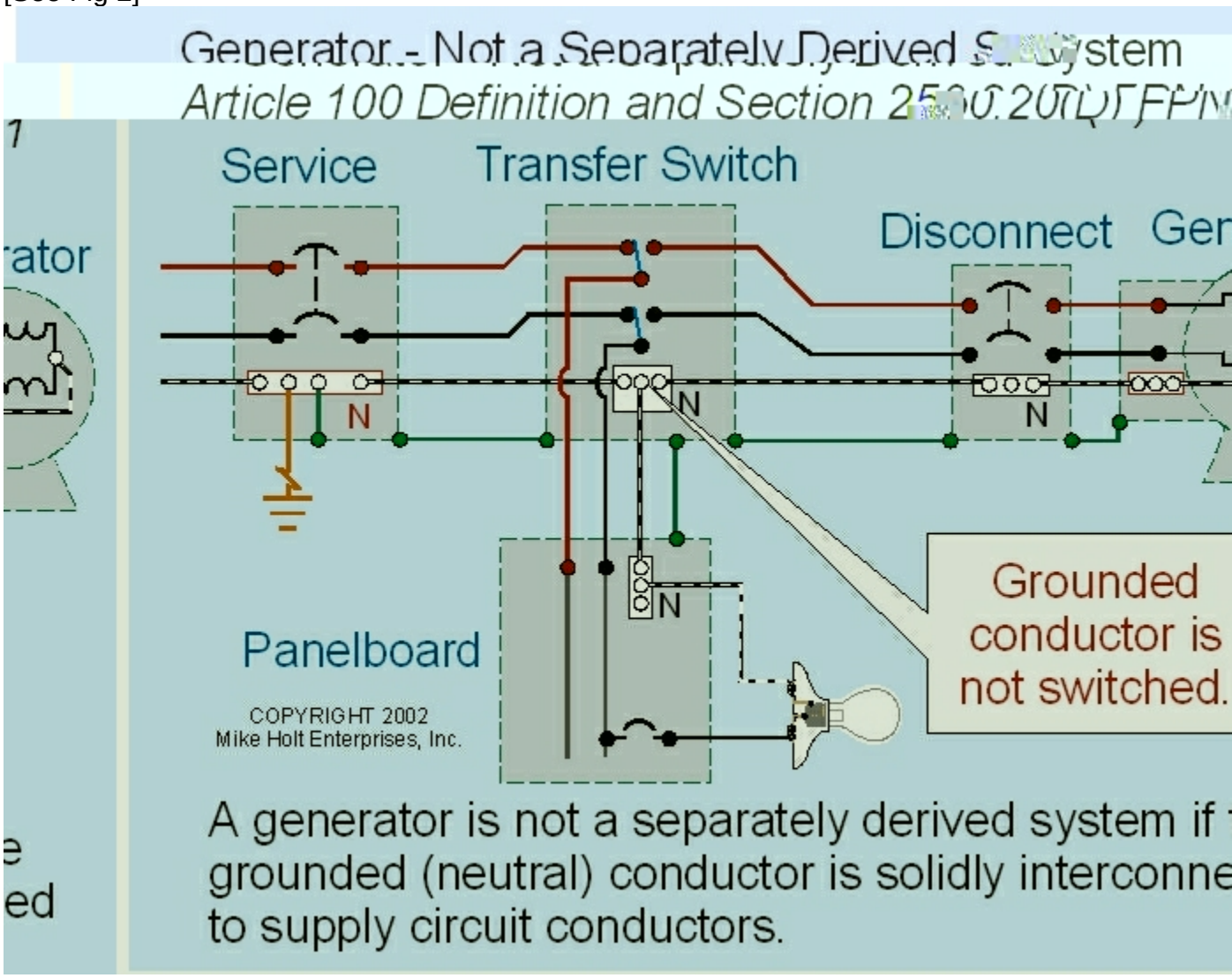
Generator Grounding
When are Ground Rods Required at Portable Generators?

Portable generators are often used for backup power at traffic signals, buildings, structures and special events. Ground rods (grounding electrodes) are only required if the generator is a separately derived system. (For the complete text of sections cited please see the 2002 NEC)

What is a Separately Derived System?
The NEC in Article 100 defines a Separately Derived System as:
Separately Derived System. A premises wiring system whose power is derived from a battery, from a solar photovoltaic system, or from a generator, transformer, or converter windings, and that has no direct electrical connection, including a solidly connected grounded circuit conductor, to supply conductors originating in another system. [See Fig 1]

The key to knowing if a generator is a Separately Derived System is not the generator, but rather the transfer switch. If the transfer switch does not transfer the neutral (grounded conductor), then the generator has a “solidly connected” grounded circuit conductor and the generator is not a separately derived system. [See Fig 2]



If the generator is connected to a transfer switch that transfers the neutral, and the generator does not have a “solidly connected” grounded circuit conductor, then it is a separately derived system. A separately derived system requires a connection to a grounding electrodes or ground rod(s).

A transfer switch is required between the generator and connected load. It provides isolation and prevents backfeed to the utility source from the generator. New for the 2002 NEC is Section 702.6 Transfer Equipment, which requires suitable equipment for the use, designed and installed so as to prevent the inadvertent interconnection of normal and alternate sources of supply in any operation of the transfer equipment. Interlocked circuit breakers or manual double pole, double throw, center off switch can be used.

Why Do Separately Derived Systems Require a Ground Rod?
Article 250 has the requirements for grounding of systems. In Section 250.20

Alternating-Current Circuits and Systems to Be Grounded, Part (D) states that systems covered in 250.20(A) or (B) are to be grounded per 250.30. A fine print note clarifies the connection of a generator:
FPN No. 1: An alternate ac power source such as an on-site generator is not a separately derived system if the neutral is solidly interconnected to a service-supplied system neutral.

Part (B) is for AC systems over 50 V:

- 120V or 120/240V single phase
- 277/480Y 4 wire, three phase, 120/208V 4 wire, three phase
- 120/240V 4 wire, 3 phase delta

These are the typical AC systems used for traffic signal or roadway lighting applications.

Section 250.30 Grounding Separately Derived Alternating-Current Systems, gives the requirements for grounding. A common type of Separately Derived Service is a 480 x 120/240V step down transformer. When there is no direct electrical connection to the primary grounded conductor, and the secondary grounded conductor must be connected to a grounding electrode system.

What is the Purpose of the Ground Rod?
The ground rods serve no purpose in clearing line to line or line to case faults. An electrical system will operate “ungrounded” and some industrial systems are designed to operate ungrounded. The purpose of the Ground Rod, or more accurately Grounding Electrode System is given in Section 250.4(A) (1) and (2):
(1) Electrical System Grounding. Electrical systems that are grounded shall be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operation.
(2) Grounding of Electrical Equipment. Non–current-carrying conductive materials enclosing electrical conductors or equipment, or forming part of such equipment, shall be connected to earth so as to limit the voltage to ground on these materials.

Authors Note: A ground fault at a metal street lighting pole, with a ground rod but no low impedance (green wire) path back to the source, does not allow sufficient current to flow to open the over current protective device when using the earth as the sole return path. Even at 25 ohms ground resistance, a ground rod will not assist in clearing the fault for a 120 V supply source. At 25 ohms resistance the maximum current will be 4.8 amps at 120V. The metal lighting pole will remain energized and a serious shock hazard. A supplemental grounding electrode can be added at street lighting and traffic signal poles, but Section 250.54 states the earth shall not be used as the sole equipment grounding conductor.

Most generators are connected through transfer switches that do not transfer the neutral. Switching the neutral is done by design, due to other electrical requirements.
Where required for a generator, the purpose of the ground rod(s) at a generator is to limit the voltage from surges, lightning or unintentional contact with high voltage lines, and to limit the voltage to ground on conductive metal parts.

What About Portable and Vehicle-Mounted Generators?

Portable generators are covered in Section 250.34 Portable and Vehicle-Mounted Generators. This section allows the generator or vehicle frame to serve as the grounding electrode when:
(1) The generator supplies only equipment mounted on the generator, cord-and-plug-connected equipment through receptacles mounted on the generator, or both, and
(2) The non–current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame.

Caution-Generator Neutral Grounding
Generators will often have the neutral conductor bonded to the generator frame. This is commonly done on small portable generators supplied with receptacles. [Illustration 3]
Larger generators with a cord supplied pin and sleeve connector typically do not have the neutral grounded to the frame. There is no industry standard for when the neutral is or is not grounded, however it seems to be dependant on the generator having receptacles mounted on the frame, as then the neutral is grounded to the generator frame. The generator user needs to know if the neutral is grounded or not.

If the generator neutral is grounded then the generator can only be used with a transfer switch that transfers the neutral, or as a stand alone generator for a carnival or special even, and then ground rods are required.

IMSA Member Tom Baker is a Master Electrician, and is certified as an IMSA Level II Traffic Signal and Roadway Lighting Level I. His business, Puget Sound Electrical Training, provides classes on the NEC, Grounding and Bonding, and other electrical subjects. He is the IMSA representative to the Illumination Engineering Society. Contact him via email at tom@psetraining.com