Personal Protective Grounding

Revised April 2024

Purpose

The PRIMARY function of personal protective grounds is to provide maximum safety for our employees while they are working on de-energized lines or equipment. This will be accomplished by making provisions that will reduce the potential voltage differences at the worksite (voltage across the person) to a safe value in case the equipment or line being worked on is accidentally energized from any possible source.

The SECONDARY function is to protect against induced voltage from adjacent parallel energized lines.

The THIRD function is to make the protective devices (relays, circuit breakers or fuses) disconnect the energizing source within a given time/current relationship.

EQUIPOTENTIAL ZONE (EPZ) Temporary protective grounds shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to hazardous differences in the electrical potential.

Applicability

Personal Protective Grounding applies to all District employees working under the scope and application of WAC 296-45 Electric Power Generation, Transmission, and Distribution .

This section is intended to be used in conjunction with WAC 296-45, the District's Switching and Clearance Procedures, and the T & D Guidelines.

Grounding Equipment

Grounding equipment shall be of approved current-carrying capacity capable of accommodating the maximum fault current to which the line or equipment could be subjected. Protective grounds shall only be used for grounding. Personal protective grounds will be tested annually.

Grounding jumpers shall have approved ferrules and grounding clamps that provide mechanical support for jumper cables independent of the electrical connection.

Protective grounds shall have an impedance low enough to cause immediate operation of protective devices in case of accidental energizing of the line or equipment.

Personal Protective Grounds Used at the District

1. All 12kV distribution system circuits have low enough fault current to permit the use of a single set of #1/0 copper Personal Protective Grounding (PPG).
2. At all District substations 115kV and on District 115kV transmission lines not connected to a Bonneville Power Administration (BPA) delivery point (see bullet #3), a single set of #2/0 copper PPG is sufficient.
3. The 115kV line emulating from BPA delivery points (BPA Murray, BPA Snohomish, BPA SnoKing) have a higher fault current and two #2/0 copper PPG in parallel are required to withstand that level of fault current when PPG are applied before the first substation. One set of #4/0 copper PPG is an acceptable alternative. Once a transmission line reaches the first District substation, a single set of #2/0 copper PPG is sufficient.
4. Jackson Hydroelectric Plant has a high level of fault current on the 13.8kV bus, and a single set of #2/0 copper PPG would be required for either the 115kV bus or the 13.8kV bus.
5. One set of #2/0 copper PPG is adequate at North Mountain 230kV bus.
6. On #2 or smaller size conductor distribution (12kV) lines, the qualified electrical employee may choose to apply a #2 copper PPG.
7. This procedure describes the minimum permissible PPG size, and a larger PPG is always acceptable.

Before grounds are installed, the de-energized line or equipment shall be tested for absence of voltage.

Attaching and Removing Ground(s)

Grounding equipment shall be given a visual inspection, and all mechanical connections shall be checked for tightness before each use. Protective grounds shall only be used for grounding.

The surface to which the ground is attached shall be clean before the ground clamp is installed; otherwise, a self-cleaning clamp shall be used.

When attaching ground(s), the ground end shall be firmly attached first to a reliable ground with the other end attached to the line or equipment by means of an approved live line tool.

When a ground is removed, the grounding device shall be removed from the line or equipment using a live line tool before the ground end connection is removed.

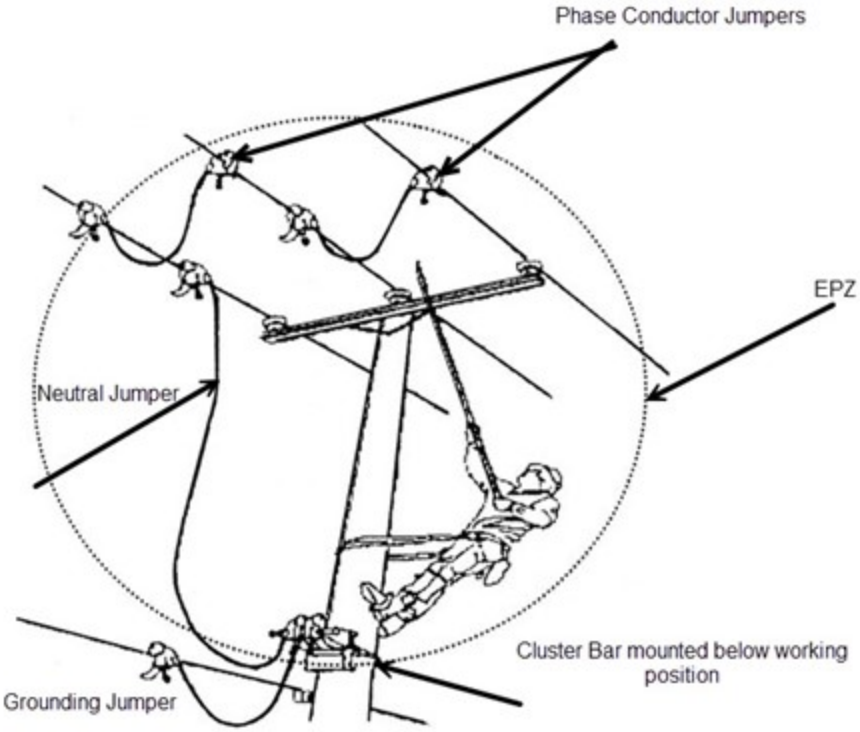
Grounds may be temporarily removed, when necessary, for testing purposes. During a test procedure, the lead worker shall ensure each employee uses insulating equipment and is isolated from hazards and shall institute any additional measures necessary to protect each exposed employee until the grounds are reinstalled.

