

Optional Standby Systems

The technical information provided herein is to assist qualified persons in planning and installing electric service to farms and residences. **Qualified person** is defined in Article 100 of the National Electrical Code (2008 edition) *as one who has the skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.* Qualified persons are encouraged to review the National Fire Protection Association (NFPA) 70E-2004, Standards for Electrical Safety in the Workplace, for electrical safety training requirements. **A person who is not qualified should not attempt the planning and installation of electric service.**

Your electric cooperative and its officers, directors, employees and agents disclaim any and all liability for any personal injury, property damage or other damages of any kind, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use or reliance on the material contained in the following specifications. No warranties are made, whether express or implied, as to the accuracy or completeness of the information contained herein.



Note: Any reference to “Code” or “Code Handbook” in the following information refers to the 2008 National Electrical Code and the NEC 2008 Handbook respectively.

Whether one calls it an emergency backup system, a generator system, or a standby system, they all do the same thing. These systems provide another source of electrical power when the main source of electricity is experiencing a power outage.

In this discussion, we will be referring to Optional Standby Systems as discussed in Article 702 of the Code.

Optional Standby Systems are those backup systems that are utilized when normal power failure can cause physical discomfort, serious interruption of an industrial process, damage to process equipment, or disruption of business — but the power failure does not cause life threatening conditions or impose any safety hazards.

According to the Code, Optional Standby Systems consist of two types: (1) those that are permanently installed in their entirety including prime movers, and (2) those that are arranged for a connection to a premises wiring system from a portable alternate power supply.

Generator Types (automatic or manual)

Automatic engine-driven generators are permanently installed and are designed to automatically bring on the alternate source of electric power in case of main power failure after a predetermined amount of time has lapsed. A farm consisting of a livestock confinement operation, for example, needs to have immediate power to keep ventilation fans operating to keep the confined animals with a continual supply of fresh air — so they don’t become overcome with the toxic fumes from the manure pits located underneath the animal stalls. These automatic systems use transfer switches that bring on the backup power automatically when the normal power goes out.

Manual engine-driven generators — as described in 250.34 of the Code — are used where it is not critical that an immediate backup supply of electricity is readily available. They are usually of two types — PTO driven generators and gas engine driven generators that are mounted on either a cradle or on wheels which can be moved manually.

If one has access to a tractor, PTO driven generators are quite handy. Depending on size, the generator is either mounted on the tractor's 3-point hitch or on a trailer and is powered by the tractor's PTO (power take-off) shaft. However, because power failures are more frequent in adverse weather, one needs to make sure the tractor will start in cold weather. One may want to install an engine block heater on the designated tractor — and make sure it is plugged in during adverse weather — before the normal power actually goes out.

Gas engine generators are usually smaller capacity generators than their PTO counterparts — and are mounted in cradles or on carts or wheels. These types of generators can either be manual start or electric start.

Generator Sizing

The generator should have adequate capacity to supply electricity to all equipment intended to be operated at one time. Before purchasing a generator, decide whether the entire dwelling/farm needs to be operated at one time or only the essentials such as a furnace, a few lights, the well, etc.

When sizing a generator, calculate the wattage needed at any one time and purchase a generator that is capable of supplying the amounts of watts you need. Remember when adding up the wattages of motors, the motors may use up to six times as much wattage when starting as compared to running. Therefore, one may need to start motors one at a time to cut down on the total load.

Transfer Equipment Provides Safety and Generator Protection

Transfer equipment **must be used** with Optional Standby Systems as required by 702.6 of the Code. However, transfer equipment is not inexpensive and too often one may find that a consumer has “cut corners” and is operating a generator without utilizing proper transfer equipment. Is it safe? **DEFINITELY NOT.**

Here's why. That same transformer at your residence, or in your neighborhood or on your farm that “steps down” the high voltage in the cooperative distribution lines to the usable voltage one needs to power lights and equipment — also works in reverse during a power outage. It will take the 120 and or 240 volts from the generator and will “step up” the voltage to the normally high voltages found every day on the cooperative's distribution lines. The linemen working to repair the cooperatives lines may think the lines are not energized and are safe to work on, but in essence they have dangerous high voltage on them because you did not use transfer equipment. You have put their lives in danger because you did not follow the requirements of the National Electrical Code.

