

## **Common 2011 National Electrical Code® Violations**

Noted by Maine Electricians' Examining Board staff in 2011-2013

### **And Bonding of CSST**

#### **1. A metal raceway emerging from grade at a pole and enclosing service conductors is not bonded to the grounded system conductor. [250.80]**

Often an underground service supplied from a pole requires protection from physical damage for service conductors up to 8' above grade at the pole. Where rigid metal conduit or intermediate metal conduit is used for protection, the raceway must be connected (bonded) to the service neutral. The underground service conductors from the pole to the building or structure are usually direct buried or enclosed in PVC or other nonmetallic raceway. The isolated metal conduit on the pole is bonded to the utility's "down ground," the conductor installed to ground the neutral tap of the transformer to a ground rod at the base of the pole. The common violation that staff has encountered occurs in instances where the pole is a point pole (no transformer on the pole). In the event that insulation failure of an ungrounded conductor energizes the conduit, connection of the steel conduit to a ground rod alone will not clear the fault. Generally, the best option is to coordinate with the utility so that a conductor connected to the utility neutral is run down the pole for connection to the service conduit. If steel conduit is installed all the way up the pole, the connection to the grounded system conductor could be made at the top of the pole by utility workers. Electrical metallic tubing (EMT) could be used on the pole above 8' above grade if acceptable to the utility. The relevant NEC® sections are: 250.80; 250.102 [except 250.102(D) and particularly 250.102(E)(2), Exception]; 250.8; Table 250.66; and 300.5(D)(1) and (D)(4). Utility company standards also apply. See Rules 360C and 314B of the National Electrical Safety Code® (NESC®), C2-2007.

#### **2. A commercial service supplied with 2 AWG aluminum service-entrance conductors is protected at 100 amperes. [Table 310.15(B)(16)]**

For conductor types rated at 75°C, Table 310.15(B)(16) lists the ampacity of AWG 2 aluminum as 90 amperes. According to 240.6(A), a 90-A overcurrent device is a standard size. It is rare that the ampacity in the 90°C column can be used, since all circuit terminations, conductors, and equipment would have to be rated for 90°C [see 110.14(C)]. For a residential service, Section 310.15(B)(7) permits 2 AWG aluminum to be protected at 100 amps.

#### **3. The grounding electrode conductor (GEC) is not secured to the meter socket enclosure. [110.3(B)]**

Section 312.5(C) requires that cables be secured to cabinets, cutout boxes, and meter socket enclosures. True, the GEC is technically a conductor rather than a cable. The State Electrical Inspectors often encounter installations where the GEC is run through a small factory supplied knock-out (KO) in the bottom of the meter socket. These KOs (often ¼") are either single KOs or are the center of a concentric set of KOs. These small KOs are

not intended for passage of grounding electrode conductors. A connector is required to help prevent stress on the cable/conductor from being transmitted to the GEC termination in the socket. It also prevents the GEC from being pushed into the enclosure, possibly contacting live parts. Additionally, the GEC must be securely fastened to the surface on which it is carried [250.64(B)].

**4. A concrete-encased electrode is not bonded to the grounding electrode system. [250.50]**

Section 250.50 states that all grounding electrodes as described in 250.52(A)(1) through (A)(7) that are present at each building or structure served shall be bonded together to form the grounding electrode system. A concrete-encased electrode as specified in 250.52(A)(3)(1) is almost always available for new construction. However, arrangements must be made to make the grounding electrode (reinforcing steel) available after concrete is poured or to connect a conductor to the reinforcing steel prior to concrete pouring. A copper grounding electrode conductor connected to reinforcing bar and exiting the concrete structure in the area where the electrical service is to be located is ideal. A box out near the top of a concrete wall allowing access to re-bar after the pour also works well. A concrete-encased electrode, particular in a footing, is usually a very effective grounding electrode. The electrode remains below the frost line, and, where there is a full basement or living space below grade, the electrode in the footing is relatively deep for its entire length (as opposed to a driven rod). If concrete walls are not covered with insulating foam or other material preventing direct contact with the earth, the concrete surface in direct contact with the earth is substantial and a very effective grounding electrode. If a concrete footing does not include reinforcing bars, placement of 20' minimum of 4 AWG copper minimum as described in 250.52(A)(3)(2) is worth the effort in terms of service grounding.

