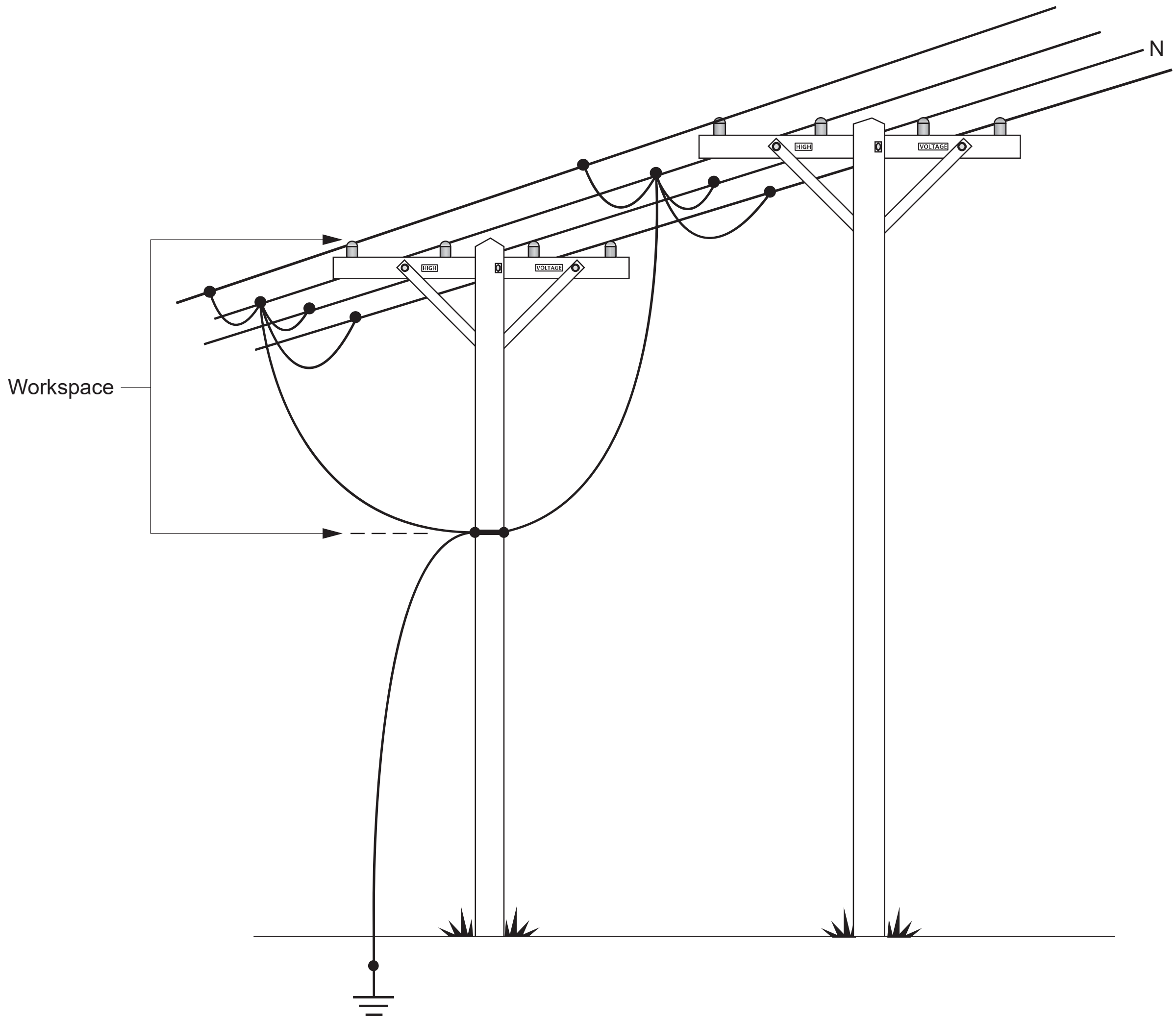
Figure 3–31: Overhead Equipotential Bracket Grounding — Example 3



Example 4 — Overhead Equipotential Bracket Grounding

Sources are open. There are no parallel line(s) therefore no hazardous induction exists. Both sets of bracket grounds are installed at the work site. All phases are grounded and are shunted to the pole band at the work site creating a workspace EPZ.

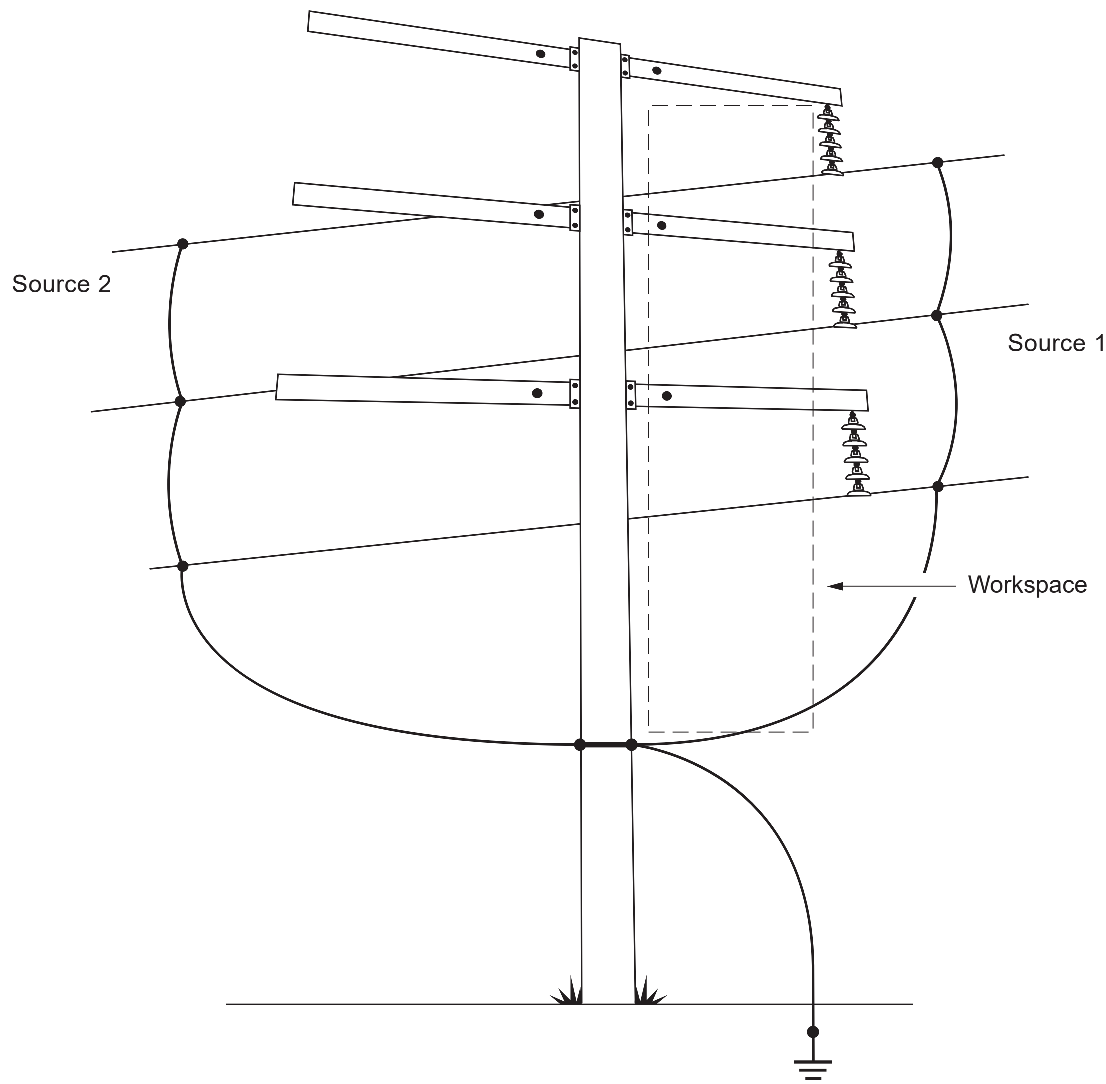
Figure 3–32: Overhead Equipotential Bracket Grounding — Example 4



Example 5 — Overhead Equipotential Bracket Grounding

Sources are open. There are parallel line(s) (not shown in the figure for clarity) and hazardous induction exists. Both sets of bracket grounds are installed at the work site. All phases are grounded and are shunted to the pole band at the work site creating a workspace EPZ.

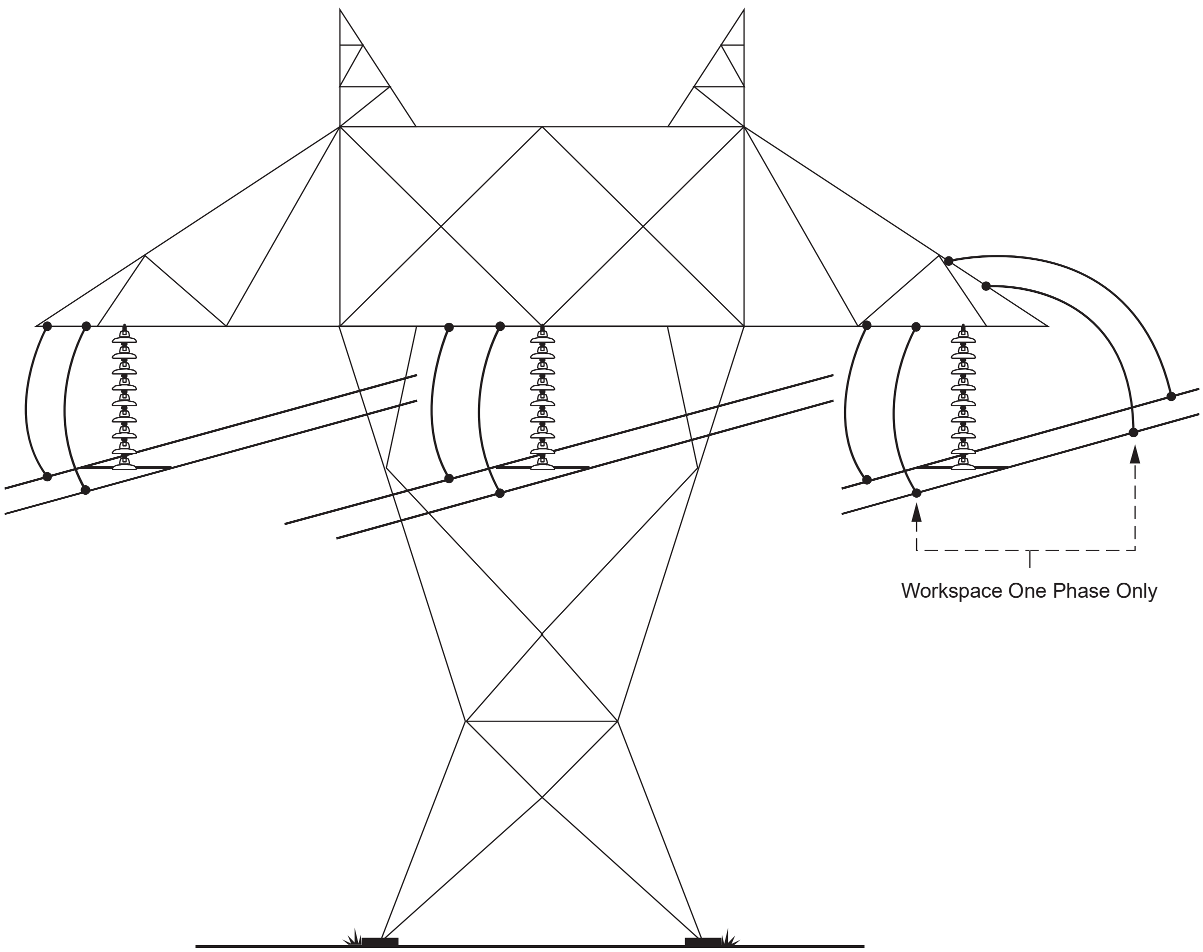
Figure 3–33: Overhead Equipotential Bracket Grounding — Example 5



Example 6 — Overhead Equipotential Bracket Grounding

This method is applicable when working on one phase of a 115 kV, 161 kV, 220 kV, or 500 kV single circuit horizontal construction. Sources are open. Grounds may be installed as shown in Figure 3–34 to work on one phase of a 115 kV, 161 kV, 220 kV, or 500 kV single circuit horizontal construction. On one side of the structure, install grounds on all three phases. On the other side of the same structure, apply ground(s) to the phase intended to be worked on. This method may be used only when minimum approach distance to other phases is maintained. A workspace EPZ has been created at the work site for one phase.

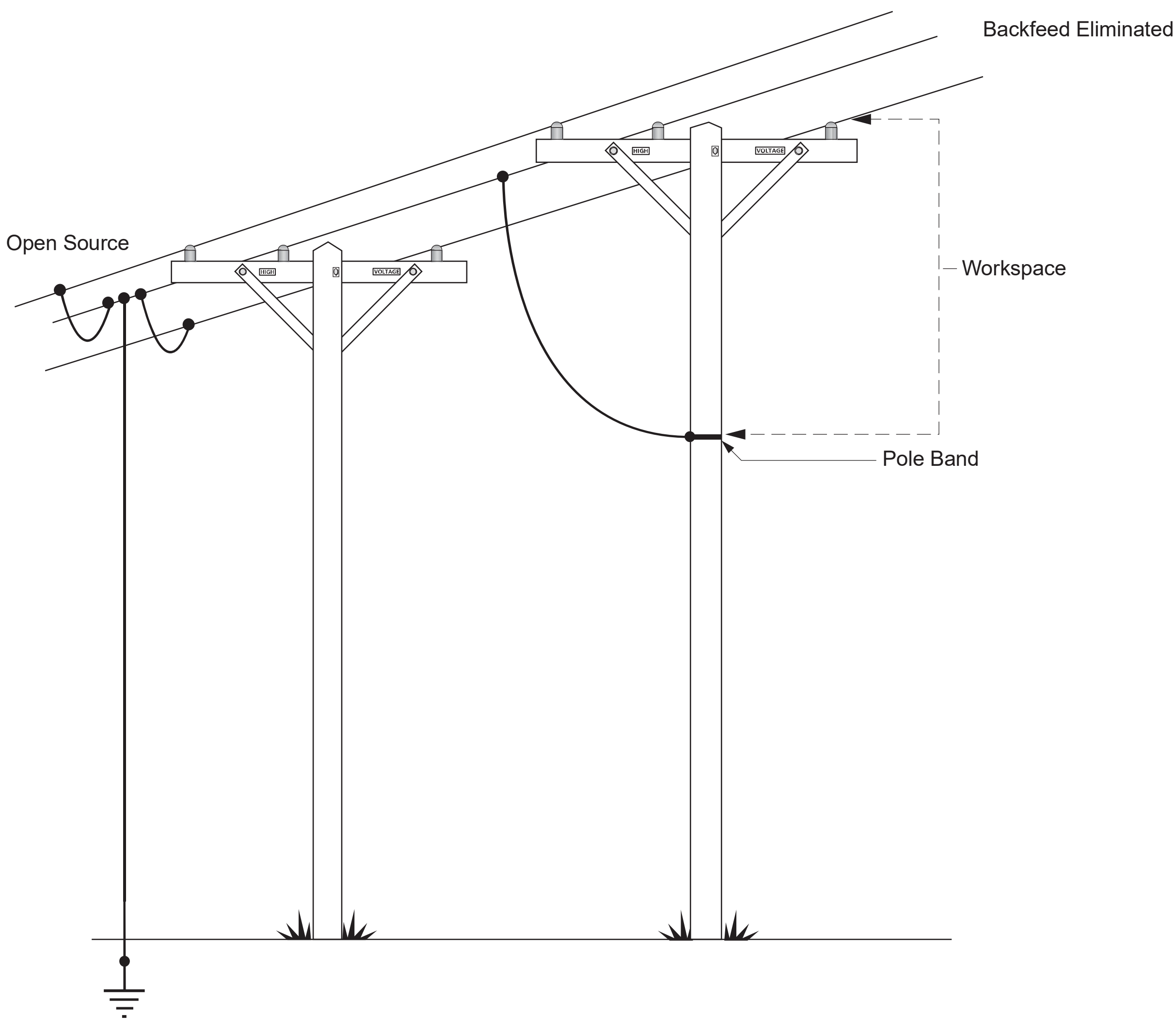
Figure 3–34: Overhead Equipotential Bracket Grounding — Example 6



Example 7 — Overhead Equipotential Bracket Grounding

This example is applicable to single source distribution tap lines. Source is open. Backfeed has been eliminated per APM, Rule 149. There are no parallel line(s) and no hazardous induction exists. One set of bracket grounds is installed between the work site and the source. The distance between the work site and bracket ground(s) is less than 1,250 feet. A workspace EPZ has been created at the work site. One phase that is continuous to the bracket ground is shunted to the pole band. Other phases can be worked upon without approved live-line tools or high voltage rubber gloves when the workspace EPZ is on a wood, composite, or a concrete pole.

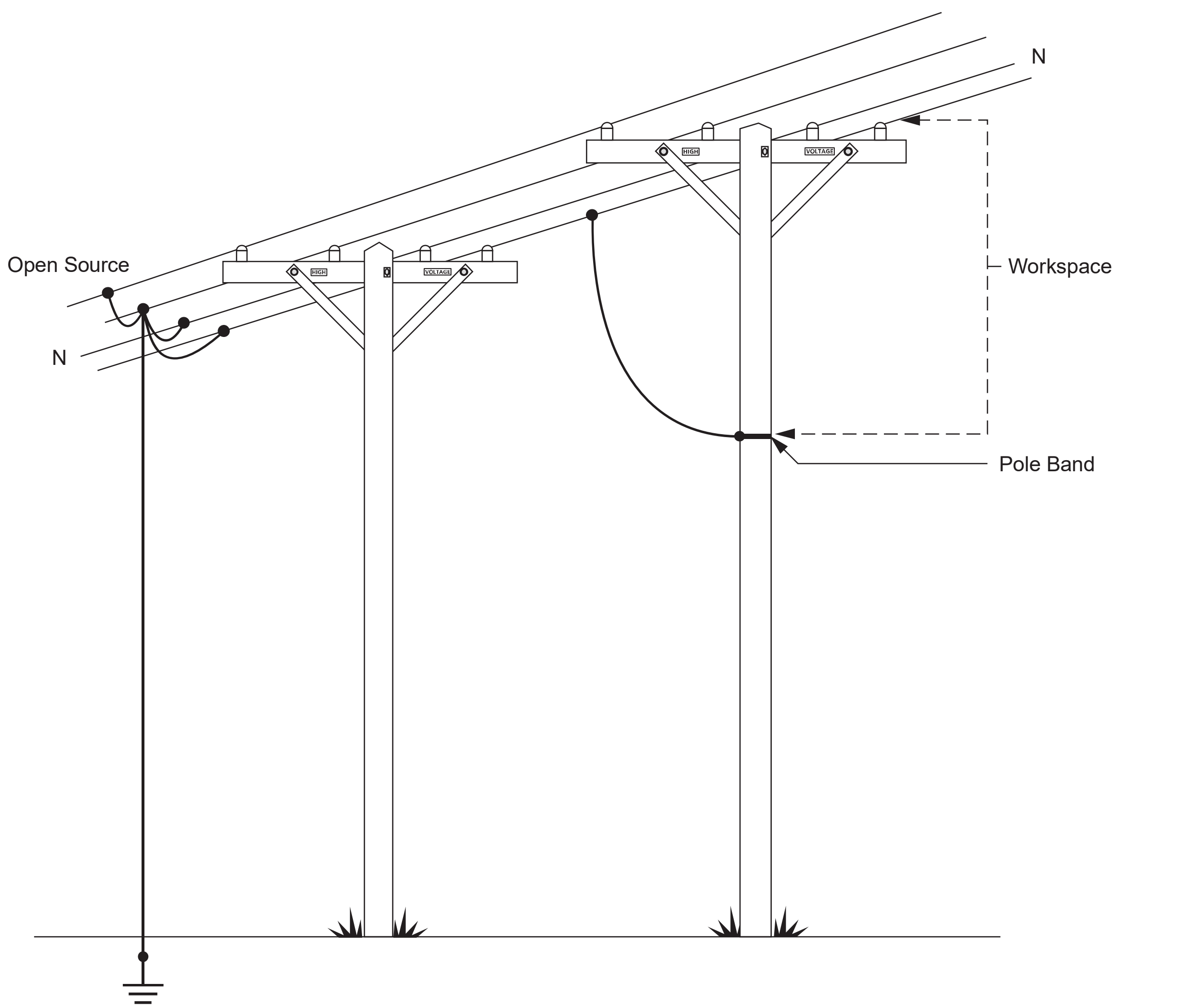
Figure 3–35: Overhead Equipotential Bracket Grounding — Example 7



Example 8 — Overhead Equipotential Bracket Grounding

This example is applicable to single source distribution tap lines with a neutral. Source is open. Backfeed has been eliminated per APM, Rule 149. There are no parallel line(s) and no hazardous induction exists. One set of bracket grounds is installed between the work site and the source. Neutral has been used as priority of ground medium. The distance between the work site and bracket ground(s) is less than 1,250 feet. A workspace EPZ has been created at the work site. One phase that is continuous to the bracket ground is shunted to the pole band. Other phases can be worked upon without approved live-line tools or high voltage rubber gloves when the workspace EPZ is on a wood, composite, or a concrete pole.

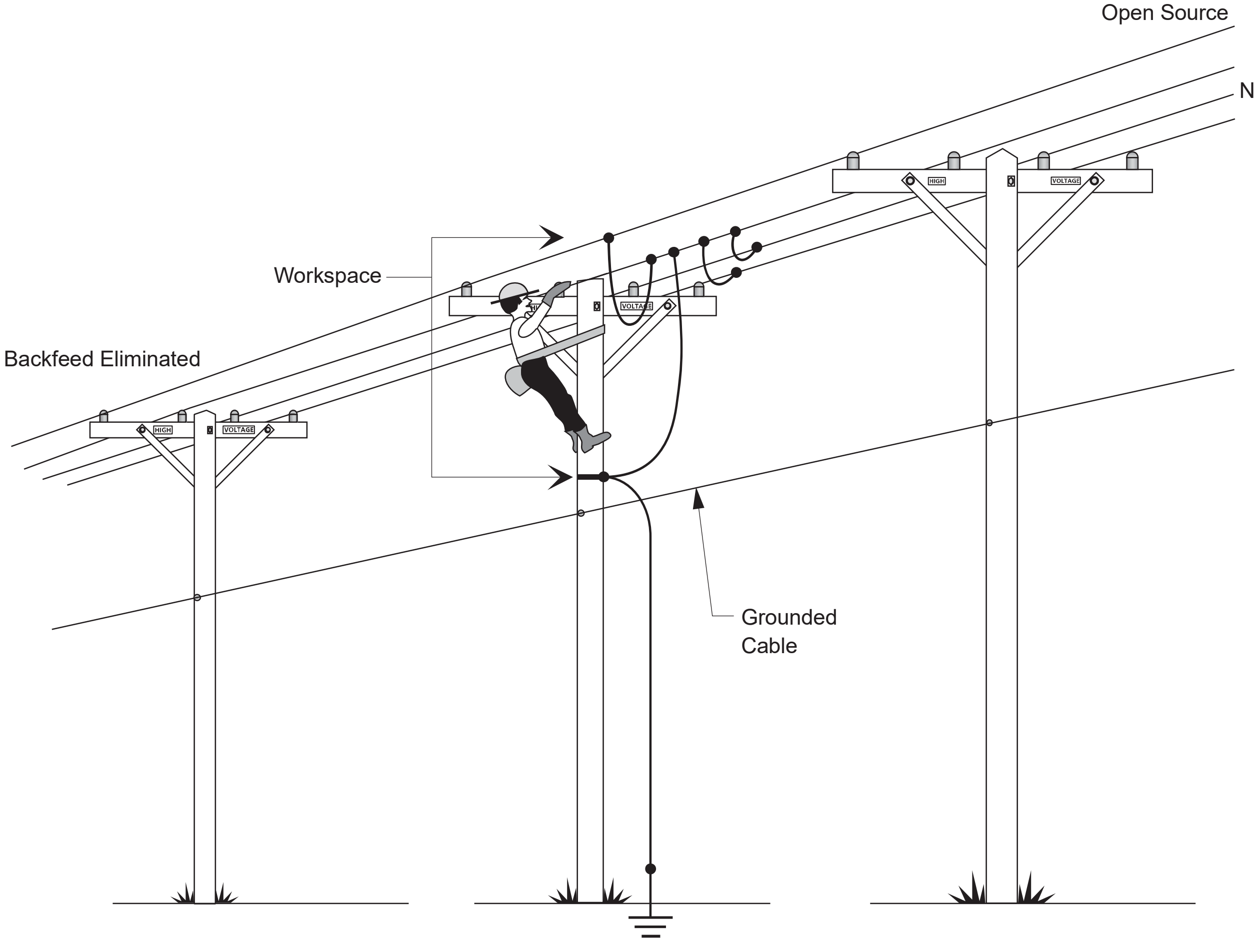
Figure 3–36: Overhead Equipotential Bracket Grounding — Example 8



Example 9 — Overhead Equipotential Bracket Grounding

This example is applicable to single source distribution tap lines with a neutral. This example may also be used where there are parallel line(s) and where hazardous induction exists. Source is open. Backfeed is eliminated per APM, Rule 149. One set of bracket grounds is installed at the work site between the work site and the source. Neutral is used as a ground medium. A workspace EPZ is created at the work site.

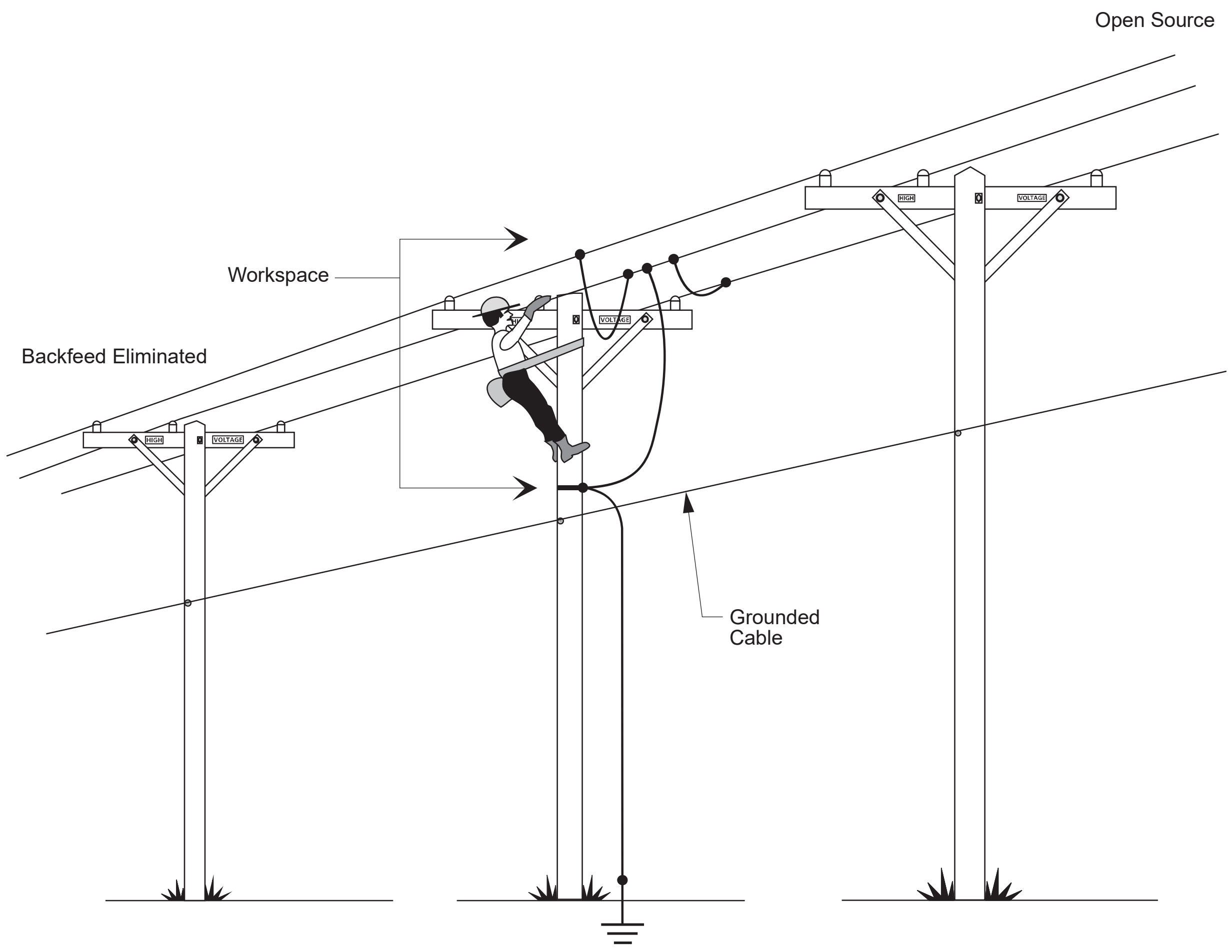
Figure 3–37: Overhead Equipotential Bracket Grounding — Example 9



Example 10 — Overhead Equipotential Bracket Grounding

This example is applicable to single source distribution tap lines with no neutral. This example may also be used where there are parallel line(s) and where hazardous induction exists. Source is open. Backfeed is eliminated per APM, Rule 149. One set of bracket grounds is installed at the work site between the work site and the source. A workspace EPZ is created at the work site.

Figure 3–38: Overhead Equipotential Bracket Grounding — Example 10

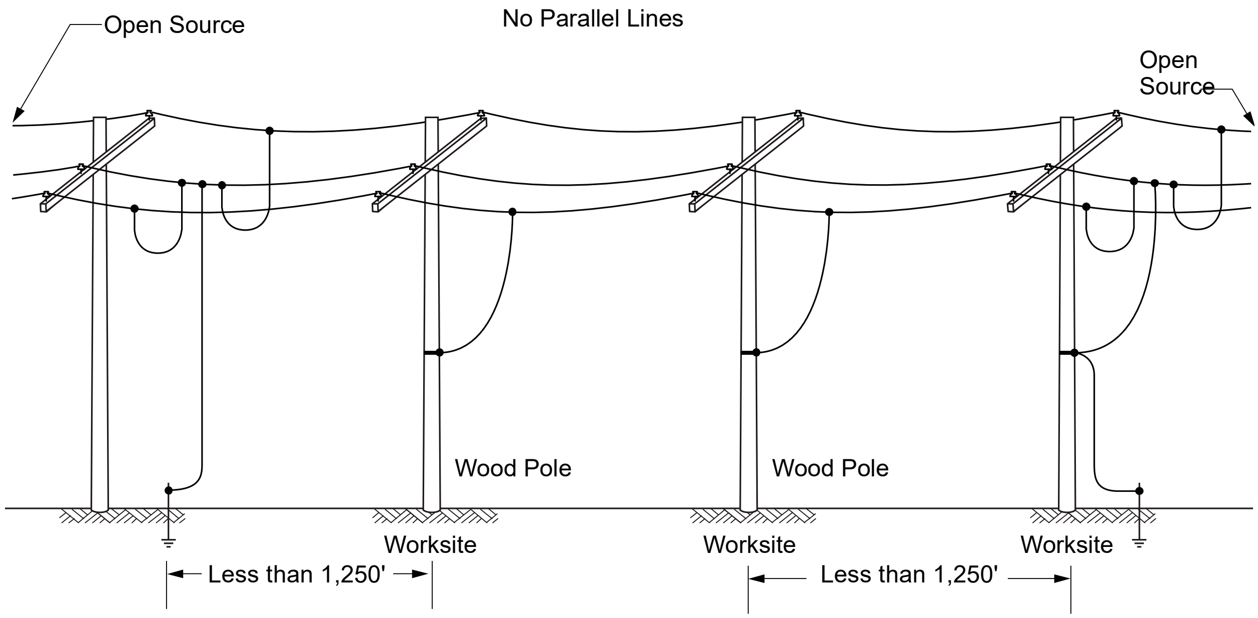


Example 11 — Overhead Equipotential Bracket Grounding

This example is applicable to 3 or 4-wire systems. This example shall not be used where there are parallel line(s) and where hazardous induction exists. Sources are open. Bracket grounds are installed between the work site(s) and every source. The distance between each work site and one of the bracket grounds is less than 1,250 feet.

Workspace EPZ is created using a pole band and one shunt/ground connected to one phase. The conductor that will be connected to the pole band shall be continuous between bracket grounds. Other phases can be worked upon inside workspace EPZ without approved live-line tools or high voltage rubber gloves when the workspace EPZ is on a wood, composite, or a concrete pole.

Figure 3–39: Overhead Equipotential Bracket Grounding — Example 11

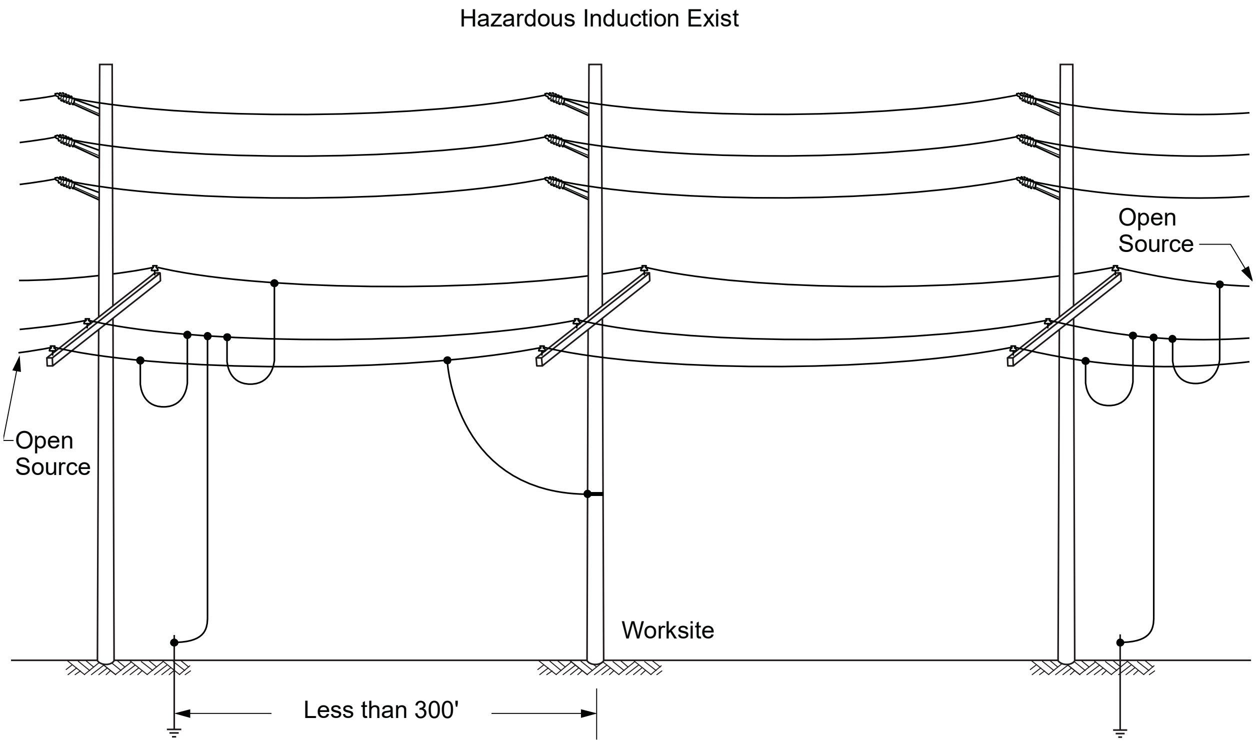


Example 12 — Overhead Equipotential Bracket Grounding

This example is applicable to 3 or 4-wire systems. This example may be used where there are parallel line(s) and where hazardous induction exists. Sources are open. Bracket grounds are installed between the work site(s) and every source. The distance between each work site and one of the bracket grounds is less than 300 feet.

Workspace EPZ is created using a pole band and one shunt/ground connected to one phase. The conductor that will be connected to the pole band shall be continuous between bracket grounds. Other phases can be worked upon inside workspace EPZ without approved live-line tools or high voltage rubber gloves when the workspace EPZ is on a wood, composite, or a concrete pole.

Figure 3–40: Overhead Equipotential Bracket Grounding — Example 12

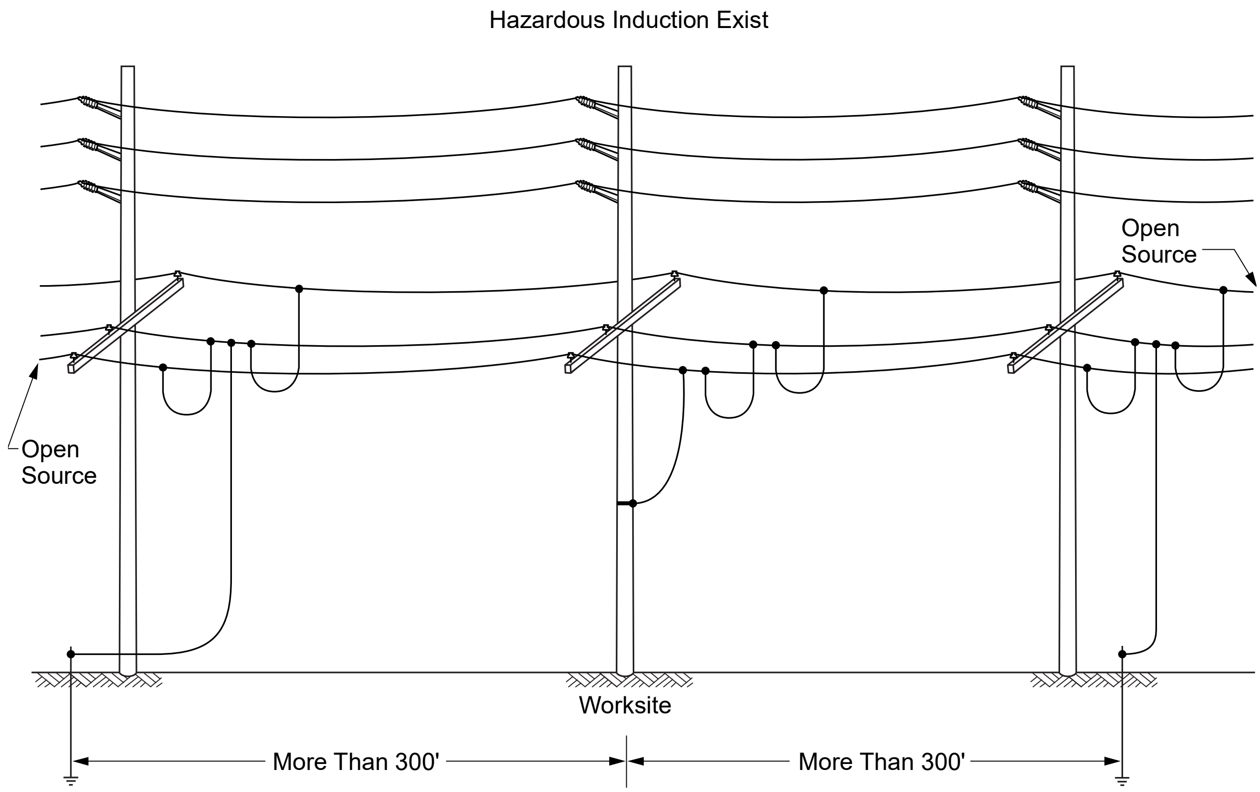


Example 13 — Overhead Equipotential Bracket Grounding

This example is applicable to 3 or 4-wire systems and may be used where there are parallel line(s) and where hazardous induction exists. Sources are open. Bracket grounds are installed between the work site(s) and every source. The distance between each work site and all of the bracket grounds is more than 300 feet.

Work site EPZ shall be created using a pole band and shunt/grounds connected to phase(s) being worked on and all other phases within minimum approach distance.

Figure 3–41: Overhead Equipotential Bracket Grounding — Example 13



Example 14 — Overhead Equipotential Bracket Grounding

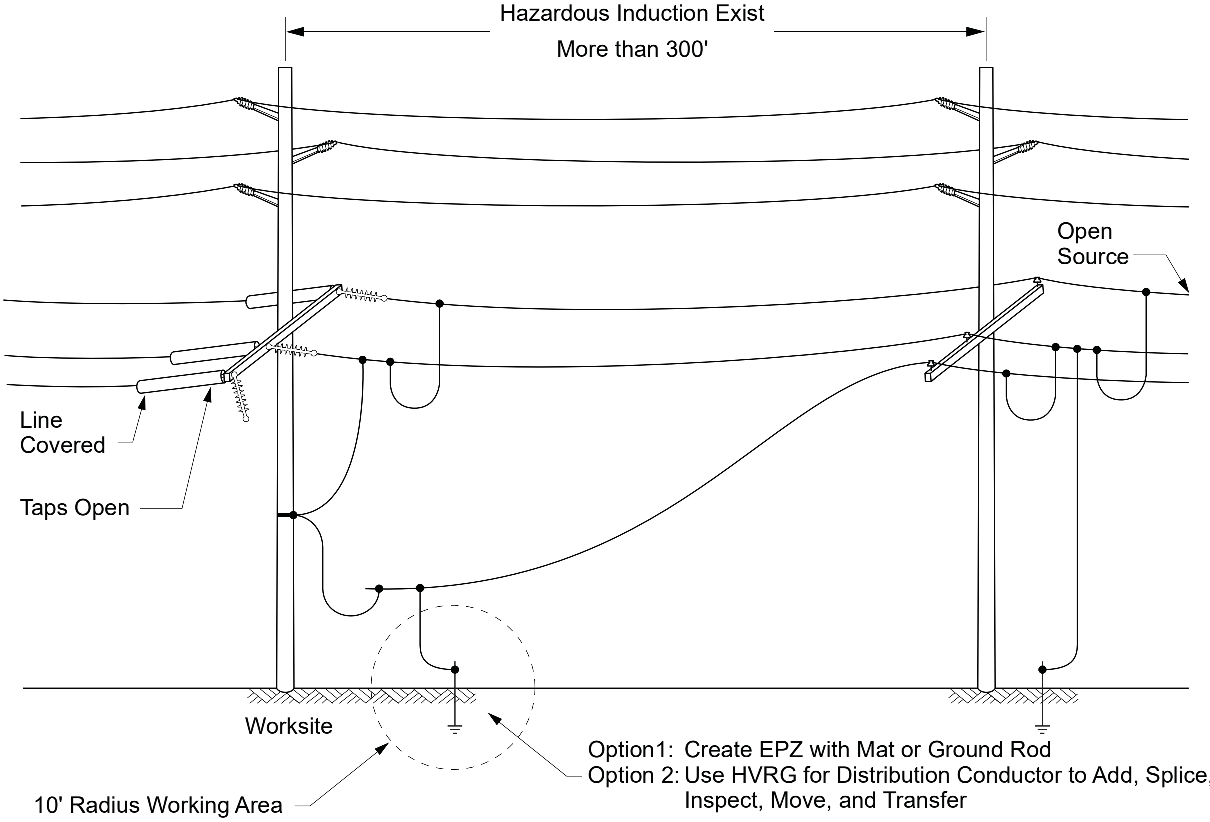
This example is applicable to working on a source pole and may be used where there are parallel line(s) and where hazardous induction exists. Also, this method is applicable to 3 or 4-wire system.

Sources are open. One set of bracket grounds is installed between the work site (that is a source pole) and other source(s). The bracket grounds should be installed as close as practicable to the work site. In this example, the distance between the work site and the bracket grounds is more than 300 feet.

Working on a source pole will require a workspace EPZ. Workspace EPZ shall be created using a pole band and shunt/grounds connected to phase(s) being worked on and all other phases within minimum approach distance. When a conductor is raised to be connected to the source pole, it shall also be included in the workspace EPZ prior to making contact.

For working on conductor on the ground, an EPZ shall be created. EPZ can be created using EPZ mat or temporary ground rods. High Voltage Rubber Gloves can be used to add, splice, inspect, move, and transfer grounded distribution conductors on the ground.

Figure 3–42: Overhead Equipotential Bracket Grounding — Example 14



Example 15 — Overhead Equipotential Bracket Grounding

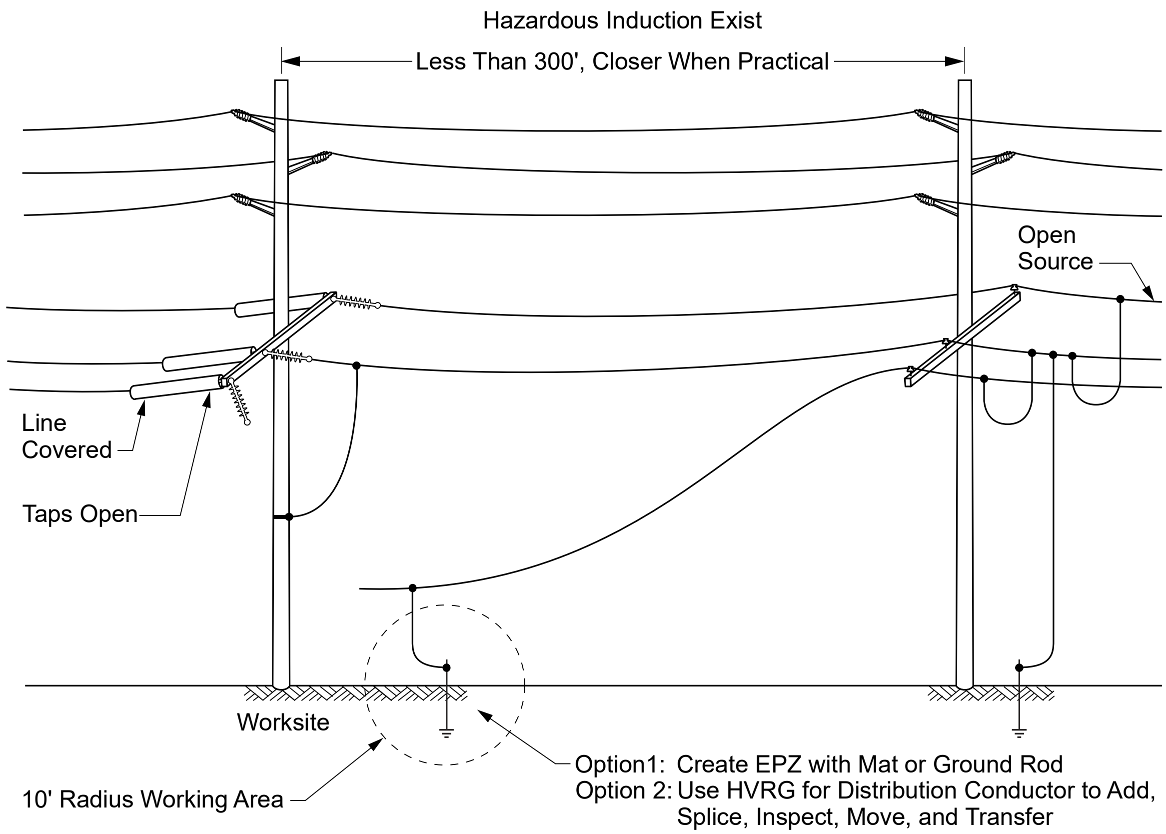
This example is applicable to working on a distribution source pole and may be used where there are parallel line(s) and where hazardous induction exists. Also, this method is applicable to 3- or 4-wire system.

Sources are open. One set of bracket grounds is installed between the work site (that is a source pole), and other source(s). The bracket grounds should be installed as close as practicable to the work site. In this example, the distance between the work site and the bracket grounds is less than 300 feet.

Working on a source pole will require a workspace EPZ. Workspace EPZ using a pole band and one shunt/ground connected to one phase is created. The conductor that will be connected to the pole band shall be continuous to the bracket grounds. Other phases can be worked on inside workspace EPZ without approved live-line tools or high voltage rubber gloves when the workspace EPZ is on a wood, composite, or a concrete pole.

For working on conductor on the ground, an EPZ shall be created. EPZ can be created using EPZ mat or temporary ground rods. High voltage rubber gloves can be used to add, splice, inspect, move, and transfer grounded distribution conductors on the ground.

Figure 3–43: Overhead Equipotential Bracket Grounding — Example 15



Example 16 — Overhead Equipotential Bracket Grounding

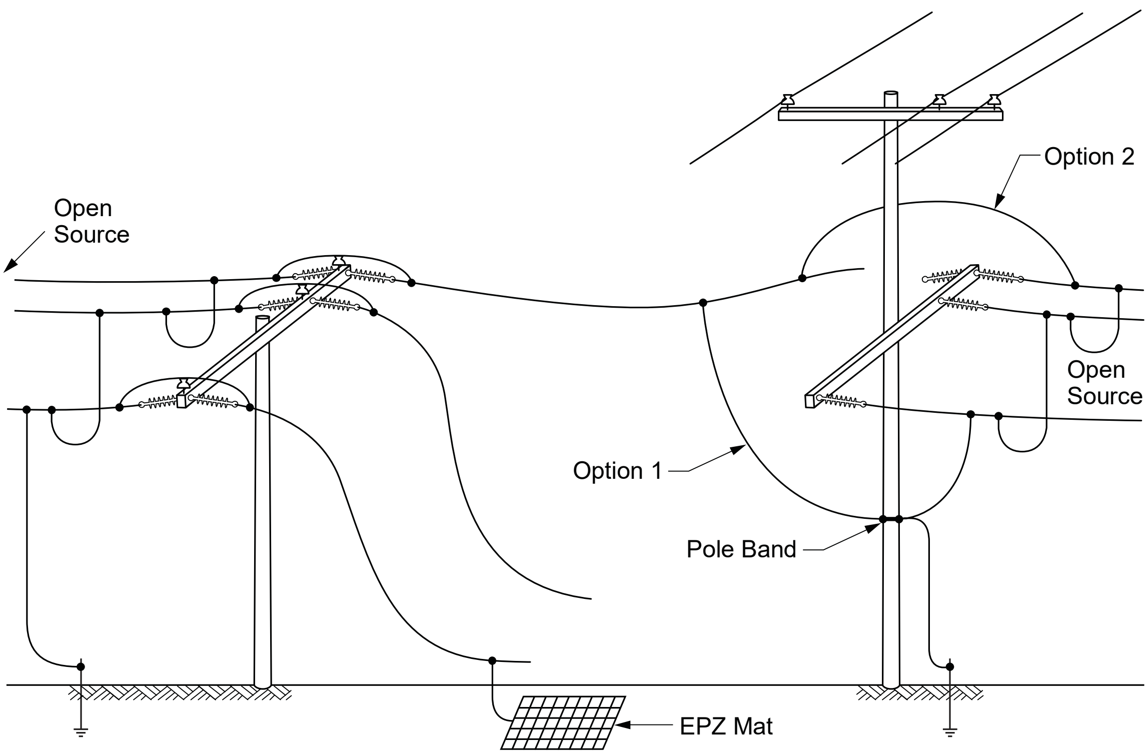
This example is applicable to working on a distribution pole with attached crossing. This example may also be applicable where there are parallel line(s) and where hazardous induction exists. Also, this method is applicable to 3- or 4-wire system.

Sources are open. Bracket grounds are installed between the work site and open source(s). Because of attached crossing, one of the bracket grounds shall be installed as close as practicable to the work site. Installing the bracket grounds on the pole with attached crossing (that is work site) is preferred.

Working on this pole will require a workspace EPZ. Workspace EPZ shall be created using a pole band and shunt/grounds connected to phase(s) being worked on and all other phases within minimum approach distance per Table 3–2. When a conductor is raised to be connected to this pole, it shall also be included in the workspace EPZ (see Options 1 and 2 in Figure 3–44).

For working on conductors on the ground, an EPZ shall be created. EPZ can be created using EPZ mat or temporary ground rods. High voltage rubber gloves can be used to add, splice, inspect, move, and transfer grounded distribution conductors on the ground.

Figure 3–44: Overhead Equipotential Bracket Grounding — Example 16



3.6.13.2 Overhead Bracket Grounding Method

This method is applicable when sources (breakers, fuse, switch or taps) are isolated. This method is achieved by applying a set of grounds between the work site and each isolated source and each crossing. Additional grounds may be needed when induction exists that can cause a hazardous difference of electrical potential.

This method will also apply to 4-wire systems with the neutral opened or in service. Unless neutral is taken out of service, an electrical path for neutral current shall be maintained.

This method may also apply when multiple structures are down.

Overhead Bracket Grounding Method may be used on new line construction where the conductors have not been pulled/attached to the source pole.

Overhead Bracket Grounding Method will apply when new conductors are pulled/attached to the source pole and only when the source remains isolated.

For new line sections with no source, a set of grounds shall be installed to protect from crossings (between work site and the crossing), induction, and static.

To work from steel structures, the Overhead Equipotential Bracket Grounding method shall be applied.

WARNING

When bracket grounds are located more than 1,250 feet from the work site, the Overhead Equipotential Bracket Grounding Method shall be applied.

WARNING

When there is hazardous induction present and bracket grounds are located more than 300 feet away from the work site, the Overhead Equipotential Bracket Grounding Method shall be applied. Hazardous induction is present when structures within the bracket grounds are located within transmission/sub-transmission corridors, or support energized line(s) which are in parallel with the circuit being worked on for more than 600 feet.

The size of grounds shall be determined from Table 3–1 based on the highest fault-current duty source. All grounds applied shall be capable of withstanding the highest fault duty. Larger size grounds than those required may be applied at any time. Grounds shall be applied between all sources and/or at the work site.

Procedure

STEP 1. Isolate all phases of the source by any one of the following actions:

- Removing jumpers for transmission
- Removing a span of wires from the source transmission or distribution structure, for example, (the last span of wires is not strung).
- Installing isolators for Distribution, physically removing taps. That is, remove a section of the conductor so the ends cannot touch. Bend the conductors back towards the line to create a physical separation at least equal to the length of the insulator. Completely protecting (*) the source with approved protective devices, installing a sign [tag (SCE161-T-P2-T94)], and issuing/taking a clearance per APM, Rule 105 for distribution circuits (main or tap line).
- Physically removing taps, completely protecting (*) the source with approved protective devices, installing a sign [tag (SCE161-T-P2-T94)], and issuing/taking a clearance per APM, Rule 105 for distribution circuits (main or tap line). Fuses for branch lines shall also be removed.

***Complete Protection:** Energized conductors at the source location shall be covered using approved protective devices such that there are no exposed energized source conductor(s).

STEP 2. Install a set of approved grounds between the work site and every isolated source of supply and each crossing. Maximum distance between grounds is 2,500 feet (or closest structures for transmission). Grounds installed at or near the work site are preferred.

STEP 3. For new line sections with no source, a set of grounds shall be installed to protect from crossings (between work site and the crossing), induction, and static.

STEP 4. No work shall be performed at the source location(s), (that is dead- ending conductors or installing taps) while work is in progress between bracket grounds, and vice versa. In addition no work shall be performed on multiple source poles simultaneously following Overhead Bracket Grounding Method.

STEP 5. One of the bracket grounds shall be located within 300 feet of the work location, for example, (between bracket grounds or source pole), or the Overhead Equipotential Bracket Grounding Method shall be used when hazardous induction is present. Hazardous induction is present when structures within the bracket grounds are located within transmission/sub-transmission corridors, or support energized line(s) which are in parallel with the circuit being worked on for more than 600 feet.

STEP 6. Exercise caution when utilizing this procedure where there is a ground within the work area on the structure. Always avoid getting between differences of ground potentials (shunt and/or cover).

STEP 7. When moving/inspecting/adding/splicing wire on downed conductors on the ground an EPZ would not be required when no work is being performed on the source pole and one of the following conditions is met:

STEP 7.1 Bracket grounds are within 1,250 feet of the work site and there are no energized parallel lines; or,

STEP 7.2 Bracket grounds are within 300 feet of the work site and there are energized parallel lines.

STEP 8. When the work between bracket grounds has been completed the first source pole can be worked, for example, (dead-ending conductors, or installing taps), provided there is a set of approved grounds sized in accordance with Table 3–1 is installed as close as practicable to the source pole. The conductors shall be brought up to the source pole while maintaining minimum approach distance to energized conductors. In addition, complete cover shall be applied to the source when required such that there are no exposed energized conductor(s). A workspace EPZ will not be needed on the source pole provided one of the following conditions is met.

STEP 8.1 Bracket grounds are within 1,250 feet of the work site and there are no energized parallel lines; or,

STEP 8.2 Bracket grounds are within 300 feet of the work site and there are energized parallel lines.

STEP 9. When the work is completed on the source pole and when the source is no longer isolated, for example, (taps installed), work on the de-energized line shall be performed utilizing Overhead Equipotential Bracket Grounding Method.

STEP 10. In order to work multiple source poles simultaneously, Overhead Equipotential Bracket Grounding Method shall be used.

STEP 11. Before closing any conductor that may be exposed to a hazardous difference of electrical potential approved jumpers shall be in place across the point to be closed to ensure continuity of the conductor.

When closing distribution conductors that are grounded, and when the distance of grounds to the work site is within 1,250 feet with no parallel lines and 300 feet with parallel lines, one conductor shall remain continuous between grounds in order to maintain continuity and to eliminate hazardous difference of electrical potential. Therefore; to close the first conductor an approved shunt shall be used. Closing additional distribution conductor(s) would not require a shunt when the above conditions are met.

When the distance of grounds to the work site is outside1,250 feet with no parallel lines and 300 feet with parallel lines, or one side is not grounded, a hazardous difference of electrical potential might exist. Therefore, closing of any conductor would require a shunt.

Overhead Bracket Grounding Method examples are shown in Figure 3–45 through Figure 3–49.

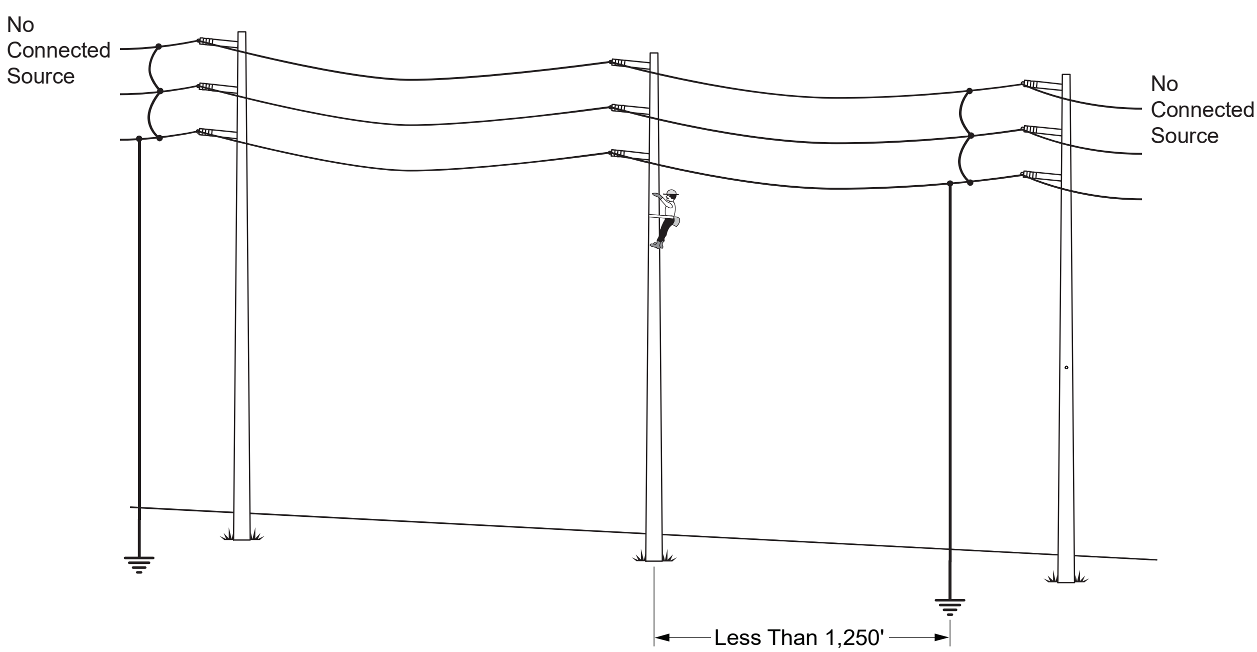
Example 1 — Overhead Bracket Grounding

This example is for a new line section recently constructed and lines with sources isolated. This example is applicable to 3- or 4-wire systems. There are no connected sources (that is the last span of wires has not been strung). There are no parallel line(s) and no hazardous induction exists. Prior to installing the conductors on the source pole(s), grounds shall be installed. The distance between the work site and one of the bracket ground(s) is less than 1,250 feet. Therefore, no workspace EPZ is required to work on newly strung conductors on wood, composite, and concrete poles.

When there is no source, no parallel lines, no crossings, no induction, no static, grounds would not be required on new line sections. Use Bracket Grounds to protect from induction and static.

However, if the distance between the work site and all of the bracket ground(s) was more than 1,250 feet, a workspace EPZ would be required.

