

## CHAPTER 13 – GROUNDING AND BONDING

### GROUNDING AND BONDING

Grounding and bonding must be in accordance with Article 250 of the National Electrical Code (NEC).

Bonding is defined in the NEC as the permanent joining of metallic parts required to be electrically connected. In a traffic control signal or lighting system, the term is used to describe the electrical and mechanical connection of conduit, metal poles, cabinets, and service equipment.

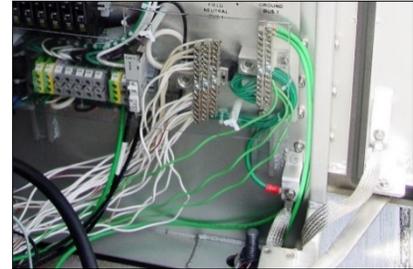


Figure 13-1: Bonding

Grounding is defined in the NEC as a conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conductive body that serves in place of earth. By directing current along a path to earth, bonding and grounding reduces, but does not eliminate, the danger of unwanted electrical current reaching the surface of equipment, causing damage and electrical shocks to anyone working on the system.

For traffic control signal systems grounding electrodes (ground rod electrodes) are installed at all service points, in the handhole adjacent to the mast arm pole bases, and within pedestal concrete foundations as specified in the contract documents.



Figure 13-2: Grounding

All MnDOT service equipment pads (signals and lighting) must have two grounding electrodes installed.

Additionally, any rebar grids within the service equipment pads must also be bonded to ground.

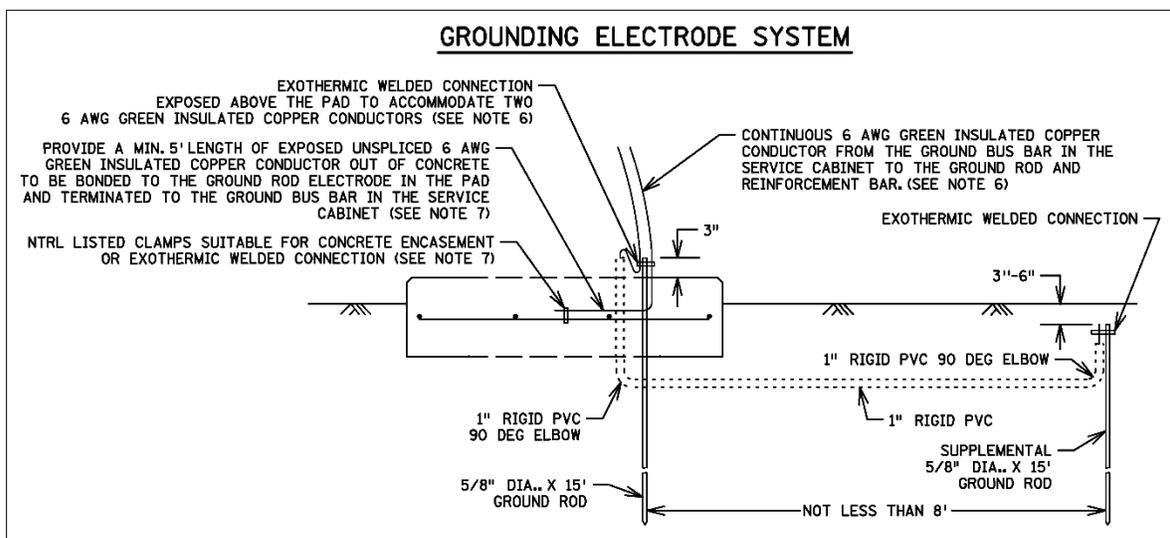


Figure 13-3: Grounding Electrode System

### 13.1 Connections

Rigid steel conduit runs are tied together by screwing each length of conduit together so that the ends of the conduit butt or come together for the full circumference to provide an electrically bonded and grounded connection throughout the entire length of the conduit run.

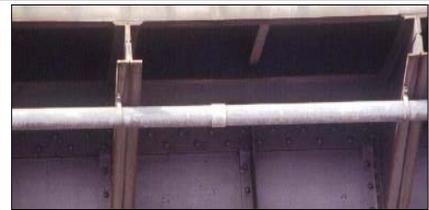


Figure 13-4: Steel Conduit

#### 13.1.1 GROUNDING WIRE

Rigid steel conduit runs are bonded together in handholes by a solid 6 AWG bare copper wire attached to the lug on thread bushings which are installed on the open ends of conduit at the end of the run. A 6 AWG stranded green insulated conductor is also pulled through rigid steel conduit as indicated in the contract documents.

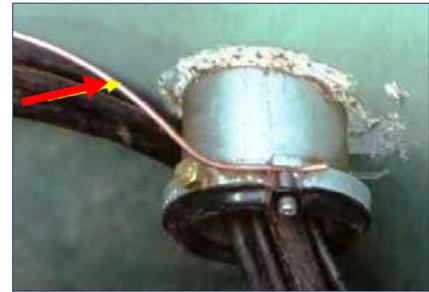


Figure 13-5: Conduit in Handholes

In pole bases, rigid steel conduit and grounding conductors are tied to the grounding stud provided in the metal base utilizing an active clamping grounding lug with mounting tang.



Figure 13-6: Grounding Stud

On an equipment pad, the ground rod and grounding connection is located in the signal service cabinet.

Bonding of all ground rod electrodes to the 6 AWG stranded green insulated ground wire must be accomplished by exothermic welding.

Service equipment is tied to a ground rod if the service is not on the equipment pad (see Figure 13-8).



