TRAFFIC SIGNAL AND ROADWAY LIGHTING
Ten Common NEC Violations

By Tom Baker

Authors Note: The following are some of the common Traffic Signal and Roadway Lighting NEC violations that I have noted as an instructor. If you feel strongly that the following practices should be allowed, submit a proposal to change the NEC. Since the deadline for 2008 NEC proposals has passed, your proposal will be for a change to the 2011 NEC. Deadlines for 2011 NEC proposals will be November 2008.

The author made the following proposal to allow the continued use of IMSA 19-1 Cable:

Proposal:
250.119 Identification of Equipment Grounding Conductors

Unless required elsewhere in this Code, equipment grounding conductors shall be permitted to be bare, covered, or insulated. Individually covered or insulated equipment grounding conductors shall have a continuous outer finish that is either green or green with one or more yellow stripes except as permitted in this section. Conductors with insulation or individual covering that is green, green with one or more yellow stripes, or otherwise identified as permitted by this section shall not be used for ungrounded or grounded circuit conductors.

Exception: A green or green with yellow stripe conductor may be used for other than equipment grounding purposes for traffic signals, when the conditions of maintenance and supervision ensure that only qualified persons service the installation, and a listed traffic signal cable is used.

Note: Comments for the 2008 NEC proposals can be made once the proposals are published in April, 2006 and will be accepted until October 2006.

1. Low Voltage and Power/Lighting Circuits in the same enclosure, raceway, or pole

Examples:
• Pedestrian push button circuits and signal power in a junction box
• Video camera coaxial cable and luminaire power in a lighting pole

NEC Sections Violated:
• 725.55 Separation from Electric Light, Power, Class 1, Non–Power-Limited Fire Alarm Circuit Conductors, and Medium Power Network-Powered Broadband Communications Cables - (A) General
• 410.15 Supports - (B) Metal Poles Supporting Luminaires (Lighting Fixtures).

Why it’s a violation:
NEC section 300.3(C)(1) seems to allow conductors insulated for the same maximum voltage in the same enclosure or raceway:

Conductors of circuits rated 600 volts, nominal, or less, ac circuits, and dc circuits shall be permitted to occupy the same equipment wiring enclosure, cable, or raceway. All conductors shall have an insulation rating equal to at least the maximum circuit voltage applied to any conductor within the enclosure, cable, or raceway.

However a fine print note refers to section 725.55(A), and this section does not allow “low voltage” in any cable, cable tray, compartment, enclosure, manhole, outlet box, device box, raceway, or similar fitting with conductors of electric light, or power.

In the event of a short between power/lighting and low voltage, separation will prevent a fire or shock hazard, as the low voltage equipment is not insulated for the higher voltage of electric light and power. Also low voltage wiring is subject to induced noise when run in the vicinity of electric light and power.

Statement of Problem and Substantiation for Proposal

The 2005 NEC restricted a green or green with a yellow stripe conductor for use only as the equipment grounding conductor. Traffic signal heads commonly use a 5 conductor cable, where black is a spare, white is the grounded conductor, red supplies the red signal, yellow supplies the yellow signal and green supplies the green signal. There are thousands of traffic signals installed with the green conductor supplying the green signal.

There is a UL Listing for Traffic Signal Cable, Classified in Accordance with IMSA (International Municipal Signal Association) Specifications (XNTL), which states “this cable employs a color-code scheme that permits a conductor with green insulation to be used for other than grounding purposes”. This proposal would continue to allow the use of a listed traffic signal cable where installed and maintained by qualified persons.

Note: Comments for the 2008 NEC proposals...
Section 410.15(B) defines a metal lighting pole as a raceway to enclose supply conductors, since it’s a raceway, the rules in 725.55(A) apply.

2. Protecting a grounding electrode conductor using a ferrous metal raceway without bonding it to each end of the raceway

Example: A grounding electrode conductor is run an underground ¾” PVC conduit with metallic elbows; the metallic elbows are used to prevent burn-through during pulling.

