

## ARTICLE

## 445 Generators

**445.1 Scope.** This article contains installation and other requirements for generators.

Article 445 covers the installation of generators. The following articles cover the use of generators in specific applications. Exhibit 445.1 shows an example of a diesel engine-driven generator.

**See also**

**Article 695** for fire pumps

**Article 700** for emergency systems

**Article 701** for legally required standby systems

**Article 702** for optional standby systems

**Article 705** for interconnected electric power production sources

**Article 708** for critical operations power systems

Δ **445.6 Listing.** Stationary generators shall be listed.

*Exception: One of a kind or custom manufactured generators shall be permitted to be field labeled.*

Informational Note: See UL 2200, *Standard for Stationary Engine Generator Assemblies*, for additional information.

Although model building codes contain specific listing requirements for stationary generators used as the alternate power source for emergency and legally required standby power systems, this requirement applies to all stationary generators rated 600 volts or less regardless of the type of system being powered.



**EXHIBIT 445.1** A diesel engine-driven generator that can be used as the alternate power source for an emergency system, legally required standby system, optional standby system, or critical operations standby system or as a parallel source in an interconnected power production system.

This includes stationary generators installed as the alternate power source for optional standby systems installed in residential, commercial, institutional, and industrial applications as well as stationary generators brought to a site as a temporary power source.

UL 2200, *Standard for Stationary Engine Generator Assemblies*, defines a *stationary unit (generator)* as “an engine generator that is intended to be hard-wired and/or permanently installed.”

**445.10 Location.** Generators shall be of a type suitable for the locations in which they are installed. They shall also meet the requirements for motors in 430.14.

Informational Note: See NFPA 37-2021, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, for information on the location of generators.

**445.11 Marking.** Each generator shall be provided with an accessible nameplate giving the manufacturer’s name, the rated frequency, the number of phases if ac, the rating in kilowatts or kilovolt-amperes, the power factor, the normal volts and amperes corresponding to the rating, and the rated ambient temperature.

Nameplates or manufacturer’s instructions shall provide the following information for all stationary generators and portable generators rated more than 15 kW:

- (1) Alternator subtransient, transient, synchronous, and zero sequence reactances
- (2) Generator set power rating category (including but not limited to prime, standby, or continuous)
- (3) Alternator temperature rise at rated load and insulation system class
- (4) Indication if the generator is protected against overload by inherent design, an overcurrent protective relay, a circuit breaker, or a fuse
- (5) Available fault current for inverter-based generators, in lieu of the synchronous, subtransient, and transient reactances

Marking shall be provided by the manufacturer to indicate whether or not the generator neutral is bonded to its frame. Where the bonding is modified in the field, additional marking shall be required to indicate whether the neutral is bonded to the frame.

Portable generators rated larger than 15 kilowatts and stationary generators must be marked with their reactances using the correct industry terms. The marking of the generator’s maximum short-circuit current assists the inspector and the installer in verifying proper overcurrent protection in the field. Newer generators are being manufactured with inverter-based designs. Determining available fault current ratings for those generators is more complicated, and marking on the generator by the manufacturer is more appropriate and can be used instead of marking the generators’ reactances.

Marking to indicate whether the generator is inherently designed to prevent overload, or whether an overcurrent protective relay is provided, assists designers and installers to size



conductors from the generator output terminals for an ampacity of 100 percent, based on the exception to 445.13(A).

Marking provided by the manufacturer to indicate whether or not the generator neutral is bonded to the generator frame, plus the configuration of the transfer switch (solid neutral or switched neutral) provides installers with the necessary information to apply the requirements of Article 250 in respect to treating the generator supplied system as separately derived or non-separately derived. If the bonding of a generator is modified in the field, additional marking indicates whether the generator is configured as a separately derived or non-separately derived system.

#### See also

**Exhibits 250.12 and 250.13** for examples of grounding and bonding connections at generators that supply premises wiring systems

### 445.12 Overcurrent Protection.

**(A) Constant-Voltage Generators.** Constant-voltage generators, except ac generator exciters, shall be protected from overload by inherent design, circuit breakers, fuses, protective relays, or other identified overcurrent protective means suitable for the conditions of use.