Figure 13-7: Green Insulated Ground Wire



Figure 13-8: Ground Rod Tie

All new traffic control signal systems must have a 6 AWG green insulated stranded grounding wire installed from the signal cabinet to each pole base. This grounding wire may be daisy chained from signal pole base to signal pole base. Consult the field wiring diagram for details. Each signal pole must have its own ground rod located in the handhole adjacent to the signal base. A 6 AWG

green insulated stranded grounding wire must run from the ground rod to the pole base. The ground wire coming from the ground rod will be spliced to the grounding wire running to the signal cabinet and to the 6 AWG grounding wire running to the ground lug on the transformer base using exothermic welding.

**13.1.2 EQUIPMENT GROUND BUS**

The equipment ground bus must be grounded to the source of power ground rods with a 6 AWG green insulated stranded ground wire. If cracks or pavement joints are encountered, refer to Standard Plate No. 8130 for complete details of installation requirements.

When ground rod electrodes are required to be installed outside of the foundation and rock is encountered preventing the ground rods from being installed vertically, follow the installation requirements for rod electrodes in accordance with the NEC. If it is not possible to install ground rods according to the installation requirements of the NEC, install plate electrodes in accordance with Standard Specification 3818 as directed by the engineer.

As presented in Figure 13-10, a 6 AWG equipment grounding wire must be properly connected from the equipment ground bus in the cabinet to the neutral bonding bar of the service equipment and to each incoming RSC conduit grounding bushing lug if RSC conduit is used.

A separate 6 AWG green insulated grounding conductor is run through the conduit system and used for equipment ground purposes. The separate 6 AWG green insulated conductor is used in both non-metallic conduit (NMC) and rigid steel conduit (RSC) systems.

Oxide inhibitor agent for use on electrical conductors must be applied to all 6 AWG grounding connections after both assembly and final connection.



Figure 13-9: Grounding Wire in Pole Base

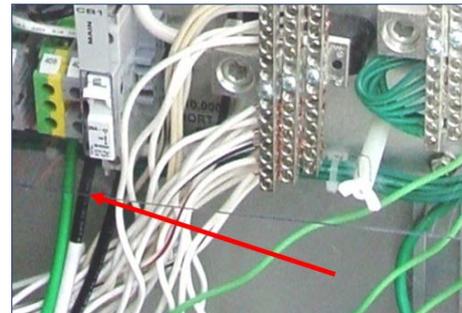


Figure 13-10: Ground Wire in a Signal Cabinet



Figure 13-11: Oxide Inhibitor Agent

When existing conduit is incorporated into a new system, the contractor must furnish and install new bonding and grounding jumpers and new threaded conduit bushings on open ends of in place conduit as directed by the engineer.

Additional details on this subject are in the contract documents and must be reviewed. Standard Specifications 2545.3.R and 2565.3.D.4.b provide additional guidance.

### 13.2 Direct Buried Lighting Cable

The direct buried lighting cable must be 4 conductor 4 AWG (4/C 4 AWG) and meet the specifications in the contract documents.

Install supplemental ground rod electrodes in locations specified in the contract.

Provide two grounding electrodes at the service points and every other light pole foundation and at the light pole foundation located at both ends of a run, unless otherwise specified in the contract.

See Standard Specification 2545.3R for additional information regarding bonding and grounding.



Figure 13-12: Direct Buried Lighting Cable

The direct buried lighting cable must be grounded and bonded as follows:

- The copper shield must be terminated on the equipment ground bus in the service cabinet.
- The green insulated grounding conductor must be terminated on the equipment ground bus in the service cabinet.

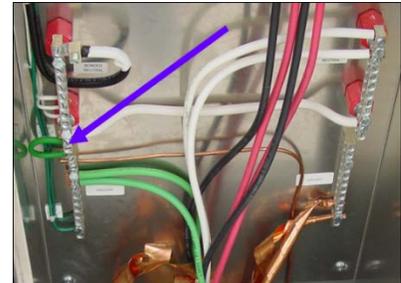


Figure 13-13: Proper Ground Connection in a Lighting Service Cabinet

In the light pole base, the copper shield and grounding conductor must be bonded together by drilling the copper shielding and placing it underneath the grounding lug before bolting the assembly to the pole base. The grounding conductor should then be terminated in the active clamping grounding lug.

Oxide inhibitor agent must be applied to all grounding connections after both assembly and final connection.



Figure 13-14: Grounding Connection

Below are the special provisions for high mast light tower pole grounding?

### 1. Electrical Requirements

Provide bonding and grounding that meets the provisions of MnDOT 2545.3R, as detailed in the Plans and as follows:

- a. Use 5/8<sup>th</sup> inch by 15 foot NRTL listed ground rod electrodes.
- b. Drill the copper shielding for each cable assembly, in each pole base, with an 11/32 drill and place on the grounding stud provided in the pole base.
- c. Place a Re-usable screw type active clamping ground lug with a tang on top of the shielding.
- d. Provide bonding of the 6 AWG solid bare grounding conductor to the pole base 11/32" grounding stud by using a UL listed Re-usable screw type active clamping ground lug with a tang that connects to the 11/32" pole base grounding stud and to the grounding terminal in the pole circuit breaker enclosure.
- e. A No. 6 bare copper wire must connect the pole grounding lug to the equipment ground terminal in the pole circuit breaker box and to the pole grounding electrode system (steel piling or alternate grounding system).
- f. Tighten the entire assembly (copper shielding and the grounding lug) to form an electrically bonded and grounded connection.
- g. Apply an oxide inhibiting agent to the connection after both final connection and assembly.



Figure 13-15: High Mast Tower Grounding Requirements

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### **13.3 Chapter 13 Resources**

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- Article 250 of the National Electrical Code (NEC)
- MnDOT Standard Specifications for Construction 2545.3.R, 2565.3.D.4.b, 3815.2C.1, and 3818
- Standard Plates 8106, 8107