When the conductor separation at any pole or structure is so great as to make it impractical to apply shorts on all conductors, and where only one conductor is to be worked on, only the conductor to be worked on needs to be grounded.

In cases where ground rods or pole grounds are utilized for personal protective grounding, personnel working on the ground should maintain a sufficient distance from such equipment or utilize other approved procedures designed to prevent touch and step potential hazards.

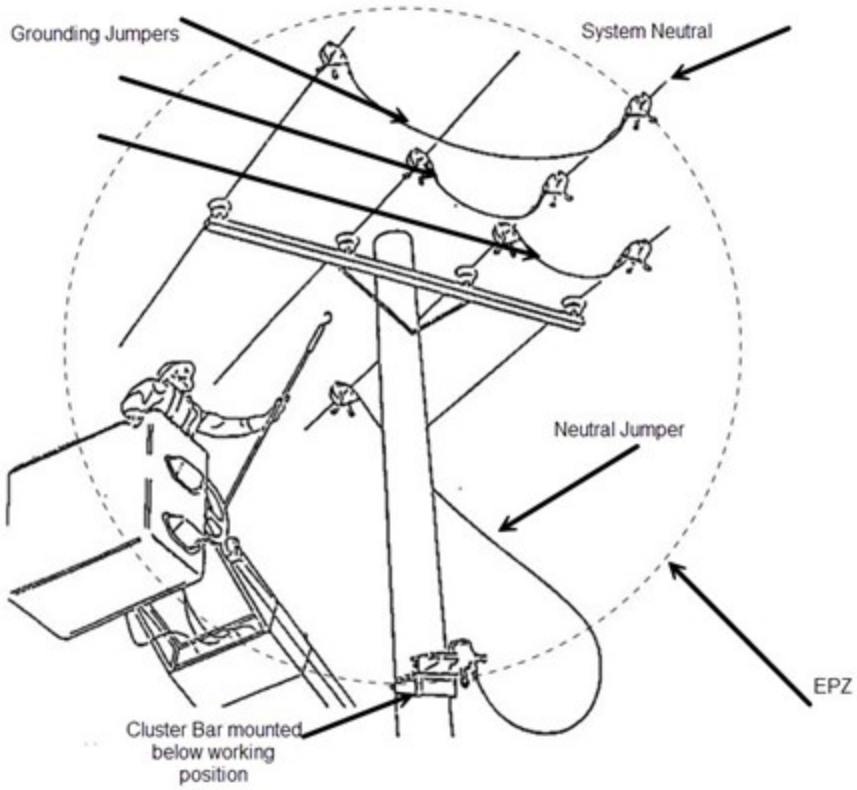
Caution must be taken if the de-energized line to be worked on is parallel to an energized transmission line. Induced voltages and circulating currents may be substantial enough to cause injury or death.

