Grounding Electrodes for Handholes and Vaults

1. Scope

This standard details the requirements for installing grounding electrodes in Network and Looped Radial vaults and handholes.

This standard does not cover streetlight system grounding electrodes which are detailed in Seattle City Light (SCL) Construction Standard 1710.50.

2. Application

This standard provides direction to SCL engineers, crews, inspectors and others about installing a grounding electrode system for use in vaults and handholes.

3. Definitions

Ground electrode: a conductor or group of conductors in intimate contact with the earth for the purpose of providing a connection with the ground.

Concrete-encased electrode: a metallic wire encased in concrete, that is not insulated from direct contact with earth, run as straight as practical for the purpose of providing a connection with the ground.

Wire electrode: a bare wire buried in earth, laid approximately straight for the purpose of providing a connection with the ground.

4. Introduction

A safe electrical system is dependent on its grounding and bonding system. Because conductors, exposed metallic components and other conductive surfaces can become energized, it is critical that grounding and bonding systems be installed correctly. Grounding electrodes are a key component of the grounding and bonding system.

Guiding codes, including the National Electrical Safety Code (NESC), recognize that the ground resistance of an electrode should not exceed 25 ohms.

While an individual 5/8-inch diameter by 8 foot long ground rod is an electrode recognized by the NESC and used extensively by SCL to ground poles and other equipment, soil conditions vary widely throughout seasons of the year and throughout the service territory. Additionally, damage to and theft of grounding conductors continues to be an industry-wide problem so augmenting the grounding electrode system is beneficial to both the safety and the efficacy of the distribution system.

Due to these factors, SCL has chosen to supplement the grounding capability of a single ground rod when installed in a handhole or vault by connecting a concrete-encased electrode whenever possible or at the minimum, a wire buried in dirt directly below the conduit route.

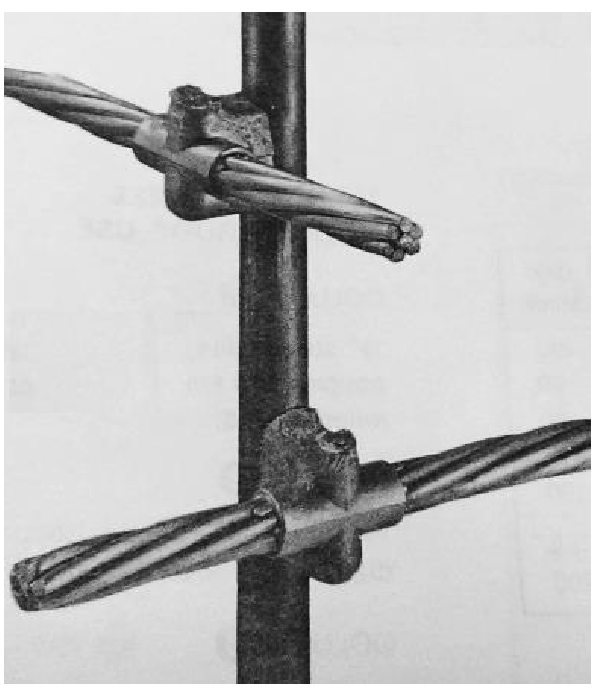
SCL has found installing multiple ground rods at the same location to provide only marginal improvement in reducing ground resistance.

Concrete-encased electrodes are recognized in the industry as a superior grounding electrode in terms of longevity and success in extreme environments and are SCL’s preferred grounding electrode for vaults.

Wire buried directly in earth is also a recognized grounding electrode and is an acceptable substitute when a nearby concrete duct bank is not available to form a concrete-encased electrode.

Exothermic weld connections are recognized as a superior method for connecting grounding components as there are no mechanical parts to fail. This is SCL’s required grounding connection method. See Figure 4.

Figure 4. Exothermic weld for cable to ground rod connection, Example



5. Components

The components necessary for constructing vault and handhole grounding electrodes are shown in Table 5.

Table 5. Grounding Electrode Components

Description	Stock No.	Material Standard
5/8-in x 8-ft ground rod	564238	5642.10
#2 AWG copper wire, bare, stranded	610434	6103.90
250 kcmil copper wire, bare, stranded	610412	6103.90

6. Connections

The following subsections summarize preferred grounding electrode methods. For each trench of conduits that enters a handhole, provide a grounding electrode and connect via exothermic weld per SCL 0468.90. See Table 6.

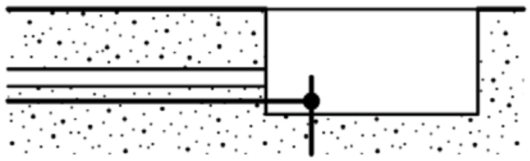
If the grounding electrode recommended below comes in contact with a metallic pole riser conduit, connect with a conduit grounding clamp. See U7-10.9/NDK-120.

Table 6. Grounding Electrode Methods

Condition	Single Vault or Handhole	Series of Vaults or Handholes
Conduits in Soil Trench	Install a ground rod in vault or handhole. For each trench that penetrates vault or handhole, install a 50-ft, #2 AWG wire electrode routed in the bottom of that trench and connect to ground rod with exothermic weld. See Section 6.1.	Install a ground rod in each vault or handhole. Install a continuous #2 AWG wire electrode routed in the bottom of trench throughout the conduit system. Connect cable electrode to ground rod in each vault or handhole with an exothermic weld. See Section 6.2.
Conduits in Encased Ductbank	Install a ground rod outside the vault or handhole. For each duct bank that penetrates vault or handhole, install a 50-ft, 250 kcmil, concrete-encased electrode in the bottom of the duct bank. See Section 6.3.	For each duct bank that penetrates vault or handhole, install a 50-ft, 250 kcmil, concrete-encased electrode in the bottom of the duct bank. See Section 6.4.