Figure 3–45: Overhead Bracket Grounding — Example 1

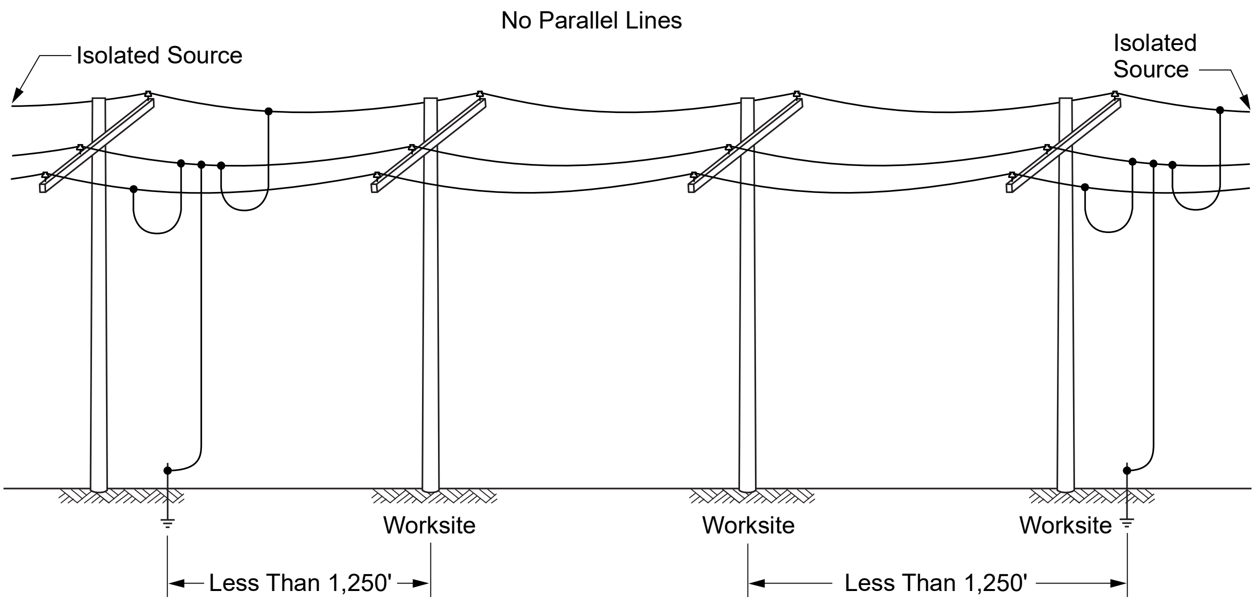


Example 2 — Overhead Bracket Grounding

This example is applicable to 3- or 4-wire systems. Sources are isolated by physically removing taps, installing a sign [tag (SCE161-T-P2-T94)], and issuing/taking a clearance per APM, Rule 105 for distribution circuits main line. In addition, energized conductors on the source pole are covered using approved protective devices such that there are no exposed energized source conductor(s). There are no parallel line(s) and no hazardous induction exists. Bracket grounds are installed between the work site and all source(s). The distance between the work site and one of the bracket ground(s) is less than 1,250 feet. Therefore, no workspace EPZ is required to work on conductors on wood, composite, and concrete poles.

However, if the distance between the work site and all of the bracket ground(s) was more than 1,250 feet, a workspace EPZ would be required.

Figure 3–46: Overhead Bracket Grounding — Example 2

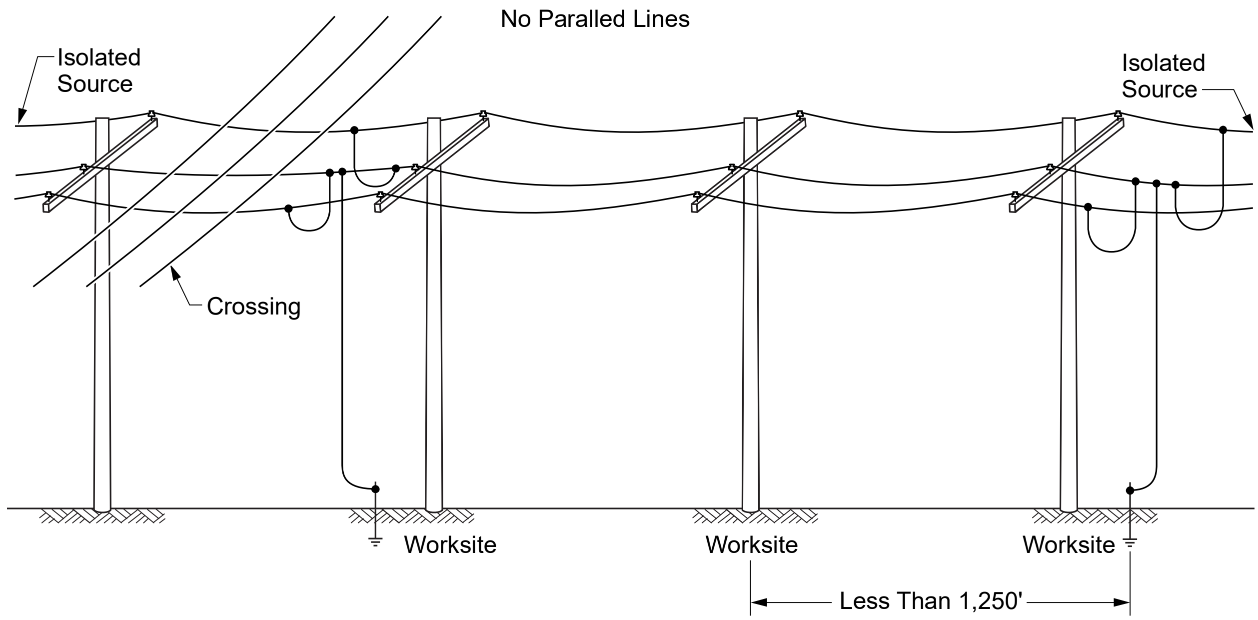


Example 3 — Overhead Bracket Grounding

This example is applicable to 3- or 4-wire systems. Sources are isolated by physically removing taps, installing a sign [tag (SCE161-T-P2-T94)], and issuing/taking a clearance per APM, Rule 105 for distribution circuits main line. In addition, energized conductors on the source pole are covered using approved protective devices such that there are no exposed energized source conductor(s). There are no parallel line(s) and no hazardous induction exists. There is a crossing. Bracket grounds are installed between the work site and all source(s) and crossing(s). The distance between the work site and one of the bracket ground(s) is less than 1,250 feet. No workspace EPZ is required to work on conductors on wood, composite, and concrete poles.

However, if the distance between the work site and all of the bracket ground(s) was more than 1,250 feet, a workspace EPZ would be required.

Figure 3–47: Overhead Bracket Grounding — Example 3

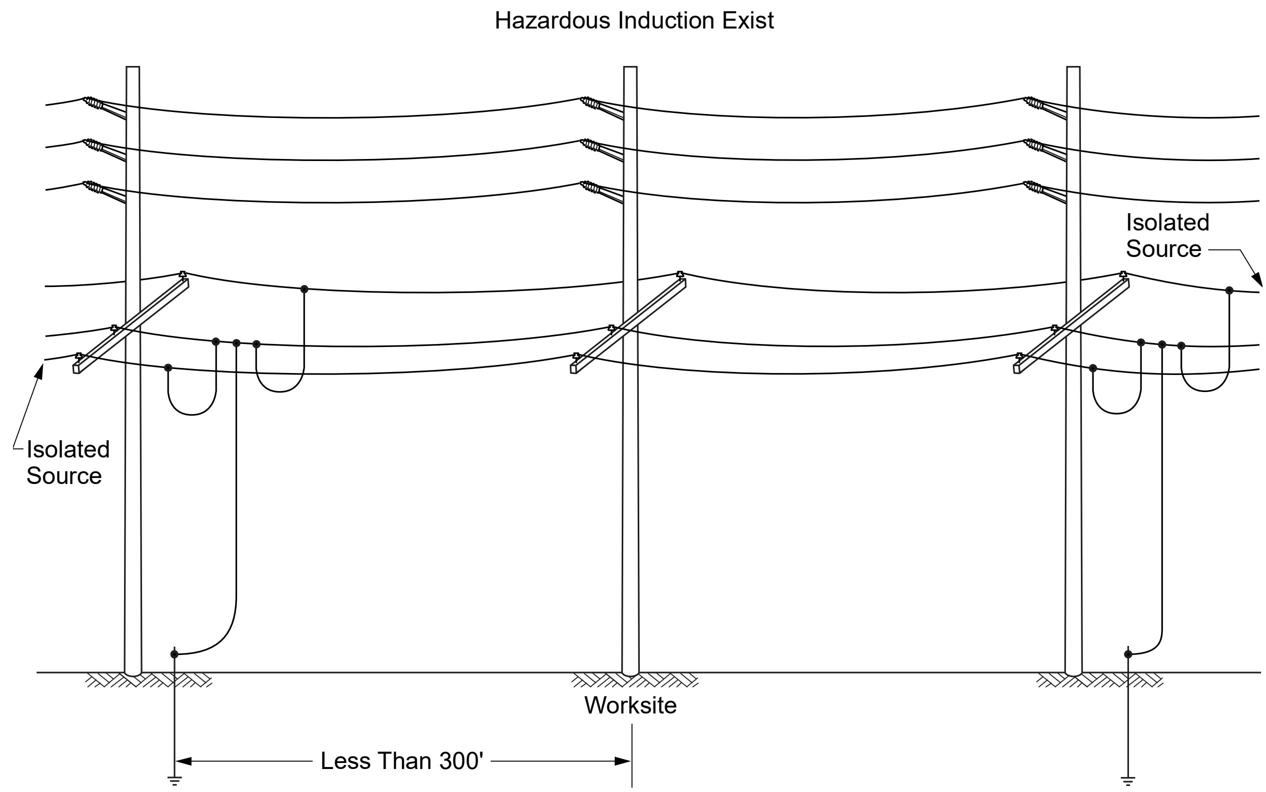


Example 4 — Overhead Bracket Grounding

This example is applicable to 3- or 4-wire systems. Sources are isolated by physically removing taps, installing a sign [tag (SCE161-T-P2-T94)], and issuing/taking a clearance per APM, Rule 105 for distribution circuits main line. In addition, energized conductors on the source pole are covered using approved protective devices such that there are no exposed energized source conductor(s). There are parallel line(s) and hazardous induction exists. Bracket grounds are installed between the work site and all source(s). The distance between the work site and one of the bracket ground(s) is less than 300 feet. No workspace EPZ is required to work on conductors on wood, composite, and concrete poles that are within 300 feet of a bracket ground.

However, if the distance between the work site and all of the bracket ground(s) was more than 300 feet, a workspace EPZ would be required.

Figure 3–48: Overhead Bracket Grounding — Example 4



Example 5 — Overhead Bracket Grounding

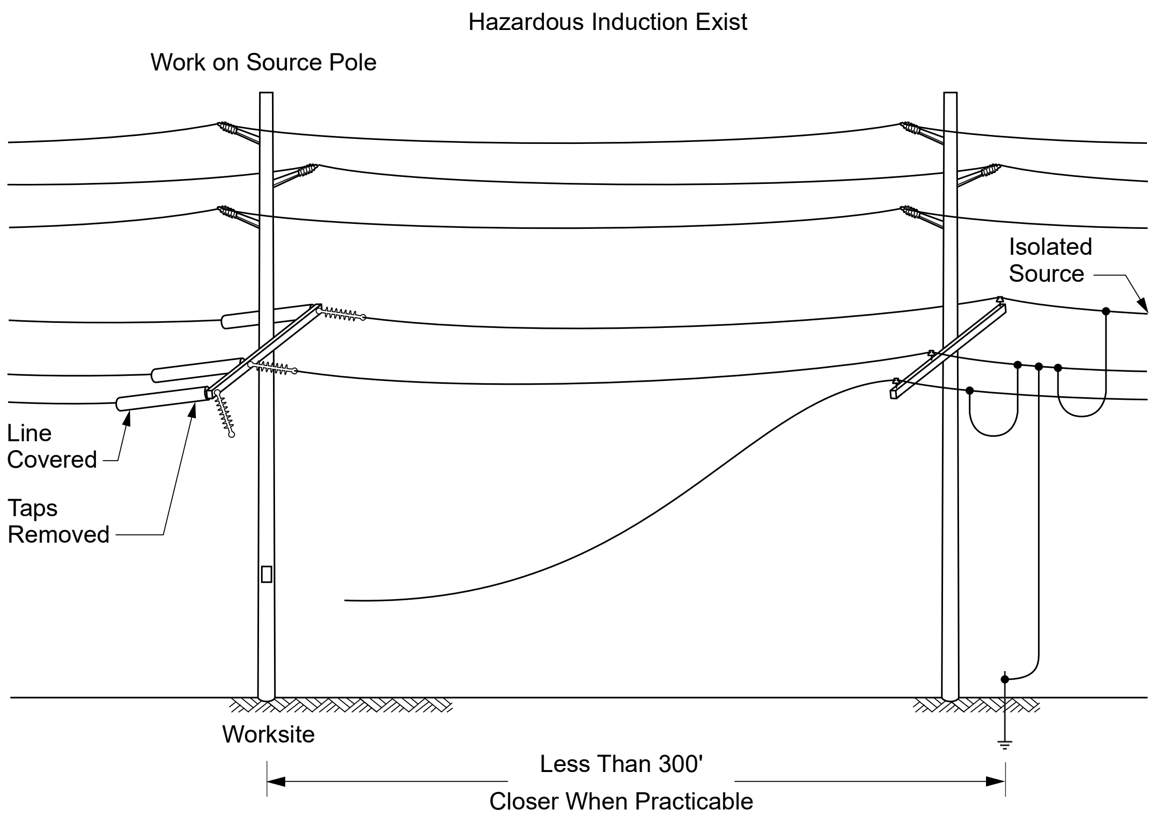
This example is applicable to working on a source pole and where there are parallel line(s) and where hazardous induction exists. Also, this method is applicable to 3- or 4-wire system.

Sources are isolated by physically removing taps, installing a sign [tag (SCE161-T-P2-T94)], and issuing/taking a clearance per APM, Rule 105 for distribution circuits main line. In addition, energized conductors on the source pole are covered using approved protective devices such that there are no exposed energized source conductor(s). One set of bracket grounds is installed between the work site (that is a source pole) and other isolated source(s). The bracket grounds should be installed as close as practicable to the work site, for example, (at next pole).

In this example, the distance between the work site and the bracket grounds is less than 300 feet. Therefore, working on a source pole will not require a workspace EPZ when the work site is on a wood, composite, or a concrete pole. In addition, for handling conductor on the ground, an EPZ is not required.

However, if the distance between the work site and the bracket ground(s) was more than 300 feet, a workspace EPZ on the source pole and EPZ on the ground will be required to handle the conductor.

Figure 3–49: Overhead Bracket Grounding — Example 5



3.6.13.3 Aerial Cable Isolation Method

This method is applicable when all sources (breakers, fuse, switch or taps) are isolated and the cables/potheads are floated or aerial components are installed on insulated standoffs.

This method will not require any working grounds or EPZ at the work site. However, the cable or equipment to be worked on shall be proven de-energized by one of the following methods:

- Testing and grounding,
- Cable spiking shall be done remotely using approved spiking tools. Verify concentrics are grounded before spiking. Spiking shall be performed on both the grounded concentrics and cable simultaneously.

Caution shall be exercised to avoid getting between hazardous ground potentials.

When using Aerial Cable Isolation Method, additional opening(s) between the work location and the isolated source is acceptable.

On a main line, when the neutral is not isolated from the source, the neutral shall be grounded at the work site.

Induction will cause a hazardous difference of electrical potential when structures of the aerial cable are located within transmission/sub-transmission corridors, or support energized line(s) which are in parallel with the circuit being worked on for more than 600 feet. Insulated or exposed phase conductors, messenger, and concentrics of aerial cable are susceptible to hazardous induction.

After sources have been isolated or eliminated; one of the following work methods shall be used to move, inspect, splice, work on, or attach/detach from its supporting structure where there is hazardous induction:

- Use HVRG. While using HVRG the worker shall not contact any exposed conductor with any part of their body;
- Work within 300 feet of a bracket grounds (when bracket grounds are installed);
- Work on the messenger/Neutral/concentrics within 300 feet of a permanent or temporary ground; or
- The conductor, messenger, Neutral, and/or concentrics can be worked on while draining/bleeding hazardous induction by use of an anchor rod or temporary ground rod(s) and grounds connected between the exposed conductors and the rod(s) provided the workspace is within 300 feet of the grounds.

NOTE When the insulation of an aerial cable is in-tact and the phase conductor is not exposed, the insulation of an aerial cable provides adequate protection from hazardous induction that might be present on the phase conductor.

Procedure

STEP 1. De-energize and issue/take a clearance per APM Rule 105 for the distribution circuit.

STEP 2. Isolate all phases from each source using one of the following methods:

STEP 2.1 Remove taps from pothead(s), adequately protect the source with approved protective devices, clean, test, and ground at each source location, and then remove the pothead(s) from the bracket, disconnects, cutouts, fuse holders, and so forth.

STEP 2.2 Test 200 amp elbows de-energized and ground, then remove from the source (for example, from switches, J-bars, RTPs, various equipment), safe end the source, and install the elbows on insulated standoffs. The use of Live Line Tools is required to expose and separate 200 amp components.

STEP 2.3 Spike cable, using approved spiking tools and methods, and safe-end the source side cable utilizing an approved work method.

WARNING Isolation Method as described above does not apply to work on the source side. In order to work on the source side, grounding or additional isolating would be required.

WARNING The cable, components, or equipment to be worked on shall be tested and proven de-energized.

WARNING 600 amp basic elbow components (T-Bodies) shall not be separated/installed using live line tools.

WARNING Previously energized aerial cable shall be proven de-energized prior to making contact. In addition, when the status of the line has changed, shift/crew changed, clearance boundary changed, or when in doubt, aerial cables shall be proven de-energized prior to encroaching at the work location.

WARNING Cable spiking is required to prove the cable de-energized when no other method of testing exists at the work location. Cable spiking shall be done remotely using approved spiking tools. Verify concentrics are grounded before spiking. Spiking shall be performed on both the grounded concentrics and cable simultaneously.

STEP 3. Backfeed shall be eliminated per APM, Rule 149.

STEP 4. Cover exposed energized components/conductors at the work/grounding location or maintain minimum approach distance at all times.

STEP 5. When working on a main line and the neutral is not isolated from the source, the neutral shall be grounded at the work site.

STEP 6. Test and ground (minimum of #2 approved grounds shall be used for this purpose), or remote spike the cable and grounded concentrics simultaneously.

WARNING When cutting of the cable is not needed at the work location it shall be traced back from the location where it has been proven de-energized.

STEP 7. Work can be performed without use of Live Line Tools, EPZ, or HVRG.

STEP 8. No work shall be performed on source location(s) while work is in progress using this isolation method.

Exception: Work may be performed on separable components at the source location provided the source components are safe-ended.

STEP 9. When the aerial cable is no longer isolated (for example at the source location taps installed, components landed, safe ends removed from the source), work on the de-energized line shall be performed utilizing one of the approved Grounding Methods.

3.6.14 Leaving Grounds Overnight

Grounds are normally removed at the end of each workday. However, under some conditions it may be desirable to leave grounds installed on conductors or leave the ground jumpers and long ground on a structure but not installed on conductor overnight.

The two approved options for leaving grounds overnight are:

1. The ground-level connection shall be buried or placed in a secure enclosure. In addition, the first ten feet from the ground level of the long ground conductor will be covered with wood molding or PVC covering. Before starting work again, the ground connection cover and long ground conductor cover shall be removed and inspected, or,
2. The grounds shall be removed from all conductors first, and then the long ground can be disconnected from the ground medium. Always ensure there is adequate clearance from conductors when leaving grounds on the structure overnight in case the circuit should become energized. The end of the long ground shall be rolled up and secured on the structure at least 15 feet above ground level. All conductors shall be tested de-energized before any grounds can be reinstalled following a break in the work. This would include any situation where the grounds were removed and will then be reinstalled.

3.7 Remove Grounds

Before releasing a clearance or re-energizing the section of line or equipment that the grounds were installed on, the supervisor or employee in charge ensures that all grounds have been removed.

Before disconnecting from the ground medium, remove grounds from all conductors or equipment in reverse order of installation using approved live-line tools.

4.0: Grounding Procedures

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4.0: Grounding Procedures

To provide protection for workers, grounds shall be installed properly. This section contains specific grounding procedures and illustrations that show proper grounding on various structure types. Sections that describe grounding on the structure types depict one set of grounds. It should be noted that another set of grounds is needed to complete equipotential bracket grounding or bracket grounding which are not shown.

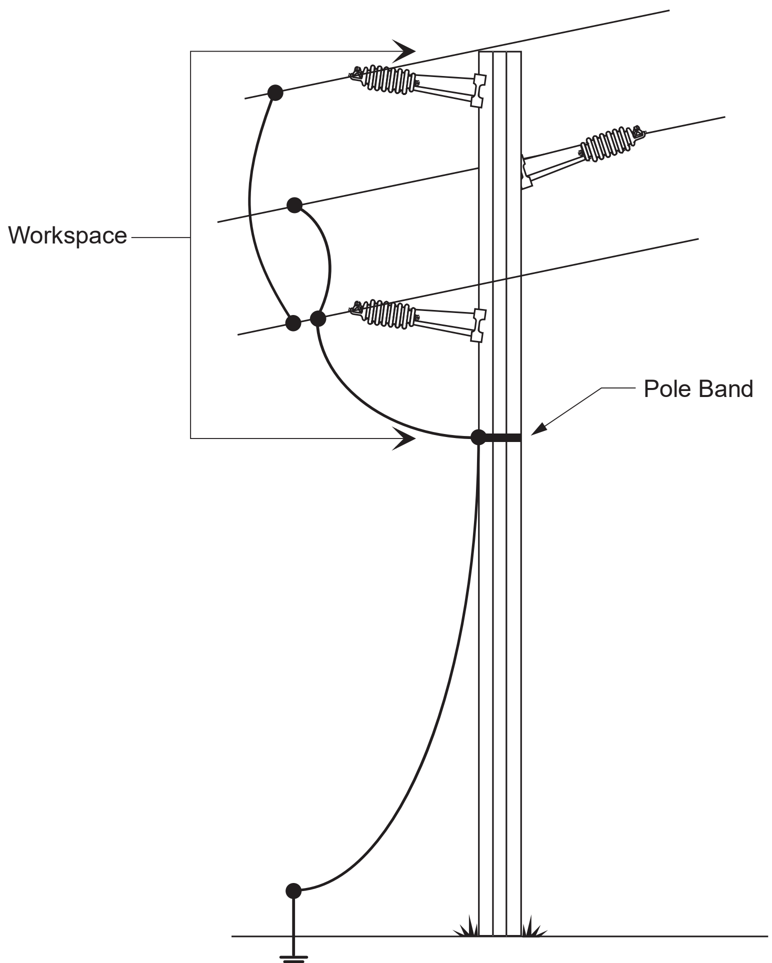
Other grounding procedures are also described in this section.

4.1 Grounding Circuits on Wood, Composite, and Concrete Poles

Grounding on wood, composite, and concrete poles may include a pole band, long ground, shunt, and ground medium.

The pole band shall not be tightened to a point that will damage the composite pole. In Figure 4–1, the circuit is grounded and an Equipotential Zone (that is workspace) is established. The Equipotential Zone is above the pole band.

Figure 4–1: Grounded Circuit — Workspace above Pole Band



4.2 Grounding Circuits on Steel Poles

4.2.1 Light Weight Steel Poles

Working on a Light Weight Steel (LWS) pole requires the use of a pole band or approved step/grounding bolt to create an Equipotential Zone (EPZ) workspace. These are the only approved means of attaching grounds to a LWS pole.

To ground the circuit on LWS pole, install a long ground from the ground medium to the pole band or approved step/grounding bolt. The entire surface of a steel pole becomes an Equipotential Zone when a pole band or approved step/grounding bolt is used to ground the conductors. There are no additional grounding requirements for guy wires attached to the LWS.

WARNING Combination of a step/grounding bolt and pole band is not allowed.

Figure 4–2: Workspace on LWS Pole — Example 1

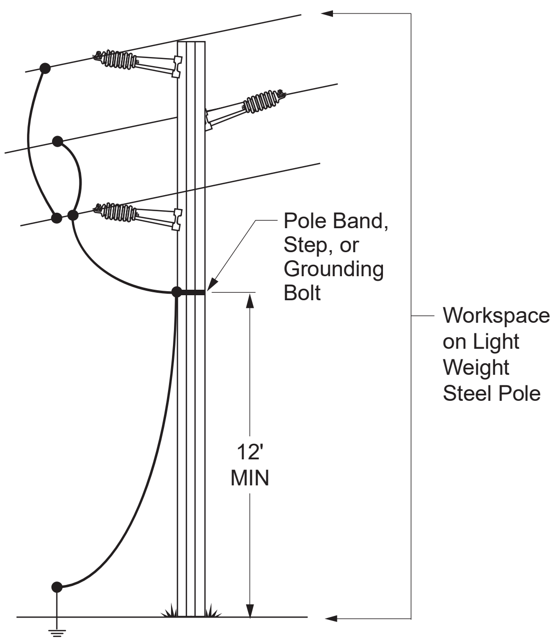
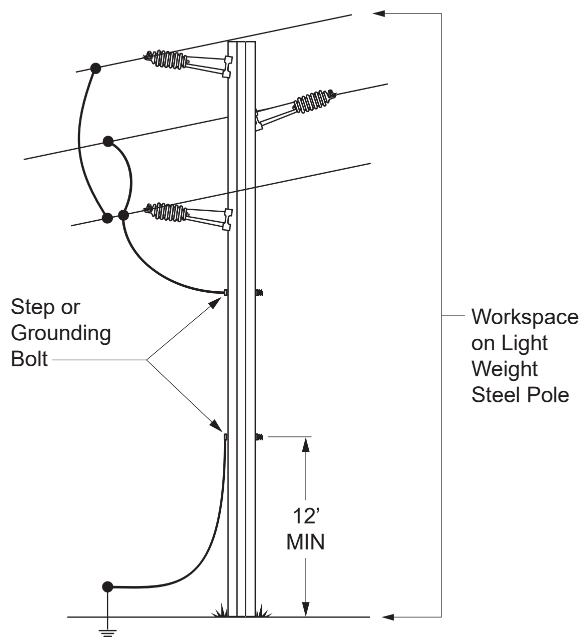


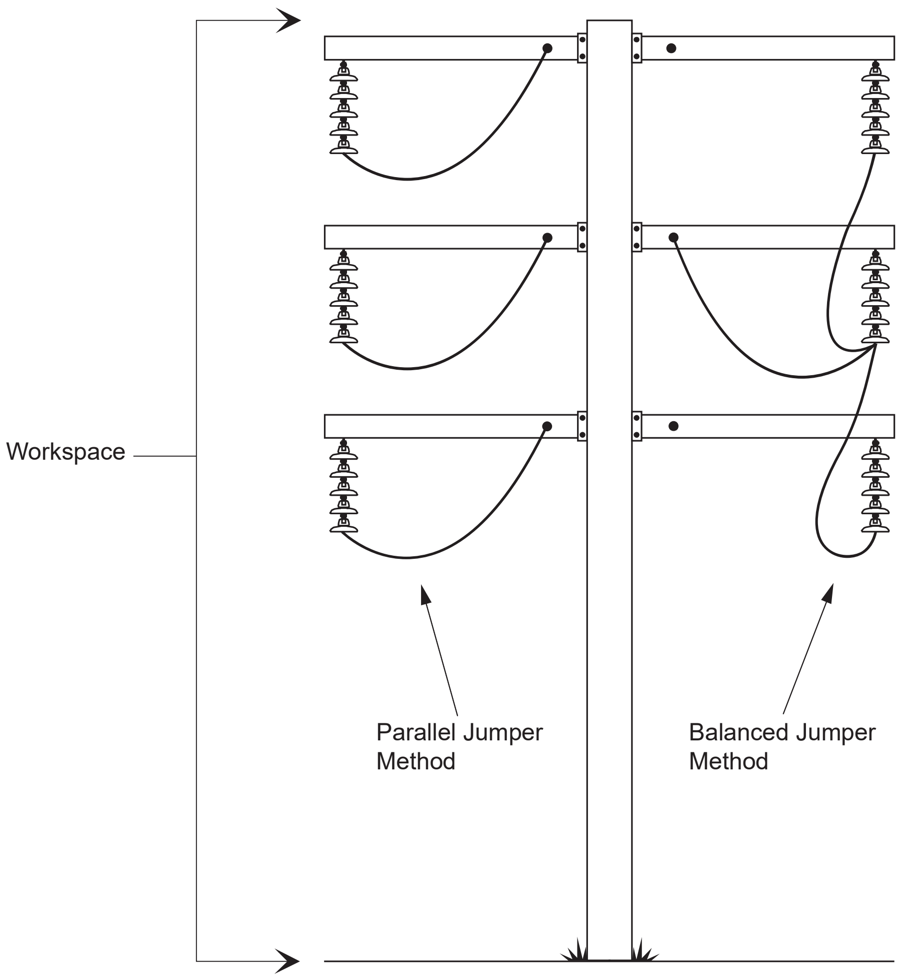
Figure 4–3: Workspace on LWS Pole — Example 2



4.2.2 Engineered Tubular Steel Poles

Engineered Tubular Steel Poles (TSPs) are grounded structures. Grounding of line conductors on Engineered TSPs does not require use of an additional ground medium. Ground connections to the pole should be made utilizing the welded grounding lug on TSP arms. If not available, then a step bolt or copper grounding bolt should be utilized. For specific information, see Subsection 3.6.5, Subsection 3.6.6, and Subsection 3.6.7. The entire surface of a steel pole becomes an equipotential workspace when the conductors are grounded to the pole (see Figure 4–4).

Figure 4–4: Grounding Using TSP Arm Ground Lug



Ground connections to the pole may also be attached to welded nut(s) using a 3/4 inch approved step/grounding bolt(s). The entire surface of a steel pole becomes an equipotential workspace when the conductors are grounded using the approved step/grounding bolt(s).

4.2.3 Lattice Steel Poles

Lattice steel poles are grounded structures.

- When grounding conductors supported on a lattice steel pole, include a ground from all de-energized conductors to the lattice steel pole. A long ground is not required.
- When present, use a multi-grounded primary neutral in the grounding scheme.
- Apply a ground from the primary neutral to either the steel structure or grounded conductor.
- Use approved flat jaw clamps for grounding to lattice steel poles. The entire surface of a lattice steel pole becomes an Equipotential Zone when the conductors are grounded to the pole.
- Do not use step bolts on lattice steel poles for grounding.

See Figure 4–5 and Figure 4–6.

Figure 4–5: Lattice Steel Pole — Example 1

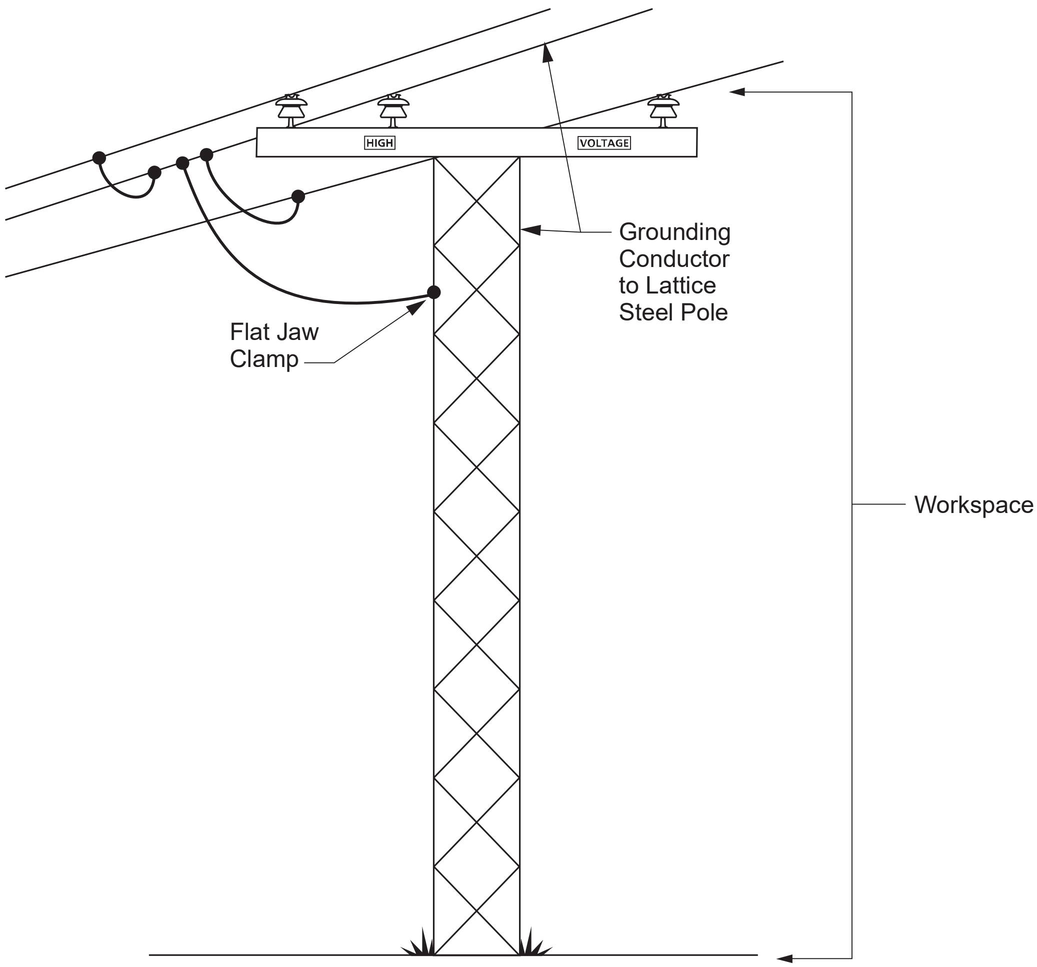
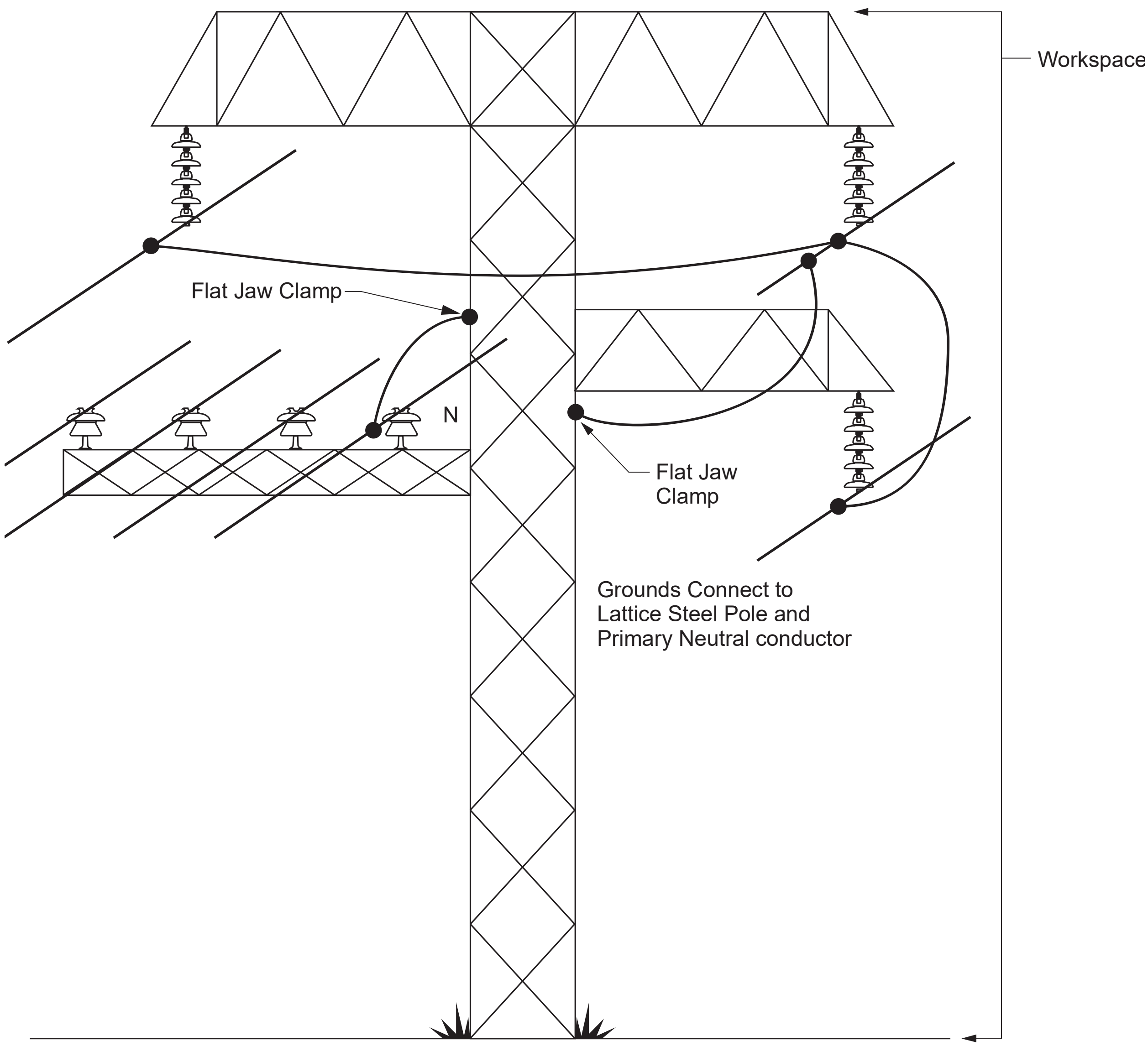


Figure 4–6: Lattice Steel Pole — Example 2



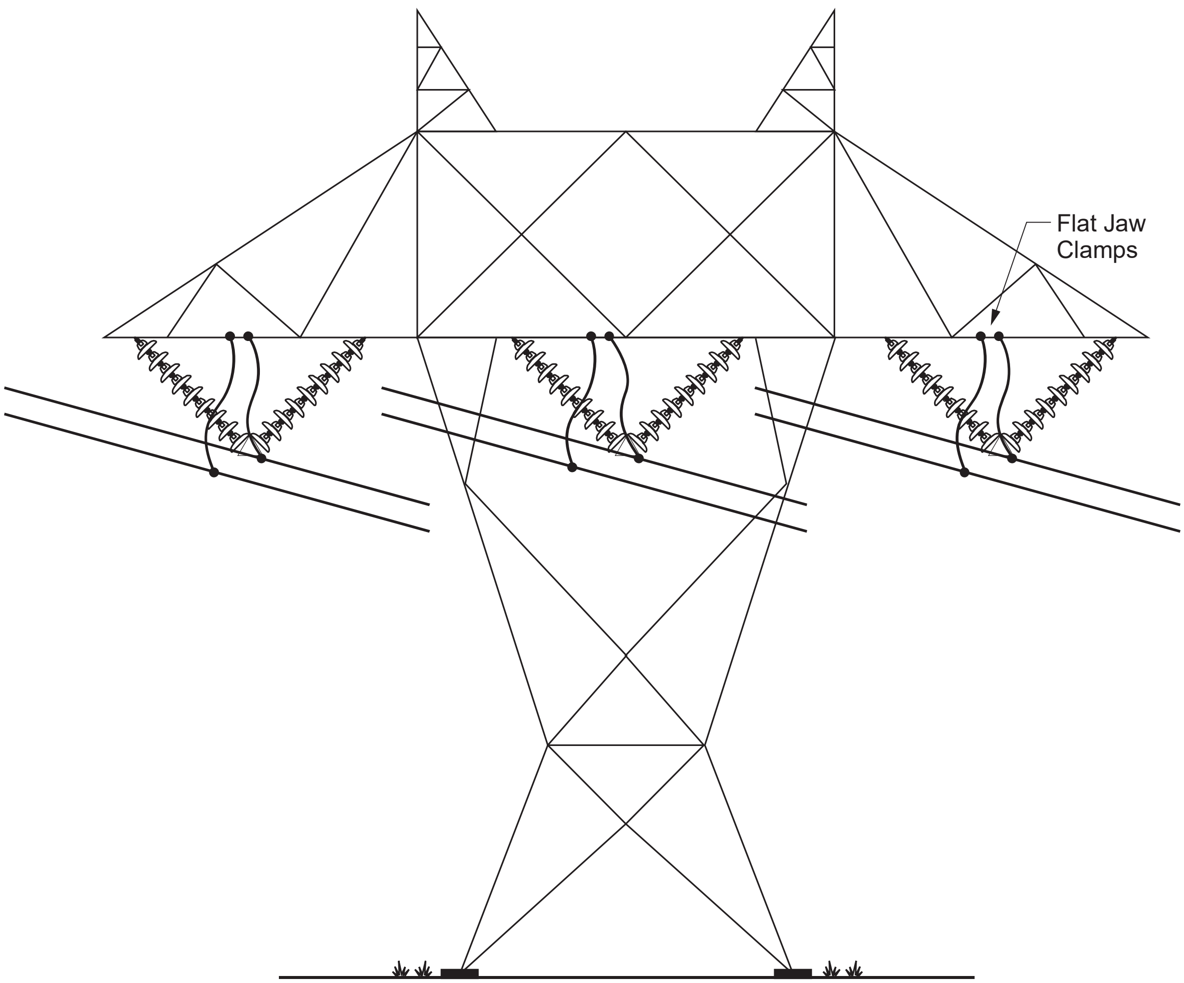
4.3 Grounding Circuits on Steel Lattice Towers, Contemporary and Portal Structures, and Substation Racks

Lattice steel towers, contemporary towers, portal structures, and substation racks are grounded structures.

Use approved flat jaw clamps for grounding to steel structures. The entire surface of a steel structure becomes an Equipotential Zone when the conductors are grounded to the structure. See Subsection 5.2.4 for flat jaw clamp fault current carrying capability. When the fault duty of the circuit being grounded exceeds the maximum fault current that a single flat jaw clamp can carry, two flat jaw clamps per phase shall be used. When using two flat jaw clamps per phase, grounds connected between each phase and these flat jaw clamps shall be the same size and length.

Step bolts on lattice steel structures shall not be used for grounding. Welded steps on Contemporary and Portal towers may be used for grounding. See Figure 4–7 for an illustration of grounding on steel towers.

Figure 4–7: 500 kV Tower Bundled Conductor



500 kV Tower Bundled Conductor

4.4 Grounding Circuits on H-Frame Structures

On an H-Frame structure of wood, composite, Light Weight Steel (LWS) pole, or concrete poles, a pole band is required on each pole and shall be connected to the line conductor(s) to be worked on. The approved step/grounding bolt(s) can be used on LWS poles instead of a pole band. The following examples are approved configurations for installing grounds.

- Install pole bands at approximately the same level on each pole, either above or below the X-Braces.
- When attached grounds are present on a structure, connect the attached grounds to the pole bands.
- Thirteen-six racks (and other similar racks) are considered the same as H-Frame structures. Install pole bands at approximately the same level on each pole, either above or below the rack.

Figure 4–8 through Figure 4–12 show approved grounding configurations in order of preference.

Figure 4–8: H-Frame Grounding — Example 1

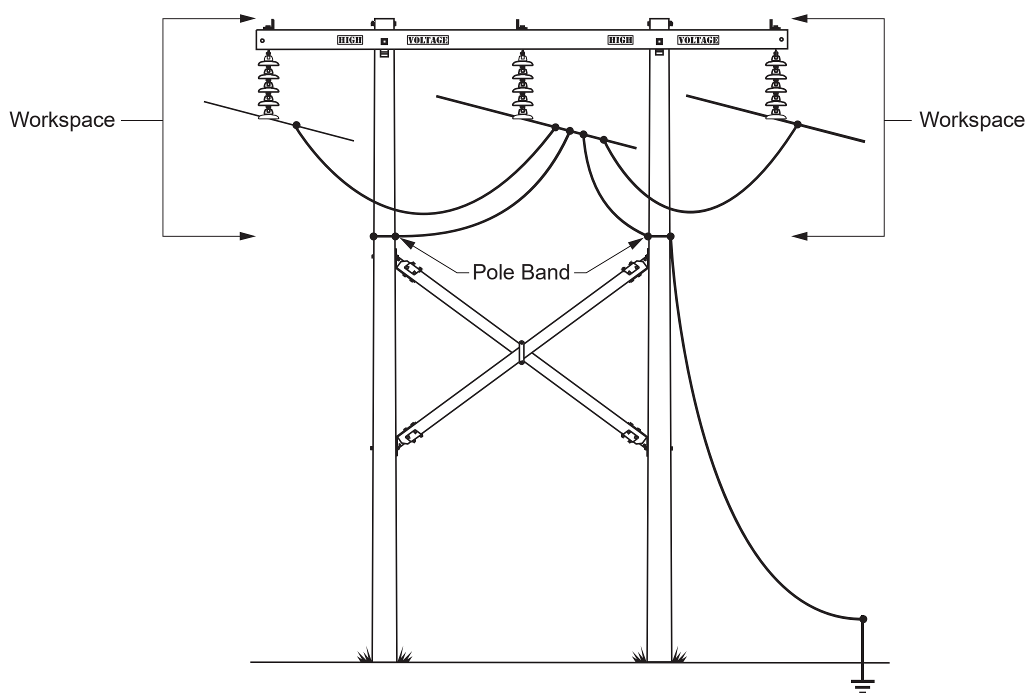


Figure 4–9: H-Frame Grounding — Example 2

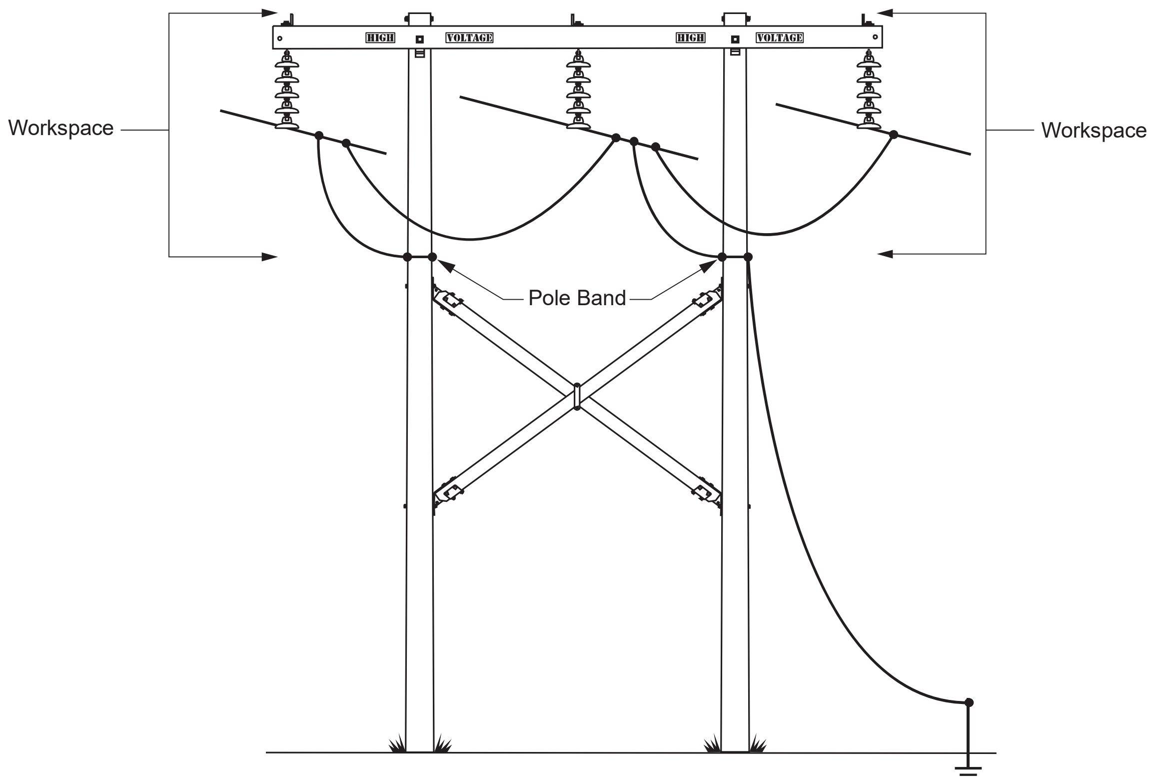


Figure 4–10: H-Frame Grounding — Example 3

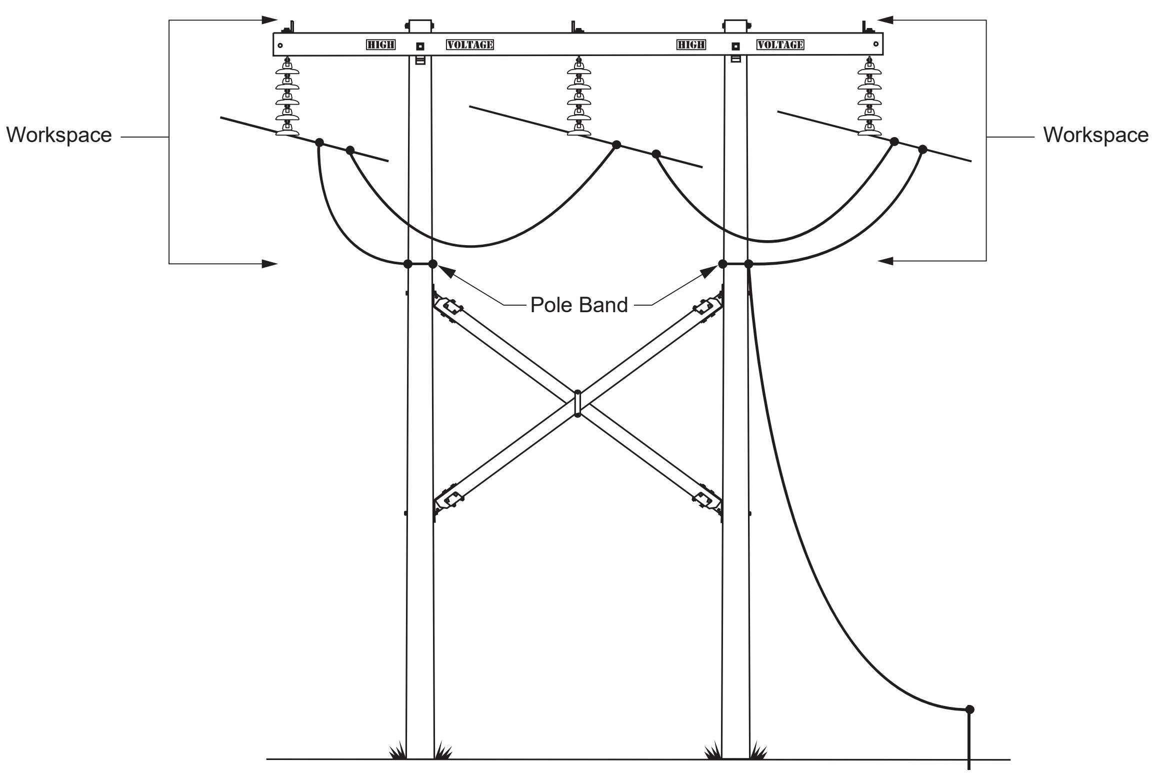


Figure 4–11: H-Frame Grounding — Example 4

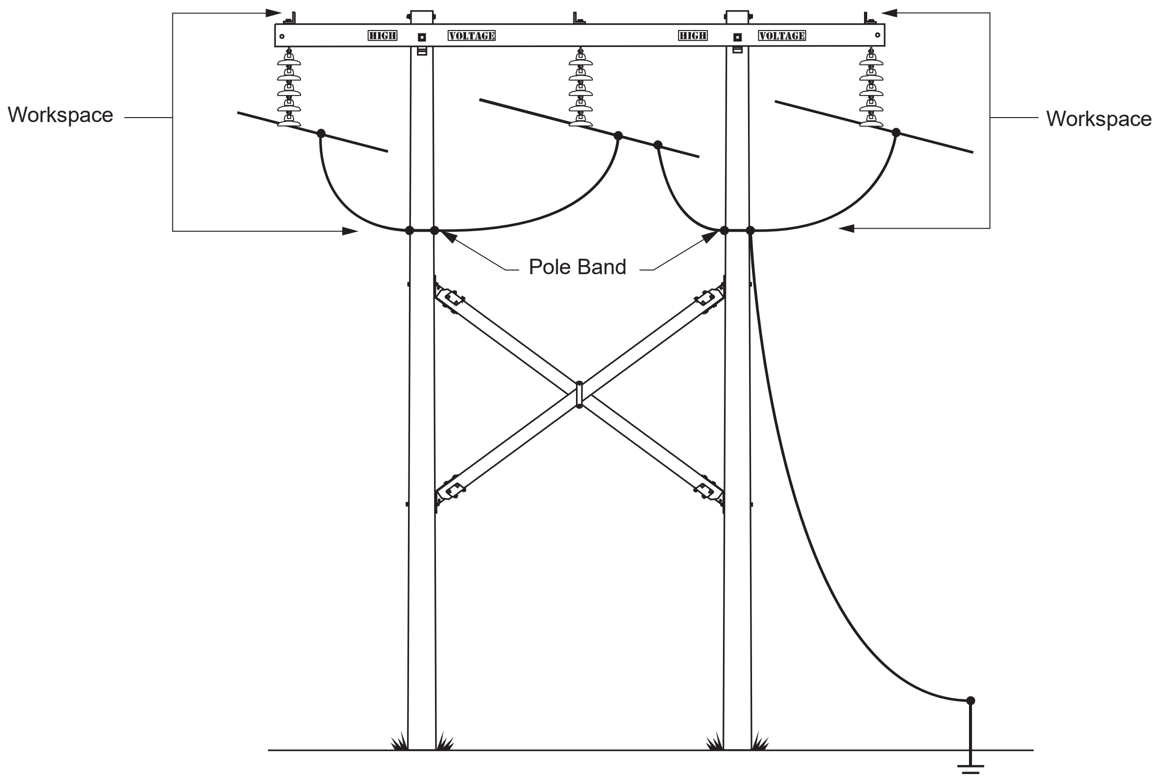
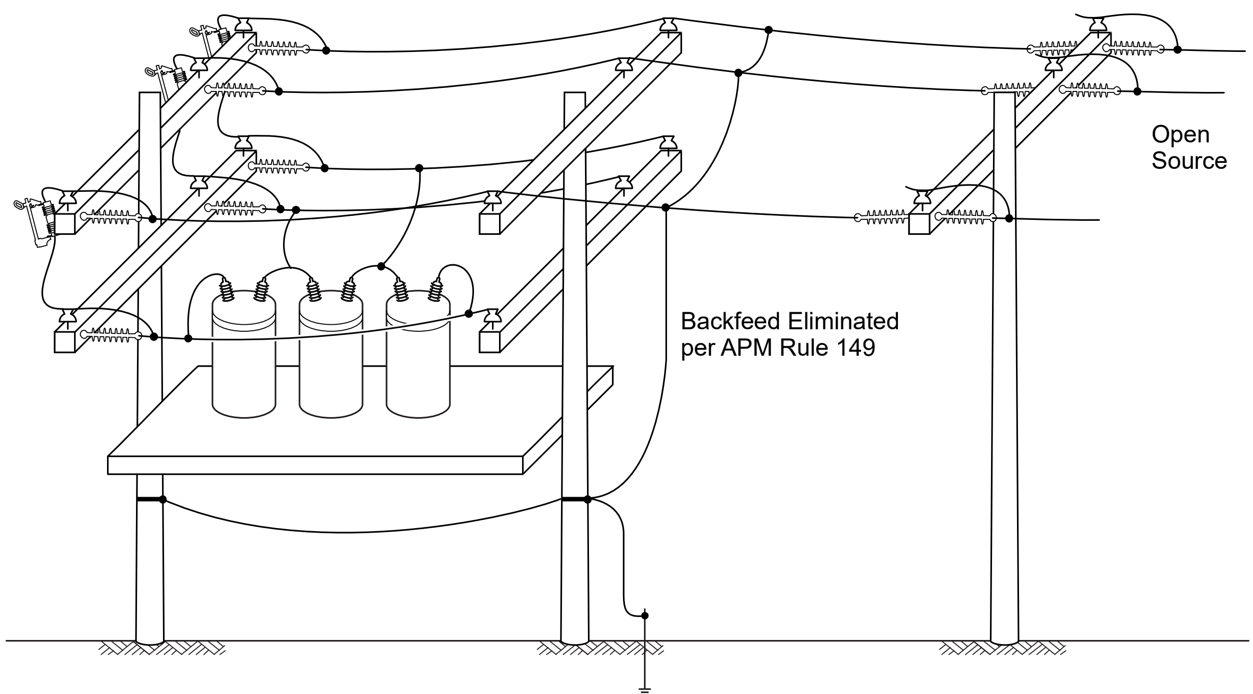


Figure 4–12: H-Frame Grounding — Example 5



4.5 Grounding Overhead Ground Wire

NOTE The term Overhead Ground Wire (OHGW) as used in this section also refers to Optical Ground Wire (OPGW). Optical Ground Wire grounding requirements are the same as OHGW grounding requirements.

4.5.1 Grounding OHGW on Wood, Composite, LWS Pole, or Concrete Structures

Installation of approved grounds is required to perform work on or in the proximity of Overhead Ground Wire (OHGW) on wood, composite, Light Weight Steel (LWS) pole, or concrete structures.

Bond wire and hardware for the overhead ground wire shall be worked with approved live-line tools unless the overhead ground wire and the bond wire are grounded at the same potential.

Bond wire and hardware for overhead ground wire shall be considered properly grounded when approved grounds are connected to an approved ground medium, grounded pole band, or grounded conductor; and then attached to the overhead ground wire.

When opening or closing an overhead ground wire, workers shall avoid placing themselves in series between hazardous difference of electrical potential.

Procedure

STEP 1. Install an approved ground on the overhead ground wire, even when there is a permanently attached ground connected to the overhead ground wire.

STEP 2. Connect grounds for the overhead ground wire to an approved ground medium, grounded pole band, or to a grounded conductor; and then connect the ground to the OHGW.

STEP 3. Ensure bond wires and hardware of the OHGW are included in the grounding scheme.

See Figure 4–13 and Figure 4–14 for examples of OHGW grounding.

Figure 4–13: OHGW Grounding — Example 1

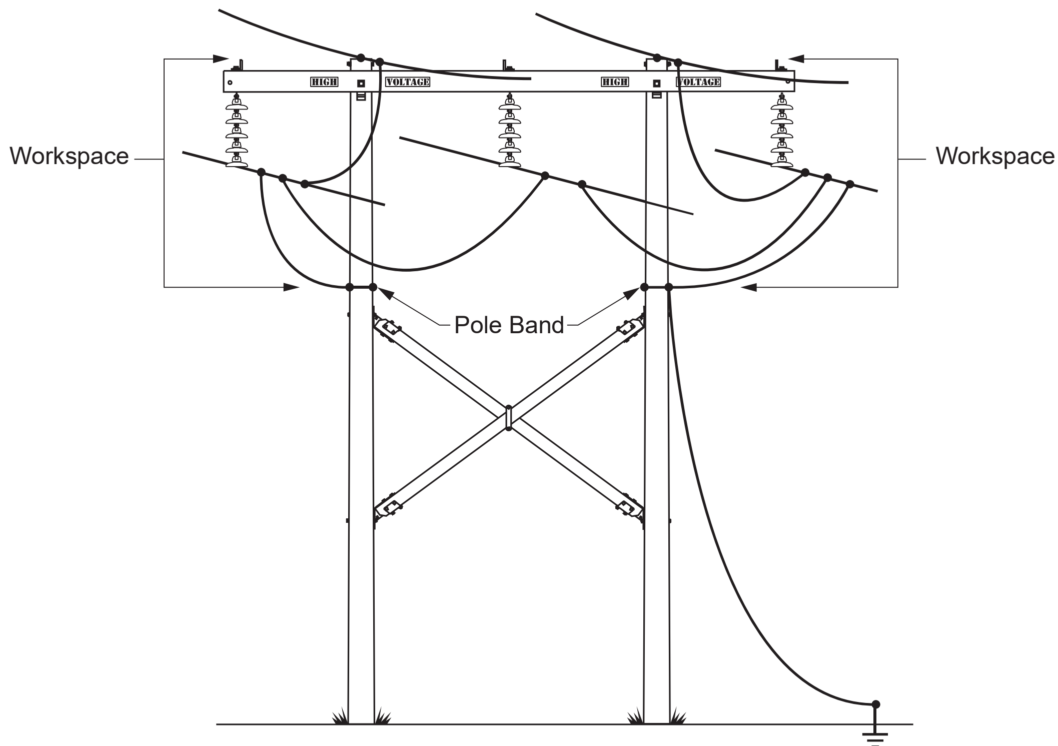
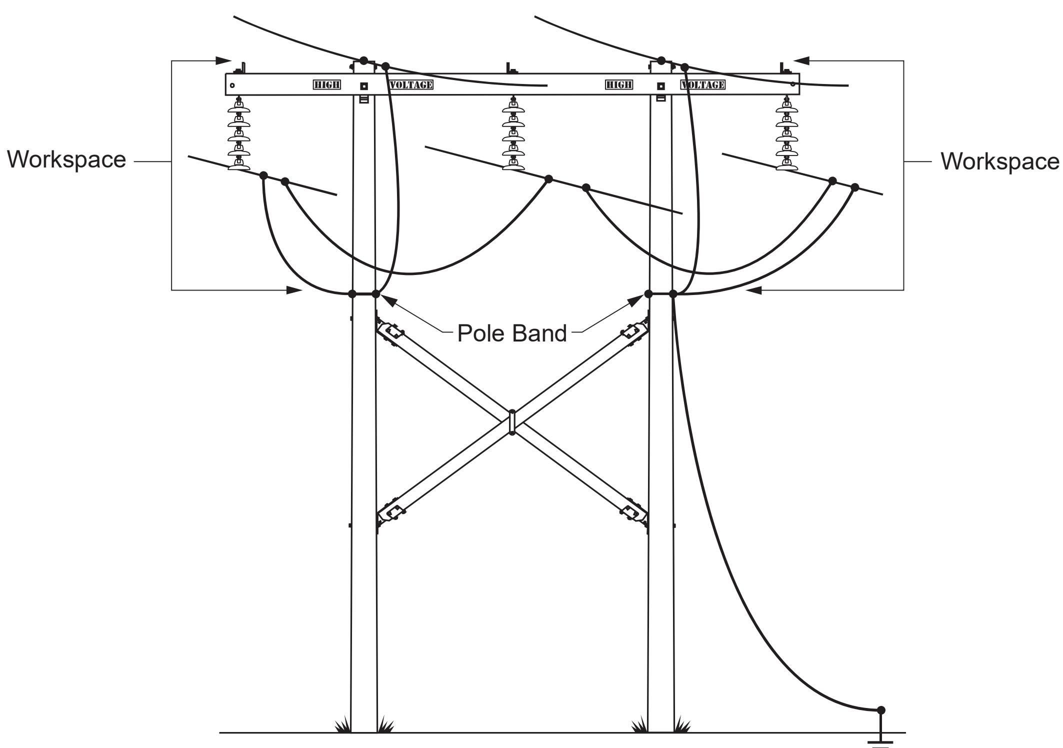


Figure 4–14: OHGW Grounding — Example 2



4.5.2 Grounding OHGW and OPGW on 500 kV Structures

NOTE

The term Insulated Overhead Ground Wire (OHGW) as used in this section refers to overhead ground wires on 500 kV towers that are supported from the tower by an insulator. This support can either be in a dead-end or suspension configuration.