**(B) Two-Wire Generators.** Two-wire, dc generators shall be permitted to have overcurrent protection in one conductor only if the overcurrent device is actuated by the entire current generated other than the current in the shunt field. The overcurrent device shall not open the shunt field.

**(C) 65 Volts or Less.** Generators operating at 65 volts or less and driven by individual motors shall be considered as protected by the overcurrent device protecting the motor if these devices will operate when the generators are delivering not more than 150 percent of their full-load rated current.

**(D) Balancer Sets.** Two-wire, dc generators used in conjunction with balancer sets to obtain neutral points for 3-wire systems shall be equipped with overcurrent devices that disconnect the 3-wire system in case of excessive unbalancing of voltages or currents.

**(E) Three-Wire, Direct-Current Generators.** Three-wire, dc generators, whether compound or shunt wound, shall be equipped with overcurrent devices, one in each armature lead, and connected so as to be actuated by the entire current from the armature. Such overcurrent devices shall consist either of a double-pole, double-coil circuit breaker or of a 4-pole circuit breaker connected in the main and equalizer leads and tripped by two overcurrent devices, one in each armature lead. Such protective devices shall be interlocked so that no one pole can be opened without simultaneously disconnecting both leads of the armature from the system.

*Exception to (A) through (E): Where deemed by the authority having jurisdiction that a generator is vital to the operation of*

*an electrical system and the generator should operate to failure to prevent a greater hazard to persons, the overload sensing device(s) shall be permitted to be connected to an annunciator or alarm supervised by authorized personnel instead of interrupting the generator circuit.*

### 445.13 Ampacity of Conductors.

**(A) General.** The ampacity of the conductors from the generator output terminals to the first distribution device(s) containing overcurrent protection shall not be less than 115 percent of the nameplate current rating of the generator. It shall be permitted to size the neutral conductors in accordance with 220.61. Conductors that must carry ground-fault currents shall not be smaller than required by 250.30(A). Neutral conductors of dc generators that must carry ground-fault currents shall not be smaller than the minimum required size of the largest conductor.

*Exception: Where the design and operation of the generator prevent overloading, the ampacity of the conductors shall not be less than 100 percent of the nameplate current rating of the generator.*

If the generator is inherently designed to prevent overload or if an overcurrent protective relay is provided, the conductors supplied from the generator output terminals are permitted to have a minimum ampacity based on 100 percent of the nameplate current rating of the generator, based upon the exception to 445.13(A).

**(B) Overcurrent Protection Provided.** Where the generator set is equipped with a listed overcurrent protective device or a combination of a current transformer and overcurrent relay, conductors shall be permitted to be tapped from the load side of the protected terminals in accordance with 240.21(B).

Tapped conductors shall not be permitted for portable generators rated 15 kW or less where field wiring connection terminals are not accessible.

The listed branch-circuit overcurrent protective device (OCPD), or a combination of a current transformer and overcurrent relay on the tap conductor source side terminals, provides short-circuit protection for the tap conductors. If the generator is equipped with such protection, feeder tap rules can be used with overload protection for the feeder conductors being provided by the overcurrent device that the tap conductors supply.

**445.14 Protection of Live Parts.** Live parts of generators operated at more than 50 volts ac or 60 volts dc to ground shall not be exposed to accidental contact where accessible to unqualified persons.

**445.15 Guards for Attendants.** Where necessary for the safety of attendants, the requirements of 430.233 shall apply.

**445.16 Bushings.** Where field-installed wiring passes through an opening in an enclosure, a conduit box, or a barrier, a bushing



shall be used to protect the conductors from the edges of an opening having sharp edges. The bushing shall have smooth, well-rounded surfaces where it may be in contact with the conductors. If used where oils, grease, or other contaminants may be present, the bushing shall be made of a material not deleteriously affected.

**445.17 Generator Terminal Housings.** Generator terminal housings shall comply with 430.12. Where a horsepower rating is required to determine the required minimum size of the generator terminal housing, the full-load current of the generator shall be compared with comparable motors in Table 430.247 through Table 430.250. The higher horsepower rating of Table 430.247 and Table 430.250 shall be used whenever the generator selection is between two ratings.

*Exception: This section shall not apply to generators rated over 600 volts.*

#### Δ 445.18 Disconnecting Means.

**(A) Disconnecting Means.** Generators other than cord-and-plug-connected portable generators shall have one or more disconnecting means. Each disconnecting means shall simultaneously open all associated ungrounded conductors. Each disconnecting means shall be lockable open in accordance with 110.25.

