

Vehicle and Equipment Grounding in Substations

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Scope:

This document details the steps required to apply temporary grounding to vehicles and equipment when located in Transmission and Distribution Substations, while maintaining minimum approach distances.

Safety:

Providing a work environment, free of recognized hazards is a value at Eversource. Therefore, prior to the start of any work, ensure that you are familiar and knowledgeable with all Eversource Safety Rules, Policies and Procedures that are applicable to the work and tasks at hand and perform a job brief at the job site, prior to commencing work. PPE requirements to protect the worker shall be followed as required in the [Eversource Employee Safety Manual](#).

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Rev No.	Description	Date
1	Added an exemption to the 4/0 ground cable requirement for fault locating vehicles and test sets that are equipped with manufacturer supplied grounds.	June 16, 2020
0	New Issue	31-May-2020

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1.0 Introduction

- 1.1 When operating vehicles and equipment in Substations electric hazards may be encountered; including energized lines, electric field induction and magnetic field induction.
 - 1.1.1 Proper grounding and isolation techniques covered in this standard help reduce these effects and prevent hazards.
- 1.2 The grounding described in this standard pertains to vehicles and equipment actively engaged in construction and maintenance activities on or near energized or de-energized lines.
 - 1.2.1 Vehicles and equipment NOT actively engaged in construction and maintenance activities and thus not encroaching upon minimum approach distances (MAD), DO NOT require grounding, i.e. a parked vehicle away from the work area.
 - 1.2.2 Vehicles/trucks/vans used for Underground splicing shall be grounded.
- 1.3 To work within MAD, qualified workers must use proper work techniques, equipment, and personal protective equipment (PPE).
- 1.4 This standard SHALL be used in addition to the requirements for applying Temporary Protective Grounding equipment per Work Standard WMS 89.06-234.

2.0 Reference Documents

- SUB 014.3 Substation Grounding Material Catalog
- ESOP 100 Switching and Tagging
- IEEE C57.93 Guide for Installation and Maintenance of Liquid-Immersed Power Transformers
- TD 216 Hot-Sticks Used in Live Line Operations (Maintenance, Inspection, and Testing)
- WMS 89.06-234 Temporary Protective Grounding in Substations
- WMS 88.11-234 Substation Work Area Identification
- WMS 89.11-234 Maintenance & Testing of Personal Protective Grounding Equipment

3.0 Bill of Materials

- 3.1 Refer to Material Standard SUB 014.3 for the Substation grounding material catalog.

4.0 Definitions

- 4.1 Actively Engaged in Operations: Any worker, tool, device or piece of equipment that is performing a task for the project being worked.
- 4.2 Bonding: The practice of intentionally creating an electrical interconnection of conductive parts designed to maintain a common electric potential.
- 4.3 Bonding Cable (Bonding Jumper): A cable connected to two conductive parts to bond the parts together.
- 4.4 Ground Grid (mesh): Dissipates the current flowing in from above grade steel structures or cables into the earth, maintains surface gradients safe for human contact i.e. step and touch potential.
- 4.5 Grounding: Intentionally connecting to earth through a ground connection.

5.0 General

- 5.1 Only trained and qualified personnel shall determine the specific vehicles and equipment requiring grounding within the Substation.
- 5.2 Only trained and qualified personnel shall install and remove ground cables.
- 5.3 The MAD required SHALL never be breached when working around energized equipment.
- 5.4 All bonding and grounding SHALL remain in place until the work is completed.
- 5.5 When ground cable(s) are coiled or on reels, they SHALL be completely removed from the reels or holders, unwound and straightened or laid out in an "S" shape on the ground with no crossover, to reduce the possibility of induced voltages.
- 5.6 When vehicles and/or multiple pieces of equipment are situated where a worker can contact them simultaneously, they SHALL be bonded together into a common ground.
- 5.7 Ground attachment points SHALL be cleaned, and wire brushed prior to the installation of ground cables.
 - 5.7.1 Ensure the ground point of the device to be grounded is metallic and structurally connected to the device.
- 5.8 Bond and ground equipment when pumping, draining or filtering the insulating fluid.

NOTE: Insulating fluids have extremely low conductivity and the static generated when the fluid is pumped, drained or filtered cannot be dissipated and may be carried into the equipment. The static charge can cause high voltages, equipment damage, and injury, unless proper bonding and grounding is implemented.