The OHGW on the 500 kV system is sectionalized and insulated from most of the towers. Each section of the 500 kV system OHGW is typically grounded to a tower. Due to the high-operating voltage of the circuit, a fairly high voltage can be induced on the OHGW in each section.

The Optical Ground Wire (OPGW) on 500 kV structure is generally grounded on every structure.

The procedure described below is also applicable to 500 kV structures that are operated at lower voltage.

Procedure

STEP 1. Maintain a safe working distance of 28 inches from 500 kV system overhead ground wire until an approved ground is installed using approved live-line tools.

STEP 2. When working on or in proximity to the 500 kV system OHGW/OPGW, ground the OHGW/OPGW to the structure at the work location, even when there is a permanently attached ground connected to OHGW/OPGW. OPGW on structures where it transitions to a termination box do not require additional grounding below the OHGW peak if not being worked on.

STEP 3. When working on overhead ground wire transposition towers or on towers where the ground wire is sectionalized, ground all the overhead ground wires.

STEP 4. When applying or removing grounds on the overhead ground wires, the workers entire body shall be below the level of the overhead ground wires.

STEP 5. When performing work on or in proximity of the overhead ground wires, approved grounds shall be installed on each overhead ground wire section using approved live-line tools.

STEP 6. Connect the first ground from the structure to the overhead ground wire (see Figure 4–15 and Figure 4–16).

STEP 7. Connect an additional ground from the structure to the overhead ground wire (see Figure 4–15 and Figure 4–16).

STEP 8. When opening or closing an insulated overhead ground wire, install approved jumper(s) (approved 2/0 grounds) to avoid placing workers in series between different potentials (see Figure 4–15).

STEP 9. Use approved flat jaw clamps for grounding to steel lattice towers.

STEP 10. Use 2/0 grounds to ground and maintain continuity of overhead ground wire on 500 kV towers.

Figure 4–15: Grounding Insulated OHGW 500 kV — Example 1

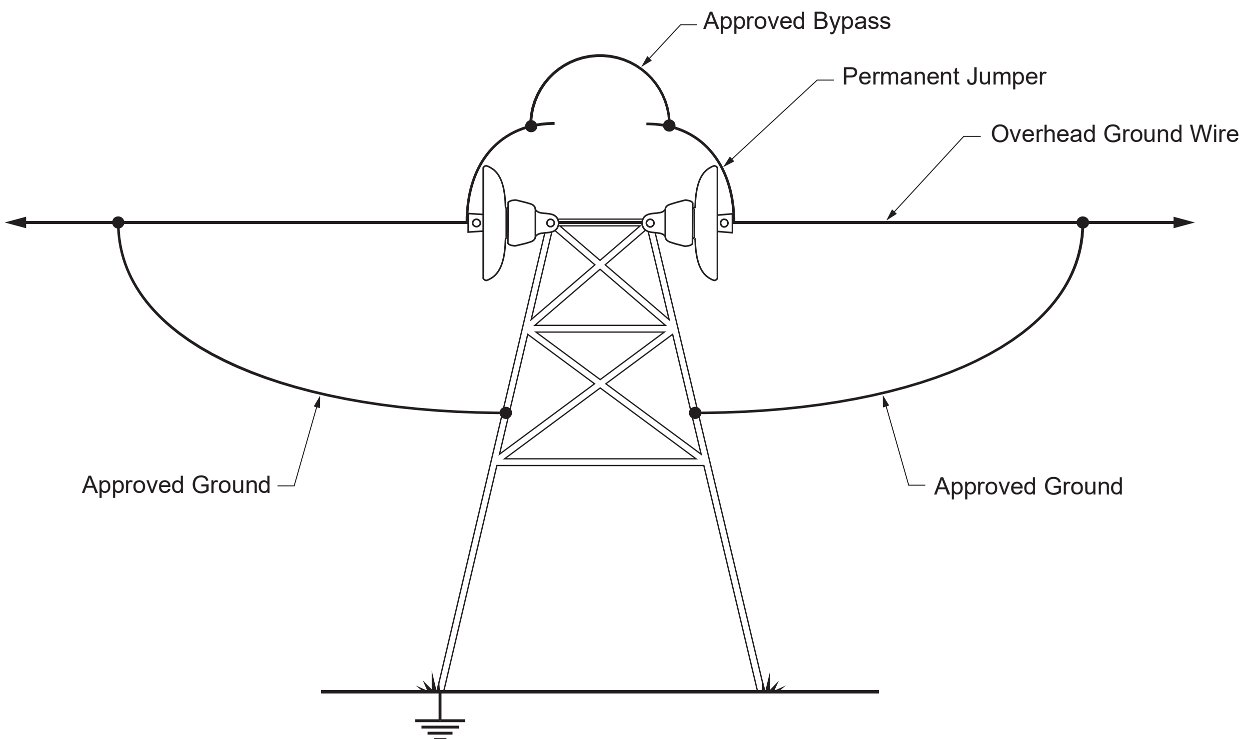


Figure 4–16: Grounding Insulated OHGW 500 kV — Example 2

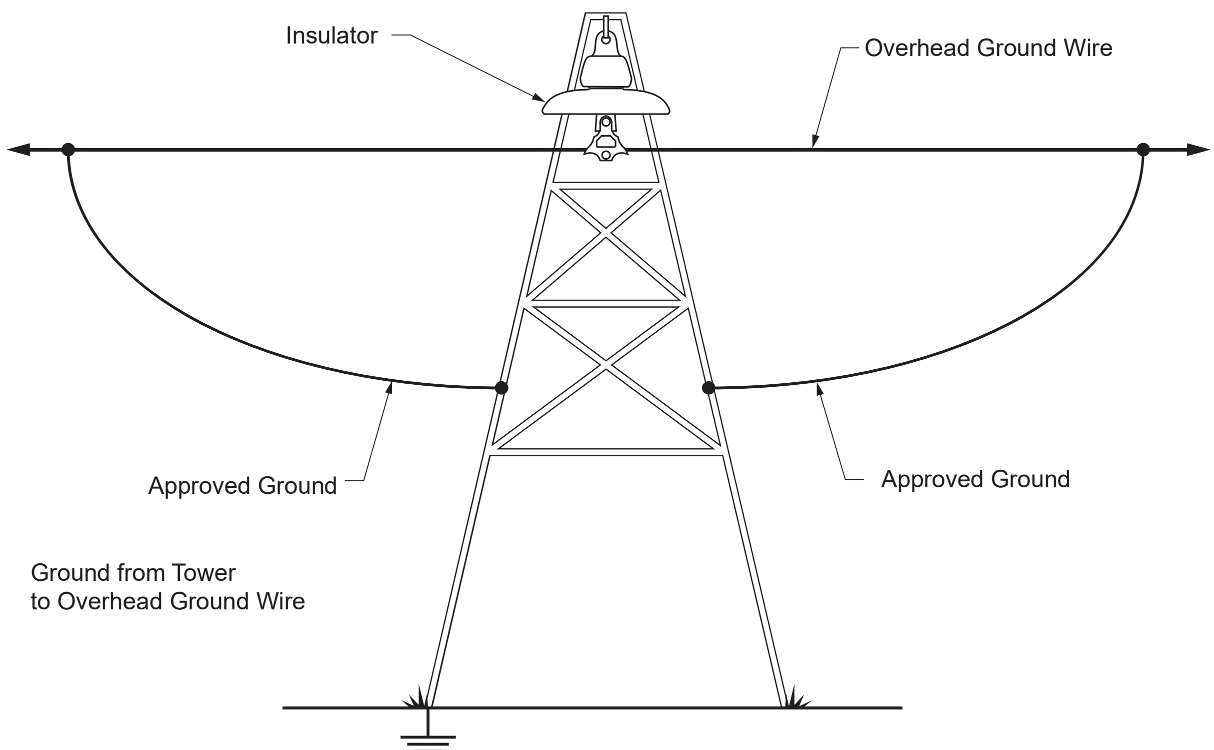


Figure 4–17: Grounding OPGW 500 kV — Example 1

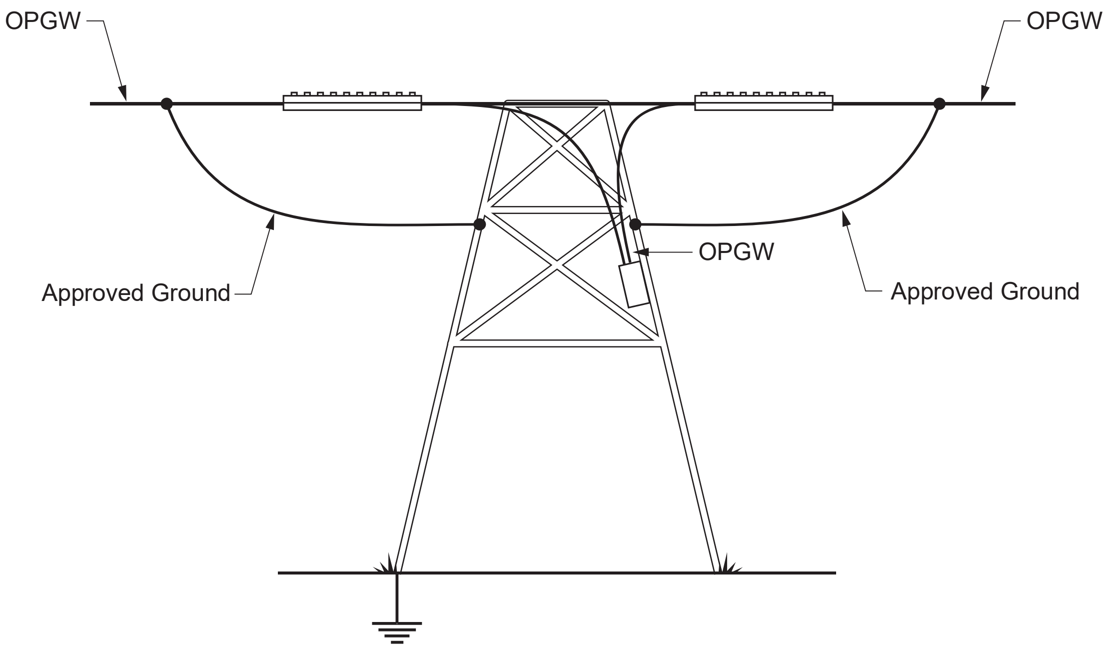
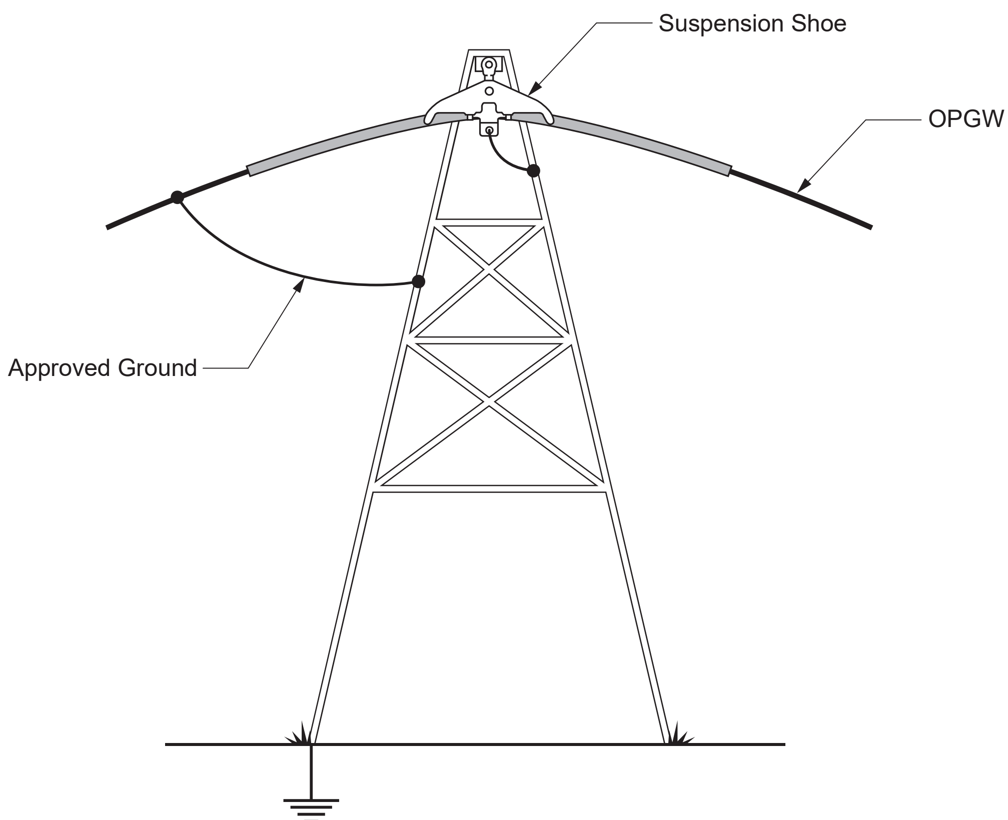


Figure 4–18: Grounding OPGW 500 kV — Example 2



4.5.3 Grounding of Non-Insulated Overhead Ground Wire on Steel Structures

Grounding of non-insulated overhead ground wire on steel structures is not necessary unless the overhead ground wire is removed or electrically isolated from the structure or the overhead ground wire jumper loop is opened.

When an overhead ground wire is opened or removed from the structure, additional ground(s) [by-passes, shunt(s), or jumper(s)] shall be installed to maintain continuity and to eliminate hazardous difference of electrical potential.

4.6 Grounding when Multi-Grounded Primary Neutral Is Present

In some situations, the size of multi-grounded neutral conductor is smaller than the phase conductors being grounded. As a result, the neutral conductor may not be capable of carrying the entire available fault current. Therefore, the neutral conductor shall not be used in such a way that it is forced to carry the entire fault current. Connecting the grounding scheme to the neutral at only one point is recommended to avoid forcing all available fault current into the neutral conductor.

WARNING Isolated/Floating neutrals beyond distribution Automatic Reclosers (ARs) shall not be used as a ground medium; the floating neutral shall be opened between the AR and the bracket grounds. Floating neutrals that are not part of the line being grounded, should not be incorporated into the grounding scheme because that connection could cause an unplanned operation, for example, (AR tripping).

When more than one multi-grounded primary neutrals exist on a structure, a minimum of one shall be used as a ground medium. Foreign utility neutrals shall not be used in SCE's grounding configurations.

When a multi-grounded primary neutral conductor is incorporated into the grounding scheme, ensure that an additional approved ground medium is also utilized.

Procedure

STEP 1. When grounding a de-energized circuit and there is a multi-grounded primary neutral on the structure being grounded, include the neutral in the grounding scheme.

STEP 2. Attach an approved ground from the multi-grounded primary neutral to a grounded conductor, the pole band, the structure, or to the same ground medium used for grounding the circuit.

STEP 3. Always make the connection to the ground medium first, for example, (anchor rod or temporary driven ground rod), and then connect to the primary neutral conductor or

STEP 4. de-energized phases using approved live-line tools.

STEP 5. Size of grounds being attached to neutral shall be equivalent size as the grounds being used on the phase conductors unless otherwise noted in Notes 1 and 2 of Table 3–1.

The following examples (Figure 4–19 through Figure 4–22) illustrate approved configurations of grounding de-energized conductors using a multi-grounded primary neutral conductor in the grounding scheme.

Figure 4–19: Grounding with Multi-Grounded Primary Neutral — Example 1

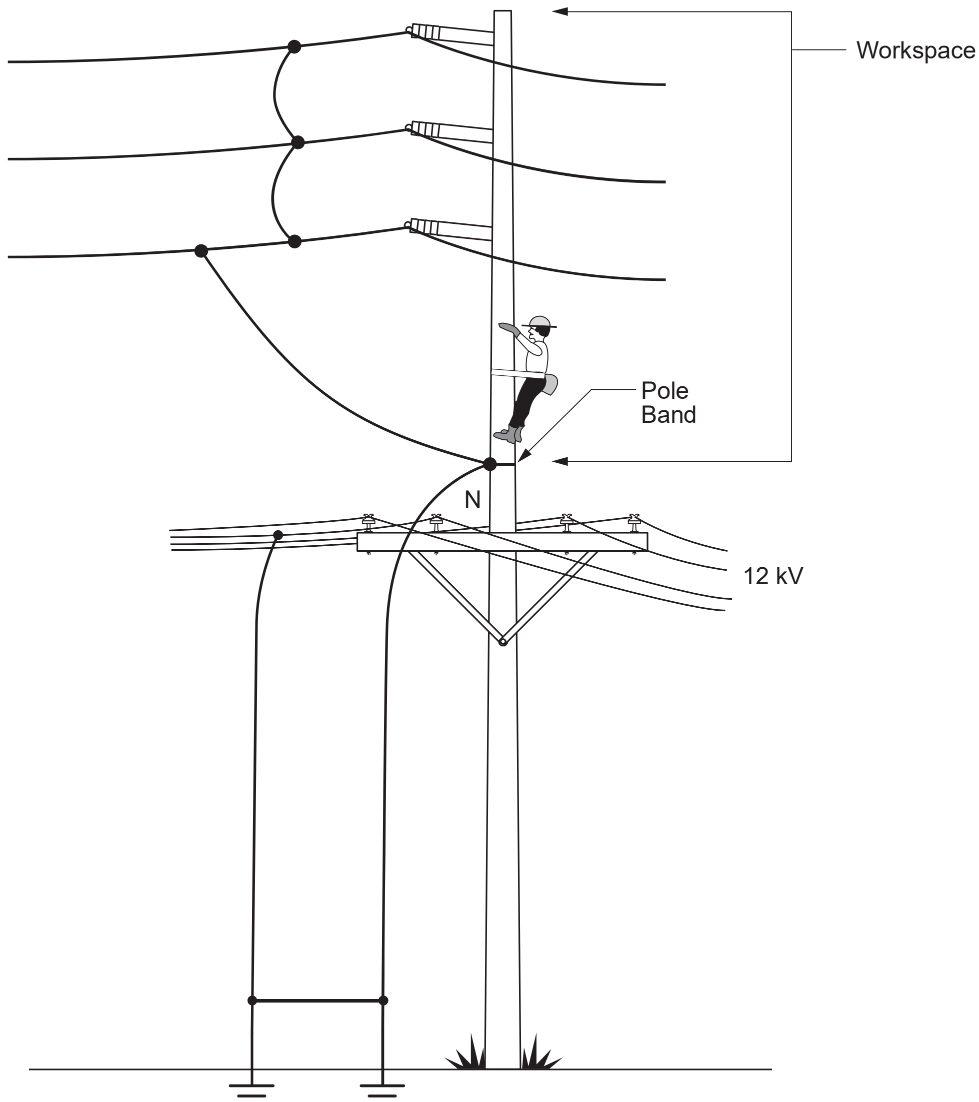
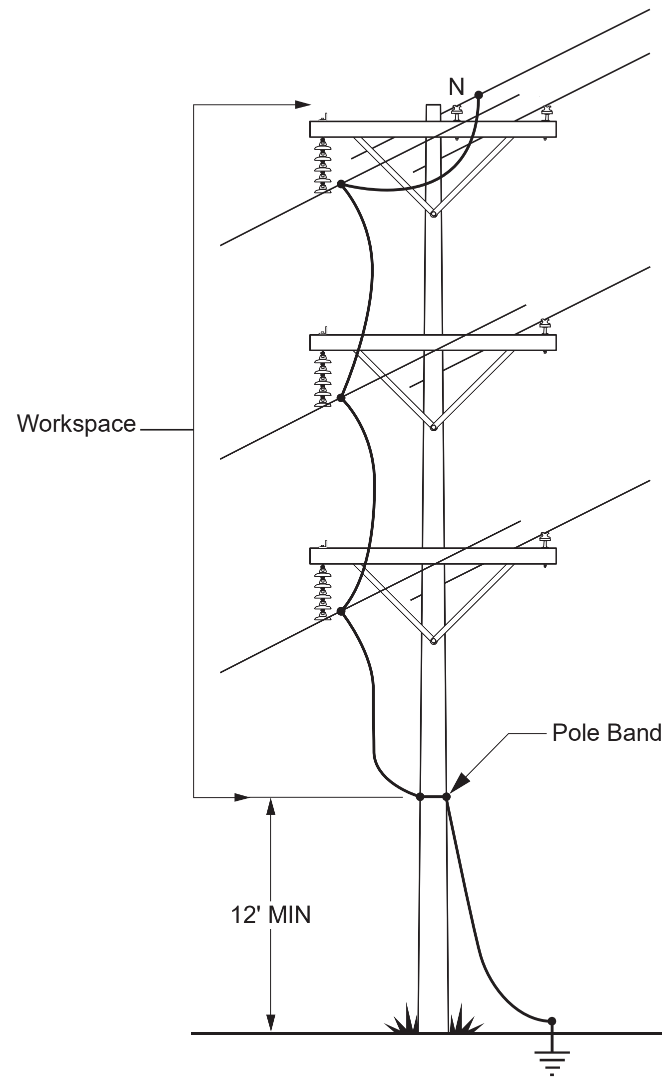


Figure 4–20: Grounding with Multi-Grounded Primary Neutral — Example 2



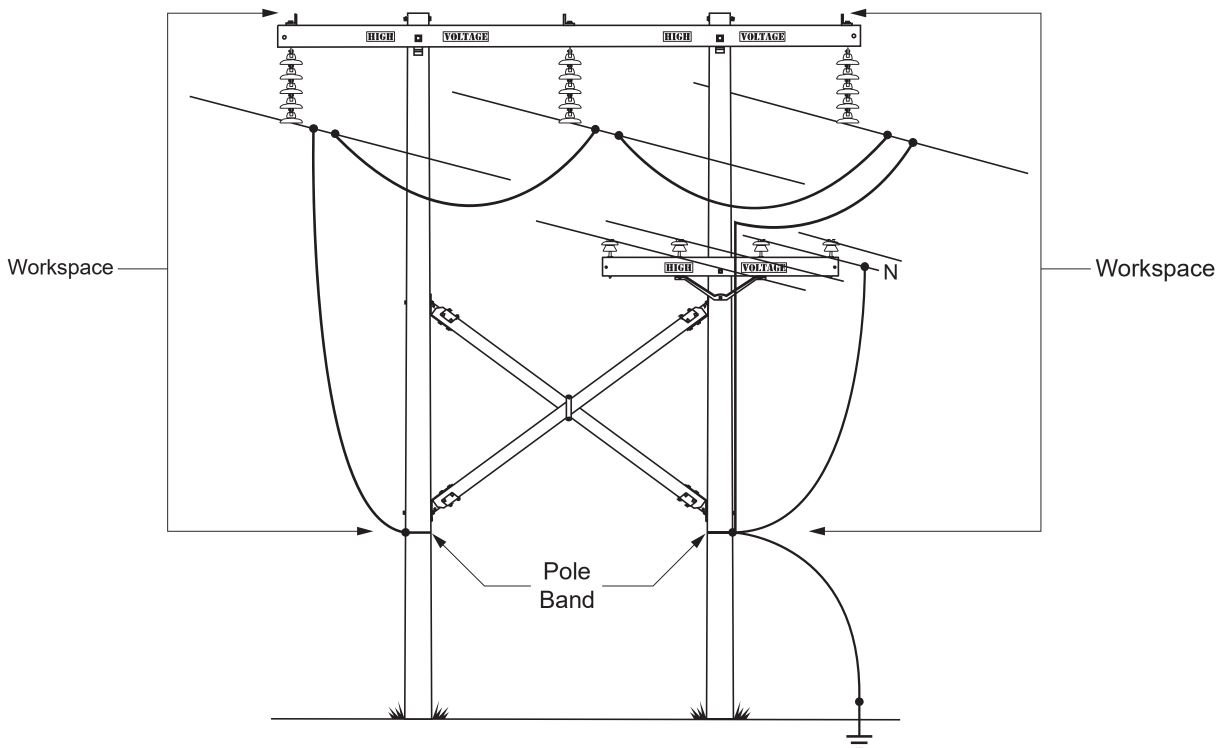


Figure 4–21: Grounding with Multi-Grounded Primary Neutral — Example 3

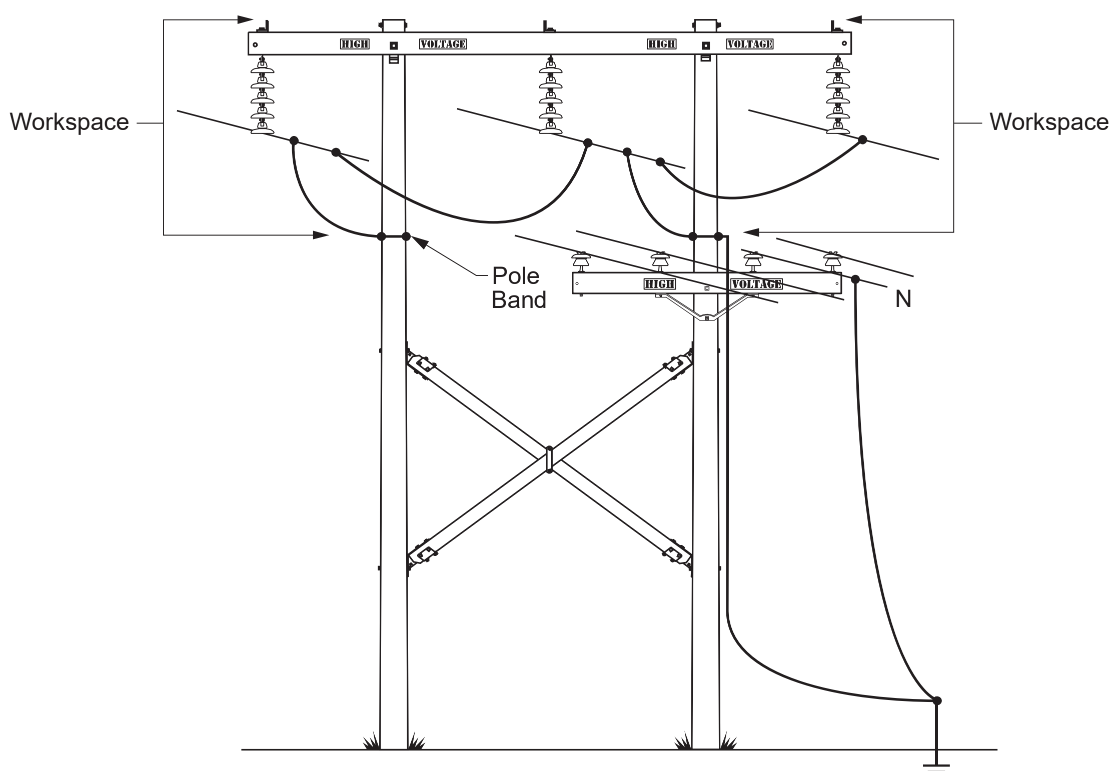


Figure 4–22: Grounding with Multi-Grounded Primary Neutral — Example 4

4.7 Grounds and Bonds Attached to the Pole

4.7.1 Connecting Attached Pole Grounds to the Pole Band

Connect attached grounds located within the Equipotential Zone workspace to the pole band using a minimum #4 copper conductor. This shall be done before the pole band is connected to the conductors. Attached grounds include:

- CATV and telephone grounded messengers
- Secondary grounds
- Surge arrestor grounds
- Structure grounds
- Fault Return Conductor (FRC)
- Grounded anchor (down) guys and span guys
- Concentrics on 3 wire system
- Umbrella (Communication Cable Protector)
- Or any other ground located within the workspace

Ensure there is a good electrical connection.

WARNING Wood pole grounds covered with wood molding are considered attached grounds.

See Figure 4–23.

When Pole grounds extend through the workspace EPZ inside PVC or Protective Ground Wire (PGW) and are isolated from pole/arm then there is no need to bond to the pole band.

External ground(s) that are in contact with the pole/arm within the workspace EPZ shall be bonded to the pole band. External grounds that are not in contact with the pole but are exposed in the workspace and are within reach shall be covered or bonded to the pole band.

Figure 4–23: Wood Covered Attached Ground

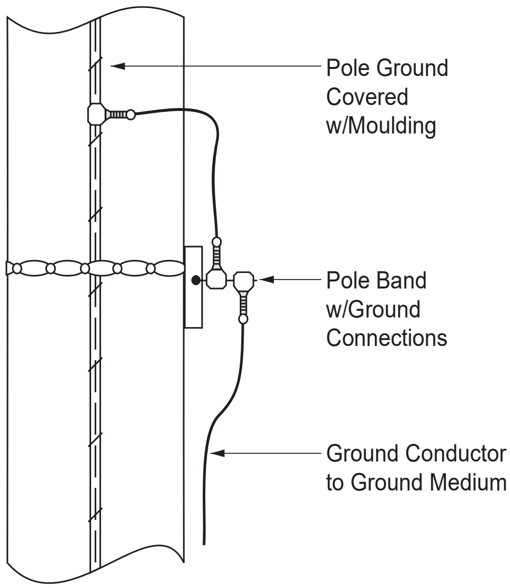
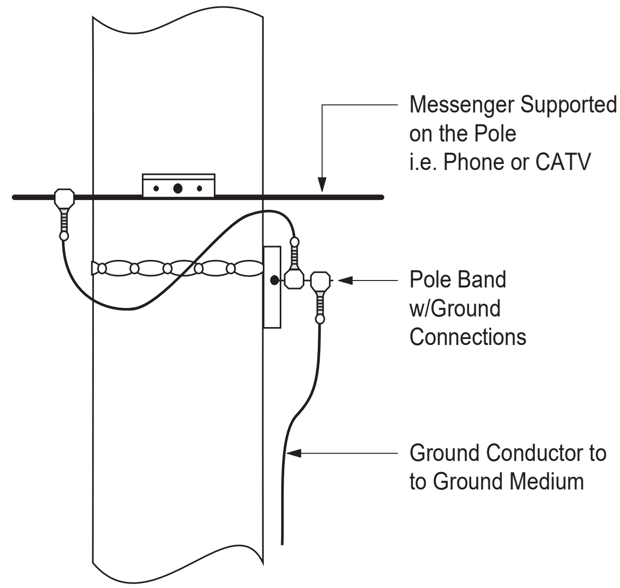


Figure 4–24: Grounded Messenger



A messenger not physically grounded on the pole (that is insulated or isolated from the pole surface) is not considered an attached ground. However, the messenger shall be protected or it shall be bonded to the pole band when it is physically located above the pole band (see Figure 4–24).

4.7.2 Connecting Fault Return Conductor to the Pole Band

Fault Return Conductor (FRC) provides a metallic bond between Light Weight Steel (LWS) pole structures. Fault Return Conductor may also, in some situations, exist on intermediate wood poles.

WARNING

Extreme caution shall be exercised when working on or near the attached FRC that workers do not place themselves in series between the structure and the FRC.

- When the FRC needs to be removed or electrically isolated from the structure, install a pole band and an approved ground jumper applied to the FRC.
- When the FRC is to be cut, use an approved 2/0 minimum jumper/by-pass across the open ends of the FRC.

WARNING

The FRC shall not be used as a ground medium under any circumstance.

Fault Return Conductor on LWS structures is bonded to the LWS and no additional connection to the FRC is needed. However, on wood, concrete, and composite poles when the FRC is inside the EPZ workspace then it shall be connected to the pole band.

4.8 Grounded Span and Down Guys

Definition — The term “grounded span and down guys” refers to guy wires that do not have strain insulators or fiberglass strain rods. When a strain insulator is present and has been jumpered, the span or down guy is considered grounded.

Grounded down and span guys that are attached to the pole being worked on and which are located within the workspace shall be connected to the grounding scheme.

The preferred method for connecting down and span guys to the grounding scheme is to use the associated anchor rod(s) as the ground medium (see Figure 4–25 and Figure 4–26).

Figure 4–25: Connecting a Single Down Guy on Wood or LWS Pole — Example 1

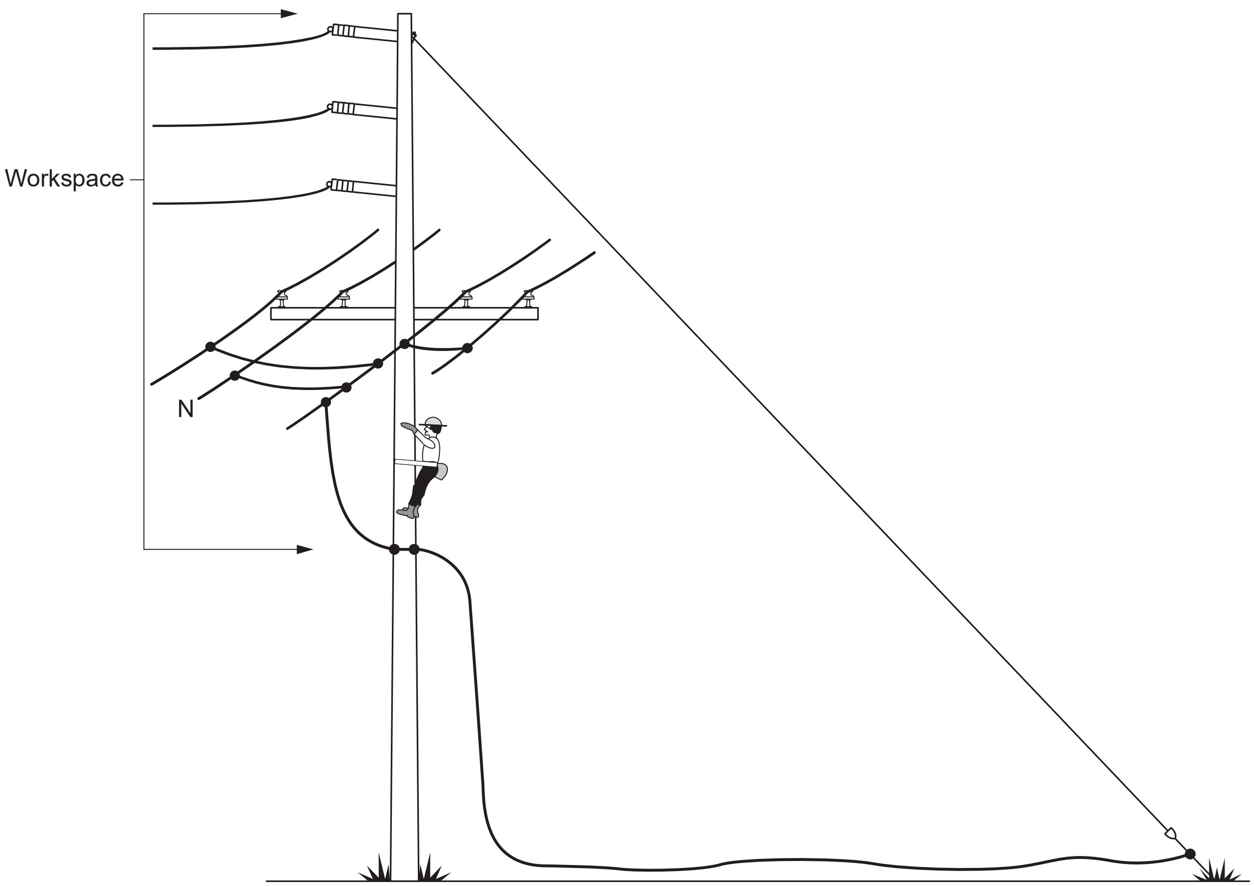
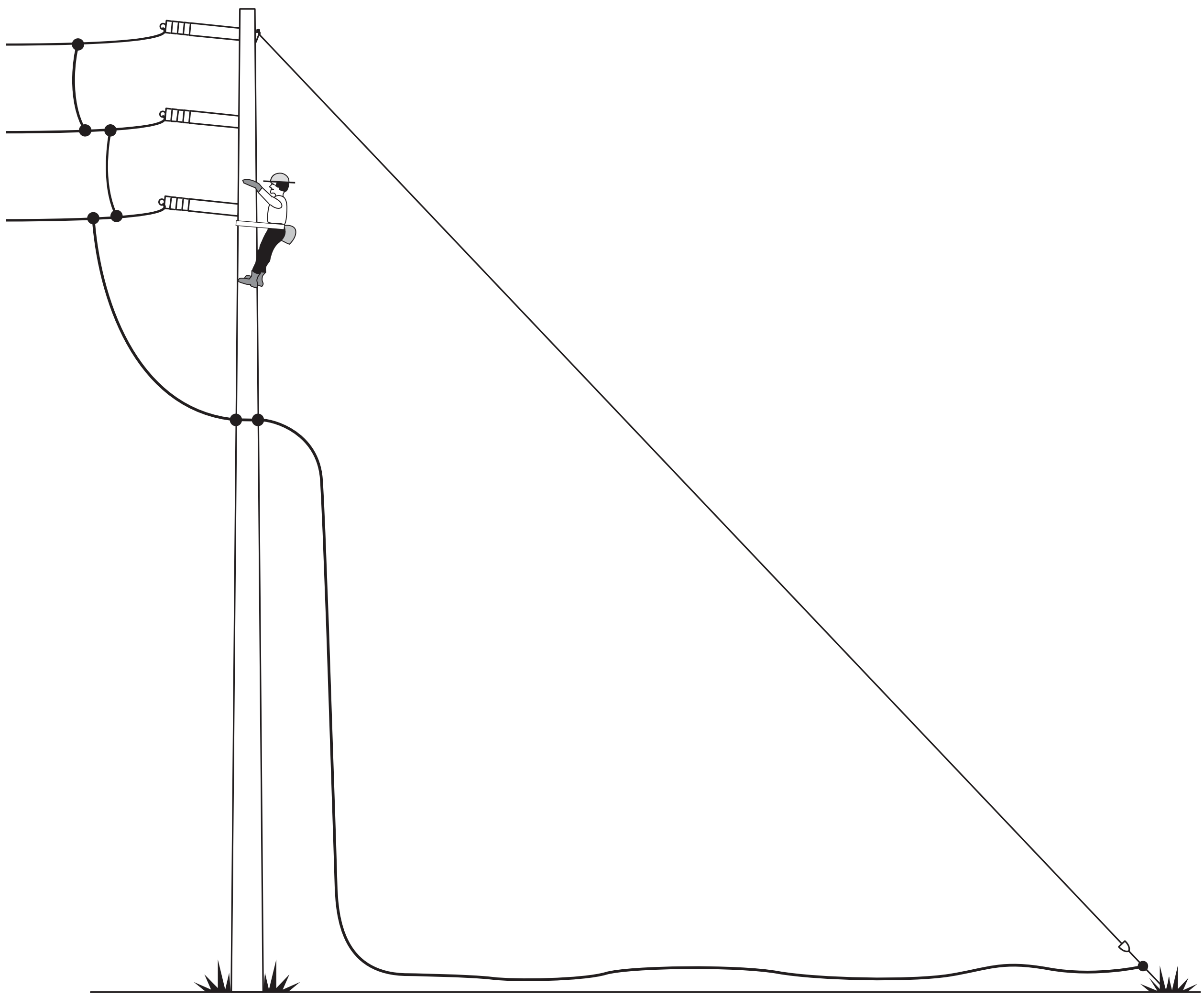


Figure 4–26: Connecting a Single Down Guy on Wood or LWS Pole — Example 2



Multiple Span and Down Guys — When multiple grounded guy wires are attached to the wood, composite, concrete, or LWS pole, and then bond the anchor rods together to eliminate any hazardous difference of electrical potential. Use approved grounds to bond the anchor rods (see Figure 4–27, Figure 4–28, and Figure 4–29).

Figure 4–27: Connecting Multiple Down Guys on Wood or LWS Pole — Example 3

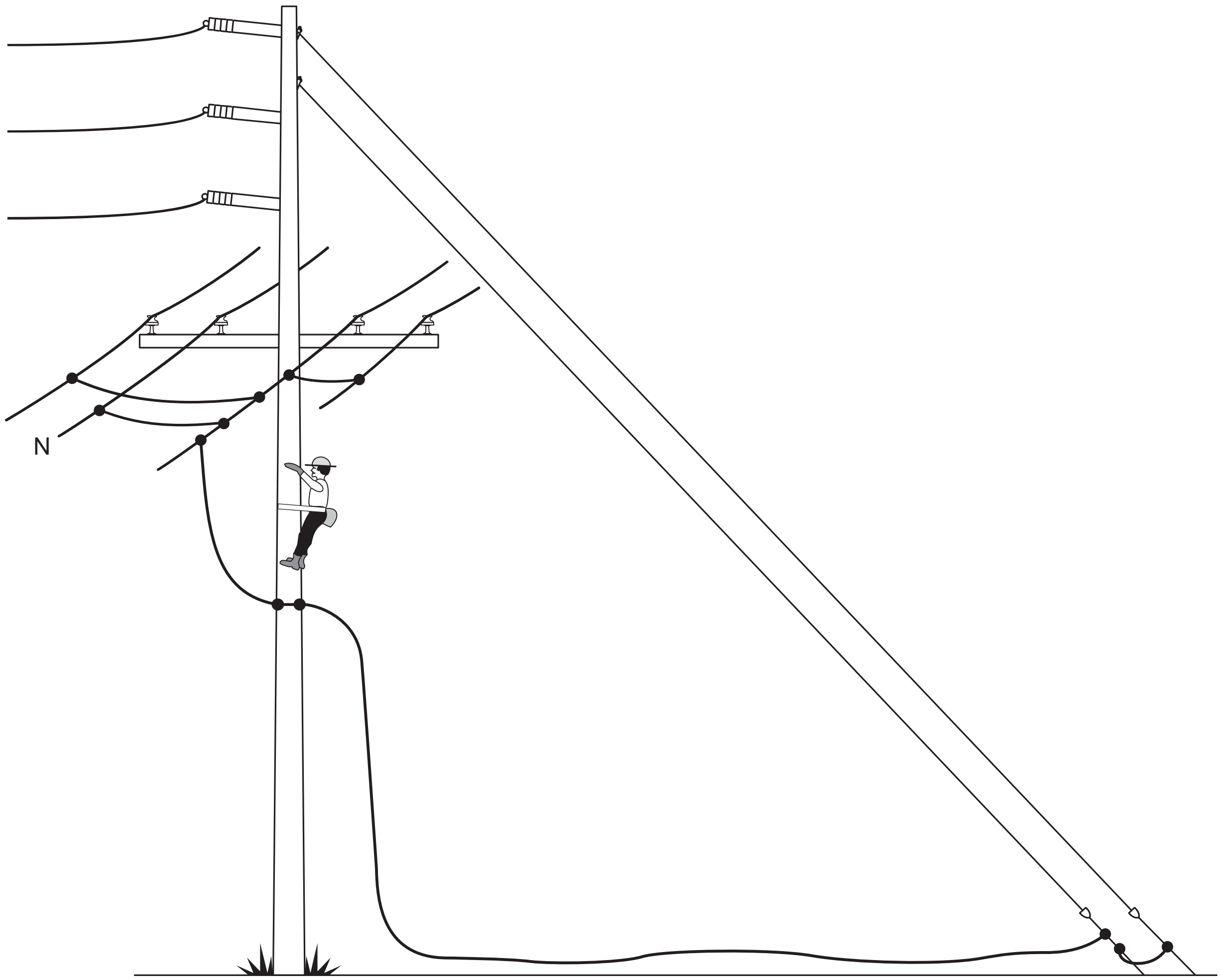
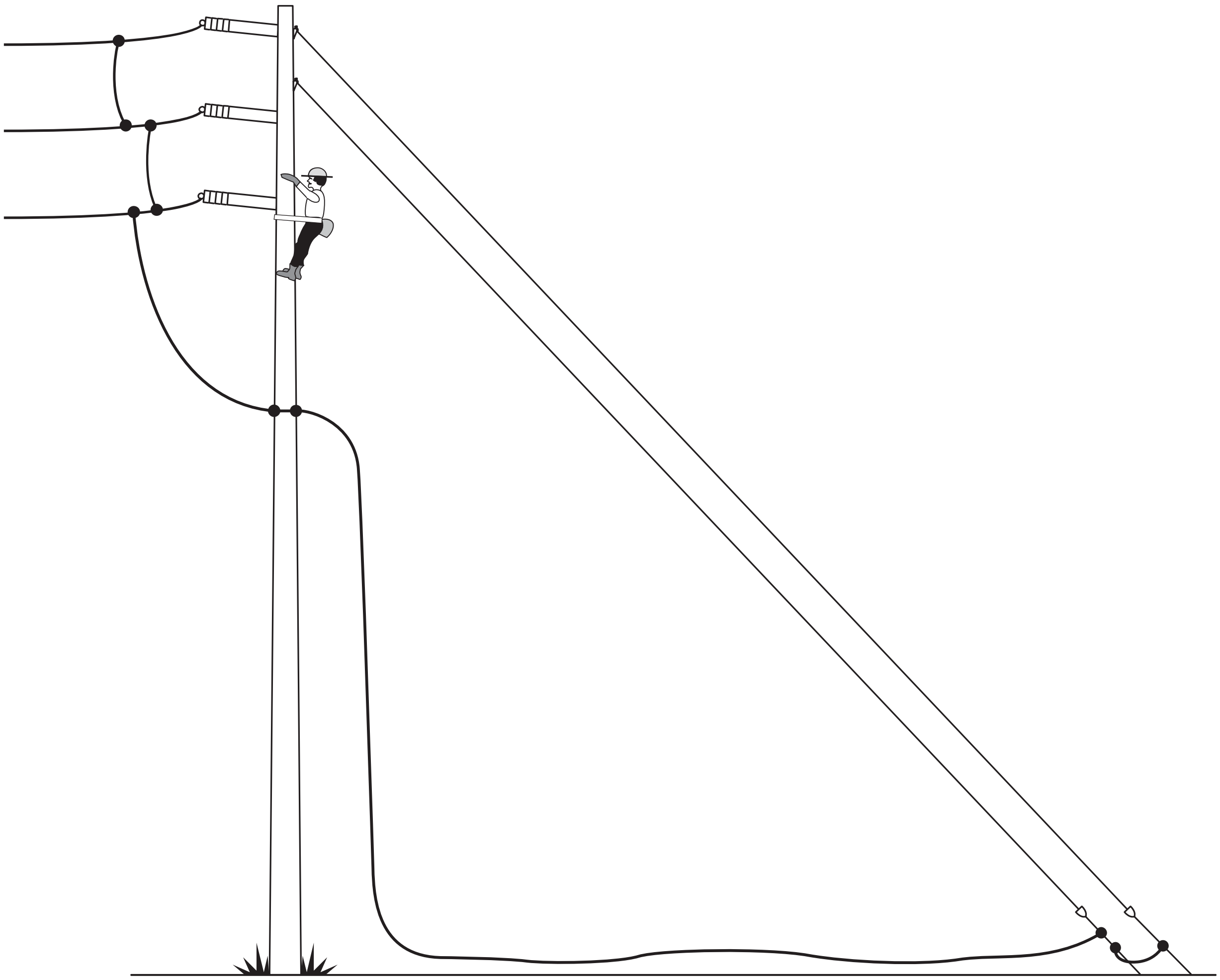
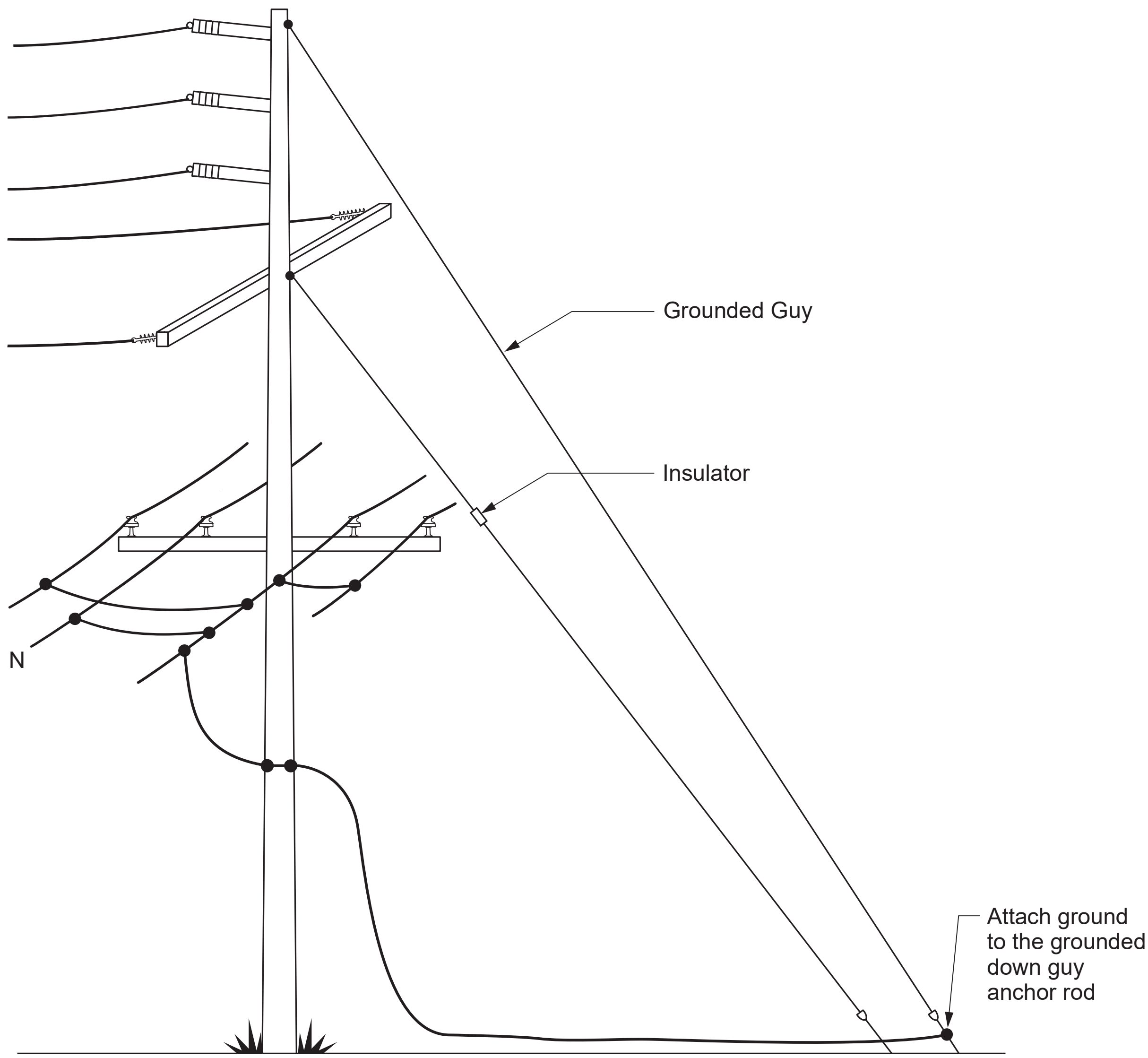


Figure 4–28: Connecting Multiple Down Guys on Wood or LWS Pole — Example 4



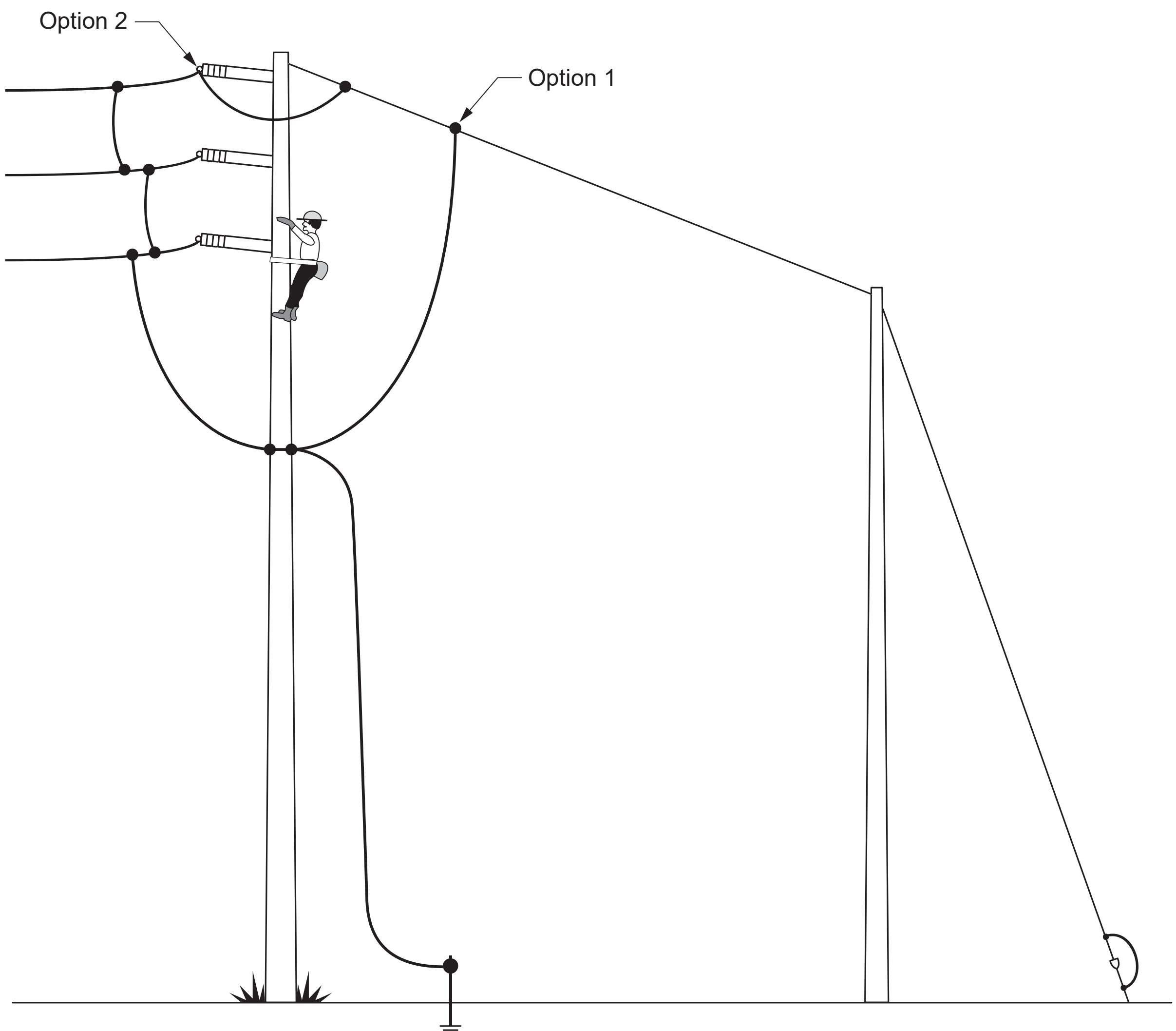
When one down guy is isolated (a strain rod or insulator is present) and the other down guy is grounded, use the grounded down guy anchor for the ground medium (see Figure 4–29).

Figure 4–29: Connecting Multiple Down Guys on Wood or LWS Pole — Example 5



The Anchor Rod cannot be used as a Ground Medium on a wood, composite, or concrete pole — When an anchor rod cannot be used as a ground medium; using an approved jumper, connect the grounded down/span guy into the grounding scheme. Since the anchor rod(s) are not used as the ground medium an approved jumper(s) shall be installed from the guy wire to the anchor rod(s) to by-pass the guy wire dead-end at the ground level (see Figure 4–30).

Figure 4–30: Incorporate the Grounded Guy into the Grounding Scheme — Example 6

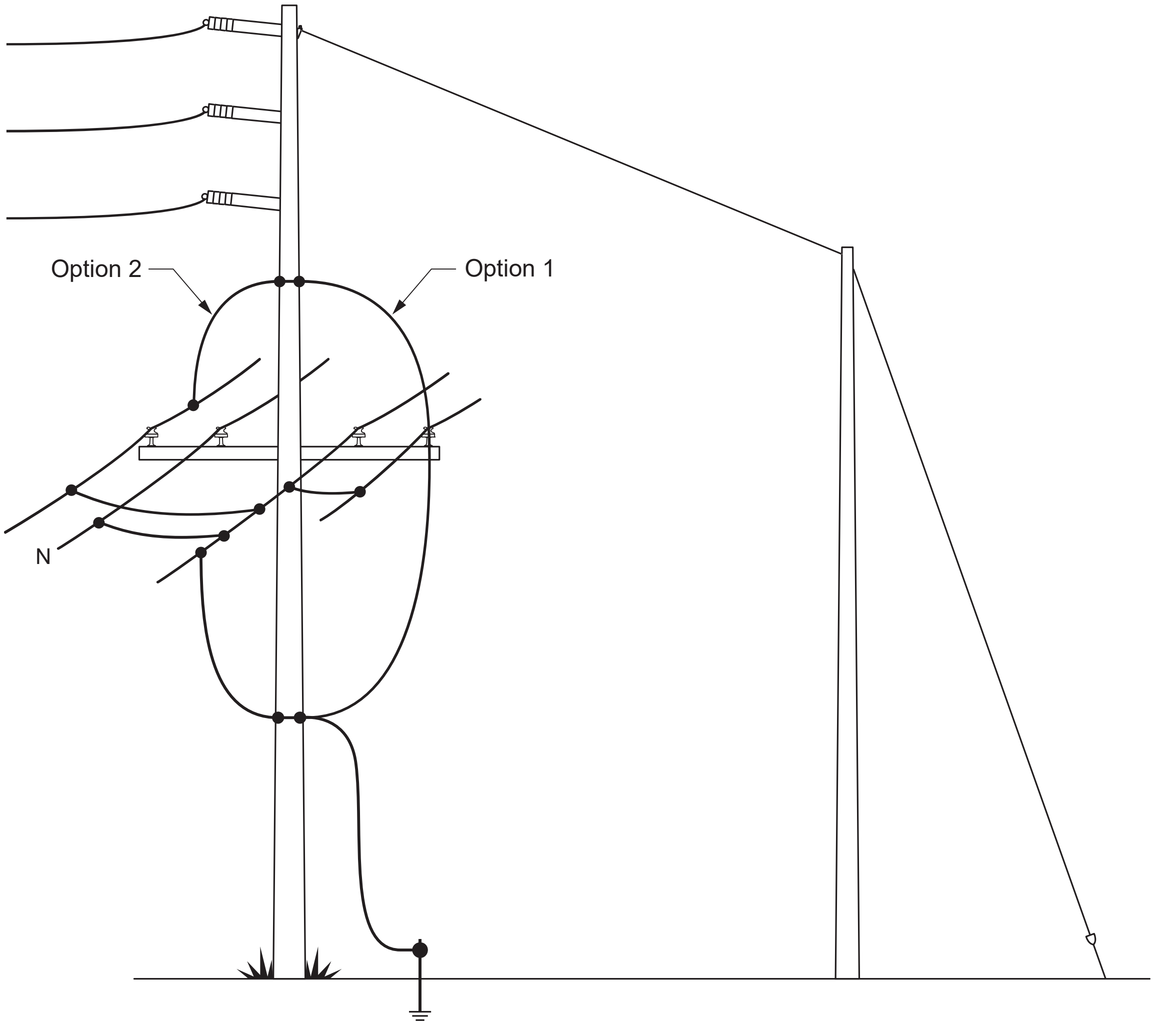


Option 1 — Install an approved jumper from pole band to the span guy.

Option 2 — Install an approved jumper from one of the grounded conductors to the span guy.

Two pole bands on a wood, composite, or concrete pole — When an anchor rod cannot be used as a ground medium; install another pole band above the de-energized and grounded distribution circuit. The second pole band shall be connected to the grounding scheme to create an Equipotential Zone on the structure between the two pole bands. Utilizing two pole bands on a wood, composite, or concrete pole removes the span guy from the workspace. Additionally, the need for by-passing the guy wire dead-end at the ground level is eliminated (see Figure 4–31).

Figure 4–31: Two Pole Bands in Grounding Scheme — Example 7



Option 1 — Install an approved jumper from pole band to pole band.

Option 2 — Install an approved jumper from one of the grounded conductors to the upper pole band.

Light Weight Steel Pole — Guy wires on steel structures do not need to be incorporated in the grounding scheme since the guy wires are electrically attached to the structure. However, anchor rod(s) should be used as a ground medium. When the anchor rods are not used as a ground medium, then the grounded guy wire dead-end(s) at the ground level shall be by-passed (see Figure 4–32 and Figure 4–33).

