

The National Electrical Code or the National Electrical Safety Code?

IMSA Journal Article by Tom Baker

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Which Applies to Traffic Signal and Roadway Lighting Applications?

It is often confusing as to when the National Electrical Code (NEC) applies, and when the National Electrical Safety Code (NESC) applies for Traffic Signal and Roadway Lighting applications. The last version of the IMSA Traffic Signal Level II Study Guide stated the NESC is the primary document of interest with respect to traffic signal design and construction. The NEC and the NESC are vastly different as to their purpose and use.

The NEC

The purpose of the NEC is given in section [90.1] Purpose:

(A) Practical Safeguarding. The purpose of this Code is the practical safeguarding of persons and property from hazards arising from the use of electricity.

In section [90.2] Scope, the NEC defines what is covered and not covered:

(A) Covered. This Code covers the installation of electric conductors, electric equipment, signaling and communications conductors and equipment, and fiber optic cables and raceways for the following:

- (1) Public and private premises, including buildings, structures, mobile homes, recreational vehicles, and floating buildings*
- (2) Yards, lots, parking lots, carnivals, and industrial substations*
- (3) Installations of conductors and equipment that connect to the supply of electricity*

While street lighting is not specifically mentioned, if installed by other than an electric utility (see below), it would constitute electric conductors and equipment, whether installed on public or private premises, street lighting would be under the scope of the NEC. Of course this is dependent upon any local laws and ordinances.

In NEC Article 100, the definition of Premise Wiring states it is the interior and exterior wiring, including lighting, control, and signal circuit wiring together with all fittings, extending from the service point to the outlet(s). The service point is the point of connection between the electric utility and the premises wiring [Article 100 Definition-Service Point].

The NEC applies to traffic signal and roadway lighting, as it is premise wiring on the customer side of the service point.

What the NEC does not cover is given in section [90.2(B)]:

(B) Not Covered. This Code does not cover the following:

- (5) Installations under the exclusive control of an electric utility where such installations*
 - a. Consist of service drops or service laterals, and associated metering, or*
 - b. Are located in legally established easements, rights-of-way, or by other agreements either designated by or recognized by public service commissions, utility commissions, or other regulatory agencies having jurisdiction for such installations, or*
 - c. Are on property owned or leased by the electric utility for the purpose of communications, metering, generation, control, transformation, transmission, or distribution of electric energy.*

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Section (B)(5)(b) was added in the 2002 NEC. It allows an electric utility to install equipment and conductors on easements, as defined by a regulatory agency. This is typically taken to allow an electric utility to install street and area lighting on rights of ways. Some jurisdictions allow area lighting in common areas, but not normally on private property. An electric utility installing lighting under Section (B)(5)(b) would follow the rules of the NESC.

2005 NEC Proposal Clarifies Street Lighting is Covered in Scope

Proposal 1-19 for the 2005 NEC would have added “street lights” to the list of covered installations. The Code Making Panel rejected the proposal and the panel statement makes it clear that the NEC covers street lighting other than those described in 90.2(B)(5)(b).

The NESC

Section 1 010 Purpose

The purpose of these rules is the practical safeguarding of persons during the installation, operation or maintenance of electric supply and communications lines and associated equipment. These rules contain the basic provisions that are considered necessary for the safety of employees and the public under the specified conditions. This code is not intended as a design specification or as an instruction manual.

The NESC covers electric utility facilities and operations up to the service point [Rule 011.B]. Street and area lights under the exclusive control of electric utilities are covered by the NESC even if installed by their authorized contractors or other qualified persons. [Rule 011.C]. The thrust of Rule 011 is to permit the installation of area lighting on private property if the lighting is installed on the utility side of the service point. The local ordinances, laws, and utility commissions have to determine the interpretation of the discrepancy between the two Codes.

Difference between the NEC and NESC

The NEC is a minimum standard, and observing its requirements and proper maintenance will result in an installation basically hazard free; however it may not be convenient or allow for future expansion [90.2 (B)]. Its purpose is the “practical safeguarding of persons and property against hazards arising from the use of electricity”.

The NESC purpose is to the practical safeguarding of people during the installation, operation or maintenance of electric supply and communications lines and associated equipment. [Rule 010]

Example of NEC and NESC Differences

The NEC is a prescriptive document. Following the basic requirements will result in an installation that is essentially free from hazard. By following the instructions (prescriptive compliance) you will achieve the desired results [Section 90.1].