This should be reason enough to use transfer equipment. However, another reason to use proper transfer equipment is to keep the cooperative voltage from entering your generator and **destroying it** — when the power outage is over.

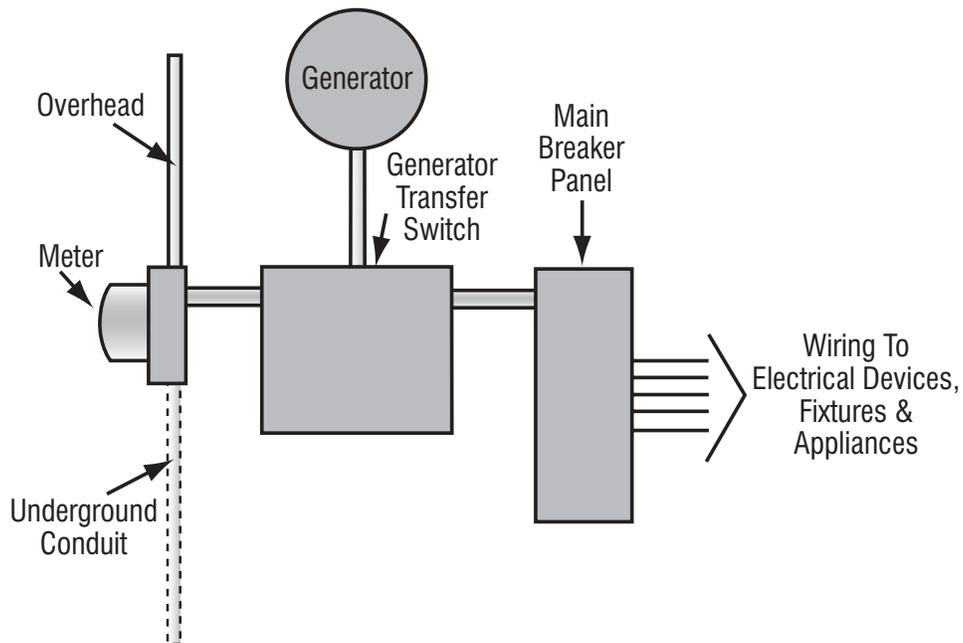
The most common type of manual transfer equipment for a 120/240 volt system is a double-pole double-throw (DPDT) transfer switch. The double pole means there are two conductors that can be controlled; and the double throw means these two conductors can

be energized from two different sources. There are several types of DPDT transfer switches. The first four options below describe how to use DPDT transfer switches.