Figure 4–32: LWS Grounded Guy Wire — Example 8

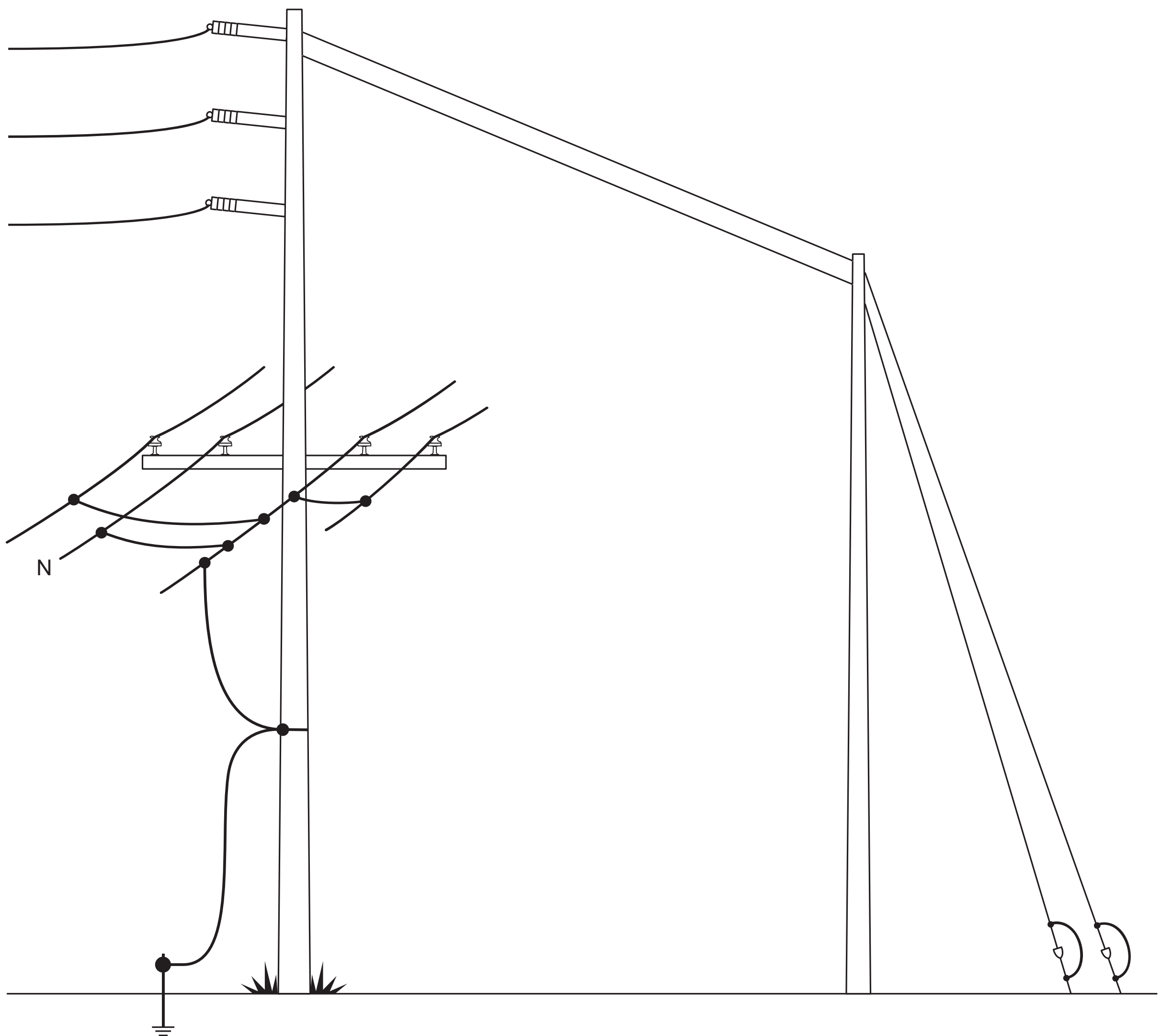
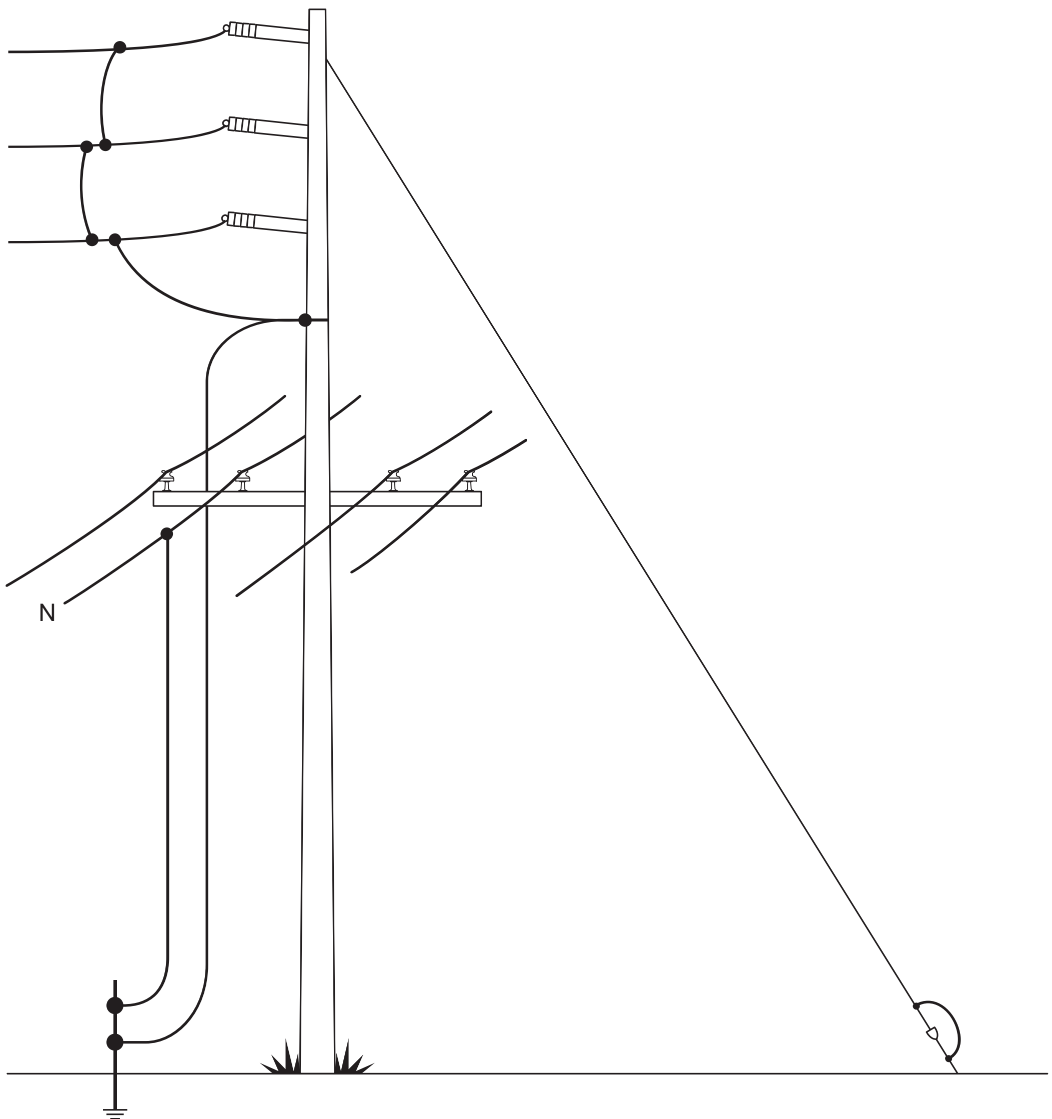


Figure 4–33: LWS Grounded Guy Wire — Example 9

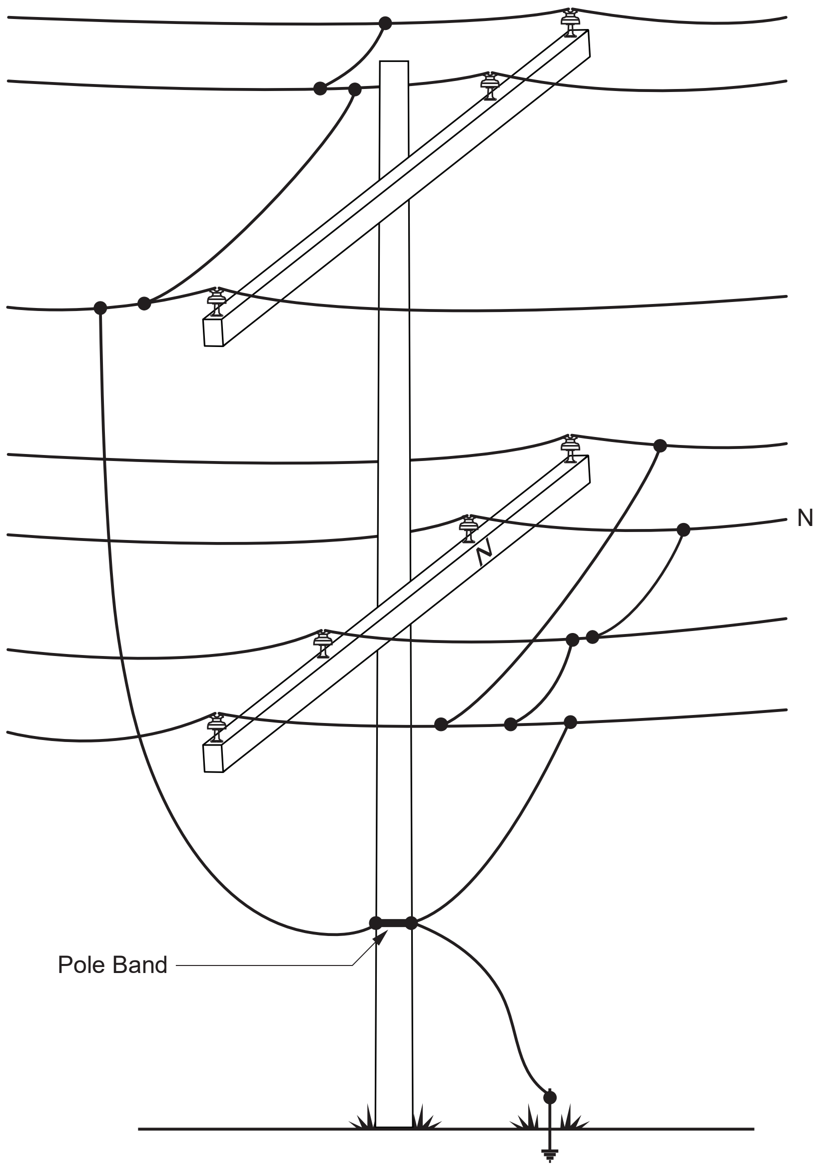


4.9 Grounding Multiple Circuits on One Structure

When grounding multiple circuits on one structure, determine the ground conductor size and length per Section 3.2 and Table 3–1, considering the greatest fault-current duty on the structure. For example, (when one circuit requires 2/0 grounds and another circuit requires #2), all grounds on the structure shall be minimum of 2/0, except where Notes 1 and 2 of Table 3–1 are applicable.

When grounding multiple circuits on one structure, the long ground and the pole band may be shared for grounding the circuits. However, each circuit shall be grounded and shunted independently from the pole band up.

Figure 4–34: Proper Grounding of Multiple Circuits on One Structure



4.10 Grounding for Work from an Aerial Device

Definition — For the purpose of this section, "working mid-span" means that workers shall not place themselves closer to the supporting structure than the "minimum working" distance as outlined in APM, Rule 147.

Subsection 4.10.1, Subsection 4.10.2, and Subsection 4.10.3 contain procedures to follow when grounding conductor(s) to perform midspan work. Subsection 4.10.4 contains the procedure to follow when working on or near a structure from a lift or other aerial device.

NOTE

This method utilizes insulating value of the boom for worker protection.

Insulated lift device with a qualification voltage at or above the system voltage. When the insulated aerial lift device is rated less than the system voltage, you must follow procedures in Subsection 4.10.2 (that is, Rentals) may have different voltage qualifications ratings.

4.10.1 Insulated Aerial Lift Device on Circuit Voltage of 115 kV or Less

Procedure

STEP 1. Use the equipotential bracket grounding method by installing a set of grounds on each side of the work location as close as practicable to the actual mid-span work location.

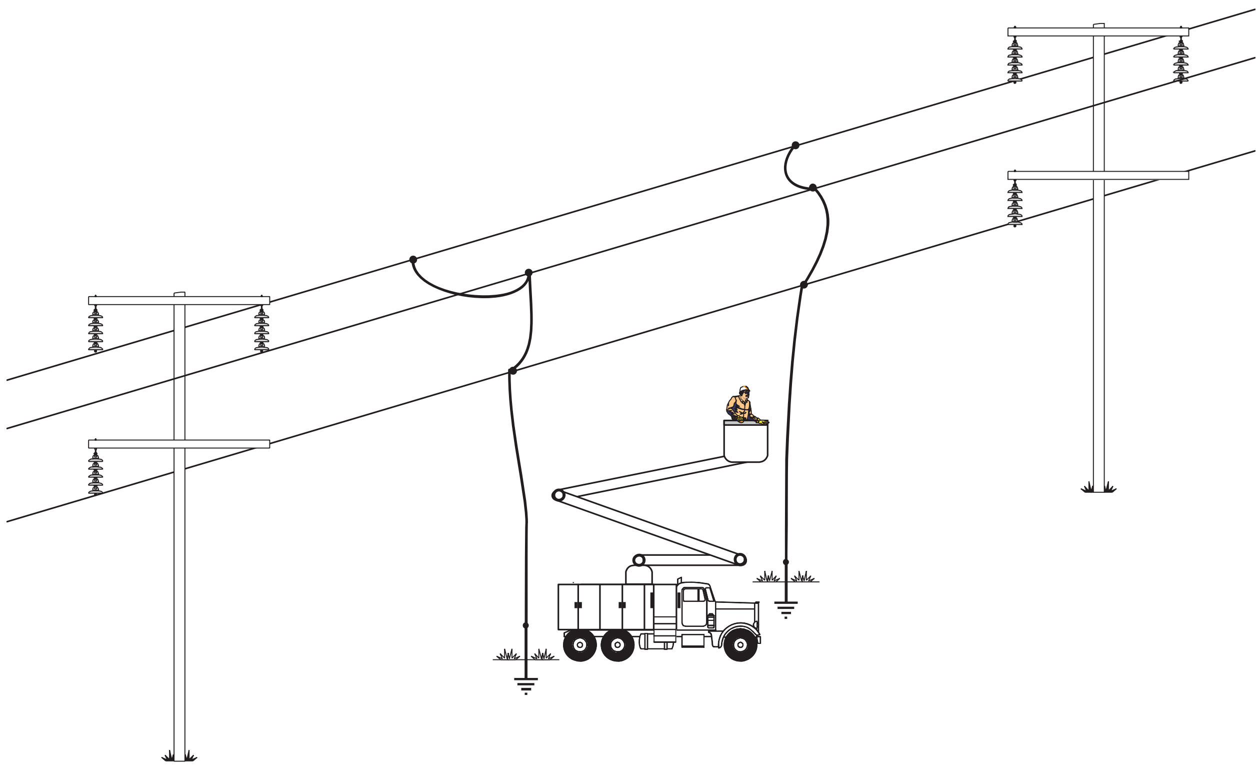
STEP 2. When the grounds cannot be installed at or near the mid-span work location, install the grounds on the first adjacent supporting structures on each side of the midspan work location.

STEP 3. For work on multiple spans the distance between the work site and the bracket grounds should not exceed the values identified in Subsection 3.6.13, Equipotential Bracket Grounding Method. (1,250 feet with no parallel lines, 300 feet with hazardous induction). When the distance exceeds the previously mentioned values the phase(s) within minimum approach distance shall be shunted to each other.

STEP 4. Follow procedures described in Subsection 4.10.4 when structures are within minimum approach distance of the worker(s).

See Figure 4–35.

Figure 4–35: Midspan Insulated Aerial Device — 115 kV or Less



4.10.2 Insulated Aerial Lift Device on Circuits Greater than 115 kV

NOTE

Insulated aerial lift device with voltage qualification ratings less than system voltage will also utilize this procedure.

Procedure

STEP 1. Use the equipotential grounding method by installing a set of grounds on each side of the work location as close as practicable to the actual midspan work location.

STEP 2. When the grounds cannot be installed at or near the midspan work location, install the grounds on the first adjacent supporting structures on each side of the midspan work location.

STEP 3. Using approved live-line tools, apply an approved breakaway bond from the boom tip to the conductor(s) within reach of workers in the aerial lift. When breakaway bonds are not available, approved grounds may be used. (Breakaway Bond, SAP: 10' — Duckbill Clamp, 10109309; 12' — Duckbill Clamp, 10109310; 12' — All-Angle Clamp, 10176770).

STEP 4. On aerial lift devices, that is, Rentals, that do not have provisions for attaching an approved bond at the boom tip, use an EPZ mat placed on the floor of the bucket that is bonded with an approved bond to the conductor(s) being worked on. The bond shall be applied and removed using approved live-line tools.

STEP 5. If there will be any contact with the truck that is bonded to the conductor by personnel on the ground, bond an EPZ mat to the truck chassis using an approved grounding device and the ground lug on the truck chassis.

STEP 6. Transition on and off the EPZ mat should be performed quickly and safely to minimize exposure to step and touch potential.

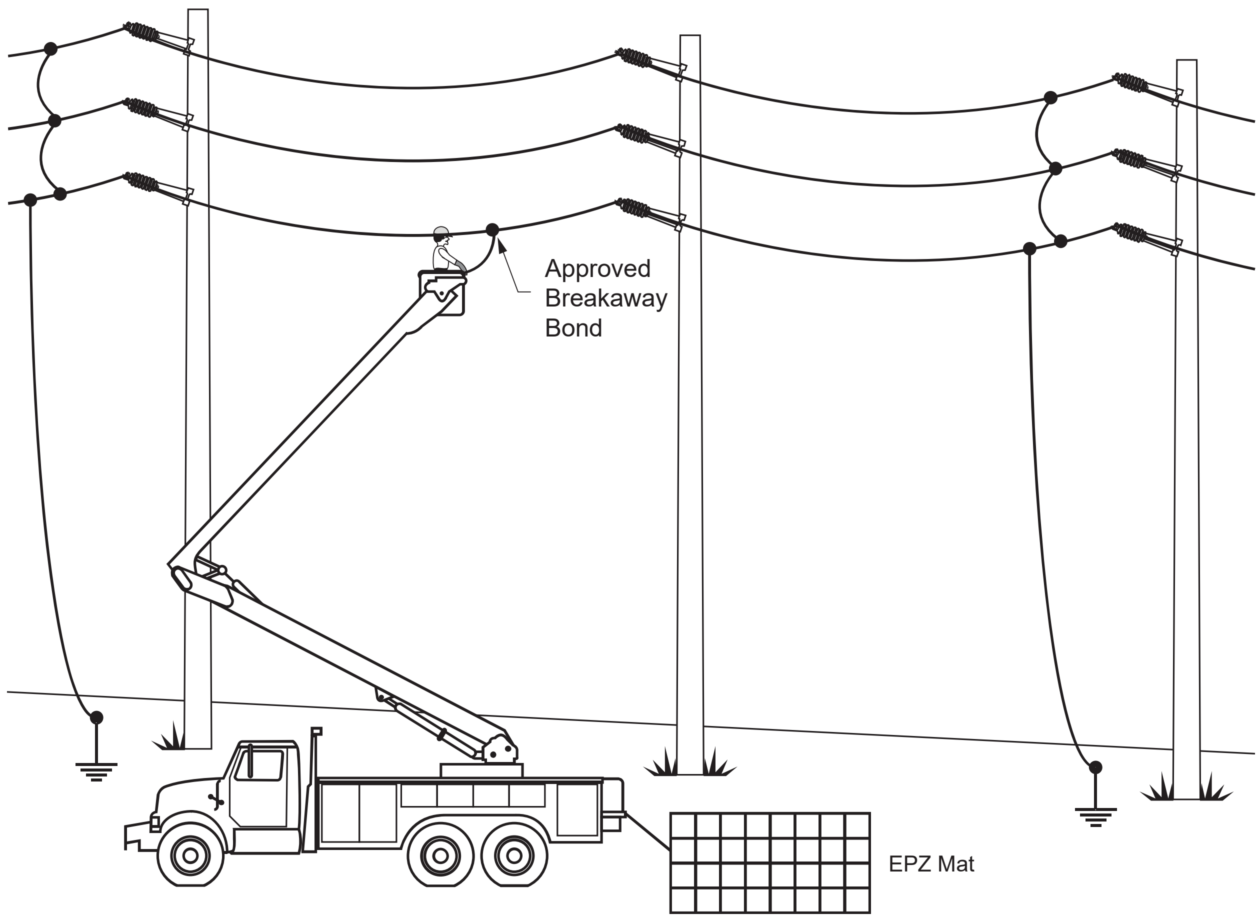
STEP 7. Follow procedures described in Subsection 4.10.4, when structures are within minimum approach distance of worker(s).

NOTE

This method utilizes the insulating value of the boom for worker protection. In addition, the breakaway bond will prevent charging current going through the worker if the line is inadvertently energized.

See Figure 4–36.

Figure 4–36: Midspan Insulated Aerial Device — Greater than 115 kV



4.10.3 Crane Baskets or Other Conductive Aerial Lift Devices for All Voltages

Workers shall not make contact with the chassis of the aerial lift device when the aerial platform or basket is in proximity or bonded to overhead conductors.

An EPZ mat that is bonded to the crane or truck chassis shall be used for workers to stand on when access to bins or climbing on or off the truck is required. Transition on and off the EPZ mat should be performed quickly and safely to minimize exposure to step and touch potential.

Procedure

STEP 1. Use the equipotential grounding method by installing a set of grounds on each side of the work location as close as practicable to the actual mid-span work location.

STEP 2. When the grounds cannot be installed at or near the mid-span work location, install the grounds on the first adjacent supporting structures on each side of the mid-span work location.

STEP 3. Before bonding the crane basket or platform to the conductor being worked on, ground the crane or truck chassis to an approved ground medium.

STEP 4. Using approved live-line tools, bond the crane basket or aerial lift platform using an approved breakaway bond to the conductors within reach of the workers in the aerial lift. When breakaway bonds are not available, approved grounds may be used. (Breakaway Bond, SAP: 10' — Duckbill Clamp, 10109309;
12' — Duckbill Clamp, 10109310; 12' — All-Angle Clamp, 10176770)
(see Figure 4–37).

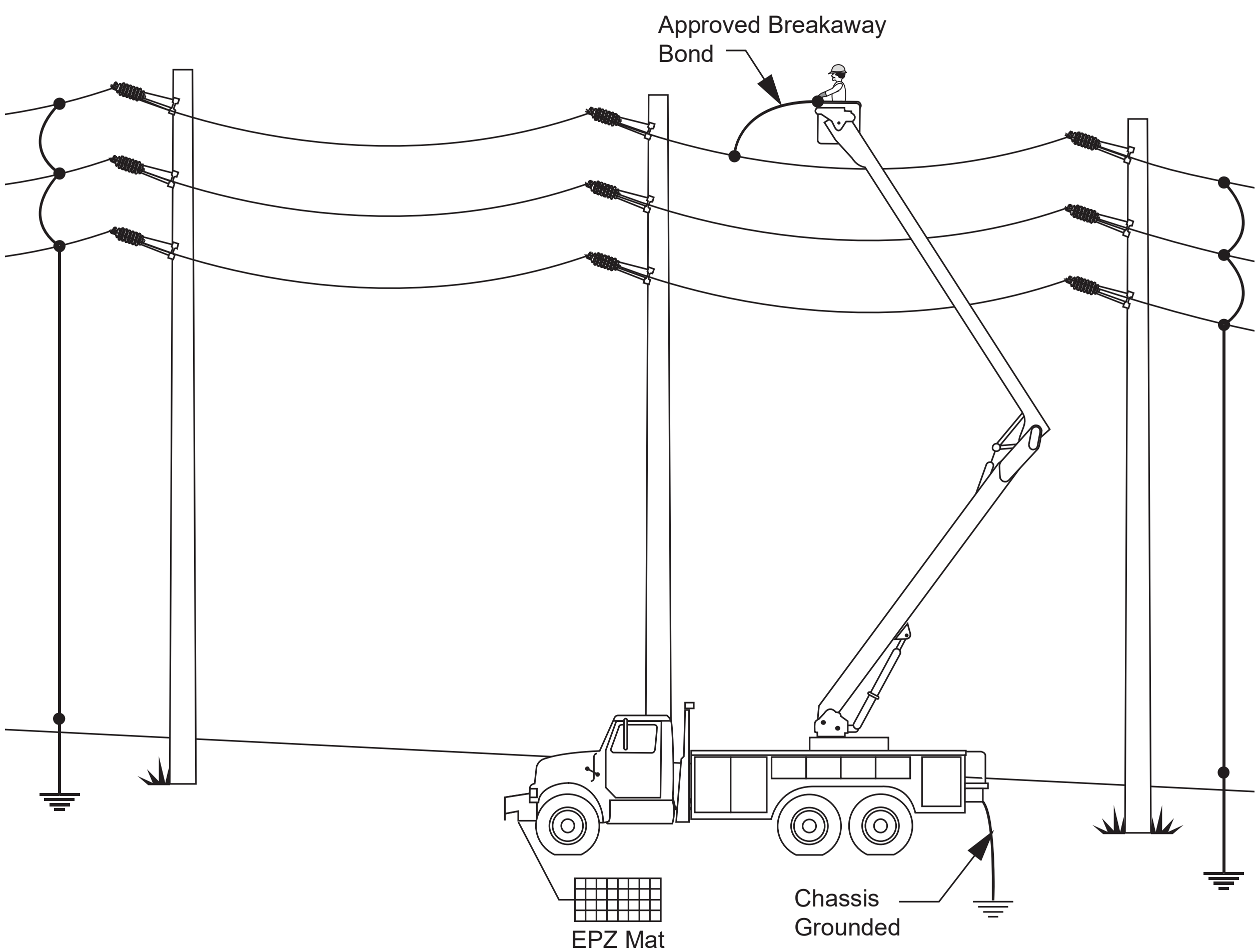
STEP 5. The crane basket or platform bond shall not be applied directly to the load line of the crane. A suitable bonding surface within the crane basket/platform or an approved ground lug shall be used for connection of the bond.

STEP 6. Follow procedures in Subsection 4.10.4, when structures are within minimum approach distance of the worker(s).

STEP 7. If there will be any contact with the truck that is bonded to the conductor by personnel on the ground, bond an EPZ mat to the truck chassis using an approved grounding device and the ground lug on the truck chassis.

STEP 8. Transition on and off the EPZ mat should be performed quickly and safely to minimize exposure to step and touch potential.

Figure 4–37: Non-insulated Aerial Lift Device for All Voltages



4.10.4 Grounding for Work on or Near a Structure from an Aerial Device

NOTE

When working from an aerial device, caution shall be exercised to avoid the possibility of the workers placing themselves in series between a de-energized grounded conductor and the pole or structure that are not bonded.

For work on or near a structure from an aerial device, the following grounds are required:

Procedure

STEP 1. Use the equipotential grounding method by installing a set of grounds on each side of the work location as close as practical to the actual mid-span work location.

STEP 2. If the workers will be closer to the structure than the minimum working distances they shall install the approved grounding for the applicable structure according to Section 4.1 through Section 4.9.

STEP 3. All procedures described in Subsection 4.10.2 and Subsection 4.10.3 shall also be followed.

4.11 Grounding for Splicing Conductor(s) on the Ground

This section is applicable when an EPZ is required to splice conductor or add wire on the ground. EPZ is required when:

- Utilizing Overhead Equipotential Bracket Grounding Method,
- Utilizing Overhead Bracket Grounding Method when hazardous induction exists and bracket grounds are more than 300 feet from work site; or,
- Utilizing Overhead Bracket Grounding Method when bracket grounds are more than 1,250 feet from the work site.

NOTE

In this section, the word “conductor” also refers to Transmission Overhead Ground Wire (OHGW).

4.11.1 Splicing Conductors with Connected Source(s)

Procedure

STEP 1. When conductors are lying on the ground, install a set of grounds between the work site and each source(s) of supply on all phases of the circuit(s) involved.

STEP 2. Install an approved by-pass or ground across open conductor(s) using approved live-line tool(s). This action may be performed before or after creating an EPZ.

STEP 3. When splicing overhead conductors at ground level, perform either Subsection 4.11.1, Step 3.1, Subsection 4.11.1, Step 3.2, or Subsection 4.11.1, Step 3.2 as described below:

STEP 3.1 High Voltage Rubber Gloves can be used to splice grounded distribution conductor(s). Conductors cannot touch any part of the body.

STEP 3.2 Install an approved ground and ground rod on each side and within ten feet of the working area. See Figure 4–38 and Figure 4–39. (See Subsection 3.6.7 for approved ground rod configurations).

STEP 3.3 Using an approved live-line tool, bond an EPZ mat(s) to the conductor at a single point (see Figure 4–40).

NOTE

Standing on the EPZ mat while splicing will minimize potential hazards. Transition on and off the EPZ mat should be performed quickly and safely to minimize exposure to step and touch potential.

When more than one EPZ mat is used, first bond the mats together and then bond the mats to the conductors being spliced.

WARNING

EPZ mat(s) are not designed to take the place of an approved by-pass. Workers shall not place themselves between the two ends of severed conductors before installing a by-pass.

Figure 4–38: Grounding for Splicing Conductor(s) on the Ground — Example 1

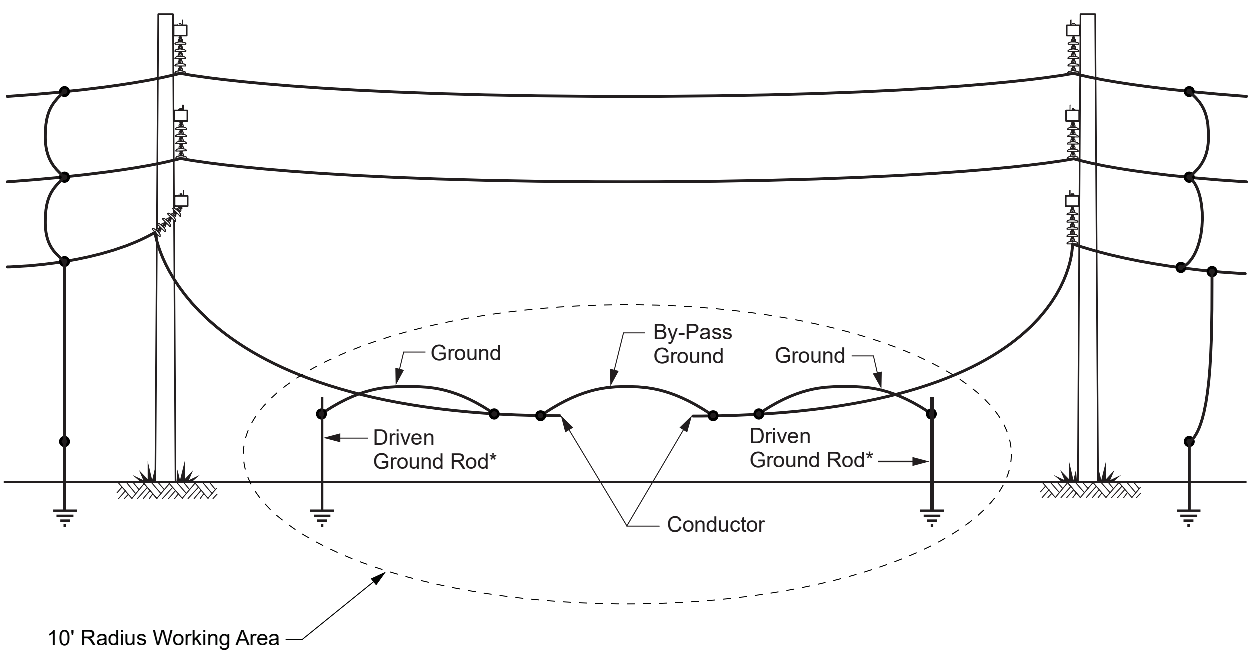


Figure 4–39: Grounding for Splicing Conductor(s) on the Ground — Example 2

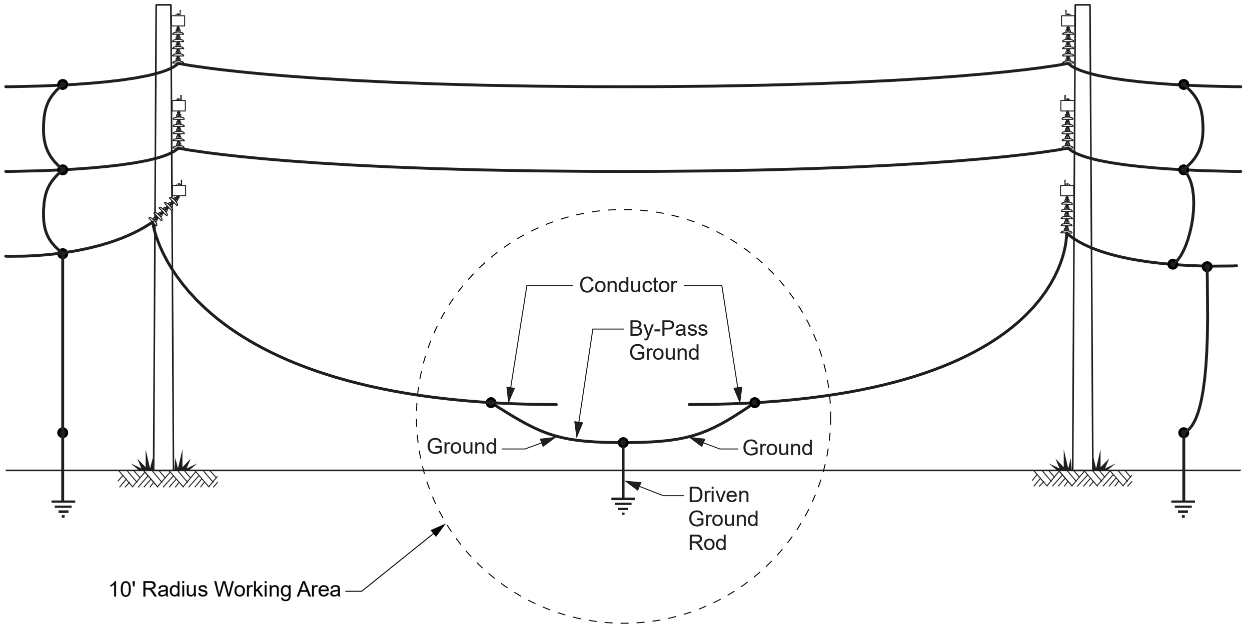
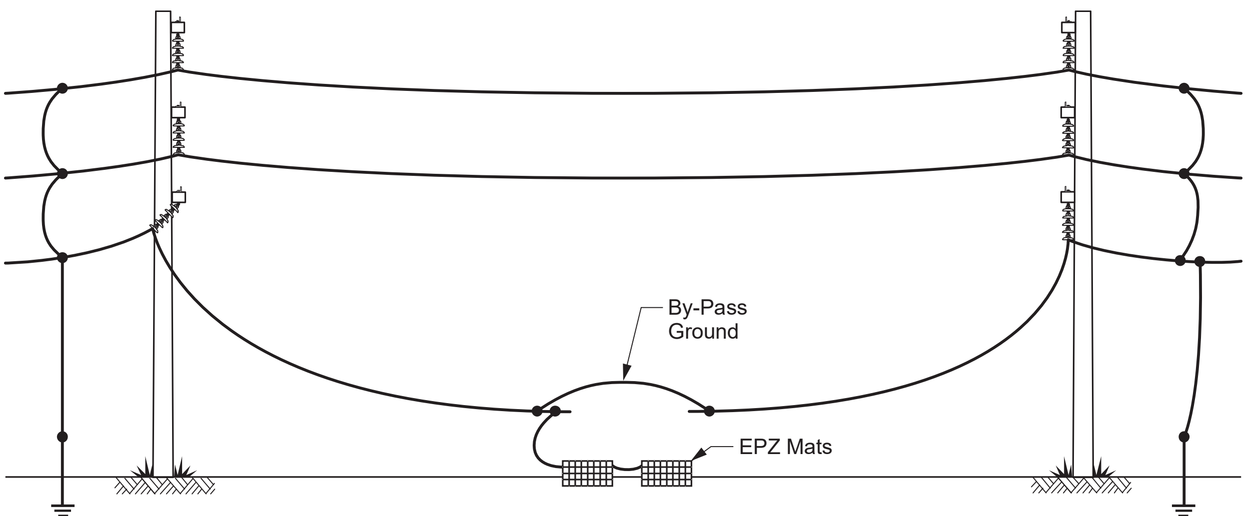


Figure 4–40: Use of EPZ Mat for Splicing Conductors on the Ground



4.11.2 Adding Wire(s) on the Ground

Procedure

STEP 1. When conductors are lying on the ground, install a set of grounds between the work site and each source(s) of supply on all phases of the circuit(s) involved.

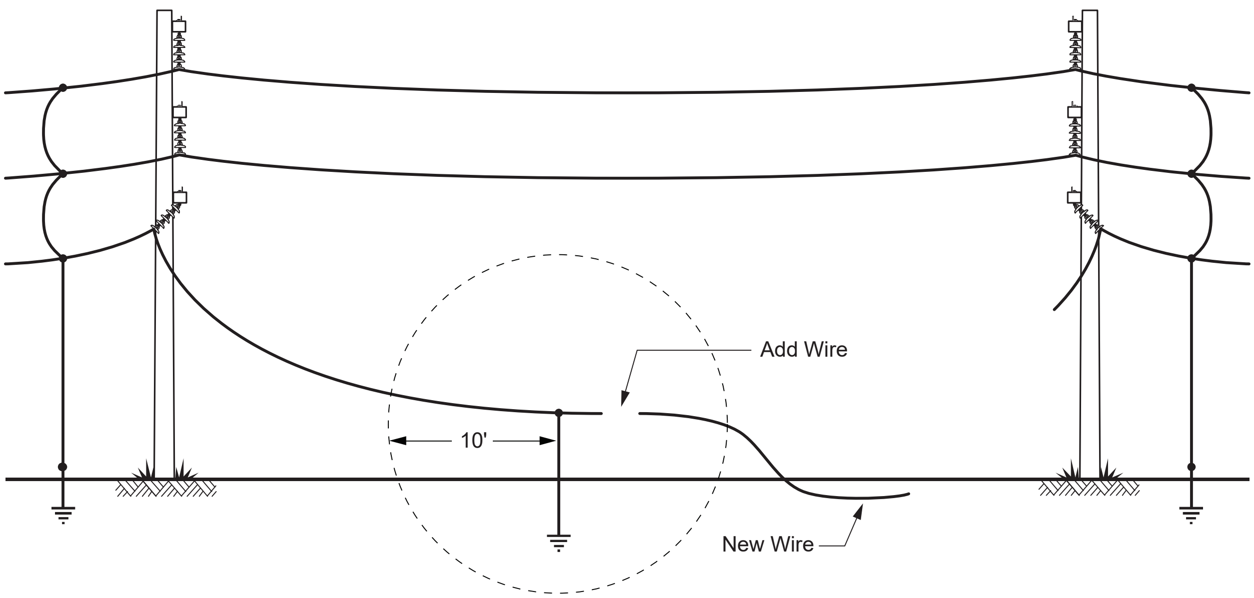
STEP 2. When adding a length of wire to the overhead conductors, perform either Subsection 4.11.2, Step 2.1, Subsection 4.11.2, Step 2.2, or Subsection 4.11.2, Step 2.3, described below.

STEP 2.1 High Voltage Rubber Gloves can be used to add wire to grounded distribution conductor(s). Conductors cannot touch any part of the body.

STEP 2.2 Install an approved ground and ground rod(s) within 10 feet of working area and ground the phase conductor(s) using approved live-line tools (see Figure 4–41). Add wire to the conductor.

STEP 2.3 Using an approved live-line tool bond EPZ mat(s) to the phase conductor(s) (see Figure 4–42). Add wire to the conductor.

Figure 4–41: Grounding for Adding Wire to Conductor(s) on the Ground — Example 1

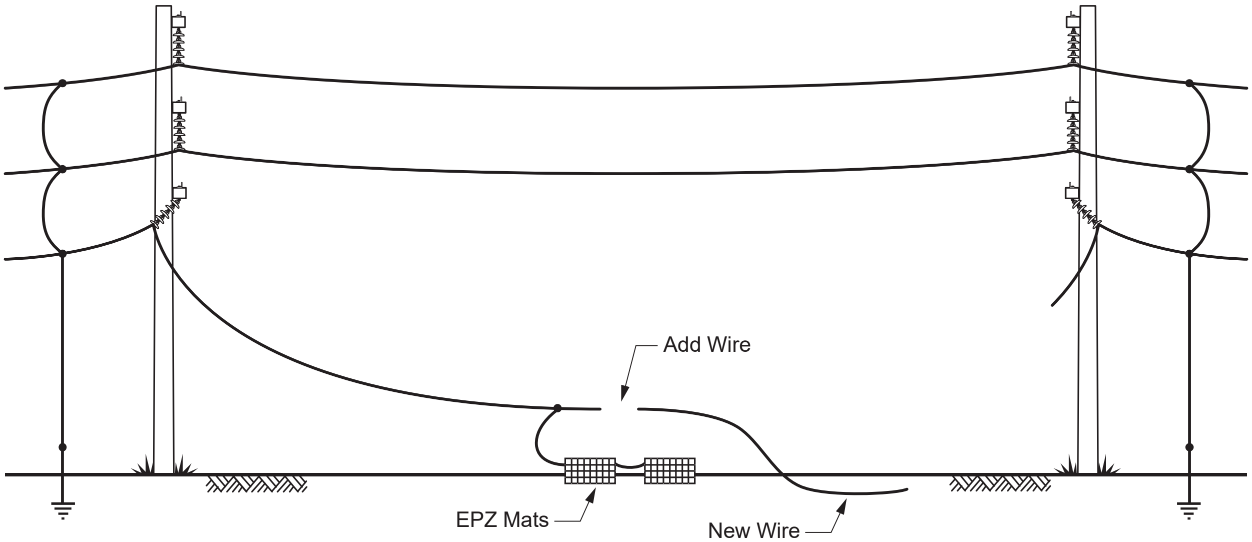


NOTE

Standing on the EPZ mat while adding wire will minimize potential hazards. Transition on and off the EPZ mat should be performed quickly and safely to minimize exposure to step and touch potential.

When more than one EPZ mat is used, first bond the mats together and then bond the mats to the conductors being spliced.

Figure 4–42: Grounding for Adding Wire to Conductor(s) on the Ground — Example 2



4.12 Grounding Conductors for Work with Multiple Structures Down

When multiple structures are down, utilize one of the approved overhead grounding methods. APM, Rule 207e States: “work shall not be performed on downed overhead lines until they have been proven de-energized and grounded as provided in Rule 141, unless they are being cut in the clear, with approved live-line tools, to protect from personal injury.”

When multiple structures are down with both distribution and transmission circuits, all grounds shall be capable of handling the highest available fault duty per Table 3–1. However, for small conductors, Note 1 and 2 of Table 3–1 may be followed for sizing the grounds. In addition, the same grounding method shall be utilized for all circuits. When the Overhead Bracket Grounding Method is used, all distribution and transmission sources shall be isolated.

After grounding scheme is in place (that is all sources isolated/open and grounded); backfeed eliminated; with no induction, static, and crossing; conductors severed from the system and completely separated circuit sections do not require grounding.

Figure 4–43: Multi-Structure Down — Example 1

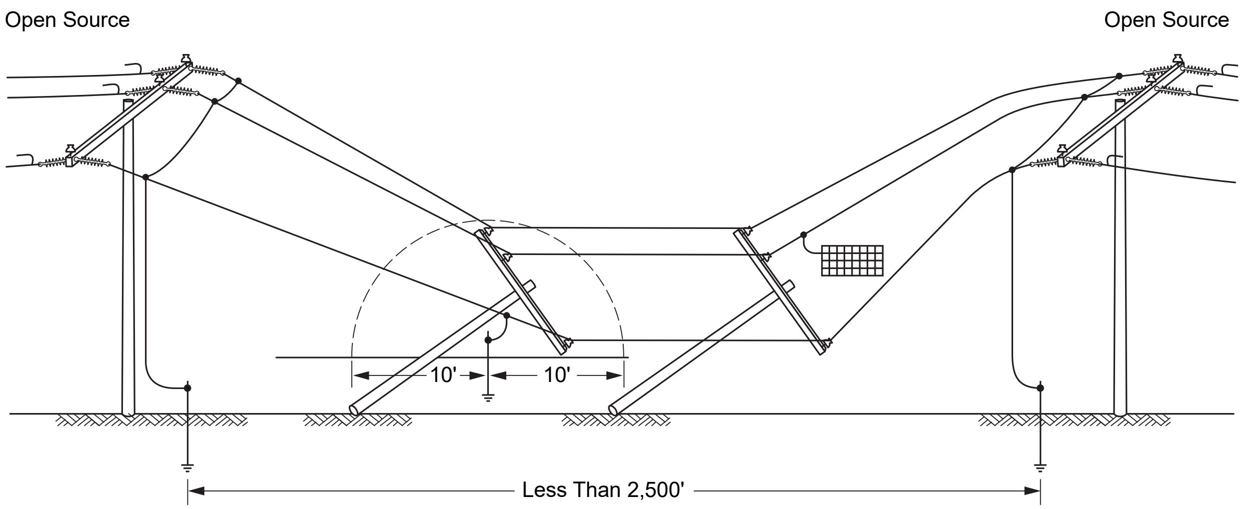


Figure 4–44: Multi-Structure Down — Example 2

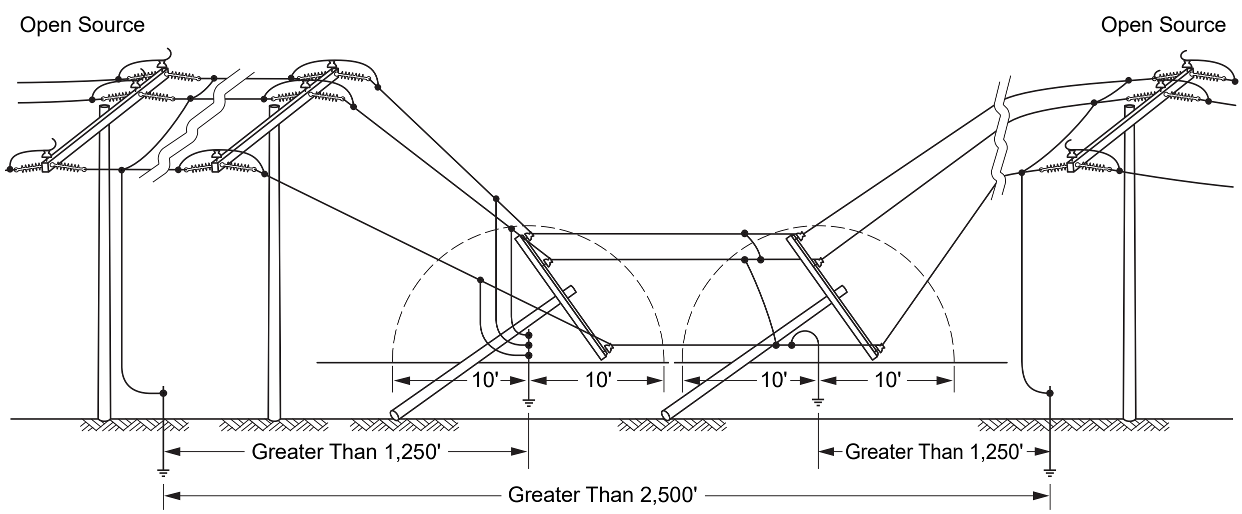


Figure 4–45: Multi-Structure Down — Example 3

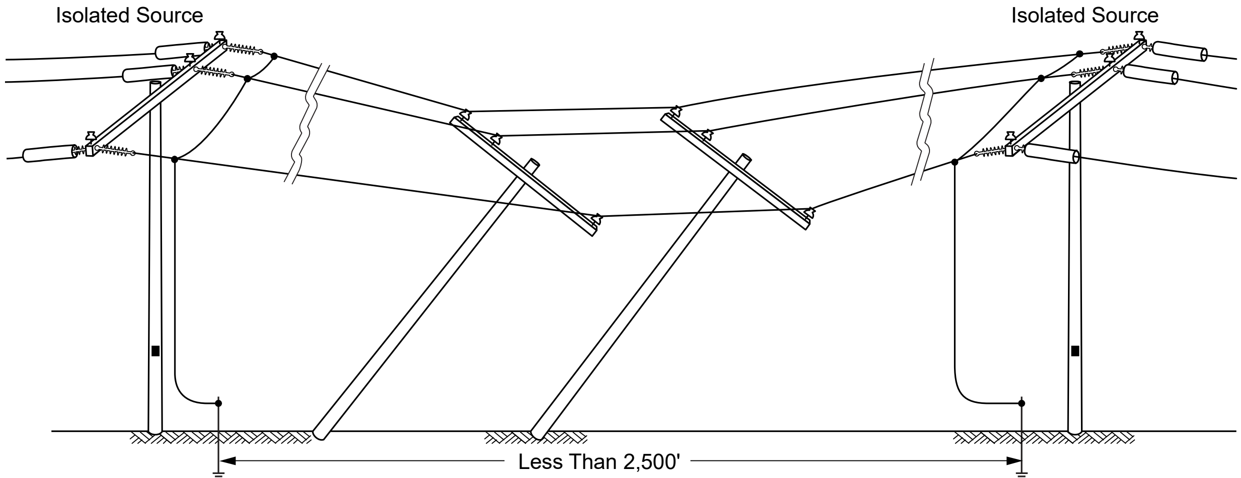
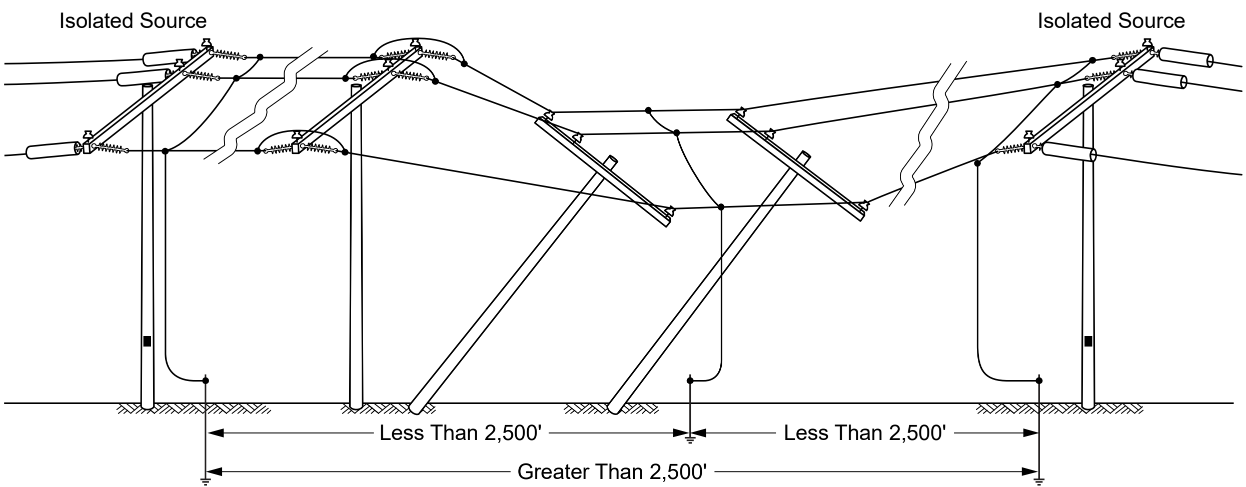


Figure 4–46: Multi-Structure Down — Example 4



4.13 Grounding During Wire Stringing

Roller grounds for wire stringing shall be approved 2/0 or larger extra-flexible copper conductor for sub-transmission and transmission voltages, and minimum #2 extra-flexible copper conductor for distribution voltages.

Traveling grounds and equipment grounds shall be approved #2 or larger extra-flexible copper conductor. Stringing grounds including traveling grounds and grounded rollers are not considered approved personal grounds.

When stringing or taking down conductors, APM, Rule 214 shall be adhered to.

Traveling grounds are installed via the traveling ground rollers on the conductor at the payout end of the "wire pull." These grounds are typically located on the conductors between the payout dolly and the first structure. When re-conductoring (wire-to-wire), there will be another set of traveling grounds at the take up location (see Figure 4–47).

4.13.1 Grounding Methods

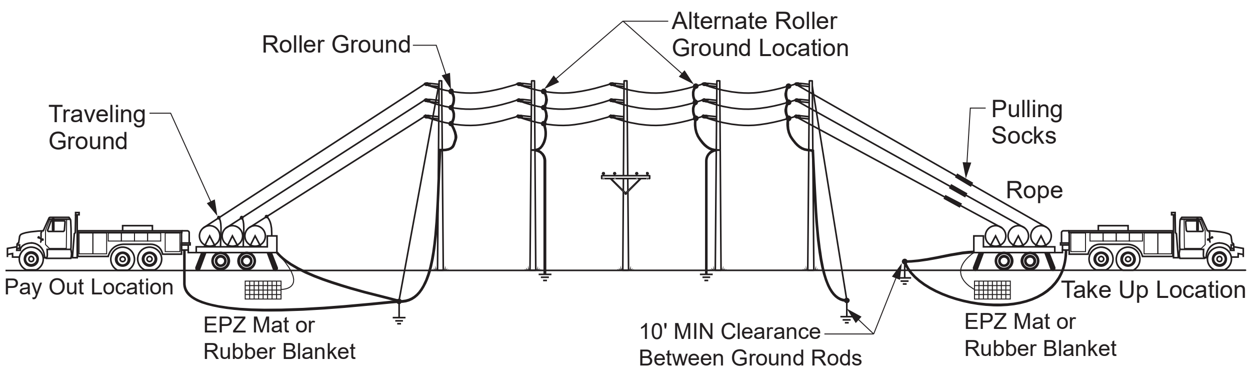
All equipment connected to wire stringing operations is required to be grounded. However in some scenarios the risk is reduced by having two separate grounding schemes. This is because all vehicles tied to the same grounding scheme will be energized during an inadvertant energization (see Figure 4–47 and Figure 4–48).

As shown in Figure 4–47, at the take up (rope dolly) location a separate grounding scheme shall be used to ground vehicles when no wires or other metallic connections to the conductors are required. All equipment/conductors grounding to one grounding scheme is to remain at least 10 feet away from equipment/conductors grounded to the second grounding scheme.

NOTE

Induction will cause a hazardous difference of electrical potential when structure within the bracket grounds are located within transmission/sub transmission corridors or support energized line(s) which are in parallel with the circuit being worked on for more than 600 feet.

Figure 4–47: Grounding Method When Pulling with Ropes



In cases where it is necessary to make metallic connections to the new conductors, such as when pulling with wire. All vehicles shall be tied into the same grounding scheme.

Figure 4–48: Grounding Method When Pulling with Wires, or Otherwise Making Connections from the Pulling Equipment to the Phase Conductors

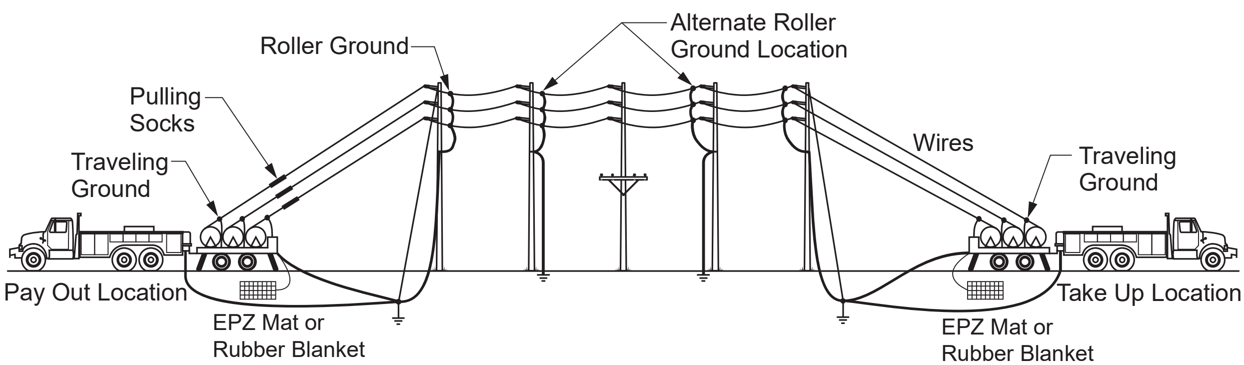
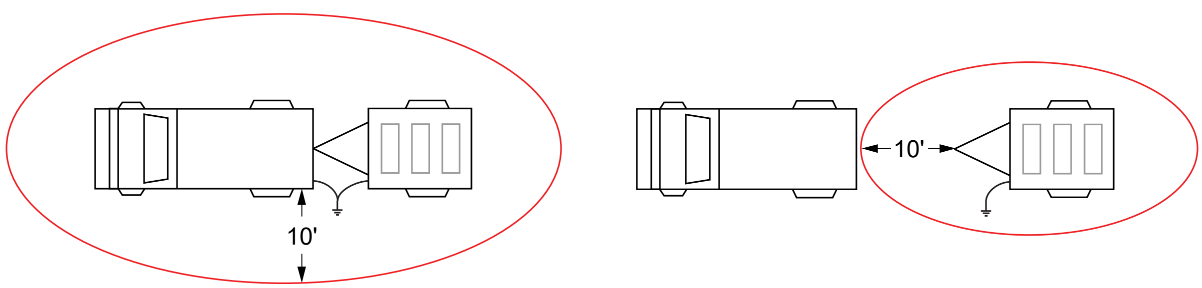


Figure 4–49: Step Potential for Truck and Dolly Attached and Truck and Dolly Unattached



NOTE

When truck and dolly are separated by a minimum of 10 feet the truck does not need to be grounded.

NOTE If the vehicle does not have approved grounding points, **it must be separated from the dolly**.

NOTE When there are no high voltage sources (For example: no energized parallel lines, no crossings, no hazardous induction), grounds will not be required when stringing new line section(s) on wood, composite, or concrete poles.

Procedure

STEP 1. When performing a wire stringing operation, install approved traveling grounds.

STEP 2. Locate roller grounds at the first or second structure from the payout and take up equipment and in increments so that no point is more than 2 miles from a ground. However, when stringing parallel to lines energized in excess of 35 kV, locate roller grounds at the first structure from the payout and take up equipment.

STEP 3. Ensure all equipment connected to wire stringing operations is grounded.

STEP 4. Ensure all personnel associated with wire stringing operations do not make contact with the wire stringing equipment in a way that would place them in a path to ground. Contact with wire stringing equipment can be accomplished through the use of EPZ mat(s) and/or insulating blanket(s) in accordance with APM, Rule 214.

STEP 5. Where practical, maintain a ten foot minimum working clearance area around wire stringing equipment during the stringing operation.

STEP 6. When the wire stringing operation is completed and before a worker touches the newly installed conductor(s), clean, test and utilize approved grounds to ground the new conductors with a approved live-line tool in accordance with the instructions in this manual.

4.14 Aerial Cable

Previously energized aerial cable can be worked on at ground level or in the air provided:

- Testing and grounding.
- Cable spiking shall be done remotely using approved spiking tools. Verify concentrics are grounded before spiking. Spiking shall be performed on both the grounded concentrics and cable simultaneously.

HVRG can be used to move aerial cable energized or de-energized. The automatic circuit recloser shall be made non-automatic when moving energized cable under the direction of the supervisor or employee in charge.

HVRG can be used to make/break torque only on de-energized aerial cable separable components.

WARNING

Isolated/Floating neutrals beyond distribution Automatic Reclosers (ARs) shall not be used as a ground medium; and the isolated/floating neutral shall be opened between the AR and the bracket grounds. Isolated/Floating neutrals that are not part of the line being grounded shall not be incorporated into the grounding scheme because that connection could cause an unplanned operation, for example, (AR tripping).

After cutting a cable, if a section of a cable is NOT grounded or isolated from all sources, then that cable section shall not be contacted.

4.14.1 Work on Aerial Cables will be Performed as Follows

Warnings

- Messenger wire may or may not be a neutral
- Messenger wire shall be included in the grounding scheme

Procedure

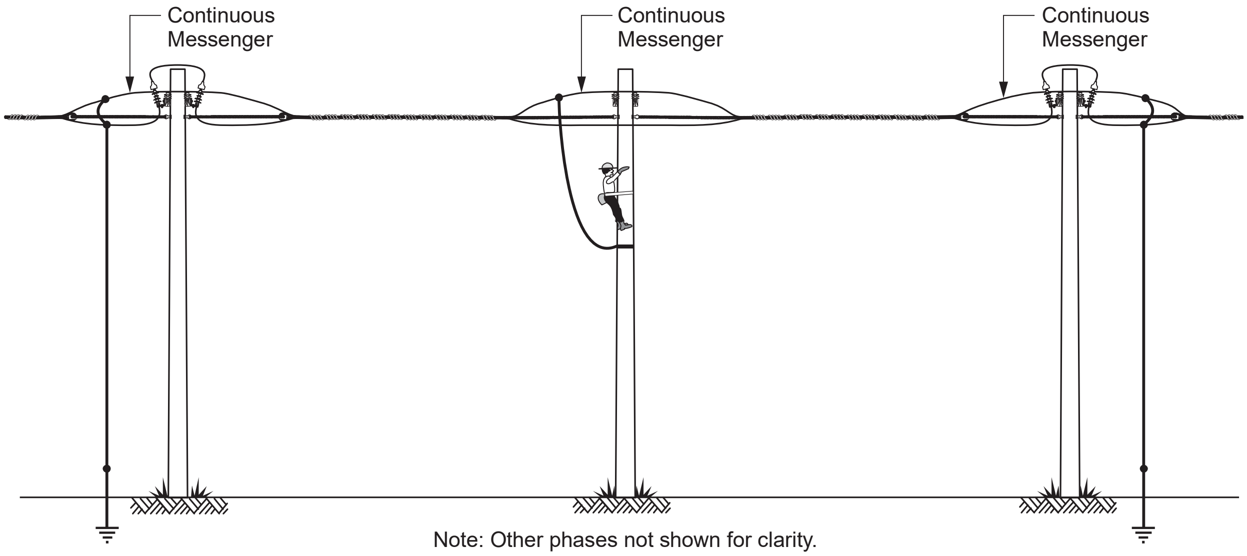
STEP 1. Verify continuity of the messenger wire between locations where grounds will be installed and the work location. When needed, install bypass jumpers to ensure messenger wire continuity.

STEP 2. Utilize an approved grounding method and ground medium(s), clean, test and install appropriately sized grounds on all phases of the circuit, concentric wires, and include the messenger wire in the grounding scheme.