**NEC Section Violated:**
250.64 Grounding Electrode Conductor Installation - (E) Enclosures for Grounding Electrode Conductors

**Why it’s a Violation:**
A metallic raceway, if not bonded at each end to the grounding electrode conductor, acts as an impedance choke, and can restricts up to 97% of the fault current from lightning induced current on the grounding electrode conductor. Raceways and any intervening metallic junction boxes must be bonded with a grounding bushing, not a grounding locknut. While the NEC does allow a metallic elbow in an isolated non-metallic conduit run, with 18” of cover [250.80] this rule is in Article 250 Part IV, and the requirement for bonding a metallic raceway with a grounding electrode conductor is in Article 250 Part III. Per the NEC style manual, the rules in one article part do not apply to the rules in another article part, unless a specific reference is made. The rules in Part I apply to the entire article.

3. Using the green conductor in IMSA 19-1 cable for other than an equipment grounding conductor

Example: The green conductor is used as ungrounded conductor for the green lamp in a traffic signal head.

**NEC Section Violated:** 250.119 Identification of Equipment Grounding Conductors

**Why it’s a Violation:**
Although a common practice in the traffic signal industry to use a green conductor for the green lamp, the 2005 NEC restricts the use of the color green for use only as an equipment grounding conductor. The 2002 NEC required the color green for an equipment grounding conductor, but did not prohibit green for other uses.

4. No service disconnecting means for a traffic signal service

Example: A traffic signal cabinet is fed from an adjacent vault, the overcurrent protection is provided by fuses. There is no service disconnecting means at or near the traffic signal cabinet.

**NEC Sections Violated:**
• 250.28 Main Bonding Jumper
• 250.24 Grounding Service-Supplied Alternating-Current Systems - (A) System Grounding Connections
• 250.24(B) Grounded Conductor Brought to Service Equipment.
• 230.2 Number of Services
• 230.91 Location of Overcurrent Device
• 230.70 General
• 230.70(A)(1) Readily Accessible Location
• 230.70 (B) Marking
• 230.70(C) Suitable for Use

**Why it’s a Violation:**
It is common for traffic signal cabinets to be installed without a service disconnect. The service disconnect provides several important functions:
• Overcurrent protection
• A readily accessible disconnecting means
• Bonding of the grounding electrode conductor and grounded conductor to the metallic service disconnect enclosure, via the main bonding jumper

In Section 230.70 General, there is the following requirement:
*Means shall be provided to disconnect all conductors in a building or other structure from the service-entrance conductors.*

Without a readily accessible service disconnecting means, there is no way to turn off the power in an emergency. If the grounded conductor is not bonded to the metallic service entrance enclosure, the current from a line to case fault can not return to its source, and the fault will not clear.

5. Lack of a grounding electrode system for a separate building or structure supplied by a 4 wire feeder, with the neutral floated at the building

Example: A 4 wire feeder (2 hots, a neutral and a ground) runs to a remote lighting control cabinet. At the remote cabinet, the neutral is terminated to a buss that is isolated from the equipment ground. A grounding electrode system is not installed.

**NEC Sections Violated:**
250.32 Two or More Buildings or Structures Supplied from a Common Service - (A) Grounding Electrode

**Why it’s a Violation:**
Every building or structure (except those fed by a branch circuit) requires a grounding electrode system to protect against overvoltage from lightning and line surges. The neutral is isolated at the building to prevent dangerous neutral current on metallic surfaces and conduits. Common practice in the electrical trade up until the 2002 NEC was to “reground” the neutral at separate building supplied by a feeder. The 2002 NEC stated that this was only allowed if there are no parallel neutral paths [250.32(B)(2)]. While a neutral can be regrounded at a separate building it is not a recommended practice. When the neutral is regrounded, dangerous neutral current flows on all metallic paths, including raceways, possibly causing fires, and is a shock hazard. This is the reason why the
neutral is not regrounded at a panel on the load side of a service in a building. Running a separate equipment grounding conductor and not regrounding the neutral, if no parallel paths exist, is a design decision, but a grounding electrode system is always required.

