WIRING METHODS FOR PATIENT CARE AREAS

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Patient care areas are often referred to as needing a wiring method that will provide "redundant grounding," but more is involved.

Editor's Note:
These answers are given by our panel of experts. I am chairing this panel, and the other panel members include Bill Summers, James Stallcup and Dan Leaf. The opinion expressed is that of the panel. If a panelist disagrees with the majority opinion, his explanation is printed following the answer. Although authoritative, the answers printed here are not, and cannot be relied on as formal interpretations of the National Electrical Code.
—FPH

For rebuttal comments from the manufacturer noted see page 94.

MOST installers are aware that patient care areas in health care facilities have special grounding requirements, and that these are reflected in some restrictions on what wiring methods are permitted. These requirements are often summarized as a need for "redundant grounding."

Although that term does not appear in the NEC, it is fairly close to what is actually involved and intended in the rules, deceptively close. Since two properly sized individual equipment grounding conductors run to the same device or other equipment are obviously redundant, some argue that wiring methods that provide such grounding are permitted, or at least meet the intent of the rules.

One of the most confusing of the possible wiring methods is Type MC cable, which comes in three different forms. We have received specific questions about the interlocking armor variety, which is available with two grounding conductors. Some manufacturer's representatives have explained that, in this form, this product can be used in patient care areas.

The EC&M Panel's response

This wiring method is an excellent example of why the term "redundant grounding" can be misleading. It does indeed provide a redundant ground return path, while at the same time it directly violates both the intent and the literal text of the rule. The first grounding return path, the insulated copper conductor, is covered in **Sec. 517-13(a)**, as follows:

> **(a) Patient Care Area.** In an area used for patient care, the grounding terminals of all receptacles and all noncurrent-carrying conductive surfaces of fixed electric equipment likely to become energized that are subject to personal contact, operating at over 100 volts, shall be grounded by an insulated copper conductor. The grounding conductor shall be sized in accordance with Section 250-95 and installed in metal raceways with the branch-circuit conductors supplying these receptacles of fixed equipment.
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> *Exception No. 1: Metal raceways shall not be required where Type MI cable, and Types MC and AC cables where the outer metal jacket is an approved grounding means of a listed cable assembly.*

Although the main rule calls for metal raceways, the exception recognizes metal jacketed cable assemblies. This is reasonably clear, although the exception is both grammatically and technically incorrect. The cable types in the second clause have no verb, and Type MI cable is listed by right, with the allowance for Types MC and AC cables conditioned on the grounding status of the jacket. This is *only* correct for Type MC cable.

Type MI cable comes in a copper and a stainless steel version and, as covered in **Sec. 330-22,** the stainless steel type is *not* recognized as a grounding return path. On the other hand, the Type AC cable armor assembly, which consists of an interlocking metal armor together with a bare copper or aluminum bonding strip, is *always* acceptable. Here, the requirement for specific grounding approval is *incorrect*. For patient care areas, Type AC cable is available with a separate grounding conductor to comply with the main rule.

Type MC cable, however, comes in *three* versions (interlocking armor, corrugated, and smooth), and the grounding suitability of the outer metal jacket varies significantly. In the usual branch-circuit sizes, it is generally acceptable for the corrugated and smooth varieties; but for the interlocking armor version, it is *never* acceptable. The smooth and corrugated metal-clad cable designs that *could* be used for patient care areas also include a copper grounding conductor to comply with the main rule. Testing laboratory rules require that if the armor is qualified and such grounding conductors are supplementary, they must use green insulation with a yellow stripe. This rule, as yet, is being inconsistently followed, so it is wise to review manufacturers' specifications.

The next subsection [**Sec. 517-13(b)**] fo cuses more directly on the wiring metho rules. It correctly covers the various cable and, in so doing, largely overcomes the preceding errors:

> **(b) Methods.** In addition to the requirements of Section 517-13(a), all branch circuits serving patient care areas shall be provided with a ground path for fault current by installation in a metal raceway system or cable assembly. The metal raceway system, or cable armor or sheath

assembly, shall qualify as an equipment grounding return path in accordance with Section 250-91(b). Type MC and Type MI cable shall have an outer metal armor or sheath that is identified as an acceptable grounding return path.

This section is carefully worded to ensure that *whatever* the metallic enclosure, it will stand alone as a grounding return path. The phrase "cable armor or sheath assembly" includes qualified Type MC cables, as well as Type AC cable, where the return path is the armor in conjunction with the bonding conductor run just below and in contact with it.

It does *not* include interlocking armor Type MC cable, even with *two* equipment grounding conductors. Those grounding conductors are *not* components of a "sheath assembly"; they are merely grounding conductors electrically similar and of equal status to the additional grounding conductor(s) that would be installed in a nonmetallic wiring method. This construction does, however, have very valid applications for equipment connected so as to reduce electromagnetic interference by using an insulated ground. These systems need two equipment grounding return paths running with the circuit conductors, one to the equipment and the other for conductive raceways, boxes, etc.

We note here that this discussion does *not* apply to feeders and is for health care facilities generally. If a branch circuit is a component of a hospital emergency system, as covered in **Sec. 517-30(c)(3)**, then cabled wiring is *not* permitted (since none of the exceptions will apply):

> The wiring of the emergency system of a hospital shall be mechanically protected by installation in metal raceways.

History and intent

Many, particularly those with an incomplete understanding of the background behind the rule, still argue that wiring methods using multiple equipment grounding conductors *should* be permitted, since they provide redundancy. The rule originated in the 1987 NEC and was seen by many as an unfair restriction against nonmetallic wiring methods. Accordingly, a serious attempt was made to sidetrack the requirement at the NFPA Annual Meeting.

Those attempts were met by negative arguments from a speaker who had extensively researched hospital grounding performance, particularly in older hospitals that had metal raceways in questionable condition. He found that the mere contact between the conductive surfaces of the raceways and normal building elements resulted in *multiple* grounding return paths, through concrete reinforcing, plumbing, building steel, and other paths. He found that the total impedance to ground over the raceway often ran between 10 and 50 times *lower* than the copper grounding conductor; duplicating that copper conductor would only reduce the impedance by a factor of two.

The attempt was defeated, but questions as to the accuracy of that research persisted. Another attempt to derail the requirement was made on the floor of the 1989 NFPA Annual Meeting. The same speaker responded, reporting on his more recent research. The research he had reported three years earlier was not correct, he said. Actually, the improvement in grounding return performance was between *20* and *100* times! No serious attempt was made to rebut his arguments and the rule stayed in the 1990 NEC. No challenge was made at the Annual Meeting for the 1993 NEC.

The point is that the a conductive outer wiring enclosure appears to significantly affect the equipment grounding performance of these systems, particularly in health care facilities where very small residual voltages on grounded equipment can cause severe problems. It is for this reason that redundancy *alone* is insufficient; the outer enclosure *itself* must perform as an equipment grounding return path so the system will benefit from the other grounding paths. This is also noted in the fine print note that follows the allowance for isolated grounding receptacles in **Sec. 517-16**:

> (FPN): Caution is important in specifying such a system with receptacles having isolated grounding terminals, since the grounding impedance is controlled only by the grounding conductors and does not benefit functionally from any parallel grounding paths.

This editor attended the meetings reported here, and this editor wrote the version of **Sec. 517-13(b)** that now appears in the NEC. At some time, credible evidence may well emerge challenging the assumptions behind the rule. Until that happens, and the NEC is changed accordingly, wiring methods that do *not* use their outer enclosures as a qualified grounding return path are neither permitted nor intended. ■