STEP 3. At the work site, create an Equipotential Zone using the messenger wire (see Figure 4–50).

STEP 4. At the work site, insulated aerial cable(s) should be opened one phase at a time. One of the other phases or the messenger wire shall be kept electrically continuous to provide ground potential continuity between installed grounds and the work location.

Figure 4–50: Aerial Cable



4.14.2 Reattaching/Moving — De-Energized (not grounded)

De-energized Aerial Cable up to 16 kV may be reattached/moved using the following procedures.

Requirements

- No exposed conductors.
- Contact shall not be made with messenger/cable without the use of HVRG.
- Use High Voltage Rubber Gloves (HVRG) to protect from a difference of ground potential.

Procedure

STEP 1. Test the circuit de-energized.

STEP 2. Inspect messenger/cable using HVRG.

STEP 3. Re-attach messenger/cable to the structure. HVRG shall be worn when contacting the messenger/cable.

4.14.3 Reattaching/Moving — Energized

Energized Aerial Cable up to 16 kV may be reattached/moved using the following procedures.

Requirements

- No exposed energized conductors.
- Messenger wire shall be continuous and grounded at a maximum of 1,250 feet from the work site.
- Use High Voltage Rubber Gloves (HVRG) to protect from a difference of ground potential.

Procedure

STEP 1. Take no test orders.

STEP 2. Messenger and energized aerial cables shall be inspected using HVRG.

STEP 3. In order to utilize HVRG to reattach/move energized aerial cable to the structure, verify the messenger is grounded, permanent or temporary, at a maximum of 1,250 feet from the work site. Use live line tools to install temporary grounds.

STEP 4. Re-attach messenger/cable to the structure. HVRG shall be worn when contacting the messenger/cable.

4.14.4 Grounding while Stringing Aerial Cable

During stringing of aerial cables, APM Rule 214 shall be followed. When high voltage sources are present, the messenger wire shall remain grounded at all times while stringing. Rotating Ground Tool (SAP 10139461) can be used for messenger wire grounding.

4.14.5 Working on Aerial Cable when Messenger Wire is Continuous using Equipotential Bracket Grounding Method

This scenario is applicable when the messenger is continuous or is made continuous between the work site and grounds using approved jumpers. The work can be performed in the air or on the ground.

STEP 1. Open source(s).

STEP 2. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply. The messenger and concentrics shall be included in the grounding scheme.

STEP 3. Eliminate backfeed per APM Rule 149.

STEP 4. To splice a phase on the ground:

STEP 4.1 When an EPZ is created at the work location using the messenger, phase conductor(s) may be repaired without using HVRG or live line tools, OR

STEP 4.2 Use HVRG in lieu of an EPZ to splice phase conductor(s)

STEP 5. Reattach messenger/cable to the structure. Use HVRG or live line tools when contacting the messenger/cable when an EPZ is not maintained.

STEP 6. Remove grounds in reverse order.

4.14.6 Working on Main Line/Tap Line Aerial Cable when Messenger Wire is not Continuous Between Grounds and the Work site using Equipotential Bracket Grounding Method

This scenario is applicable when there is a known opening(s) of the messenger or location(s) where the messenger is broken. The work can be performed in the air or on the ground.

STEP 1. Open source(s).

STEP 2. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply. The messenger and concentrics shall be included in the grounding scheme.

STEP 3. Eliminate backfeed per APM Rule 149.

STEP 4. When the messenger is broken at the work site,

STEP 4.1 Use HVRG to repair the messenger, OR

STEP 4.2 Install an approved jumper between the two ends of the messenger wire using HVRG or live line tools, create an EPZ using live line tools and the messenger, and then repair the messenger without using HVRG or live line tools.

WARNING While repairing the messenger using HVRG, the worker shall not contact the exposed conductor (aerial cable, concentrics, messenger, and so forth) with any part of their body.

STEP 5. To splice a phase on the ground:

STEP 5.1 Use HVRG to splice cable(s), OR

STEP 5.2 When all phases are severed, use HVRG to expose ends of a phase, install an approved jumper, and create an EPZ using the exposed phase. All other phases may be repaired without HVRG as long as the EPZ is maintained. The last phase shall be repaired using HVRG when an EPZ cannot be maintained.

STEP 6. Reattach messenger/cable to the structure. Use HVRG or live line tools when contacting the messenger/cable.

STEP 7. Remove grounds in reverse order.

4.14.7 Removal of Aerial Cable using Equipotential Bracket Grounding Method

This scenario illustrates removing existing aerial cables of a distribution main/tap line permanently.

STEP 1. Open source(s).

STEP 2. Issue/take a clearance per APM Rule 105 for the distribution circuit.

STEP 3. Clean, test, and ground the line. Include the messenger and concentrics in the grounding scheme. Install a set of bracket grounds between the work site (that is, cable isolation points) and each source of supply. When grounds cannot be installed between a source and where the aerial cable is being isolated, the grounds shall be installed as close as practicable to the source locations (for example, within one span).

STEP 4. Eliminate backfeed per APM Rule 149.

STEP 5. Adequately cover all sources.

STEP 6. In order to work multiple locations simultaneously while isolating aerial cable from the source, Equipotential Bracket Grounding Method shall be used at each location. Therefore, each location shall ensure the circuit is grounded between their location and all source(s) of supply. Prior to isolating the aerial cable from any structure, ensure all other workers are clear of the circuit and sufficient cover is applied to prevent accidental contact with an energized source, per APM Rule 147.

To isolate aerial cable one source location at a time from the first and subsequent source(s)/structure(s); ensure the circuit is grounded between the work site and every source of supply and work within an EPZ (which can be created using a pole band connected to a continuous messenger/concentric/phase).

When isolating conductor(s) from a source structure, EPZ must be maintained at that source structure until the last phase conductor is isolated. Exception: No EPZ is needed to isolate conductor from the last source structure.

Eliminate each source by isolating aerial cable from source structure(s).

WARNING

When hazardous induction is present, additional steps are required to protect from induction. These steps are described in Equipotential Bracket Grounding and Aerial Cable Isolation methods (see Paragraph 3.6.13.2, Step 1).

STEP 7. Once all sources have been eliminated, grounds are no longer required for the removal of the remaining aerial cable and equipment.

4.14.8 Working on Aerial Cable using Bracket Grounding Method

This scenario is applicable when the messenger is continuous or not continuous between the work site and source(s). The work can be performed in the air or on the ground.

STEP 1. Isolate all phases from source(s) per Bracket Grounding Method (see Paragraph 3.6.13.2, Step 1).

STEP 2. Adequately protect the source with approved protective devices. Energized conductors on the source pole shall be covered using approved protective devices such that there are no exposed energized source conductor(s).

STEP 3. Issue/take a clearance per APM Rule 105 for the distribution circuit.

STEP 4. Eliminate backfeed per APM Rule 149.

STEP 5. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply. The messenger and concentrics shall be included in the grounding scheme.

STEP 6. After grounding the line from all sources, it is required to prove this overhead aerial cable de-energized at the work location(s).

STEP 7. Repair messenger and splice cable(s). Use of live line tools, HVRG, or EPZ is not required.

STEP 8. Reattach messenger/cable to the structure. Use of HVRG or live line tools is not required.

STEP 9. Remove grounds in reverse order.

4.14.9 Removal of Aerial Cable using Bracket Grounding Method

This scenario illustrates removing existing cables of a distribution main/tap line permanently. This scenario is applicable when the source pole is wood, composite, or concrete.

WARNING When a source pole is steel, then Equipotential Bracket Grounding Method shall be used.

STEP 1. Isolate Source by physically removing the taps or other methods described in Overhead Bracket Grounding (see Paragraph 3.6.13.2, Step 1).

STEP 2. Adequately protect the source with approved protective devices. Energized conductors on the source pole shall be covered using approved protective devices such that there are no exposed energized source conductor(s).

STEP 3. Issue/take a clearance per APM Rule 105 for the distribution circuit.

STEP 4. Clean, test, and ground the line. Install bracket grounds to protect from all sources. Include the messenger and concentrics in the grounding scheme. For work on the source pole the bracket grounds shall be installed as close as practicable to the work site (for example, within one span).

STEP 5. Eliminate backfeed per APM Rule 149.

WARNING No work shall be performed simultaneously on multiple source poles unless Equipotential Bracket Grounding Method is used. Similarly, no work shall be performed on the line while work is in progress on the source pole.

WARNING When hazardous induction is present, additional steps are required to protect from induction. These steps are described in Equipotential Bracket Grounding (see Paragraph 3.6.13.1) and Aerial Cable Isolation methods (see Paragraph 3.6.13.3).

STEP 6. Eliminate each source by removing aerial cable from the source/structure.

STEP 7. Once all sources have been eliminated, grounds are no longer required for the removal of the remaining aerial cable and equipment, as long as induction doesn't exist.

4.14.10 Working on Main or Tap Line Aerial Cable using an Approved Grounding Method with an Alternate Method for Eliminating Backfeed

This scenario is applicable on aerial cable only, when multiple backfeed sources are eliminated by grounding and HVRG are used to perform the work. The work can be performed in the air or on the ground.

STEP 1. Open source(s) or Isolate all phases from source(s) per Bracket Grounding Method (see Paragraph 3.6.13.2, Step 1).

STEP 2. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply. The messenger and concentrics shall be included in the grounding scheme.

STEP 3. Eliminate backfeed:

STEP 3.1 Per APM Rule 149, or

STEP 3.2 Use an alternate method: Install a set (or multiple sets) of grounds on all phases of the primary circuit anywhere on the main/tap line that the conductors are continuous and will remain continuous to all backfeed sources for the duration of the work. This method will require use of HVRG to perform work.

NOTE

This alternate method is applicable to aerial cable only; backfeed is considered eliminated when HVRG is used to perform the work and backfeed sources are grounded per the Alternate Method above. Grounds do not need to be located between all the backfeed sources and the work site.

STEP 4. Use HVRG (when alternate method is used to eliminate backfeed) to repair, splice, or perform work on the aerial cable.

WARNING

While repairing the aerial cable/messenger using HVRG, the worker shall not contact any exposed conductor (aerial cable, concentrics, messenger, and so forth) with any part of their body.

STEP 5. Reattach messenger/cable to the structure. Use HVRG or live line tools when contacting the messenger/cable.

STEP 6. Remove grounds in reverse order.

4.14.11 Working on Aerial Cable using Aerial Cable Isolation Method

This scenario is applicable when the messenger is continuous or not continuous between the work site and source(s). The work can be performed in the air or on the ground.

STEP 1. Isolate all phases from the source(s) per Aerial Cable Isolation method (see Paragraph 3.6.13.3).

STEP 2. Eliminate backfeed per APM Rule 149.

STEP 3. Cover exposed energized components/conductors at the work location or maintain minimum approach distance at all times.

STEP 4. When working on a main line and the neutral is not isolated from the source, the neutral shall be grounded at the work site or contact shall be avoided.

STEP 5. The circuit shall be proven de-energized by testing and grounding or, by remote spiking the cable. Cut the cable and grounded concentrics simultaneously to prove the circuit/cable/equipment de-energized at any location, preferably at the source or work location.

STEP 6. Repair messenger and splice cable(s). Use of live line tools, HVRG, or EPZ is not required provided the messenger is not an in service neutral.

STEP 7. Reattach messenger/cable to the structure. Use of HVRG or live line tools is not required provided the messenger is not an in service neutral.

4.14.12 Removal of Aerial Cable using Aerial Cable Isolation Method

This scenario illustrates removing existing aerial cables of a distribution main/tap line permanently.

When a parallel line is present a hazardous difference of electrical potential may exist at the work site.

Induction will cause a hazardous difference of electrical potential when structures supporting aerial cable(s) are located within transmission/sub-transmission corridors, or support energized line(s) which are in parallel with the circuit being worked on for more than 600 feet. Insulated or exposed aerial cable conductors, messenger, and concentrics of aerial cable are susceptible to hazardous induction.

STEP 1. Isolate all Source(s) by any one method described in Aerial Cable Isolation Method (see Paragraph 3.6.13.3) (For example: floating potheads, removing elbows and safe ending the source, or spiking cable).

STEP 2. Adequately protect all source(s) with approved protective devices or safe end the source.

STEP 3. Issue/take a clearance per APM Rule 105 for the distribution circuit.

STEP 4. Eliminate all backfeed per APM Rule 149.

STEP 5. The circuit shall be proven de-energized by testing and grounding, or by remote spiking the cable. Cut the cable and grounded concentrics simultaneously to prove the circuit/cable/equipment de energized at any location, preferably at the source or work location.

STEP 6. Remove aerial cables from source structures. Live line tools or HVRG is not required to remove isolated aerial cable.

STEP 7. Remaining aerial cable(s) and equipment that have been isolated from all sources may be removed without the use of HVRG or live line tools.

NOTE

After sources have been isolated or eliminated; one of the following work methods shall be used to move or detach an aerial cable from its supporting structure where hazardous induction may exist:

- Use HVRG to move or detach aerial cable. While using HVRG the worker shall not contact any exposed conductor with any part of their body;
- Work within 300 feet of a bracket ground, if grounds are not removed;
- Work on the messenger/Neutral/concentrics within 300 feet of a permanent or temporary ground; or
- Without contacting any exposed conductor, messenger, and concentrics of the aerial cable, cut the aerial cable, messenger, and concentrics in lengths of less than 600 feet and then remove these short sections without using HVRG.
- The conductor, messenger, Neutral, and/or concentrics can be worked on while draining/bleeding hazardous induction by use of an anchor rod or temporary ground rod(s) and grounds connected between the exposed conductors and the rod(s) provided the workspace is within 300 feet of the grounds.

4.14.13 Working on Main or Tap Line Aerial Cable using Aerial Cable Isolation Method with an Alternate Method for Eliminating Backfeed

This scenario is applicable on aerial cable only, when multiple backfeed sources are eliminated by grounding and using HVRG. The work can be performed in the air or on the ground.

STEP 1. Isolate all phases from source(s) per Aerial Cable Isolation Method (see Paragraph 3.6.13.3).

STEP 2. Eliminate backfeed:

- Per APM Rule 149, or
- Use an alternate method: Install a set (or multiple sets) of grounds on all phases of the primary circuit anywhere on the main/tap line that the conductors are continuous and will remain continuous to all backfeed sources for the duration of the work. This method will require use of HVRG to perform work.

NOTE

This alternate method is applicable to aerial cable only; backfeed is considered eliminated when HVRG is used to perform the work and backfeed sources are grounded per the alternate method above. Grounds do not need to be located between all the backfeed sources and the work site.

STEP 3. Cover exposed energized components/conductors at the work location or maintain minimum approach distance at all times.

STEP 4. When working on a main line and the neutral is not isolated from the source, the neutral shall be grounded at the work site or contact shall be avoided.

STEP 5. The circuit shall be proven de-energized by testing and grounding, or remote spiking. At any location, preferably at the source or work site. There is no need to prove the cable de-energized at the work location as long as the cable can be positively identified through the use and verification of circuit maps, structure numbers, equipment numbers, and visually tracing the conductors from the point of grounding to the work site, and so forth. When in doubt, prove the circuit de-energized at the work site.

STEP 6. Use HVRG (when alternate method is used to eliminate backfeed) to repair, splice, or perform work on the aerial cable.

NOTE

While repairing the aerial cable/messenger using HVRG, the worker shall not contact any exposed conductor (aerial cable, concentrics, messenger, and so forth) with any part of their body.

STEP 7. Reattach messenger/cable to the structure. Use HVRG or live line tools when contacting the messenger/cable.

STEP 8. Remove grounds.

4.15 Grounding Scenarios Using Overhead Equipotential Bracket Grounding Method

Overhead Equipotential Bracket Grounding Method is the preferred method and may be used in all grounding scenarios whether the sources are open or isolated.

This section contains grounding examples and illustrations that show proper use of Overhead Equipotential Bracket Grounding Method.

4.15.1 Overhead Equipotential Bracket Grounding Method — Distribution Main Line

This scenario illustrates working on multiple poles of a distribution main line to replace crossarms and insulators. The poles are wood, composite, or concrete. There are no crossings and there are no parallel lines that can cause hazardous induction.

Procedure:

STEP 1. Open sources;

STEP 2. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply;

STEP 3. Create workspace EPZ:

- STEP 3.1 When the work site is within 1,250 feet of a bracket ground, then install a pole band and one shunt from the pole band to one phase that is continuous between bracket grounds; and/or,
- STEP 3.2 When the work site is located more than 1,250 feet from all bracket grounds, then install a pole band and shunt(s) from the pole band to the phases being worked on and other phases within the minimum approach distance.

NOTE Distribution conductors within minimum approach distance can be adequately cover/protected in lieu of shunting to the pole band.

STEP 4. Bond external ground(s) that are in contact with the pole within the workspace to the pole band. External grounds that are not in contact with the pole but are exposed in the workspace shall be covered or bonded to the pole band.

See Figure 4–51 through Figure 4–53 for illustrations.

Figure 4–51: Overhead Equipotential Bracket Grounding Method — Example 1

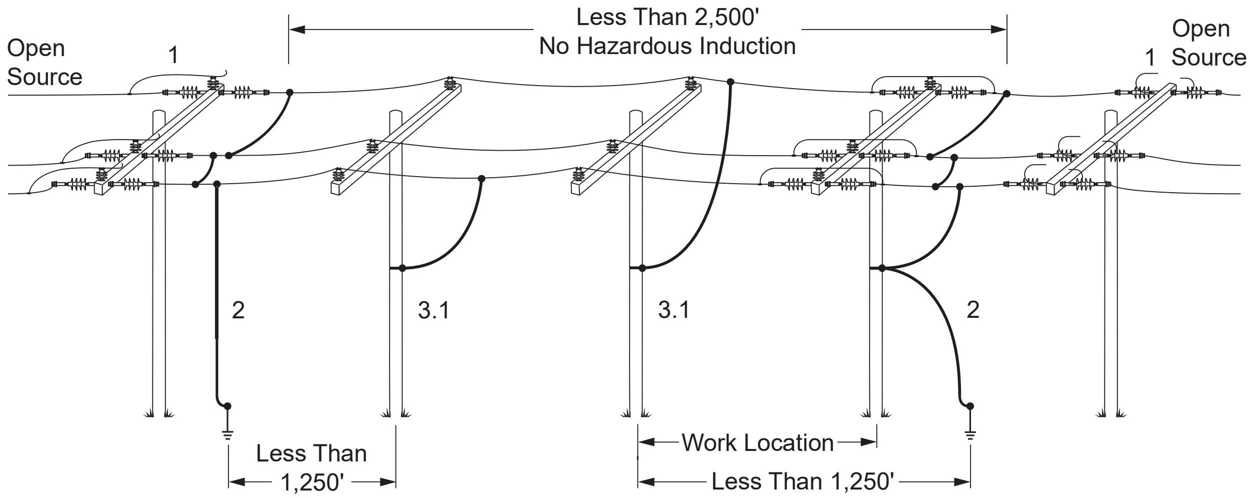


Figure 4–52: Overhead Equipotential Bracket Grounding Method — Example 2

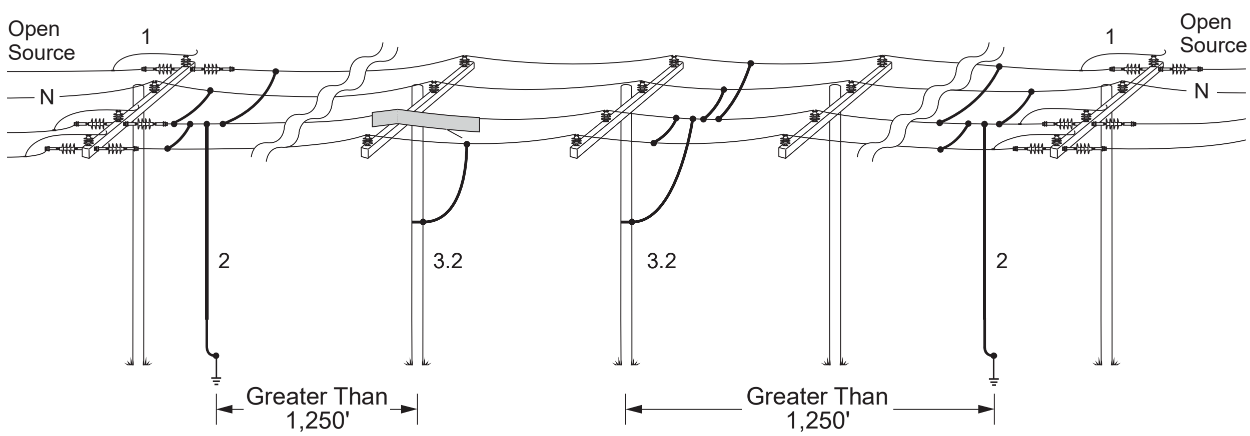
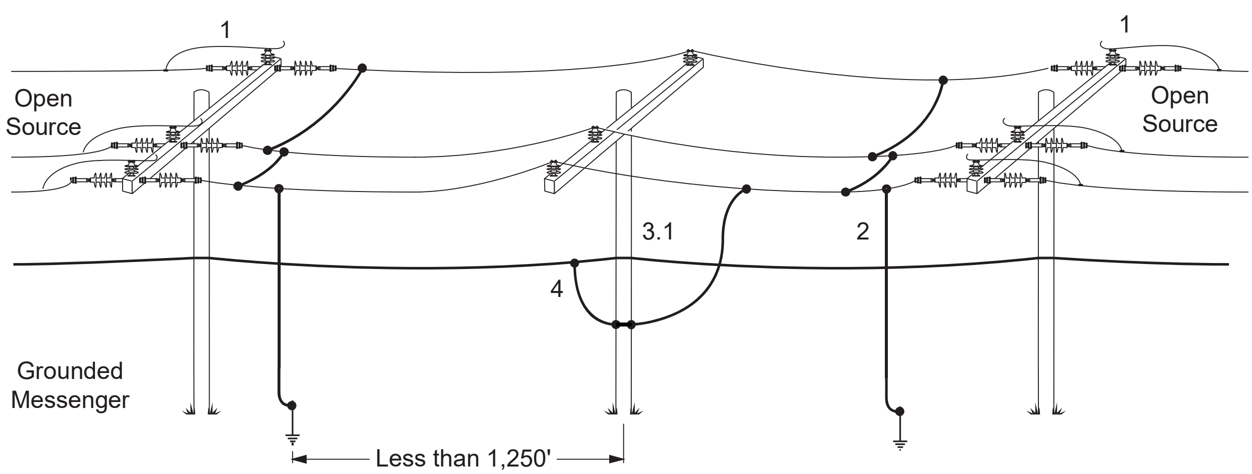


Figure 4–53: Overhead Equipotential Bracket Grounding Method — Example 3



4.15.2 Overhead Equipotential Bracket Grounding Method — Working on a Source Pole

This scenario illustrates working on a source pole of a distribution main line. This scenario also applies to distribution tap lines. The source pole is wood, composite, or concrete. There are no crossings and there are no parallel lines that can cause hazardous induction. The work is to pull up and dead-end all conductors to the source pole.

Discussion:

APM, Rule 207e States: "work shall not be performed on downed overhead lines until they have been proven de-energized and grounded as provided in Rule 141, unless they are being cut in the clear, with approved live-line tools, to protect from personal injury."

Procedure:

STEP 1. Open sources;

STEP 2. Clean, test, and ground the line. Install a set of bracket grounds to protect from all sources. The bracket grounds shall be installed as close as practicable to the work site, for example, (at the next pole);

STEP 3. Apply adequate cover to the energized conductors on the source pole;

STEP 4. Create a workspace EPZ at the source pole:

- STEP 4.1 When the work site is within 1,250 feet of a bracket ground, then install a pole band and one shunt from the pole band to first phase that is pulled up to the source pole. The first phase conductor shall be continuous to the bracket grounds, all other conductors being dead-ended are not required to be shunted to the pole band; and/or,
- STEP 4.2 When the work site is located more than 1,250 feet from the bracket ground, then install a pole band and shunt(s) from the pole band to all phases being pulled up to the source pole.

STEP 5. Handling conductors on the ground would either require an EPZ or high voltage rubber gloves to move, inspect, and transfer distribution conductors. EPZ on the ground can be created by use of an EPZ mat or temporary ground rod(s) and shunts provided the workspace is within ten feet of the rod(s).

Figure 4–54: Overhead Equipotential Bracket Grounding Method — Example 4

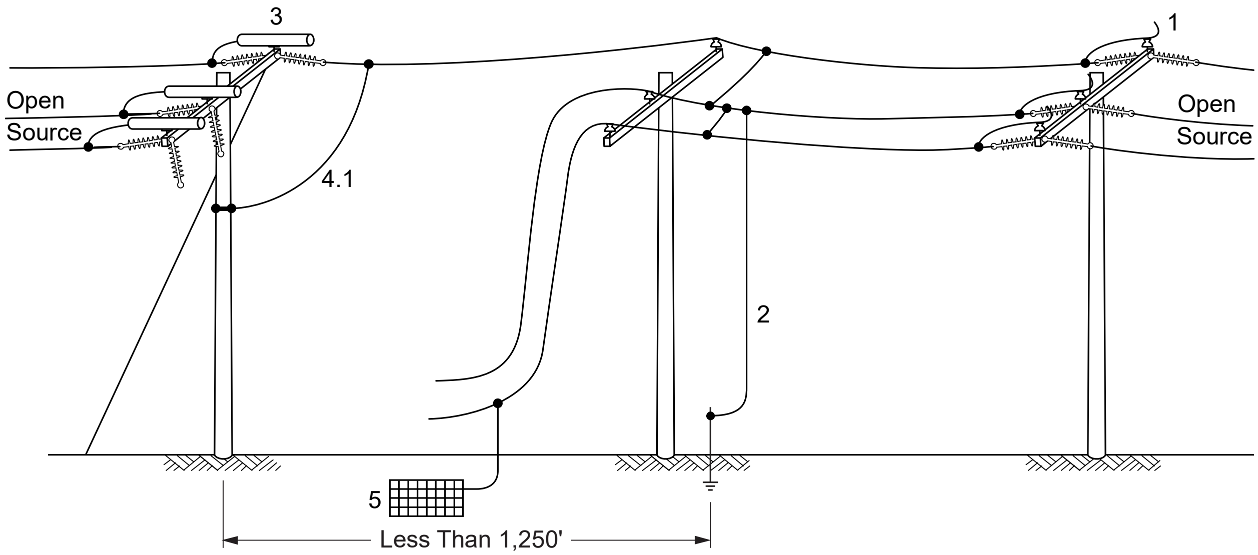


Figure 4–55: Overhead Equipotential Bracket Grounding Method — Example 5

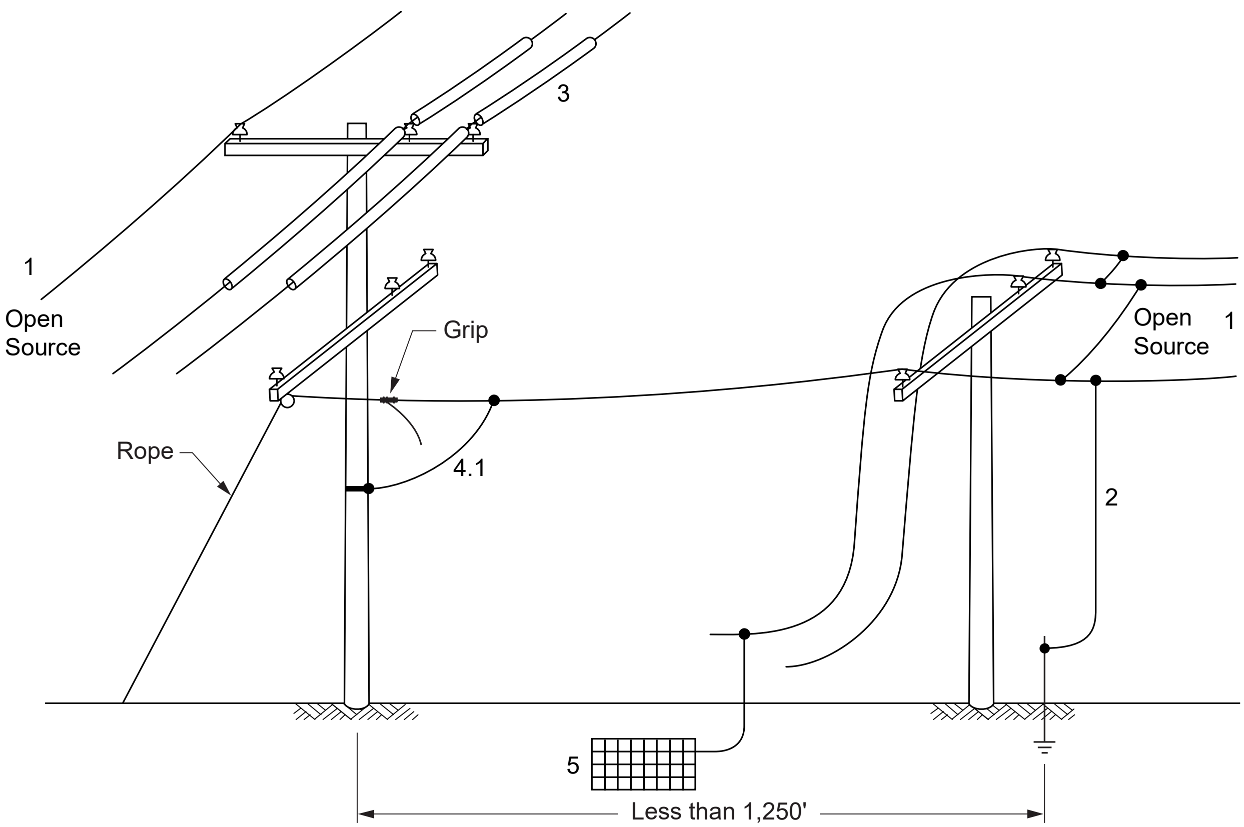
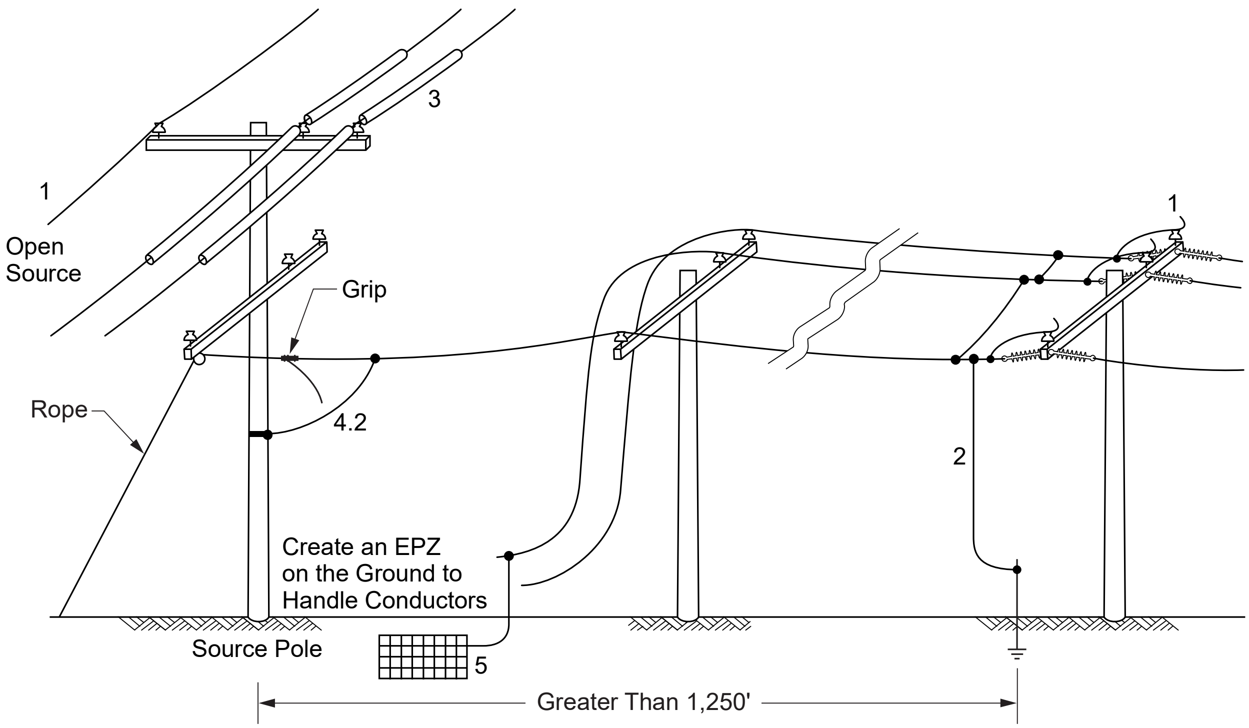


Figure 4–56: Overhead Equipotential Bracket Grounding Method — Example 6



4.15.3 Overhead Equipotential Bracket Grounding Method — Working on Multiple Circuits

This scenario illustrates working on multiple poles of two parallel distribution lines. The poles are wood, composite, or concrete. There are no crossings and there are no parallel energized lines that can cause hazardous induction.

This scenario is similar to working on a single circuit. For multiple circuits, the grounds shall be sized for the highest fault duty. In addition, each circuit shall be grounded independently from pole band up (see figure below).

Ground mediums should be shared when grounding multiple circuits to prevent from getting in between hazardous difference of electrical potentials. When ground mediums are not shared, circuits shall be bonded to each other at the work location.

Procedure:

STEP 1. Open sources;

STEP 2. Clean, test, and ground the lines. Install a set of bracket grounds between the work site and each source of supply;

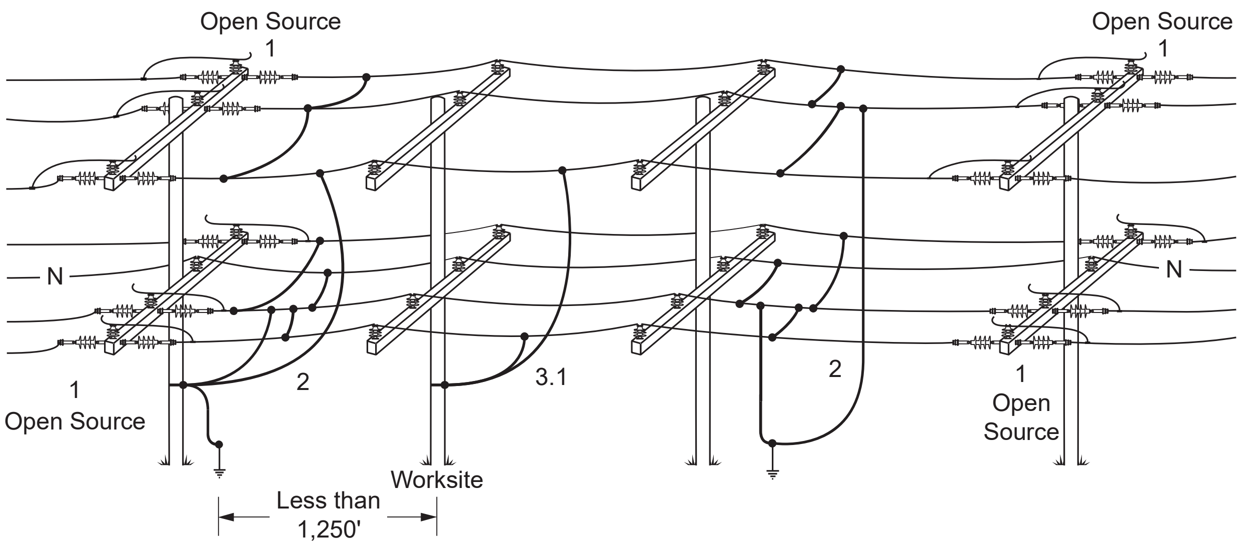
STEP 3. Create workspace EPZ:

STEP 3.1 When the work site is within 1,250 feet of a bracket ground, then install a pole band and one shunt from the pole band to one phase of each circuit that is continuous between bracket grounds; and/or,

STEP 3.2 When the work site is located more than 1,250 feet from all bracket grounds, then install a pole band and shunt(s) from the pole band to the phases being worked on and other phases within the minimum approach distance.

NOTE Distribution conductors within minimum approach distance can be adequately cover/protected in lieu of shunting to the pole band.

Figure 4–57: Overhead Equipotential Bracket Grounding Method — Example 7



4.15.4 Overhead Equipotential Bracket Grounding Method — Working on a Pole with Attached Crossing

This scenario illustrates working on a pole of a distribution line. The pole is wood, composite, or concrete. There are no parallel energized lines that can cause hazardous induction. The conductors on one side of the pole have been dropped to perform other work. The work is to pull up and dead-end all dropped conductors to the pole. The pole has an attached crossing but it is not a source pole for the circuit.

Procedure:

STEP 1. Open sources;

STEP 2. Maintain minimum approach distance to the energized circuit (that is crossing) or adequately cover/protect the energized circuit.

STEP 3. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply:

STEP 3.1 Install a set of bracket grounds to protect from the open source on the left (see Figure 4–58).

STEP 3.2 Because the work is directly under/over a crossing, a set of approved grounds sized in accordance with Table 3–1 shall be installed at the work site or as close as practicable to the work site, for example, (at the next pole).

STEP 4. Create an EPZ at the work site by use of a pole band. When grounds are not installed at the work site, create an EPZ at the work site by shunting one conductor that is continuous to the bracket ground to the pole band.

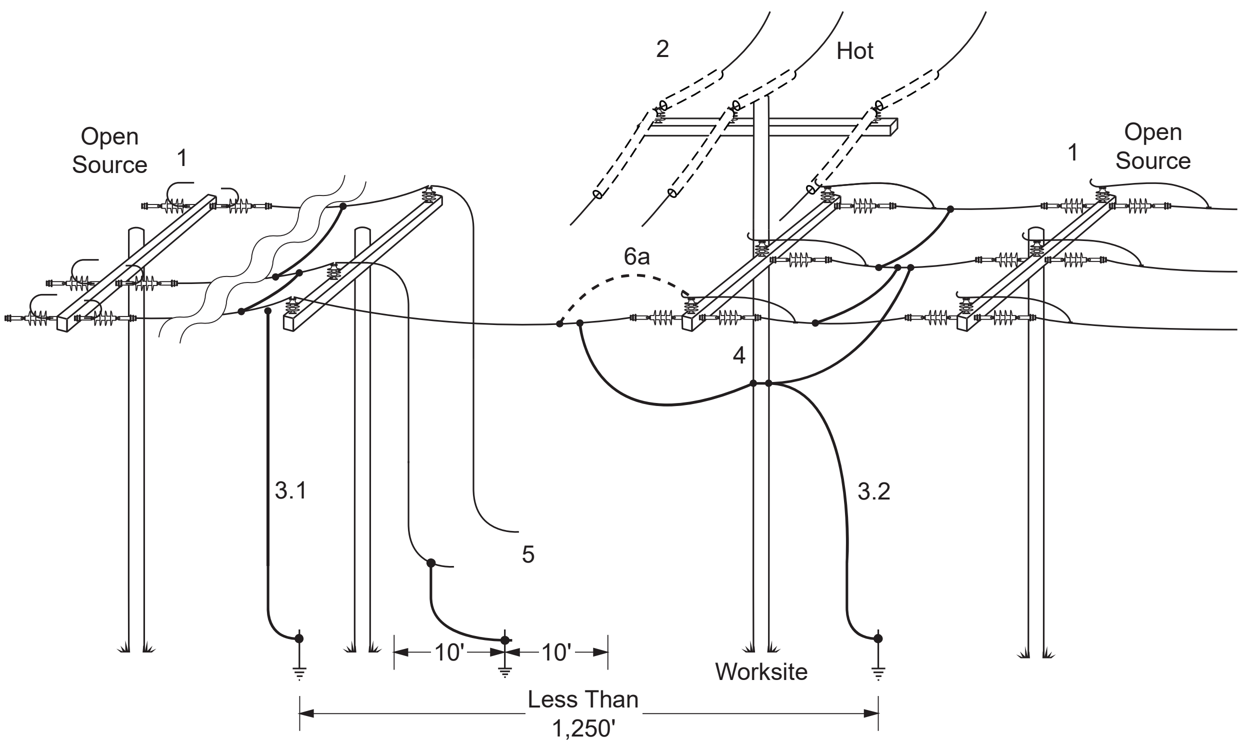
STEP 5. Handling conductors on the ground would either require an EPZ or high voltage rubber gloves to move, inspect, and transfer distribution conductors. EPZ on the ground can be created by use of an EPZ mat or temporary ground rod(s) and shunts provided the workspace is within ten feet of the rod(s). Do not allow conductors to contact any part of the body when using high voltage rubber gloves.

STEP 6. When conductors are pulled up, include conductors in the workspace EPZ at the pole as follows:

STEP 6.1 When the work site is within 1,250 feet of the bracket grounds on the left, then install one shunt from the workspace EPZ to first conductor that is pulled up to the pole. The conductor shall be continuous to the bracket grounds. Remaining conductors can be pulled up and dead-ended; or,

STEP 6.2 When the work site is located more than 1,250 feet from the bracket grounds on the left, then install shunt(s) from the pole band to all conductors being pulled up to the pole.

Figure 4–58: Overhead Equipotential Bracket Grounding Method — Example 8



4.15.5 Overhead Equipotential Bracket Grounding Method — Working on a 4-Way Corner Pole with Taps Intact/Removed

This scenario illustrates working on a 4-way distribution corner pole which is a wood, composite, or concrete pole. The corner pole distance from all adjacent poles is less than 1,250 feet. The job is to replace insulators on both levels. There are no parallel lines and therefore no hazardous induction exists. The job will be performed using Overhead Equipotential Bracket Grounding Method.

Procedure:

STEP 1. Open sources;

STEP 2. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply:

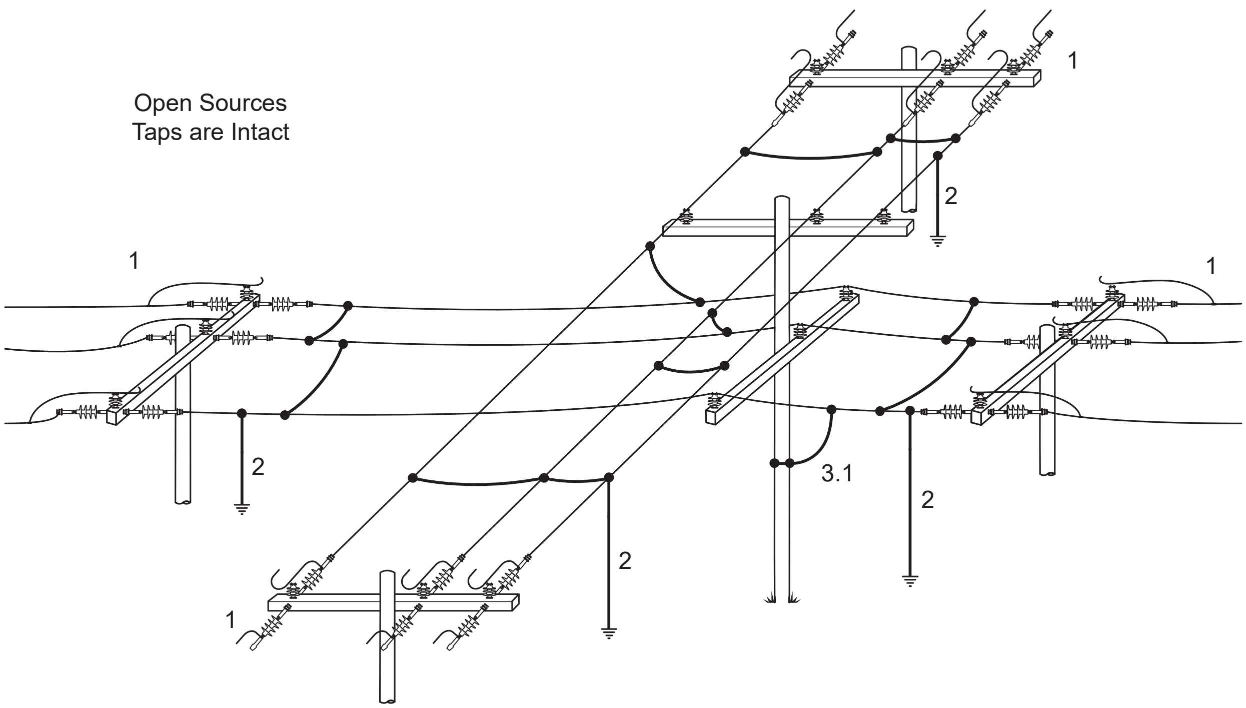
STEP 3. Create workspace EPZ at the corner pole. Phases that will be shunted to the pole band shall be continuous between bracket grounds.

STEP 3.1 When taps are intact, install a pole band and one shunt from the pole band to one phase of the bottom level,

STEP 3.2 When taps are removed, install a pole band and one shunt from the pole band to one phase of the bottom level and another shunt from the pole band to one phase of the top level, or

STEP 3.3 When taps are removed, install a pole band and one shunt from the pole band to one phase of the bottom level and install another shunt from the same phase on the lower level to a phase on the top level.

Figure 4–59: Overhead Equipotential Bracket Grounding Method — Example 9



4.15.6 Overhead Equipotential Bracket Grounding Method — Working on a 4-Way Corner Pole

This scenario illustrates working on a 4-way distribution corner pole which is a wood, composite, or concrete pole. The job is to replace insulators on both levels. The job will be performed using Overhead Equipotential Bracket Grounding Method. The grounds will be installed at the work site.

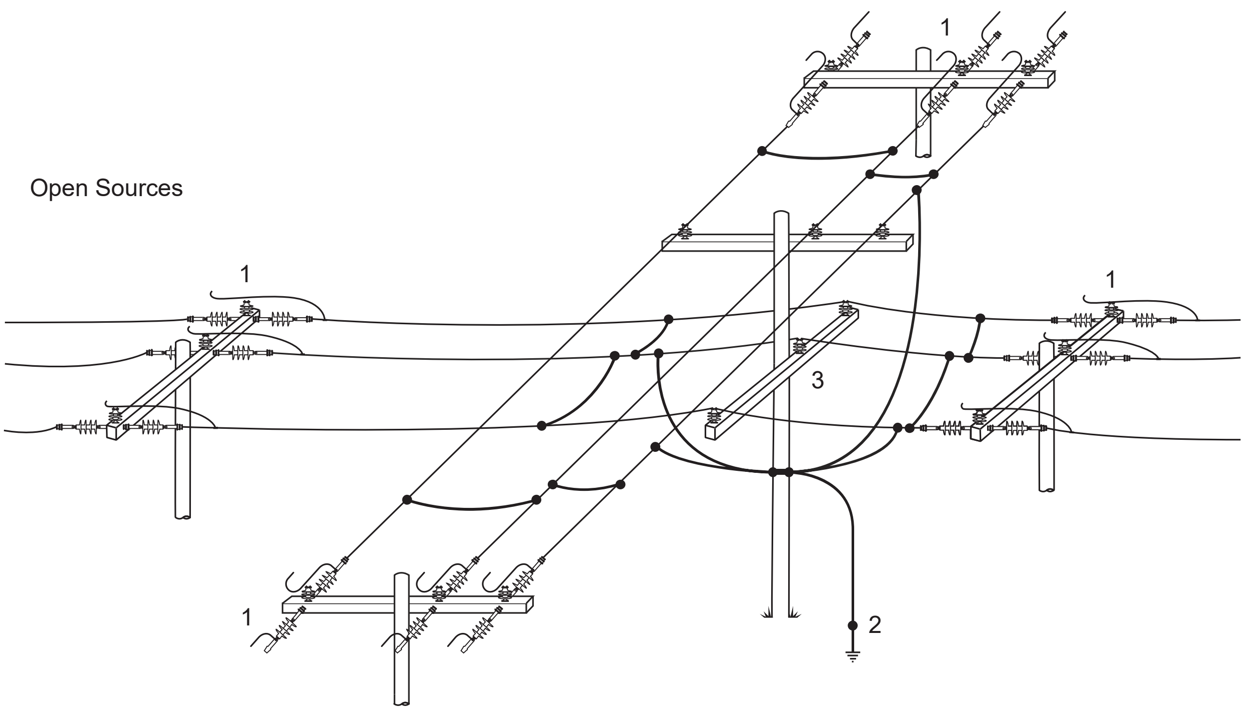
Procedure:

STEP 1. Open sources;

STEP 2. Clean, test, and ground the line. Install four bracket grounds at the work site to protect from each source of supply;

STEP 3. Create workspace EPZ at the work site by installing pole bands and shunting the pole bands to grounding scheme.

Figure 4–60: Overhead Equipotential Bracket Grounding Method — Example 10



4.15.7 Overhead Equipotential Bracket Grounding Method — Handling Conductors on the Ground

This example illustrates the methods for handling conductors on the ground when using Overhead Equipotential Bracket Grounding Method.

APM, Rule 207e States: "work shall not be performed on downed overhead lines until they have been proven de-energized and grounded as provided in Rule 141, unless they are being cut in the clear, with approved live-line tools, to protect from personal injury."

Procedure:

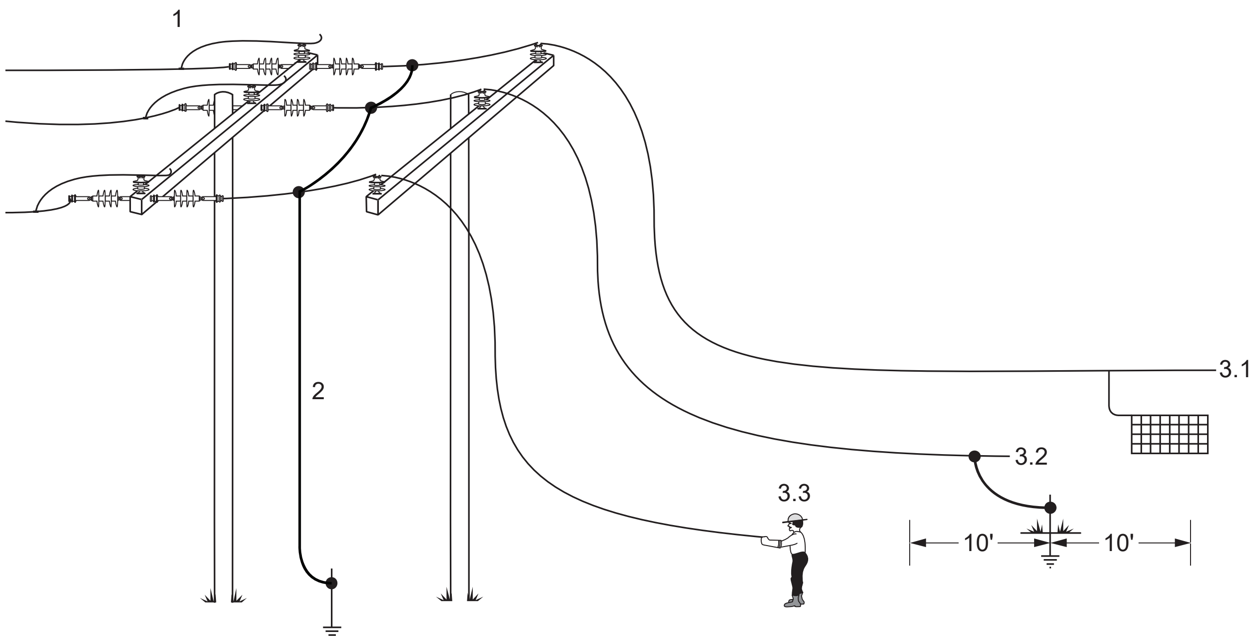
STEP 1. Open sources;

STEP 2. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply;

STEP 3. When handling downed conductors on the ground, the following three options are available:

- STEP 3.1 Create an EPZ using EPZ mat,
- STEP 3.2 Create an EPZ using temporary ground rod(s);
- STEP 3.3 High Voltage Rubber Gloves may be used to move, inspect, transfer, add, and splice grounded distribution conductors. Conductors shall not touch any part of the body.

Figure 4–61: Overhead Equipotential Bracket Grounding Method — Example 11



4.15.8 Overhead Equipotential Bracket Grounding Method — Working on Pole Between Crossing and Source

The scenario illustrates a situation where crossing exists between two sources of supply. This scenario illustrates working on multiple poles of a distribution main line. The poles are wood, composite, or concrete. There are no parallel lines that can cause hazardous induction.

Because there is a crossing, the grounds shall be installed between the work site and the crossing.

A distribution under crossing when adequately covered is not considered a source for the purpose of locating grounds between the work site and the source.

Procedure:

STEP 1. Open sources;

STEP 2. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply including any crossing. Grounds shall not be more than 2,500 feet apart and more than 1,250 feet from the work site. Grounds installed at or near the work site are preferred;

STEP 3. Create workspace EPZ

- STEP 3.1 When the work site is within 1,250 feet of a bracket ground, then install a pole band and one shunt from the pole band to one phase that is continuous between bracket grounds, and/or
- STEP 3.2 When the work site is located more than 1,250 feet from all bracket grounds, then install a pole band and shunt(s) from the pole band to the phases being worked on and other phases within the minimum approach distance.

STEP 4. A distribution under crossing when adequately covered is not considered a source. Therefore, there is no need to install grounds between the work site and the adequately covered under crossing.

STEP 5. When working on both sides of a crossing, a single set of grounds installed at the crossing will provide adequate protection on both sides of the crossing

Figure 4–62: Overhead Equipotential Bracket Grounding Method — Example 12

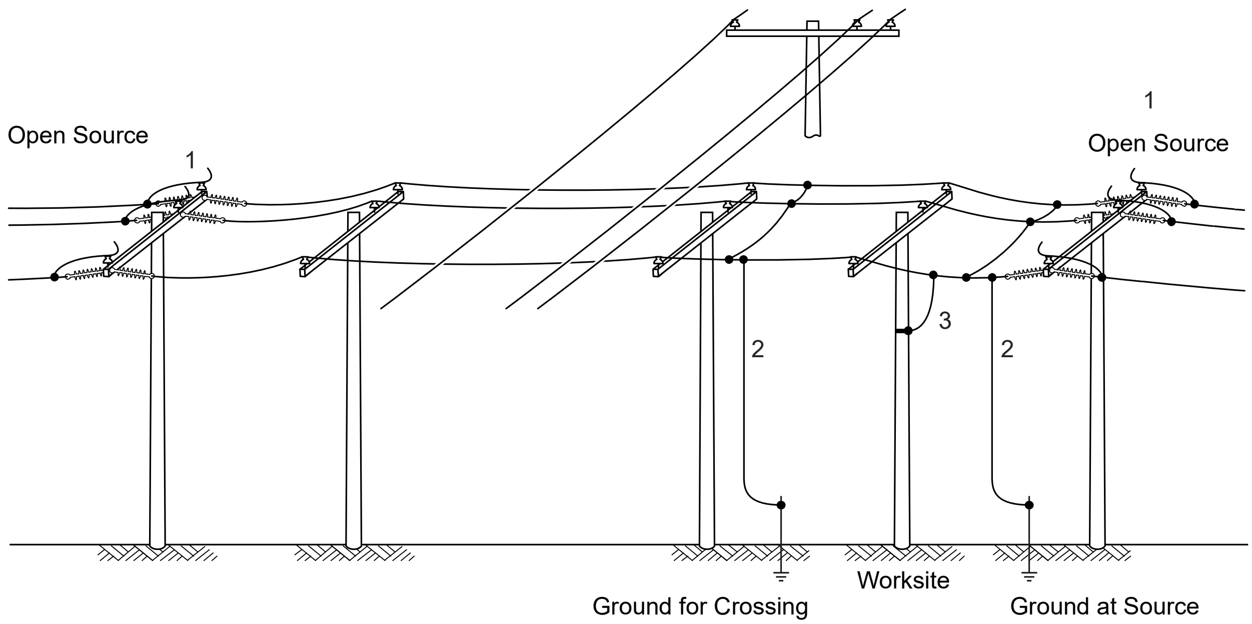


Figure 4–63: Overhead Equipotential Bracket Grounding Method — Example 13

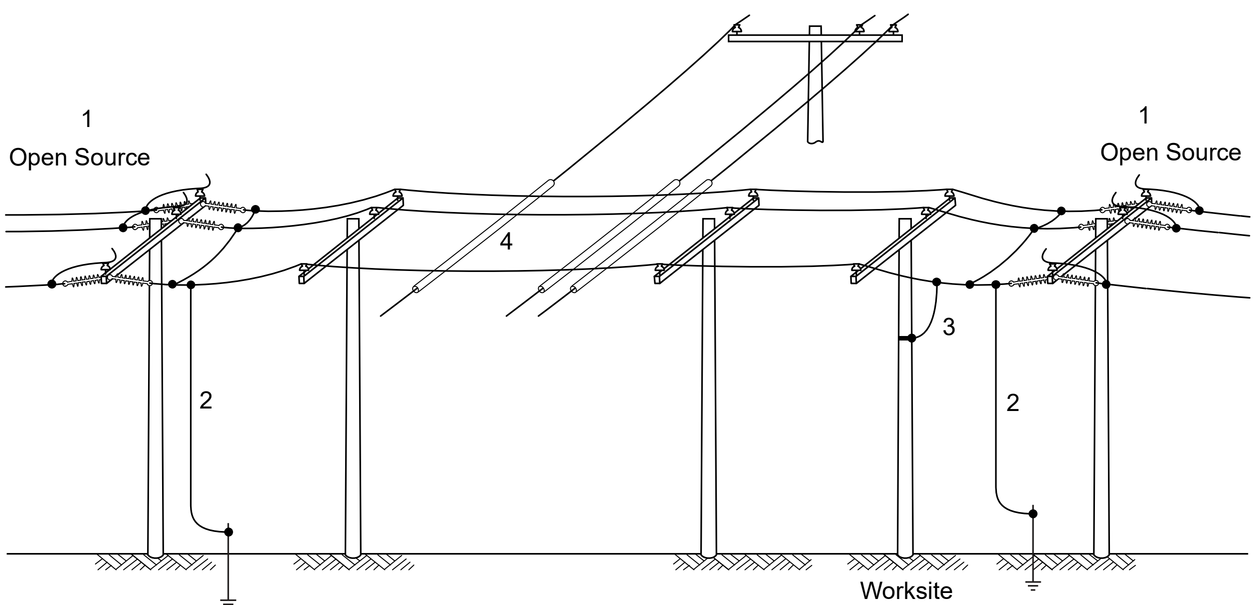
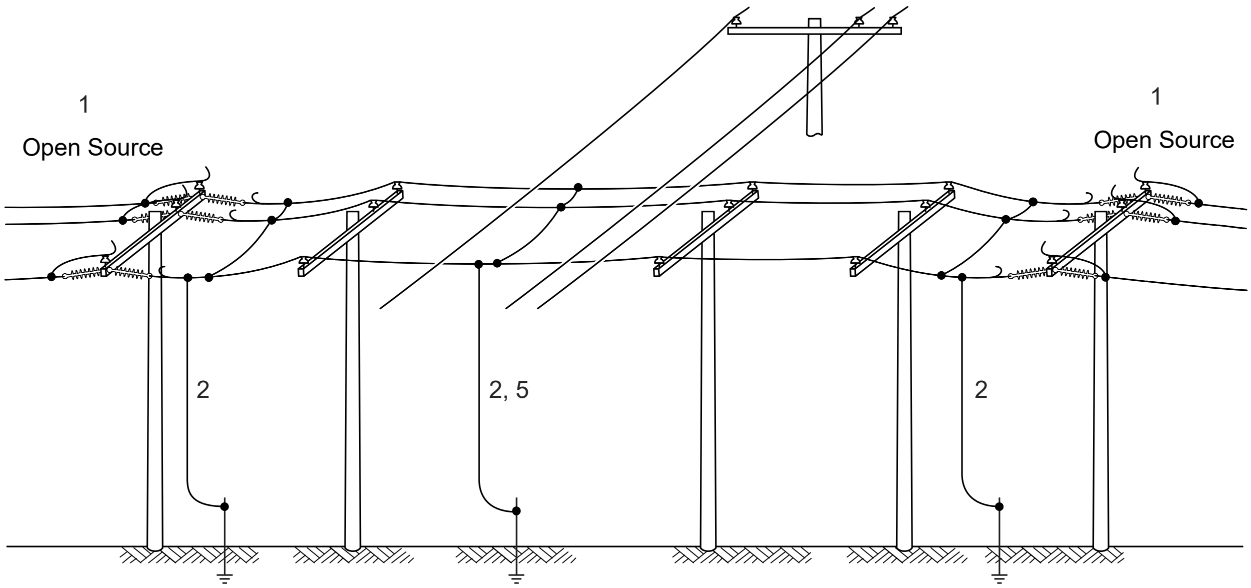


Figure 4–64: Overhead Equipotential Bracket Grounding Method — Example 14



4.15.9 Overhead Equipotential Bracket Grounding Method — Working on a Pole with a Parallel Energized Line

This scenario illustrates working on a 4-wire distribution line with an energized parallel line above. The neutral and phase conductors are the same size. The poles are wood, composite, or concrete. There are no crossings. However, there is a parallel line that can cause hazardous induction.