**5. Conductor ampacity is not adjusted (or correctly adjusted), where there are more than 30 current-carrying conductors at any cross section in a metal wireway. [376.22(B)]**

Metal wireways installed above panels are a convenient way to transition from horizontally run branch circuits to vertical raceways between the wireways and panels. Depending on where the horizontally run branch circuit wiring leaves the wireway relative to where the circuit conductors enter the wireway, the number of current-carrying conductors at a cross section of the wireway could exceed 30 conductors. The 30-conductor threshold does not relate to a total of 30 current-carrying conductors in the wireway, but to 30 current-carrying conductors at any cross section. This is clarified in Section 376.22(B) of the 2014 *NEC*. Where the number of current-carrying conductors at any cross section exceeds 30, the adjustment factors in 310.15(B)(3)(a) must be applied. If 31-40 conductors are installed at any cross section, all conductors have to be adjusted to 40% of their initial ampacity, 35% for 41 or more conductors. These are deep reductions in ampacity that apply to all current-carrying conductors, not just to the number of current-carrying conductors over 30.

**6. Type TC-ER cable and Type CL3R cable is used for mini-split heat pump wiring between the outdoor and indoor units. [336.12(2)] and [Chapter 9, Table 11(A)]**

Type TC-ER cable is not permitted to be installed outside of a raceway or cable tray, except for extended runs in supervised industrial settings as permitted in 336.10(7), or when installed outdoors supported by a messenger as permitted in 336.10(4). TC-ER cable has been used extensively in Maine to interconnect the outdoor and indoor units of mini-split heat pump systems. Usually the outdoor unit is secured to an outside wall with the indoor unit mounted back-to-back from the outdoor unit, except higher. For some installations, the indoor unit is located on an interior wall, and the TC-ER has been run as interior wiring similar to NM wiring. Also, the Maine State Electrical Inspectors have cited Type CL3R for this same use. Most of the indoor mini-split heat pump units that have been inspected in Maine are rated 240-V, but occasionally 120-V units are encountered. Even though CL3R is rated for 300 volts and the indoor heat pump units have a low current draw, permitted power sources for this and similar cables is limited to 150 volts and low power as prescribed in Table 11(B) of Chapter 9. Since a portion of the cabling is in a wet location, the only permitted application is a Class 3 non-inherently limited power source, applicable for 120-V units only. In addition to using the correct cable, be sure that the proper overcurrent protection is provided for the interconnecting cable. One more thing: Section 210.63 applies—a convenience receptacle for servicing HVAC equipment, located within 25' of the equipment.

**7. Recessed luminaires are not fastened to the suspended ceiling grid. [410.36(B)]**

Recessed luminaires (troffers) must be securely fastened to the suspended ceiling grid by mechanical means such as bolts, screws, rivets, or listed clips identified for use with the type of grid and luminaire. Many troffers are constructed with integral clips for this purpose. Some installers are under the impression that this requirement is not applicable where the luminaires are supported by separate wires in addition to the ceiling support wires. Section 300.11(A) addresses independent support wires for the support of wiring, but not for the support of luminaires.

**8. Arc-fault circuit-interrupter (AFCI) protection of branch circuits is not installed as required. [210.12(A)]**

The Electricians' Examining Board voted to amend Section 210.12(A) in the 2008 *NEC* and in previous editions. It was thought that an amended AFCI requirement was forthcoming with the adoption of the 2011 *NEC*. However, the Board ultimately voted to adopt 210.12 unamended in the 2011 *NEC*. This is likely part of the reason that the State Electrical Inspectors found so many violations of the AFCI requirements. All 120-volt, single phase, 15- and 20-ampere branch circuits supplying outlets installed in dwelling unit family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, or similar rooms or areas shall be protected by a listed combination-type AFCI device. This rule applies also to two-family and multifamily dwellings. This requirement is expanded in the 2014 Code.