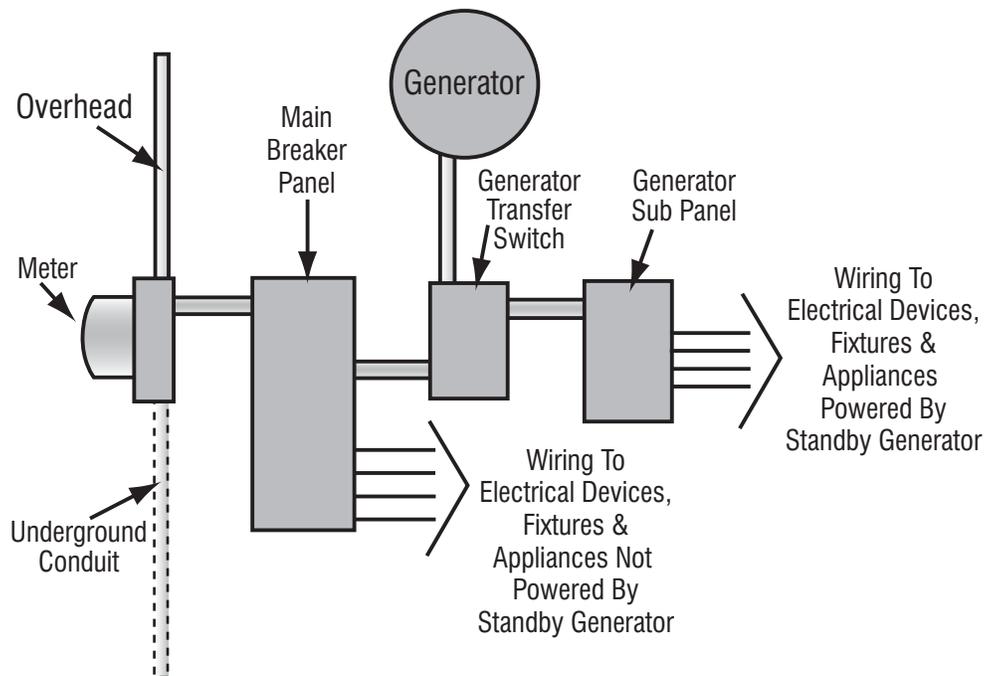
The fifth option, however, explains a completely different way of using generator power safely without utilizing a transfer switch.

Option 1 — One common location for a DPDT transfer switch is upstream of the main breaker panel. If this type is used, it must have the same amperage rating as the main disconnect — because it will handle the same load as the main disconnect. This is usually the most expensive type of transfer equipment, however, it is usually the most desired arrangement because the tie in of the generator at this location can power the entire premises.

Some manufacturers make a combination indoor/outdoor transfer switch and distribution panel — that can be used as Service Equipment. It works extremely well in this type of arrangement and has additional circuits for outdoor applications such as air conditioner compressors, boat docks, outbuildings, pump houses and the like.



Option 2 — When the generator in use is not large enough to power the entire premises, there is another method to use a transfer switch. A more economical option is to install a DPDT transfer switch downstream from the main breaker panel — and also install a smaller breaker panel after the transfer switch for those critical circuits one would like to have energized in case of a power failure. In this type of arrangement the DPDT transfer switch would only require the same amperage rating as the second breaker panel — which can be less expensive than the first option.



Option 3 — Some manufacturers make pre-wired transfer switches that look like small subpanels. These devices do not require separate DPDT switches either upstream or downstream of the main disconnect. Rather, they consist of several circuits — with each circuit having its own individual DPDT switch.

The DPDT switch on these circuits has 3 positions — UTIL, OFF, GEN. When switching between UTIL and GEN to start feeding power from the generator to those critical circuits, it always passes through the OFF position. The OFF position prevents arcing or short circuits during the transition.

These pre-wired transfer switches offer complete kits — ranging from providing dual watt-meters for balancing generator loads, a rubber cord with nylon connectors for generator connection, power inlet for the generator cord that can be mounted either in the device or in an outdoor enclosure mounted on the building, and the flexible whip that provides all the wire conductors one needs to hookup to the Main Breaker Panel.

This type of generator hookup is a cost effective way to install a DPDT transfer switch system after the wiring of a building has been completed.



Option 4 — Another type of transfer switch is through installing a generator interconnection device at the electric meter location. (Note: this option requires involvement and approval of your local electric cooperative.)

This five-inch device is a small collar installed between the electric meter and the meter socket that allows one to easily connect a small generator during power emergencies. With this device, one simply plugs the generator into this device. Through turning on or off the circuit breakers at the building's main breaker panel, one can select which circuits to operate, based on the generator capacity.

It provides the required protection for both line crews and the generator by automatically disconnecting a customer's home from the cooperative distribution system when it detects that a portable generator is plugged in and operating.