Procedure:

STEP 1. Open sources;

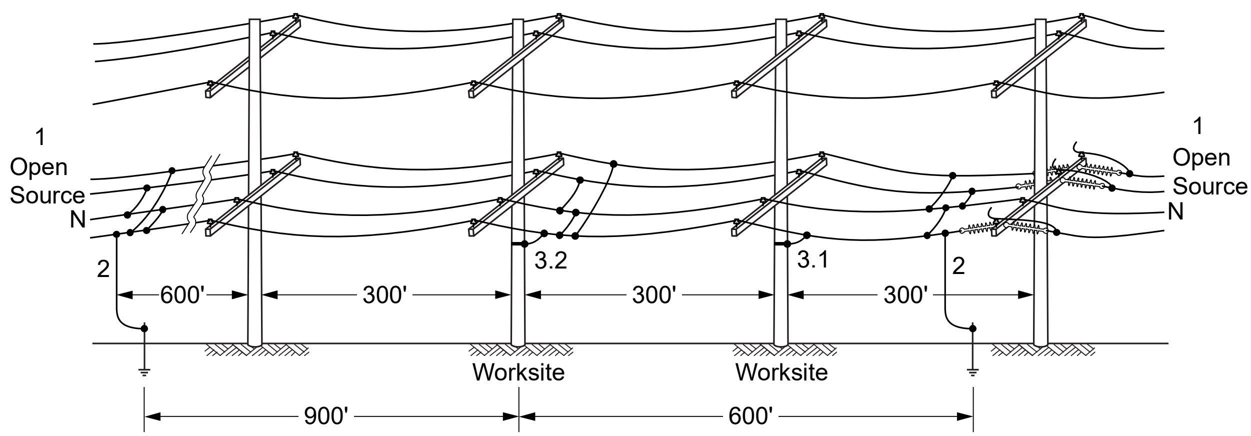
STEP 2. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply:

STEP 3. Create workspace EPZ

STEP 3.1 When the work site is within 300 feet of a bracket ground, then install a pole band and one shunt from the pole band to one phase that is continuous between bracket grounds, and/or

STEP 3.2 When the work site is located more than 300 feet from all bracket grounds, then install a pole band and shunt(s) from the pole band to the phases being worked on and other phases within the minimum approach distance. Distribution conductors not being worked on which are located within the minimum approach distance can be adequately covered/protected in lieu of shunting to the pole band.

Figure 4–65: Overhead Equipotential Bracket Grounding Method — Example 15



4.15.10 Overhead Equipotential Bracket Grounding Method — Adding Wires on the Ground and Working on a Pole with Parallel Energized Line

This scenario illustrates working on a distribution line with energized parallel line above. The work is to add wire to down conductors and bring up to dead-end. The pole is wood, composite, or concrete. The conductors on both side of the pole have been dropped to perform other work.

Procedure:

STEP 1. Open sources;

STEP 2. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply;

STEP 3. In order to make a phase continuous between bracket grounds shunts can be used. The shunt shall be an approved ground and sized adequately in accordance with Table 3–1;

STEP 4. Create workspace EPZ

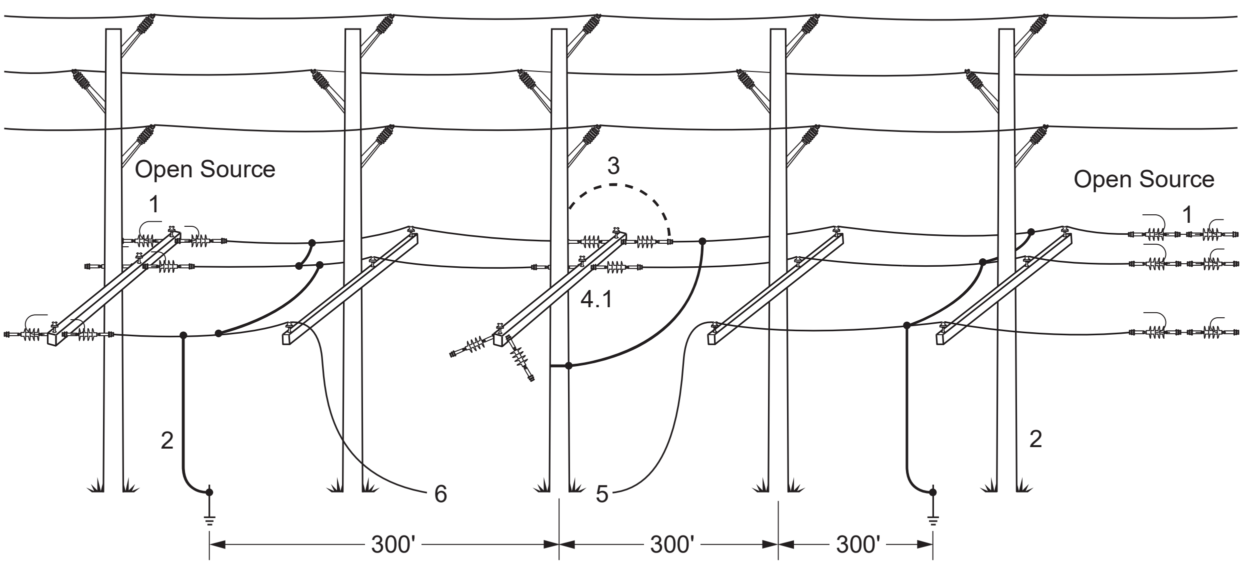
STEP 4.1 When the work site is within 300 feet of a bracket ground, then install a pole band and one shunt from the pole band to one phase that is continuous between bracket grounds; and/or,

STEP 4.2 When the work site is located more than 300 feet from all bracket grounds, then install a pole band and shunt(s) from the pole band to the phases being worked on and other phases within the minimum approach distance. Distribution conductors not being worked on which are located within the minimum approach distance can be adequately covered/protected in lieu of shunting to the pole band.

STEP 5. When adding wire or splicing on the ground EPZ is required or High Voltage Rubber Gloves shall be used.

STEP 6. Downed and grounded distribution conductors can be moved, inspected, and transferred to workers using high voltage rubber gloves or approved live-line tools with no EPZ required. However, the workers shall not contact the conductor with any part of their body.

Figure 4–66: Overhead Equipotential Bracket Grounding Method — Example 16



4.15.11 Overhead Equipotential Bracket Grounding Method — Working on Downed Pole and Conductor on a Tap Line

This scenario illustrates a downed pole on a distribution tap line with a severed conductor. The job is to install new pole, splice conductor, and restore the circuit. The poles are wood, composite, or concrete. There are no crossings and there are no parallel lines that can cause hazardous induction.

Procedure:

STEP 1. Open sources;

STEP 2. Eliminate backfeed by pulling fuses;

STEP 3. Clean, test, and ground the line. Install a set of bracket grounds between the work site and source of supply;

STEP 4. Clean, test, and ground severed conductors that have not been grounded by the installation of the bracket grounds;

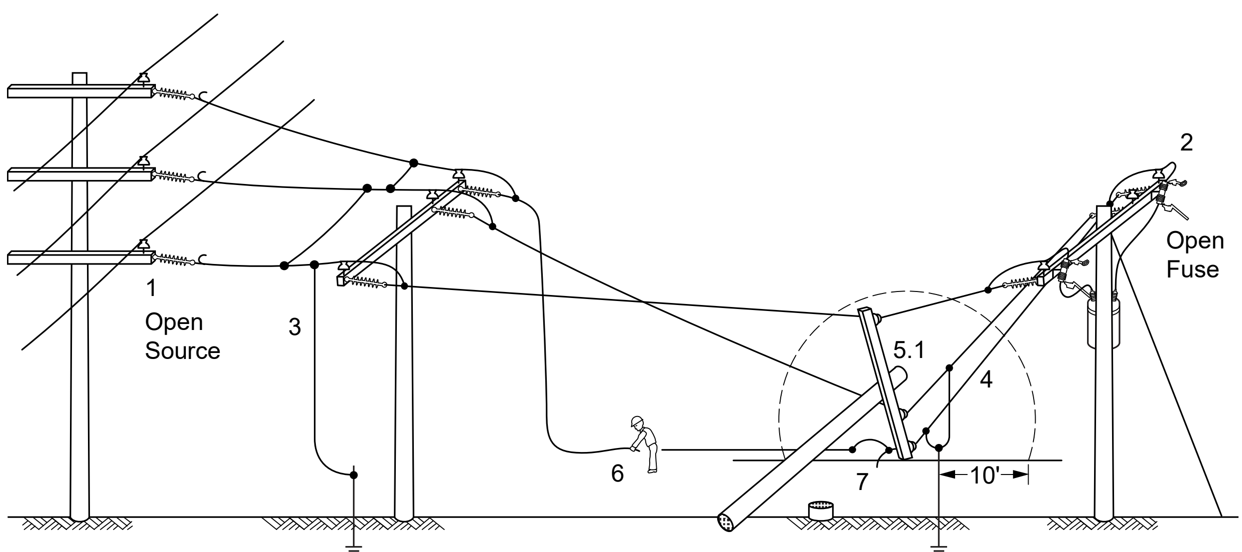
STEP 5. Create workspace EPZ:

- STEP 5.1 When the downed pole is within 1,250 feet of a bracket ground, then install a temporary ground rod and one shunt from the ground rod to one phase of the circuit that is continuous to the bracket grounds; and/or,
- STEP 5.2 When the downed pole is located more than 1,250 feet from all bracket grounds, then install a temporary ground rod and shunt(s) from the ground rod to the phases being worked on and other phases within the minimum approach distance.

STEP 6. Downed and grounded distribution conductors can be moved, inspected, and transferred to workers using high voltage rubber gloves or approved live-line tools with no EPZ required. However, the workers shall not contact the conductor with any part of their body;

STEP 7. When adding wire or splicing on the ground EPZ is required or High Voltage Rubber Gloves shall be used.

Figure 4–67: Overhead Equipotential Bracket Grounding Method — Example 17



4.15.12 Overhead Equipotential Bracket Grounding Method — One Conductor Down on the Last Span on a Distribution Tap Line

This scenario illustrates a severed conductor on a single phase distribution tap line. The line will be de-energized, grounded, and a workspace EPZ created on the pole to splice the conductor in the air. The poles are wood, composite, or concrete. There are no crossings and there are no parallel lines that can cause hazardous induction.

Procedure:

STEP 1. Open sources;

STEP 2. Eliminate backfeed by pulling fuses;

STEP 3. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply;

STEP 4. Create workspace EPZ on the pole:

- STEP 4.1 When the work site is within 1,250 feet of a bracket ground, then install a pole band and one shunt from the pole band to one phase of the circuit that is continuous to the bracket grounds; and/or,
- STEP 4.2 When the work site is located more than 1,250 feet from all bracket grounds, then install a pole band and shunt(s) from the pole band to the phases being worked on and other phases within the minimum approach distance.

STEP 5. Clean, test, and ground severed conductor(s) that have not been grounded by the installation of the bracket grounds;

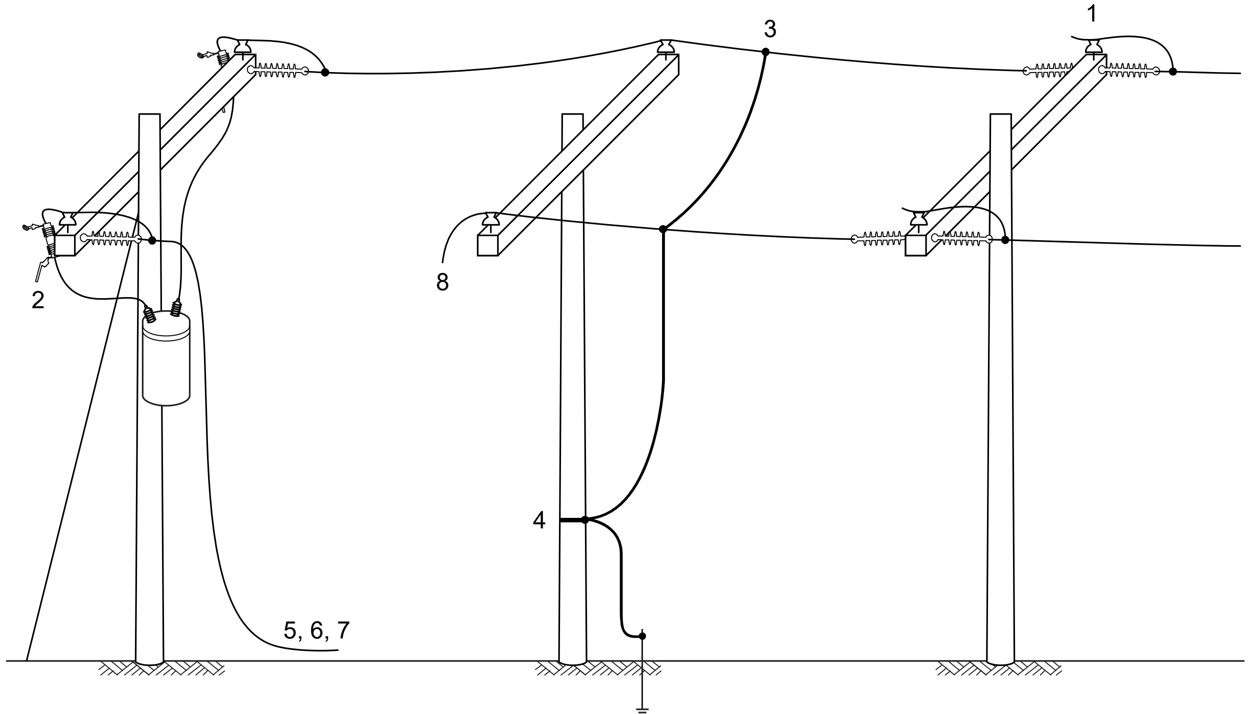
STEP 6. Downed and grounded distribution conductors can be moved, inspected, and transferred to workers using high voltage rubber gloves or approved live-line tools with no EPZ required. However, the workers shall not contact the conductor with any part of their body.

STEP 7. When adding wire or splicing on the ground EPZ is required or High Voltage Rubber Gloves shall be used.

STEP 8. Before contacting the wire that is being raised, it shall be incorporated into the workspace EPZ on the pole by installing a ground/shunt.

Figure 4–68: Overhead Equipotential Bracket Grounding Method — Example 18

Open Source



4.15.13 Overhead Equipotential Bracket Grounding Method — Working on 13'-6" Rack or Multiple Pole Structure

This scenario illustrates working on multiple pole structures. The workspace EPZ created on the structure shall have one pole band for each pole; otherwise there would be a path to ground which may create a hazardous difference of electrical potential. The poles are wood, composite, or concrete. There are no crossings and there are no parallel lines that can cause hazardous induction.

Procedure:

STEP 1. Open sources;

STEP 2. Eliminate backfeed;

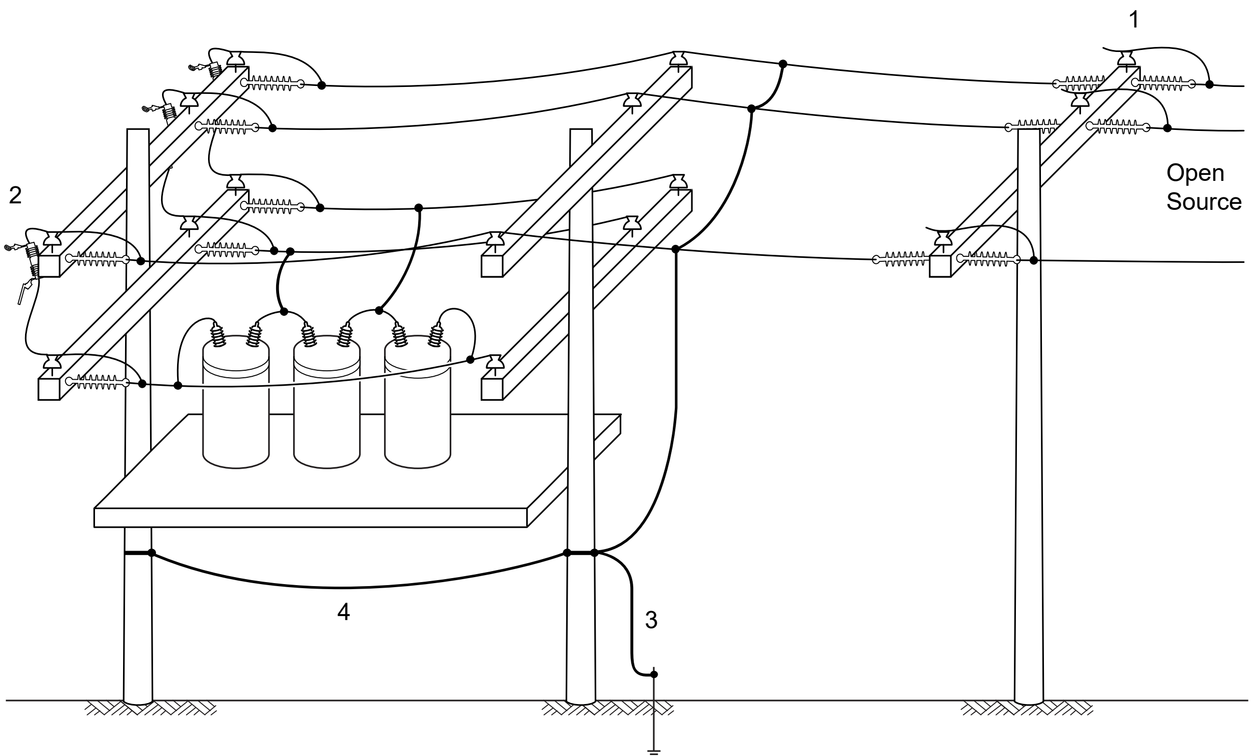
STEP 3. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply;

STEP 4. Create workspace EPZ by installing a pole band on each pole below the platform and shunt the pole bands to each other. In addition:

STEP 4.1 When the work site is within 1,250 feet of a bracket ground, then install a pole band and one shunt from the pole band to one phase of each circuit that is continuous between bracket grounds, and/or

STEP 4.2 When the work site is located more than 1,250 feet from all bracket grounds, then install a pole band and shunt(s) from the pole band to the phases being worked on and other phases within the minimum approach distance.

Figure 4–69: Overhead Equipotential Bracket Grounding Method — Example 19



4.15.14 Overhead Equipotential Bracket Grounding Method — Line Relocation

This scenario illustrates transferring distribution conductors to a new steel pole. The plan is to let one phase down at a time, add 40 feet of wire, and take it back up to the new steel pole and dead end it. The old poles are wood, composite, or concrete. There are no crossings and there is no parallel line that can cause hazardous induction.

Procedure:

STEP 1. Open sources;

STEP 2. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply:

STEP 3. Create workspace EPZ on the old pole which is wood, composite, or concrete;

- STEP 3.1 When the work site is within 1,250 feet of a bracket ground, then install a pole band and one shunt from the pole band to one phase of the circuit that is continuous between bracket grounds; and/or,
- STEP 3.2 When the work site is located more than 1,250 feet from all bracket grounds, then install a pole band and shunt(s) from the pole band to the phases being worked on and other phases within the minimum approach distance.

STEP 4. Create workspace EPZ on new steel pole;

STEP 5. Let down one conductor at a time from the old pole. When the conductor reaches the ground move the conductor to the wire adding work site. When moving conductors, workers shall use one of the following work methods:

- STEP 5.1 EPZ mats to create an Equipotential Zone,
- STEP 5.2 Temporary ground rods to create an Equipotential Zone,
- STEP 5.3 Approved live-line tools, or
- STEP 5.4 Insulate themselves from any differences of potential by using class II primary rubber gloves to move distribution circuit conductor to the structure while the circuit is grounded. However, the workers shall not contact the conductor with any part of their body.

STEP 6. EPZ is required or High Voltage Rubber Gloves shall be used to add or splice wire(s);

STEP 7. Use high voltage rubber gloves or approved live-line tools to move the conductor to the new steel pole;

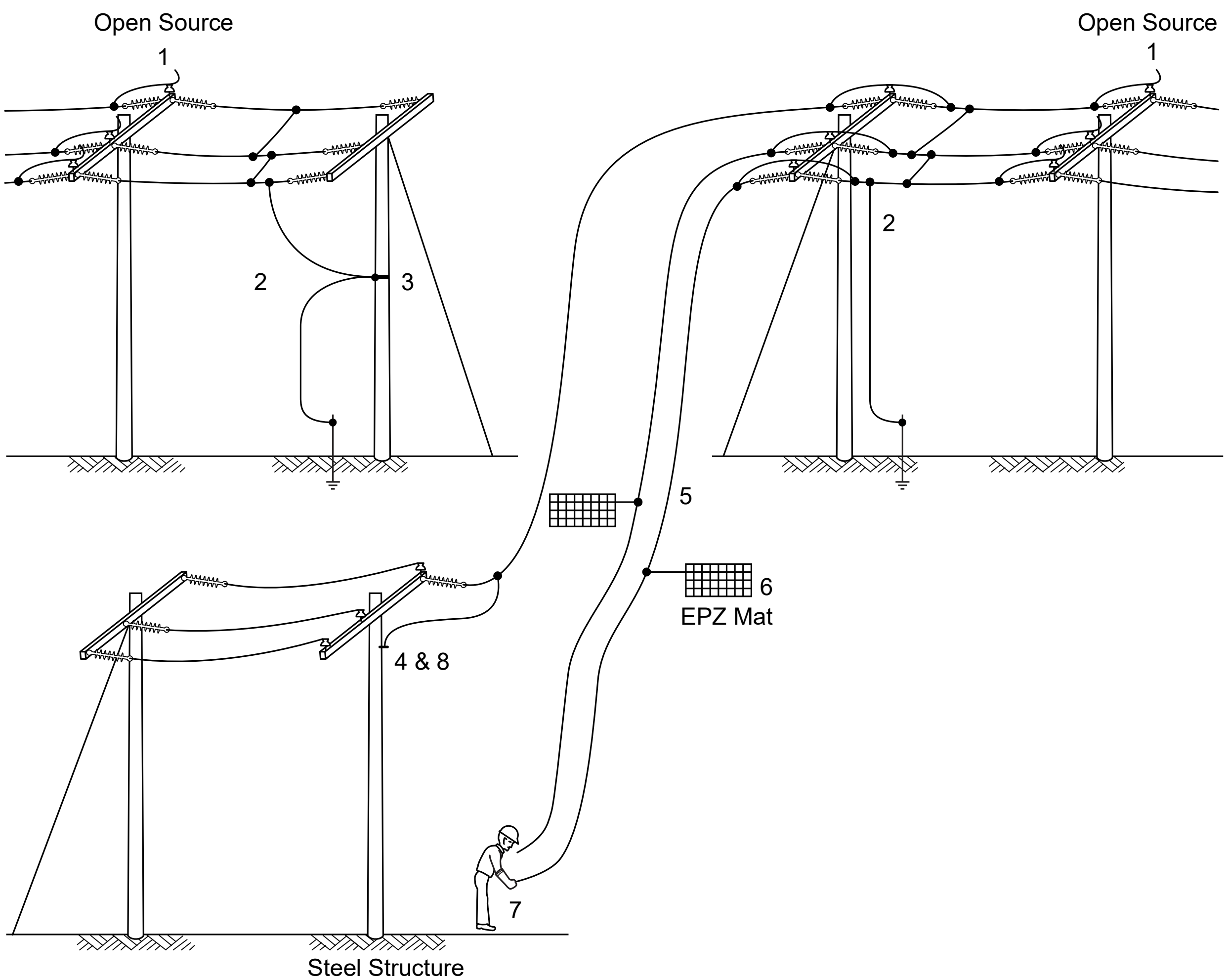
STEP 8. Before workers on the steel pole make contact with the conductor being raised, the conductor shall be incorporated into the workspace EPZ by installing a ground/shunt to the structure.

NOTE

When closing conductors that are grounded, and when the distance of grounds to the work site is within the required parameters (1,250 feet with no parallel lines or 300 feet with parallel lines), one conductor shall remain continuous between grounds in order to maintain continuity and to eliminate hazardous difference of electrical potential. Therefore, to close the first conductor, an approved shunt shall be used. Closing additional conductor(s) would not require shunt when the above conditions are met.

When the distance of grounds to the work site is outside the required parameters (1,250 feet with no parallel lines or 300 feet with parallel lines), or one side is not grounded hazardous difference of electrical potential might exist. Therefore, closing of any conductor would require a shunt.

Figure 4–70: Overhead Equipotential Bracket Grounding Method — Example 20



4.15.15 Overhead Equipotential Bracket Grounding Method — Transmission — Working on a Pole, Opening and Closing Conductors

This scenario illustrates working on a pole of a Transmission Circuit to change conductors from a suspension to a dead-end configuration. There are no parallel lines that can cause hazardous induction. This scenario also applies to cutting in or out switches.

Procedure:

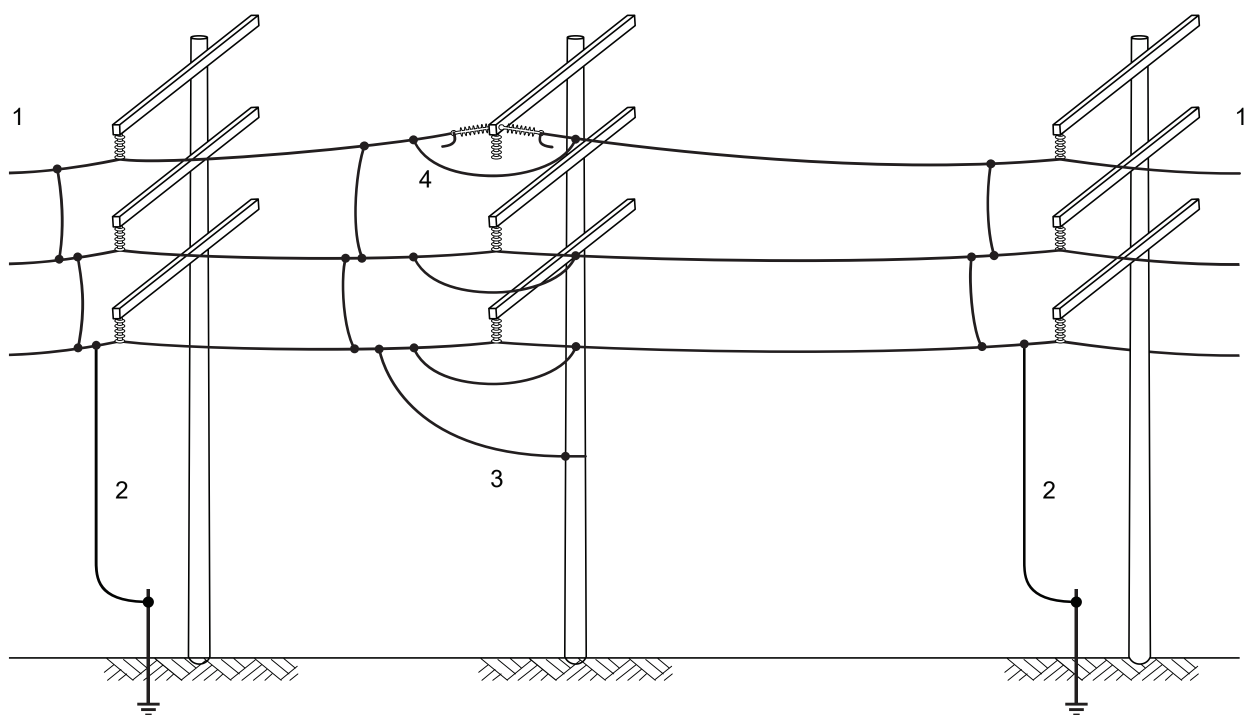
STEP 1. Take a clearance.

STEP 2. Clean, test and ground the line. Install a set of bracket grounds between the work site and each source of supply including crossings.

STEP 3. Create Work space EPZ by installing a pole band and shunts from the pole band to the phases being worked on and other phases within minimum approach distance.

STEP 4. Before opening or closing a conductor, a by-pass must be installed to maintain continuity and EPZ. When a By-Pass is used to make a phase continuous between bracket grounds, the by-pass shall be an approved ground and sized adequately in accordance with Table 3–1.

Figure 4–71: Overhead Equipotential Bracket Grounding Method — Example 21



4.15.16 Overhead Equipotential Bracket Grounding Method — Dead-Ending New Line Section at the Source Pole

This scenario illustrates dead-ending a newly constructed distribution tap line to its source pole. This scenario also applies to distribution main lines. The source pole is wood, composite, or concrete. There are no crossings and there are no parallel lines that can cause hazardous induction. The work is to pull up and dead-end newly installed conductor(s) of a new line section to the source pole at the primary level.

Procedure:

STEP 1. Clean and ground the new line conductors being dead-ended. The bracket grounds shall be installed as close as practicable to the work site, for example, (at the next pole);

STEP 2. Apply adequate cover to the energized conductors on the source pole;

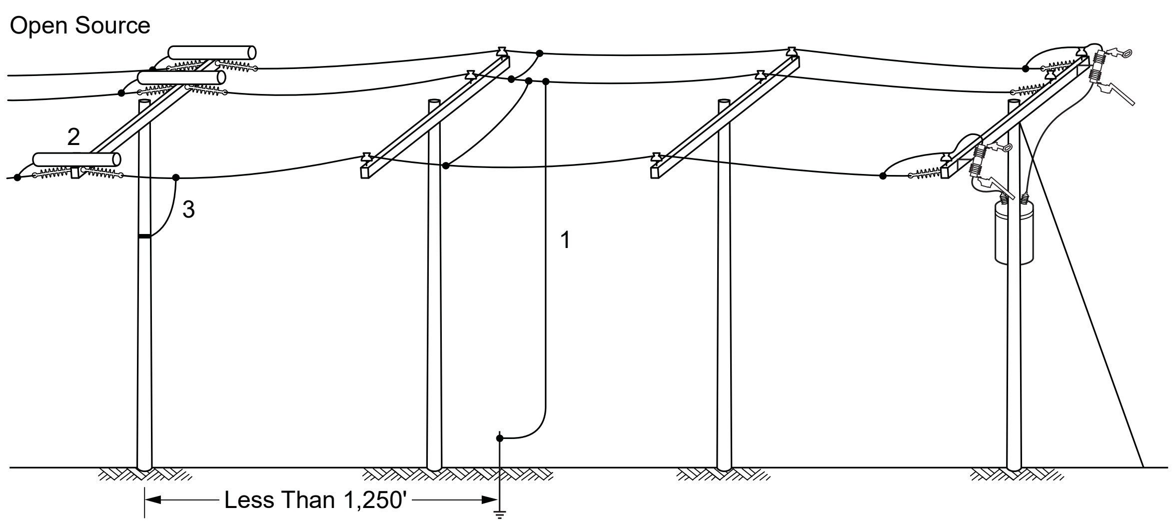
STEP 3. Create a workspace EPZ at the source pole:

STEP 3.1 When the work site is within 1,250 feet of a bracket ground, then install a pole band and one shunt from the pole band to first phase that is pulled up to the source pole. The first phase conductor shall be continuous to the bracket grounds. All other conductors being dead-ended are not required to be shunted to the pole band; and/or,

STEP 3.2 When the work site is located more than 1,250 feet from the bracket ground, then install a pole band and shunt(s) from the pole band to all phases being pulled up to the source pole.

STEP 4. After the first phase has been dead-ended at the source pole, handling conductors on the ground would either require an EPZ or high voltage rubber gloves to move, inspect, and transfer distribution conductors. EPZ on the ground can be created by use of an EPZ mat, anchor rod, or temporary ground rod(s) and shunts provided the workspace is within ten feet of the rod(s). While using high voltage rubber gloves the worker shall not contact the conductor with any part of their body.

Figure 4–72: Overhead Equipotential Bracket Grounding Method — Example 22



4.15.17 Overhead Equipotential Bracket Grounding Method — Removing Existing Conductors Permanently.

This scenario illustrates removing existing conductors of a distribution tap line permanently. This scenario also applies to distribution main lines. The source pole is wood, composite, or concrete. There are no crossings and there are no parallel lines that can cause hazardous induction.

Procedure:

STEP 1. Open Source(s),

STEP 2. Eliminate all backfeed per APM, Rule 149,

STEP 3. Issue/take a clearance per APM, Rule 105,

STEP 4. Clean, test, and ground the line. Install bracket grounds to protect from all sources. For work on the source pole the bracket grounds shall be installed as close as practicable to the work site, for example, (at the next pole);

STEP 5. Apply adequate cover to the energized conductors on the source pole;

STEP 6. Create a workspace EPZ at the source pole:

- STEP 6.1 When the work site is within 1,250 feet of a bracket ground, then install a pole band and one shunt from the pole band to one phase on the source pole. The phase conductor shunted to the pole band shall be continuous to the bracket grounds. All other phases being removed from the source pole are not required to be shunted to the pole band; and/or,
- STEP 6.2 When the work site is located more than 1,250 feet from the bracket ground, then install a pole band and shunt(s) from the pole band to all phases being removed from the source pole.

STEP 7. Remove conductor from source structure, EPZ must be maintained at source structure until last conductor is removed.

STEP 8. When handling grounded conductor(s) on the ground, create an EPZ or use high voltage rubber gloves. EPZ on the ground can be created by use of an EPZ mat, anchor rod, or temporary ground rod(s) and shunts provided the workspace is within ten feet of the rod(s). While using high voltage rubber gloves the worker shall not contact the conductor with any part of their body.

STEP 9. Once all sources have been eliminated, grounds are no longer required for the removal of the remaining lines and equipment.

Figure 4–73: Overhead Equipotential Bracket Grounding Method — Example 23

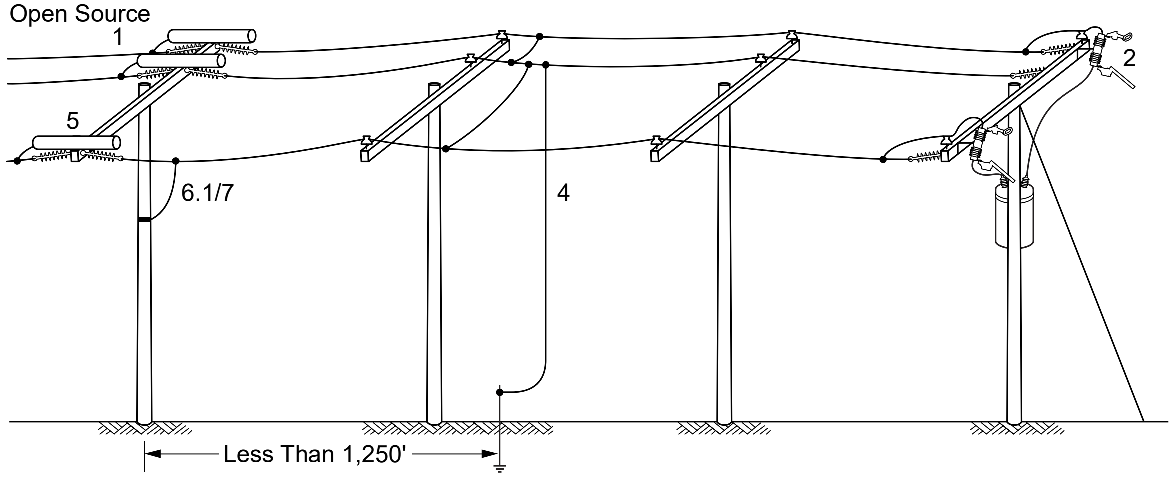


Figure 4–74: Overhead Equipotential Bracket Grounding Method — Example 24

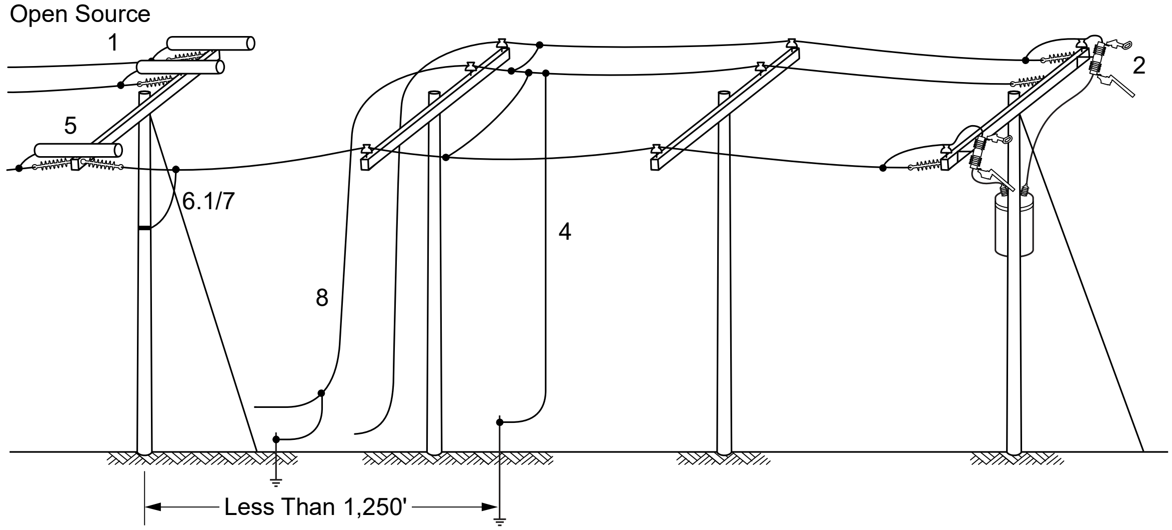
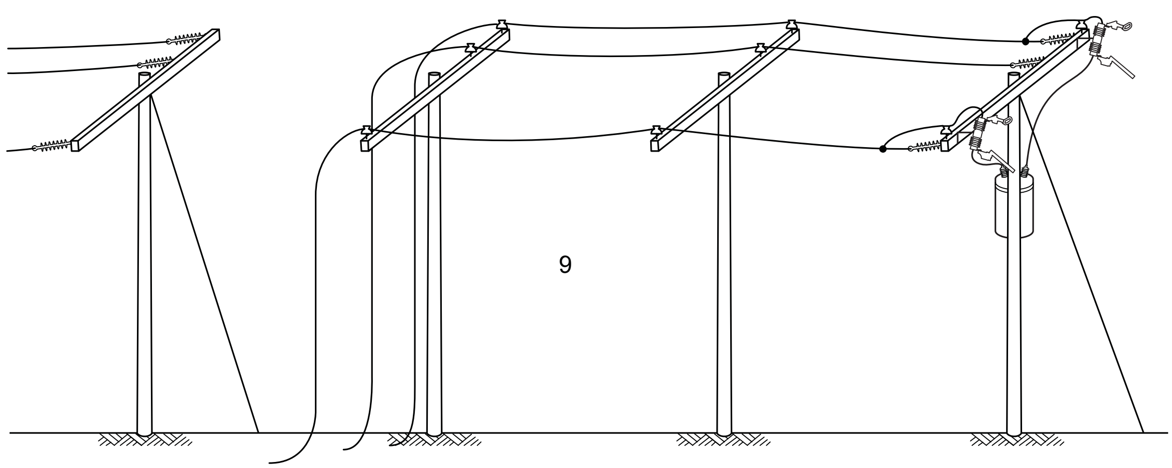


Figure 4–75: Overhead Equipotential Bracket Grounding Method — Example 25



4.15.18 Overhead Equipotential Bracket Grounding Method — Adding and Splicing Conductor(s) from an Insulated Aerial Device on a Distribution Line

This scenario illustrates adding wire and splicing conductor(s) from an insulated aerial device on a distribution main line. This scenario is also applicable to distribution tap line. The wire has been cut in the clear and is hanging down and away from both structures. The work will be done without encroaching on any structure. If the worker were to encroach on any structure a workspace EPZ would be required. The line is not located within a Transmission corridor and there are no parallel lines that can cause hazardous induction. Also, there is no crossing between the work site and the bracket ground(s).

Procedure:

STEP 1. Open sources;

STEP 2. Eliminate Backfeed per APM Rule 149;

STEP 3. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply. The grounds shall be no more than 1,250 feet from the work site;

NOTE The worker on the ground can handle and send a section of wire that is not connected to the system to be spliced/added to the insulated bucket without the use of an EPZ or high voltage rubber gloves.

STEP 4. To add wire to the conductor from an insulated aerial device, utilize one of the following 4 options:

- STEP 4.1 Use high voltage rubber gloves to add wire. Do not allow conductors to contact any part of the body when using high voltage rubber gloves; or
- STEP 4.2 Apply an approved ground using approved live line tools prior to getting between the wire and conductor. Then, the wire can be added without using live line tools or high voltage rubber gloves; or
- STEP 4.3 Attach an approved ground from the conductor supported by the structure to the wire on the ground. Then the wire can be added without using live line tools or high voltage rubber gloves; or
- STEP 4.4 Install a pole band with one approved ground to the conductor and another approved ground to the wire on the ground. Then the wire can be added without using live line tools or high voltage rubber gloves.

STEP 5. Once the wire has been attached to the conductor, an EPZ or high voltage rubber gloves would be required to handle the conductor on the ground. EPZ on the ground can be created by use of an EPZ mat, anchor rod, or temporary ground rod(s) and approved grounds provided the workspace is within ten feet of the rod(s). While using high voltage rubber gloves the worker shall not contact the conductor with any part of their body;

STEP 6. To splice conductors for distribution main line:

STEP 6.1 The conductor can be spliced without applying an approved ground across the conductor prior to splicing as long as the distance between bracket grounds is less than 2,500 feet and a conductor is continuous between bracket grounds.

STEP 6.2 When there is no continuous conductor between bracket grounds, an approved ground shall be installed across the first conductor using approved live line tools prior to splicing as long as the distance between bracket grounds is less than 2,500 feet.

STEP 6.3 When the distance between bracket grounds is more than 2,500 feet, an approved ground shall be installed across all conductors to be spliced.

STEP 7. For distribution tap line, an approved ground shall be installed prior to splicing the conductor. Utilize one of the following two options:

STEP 7.1 Install an approved ground across the two conductors to be spliced; or,

STEP 7.2 Install an approved ground from a grounded conductor to the ungrounded conductor to be spliced.

Figure 4–76: Overhead Equipotential Bracket Grounding Method — Example 26 — Adding Wire, Distribution Main Line

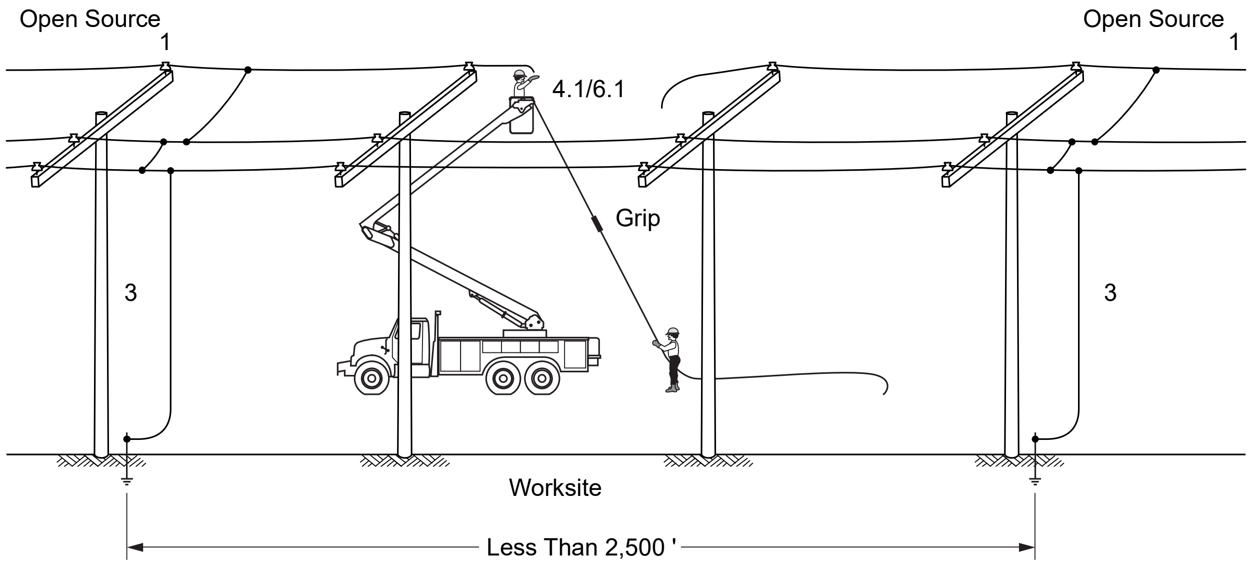


Figure 4–77: Overhead Equipotential Bracket Grounding Method — Example 27 — Splicing Wire, Distribution Main Line

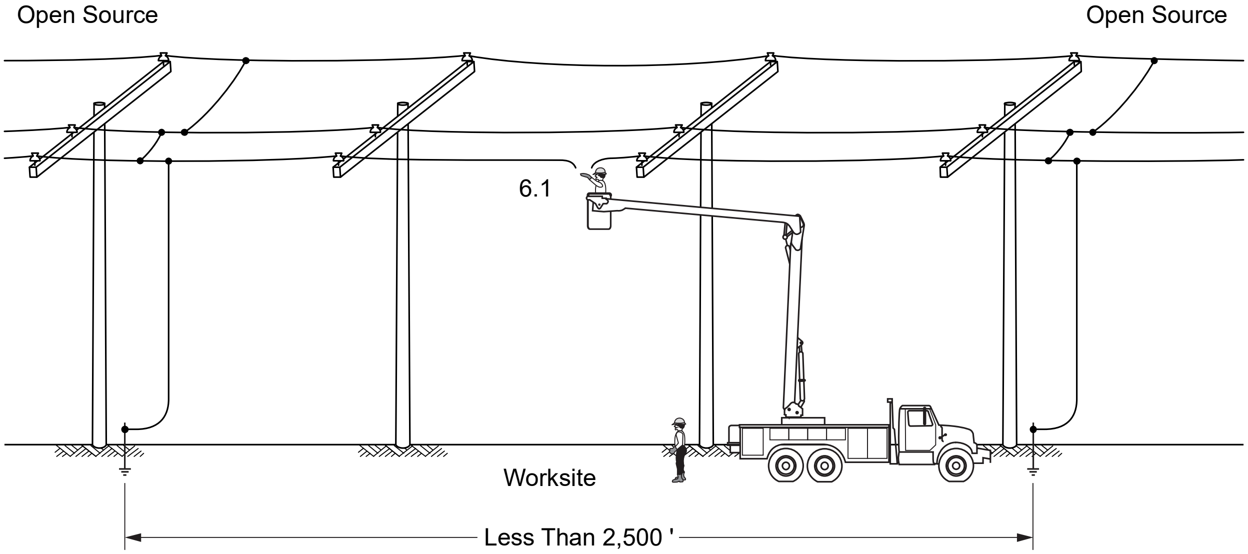
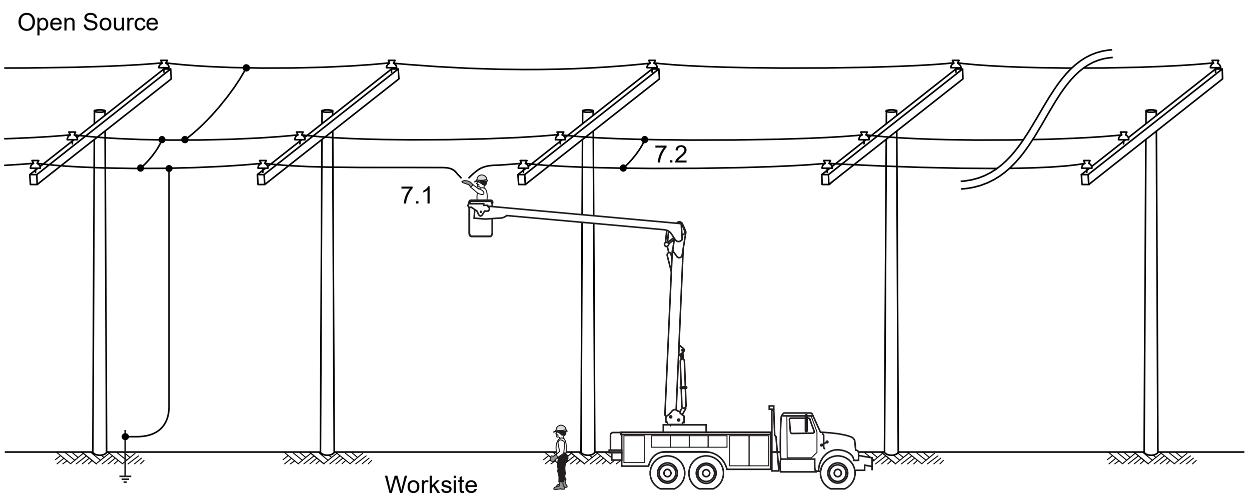


Figure 4–78: Overhead Equipotential Bracket Grounding Method — Example 28 — Splicing Wire, Distribution Tap Line



4.16 Removal of Taps for Distribution

Overhead Bracket Grounding Method requires source(s) to be isolated. Physically removing taps are required in order to isolate distribution sources.

Taps shall be removed completely.

Exception: For long-lead taps (that is vertical construction, line/buck construction), minimum of three feet shall be removed, provided:

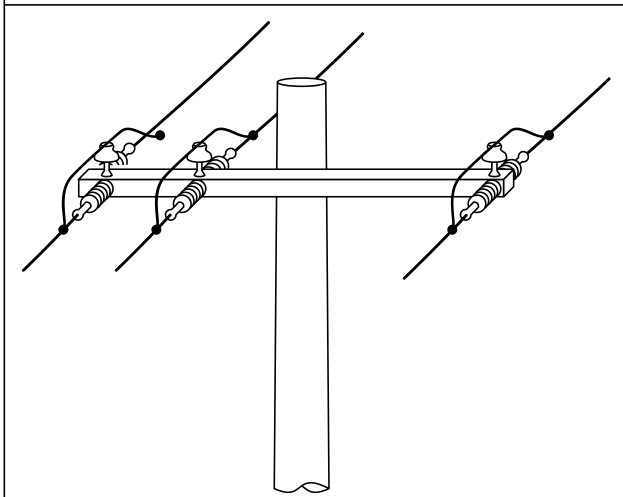
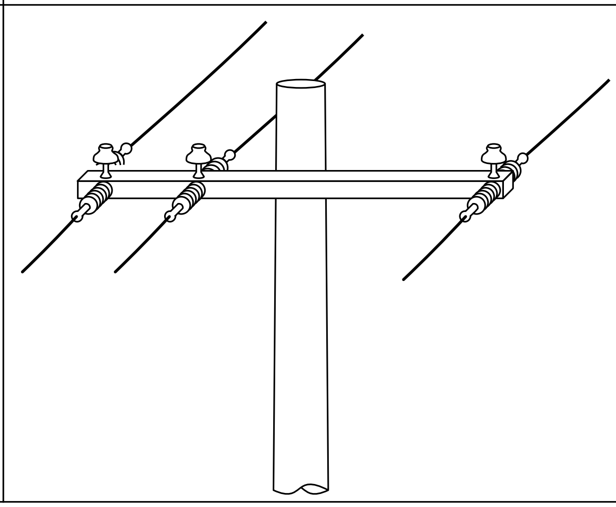
- The remaining tap length(s) to the first point of support is less than 12 inches, and
- A clear distance equal to or more than minimum approach distance is created.

NOTE

In specific circumstances removal of long-lead taps may pose an unnecessary hazard which can be minimized by the preceding exception. However, complete removal of long-lead taps is preferred to minimize number of connectors.

When installing isolators, remove a section of the conductor so the ends cannot touch. Bend conductors back towards the line to create a physical separation at least equal to the length of the insulator.

On the following pages are examples of approved options to remove taps.

Taps In:	Taps Removed:
	

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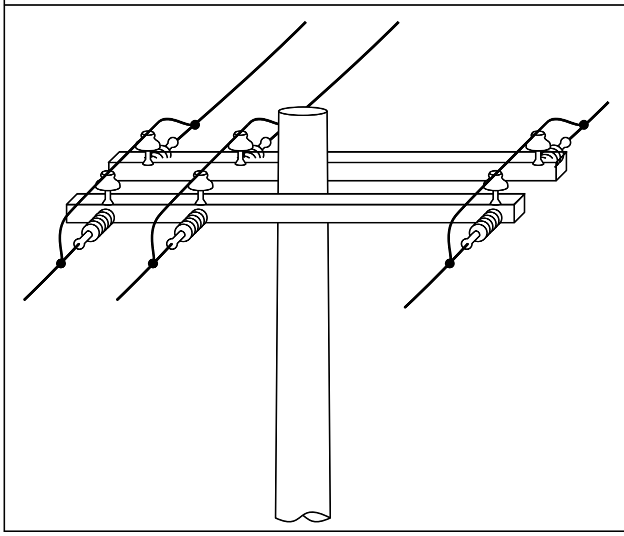	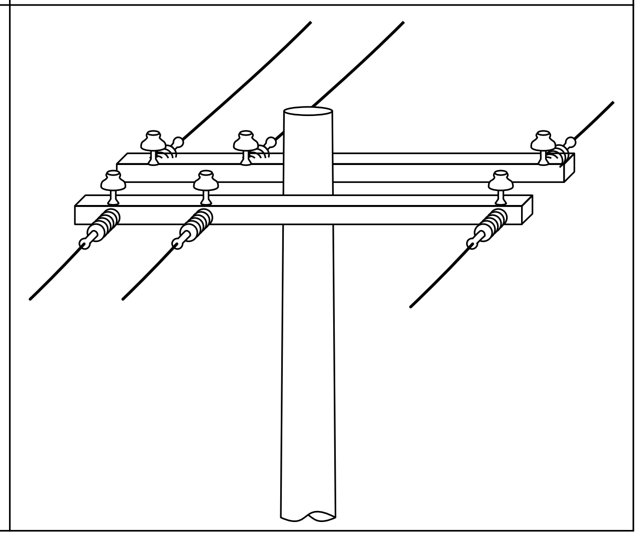

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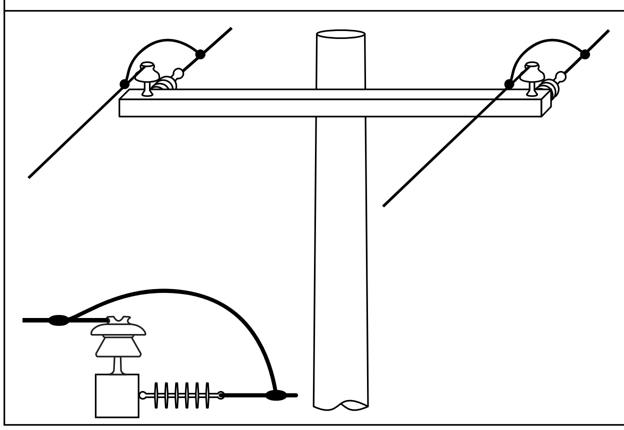	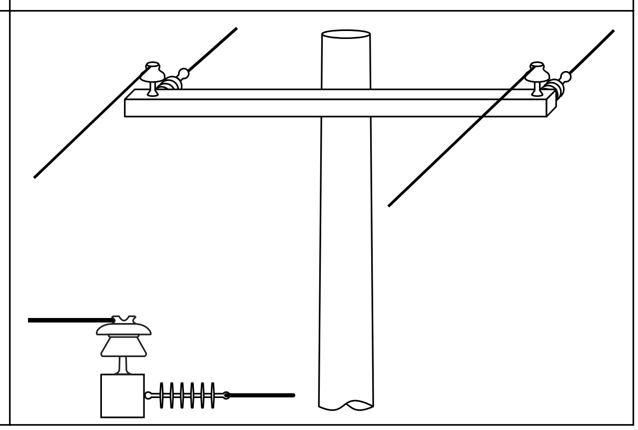

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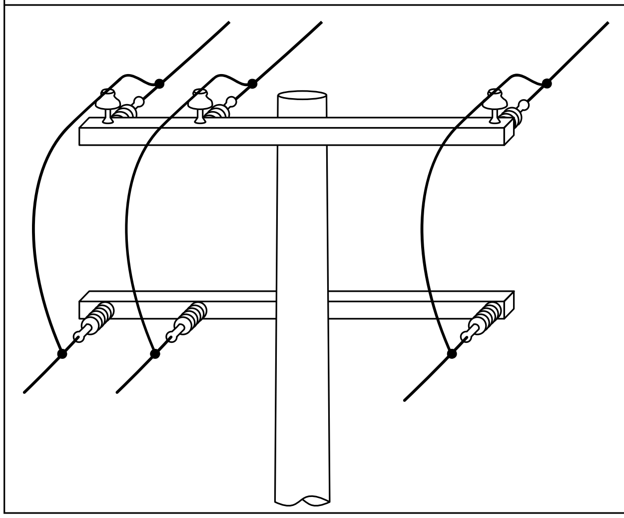
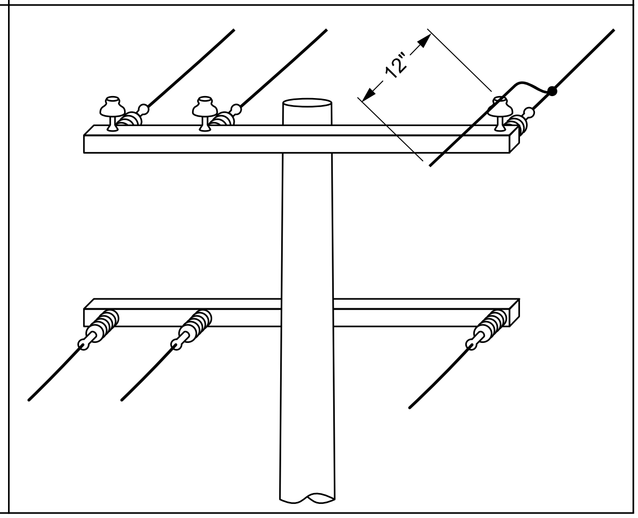
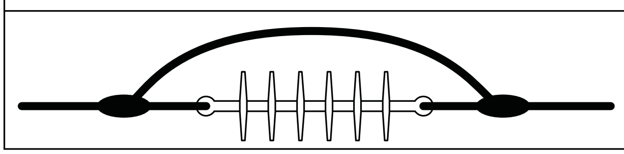


Taps Removed:



Taps In:



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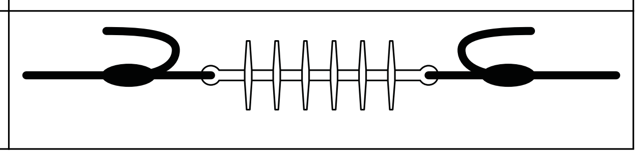

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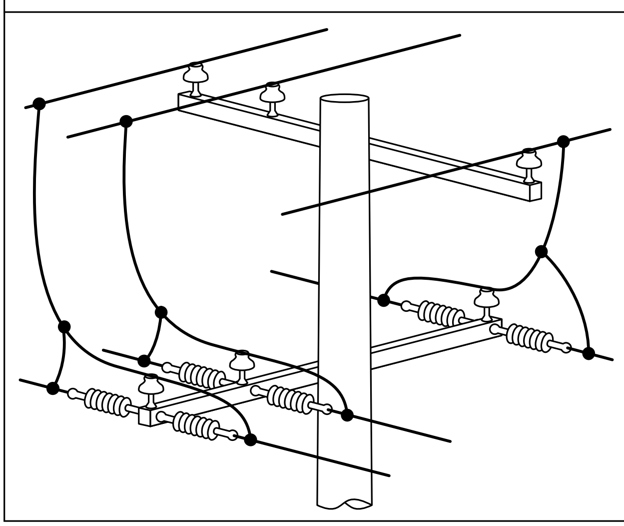

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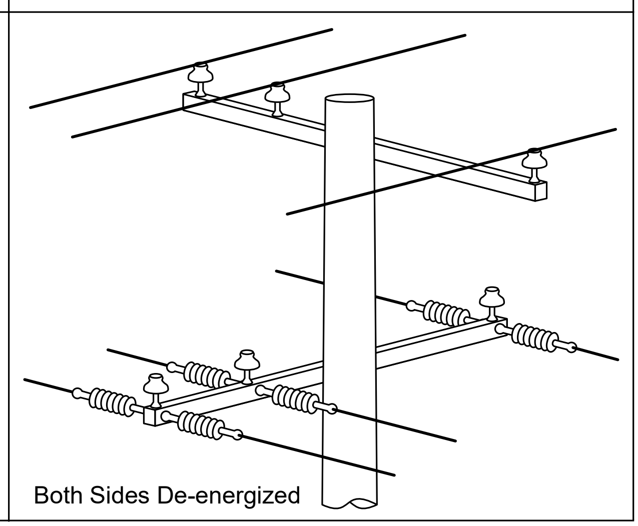
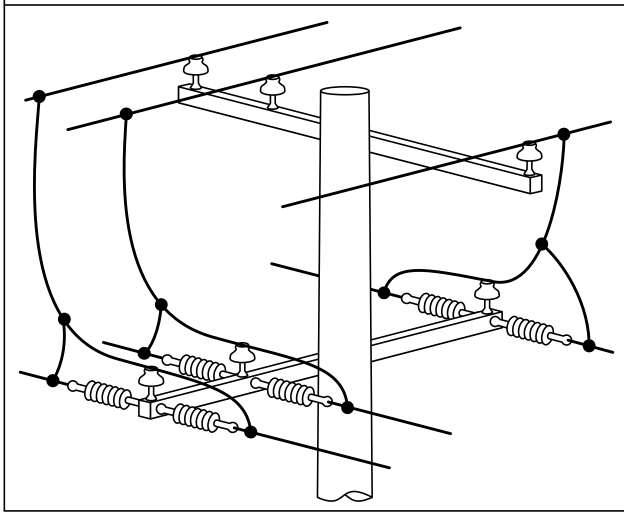
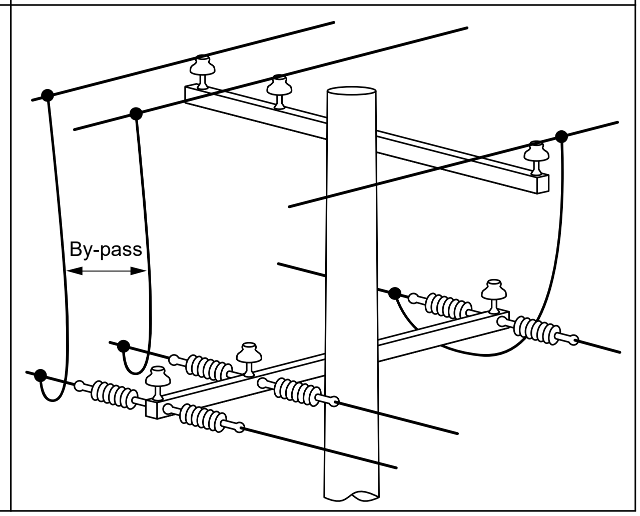


NOTE

When one side is needed to be kept energized, bypasses can be used.