Personal Protective Grounding of Overhead Distribution Lines

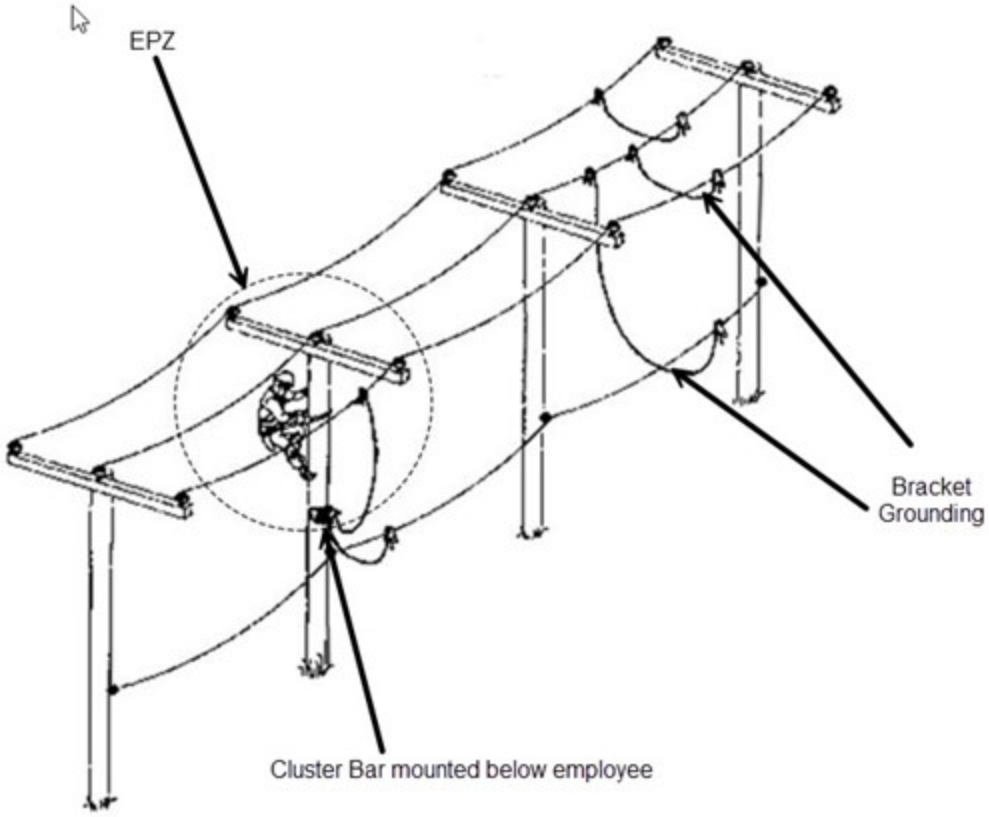


STEP ACTION

1. Identify and isolate the line. Obtain visible openings on the source side (and the load side, if possible) of the line or equipment.
2. Call ECC for a clearance. (Follow clearance guidelines outlined in the District's Switching and Clearance Procedures manual.)
3. Use an approved voltage detector to test the line or equipment to ensure it is de-energized.
4. Make grounding connections in the following order:
    a. Install a cluster bar on the pole just below the work area. Leave adequate working space above it.
    b. Clamp one end of a 4 foot. jumper to the cluster bar, and the other end to the common neutral.
    c. Jumper from the cluster bar to the closest phase conductor. Jumper the other phases together, working from the nearest to the farthest away.
5. Remove the grounds in the reverse order of installation.



If there is a possibility the employee may come into contact with any part of the structure (pole, cross arm, line hardware, grounding jumpers, etc.), personal protective grounds shall be installed. Employees working out of an insulated platform are not exempt from this rule.

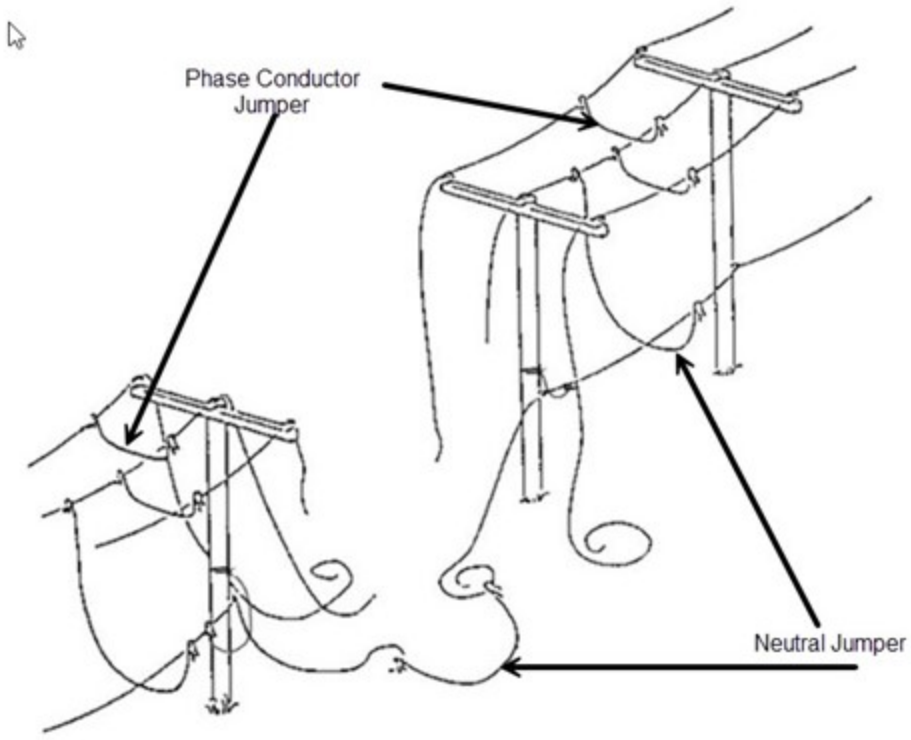


If it is preferred to use a set of bracket grounds, as shown above, line workers shall install personal protective grounding on the structure they will be working on. Install a jumper from the cluster bar to the primary phase being worked. When work moves to another phase on the same pole, move the jumper to the new phase and begin work.