This interconnection device is designed and rated to connect directly to a standard household electric service of **200 amps** or less — and can be installed by the local electric cooperative in less than 30 minutes. There is no need for one to be home when the device is installed and requires no need to do any rewiring inside the house.



Option 5 — Most people equate transfer equipment with a transfer switch — and transfer switches are probably the most common type of transfer equipment. However, one other method of obtaining backup power — and using it safely — is through a device that is not a transfer switch at all. Rather, it's an interlocking device one installs on the main breaker panel — and it still offers the required protection for both the linemen and the generator.

The interlocking device is mounted on the cover on the breaker panel. It also requires installing a “generator” circuit breaker — that is securely mounted — in the building's breaker panel in the “2 & 4” location. The purpose of this generator breaker is to control the electricity that is backed by the generator.

By its design, the interlocking device ensures that the main breaker that controls the cooperative power — and the generator breaker that controls the generator power — can both never be in the “ON” position at the same time. When the Main breaker is on, the Generator breaker is off. When the Generator breaker is on, the Main breaker is off. This system is allowed by 408.36(D) of the Code since it considers the generator breaker as a “back-fed device.”

This type of installation is a good option to use when the building has already been wired. Because it is difficult and often costly to install a DPDT transfer switch ahead of the Main Breaker Panel and requires the disruption of service to install, the interlocking device can be a logical alternative. Like the DPDT transfer switch installed upstream of the Main Breaker Panel, it also allows one to operate every circuit in the building with backup power — if the generator is able to handle the load.



Overload Protection

The generator should be protected from overloads conditions by using overcurrent protection on the generator itself, overcurrent protection located on the transfer equipment, or by adding overcurrent protection during installation of the power backup circuitry. Cords used to deliver power from the generator should be rated to handle the load and listed for the environment.

Using Generated Power on Electronic Equipment

It is recommended that sensitive electronic equipment such as microwaves, televisions, computers and their peripherals not be used when a portable generator is supplying backup power. The frequency output of a generator is not always consistent and it could cause harm to sensitive electronic equipment.

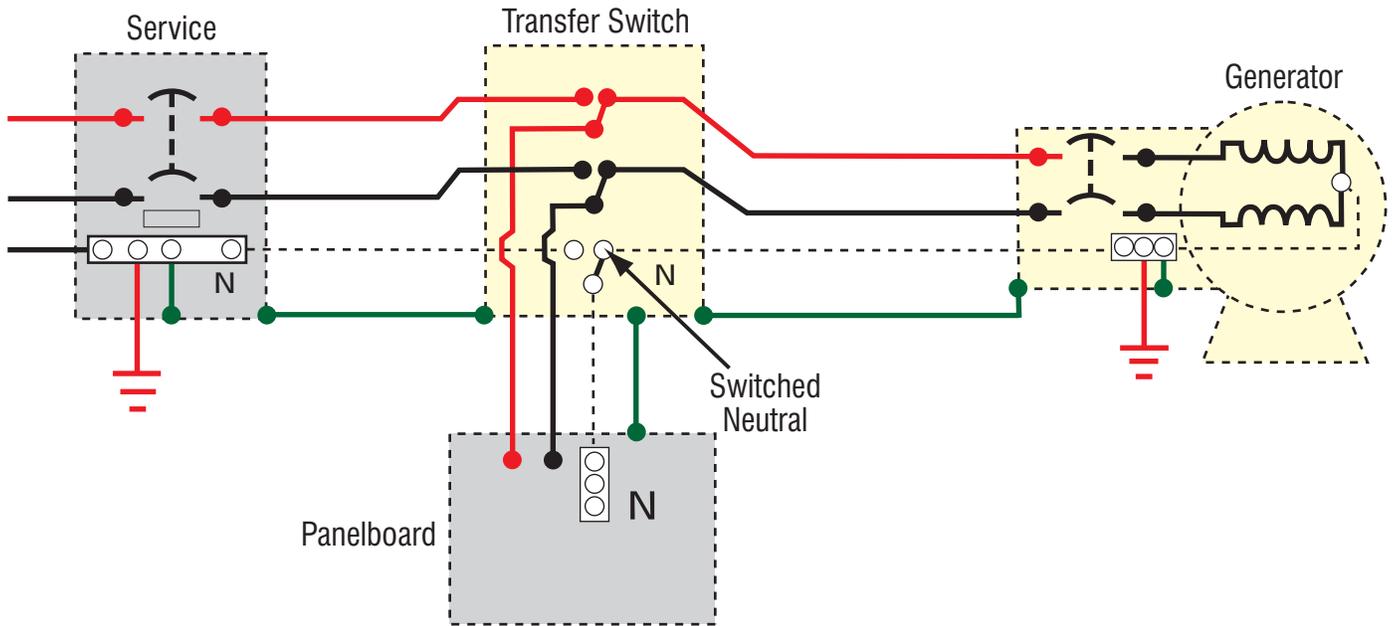
Separately Derived and Nonseparately Derived Systems

