ARTICLE

250 Grounding Versus Bonding

Introduction

The purpose of the *National Electrical Code* is the practical safeguarding of persons and property from hazards arising from the use of electricity [90.1(A)]. In addition, the *NEC* contains provisions that are considered necessary for safety. Compliance with the *NEC*, combined with proper maintenance, must result in an installation that is essentially free from hazard [90.1(B)].

No other article can match Article 250 for misapplication, violation, and misinterpretation. People often insist on completing installations in a manner that results in violations of this Article. For example, many industrial equipment manuals require violating 250.4(A)(5) as a condition of warranty. The manuals insist on installing an "isolated grounding electrode," which is an electrode without a low-impedance fault-current path back to the electrical supply source, typically the X0 terminal of a transformer, other than through the earth itself. That means the ground-fault current return path to the electrical supply source, typically the X0 terminal (utility transformer), is on the order of several ohms rather than the fraction of an ohm that the typical *NEC*-compliant installation would provide.

If you apply basic physics and basic electrical theory, you can clearly see Article 250 is right and equipment manuals that require isolated grounding are wrong, and other references agree. IEEE-142 and *Soares Book on Grounding* use the same physics and electrical theory as Article 250. This article isn't a "preferred design specification." As with the rest of the *NEC*, it serves the purpose stated in Article 90 to be sure the installation is, and remains, SAFE!

Article 250 covers the requirements for providing paths to divert high voltage to the earth, requirements for the low-impedance fault-current path to facilitate the operation of overcurrent protection devices, and how to remove dangerous voltage potentials between conductive parts of building components and electrical systems.

Over the past two *Code* cycles, this article was extensively revised to make it better organized and easier to implement. It's arranged in a logical manner, so it's a good idea to just read through Article 250 to get a big picture view—after you review the definitions. Then study the article closely so you understand the details. The illustrations will help you understand the key points.

> **Author's Comment:** When the *NEC* uses the word "ground" or "grounding" where the intent is the connection to the earth, this textbook will add "(earth)." If the *NEC* used the word "ground" or "grounding" where the intent is bonding metal parts to the supply source, I will add "(bonding)" to the text. It's unfortunate that the word "grounding" is used interchangeably for grounding and bonding, which are two different things.

PART I. GENERAL

250.1 Scope. Article 250 contains the following grounding and bonding requirements for electrical installations:

(1) Systems and equipment required to be grounded

(2) Circuit conductor to be grounded on grounded systems

(3) Location of grounding connections

(4) Types and sizes of grounding and bonding conductors and electrodes

(5) Methods of grounding and bonding

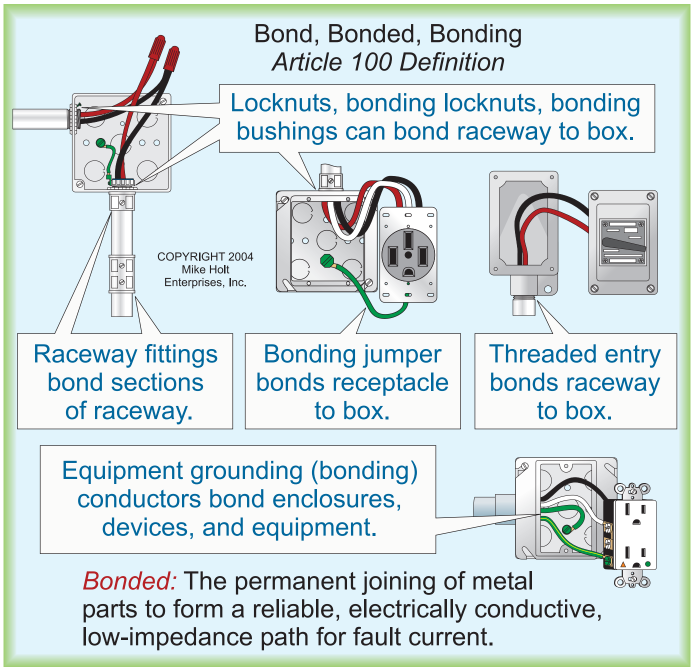

Figure 250–1

250.2 Definitions.

> **Author's Comment:** Why is grounding so difficult to understand? One reason is because many do not understand the definition of many important terms. So before we get too deep into this subject, let's review a few important definitions contained in Articles 100 and 250.

Bonding [100]. The permanent joining of metal parts together to form an electrically conductive path that has the capacity to conduct safely any fault current likely to be imposed on it. Figure 250–1

> **Author's Comment:** Bonding is accomplished by the use of conductors, metallic raceways, connectors, couplings, metallic-sheathed cables with fittings, and other devices recognized for this purpose [250.118].

Bonding Jumper [100]. A conductor properly sized in accordance with Article 250 that ensures electrical conductivity between metal parts of the electrical installation. Figure 250–2

Effective Ground-Fault Current Path [250.2]. An intentionally constructed, permanent, low-impedance conductive path designed to carry fault current from the point of a ground fault on a wiring system to the electrical supply source. Figure 250–3

The effective ground-fault current path is intended to help remove dangerous voltage from a ground fault by opening the circuit overcurrent protective device. Figure 250–4

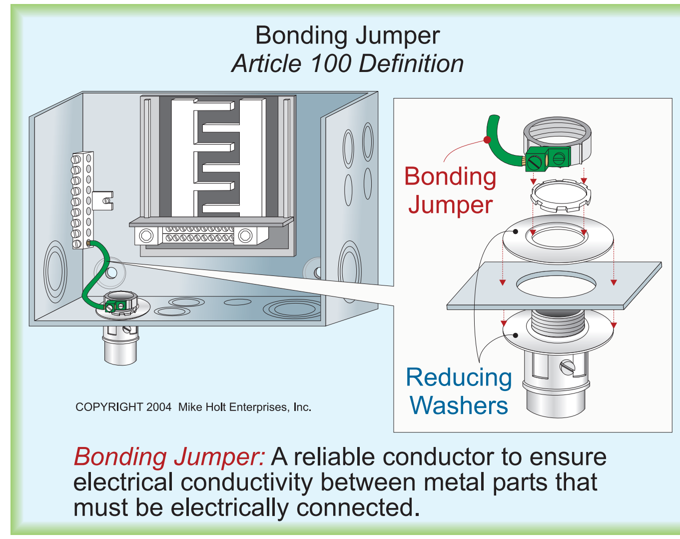

Figure 250–2

Equipment Grounding Conductor [100]. The low-impedance fault-current path used to bond metal parts of electrical equipment, raceways, and enclosures to the effective ground-fault-current path at service equipment or the source of a separately derived system.

> **Author's Comments:**
>
> - The purpose of the equipment grounding (bonding) conductor is to provide the low-impedance fault-current path to the electrical supply source to facilitate the operation of circuit

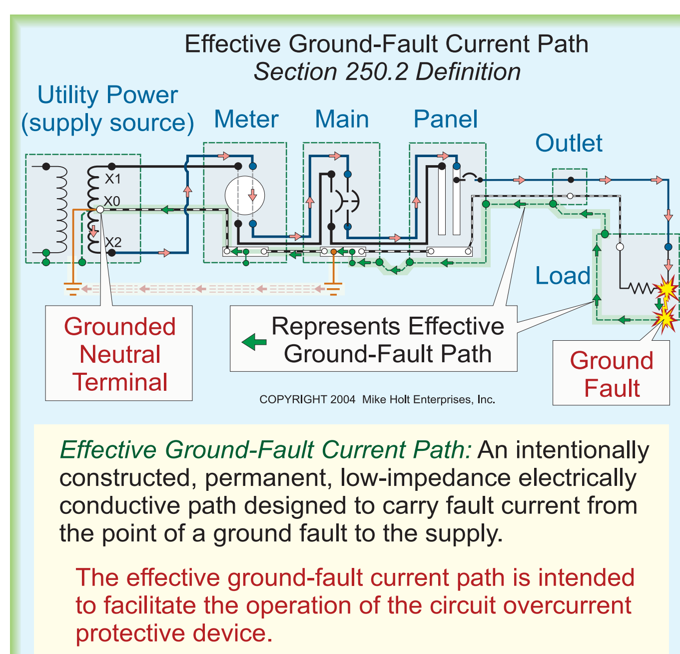

Figure 250–3