6.0 Ground Cable Installation

- 6.1 When Temporary Protective Grounding is required, refer to Work Standard WMS 89.06-234 for applying such equipment.
- 6.2 Identify the work area, as defined by WMS 88.11-234.
- 6.3 The lines and equipment being worked SHALL be de-energized under the provisions of the applicable switching authority, see procedure ESOP 100.
- 6.4 Verify the MAD is not being encroached or violated.
- 6.5 Approved live-line tools and rubber gloves SHALL be used to install and remove ground cable assemblies, test equipment leads, or dead-line potential fuses from the live end.
 - 6.5.1 Rubber gloves SHALL be worn, at a minimum, when removing and installing the cold end.
 - 6.5.2 If field conditions do not permit the use of live-line tools, contact Eversource Supervision.
 - 6.5.3 Ensure live-line tools in use have been tested and labeled per TD 216.
- 6.6 Prior to the installation of ground cable assemblies, visually inspect and clean each assembly as detailed in WMS 89.11-234.
 - 6.6.1 If any damage is found, return grounding assembly for repair and testing.

- 6.7 Each clamp and point of attachment shall be cleaned by removing contaminants present like all paint, corrosion, and galvanization.
 - 6.7.1 Clean structural grounding stud with the serrated jaw edges of a ground clamp by manipulating the partially tightened clamp back and forth, or with a stiff wire brush.
 - 6.7.2 Clean conductors, if the connection is made directly to the Substation ground grid, with a wire brush rather than using the serrated jaw of the clamp.
 - 6.7.3 Clean structures to ensure the proper clamp connections.

NOTE: Vehicle grounds are installed in the reverse order of line and equipment grounding. This methodology reduces the risk of a spark at the vehicle.

- 6.8 Installing a ground cable assembly:
 - 6.8.1 FIRST, connect one end of the ground cable to the vehicle or equipment being used.
 - 6.8.2 LAST, the other end SHALL be connected to the appropriate grounding point.
- 6.9 Removing a ground cable assembly:
 - 6.9.1 FIRST, disconnect the grounding point.
 - 6.9.2 LAST, disconnect the ground cable from the vehicle or equipment.

7.0 **Vehicle & Equipment Grounding**

NOTE: Fault locating vehicles and test sets that are equipped with a manufacturer supplied ground cable/wire (i.e. Doble TDR9100) are exempt from the 4/0 ground requirement. The ground cable/wire provided by the manufacturer should be used.

- 7.1 All vehicles and equipment Actively Engaged in construction or maintenance activities SHALL be:
 - 7.1.1 Positioned where they will NOT encroach upon the MAD.
 - 7.1.2 Grounded before work begins, with one (1) ground cable with a minimum size of 4/0 AWG, see Figure 1.
 - 7.1.3 Grounded to the closest ground connection point of the equipment/structure being worked.
- 7.2 All vehicles and equipment Actively Engaged in construction or maintenance activities SHALL be positioned inside the substation fence or, when outside the fence, on the extended substation ground grid.
 - 7.2.1 An equipotential zone for the vehicle, equipment or material outside the substation fence SHALL be created and bonded to the substation ground grid when the vehicle or equipment is:
 - .1.1. Located inside the substation fence and making picks outside the substation fence and off the ground grid, or
 - .1.2. Located outside the substation fence off of the ground grid and making picks inside the substation fence or delivering material into the station yard (i.e. crane).

NOTE: If more than one vehicle is being used, they SHALL be bonded together.

7.3 When a vehicle or piece of equipment is required to be repositioned:

7.3.1 Leave the ground cable ends attached.

.1.1. If the ground cable ends cannot be left attached, they can be removed while the vehicle is repositioned.

7.3.2 A Spotter should be used to ensure the safe travel path and MAD is maintained.

CAUTION: Ground cables SHALL be re-applied before work resumes.

7.4 When a vehicle or piece of equipment is required to be in constant movement:

7.4.1 Preplan a route to avoid encroaching upon the MAD.

.1.1. If a route cannot be determined without encroaching upon the MAD, do NOT proceed until other arrangements are made.

7.5 When a vehicle or piece of equipment is to sit for an extended period:

7.5.1 The vehicle or piece of equipment shall be removed from the work zone.

.1.1. If it cannot be removed from the work zone, it shall be grounded.

.1.2. All Underground splicing vehicles/trucks/vans, regardless of operation, shall be grounded inside a Substation.

8.0 **Aerial Device (Lift) Bonding**

8.1 Bonding cables shall be a minimum 2/0 AWG cable.

8.2 Non-Insulated aerial devices actively engaged in work on de-energized equipment shall be bonded to the properly grounded equipment being worked on, refer to Figure 1.

8.2.1 Whenever possible, the 2/0 RED breakaway bond cable should be used.

8.2.2 If an aerial device is insulated but not rated for the voltage being worked, it shall be treated as a non-insulated device.

