

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.

See SCL 1714.50 for additional streetlight system details.

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.

Exothermic waterstop: A multi-strand wire electrode and pigtail spliced exothermically to form a barrier against water intrusion. The waterstop is grouted at the exterior vault wall penetration.

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.

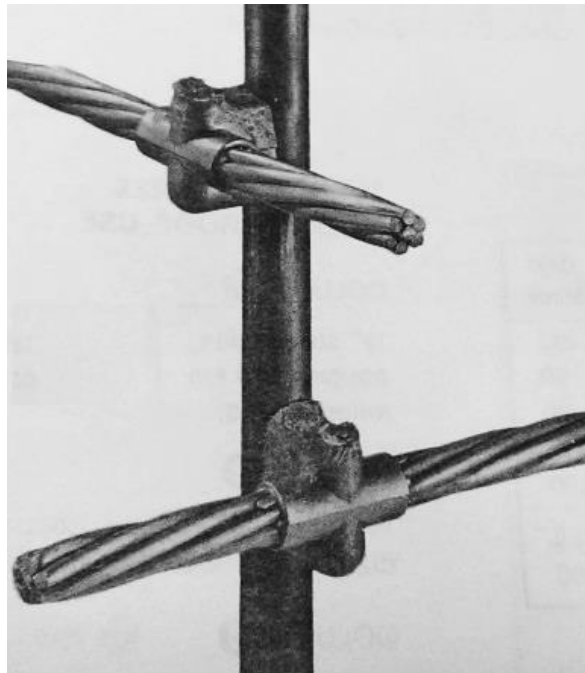
SCL has found installing multiple ground rods at the same location to provide only marginal improvement in reducing ground resistance.

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	6762.25
#2 AWG copper wire, bare, stranded	610434	6103.90
250 kcmil copper wire, bare, stranded	610412	6103.90
#4 AWG copper wire, bare, solid	610208	6102.20

6. Connections

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

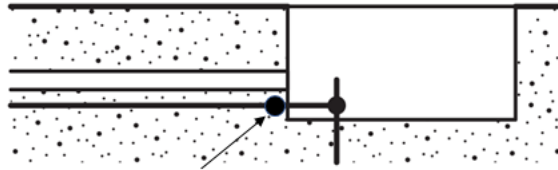
If the grounding electrode recommended below comes in contact with a metallic pole riser conduit, connect with a conduit grounding clamp. See U7-10.9/NDK-120.

Table 6. Grounding Electrode Methods

Condition	Single Vault or Handhole	Series of Vaults or Handholes
Conduits in Soil Trench	<p>Install a ground rod in vault or handhole.</p> <p>For each trench that penetrates vault, handhole, or pole foundation, install a 50-ft, wire (#2 AWG for Service or #4 AWG for Streetlight) electrode routed in the bottom of that trench and connect to ground rod with exothermic weld. See Section 6.1.</p>	<p>Install a ground rod in each vault or handhole.</p> <p>Install a continuous wire (#2 AWG for Service or #4 AWG for Streetlight) 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.</p>
Conduits in Encased Duct Bank	<p>Install a ground rod outside the vault or handhole.</p> <p>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.</p>	<p>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.</p>

6.1 Direct-Buried Conduits Entering a Single Vault or Handhole

Figure 6.1. Direct-Buried Conduits Entering a Single Vault or Handhole



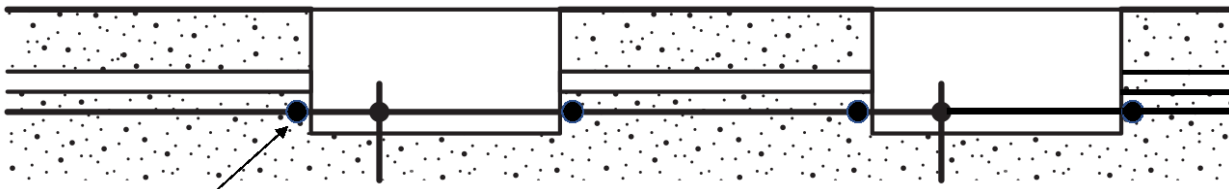
EXOTHERMIC WATERSTOP, TYPICAL

For each direct-buried conduit entering a single vault or handhole:

- Install a ground rod and connect 50 ft of wire (#2 AWG for Service or #4 AWG for Streetlight).
- 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 and form an exothermic waterstop.
- Seal the wire's entry into vault with non-shrink grout 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



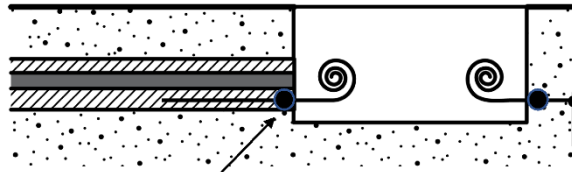
EXOTHERMIC WATERSTOP, TYPICAL

For each direct-buried conduit entering a series of vaults or handholes:

- Install a continuous wire (#2 AWG for Service or #4 AWG for Streetlight) 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 by cutting the wire and welding it back together to eliminate air gaps between strands and form an exothermic waterstop.
- Seal the wire's entry into vault with non-shrink grout 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



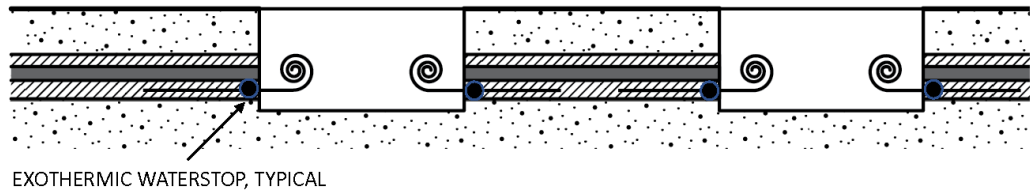
EXOTHERMIC WATERSTOP, TYPICAL

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 near the bottom corner of encasement to ensure it is surrounded by a minimum of 2 inches 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 by cutting the wire and welding it back together to eliminate air gaps between strands and form an exothermic waterstop.
- Seal the wire's entry into vault with non-shrink grout 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

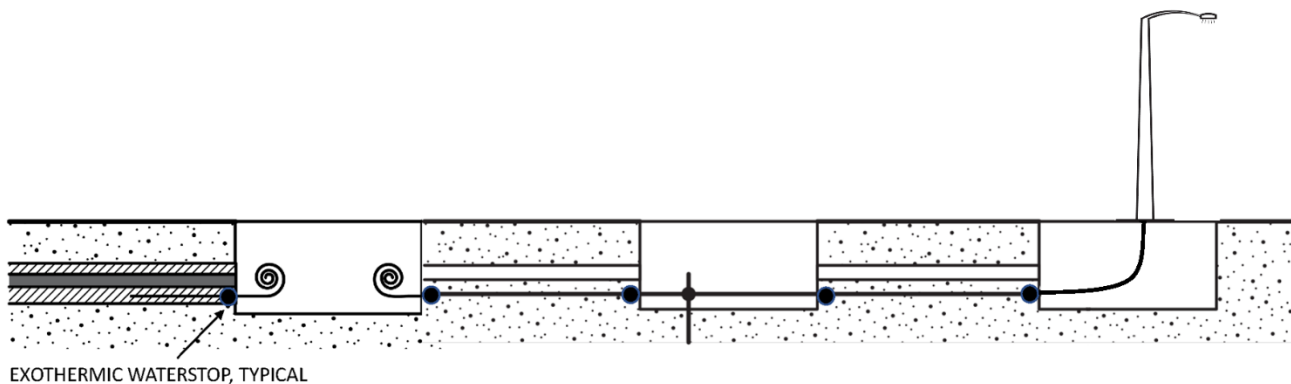


For each duct bank that penetrates the vault or handhole:

- 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 near the bottom corner of encasement to ensure it is surrounded by a minimum of 2 inches 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 by cutting the wire and welding it back together to eliminate air gaps between strands and form an exothermic waterstop.
- Seal the wire's entry into vault with non-shrink grout to prevent water intrusion.

6.5 Mixed-Use Vault, Handhole, or Pole/Pedestal Foundation

Figure 6.5. Mixed-Use Vault, Handhole, or Pole/Pedestal Foundation



For each set of conduits that enter the vault or handhole:

- Install a continuous wire (#2 AWG for Service or #4 AWG for Streetlight) 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 by cutting the wire and welding it back together to eliminate air gaps between strands to form an exothermic waterstop.
- Seal the wire's entry into vault with non-shrink grout to prevent water intrusion.

For each duct bank 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 near the bottom corner of encasement to ensure it is surrounded by a minimum of 2 inches 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 by cutting the wire and welding it back together to eliminate air gaps between strands to form an exothermic waterstop.
- Seal the wire's entry into vault with non-shrink grout to prevent water intrusion.

For each pole/pedestal foundation served by the vault or handhole, extend the continuous wire to the fixture.

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 Construction Standard 1714.50**; Underground Streetlight Systems
- SCL Material Standard 6102.20**; "Wire, Solid Bare Copper, Dead-Soft-Annealed"
- SCL Material Standard 6103.90**; "Wire, Copper, Bare, Soft-drawn"
- SCL Material Standard 6762.25**; "Ground Rods, Copper-Covered, Sectional"
- SCL Material Standard 6762.90**; "Exothermic Connection System"

9. Sources

Hanson, Brett; SCL Standards Engineer, originator and subject matter expert for 0461.10

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