Use of portable generators is classified into two types of systems — separately derived system and nonseparately derived system. A separately derived system is defined by the Code as: *A premises wiring system whose power is derived from a source of electric energy or equipment other than a service. Such systems have no direct electrical connection, including a solidly connected grounded circuit conductor, to supply conductors originating in another system.* If the generator system does not meet these qualifications, the system is considered a nonseparately derived system.

An easy way to determine whether or not the generator is the power source of a separately derived system is to look at the grounded conductor (neutral) connection inside the transfer switch. If the grounded conductor is being switched along with the phase conductors, it is a separately derived system. If the grounded conductor is not switched, but is solidly connected, it is a nonseparately derived system.

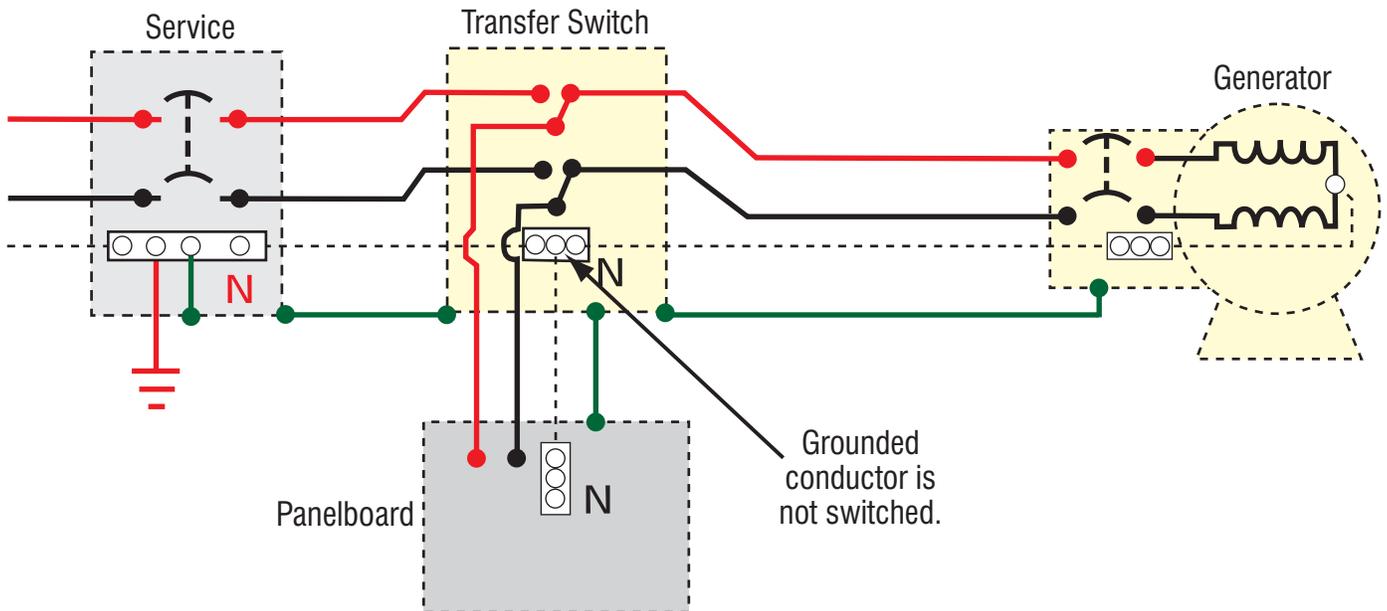
If the generator system is utilizing an interlocking device or a pre-wired transfer switch, the generator is the power source of a nonseparately derived system — because the generator's grounded conductor is solidly connected to the service's grounded conductor.