6. Re-identification of a black 6 AWG conductor with white phase tape as a grounded (neutral) conductor

**NEC Sections Violated:** 200.6 Means of Identifying Grounded Conductors - (A) Sizes 6 AWG or Smaller

**Why it’s a Violation:** Article 200, while short and often overlooked, gives the allowed methods of identifying the grounded conductor. The NEC only allows a 4 AWG and larger conductor to be re-identified as a grounded conductor. While commonly stocked in colors thru sizes 8 AWG, colored conductors are available in any size. If you need a 6 AWG grounded conductor, the correct and professional method is to install a white 6 AWG conductor.

7. Re-identification of a red 8 AWG conductor with white phase tape as an equipment grounding conductor

**NEC Sections Violated:** 250.119 Identification of Equipment Grounding Conductors - (A) Conductors Larger Than 6 AWG

**Why it’s a Violation:** The NEC only allows a 4 AWG and larger conductor to be re-identified as an equipment grounding conductor. While commonly stocked in colors thru sizes 8 AWG, colored conductors are available in any size.

8. No Arc Flash Labeling on Services and Cabins

**NEC Sections Violated:** 250.116 Flash Protection

**Why it’s a Violation:** Starting with the 2002 NEC, this requirement is to alert qualified users of potential arc flash hazards. Electricians are all aware of the dangers of electrical shock, but there is now an industry awareness of the dangers from an electric arc flash. An arc flash results in thermal energy and blast energy. The amount of short circuit current available determines the arc flash, and the personnel protective equipment required. A FPN to section 250.116 gives a reference to NFPA 70E-2000, Electrical Safety Requirements for Employee Workplaces, for use in determining potential exposure, planning safe work practices, and selecting personal protective equipment. An employer would be at risk if the correct arc flash label was not installed. The employee would be at risk without the correct personal protective equipment.

9. A metal street lighting pole with no equipment grounding conductor and a ground rod bonded to the pole

**NEC Sections Violated:**
- 250.4(A)(5) Effective Ground Fault Current Path
- 250.112 Equipment Fastened in Place
- 250.118 Equipment Grounding Conductor
- 250.134 Equipment Fastened in Place or Connected by Permanent Wiring Methods (Fixed) — Grounding

**Why it’s a Violation:** This common and dangerous installation has caused many shocks and electrocutions. The metal lighting pole must be bonded to an equipment grounding conductor [250.134]. In the event of a line to case fault, a low impedance path back to the circuit source will rapidly clear the overcurrent protective device. A 20 ampere circuit breaker may take up to 140 seconds to clear a 40 ampere line to case fault, during this time, the metal line pole will be energized and a serious shock hazard exists. A ground rod will never clear a line to case fault, for example with a 115 volt source, a ground rod with a resistance of 25 ohms will allow 4.8 amperes to ground, and this will not clear the overcurrent protective device. The following was added to section 250.4(A)(5) for the 2005 NEC: *The earth shall not be used as the sole equipment grounding conductor or effective ground-fault current path.*

There is no standard that requires a ground rod at a metal lighting pole. A ground rod does not prevent lightning damage to the concrete pole base. A ground rod does not protect the luminare from damage if lightning strikes the luminare.

A ground rod can be installed at a metal lighting pole, but not to clear a ground fault. A ground rod installed at a metal lighting pole would be a *Supplementary Grounding Electrode* [250.54], and not subject to the 25 ohm requirement of 250.56, or the electrode bonding requirements in 250.50.

**Authors Note:** I refer to a ground rod at a metal lighting pole (Supplementary Grounding Electrode) as a “Time and Materials” electrode, as it serves no apparent useful purpose, unless you are being paid to install them.

