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# Get it Right the First Time – Avoid These Commonly Cited Errors

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**[nfpa.org](http://nfpa.org)**

Good electrical contractors understand the value of electrical inspections performed by qualified inspectors. Problems identified during the inspection of an electrical installation not only help ensure that public safety is maintained but can help a contractor to avoid the problem in the future. Electrical inspectors are a great resource for electrical contractors to help them correctly apply *National Electrical Code*® (*NEC*®) requirements and get the job done right ... the first time.

Recognizing that informed electricians is a means to the desired goal of safe electrical installations, the State of New Hampshire Electricians Licensing Board asked its inspectors to compile a list of the installation problems that they most frequently encountered. This effort began nearly 15 years ago as the state moved forward with adoption of the 1999 *NEC*. In order to renew electricians' licenses, New Hampshire has required 15 hours of continuing education on a triennial basis since 1984. To augment their classroom discussion of the changes in each newly adopted *NEC*, the list of installation problems is distributed to the providers of continuing education. This "awareness" training has proven to be an extremely successful tool in achieving code compliance. Reducing compliance problems benefits everyone and fulfills the safety mission of the *NEC*. The list is periodically updated, distributed to continuing education providers, and disseminated in the required continuing education programs. This paper focuses on some of the items contained in the current New Hampshire list.

### **Listed Products [110.3(B)]**

Manufacturers design products to be installed in a certain environment and used in accordance with a specific need. Most electrical products are listed by independent laboratories for installation in accordance with their intended use. Listed products are tested and evaluated in accordance with applicable product standards. The evaluation criteria may vary based on how and where the product will be used. A product could be intended for a very high or very low temperature application. It could be designed for use where it is subject to vibration or to mechanical damage. It might be designed to be installed outdoors. Yet, often, some installers will use products in environments that were never intended by the manufacturer. Some of these unintended methods can result in dangerous installations. Section 110.3(B) of the *NEC* requires that listed or labeled products be installed in accordance with any instructions included in their listing or labeling. This makes compliance with those restrictions part of the requirements of the *NEC*.

Use limitations for listed products are usually included in the instructions that are provided with the product. Other information may be published in the listing directory published by the testing laboratory. For example, UL publishes the *White Book — Guide Information for Electrical Equipment*, which provides information on the parameters that may limit how a product can be installed or used in the field. Key information provided in the directory includes any specific marking that is used to identify specific product features that affect how the product may be used.

Despite the efforts to make sure that installers are aware of these product restrictions, Section 110.3(B) is an often violated requirement of the *NEC*. Common examples cited by the state include the use of

expansion fitting in runs of PVC conduit and the tightening of electrical connections. Often, expansion joints are omitted entirely, which can result in cracking of the conduit and the fittings. Where expansion fittings are installed, they might be secured at the wrong end. It is intended that they be installed at the fixed (bell) end. In vertical installations, the expanding end of the fitting should be installed below the fixed end.

### **Electrical Connections [110.3(B) and 110.14]**

Proper tightening of electrical connections is important to ensure a good low-resistance connection. Loose connections lead to arcing and pitting of contacts. This can lead to overheating, which can cause a fire. Loose connections will often become looser due to mechanical vibration. Loose connections become a more critical problem in circuits with higher loads. Simple screw driver or wrench tight connections may be insufficient.

Some terminations require that screws be torqued with the proper tool. Torque requirements, where needed, are often provided in the product manufacturer's installation instructions. Annex I was added to the 2011 edition of the code to provide needed torque information to users in the field. This annex is based on the requirements in UL 486A-B, *Wire Connectors*.

### **Spaces around Electrical Equipment [110.26]**

Requirements for space around electrical equipment continue to be overlooked or misinterpreted. There are two basic types of space: equipment space and working space. The equipment space is not only the space occupied by the equipment; it can also extend up to six feet over the equipment or to the structural ceiling, whichever is less. This space is needed for proper operation of the equipment and subsequent maintenance of the equipment. Often, the equipment space is violated when ducts or pipes foreign to the electrical installation are installed in the space. This can make installation of wiring methods and maintenance of the electrical equipment difficult, and can also make maintenance of the piping or ductwork difficult. In addition, accidental leaks could damage equipment or endanger workers.

The working space is a three dimensional area that must meet minimum requirements for depth, width, and height. This is the area occupied by workers while they maintain equipment. The minimum required dimensions are intended to provide adequate space for the worker to do his or her tasks safely. The depth of the working space is the space extending outward from the front of the equipment. The depth is based on the operating voltage to ground and the conditions of the installation. The depth requirements are found in Table 110.26(A)(1), and the installation conditions are found in the notes to the table.