Generator as a Power Source of a Separately Derived System



A generator is the power source of a separately derived system if it has no direct connection to other system conductors.

Generator as a Power Source of a Nonseparately Derived System



A generator is the power source of a nonseparately derived system if the grounded conductor (neutral) is solidly interconnected to supply circuit conductors.

Steps to Determine How to Ground and Bond a Portable Generator

Step 1 — Is the generator going to be connected to a fixed wiring system or used for portable tools?

- **Fixed Wiring System. PROCEED TO STEP 2.**
- **Portable Tools.** According to 250.34(A) of the Code, the frame of a portable generator does not need to be connected to its own grounding electrode **if** the following 2 requirements are met:
 1. The generator supplies only equipment mounted on the generator or cord-and-plug-connected equipment (e.g., power tools such as drills, saws, etc.) through receptacles mounted on the generator, or both AND
 2. The normally non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are connected to the generator frame. **STOP — END OF QUESTIONS.**

Step 2 — Is the generator part of a separately derived system?

- **YES.** According to 250.20(D); 250.30(A); 702.10(A); and the Fine Print Note (FPN) of 250.34(C) of the Code:
 1. The generator frame, the generator's equipment grounding conductors, the generator's grounded conductor (neutral) must be interconnected to each other through a system bonding jumper. (Note: Many generators usually have this system bonding jumper already installed during manufacture. However, don't assume — verify that it does by using a continuity checker.) If it does not, the system bonding jumper may be installed, either at the generator or at the first disconnecting means or overcurrent device, or any point between.
 2. A grounding electrode conductor must be installed connecting the generator's grounded conductor (neutral) and the generator's own grounding electrode. According to the tenth edition of the *Soares Book on Grounding and Bonding*, the grounding electrode conductor connection to the generator system must be located at the same point where the system bonding jumper is installed.
 3. If the system bonding jumper is at the generator, to obtain 120/240 volts, a 4-conductor cord or cable must be utilized between the generator and transfer equipment. If the system bonding jumper is downstream from the generator, a 3-conductor cord or cable may be utilized from the generator to the location of the system bonding jumper. Then a 4-conductor wiring system must be utilized after that point.
 4. A sign needs to be placed at the Service Equipment that indicating the type and location of optional standby power sources. **STOP — END OF QUESTIONS.**
- **NO.** According to 702.8(B) and (702.10(B), this means:
 1. The generator's neutral must be kept separate from the generator frame and the generator's equipment grounding conductors through the removal of the system bonding jumper.
 2. An extra grounding electrode at the generator is prohibited. This is because the generator system's neutral is grounded through the connection to the neutral of the premises wiring system.
 3. To obtain 120/240 volts, a 4-conductor cord or cable must be utilized between the generator and transfer equipment.

4. A sign needs to be placed at the Service Equipment that indicates the type and location of optional standby power sources.
5. A sign needs to be placed at the Service Equipment that indicates the electrode connection for both the service and for the generator is located in the Service Equipment enclosure. **STOP — END OF QUESTIONS.**