10. Service entrance conductors with non-service conductors in a raceway

**Example:** A raceway to a flasher cabinet has the service entrance conductors and the load side conductors to the flasher in the same raceway.

**NEC Sections Violated:** 230.7 Other Conductors in a Raceway or Cable

**Why it’s a Violation:** Electrical service conductors are protected only against overload, and not overcurrent. There is no overcurrent protection at the supply point, rather the protection is on the primary side of the utility transformer. Also the location of the service...
disconnecting means is required to be nearest the point of entrance of the service conductors [230.70(A)(1)]. Only service entrance conductors are allowed to be in a service entrance raceway, if other load side conductors were in the raceway, a short or overload of the service conductors could damage the load side conductors, a possible fire hazard.

11. The Ampacity of 12 THHN copper is not 20 amperes

NEC Sections Misunderstood:
- Table 310.16 Allowable Ampacities of Insulated Conductors
- 240.4 Protection of Conductors - (D) Small Conductors

Why it’s a Misunderstanding: Perhaps the most misunderstood rule in the NEC is that the ampacity of 12 THHN copper is “20 amperes”.

The 1996 and earlier codes had this obelisk note (†) to Table 310.16, wire sizes 14, 12 and 10: †Unless otherwise specifically permitted elsewhere in this Code, the overcurrent protection for conductor types marked with an obelisk (†) shall not exceed 15 amperes for No. 14, 20 amperes for No. 12, and 30 amperes for No. 10 copper; or 15 amperes for No. 12 and 25 amperes for No. 10 aluminum and copper-clad aluminum after any correction factors for ambient temperature and number of conductors have been applied.

1999 NEC moved the obelisk note to Section 240-3, and added the following note for Table 310.16 *See Section 240-3, with an asterisk for wire sizes 14, 12 and 10.

The 2002 and later NEC retains the asterisk with the reference *See Section 240.4(D)

The obelisk footnote was relocated as the requirement in Article 240-Overcurrent Protection has no relationship to Article 310-Conductors for General Wiring, and created confusion on the ampacity of small conductors.

The ampacity of 12 THHN is the 90 degree C rating of 30 amperes: The 30 ampere value is the starting point, after derating for temperature or conduit fill, the final ampacity for most applications can not exceed 20 amperes per 240.4(D).

Example:
A raceway contains 6 current carrying 12 THHN conductors. What is the final ampacity?
30 amperes (Table 310.16) x 70% (derating for conductor fill) = 21 amperes. Since 21 amperes is greater than the 240.4(D) value, the final adjusted ampacity is 20 amperes. If additional derating was required due to elevated temperature, then the circuit may be required to have a 15 ampere overcurrent protection, or the conductor size increased.

Per 240.4(D) the ampacity is 20 amperes, unless it’s an application allowed in 240.4(E) through (G). (E) is Tap Conductors, (F) is Transformer Secondary Conductors, and (G) is Overcurrent Protection for Specific Conductor Applications, as allowed in Table 240.4(G). Two common applications in Table 240.4(G) are Motor and motor-control circuit conductors [Article 430 Parts III, IV, V, VI, and V] and Air-conditioning and refrigeration equipment circuit conductors[Article 440 Parts III and IV]. It’s not uncommon to have a motor branch-circuit short-circuit ground-fault protection set at 50 amperes with circuit conductors sized at 12 AWG.

When you are sizing circuits under the Articles and Parts listed in Table 240.4(G) you size the conductors at the ampacity listed in Table 310.16 per the temperature rating of the conductor. While typically the 90 degree C rating is almost never allowed for termination, the 90 degree C rating can be used for derating, allowing in most cases a smaller conductor to be used.

The misunderstanding about the rating of 12 THHN being 20 amperes is due to the fact for most installations 12 THHN is 20 amperes. By not understanding its 30 amperes, an installation may have larger conductors than required, resulting in more material and installation costs.

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