**9. No intersystem bonding has been installed. [250.94]**

For new buildings or structures, specific rules apply for providing a means for interconnecting bonding conductors of other systems such as TV and communications services with the electric utility service grounding electrode system. There are several options and a variety of products available to meet the provisions of this section. If the service equipment is located inside of the building, the intersystem bonding provision can be located either inside or outside. Intersystem bonding provisions shall also be provided at the required disconnecting means for a separate building.

**10. The ends of a ferrous metal raceway enclosing a grounding electrode conductor are not bonded to the GEC, or the raceway is not otherwise made continuous between the metal cabinet and the electrode. [250.64(E)]**

Ferrous raceways enclosing GECs must be electrically continuous from the point of attachment to cabinets or equipment to the grounding electrode, or be made continuous by bonding each end of the raceway to the GEC. The bonding jumper for the raceway shall be the same size as, or larger than, the enclosed GEC. Where steel raceway enclosing a GEC is electrically continuous, the majority of current actually flows through the raceway. Some wireman only bond one end of the ferrous raceway. The purpose for bonding is not accomplished by bonding only one end. Bonding of only one end will set up an inductive choke effect that will impede the flow of current.

*Beyond the Code:* A GEC should not be installed in a ferrous raceway if it can be avoided. When a GEC is installed in a continuous ferrous raceway, the impedance of the grounding electrode conductor path is increased significantly over that of using the copper conductor alone. The increase in impedance when a steel conduit is used is about 40% for a 6 AWG copper conductor enclosed in a ¾" conduit, to about 500% for a 3/0 copper conductor enclosed in a 1¼" conduit. Since aluminum conduit is nonmagnetic, it will not adversely affect the impedance of the GEC path. An aluminum conduit enclosing a GEC is not required to be electrically continuous. Schedule 80 PVC conduit is a good choice when physical protection is needed for a grounding electrode conductor.

**11. Circuit breakers installed in a panel are not specified by the manufacturer as suitable for use in the panel, and the breakers are not UL Classified breakers suitable for use in the panel. [110.3(B)]**

In addition to a panel manufacturer's own brand of Listed circuit breakers, Specified breakers (manufactured by others) are listed by the panel manufacturer as suitable for use in their panels. Additionally, Classified breakers are manufactured that are suitable for use in several panel brands, in accordance with the instructions for the Classified breaker. Classified breakers are limited to applications where the available fault current is not more than 10,000 amperes, since they are not tested in a specific series rated system. The fact that a breaker "fits" (is interchangeable) in another manufacturer's panel does not necessarily constitute a Code-compliant installation.

## **Bonding of corrugated stainless steel tubing (CSST)**

Section 7.13.2 of NFPA 54-2012, *National Fuel Gas Code*, requires bonding of corrugated stainless steel tubing in an effort to protect the tubing against the potentially harmful effects of an indirect lightning strike. All manufacturers' instructions for this product require bonding using 6 AWG copper connecting to the electrical service grounding electrode system. The bonding jumper shall connect to a metallic pipe or fitting between the point of delivery and the first downstream CSST fitting. The bonding clamp may be installed on a steel pipe component of the system (black pipe) or on a CSST fitting. Newer black-jacketed CSST may not require bonding.

This requirement is beyond the NEC rule in 250.104(B) that permits the equipment grounding conductor of the branch circuit supplying a gas appliance to bond the gas piping. Even though 110.3(B) requires electrical equipment to be installed in accordance with all manufacturer's instructions, bonding of gas piping for lightning protection is beyond the purview of the *NEC*. However, licensed electricians are the most qualified trade technicians to perform this work, especially if the bonding connection is made within the service equipment enclosure. Another good reason for involvement of an electrician is the fact that this piping is not permitted to be used as a grounding electrode [250.52(B)(1)]. An isolating fitting in the piping system should be used where necessary to prevent this.