Taps In:	Taps Removed and By-pass Installed:
	

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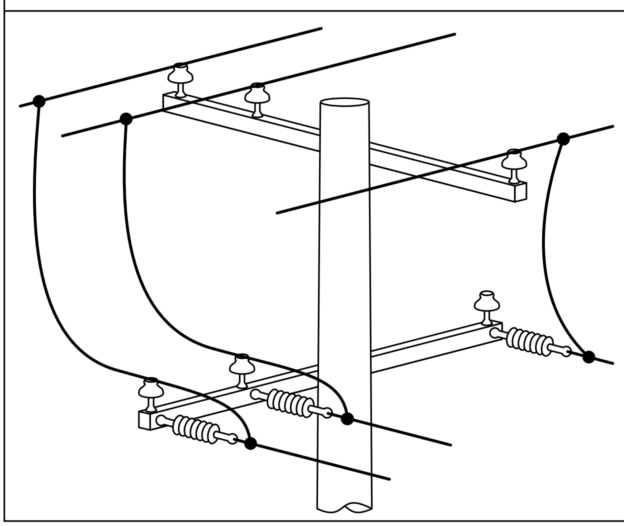	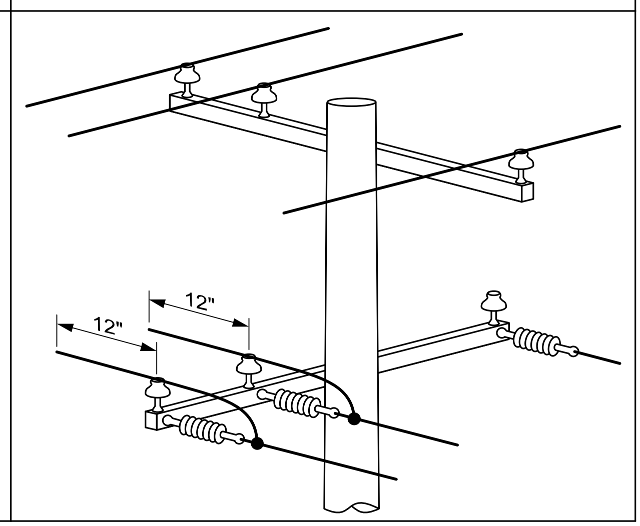

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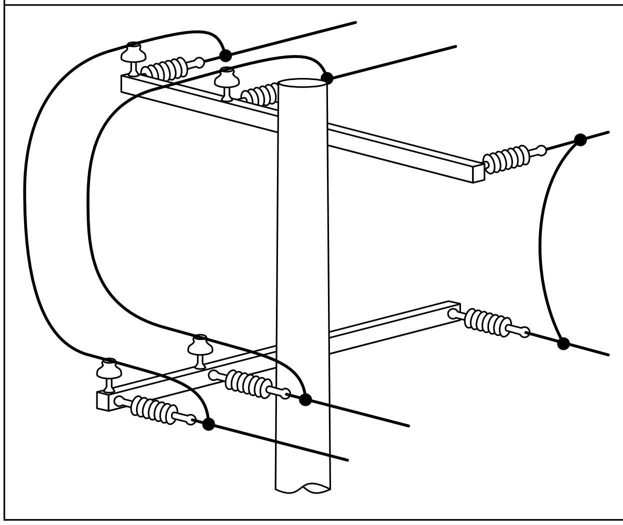	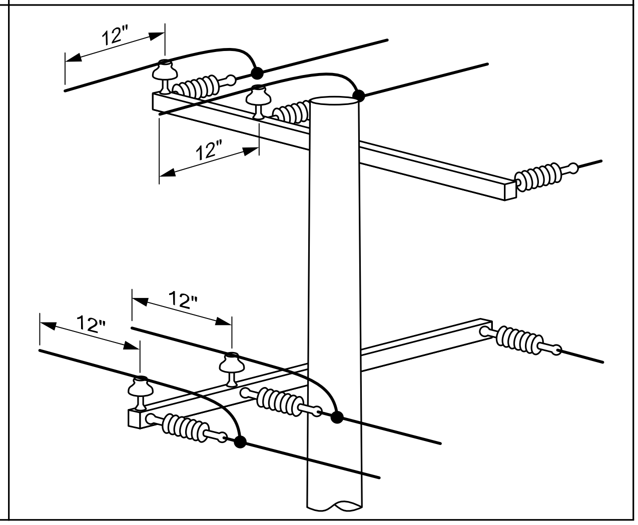

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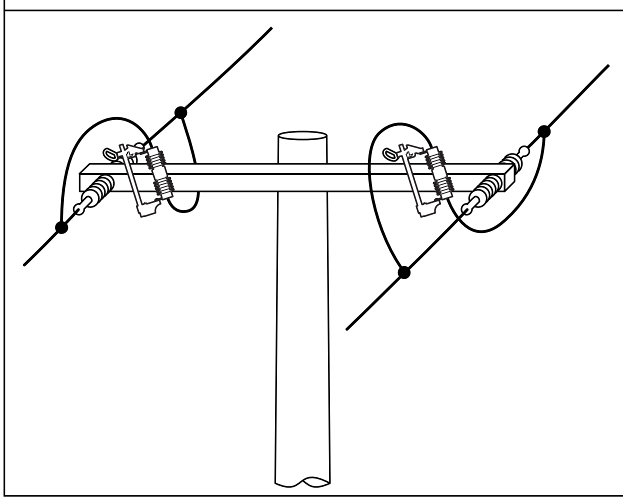	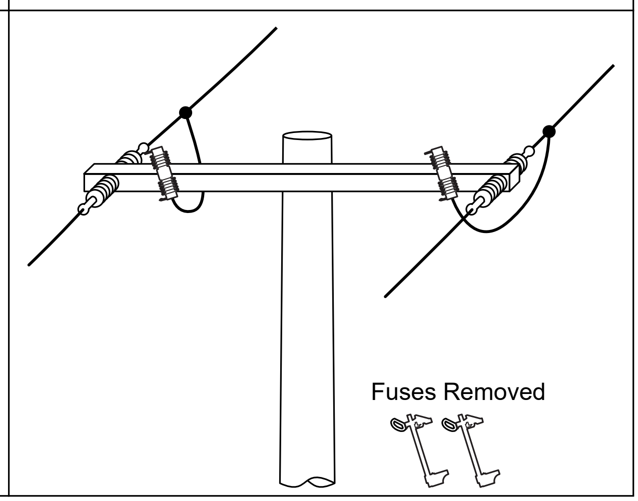

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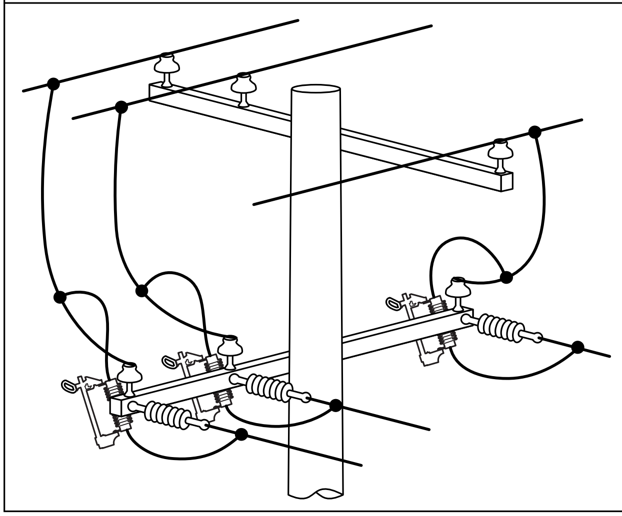	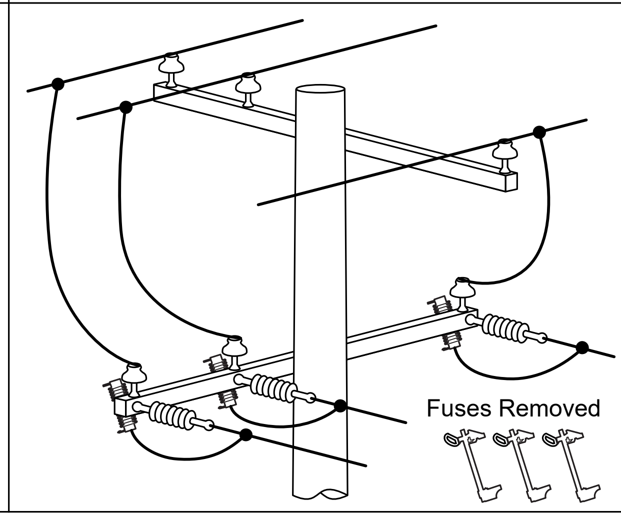

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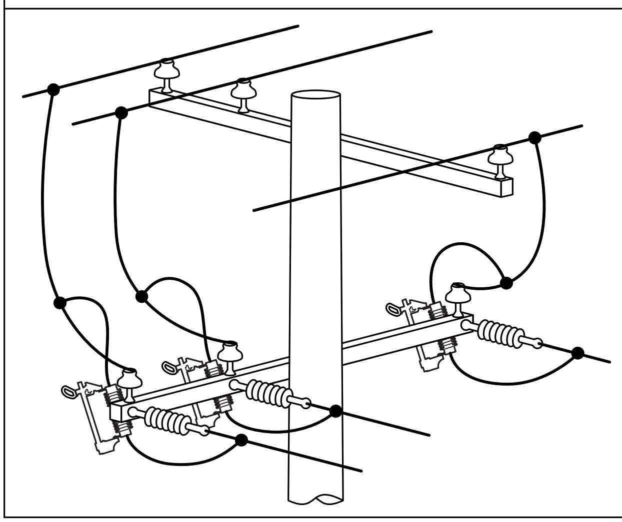	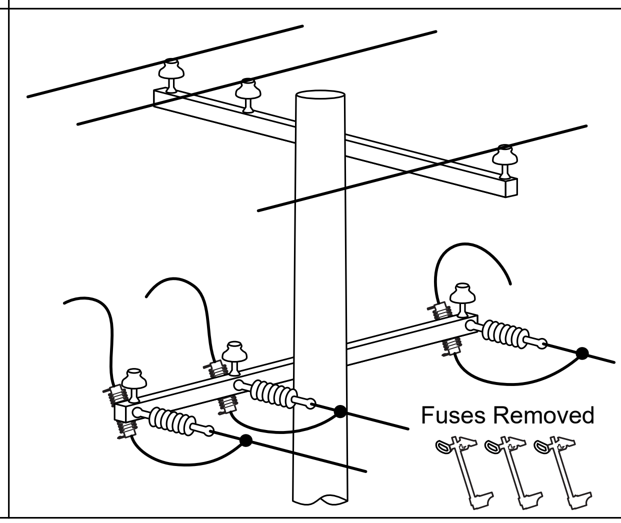

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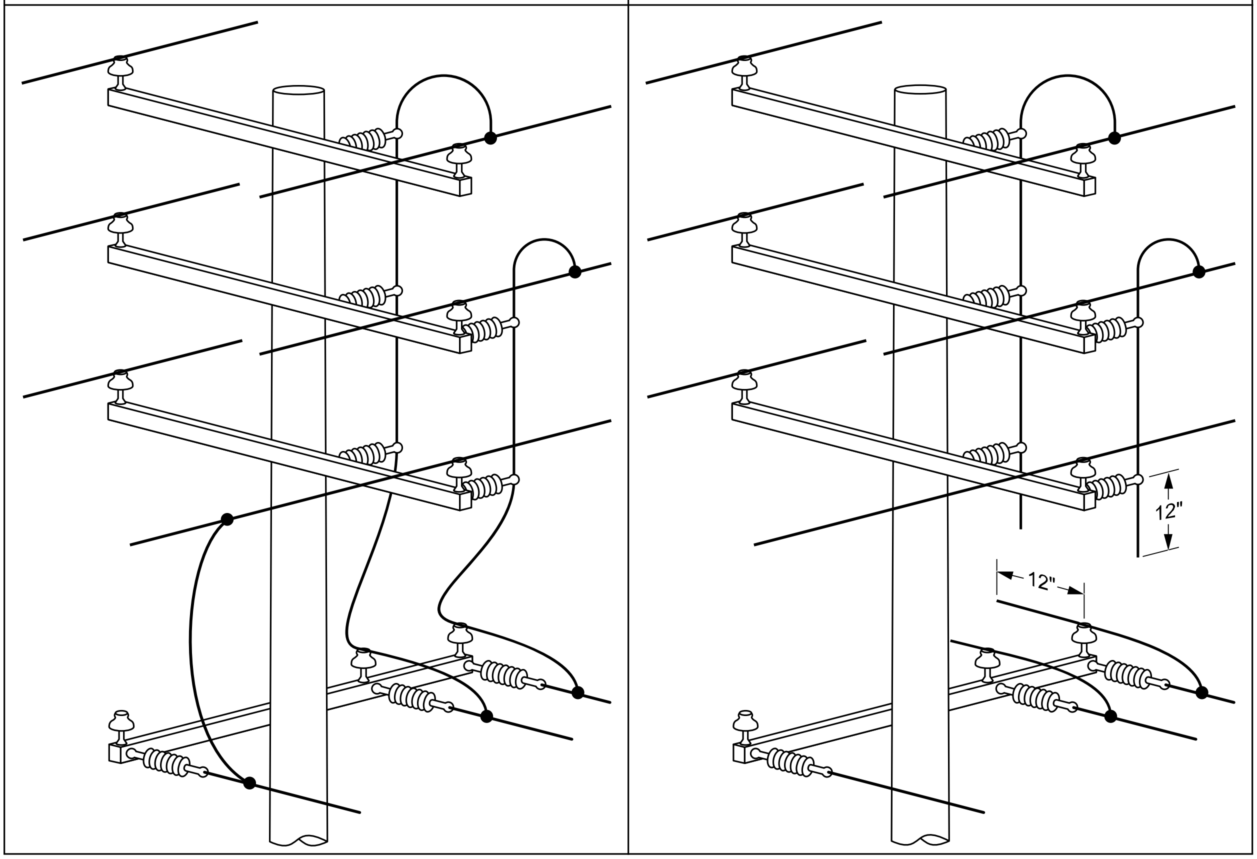
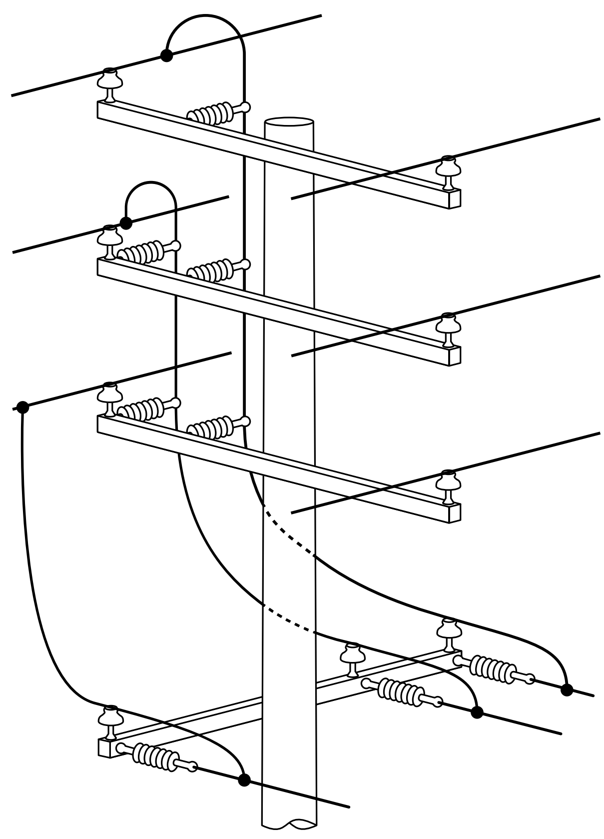
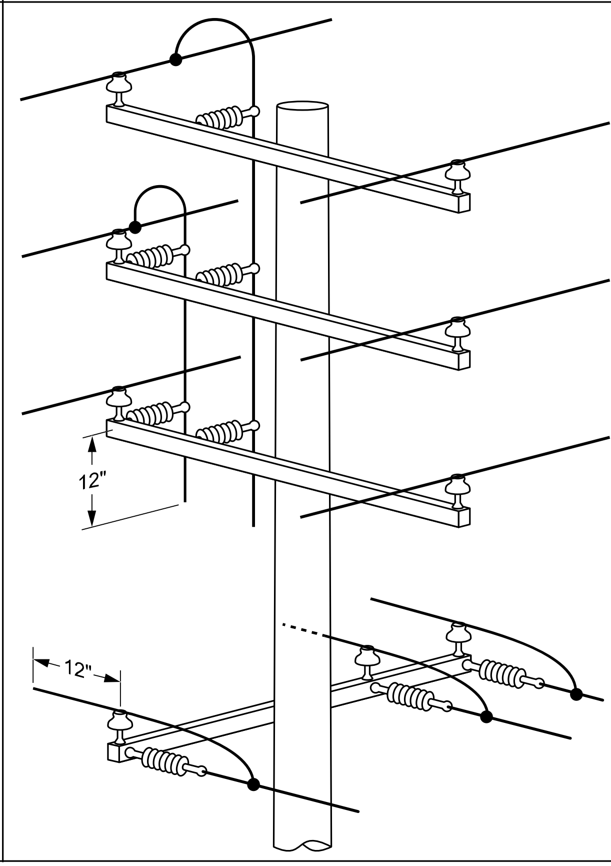


Taps In:	Taps Removed:
	

4.17 Grounding Scenarios using Overhead Bracket Grounding Method

Overhead Equipotential Bracket Grounding Method is the preferred method and may be used in all grounding scenarios whether the sources are open or isolated.

Overhead Bracket Grounding method is applicable when sources (breakers, fuse, switch, or taps) are isolated. This method is achieved by applying a set of grounds between the work site and each isolated source and each crossing. Additional grounds may be needed when induction exists that can cause a hazardous difference of electrical potential.

This section contains grounding examples and illustrations that show proper use of Overhead Bracket Grounding Method.

4.17.1 Overhead Bracket Grounding Method — Distribution Main Line

This scenario illustrates working on multiple poles of a main distribution line to replace crossarms and insulators. The crew will perform any required work on the source pole after completion of the work between bracket grounds. The poles are wood, composite, or concrete. There are no crossings.

Procedure:

STEP 1. Isolate sources by physically removing the tap(s),

STEP 2. Adequately protect the source with approved protective devices. Energized conductors on the source pole shall be covered using approved protective devices such that there are no exposed energized source conductor(s),

STEP 3. Install a sign [tag (SCE161-T-P2-T94)], and issue/take a clearance per APM, Rule 105 for the distribution circuit,

STEP 4. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply. Grounds installed at or near the work site are preferred:

- STEP 4.1 When there is no energized parallel line, grounds shall not be more than 2,500 feet apart and more than 1,250 feet from the work site; or,
- STEP 4.2 When there is an energized parallel line, grounds shall not be more than 300 feet from the work site.

STEP 5. Exercise caution when utilizing this procedure where there is a ground within the work area on the structure. Always avoid getting between differences of ground potentials. If there are external ground(s) within the work area, options are:

- STEP 5.1 Bond/shunt external ground(s) attached to the pole to the conductors being worked on;
- STEP 5.2 Cover exposed external grounds within reach;
- STEP 5.3 Do not make contact with exposed external ground(s) while in contact with the conductor(s); or,
- STEP 5.4 Create a workspace EPZ and bond external grounds within the workspace to the pole band.

STEP 6. No work shall be performed on the source pole(s), (that is dead-ending conductors or installing taps) while work is in progress between bracket grounds, and vice versa. In addition no work shall be performed on multiple source poles simultaneously following Overhead Bracket Grounding Method.

STEP 7. When the work between bracket grounds has been completed the first source pole can be worked, for example, (dead-ending conductors or installing taps), provided there is a set of approved grounds installed as close as practicable to the source pole. A workspace EPZ will not be needed on the source pole provided one of the following conditions is met.

STEP 7.1 Bracket grounds are within 1,250 feet of the work site and there are no energized parallel lines; or,

STEP 7.2 Bracket grounds are within 300 feet of the work site and there are energized parallel lines.

STEP 8. When the work is completed on the source pole and when the source is no longer isolated, for example, (taps installed), work on the de-energized line shall be performed utilizing Overhead Equipotential Bracket Grounding Method. This is necessary since taps were installed at the first source pole; the source is no longer isolated. You now have an open source which requires an EPZ.

STEP 9. In order to work multiple source poles simultaneously Overhead Equipotential Bracket Grounding Method shall be used.

See Figure 4–79 through Figure 4–81 for illustrations.

Figure 4–79: Overhead Bracket Grounding Method — Example 1

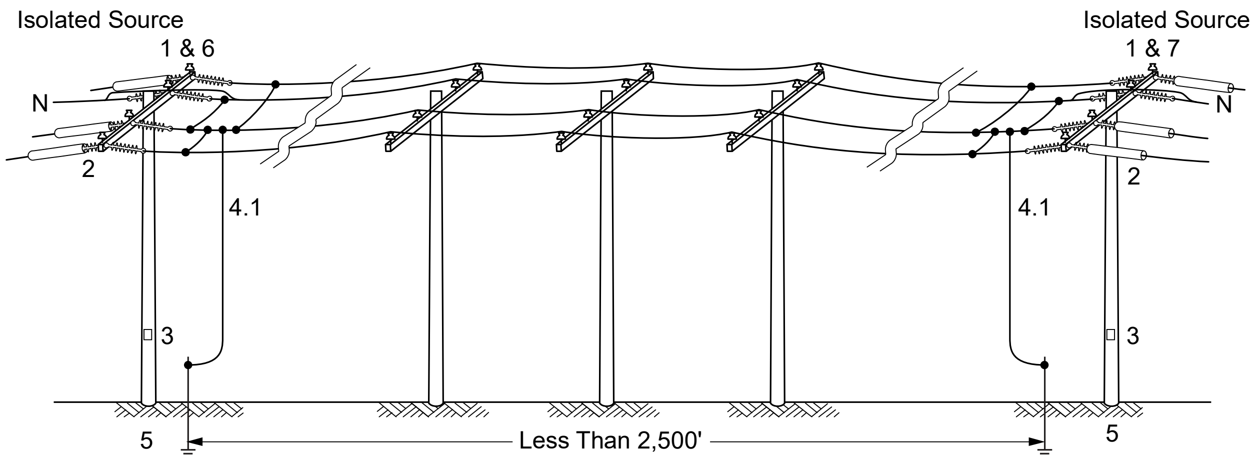


Figure 4–80: Overhead Bracket Grounding Method — Example 2

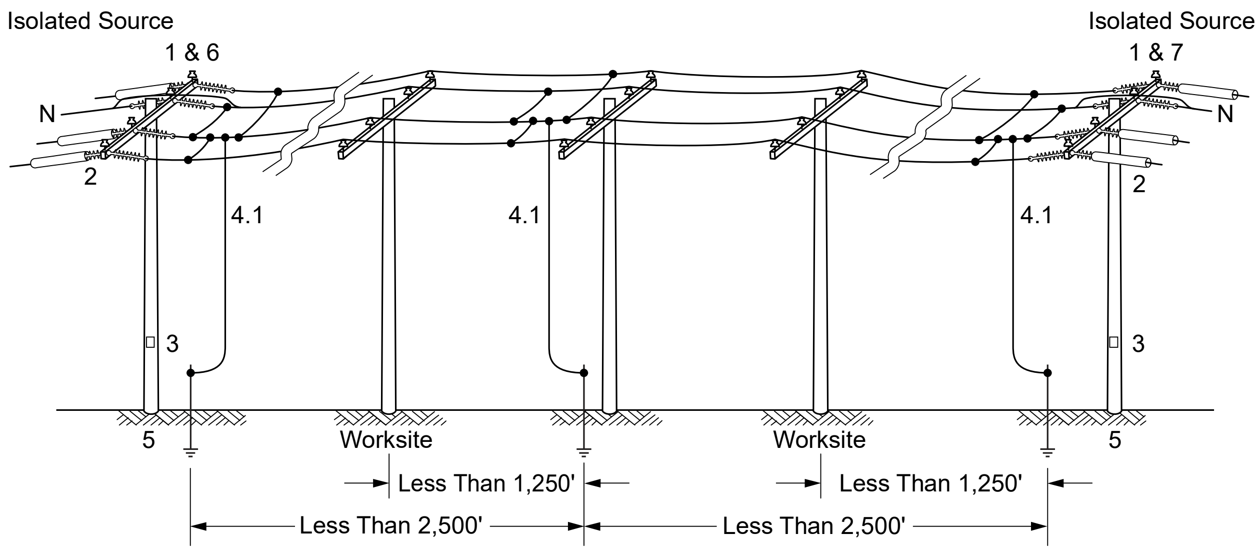
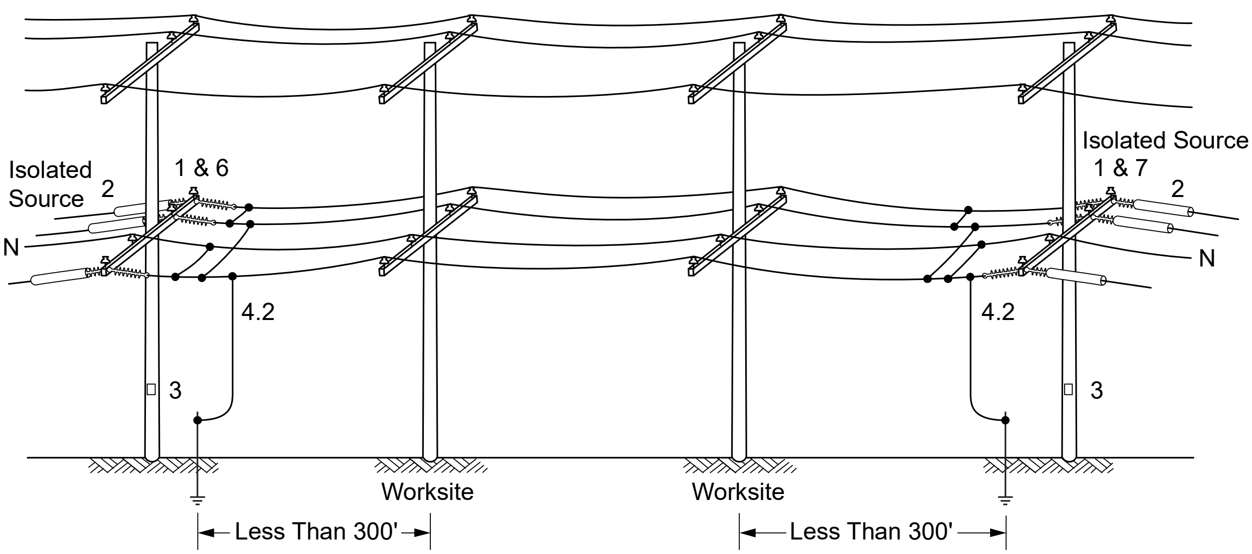


Figure 4–81: Overhead Bracket Grounding Method — Example 3



4.17.2 Overhead Bracket Grounding Method — Working on a Source Pole

This scenario illustrates working on a source pole of a distribution line. The source pole is wood, composite, or concrete. There are no crossings and there are no parallel lines that can cause hazardous induction. The work is to add wires, pull up, and dead-end all conductors to the source pole.

APM, Rule 207e states: "work shall not be performed on downed overhead lines until they have been proven de-energized and grounded as provided in Rule 141, unless they are being cut in the clear, with approved live-line tools, to protect from personal injury."

Procedure:

STEP 1. Isolate sources by physically removing the tap(s),

STEP 2. Adequately protect the source with approved protective devices. Energized conductors on the source pole shall be covered using approved protective devices such that there are no exposed energized source conductor(s),

STEP 3. Install a sign [tag (SCE161-T-P2-T94)], and issue/take a clearance per APM, Rule 105 for the distribution circuit,

STEP 4. Clean, test, and ground the line. Install a set of bracket grounds as close as practicable to the source pole, for example, (at next pole).

STEP 5. Ensure the bracket ground(s) is between the work site and backfeed sources. Otherwise, eliminate backfeed per APM, Rule 149.

STEP 6. Exercise caution when utilizing this procedure where there is a ground within the work area on the structure. Always avoid getting between differences of ground potentials. When there are external ground(s) within the work area, options are:

- STEP 6.1 Bond/shunt external ground(s) attached to the pole to the conductors being worked on;
- STEP 6.2 Cover exposed external grounds within reach;
- STEP 6.3 Do not make contact with exposed external ground(s) while in contact with the conductor(s); or,
- STEP 6.4 Create a workspace EPZ and bond external grounds within the workspace to the pole band.

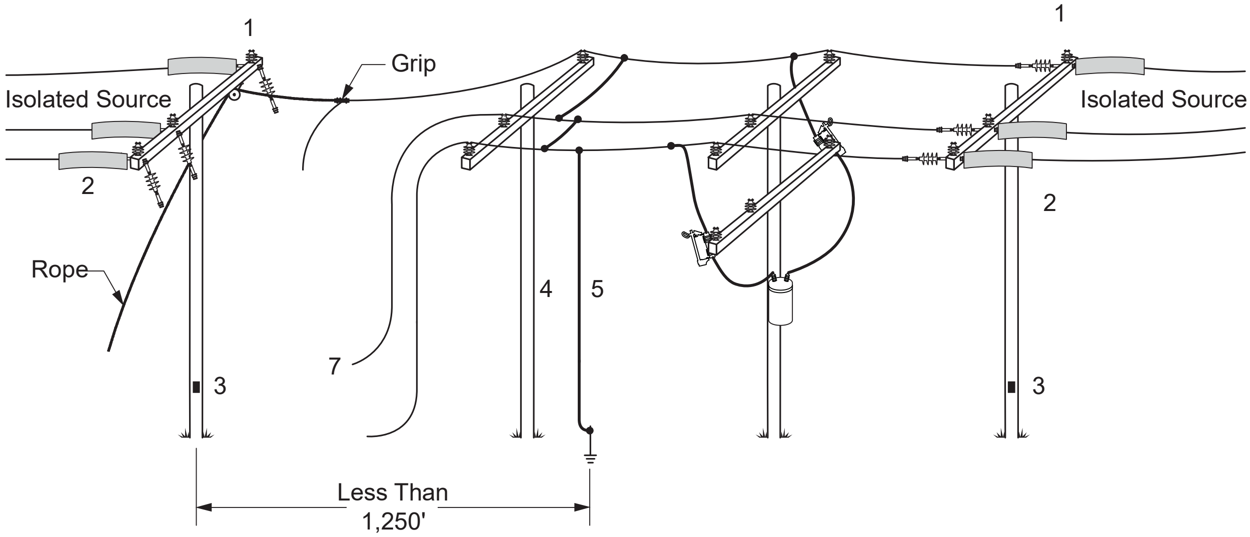
STEP 7. When moving/inspecting/adding/splicing wire on downed conductors on the ground an EPZ would not be required when no work is being performed on the source pole and one of the following conditions is met:

- STEP 7.1 Bracket grounds are within 1,250 feet of the work site and there are no energized parallel lines; or,
- STEP 7.2 Bracket grounds are within 300 feet of the work site and there are energized parallel lines.

STEP 8. When the conductors are raised and being attached to the source pole, workspace EPZ is not required on the pole when the grounds are within 1,250 feet of the work site.

STEP 9. After dead ending the first phase to the source pole, moving/inspecting/adding/splicing wire on downed conductors on the ground would not require an EPZ or high voltage rubber gloves, when no work is being performed on the source pole and the grounds are within 1,250 feet of the work site.

Figure 4–82: Overhead Bracket Grounding Method — Example 4



4.17.3 Overhead Bracket Grounding Method — Working on Multiple Circuits

This scenario illustrates working on multiple poles of two main distribution lines in parallel. The poles are wood, composite, or concrete. There are no crossings and there are no parallel energized lines that can cause hazardous induction.

The scenario is similar to working on a single circuit. For multiple circuits, the grounds shall be sized in accordance with the source with highest fault duty. In addition, each circuit shall be grounded independently from ground medium up (see Figure 4–53).

Procedure:

STEP 1. Isolate sources by physically removing the tap(s),

STEP 2. Adequately protect the source with approved protective devices. Energized conductors on the source pole shall be covered using approved protective devices such that there are no exposed energized source conductor(s),

STEP 3. Install a sign [tag (SCE161-T-P2-T94)], and issue/take a clearance per APM, Rule 105 for the distribution circuit,

STEP 4. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply. Grounds shall not be more than 2,500 feet apart and more than 1,250 feet from the work site. Grounds installed at or near the work site are preferred.

STEP 5. Ground mediums should be shared when grounding multiple circuits to prevent from getting in between hazardous difference of electrical potential. If ground mediums are not shared, circuits shall be bonded to each other at the work location if you can get in between the two circuits.

STEP 6. Exercise caution when utilizing this procedure where there is a ground within the work area on the structure. Always avoid getting between differences of ground potentials. When there are external ground(s) within the work area, options are:

STEP 6.1 Bond/shunt external ground(s) attached to the pole to the conductors being worked on;

STEP 6.2 Cover exposed external grounds within reach;

STEP 6.3 Do not make contact with exposed external ground(s) while in contact with the conductor(s); or,

STEP 6.4 Create a workspace EPZ and bond external grounds within the workspace to the pole band.

STEP 7. No work shall be performed on the source pole(s), (i.e. conductors or taps) while work is in progress between bracket grounds, and vice versa. In addition no work shall be performed on multiple source poles simultaneously following Overhead Bracket Grounding Method.

STEP 8. When the work between bracket grounds has been completed the first source pole can be worked, for example, dead-ending conductors, installing taps, provided there is a set of approved grounds installed as close as practicable to the source pole. A workspace EPZ will not be needed on the source pole provided one of the following conditions is met.

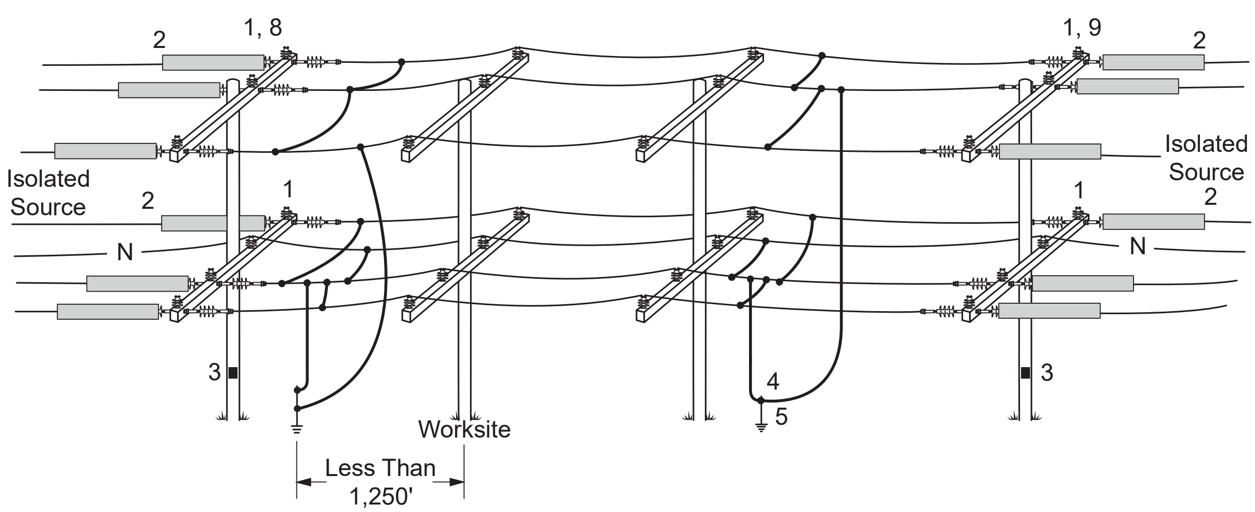
STEP 8.1 Bracket grounds are within 1,250 feet of the work site and there are no energized parallel lines; or,

STEP 8.2 Bracket grounds are within 300 feet of the work site and there are energized parallel lines.

STEP 9. When the work is completed on the source pole and when the source is no longer isolated, for example, taps installed, work on the de-energized line shall be performed utilizing Overhead Equipotential Bracket Grounding Method. This is necessary since taps were installed at the first source pole; the source is no longer isolated. You now have an open source which requires an EPZ.

STEP 10. In order to work multiple source poles simultaneously, Overhead Equipotential Bracket Grounding Method shall be used.

Figure 4–83: Overhead Bracket Grounding Method — Example 5



4.17.4 Overhead Bracket Grounding Method — Working on A Pole with Attached Crossing

This scenario illustrates working on a pole of a distribution line. The pole is wood, composite, or concrete. There are no parallel energized lines that can cause hazardous induction. The conductors on one side of the pole have been dropped to perform other work. The work is to pull up and dead-end all dropped conductors to the pole. The pole has an attached crossing.

Procedure:

STEP 1. Isolate sources by physically removing the tap(s),

STEP 2. Adequately protect the source with approved protective devices. Energized conductors on the source pole shall be covered using approved protective devices such that there are no exposed energized source conductor(s),

STEP 3. Install a sign [tag (SCE161-T-P2-T94)], and issue/take a clearance per APM, Rule 105 for the distribution circuit,

STEP 4. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply. Because the work will be performed under/over an attached crossing, one of the bracket grounds or an additional set of bracket grounds sized in accordance with Table 3–1 shall be installed at the work site or as close as practicable to the work site, for example, (at the next pole).

STEP 5. Exercise caution when utilizing this procedure where there is a ground within the work area on the structure. Always avoid getting between differences of ground potentials. When there are external ground(s) within the work area, options are:

- STEP 5.1 Bond/shunt external ground(s) attached to the pole to the conductors being worked on;
- STEP 5.2 Cover exposed external grounds within reach;
- STEP 5.3 Do not make contact with exposed external ground(s) while in contact with the conductor(s); or,
- STEP 5.4 Create a workspace EPZ and bond external grounds within the workspace to the pole band.

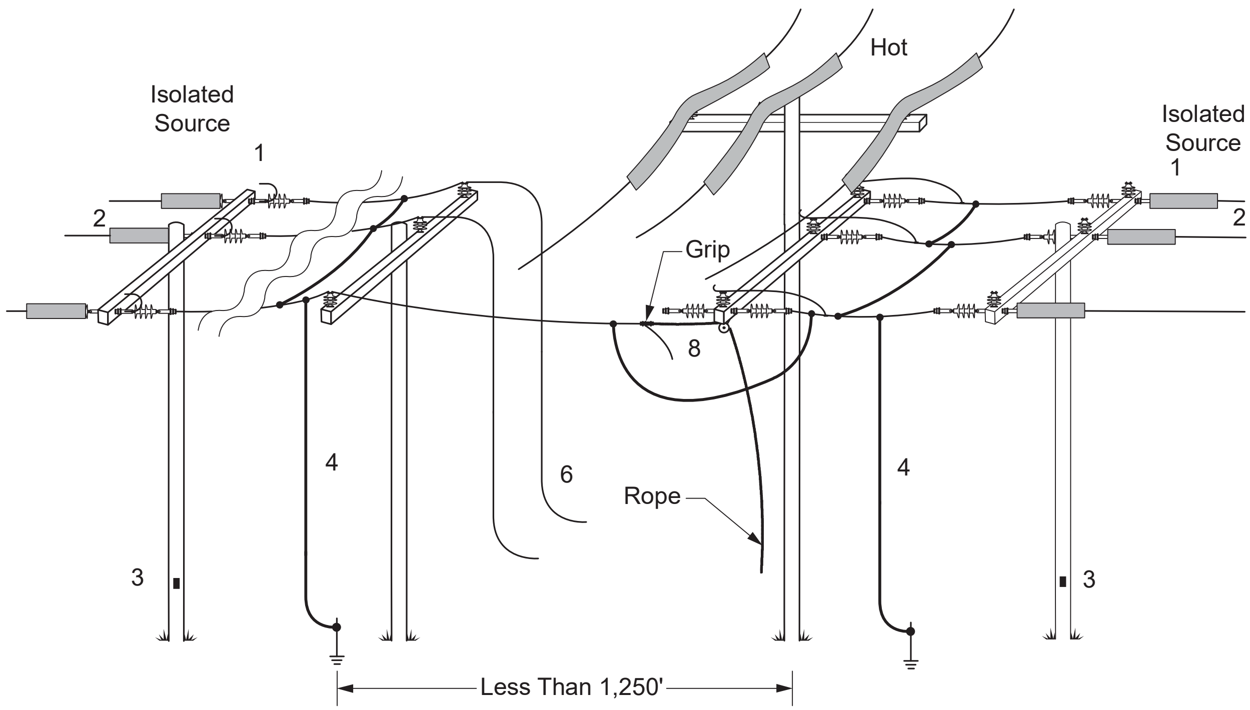
STEP 6. When moving/inspecting/adding/splicing wire on downed conductors on the ground an EPZ would not be required when no work is being performed on the source pole and one of the following conditions is met:

- STEP 6.1 Bracket grounds are within 1,250 feet of the work site and there are no energized parallel lines; or,
- STEP 6.2 Bracket grounds are within 300 feet of the work site and there are energized parallel lines.

STEP 7. When the conductors are raised and being attached to the pole, workspace EPZ is not required, when the grounds are within 1,250 feet of the work site.

STEP 8. Before closing any conductor that may be exposed to a hazardous difference of electrical potential approved jumpers shall be in place across the point to be closed to ensure continuity of the conductor by utilizing approved live-line tools.

Figure 4–84: Overhead Bracket Grounding Method — Example 6



4.17.5 Overhead Bracket Grounding Method — Handling Conductors on the Ground

This example illustrates handling conductors on the ground when using Overhead Bracket Grounding Method.

APM, Rule 207e States: "work shall not be performed on downed overhead lines until they have been proven de-energized and grounded as provided in Rule 141, unless they are being cut in the clear, with approved live-line tools, to protect from personal injury."

Procedure:

STEP 1. Isolate sources by physically removing the tap(s),

STEP 2. Adequately protect the source with approved protective devices. Energized conductors on the source pole shall be covered using approved protective devices such that there are no exposed energized source conductor(s),

STEP 3. Install a sign [tag (SCE161-T-P2-T94)], and issue/take a clearance per APM, Rule 105 for the distribution circuit,

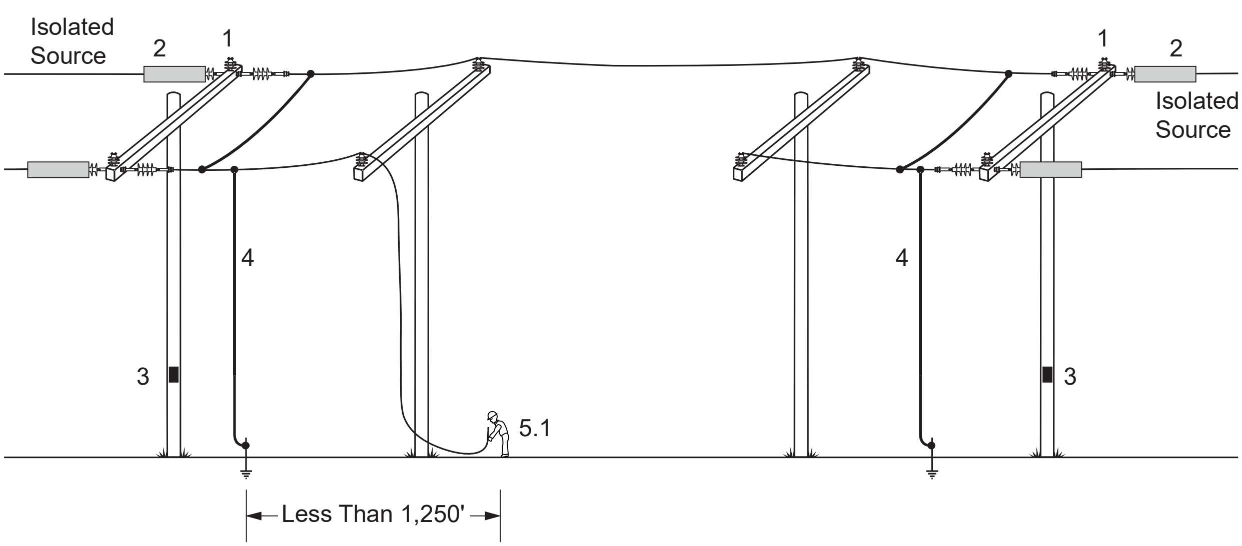
STEP 4. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply at or near the work site.

STEP 5. When moving/inspecting/adding/splicing wire on downed conductors on the ground an EPZ would not be required when no work is being performed on the source pole and one of the following conditions is met:

STEP 5.1 Bracket grounds are within 1,250 feet of the work site and there are no energized parallel lines; or,

STEP 5.2 Bracket grounds are within 300 feet of the work site and there are energized parallel lines.

Figure 4–85: Overhead Bracket Grounding Method — Example 7



4.17.6 Overhead Bracket Grounding Method — Working between a Crossing and a Source

The scenario illustrates working on multiple poles of a distribution main line where a crossing exists between two sources of supply. The poles are wood, composite, or concrete. There are no parallel lines that can cause hazardous induction.

Procedure:

STEP 1. Isolate sources by physically removing the tap(s),

STEP 2. Adequately protect the source with approved protective devices. Energized conductors on the source pole shall be covered using approved protective devices such that there are no exposed energized source conductor(s),

STEP 3. Install a sign [tag (SCE161-T-P2-T94)], and issue/take a clearance per APM, Rule 105 for the distribution circuit,

STEP 4. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply including any crossing. Grounds shall not be more than 2,500 feet apart and more than 1,250 feet the work site. Grounds installed at or near the work site are preferred.

STEP 5. Distribution under crossing when adequately covered is not considered a source for the purpose of locating grounds between the work site and that crossing.

STEP 6. When working on both sides of the crossing, a single set of grounds installed at the crossing will provide adequate protection on both sides of the crossing.

Figure 4–86: Overhead Bracket Grounding Method — Example 8

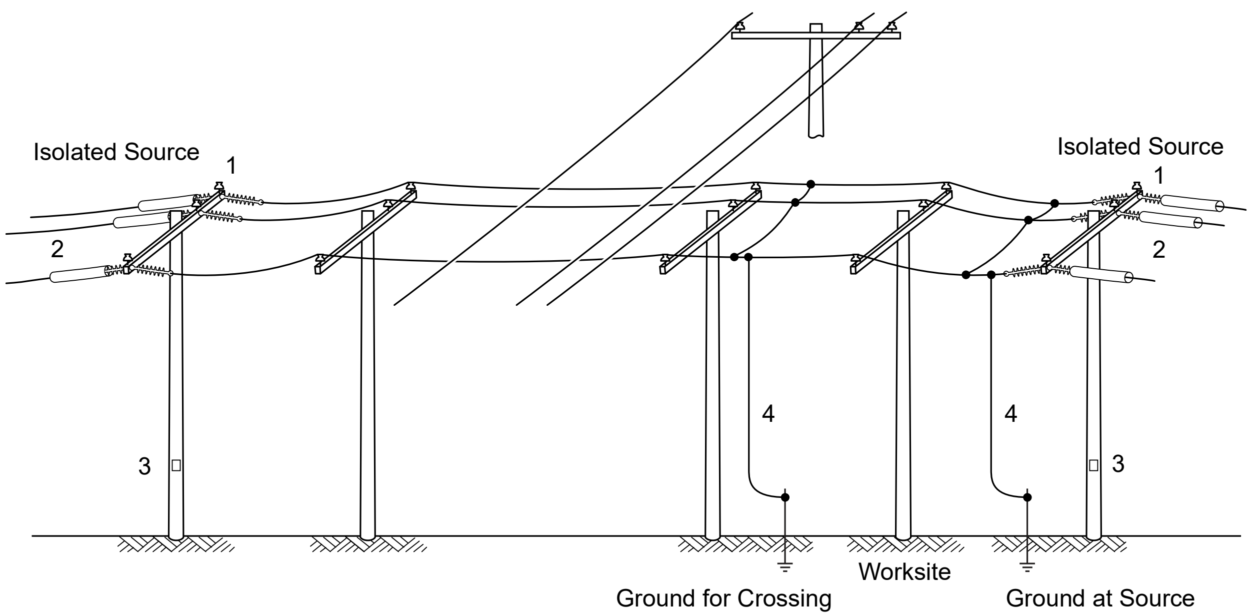


Figure 4–87: Overhead Bracket Grounding Method — Example 9

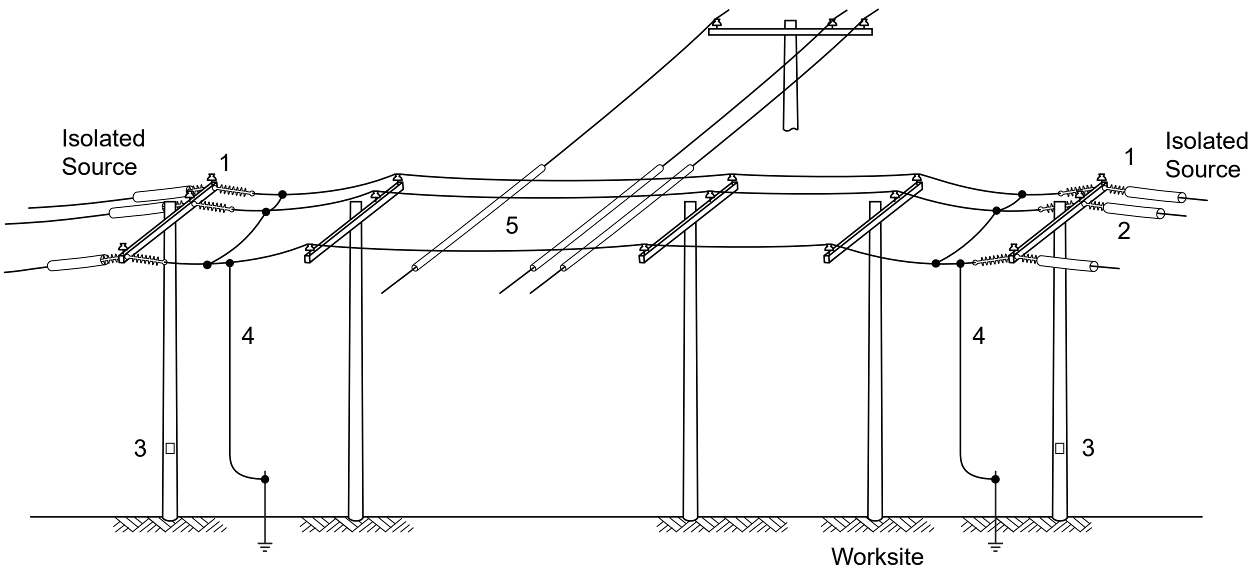
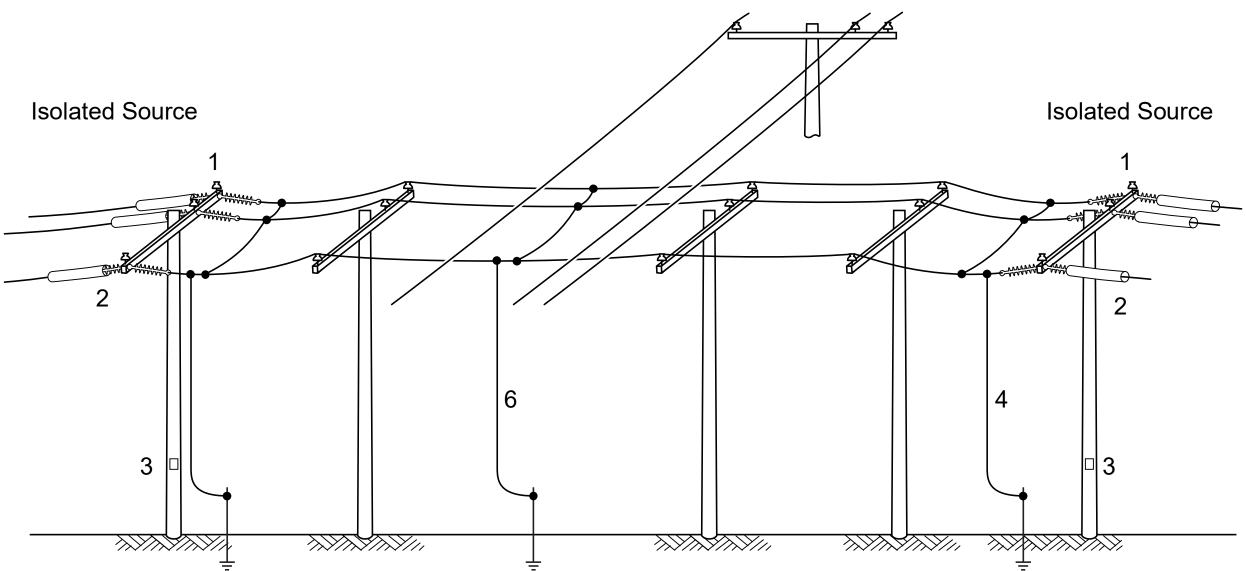


Figure 4–88: Overhead Bracket Grounding Method — Example 10



4.17.7 Overhead Bracket Grounding Method — Adding Wire on the Ground and Working on a Pole with a Parallel Energized Line

This scenario illustrates working on a distribution line with a energized parallel line above. The work is to add wire to down conductors and bring up to dead-end. The pole is wood, composite, or concrete.

Procedure:

STEP 1. Isolate sources by physically removing the tap(s),

STEP 2. Adequately protect the source with approved protective devices. Energized conductors on the source pole shall be covered using approved protective devices such that there are no exposed energized source conductor(s),

STEP 3. Install a sign [tag (SCE161-T-P2-T94)], and issue/take a clearance per APM, Rule 105 for the distribution circuit,

STEP 4. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply. Because of the parallel line, the maximum distance between each work site and the closest bracket grounds shall be 300 feet. Grounds installed at or near the work site are preferred.

WARNING When the distance between work site and the bracket grounds exceed 300 feet, Overhead Equipotential Bracket Grounding Method shall be utilized.

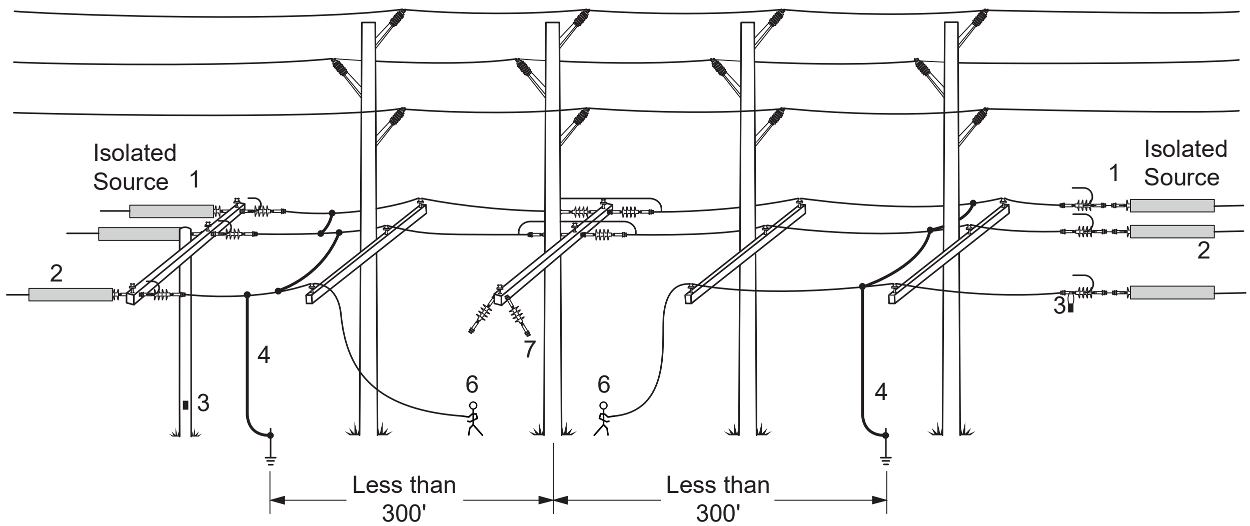
STEP 5. Exercise caution when utilizing this procedure where there is a ground within the work area on the structure. Always avoid getting between differences of ground potentials. When there are external ground(s) within the work area, options are:

- STEP 5.1 Bond/shunt external ground(s) attached to the pole to the conductors being worked on;
- STEP 5.2 Cover exposed external grounds within reach;
- STEP 5.3 Do not make contact with exposed external ground(s) while in contact with the conductor(s), or
- STEP 5.4 Create a workspace EPZ and bond external grounds within the workspace to the pole band.

STEP 6. When moving/inspecting/adding/splicing wire on downed conductors on the ground an EPZ or high voltage rubber gloves would not be required, when no work is being performed on the source pole and the grounds are within 300 feet of the work site.

STEP 7. When the conductors are raised and being attached to the pole, workspace EPZ is not required, when the grounds are within 300 feet of the work site.

Figure 4–89: Overhead Bracket Grounding Method — Example 11



4.17.8 Overhead Bracket Grounding Method — Working on a Downed Pole and Conductor on a Tap Line

This scenario illustrates a downed pole on a distribution tap line with a severed conductor. The job is to install new pole, splice conductor, and restore the circuit. The poles are wood, composite, or concrete. There are no crossings and there are no parallel lines that can cause hazardous induction.

APM, Rule 207e States: "work shall not be performed on downed overhead lines until they have been proven de-energized and grounded as provided in Rule 141, unless they are being cut in the clear, with approved live-line tools, to protect from personal injury."

Procedure:

STEP 1. Isolate sources by physically removing the tap(s),

STEP 2. Adequately protect the source with approved protective devices. Energized conductors on the source pole shall be covered using approved protective devices such that there are no exposed energized source conductor(s),

STEP 3. Install a sign [tag (SCE161-T-P2-T94)], and issue/take a clearance per APM, Rule 105 for the distribution circuit,

STEP 4. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply. Grounds installed at or near the work site are preferred.

STEP 5. Eliminate all backfeed per APM, Rule 149.

STEP 6. After grounding scheme is in place (that is all sources isolated and grounded); backfeed eliminated; with no induction, static, and crossing; conductors severed from the system and completely separated circuit sections do not require grounding.

STEP 7. Exercise caution when utilizing this procedure where there is a ground within the work area on the structure. Always avoid getting between differences of ground potentials. When there are external ground(s) within the work area, options are:

STEP 7.1 Bond/shunt external ground(s) attached to the pole to the conductors being worked on;

STEP 7.2 Cover exposed external grounds within reach;

STEP 7.3 Do not make contact with exposed external ground(s) while in contact with the conductor(s), or

STEP 7.4 Create a workspace EPZ and bond external grounds within the workspace to the pole band.

STEP 8. When moving/inspecting/adding/splicing wire on downed conductors on the ground an EPZ would not be required when no work is being performed on the source pole and one of the following conditions is met:

STEP 8.1 Bracket grounds are within 1,250 feet of the work site and there are no energized parallel lines; or,

STEP 8.2 Bracket grounds are within 300 feet of the work site and there are energized parallel lines.

STEP 9. When the conductors are raised and being attached to the pole, workspace EPZ is not required, when no work is being performed on the source pole and one of the following conditions is met:

STEP 9.1 Bracket grounds are within 1,250 feet of the work site and there are no energized parallel lines; or,

STEP 9.2 Bracket grounds are within 300 feet of the work site and there are energized parallel lines.

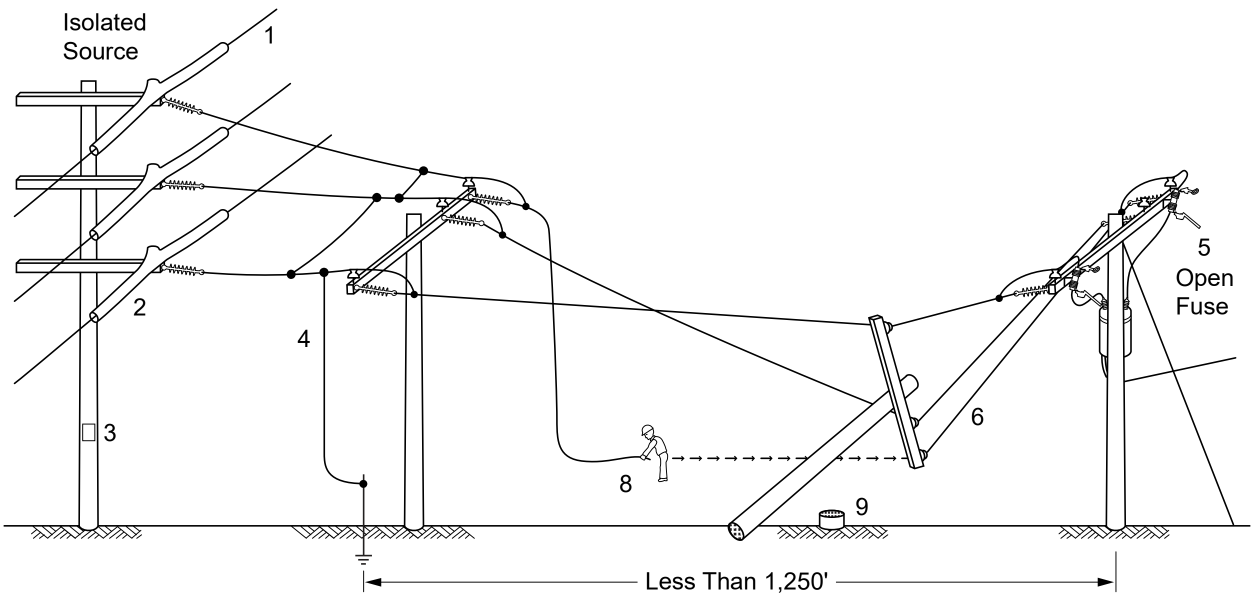
STEP 10. No work shall be performed on the source pole, (that is conductors or taps) while work is in progress on the tap line.