The NESC relies on qualified persons doing the design and installation resulting in a performance requirement [Rule 010].

An example would be the sizing of a feeder or branch circuit equipment-grounding (bonding) conductor.

- The NEC requires that the minimum size of the equipment-grounding (bonding) conductor be based on the size of the overcurrent protective device for the feeder or branch circuit [Section 250.122].

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- The NESC requires the non-current carrying metal parts of lamp posts, metal conduits and raceways, metal cases and frames of equipment be “effectively grounded” [Rule 215.C.1]. Effectively grounded is a connection of sufficiently low impedance, and adequate current carrying capacity to limit the buildup of voltages to avoid undue hazard to persons [Section 2 Definition of Effectively Grounded].

In the case of the NEC, there is a prescriptive requirement, giving a minimum size. The NESC has a performance requirement. The end result for either the NEC or NESC should be the same, the size of the equipment grounding (bonding) conductor is sufficient to conduct sufficient fault current to cause the overcurrent protective device to clear a line to case fault.

Note: Frequently in Traffic Signal and Roadway Lighting applications, the minimum size and/or type of the equipment grounding (bonding) conductor will be specified in the project specifications.

In NEC section [250.4], General Requirements for Grounding and Bonding, it states *the following general requirements identify what grounding and bonding of electrical systems are required to accomplish. The prescriptive methods contained in Article 250 shall be followed to comply with the performance requirements of this section.* The NEC is saying that by following the prescriptive requirement in Article 250, we will comply with the grounding and bonding requirements that follow in Article 250.

Summary

Following either the NEC or NESC can result in a safe installation. The NEC applies to traffic signal and roadway lighting applications, for premise wiring, at buildings and structures on the customer side of the service point. The NESC applies to Electric Utilities for the installation, operation or maintenance of electric supply and communications lines and associated equipment. An Electric Utility is recognized by a public service commissions, utility commissions or similar. The current version of the IMSA Level II Traffic Signal Study Guide has been changed to reflect that the NEC is the primary document of interest.

Grounding of Metal Traffic Signal and Roadway Lighting Poles

A low impedance path to the service grounded conductor neutral bonding point is required to allow sufficient fault current to clear the overcurrent protective device. This is required in section [250.4(A)(3)] of the NEC and [Rule 215.C1] of the NESC. Failure to provide this low impedance path can result in a metal lighting pole remaining energized in a line to case fault. Some persons incorrectly feel that ground rods assist in clearing a line to case fault.

Note: Ground rods can be used to clear utility line to case faults. Due to the higher voltages (example 12,470 V) sufficient current will normally flow through the ground rod to clear a fault. This is not the case with traffic signal and roadway lighting systems operating at 120/240 volts, or 480/277Y volts.

Authors Note: The following is reprinted with permission from Mike Holts 2002 Grounding and Bonding Text.

The NEC does permit a ground rod at a pole [250.54] but the Code does not allow the earth to be used as the sole equipment-grounding (bonding) conductor. An equipment-grounding (bonding) conductor of a type specified in 250.118 is ALWAYS required.

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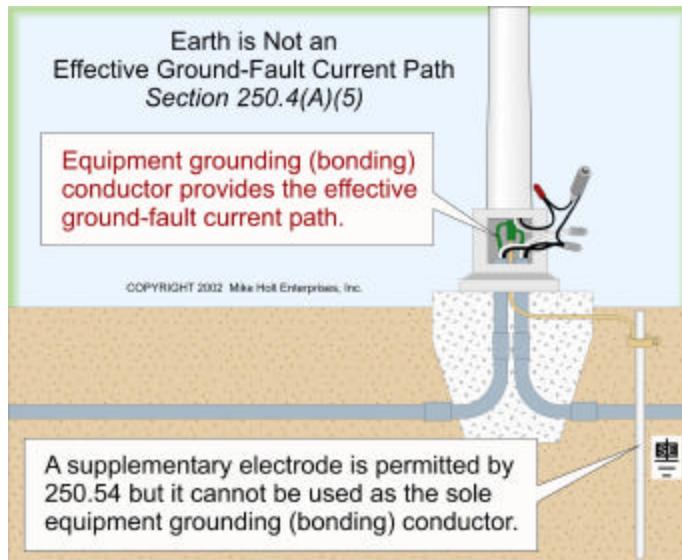


Figure 250-29

CAUTION: Because the earth is a poor conductor whose resistivity does not permit sufficient fault current to flow back to the power supply [IEEE Std. 142 Section 2.2.8], a ground rod will not serve to clear a ground fault and dangerous touch voltage will remain on metal parts if an effective ground-fault current path is not provided.