NOTE: Bonding of the aerial device does NOT replace grounding of the aerial device. Bonding SHALL be used in addition to the grounding techniques in Section 7.0 of this standard.

9.0 **Bonding Operations for Handling Insulating Fluid**

9.1 Small amounts of insulating fluid may be pumped by hand and do not require special grounding precautions. Verify the volume and pumping method with your Supervisor.

CAUTION: Plastic pumps and those with plastic impellers SHALL NOT be used.

9.2 Prior to connecting a hose to the equipment to be filled:

9.2.1 Switch and tag the equipment per ESOP 100.

9.2.2 Ground the lines and equipment as stated in this document and WMS 89.06-234.

9.3 Ground the pump, it's trailer and filtering devices to the same location as the device being worked on, refer to Figure 2.

NOTE: The size of the required static bond shall be discussed and documented as part of the Grounding Plan.

- 9.4 Bond the insulating fluid storage tank, hose, filtering, and pumping equipment with the transformer tank and to the Substation ground grid, refer to Figure 2.
 - 9.4.1 Shielded hoses bond the equipment being filled to the pump and do not require additional bonding.
 - 9.4.2 Non-shielded hoses do NOT bond the pump to the equipment being filled. Use a bond wire to directly bond the equipment being filled to the pump and its associated equipment.

NOTE: Shielded hoses SHOULD be used whenever insulating fluid handling operations are being performed.

- 9.5 Bond exposed conductors (i.e. primary and secondary transformer bushings, circuit breakers) together and to the equipment ground.
- 9.6 When returning to work on a partially completed insulating fluid pumping/filtering job after it has been shut down for any reason, perform an inspection of all switching, bonding, and grounding PRIOR to resuming work.

Appendix A – Grounding & Bonding Examples

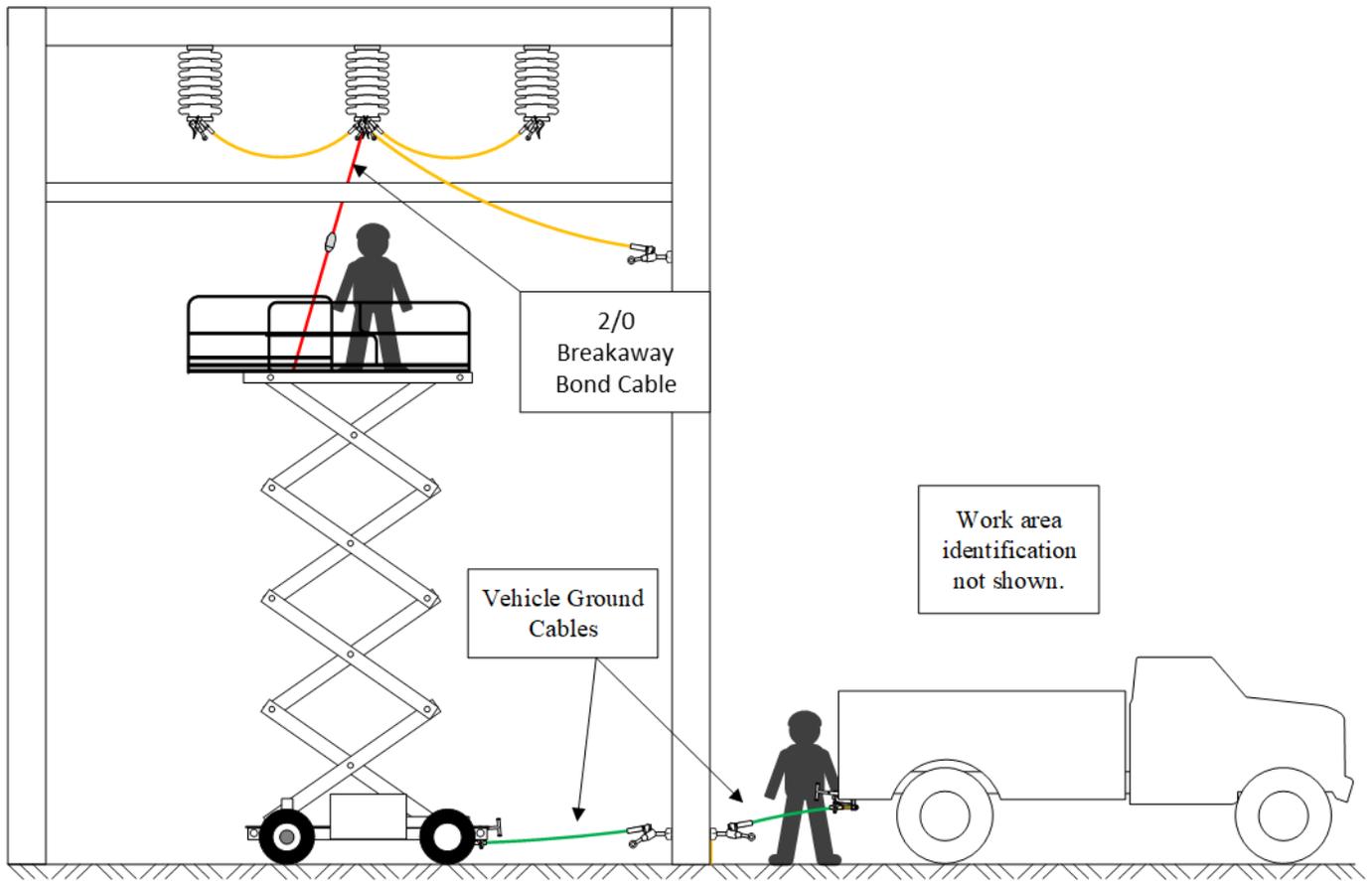


Figure 1 – Example of a Grounded & Bonded Aerial Lift

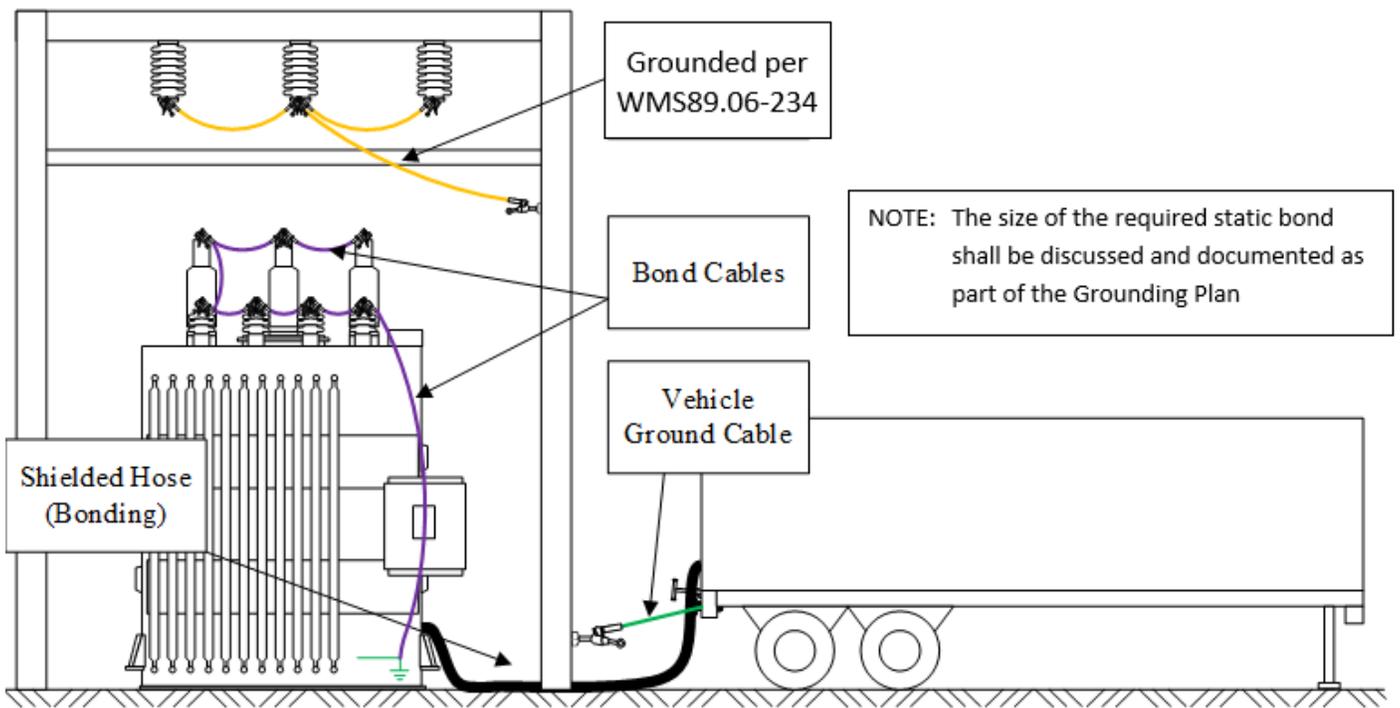


Figure 2 – Example of Insulated Fluid Filling