The working space must also be sufficiently wide to provide adequate space to work on the equipment. It must allow the removal of covers and the opening of equipment doors. The width of the required working space must be 30 inches or the width of the equipment, whichever is greater. If the equipment is less than 30 inches wide, the 30 inch minimum still applies. Where the equipment is less than 30 inches wide, the equipment does not have to be in the center of the working space. However, in all cases, the working spaces must allow at least a 90 degree opening of any equipment doors. The

minimum height of the working space is 6½ feet or the height of the equipment. This headroom is intended to permit a worker to escape the area without injuring his or her head.

Without vigilance, electrical equipment rooms will become storage rooms. Storage can be especially hazardous if it is flammable or combustible. However, it is also a hazard if the equipment room requires house cleaning before electrical equipment can be returned to service or if a worker is put in danger by working in an inadequate space that exposes the worker to harm. The code requires that the working space be kept clear, so that needed workspace is maintained.

### **Raceway Seals [225.27, 230.8, 300.7 and 300.50(F)]**

Raceways can be a path for water and gases to enter equipment. Heating and cooling cycles can cause condensation inside equipment and raceways. Temperature differentials along a raceway run can also allow condensation to form in a raceway. Examples of raceways with temperature differentials include raceways from the exterior wall of a building to the interior, raceways from unheated areas to heated areas, and underground raceways. Raceways must be sealed if they enter buildings from the exterior of the building, from underground, and where there are temperature differentials. Underground raceways can also present another hazard — the entrance of natural gas. If the raceways are not passing through a hazardous location, sealing of these raceways (in accordance with the applicable code section) should suffice.

### **NM Cable Installations [334.10(C) and Article 100 definition of *Concealed*]**

There continue to be improper installations of NM cable in some buildings permitted to be of Types III, IV, or V construction. The frequently cited problem is the misunderstanding of what is meant by the term *concealed*, which is defined in Article 100. The most common violation is an installation of NM cable in an accessible attic. This is not concealed because it is not “rendered inaccessible by the building structure or finish.” It is accessible through the scuttle opening.

### **Vertical Risers [358.30]**

Electrical inspectors often cite improper electrical metal tubing (EMT) vertical risers from industrial machinery and other fixed equipment. There are requirements in Articles 342 and 344 for the proper installation of vertical risers of up to 20 feet high using intermediate and rigid metal conduit respectively. Intermediate metal conduit and rigid metal conduit fittings are more robust than EMT fittings. An EMT vertical riser may not have the mechanical strength to adequately support conductors any higher than the 10 foot length permitted in 358.10(A).

### **Circuit Directories [408.4(A)]**

Circuit directories can be a valuable tool when trying to troubleshoot field problems. Directory notations such as “lights and plugs” are not helpful to the next person working on an installation. A circuit must be identified “as to its clear, evident, and specific purpose or use.” The identification must provide enough detail that is sufficient to distinguish circuits from one another. It is also important that the directory does not depend on “transient conditions of occupancy.” An example of a transient condition of

occupancy would include identifying a circuit to a bedroom by the name of the occupant. Several changes of ownership later, the identification can become meaningless.

### **Wireways [376.22(A)]**

Where there are multiple circuits in a wireway, ampacity adjustment (derating) may become necessary. Section 376.22(A) was revised for the 2014 edition to clarify the derating requirement for wireways. Derating is necessary for all current-carrying conductors at any cross section of metal wireways having 31 or more conductors. Failure to derate conductors may result in tripping of overcurrent devices, or it could result in a fire.

### **Flexible Cord Is not a Wiring Method [400.7 and 400.8]**

Flexible cord is not a wiring method. Yet, installations of cords used as a wiring method continue to be found in electrical installations. An example of a common misapplication is where cords are run through holes in ceilings to outlet boxes above the ceiling. This is often found in installations of projectors beneath suspended ceilings in meeting rooms and in installations of luminaires installed below ceilings.

### **Separation of Emergency System Wiring [700.10]**

Emergency system wiring is required to be kept separate from all other wiring. The requirement applies to all wiring from the source of the emergency system to all emergency system loads. This requirement is intended to ensure that an impairment that affects the normal system doesn't also affect the emergency system. As a practical matter, the normal system wiring must exist with the emergency system wiring in some enclosures, including transfer switches and disconnecting means. This section provides the specific permissions where such installations may be required. In addition to the requirement for separation from normal circuit wiring, the emergency system wiring must be kept separate from legally required standby system wiring and optional standby system wiring.

### **Conclusion**

Correcting deficiencies costs time and money. Contractors would prefer to have error-free installations. Error-free installations mean satisfied customers. This information has been well received in New Hampshire. Hopefully this information will help contractors everywhere to avoid these pitfalls.

## **About the Authors**

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## **About the National Fire Protection Association (NFPA)**

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