STEP 11. When the work has been completed, the source pole can be worked, for example, (dead-ending conductors or installing taps), provided there is a set of approved grounds installed as close as practicable to the source pole. A workspace EPZ will not be needed on the source pole provided one of the following conditions is met.

STEP 11.1 Bracket grounds are within 1,250 feet of the work site and there are no energized parallel lines; or,

STEP 11.2 Bracket grounds are within 300 feet of the work site and there are energized parallel lines.

Figure 4–90: Overhead Bracket Grounding Method — Example 12



4.17.9 Overhead Bracket Grounding Method — Line Relocation

This scenario illustrates transferring distribution conductors to a new steel pole. The plan is to let one phase down at a time, add 40 feet of wire, and take it back up to the new steel pole and dead end it. The old poles are wood, composite, or concrete. There are no crossings and there is no parallel line that can cause hazardous induction.

Procedure:

STEP 1. Isolate sources by physically removing the tap(s),

STEP 2. Adequately protect the source with approved protective devices. Energized conductors on the source pole shall be covered using approved protective devices such that there are no exposed energized source conductor(s),

STEP 3. Install a sign [tag (SCE161-T-P2-T94)], and issue/take a clearance per APM, Rule 105 for the distribution circuit,

STEP 4. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply. The maximum distance between each work site and the closest bracket grounds shall be 1,250 feet. Grounds installed at or near the work site are preferred.

WARNING When the distance between any work site and the closest bracket grounds exceed 1,250 feet, Overhead Equipotential Bracket Grounding Method shall be utilized.

STEP 5. Exercise caution when utilizing this procedure where there is a ground within the work area on the structure. Always avoid getting between differences of ground potentials. When there are external ground(s) within the work area, options are:

STEP 5.1 Bond/shunt external ground(s) attached to the pole to the conductors being worked on;

STEP 5.2 Cover exposed external grounds within reach;

STEP 5.3 Do not make contact with exposed external ground(s) while in contact with the conductor(s); or,

STEP 5.4 Create a workspace EPZ and bond external grounds within the workspace to the pole band.

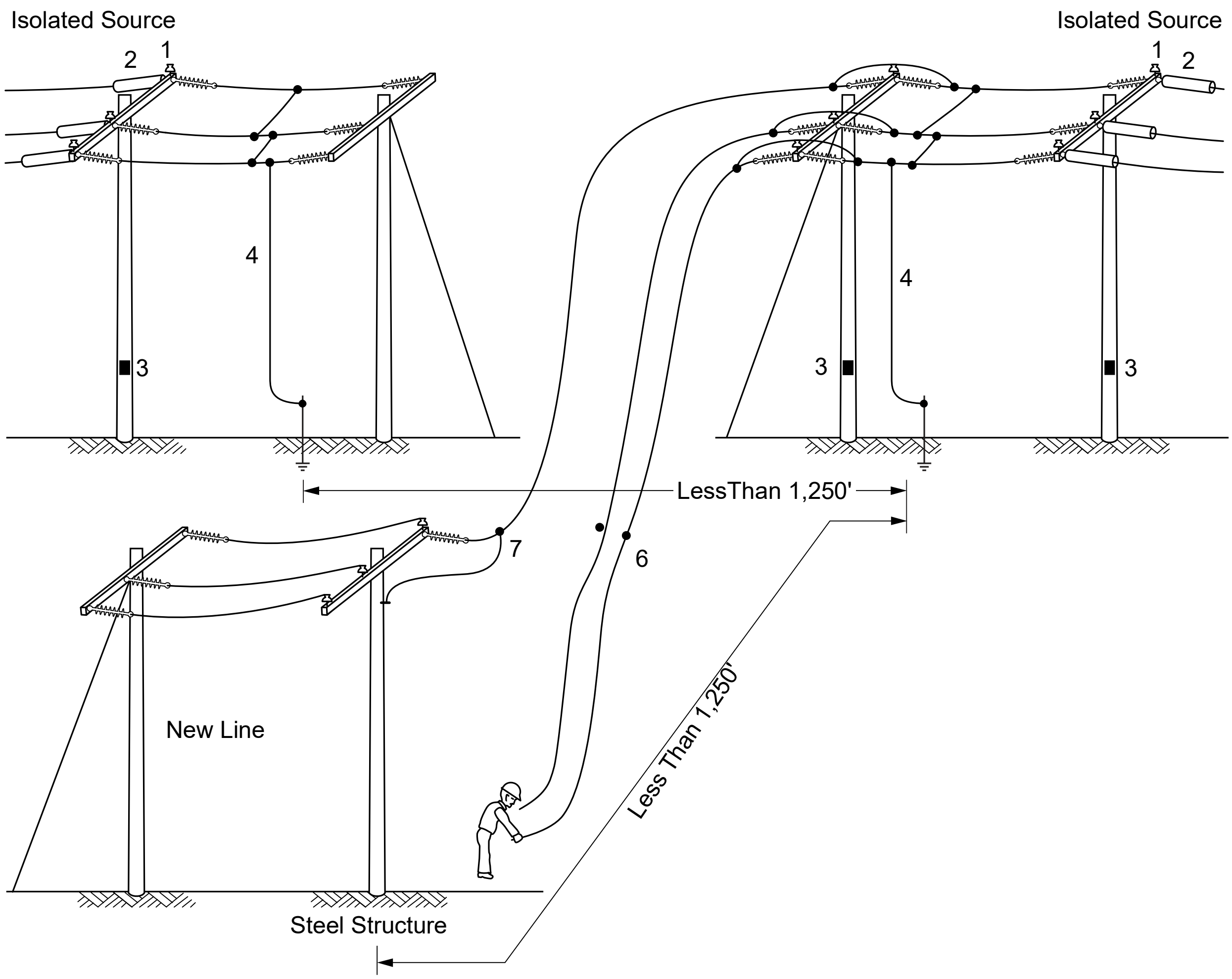
STEP 6. When moving/inspecting/adding/splicing wire on downed conductors on the ground an EPZ would not be required when no work is being performed on the source pole and one of the following conditions is met:

STEP 6.1 Bracket grounds are within 1,250 feet of the work site and there are no energized parallel lines; or,

STEP 6.2 Bracket grounds are within 300 feet of the work site and there are energized parallel lines.

STEP 7. Working on a steel pole will require a workspace EPZ. When working on a steel structure, install personal ground(s) between each conductor being worked on and the structure.

Figure 4–91: Overhead Bracket Grounding Method — Example 13



4.17.10 Overhead Bracket Grounding Method — Working on a Tap Line with Multiple Conductors Down

This scenario illustrates a distribution tap line with multiple severed conductors. The job is to splice/add wire to conductor(s), and restore the circuit. The poles are wood, composite, or concrete. There are no crossings and there are no parallel lines that can cause hazardous induction.

APM, Rule 207e States: "work shall not be performed on downed overhead lines until they have been proven de-energized and grounded as provided in Rule 141, unless they are being cut in the clear, with approved live-line tools, to protect from personal injury."

Procedure:

STEP 1. Isolate sources by physically removing the tap(s),

STEP 2. Adequately protect the source with approved protective devices. Energized conductors on the source pole shall be covered using approved protective devices such that there are no exposed energized source conductor(s),

STEP 3. Install a sign [tag (SCE161-T-P2-T94)], and issue/take a clearance per APM, Rule 105 for the distribution circuit,

STEP 4. Clean, test, and ground the line. Install a set of bracket grounds between the work site and the source. Grounds installed at or near the work site are preferred.

STEP 5. Eliminate all backfeed per APM, Rule 149.

STEP 6. After grounding scheme is in place (that is all sources isolated and grounded); backfeed eliminated; with no induction, static, and crossing; conductors severed from the system and completely separated circuit sections do not require grounding.

STEP 7. Exercise caution when utilizing this procedure where there is a ground within the work area on the structure. Always avoid getting between differences of ground potentials. When there are external ground(s) within the work area, options are:

- STEP 7.1 Bond/shunt external ground(s) attached to the pole to the conductors being worked on;
- STEP 7.2 Cover exposed external grounds within reach;
- STEP 7.3 Do not make contact with exposed external ground(s) while in contact with the conductor(s); or,
- STEP 7.4 Create a workspace EPZ and bond external grounds within the workspace to the pole band.

STEP 8. When moving/inspecting/adding/splicing wire on downed conductors on the ground an EPZ would not be required when no work is being performed on the source pole and one of the following conditions is met:

- STEP 8.1 Bracket grounds are within 1,250 feet of the work site and there are no energized parallel lines; or,
- STEP 8.2 Bracket grounds are within 300 feet of the work site and there are energized parallel lines.

STEP 9. When the conductors are raised and being attached to the pole, workspace EPZ is not required, when no work is being performed on the source pole and one of the following conditions is met:

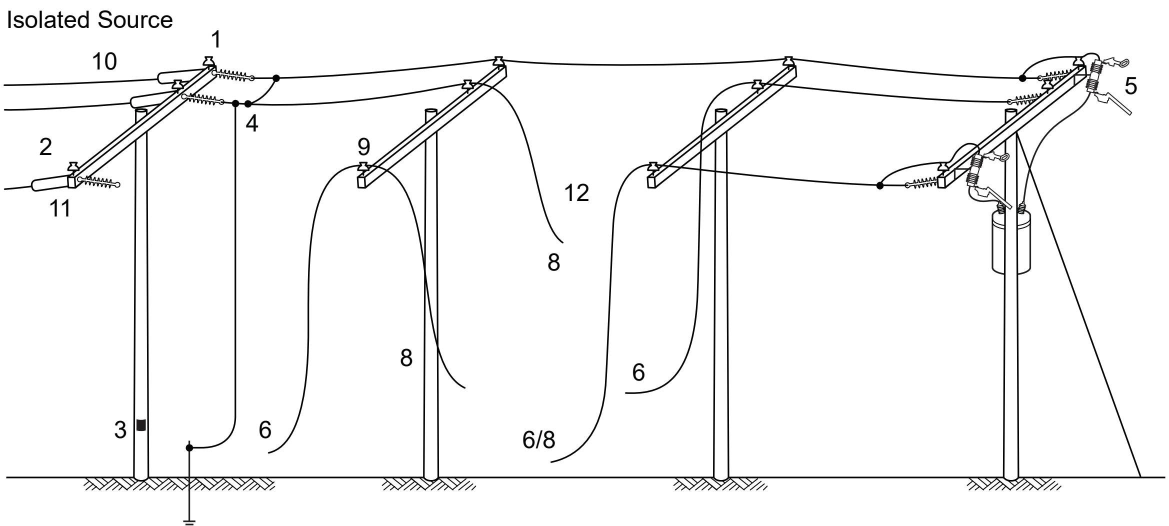
STEP 9.1 Bracket grounds are within 1,250 feet of the work site and there are no energized parallel lines; or,

STEP 9.2 Bracket grounds are within 300 feet of the work site and there are energized parallel lines.

STEP 10. No work shall be performed on the source pole, (that is conductors or taps) while work is in progress on the tap line.

STEP 11. When the work has been completed, the severed conductor shall be incorporated into the grounding scheme prior to dead-ending at the source pole.

Figure 4–92: Overhead Bracket Grounding Method — Example 14



4.17.11 Overhead Bracket Grounding Method — Distribution Tap Line with Branch-Line Fuses

This scenario illustrates working on distribution tap line with branch-line fuses. The poles are wood, composite, or concrete. There are no crossings and there are no parallel lines that can cause hazardous induction.

Procedure:

STEP 1. Open and remove branch-line fuses,

STEP 2. Isolate sources by physically removing the tap(s) from top of fuse holder to line,

STEP 3. Adequately protect the source with approved protective devices. Energized conductors on the source pole shall be covered using approved protective devices such that there are no exposed energized source conductor(s),

STEP 4. Install a sign [tag (SCE161-T-P2-T94)], and issue/take a clearance per APM, Rule 105 for the distribution circuit,

STEP 5. Eliminate backfeed per APM, Rule 149, STEP 6. Clean, test, and ground the line. Install a set of bracket grounds between the work site and source. Grounds installed at or near the work site are preferred:

STEP 6.1 When there is no energized parallel line, grounds shall not be more than 2,500 feet apart and more than 1,250 feet from the work site; or,

STEP 6.2 When there is energized parallel line, grounds shall not be more than 300 feet from the work site.

STEP 7. Exercise caution when utilizing this procedure where there is a ground within the work area on the structure. Always avoid getting between differences of ground potentials. When there are external ground(s) within the work area, options are:

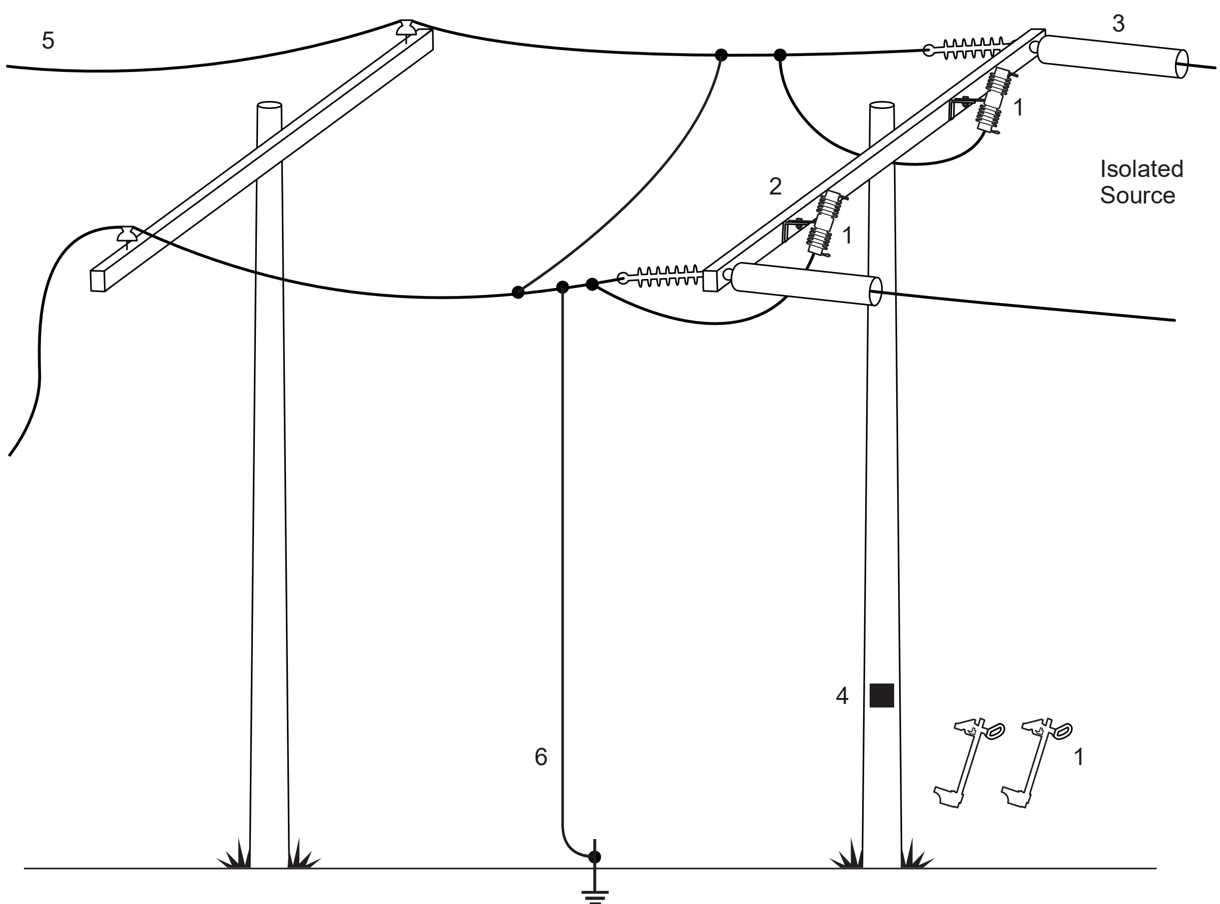
STEP 7.1 Bond/shunt external ground(s) attached to the pole to the conductors being worked on;

STEP 7.2 Cover exposed external grounds within reach;

STEP 7.3 Do not make contact with exposed external ground(s) while in contact with the conductor(s); or,

STEP 7.4 Create a workspace EPZ and bond external grounds within the workspace to the pole band.

Figure 4–93: Overhead Bracket Grounding Method — Example 15



4.17.12 Overhead Bracket Grounding Method — Working on a Distribution Line with Multiple Poles and Conductors Down

This scenario illustrates multiple poles and conductors down on a distribution line. The job is to install new poles, splice conductors, and restore the circuit. The poles are wood, composite, or concrete. There are no crossings and there are no parallel lines that can cause hazardous induction.

APM, Rule 207e States: "work shall not be performed on downed overhead lines until they have been proven de-energized and grounded as provided in Rule 141, unless they are being cut in the clear, with live-line tools, to protect from personal injury."

Procedure:

STEP 1. Isolate sources by physically removing the tap(s),

STEP 2. Adequately protect the source with approved protective devices. Energized conductors on the source pole shall be covered using approved protective devices such that there are no exposed energized source conductor(s),

STEP 3. Install a sign [tag (SCE161-T-P2-T94)], and issue/take a clearance per APM, Rule 105 for the distribution circuit.

STEP 4. Clean, test, and ground the line. Install a set of bracket grounds between the work site and each source of supply. Grounds installed at or near the work site are preferred.

- STEP 4.1 When there is no energized parallel line, grounds shall not be more than 2,500 feet apart and more than 1,250 feet from the work site; or,
- STEP 4.2 When there is an energized parallel line, grounds shall not be more than 300 feet from the work site.

STEP 5. After grounding scheme is in place (that is all sources isolated and grounded); backfeed eliminated; with no induction, static, and crossing; conductors severed from the system and completely separated circuit sections do not require grounding.

STEP 6. Exercise caution when utilizing this procedure where there is a ground within the work area on the structure. Always avoid getting between differences of ground potentials. When there are external ground(s) within the work area, options are:

- STEP 6.1 Bond/shunt external ground(s) attached to the pole to the conductors being worked on;
- STEP 6.2 Cover exposed external grounds within reach;
- STEP 6.3 Do not make contact with exposed external ground(s) while in contact with the conductor(s); or,
- STEP 6.4 Create a workspace EPZ and bond external grounds within the workspace to the pole band.

STEP 7. When moving/inspecting/adding/splicing wire on downed conductors on the ground an EPZ would not be required when no work is being performed on the source pole and one of the following conditions is met:

- STEP 7.1 Bracket grounds are within 1,250 feet of the work site and there are no energized parallel lines; or,
- STEP 7.2 Bracket grounds are within 300 feet of the work site and there are energized parallel lines.

STEP 8. When the conductors are raised and being attached to the pole, workspace EPZ is not required, when no work is being performed on the source pole and one of the following conditions is met:

STEP 8.1 Bracket grounds are within 1,250 feet of the work site and there are no energized parallel lines; or,

STEP 8.2 Bracket grounds are within 300 feet of the work site and there are energized parallel lines.

STEP 9. No work shall be performed on the source pole(s), (that is, conductors or taps) while work is in progress between bracket grounds, and vice versa. In addition no work shall be performed on multiple source poles simultaneously following Overhead Bracket Grounding Method.

STEP 10. When the work between bracket grounds has been completed, the first source pole can be worked, provided there is a set of approved grounds installed as close as practicable to the source pole. Prior to dead-ending the severed conductor to the source pole, it shall be incorporated into the grounding scheme.

STEP 11. When the work is completed on the source pole and when the source is no longer isolated, for example, (taps installed), work on the de-energized line shall be performed utilizing Overhead Equipotential Bracket Grounding Method. This is necessary since taps were installed at the first source pole; the source is no longer isolated. You now have an open source which requires an EPZ.

STEP 12. In order to work multiple source poles simultaneously Overhead Equipotential Bracket Grounding Method shall be used.

STEP 13. Before closing any conductor that may be exposed to a hazardous difference of electrical potential approved jumpers shall be in place across the point to be closed to ensure continuity of the conductor.

When closing conductors that are grounded, and when the distance of grounds to the work site is within 1,250 feet with no parallel lines and 300 feet with parallel lines, one conductor shall remain continuous between grounds in order to maintain continuity and to eliminate hazardous difference of electrical potential. Therefore; to close the first conductor an approved shunt shall be used. Closing additional conductor(s) would not require a shunt when the above conditions are met.

When the distance of grounds to the work site is outside1,250 feet with no parallel lines and 300 feet with parallel lines, or one side is not grounded hazardous difference of electrical potential might exist. Therefore, closing of any conductor would require a shunt.

Figure 4–94: Overhead Bracket Grounding Method — Example 16

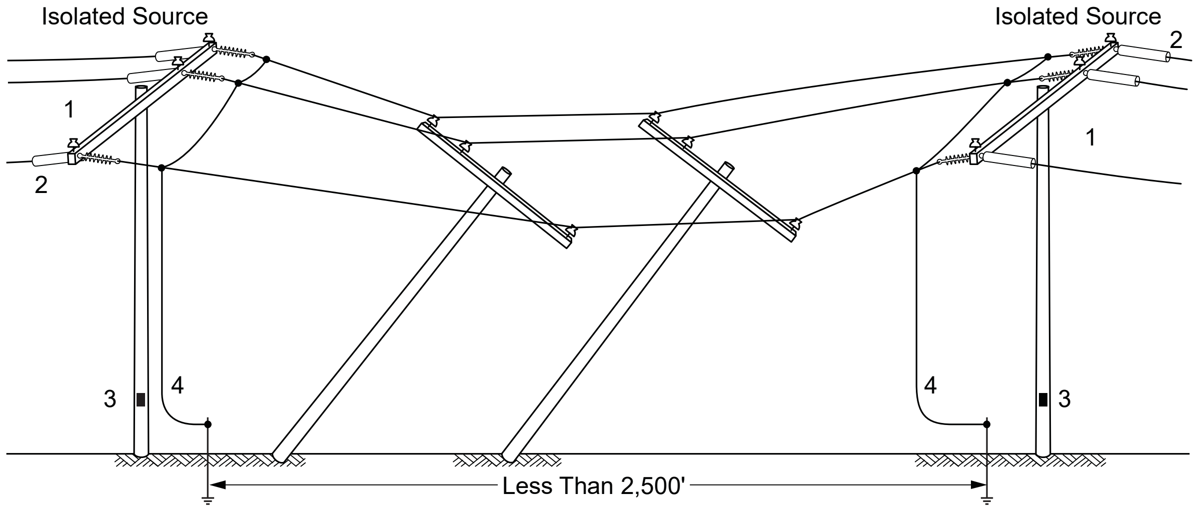


Figure 4–95: Overhead Bracket Grounding Method — Example 17

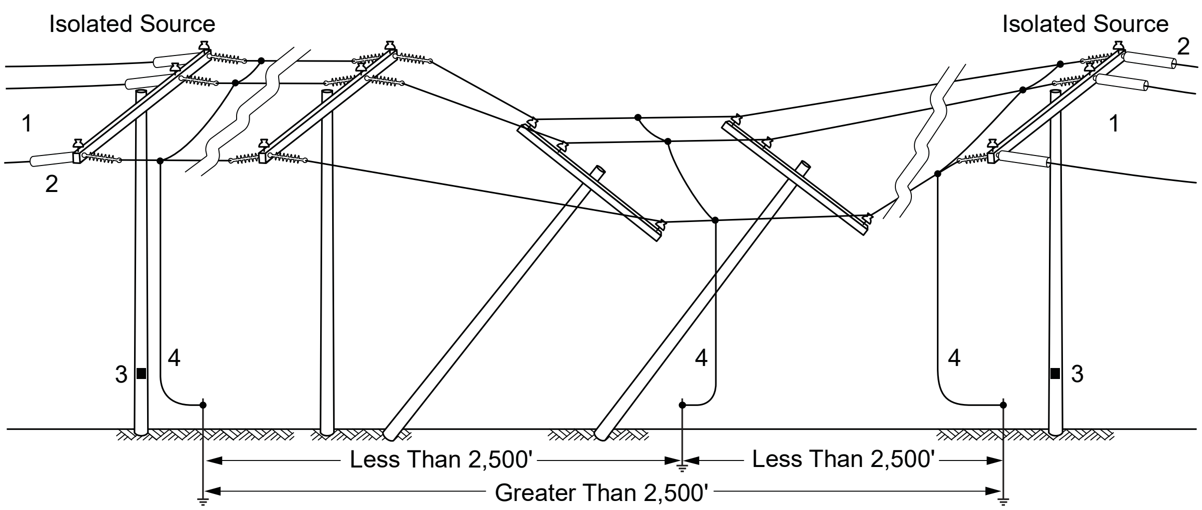
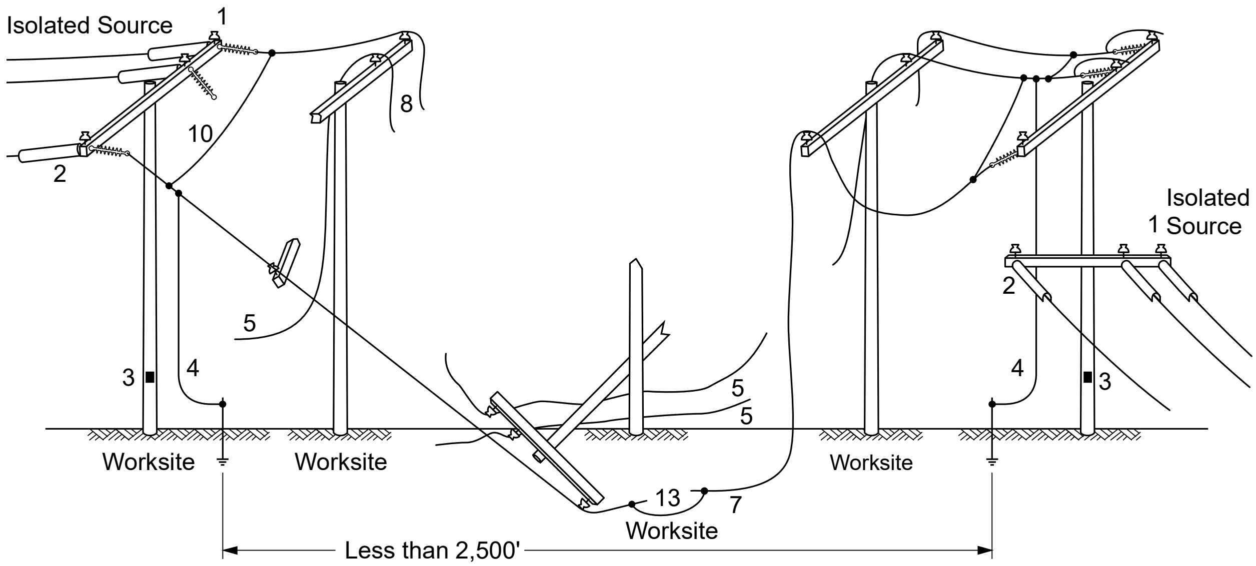


Figure 4–96: Overhead Bracket Grounding Method — Example 18



4.17.13 Overhead Bracket Grounding Method — Dead-Ending New Line Section at the Source Pole

This scenario illustrates dead-ending a newly constructed distribution tap line to its source pole. This scenario also applies to distribution main lines. The source pole is wood, composite, or concrete. There are no crossings and there are no parallel lines that can cause hazardous induction. The work is to pull up and dead-end newly installed conductor(s) of a new line section to the source pole at the primary level.

Procedure:

STEP 1. Verify that there are no tap(s) installed on the source pole. If installed, Isolate source by physically removing the tap(s),

STEP 2. Adequately protect the source with approved protective devices. Energized conductors on the source pole shall be covered using approved protective devices such that there are no exposed energized source conductor(s),

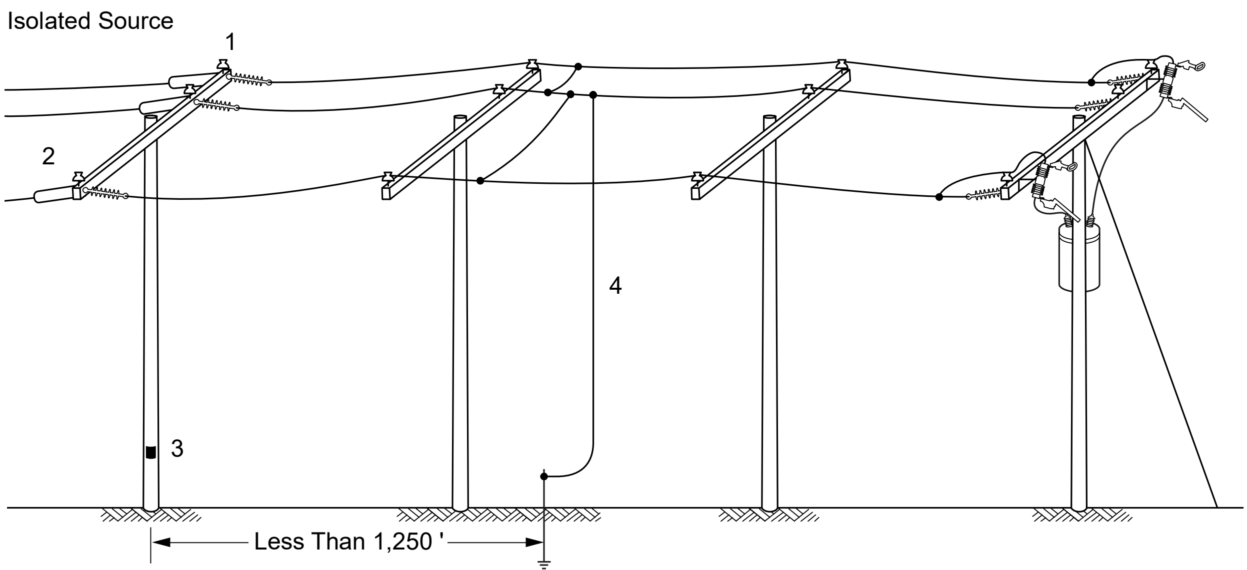
STEP 3. Verify/Install a sign [tag (SCE161-T-P2-T94)] on the source pole,

STEP 4. Clean and ground the new line conductors being dead-ended. The bracket grounds shall be installed as close as practicable to the work site, for example, (at the next pole). When the work site is located more than 1,250 feet from the bracket ground, Equipotential Bracket Grounding Method shall be utilized.

WARNING

No work shall be performed simultaneously on multiple source poles unless Equipotential Bracket Grounding Method is used. Similarly, no work shall be performed on the line while work is in progress on the source pole.

Figure 4–97: Overhead Bracket Grounding Method — Example 19



When installing conductors to a source structure using the Overhead Bracket Grounding Method, parallel grounding with long grounds (for example, 70 feet) is permitted, as shown on the following figures.

Figure 4–98: Overhead Bracket Grounding Method — Example 20 Before

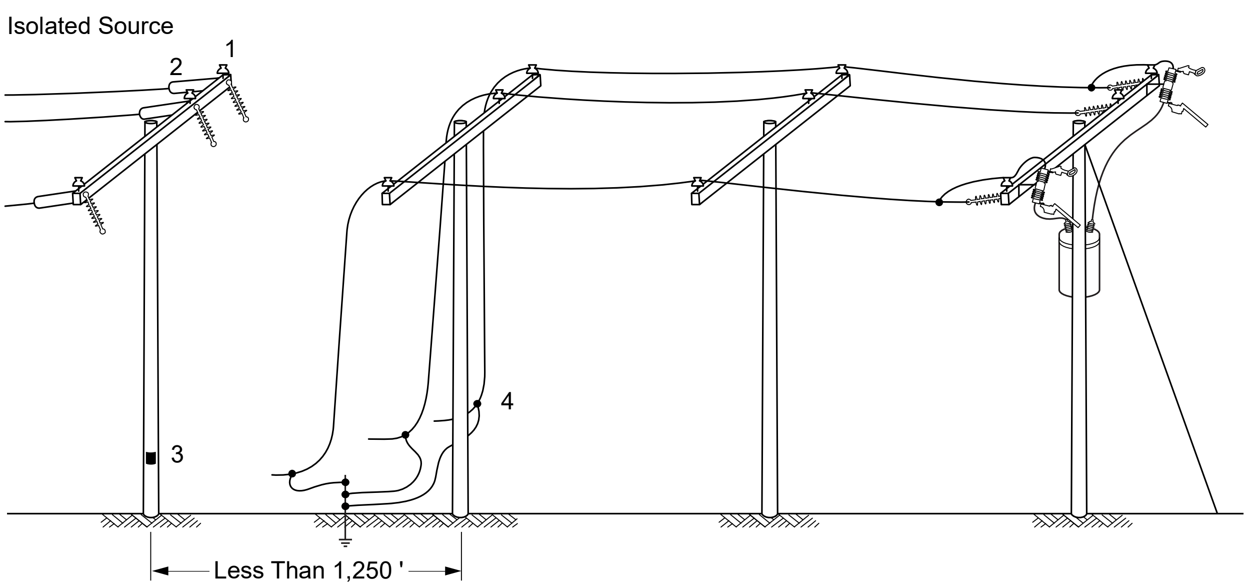
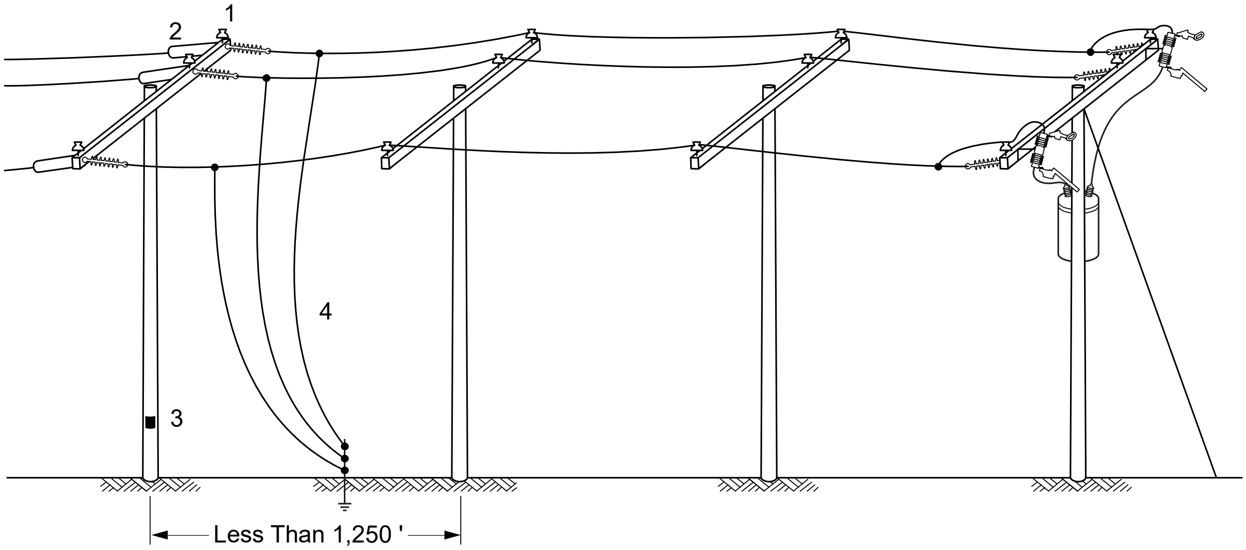


Figure 4–99: Overhead Bracket Grounding Method — Example 21 After



4.17.14 Overhead Bracket Grounding Method — Removing Existing Conductors Permanently

This scenario illustrates removing existing conductors of a distribution tap line permanently. This scenario also applies to distribution main lines. The source pole is wood, composite, or concrete. There are no crossings and there are no parallel lines that can cause hazardous induction.

Procedure:

STEP 1. Isolate Source by physically removing the taps.

STEP 2. Adequately protect the source with approved protective devices. Energized conductors on the source pole shall be covered using approved protective devices such that there are no exposed energized source conductor(s).

STEP 3. Install a sign [tag (SCE161-T-P2-T94)] and issue/take a clearance per APM, Rule 105 for the distribution circuit.

STEP 4. Eliminate all backfeed per APM, Rule 149

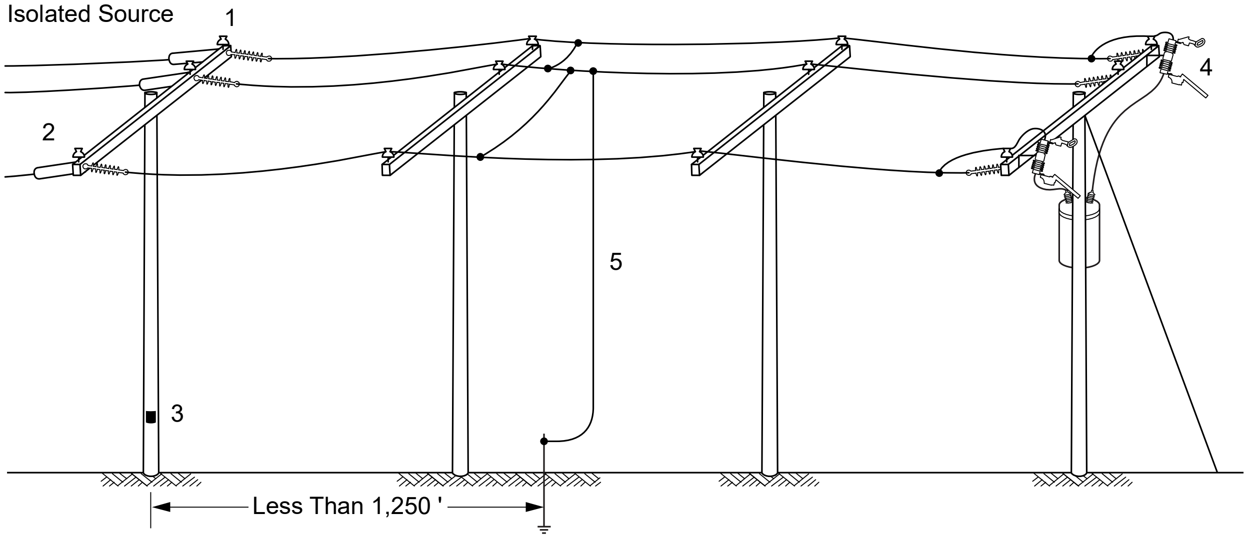
STEP 5. Clean, test, and ground the line. Install bracket grounds to protect from all sources. For work on the source pole the bracket grounds shall be installed as close as practicable to the work site, for example, (at the next pole and within 1,250 feet of the work site).

WARNING No work shall be performed simultaneously on multiple source poles unless Equipotential Bracket Grounding Method is used. Similarly, no work shall be performed on the line while work is in progress on the source pole.

STEP 6. Remove conductor from source structure,

STEP 7. Once all sources have been eliminated, grounds are no longer required for the removal of the remaining lines and equipment.

Figure 4–100: Overhead Bracket Grounding Method — Example 22



When removing conductors from a source structure using the Overhead Bracket Grounding Method, parallel grounding with long grounds (for example, 70 feet) is permitted as shown in the following figure.

Figure 4–101: Overhead Bracket Grounding Method — Example 22 Before

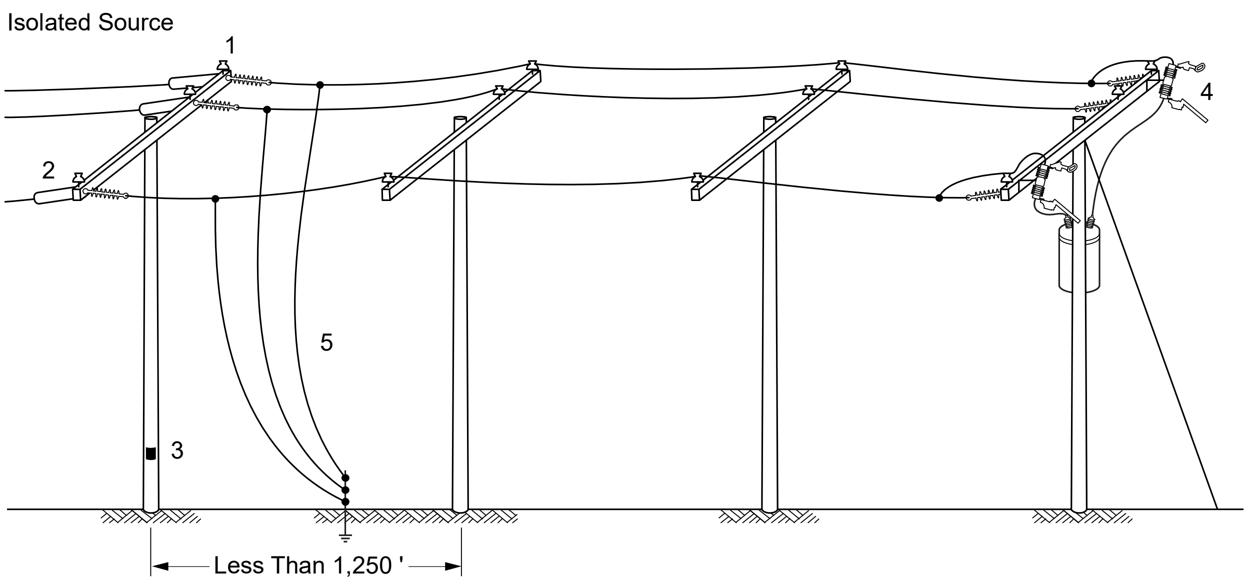


Figure 4–102: Overhead Bracket Grounding Method — Example 23 After

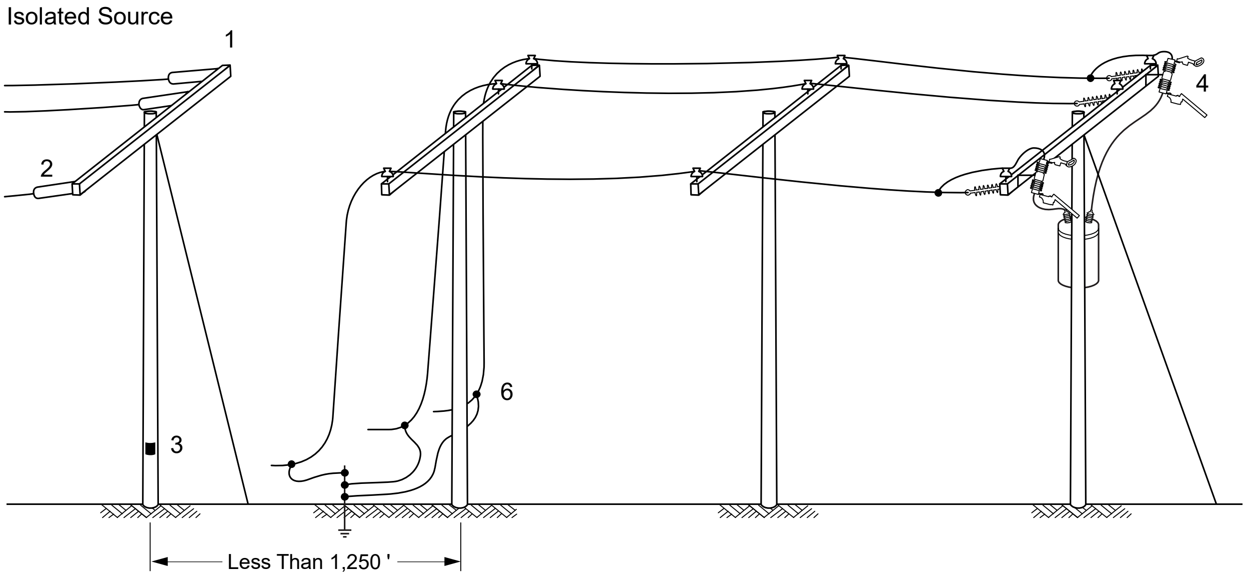
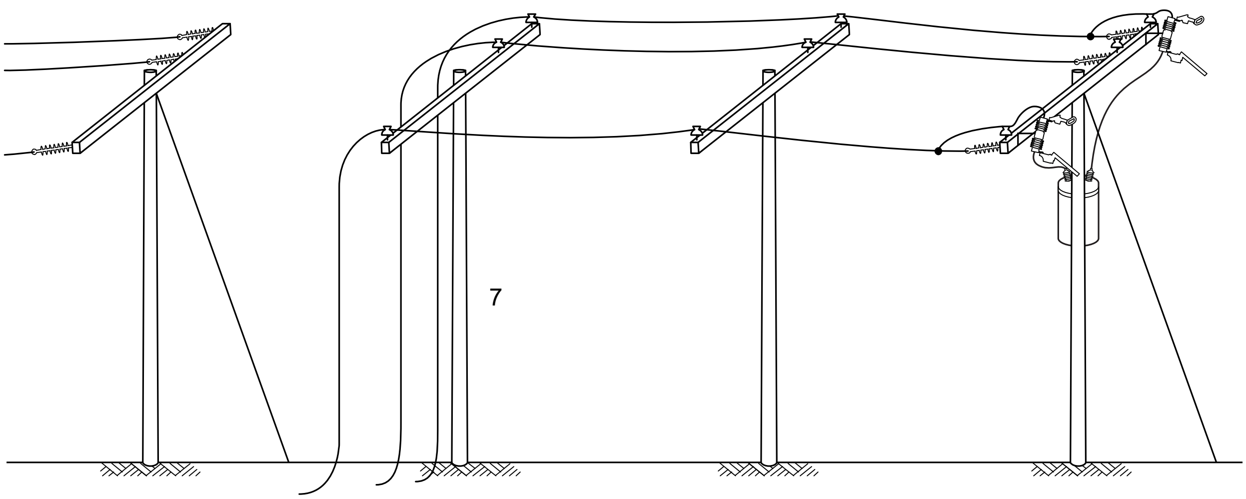


Figure 4–103: Overhead Bracket Grounding Method — Example 24



4.17.15 Overhead Bracket Grounding Method- Adding and Splicing Conductor(s) from an Insulated Aerial Device on a Distribution Tap Line

This scenario illustrates adding wire and splicing conductor from an insulated aerial device on a distribution tap line. The wire has been cut in the clear and is hanging down. The line is not located within a Transmission corridor and there are no parallel lines that can cause hazardous induction. Also, there is no crossing between the work site and the bracket ground(s).

Procedure:

STEP 1. Isolate Source by physically removing the taps.

STEP 2. Adequately protect the source with approved protective devices. Energized conductors on the source pole shall be covered using approved protective devices such that there are no exposed energized source conductor(s).

STEP 3. Install a sign [tag (SCE161-T-P2-T94)] and issue/take a clearance per APM, Rule 105 for the distribution circuit.

STEP 4. Eliminate all backfeed per APM, Rule 149

STEP 5. Clean, test, and ground the line. Install a set of bracket grounds between the work site and the source. Grounds installed at or near the work site are preferred.

NOTE

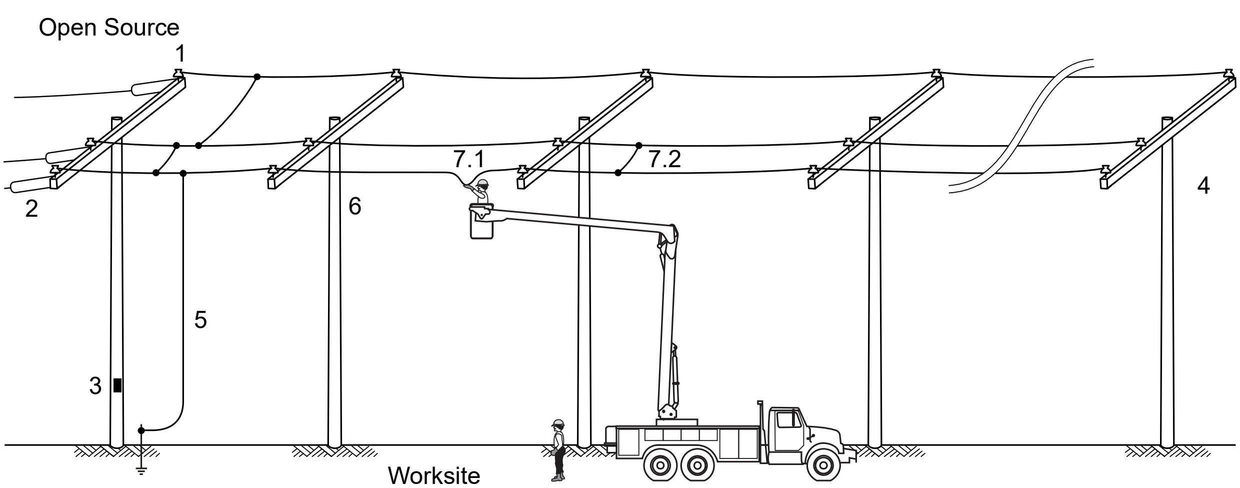
The worker on the ground can handle and send a section of wire that is not connected to the system to be spliced/added to the insulated bucket without the use of an EPZ or high voltage rubber gloves.

STEP 6. Wire can be added to the grounded conductor from the insulated aerial bucket without using high voltage rubber glove or a shunt. When wire is being added to the ungrounded conductor (that is load side), the conductor shall be incorporated into the grounding scheme prior to adding wire.

STEP 7. An approved ground shall be installed prior to splicing the conductor. Utilize one of the following two options:

- STEP 7.1 Install an approved ground across the two conductors to be spliced; or,
- STEP 7.2 Install an approved ground from a grounded conductor to the ungrounded conductor to be spliced.

Figure 4–104: Overhead Bracket Grounding Method — Example 25 — Splicing Wire, Distribution Tap Line



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SOUTHERN CALIFORNIA EDISON
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5.0: Periodic Inspection Cleaning and Testing of Portable Grounds

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5.0: Periodic Inspection Cleaning and Testing of Portable Grounds

5.1 Inspecting, Cleaning, and Testing Portable Grounds (GARP)

Transmission and Distribution ground assemblies shall be disassembled, cleaned, inspected, and periodically tested.

A clear heat shrink sleeve with date tape installed under sleeve shall be applied to each ground assembly that has passed testing. This is performed as part of the GARP.

The date tag shall indicate the month and year of testing. Grounds should not be used when the date tag is not legible, missing, or when the date is over two years old.

NOTE

Contact Construction Methods on the specifics of Ground Assembly Rotation Program procedures.

WARNING

Ground assemblies shall not be modified, dissembled, repaired, and/or reassembled after receiving from GARP.

5.2 Inspecting and Cleaning Portable Grounds Prior to Use

5.2.1 Smooth Jaw Duckbill Type Clamp

Figure 5–1: Smooth Jaw Clamp

Procedure:

STEP 1. Remove the ferrule from the end of the ground clamp.

STEP 2. Clean the ferrule with a wire brush and the threads inside the ground clamp.

STEP 3. Apply a liberal amount of corrosion inhibiting compound (SAP 10135712) to the threaded end of the ferrule terminal and the threaded insert of the ground clamp.

STEP 4. Install cable clamps and use Loctite 242 (SAP 10064201) on the hex screw or support studs as required. Use a torque wrench to tighten the nut to 20 foot pounds on the smooth jaw ground clamp.

STEP 5. After the ferrule is installed back into the clamp, wipe off the excessive compound.

STEP 6. Inspect the ground clamp. Ensure that the jaw moves freely and there is adequate spring tension and that it returns to the closed position. Spray a dry tool lubricant, such as graphite on all moving parts.

STEP 7. Inspect and clean the contact surface inside the movable jaws using a wire.

5.2.2 Serrated Jaw Type Clamps

Figure 5–2: Serrated Jaw Duckbill Clamp

Procedure:

STEP 1. Remove the nut and washer from the end of the ferrule on the serrated jaw clamp.

STEP 2. Remove the serrated jaw insert on the fixed side of the clamp:

STEP 3. Inspect the inserts and verify that less than 25 percent of the serrations are worn

STEP 4. Wire brush the front and back side of the insert.

STEP 5. Wire brush the body of the clamp; apply a corrosion-inhibiting compound (SAP 10135712) where the insert makes contact.

STEP 6. Inspect the retaining screws holding the insert and the threads in the clamp body. Apply a liberal amount of corrosion inhibiting compound (SAP 10135712) to the threaded end of the ferrule terminal.

STEP 7. Install cable clamps and use Loctite 242 (SAP 10064201) on the hex screw or support studs as required. Use a torque wrench to tighten the nut to 20 foot pounds on the serrated jaw duckbill clamp.

STEP 8. Inspect and clean the threads on the hot stick ringbolt. Spray the threads with a dry lubricant.

STEP 9. Reassemble the grounds.

5.2.3 220 kV–500 kV All-Angle Ground Clamps

Figure 5–3: All-Angle Ground Clamp with Date Tag

Procedure:

STEP 1. Perform all appropriate steps as previously listed in Subsection 5.2.1 and Subsection 5.2.2.

STEP 2. Remove and clean the pinch bolt connection using a wire brush. Ensure that both the inside and outside connection surfaces of the ground clamp are clean.

STEP 3. Install cable clamps and use Loctite 242 (SAP 10064201) on the hex screw or support studs as required. Use a torque wrench to tighten the nut to 20 foot pounds on the All-Angle Ground Clamp.

STEP 4. Inspect the mechanical action of the clamshell to ensure that it operates freely. It should be spring-loaded to the open position.

STEP 5. Remove and clean the self-cleaning jaw inserts with a wire brush.

STEP 6. While the jaw inserts are removed, clean the contact surface that supports the jaw inserts, apply a corrosion-inhibiting compound (SAP 10135712) to both contact surfaces and reassemble.

5.2.4 Flat (Jaw) Face Tower Clamp

This clamp is not part of the GARP and must be maintained by the field work locations. This clamp shall be visually inspected before each use.

Figure 5–4: Flat Jaw Clamp (SAP 10147894)

Procedure:

STEP 1. Perform all appropriate steps as previously listed in Subsection 5.2.1, and Subsection 5.2.2.

STEP 2. Check that the contact screws turn freely and the threads are in good condition.

STEP 3. Inspect the jaws for mechanical integrity and clean the jaws with a wire brush. Assure freedom of movement for moving parts.

| **NOTE**

The ground bus bar (SAP 10147833) can be used to connect two grounds to make a longer ground, when needed.

The maximum fault current that the Ground Bus Bar and Flat Jaw Clamp can carry is:

System Voltage (kV)	MAX Fault Current (A)
2.4–55	30,000
66–161	38,000
220–500	42,000

When using two flat jaw clamps per phase, the maximum fault current that these two flat jaw clamps can carry are as follows:

System Voltage (kV)	MAX Fault Current of Two Flat Jaw Clamps (A)
2.4–55	48,000
66–161	56,000
220–500	63,000

5.2.5 Pole Band

The pole band is not part of the GARP and must be maintained by the field work locations. This item shall be visually inspected before each use.

Figure 5–5: Pole Band (SAP 10147891)

Figure 5–6: Pole Band (SAP 10179337)

Procedure:

STEP 1. Inspect all bolts for mechanical integrity.

STEP 2. Check the spring tension and latch assembly making sure they operate properly.

STEP 3. Ensure there is a safety pin on the end of the chain. Check to make sure the safety pin is not bent and will properly engage in the chain bail.

STEP 4. Ensure the chain bail works properly and is not bent or deformed.

STEP 5. Inspect and clean the ground bar contact area.

STEP 6. Inspect the chain for stretching or other signs of damage. When any of these conditions exist, replace the pole band.

Locking Pin (SAP 10147982), 18 inch extension chain (SAP 10147980), and 36 inch extension chain (SAP 10147981).

The maximum fault current that the Pole Band Loop can carry is:

System Voltage (kV)	MAX Fault Current (A)
2.4–55	30,000
66–161	38,000
220–500	42,000

Figure 5–7: Duckbill to Red Head Duckbill Break-away Bond 2/0 Conductor Size

(10 Footer, SAP 10109309; 12 Footer, SAP 10109310)

Figure 5–8: All-Angle to Red Head Duckbill Break-away Bond 2/0 Conductor Size

(12 Footer, SAP 10176770)

Figure 5–9: EPZ Mat

(Small, 58" x 58", SAP 10144992; Large, 58" x 120", SAP 10144993)

6.0: Definitions

Term	Definition
Attached Grounds	Grounded conductors permanently attached to or installed on the surface of wood poles or attached to crossarms without insulators. This includes grounded guy wires, telecommunication and aerial cable messengers, fault return conductor (FRC), sky lines and conductors used for the purpose of grounding lightning arresters, potheads, primary and secondary neutrals, apparatus cases or frames, and other equipment.
Backfeed	Backfeed is produced by feeding the secondary side of transformers with the normal secondary voltage. When this takes place, the primary high-voltage bushings of the transformer are energized with the primary voltage level that is normally supplied to the transformer. An example is a 12,000–120/240 V transformer that is backfed with 120 V or 240 V. This transformer would then produce 12,000 V on the high voltage bushings. Backfeed from a secondary source can come from sources such as extension cords to a neighbor's energized panel, motor homes, portable generators, solar panels, or temporary power poles at a construction site.
Bracket Grounding	A grounding method where the shorting and grounding of de-energized conductors is performed with sets of grounds located on each end of a section of downed conductors, between the work area and all electrical sources. These grounds may be located several spans away if necessary, but will be spaced no further than 2,500 feet apart at a maximum. This method may require more than two sets of grounds. Bracket grounding also refers to a grounding method where the shorting and grounding of conductors is performed with a set of grounds located on each end of a new section of a line that is not put in a position that can be energized from electrical sources such as circuit breakers, switches, taps and fuses. These grounds may be located several spans away if necessary.
Engineered Tubular Steel Pole	A steel pole that is normally on a bolted base engineered footing and designed to hold an unequal load without the necessity of guying. These poles can be round or poly sided. There are a limited number of embedded type engineered tubular steel poles in the Edison system.
Equipotential Zone Mat (EPZ Mat)	The EPZ mat provides an easy way to help establish an Equipotential Zone for workers to stand on while performing work that could expose them to hazardous step and touch potential difference. The EPZ mat consists of a tinned-copper-braid cable sewn in a grid pattern onto a vinyl/polyester fabric.
Induction	Induced voltage can be the result of voltage in any energized line parallel to the de-energized conductors being worked. An energized high-voltage circuit located adjacent to, or in the vicinity of the de-energized conductors to be worked on, shall be considered an induction source, and therefore the circuit shall be grounded accordingly.
Light Weight Steel Pole	A direct embedded type steel pole that can be round or poly sided. Light duty tubular steel poles are not as strong or heavy as engineered tubular steel poles. Guy wires are used to balance the strain placed on these structures.
Overhead Equipotential Bracket Grounding	A grounding method that can be used in any situation and is the preferred method. Under this method, the shorting and grounding of de-energized conductors is performed with sets of grounds located on each side of the work area, between the work area and all electrical sources. In addition, an Equipotential Zone, for example, (workspace) is created at the work site. Where necessary, a pole band shall be used to create an Equipotential Zone on the pole where the work is to be performed and is located below the standing position of the worker. The pole band is connected by jumpers to the conductors being worked on. It is also bonded to any attached grounds that may be in the workspace. This creates an Equipotential Work Zone.
Personal Grounds	Portable extra flexible copper conductors with clamps that are designed, configured, and rated for the temporary shorting, shunting, and grounding of line and apparatus on which work is to be performed. The conductor used shall be, unless otherwise noted, minimum of #2 strand copper, 2/0 copper, or 4/0 copper.
Step Potential	The difference of potential between two separate points as a result of ground potential gradient difference. There is always a difference in potential between your feet when standing or walking. During a fault, this difference can be large enough to cause injury or death to workers.
Touch Potential	A potential difference between an object and ground that can cause current flow from hand to hand or hand to foot through the body.

Term	Definition
Voltage Classification	The following are classifications of voltages used in this manual: • Distribution circuits: 600 V to 33 kV • Sub-transmission circuits: 55 kV to 161 kV • Transmission circuits: 220 kV to 500 kV **Note:** A few 33 kV lines are under Transmission jurisdiction.
Workspace After Installation of the Pole Band (Equipotential Zone)	After application of the pole band and grounds, an Equipotential Zone workspace is established. The workspace is the area on the pole above the pole band including the conductors or equipment connected to the pole band to be worked on. In addition, the workspace extends to the top of the pole. However, the workspace does not extend inside the minimum approach distance of energized or de-energized circuits not connected to the pole band. In cases where workers have installed two pole bands, the Equipotential Zone workspace will be the area on the pole between the two pole bands.

7.0: References

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7.0: References

7.1 Accident Prevention Manual (APM)

- Rule 141, Grounding
- Rule 147, Working Distance
- Rule 149, Backfeed
- Rule 207, Energized Lines
- Rule 214, Wire Stringing

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8.0: Revision History

Date	Description of Revision	Contact
February 23, 2018		B. Castillo, Construction Methods
September 29, 2017	Some more clarification was needed due to the development of the training material for refresher training.	B. Castillo, Construction Methods
July 28, 2017	Grounding for distribution wire stringing has been revised, and some more clarification was needed due to the development of the training material for refresher training.	G. Gonzales, Construction Methods
March 31, 2017	The Grounding Committee has found some areas in the manual that needed clarification while developing refresher training with T&D Training. Transmission has requested to make some revisions regarding changing to voltage from 66 kV to 115 kV.	G. Gonzales, Construction Methods
July 29, 2016	Added additional information to Aerial Cable and minor revisions, completed by the Grounding Committee.	G. Gonzales, Construction Methods
July 27, 2012	Various revisions completed by The Grounding Committee as a result of field feedback during training sessions.	D. Ramirez, Construction Methods
February 24, 2012	Various revisions completed by The Grounding Committee as a result of field feedback during training sessions.	D. Ramirez, Construction Methods
October 11, 2011	Various revisions completed by the Grounding Committee and Simplify and Clarify Grounding Team as a result of field feedback during training sessions.	D. Ramirez, Construction Methods
May 1, 2007	Various revisions completed by the Grounding Committee as a result of field feedback during training sessions.	S. Ford, Construction Methods
November 1, 2004	The Overhead Grounding Manual (OGM) was extensively revised to reflect new grounding equipment, procedures, and consideration of current fault duties to enhance the safety of SCE employees and the public while maintaining compliance with regulatory requirements.	R. Contreras, Corporate EH&S

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