CAUTION: If the de-energized line to be worked is parallel to an energized HV transmission line, an induced voltage may be present. If the line worker uses a set of bracket grounds and a set of personal protective grounds, a circulating current may be present between the two sets of grounds.

The amount of induced voltage and circulating current depends on the voltage on the energized HV transmission line, how close the energized line is to the de-energized line, the distance the two lines parallel each other, and the distance between the two sets of grounds.

Always use an approved live line tool to install/remove all ground jumpers on the phase conductors to be grounded.



DANGER!

WHERE WORK ON DE-ENERGIZED AND GROUNDED LINES AND EQUIPMENT CANNOT BE DONE WITHIN THE EQUIPOTENTIAL ZONE (EPZ), APPROVED RUBBER GLOVES SHALL BE WORN.

STEP ACTION

1. Identify and isolate the line. Obtain visible openings on the source side (and the load side if possible) of the line or equipment.
2. Call ECC for a clearance. (Follow clearance guidelines outlined in the District's Switching and Clearance Procedures manual.)
3. Use an approved voltage detector to test the line or equipment to ensure it is de-energized.
4. Install personal protective grounds on both sides of the worksite at the nearest location where the primary and neutral conductors are in their normal positions, and where the grounds will not interfere with the work.

Note: Touch potential hazards refer to the difference in voltage measured between the grounding equipment and a worker in contact with the grounding equipment at the time it is accidentally energized. Step potential hazards refers to the difference in voltage measured between the feet of the worker standing or walking in an electrical field created by high voltage being brought to earth.

Additional Requirements for Underground

Before cutting into a high-voltage cable or opening a high-voltage splice, the cable shall be de-energized, a clearance obtained, tagged, tested with an approved testing device, and then grounded in an approved manner. If in an area where a high voltage cable or splice is to be cut and the ground cannot visibly be seen, the high voltage cable or splice shall be identified, tested, and spiked before work is performed.

A capacitance charge can remain in high-voltage cables after it has been disconnected from the circuit and a static-type arc can occur when grounds are applied to such cables.

When work is to be done on cables or equipment in a high voltage underground system, precautions to prevent back feed shall be taken. This shall include either isolating or grounding the secondary conductors.

When work is performed on a cable at a location remote from the cable terminal, the cable may not be grounded at the cable terminal if there is a possibility of hazardous transfer of potential should a fault occur. If the cable(s) cannot be isolated and are grounded at a remote location from the work area, an equal potential grounding blanket must be used to protect the employee performing the work.

For more detailed information for grounding different types of underground equipment see T&D Guidelines, 4-20-5.0.

Substation

Grounds applied at North Mountain Substation shall be of flexible 2/0 copper cable or equivalent. One set of grounds will be used on the 230kV side of the transformer and equivalent buss work.

Vehicle Grounding

All lifting equipment shall be bonded to an effective ground or barricaded and worked as energized when utilized on or near energized conductors.

1. Trucks must have the dielectric certification tag near the lower control station. Bucket trucks will be tested annually, and a new tag installed each year.
2. Prior to the first use of the boom each day, and any time the boom has gotten dirty, the upper and lower insulated section of the boom must be cleaned using only the boom cleaning material provided for this purpose. This is included on the preflight visual inspection checklist.
3. For added protection, employees working on the ground shall not touch the truck when standing on the ground or getting on/off the truck when it is being used around energized lines or equipment. Employee (s) on the ground must communicate with the employees in the bucket when they need to get on/off the truck. The bucket shall not be moved during this time. This must be reviewed during the job briefing.
4. All other equipment that does not meet these requirements must be grounded and barricaded as required in the Accident Prevention Manual.

All truck ground leads shall be inspected before use to ensure no damage has occurred to the ground lead or the clamps. Each clamp shall be inspected to assure tight connections at the clamp.

The point of the vehicle to which the ground cable is attached should be thoroughly cleaned and free of paint, rust, oxides, or any other material that might tend to resist the flow of ground current.

All conductors, busses, ground mats, etc., shall be cleaned before attaching ground leads to assure a solid connection.

It is recommended that the excess ground cable be uncoiled from the truck when in use and placed in an area where it will not pose an additional hazard.

Truck grounds shall be a minimum of 1/0 flexible copper or its equivalent and shall be secured to permanently grounded and clean objects in the following order or preference:

1. Station Ground Mat
2. Neutral, System of #4 copper or greater
3. Steel Tower
4. Driven Ground Rod. ONLY IF THE ABOVE ARE NOT AVAILABLE.

Training and Resources

Trainings on Grounding can be assigned to employees' Learning Plans in Learning Central.

WAC 296-45-345 Grounding for the protection of employees