DANGER: Because the resistance of the earth is so great (10 to 500?), very little current will return to the power supply via the earth if the earth is the only ground-fault return path. The result is that the circuit overcurrent protection device will not open and metal parts will remain energized at a lethal level waiting for someone to make contact with them and the earth. Therefore, a ground rod cannot be used to lower touch voltage to a safe value for metal parts that are not bonded to an effective ground-fault current path. To understand how a ground rod is useless in reducing touch voltage to a safe level, let's review the following:

- What is touch voltage?
- At what level is touch voltage hazardous?
- How earth surface voltage gradients operate.

1. Touch Voltage -The IEEE definition of touch voltage is "the potential (voltage) difference between a grounded (bonded) metallic structure and a point on the earth 3 ft from the structure."

2. Hazardous Level -NFPA 70E -Standard for Electrical Safety Requirements for Employee Workplaces, cautions that death and/or severe electric shock can occur whenever the touch voltage exceeds 30V.

3. Surface Voltage Gradients -According to IEEE Std. 142 "Green Book" [4.1.1], the resistance of the soil outward from a ground rod is equal to the sum of the series resistances of the earth shells. The shell nearest the rod has the highest resistance and each successive shell has progressively larger areas and progressively lower resistances. The following table lists the percentage of total resistance and the touch voltage based on a 120V fault. The table's percentage of resistance is based on a 10 ft ground rod having a diameter of 5/8 inches. Don't worry if you don't understand the above statement, just review the table below with [Figure 250-31]

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Distance from Rod	Resistance	Touch Voltage
1 Foot (Shell 1)	68%	82 V
3 Feet (Shells 1 and 2)	75%	90 V
5 Feet (Shells 1, 2 and 3)	86%	103 V

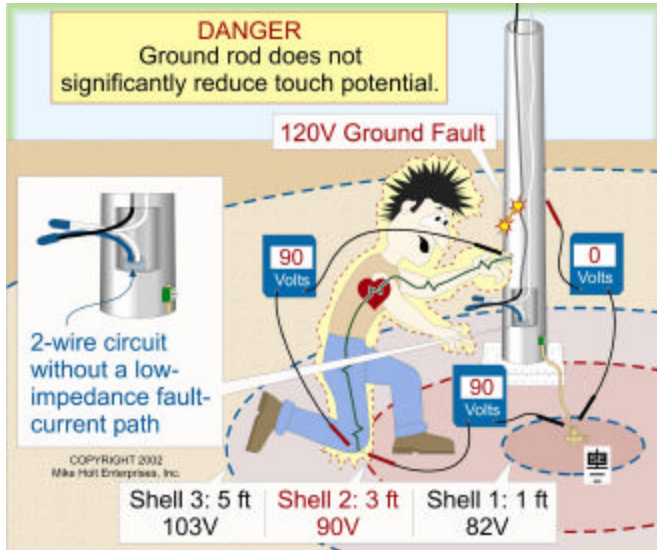


Figure 250-31

With the intention of providing a safer installation, many think a ground rod can be used to reduce touch voltage. However; as we can see in the above table, the voltage gradient of the earth drops off so rapidly that a person in contact with an energized object can receive a lethal electric shock one foot away from an energized object if the metal parts are not bonded to an effective ground-fault current path.

Scary as it might be, the accepted grounding practice for street lighting and traffic signaling for many parts of the United States was to use the ground rod as the only ground-fault current return path. That is, the metal pole of a light fixture or traffic signal is grounded to a ground rod and an effective ground-fault current path is not provided (no equipment grounding conductor)! I'm sure there are thousands of energized metal poles, just waiting for someone to make contact with them and this is one of the reasons so many people get killed with street lighting and traffic signal poles in the United States.

For an article on "Unsafe Installations at Metal Light Poles", visit www.mikeholt.com/news/archive/html/8/04-22-2002-6-35.htm

Authors Note:

Mike Holt, of Mike Holt Enterprises, Inc, kindly supplied the material from his Grounding and Bonding text for this article. For more information on his National Electrical Code materials and services, visit www.mikeholt.com.

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ⁱ IEEE Std 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems