NIXON POWER SERVICES

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Importance of Grounding Standby Generator Systems

Information Sheet # 45

1.0 Introduction:

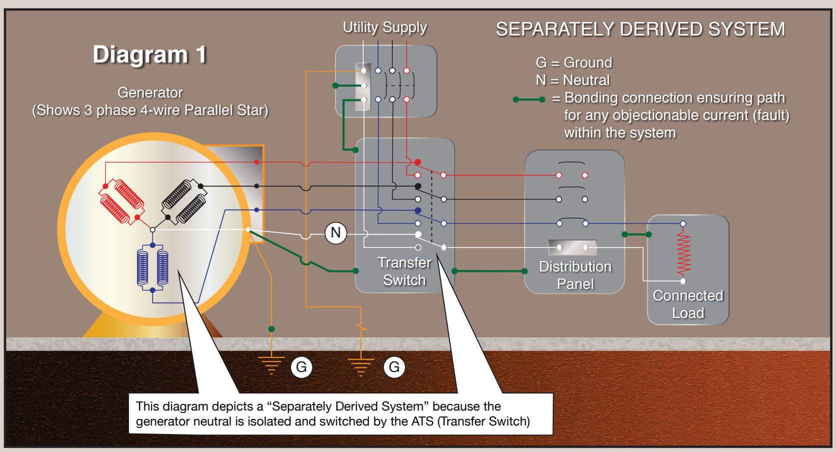
Electrical current flow, similar to water flow, takes the path of least resistance to the ground. For safety reasons and equipment protection, it is important to ensure that path is not through personnel when they come in contact with electrical equipment. Effective grounding of all circuits and bonding looks to provide an easy path to ground when objectional current flow or fault occurs.

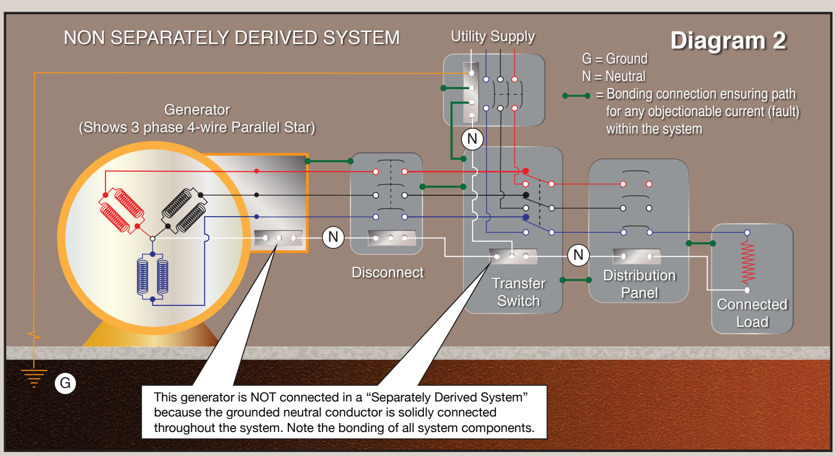
This Information Sheet discusses the importance of grounding Standby Generator Systems in order to minimize the potential for personnel injuries, equipment damage, and critical standby systems failing before or during a power outage:

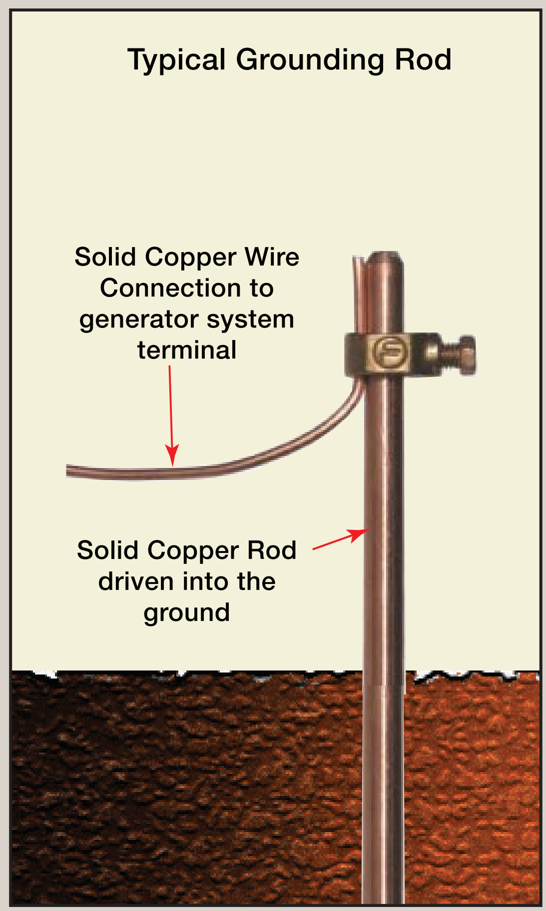
2.0 Why Ground a Generator System:

Generator systems must have proper grounding and bonding of all electrical components and transfer switches to minimize the possibility of uncommon current flow resulting in a power outage, damage to equipment and/or injuries to personnel.

The importance of grounding and bonding circuits cannot be overstated. It is especially problematic with standby power systems as circuit breakers can trip, generators can drop offline, and important emergency and life safety loads can be lost due to hidden grounding problem(s) that could occur during a utility power outage, when standby power operation is vital. *(Continued over)*







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During a planned maintenance visit from a certified generator technician, the bonding of circuits and connection to ground will be inspected to ensure it will enable any spurious current flow to ground and trip any breaker providing protection.

3.0 Grounding Coding and Terminology:

The National Electric Code (NEC) and National Fire Protection Association (NFPA) are the principal bodies that define best practice for grounding and bonding of electrical components within standby generator systems.

The following terminology as defined in 2011 NEC and NFPA 70 details key terminology:

- **Ground –** The earth is taken as "ground". Buildings have electrode systems sunken into the earth. The connection of current-carrying equipment to the earth is the definition of grounding. NEC Article 250, 4 (A) (2) states: "Grounding of Electrical Equipment. Normally, 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 of these materials."
- **Bonding –** NEC Article 250, 4 (A) (3) states: "Bonding of Electrical Equipment. Normally non-current carrying conductive materials enclosing electrical conductors or equipment, or forming part of such equipment, shall be connected together and to the electrical supply source in a manner that establishes and effective ground fault-current path."
- **Equipment Bonding Jumper –** The connection between two or more portions of the equipment grounding conductor.
- **Grounding Electrode –** A conducting object through which a direct connection to earth is established. These can include ground rods.
- **Grounding Electrode Conductor (GEC) –** Used to connect the system-grounded conductor or the equipment to a grounding electrode conductor to a point on the grounding electrode system. This conductor connects the building grounding system to the earth by means of the grounding electrode.
- **Grounding –** Connected to ground without inserting resistors or impedance devices, so as to trace a continuous conductive path from the chassis to an equipment grounding conductor; to grounding electrode conductor; to grounding electrode to the earth.
- **Equipment Grounding Conductor –** This connects objects to the grounding electrode system and to the earth.
- **Ground Fault Path –** Per NEC Article 250.2, an intentionally constructed 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.
- **Separately Derived System (SDS) –** A building wiring system whose power is derived from a source of electrical energy or equipment other than a service. Such systems have no direct connection from circuit conductors from one system to another, other than connections through the earth, metal enclosures, or equipment grounding conductors. A generator is only considered to be a separately derived system, when the grounded (neutral) conductor in the transfer switch is switched.
- **NEC Article 250 Requirements –** AC Systems not over 600 V. Alternating current systems of the following types must have the neutral (X0) terminal of the power supply bonded to a suitable grounding electrode (earth).
  Single-phase, 2- or 3-wire, 120 V or 120/240 V system
  3-phase, 4-wire, 208/120 V or 480/277V wye-connected system
  3-phase, 4-wire, 120/240 V delta-connected system (high-leg)

4.0 Ground Fault:

During a ground fault, metal parts of electrical equipment, metal piping, and structural steel will become energized. This situation provides the potential for electric shock and fire. The system bonding jumper (See diagrams 1 & 2) resolves this situation by creating a path from the metal parts back to the source and allows over-current devices to operate, thereby removing the dangerous condition.

5.0 Grounding Generator Systems:

Within a generator system, as discussed, all metal parts should be bonded to the system they are supplying. However the selection of the transfer switch depends on whether the generator system is a separately derived system or not. The following will apply:

- **Separately Derived System (SDS) –** Should the standby generator be installed in a manner that isolates the neutral connection (see diagram 1), i.e. it is not directly bonded to the a transfer neutral terminal, then for a 3-phase system (as illustrated) a 4-pole automatic transfer switch (ATS) should be selected to enable switching of the neutral, and the generator should be separately grounded as indicated in diagram 1.
- **NON Separately Derived System -** Should the generator system be fully integrated into the system it is providing standby power to, by having the generator's neutral conductor solidly connected to the neutral conductors within the rest of the system (as indicated in diagram 2), a 3-pole conductor (within a 3-phase system) can be used. In this case, the neutral is not switched but is solidly bonded to the neutral terminal within the ATS. In this arrangement it is not necessary to independently ground the generator, which will be grounded through the ground of the integrated system as it is NOT a separately derived system.
- **Mobile and Rental Generator Systems -** Most mobile generators have a grounding rod (see diagram 3) supplied with the system should it be required. A qualified technician should be consulted to advise if the generator has to be separately grounded as a separately derived system, or can use the ground of the system being supplied through a solid neutral connection. Local codes should also be checked regarding the use of a ground rod, some local authorities having jurisdiction require such an accessory to be utilized by the operator.

6.0 Further Reading and Codes:

Your authorized generator distributor is fully qualified to advise on the grounding requirements for generator systems. In addition, the following web links to respective coding bodies can be of use:

- NEC Code 250: http://www.necconnect.org/resources/2014nec_changes_article250/
- NFPA Code 70: http://www.nfpa.org

NIXON POWER SERVICES

Corporate Office
155 Franklin Road
Suite 255
Brentwood, TN 37027
Phone: 888-826-4966

Birmingham, AL
2512 Cone Dr.
Birmingham, AL 35217
Phone: 205-739-2255

Atlanta, GA
1440 Lakes Parkway
Suite 600
Lawrenceville, GA 30043
Phone: 770-448-6687

Louisville, KY
11910 Carrier Court
Louisville, KY 40299
Phone: 502-267-0474

Charlotte, NC
3101 Yorkmont Road
Suite 100
Charlotte, NC 28208
Phone: 704-588-1043

Raleigh, NC
3821 Commerce Park Dr.
Raleigh, NC 27610
Phone: 919-279-9191

Nashville, TN
1515 JP Hennessy Drive
La Vergne, TN 37086
Phone: 615-244-0650

Blountville, TN
1612 Highway 75
Blountville, TN 37617
Phone: 423-279-0357