6.1 Direct Buried Conduits Entering a Single Vault or Handhole

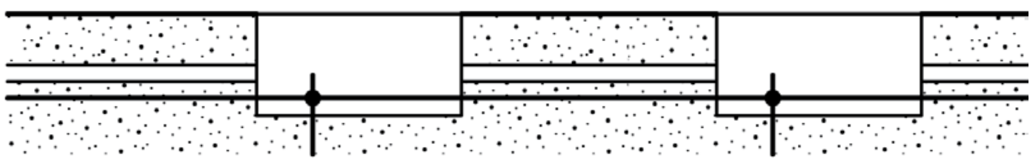
Figure 6.1. Direct buried conduits entering a single vault or handhole



Install a ground rod and connect 50 ft of #2 AWG wire. Route wire electrode in the bottom of the trench. Drill a hole into each vault wall for each grounding electrode entry. Drill each hole through the vault on the same wall that the conduits enter, above the water table if present. At entry into vault, exothermically weld each wire to eliminate air gaps between strands. Seal the wire's entry into vault to prevent water intrusion.

6.2 Direct Buried Conduits Entering a Series of Vaults or Handholes

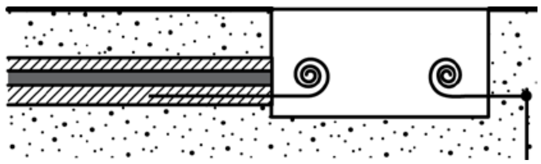
Figure 6.2. Direct buried conduits entering a series of vaults or handholes



Install a continuous #2 AWG wire throughout the system and exothermically connect to the ground rod in each handhole. Route wire electrode in the bottom of the trench. Drill a hole into each vault wall for each grounding electrode entry. Drill each hole through the vault on the same wall that the conduits enter, above the water table if present. At entry into vault, exothermically weld each wire to eliminate air gaps between strands. Seal the wire's entry into vault to prevent water intrusion.

6.3 Concrete Duct Bank Conduits Entering a Vault or Handhole

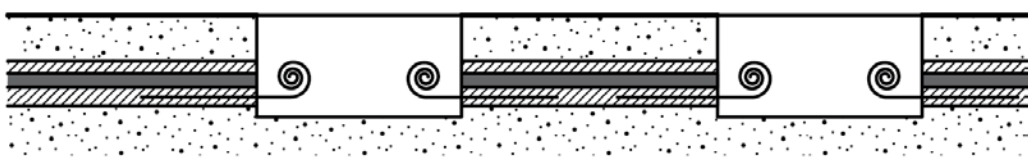
Figure 6.3. Concrete duct bank conduits entering a vault or handhole



For each duct bank that penetrates the vault or handhole, install 50 ft of bare 250 kcmil wire in the bottom of that duct bank to form a concrete-encased electrode. Wire must be positioned to ensure it is surrounded by 2 in of concrete on all sides when concrete is poured. Install a ground rod outside the vault. For each electrode, install 20 ft of additional wire in order to route it from the electrode, up through drilled hole in vault, and down to common grounding point within vault. Drill a hole into each vault wall for each grounding electrode entry. Drill each hole through the vault on the same wall that the electrode enters, above the water table if present. At entry into vault, exothermically weld each wire to eliminate air gaps between strands. Seal the wire's entry into vault to prevent water intrusion.

6.4 Concrete Duct Bank Conduits Enter a Series of Vaults or Handholes

Figure 6.4. Concrete duct bank conduits enter a series of vaults or handholes



For each duct bank that penetrates the vault or handhole, install 50 ft of bare 250 kcmil wire in the bottom of that duct bank to form a concrete-encased electrode. Wire must be positioned to ensure it is surrounded by 2 in of concrete on all sides when concrete is poured. Install 20 ft of additional wire in order to route it from the duct bank, up through drilled hole in vault, and down to common grounding point within vault. Drill a hole into each vault wall for each grounding electrode entry. Drill each hole through the vault on the same wall that the duct bank enters, above the water table if present. At entry into vault, exothermically weld each wire to eliminate air gaps between strands. Seal the wire's entry into vault to prevent water intrusion.

7. Testing

The grounding electrode system shall be constructed to ensure it has a resistance to ground of 25 ohms or less prior to connecting the neutral or service. SCL shall test to confirm compliance. If the electrode system does not result in a resistance to ground of 25 ohms or less, inform SCL engineer. SCL shall advise additional grounding measures required.

8. References

SCL Construction Standard U7-10.9/NDK-120; "Grounding Conduit Risers on Poles"

SCL Construction Standard 0468.90; "Exothermic Connection System"

SCL Material Standard 6762.90; "Exothermic Connection System"

SCL Design Standard 9702.30; "Grounding and Bonding, Fundamentals and Detailed Requirements"

9. Sources

Hanson, Brett; SCL Standards Engineer, originator and subject matter expert for 0461.10 (brett.hanson@seattle.gov)

National Electric Safety Code (NESC), C2-2012 Edition; Institute of Electrical and Electronics Engineers (IEEE), Inc. New York, NY, 2011

The Authoritative Dictionary of IEEE Standards Terms (IEEE 100-2000); Seventh Edition; Institute of Electrical and Electronics Engineers (IEEE), 2000