The disconnecting means shall be permitted to be located within the generator behind a hinged cover, door, or enclosure panel. Where the generator disconnecting means is located within the generator, a field applied label meeting the requirements of 110.21(B) shall be provided indicating the location of the generator disconnecting means.

**(B) Generators Installed in Parallel.** Where a generator is installed in parallel with other generators, the provisions of 445.18(A) shall be capable of isolating the generator output terminals from the paralleling system bus. The disconnecting means shall not be required to be located at the generator.

Arranging generators to operate in parallel is a common practice for large hospitals, data centers, and other large buildings requiring on-site emergency or standby power. Electrically operated circuit breakers automatically connect multiple generators to a common switchboard bus. They open and close via programmable logic controllers (PLC) commands. They close to the common bus when the generators are electrically synchronized and open when the generator shuts down or when commanded by the PLC for any preprogrammed sequence or adverse condition in the system. If the generator engine stops for any reason, the paralleling breaker in the paralleling switchboard, which is electrically interlocked with the equipment, will open. Where generators are installed in parallel, it is not necessary to provide a disconnecting means at each generator and at the paralleling equipment. Regardless of the location of the disconnecting means, compliance with 445.18(A) is required in respect to the circuit breaker or switch being capable of being locked in the open position. This protects a worker servicing a generator that

is taken out of the parallel lineup from being exposed to a back-feed at the output terminals of the generator.

#### N 445.19 Emergency Shutdown of Prime Mover.

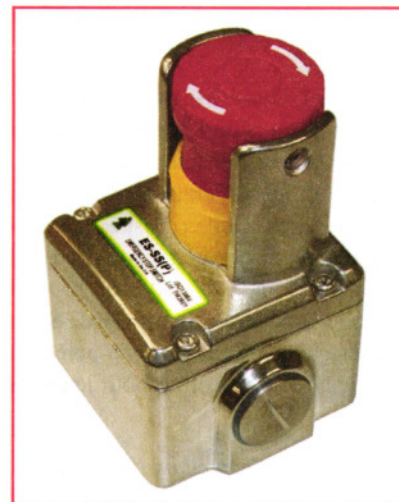
**(A) General.** Generators shall have provisions to shut down the prime mover. The means of shutdown shall comply with all of the following:

- (1) Be equipped with provisions to disable all prime mover start control circuits to render the prime mover incapable of starting
- (2) Initiate a shutdown mechanism that requires a mechanical reset

The provisions to shut down the prime mover shall be permitted to satisfy the requirements of 445.18(A) where it is capable of being locked in the open position in accordance with 110.25.

The emergency engine shutdown is permitted to serve as the generator disconnecting means that isolates the generator from the equipment it supplies. Where this device is used only as the engine shutdown required by 445.19(A), it is not required to be a locking-type device. Where the device is used to shut down the engine and also serve as the disconnecting means required by 445.18(A), it is required to be capable of being locked in the "open" position. In the case of this device, the open position is that which complies with 445.19(A)(1) and (2). This is considered to be equivalent to locking a circuit breaker or safety switch in the "open," or off, position from the perspective of protecting personnel working on equipment supplied by the generator. Where two or more generators are operating in parallel, the use of the engine shutdown is not an acceptable disconnecting means because it does not meet the requirements to isolate the generator output terminals required by 445.18(B).

Exhibit 445.2 is an example of the type of device that can be used to comply with 445.19(A) and (B). It can also be used to



**EXHIBIT 445.2** A lockable emergency shutdown device that can be used as a generator disconnecting means in accordance with 445.18(A) and 445.19(A). (Courtesy of Idem Safety Switches Ltd.)



comply with 445.18(A) because it can be locked in the position that disables the engine start circuit.

- N (B) Remote Emergency Shutdown.** For other than one- and two-family dwelling units, generators with greater than 15 kW rating shall be provided with a remote emergency stop switch to shut down the prime mover. The remote emergency stop switch shall be located outside the equipment room or generator enclosure at a readily accessible location and shall also meet the requirements of 445.19(A)(1) and (A)(2).

The remote emergency stop switch shall be permitted to be mounted on the exterior of the generator enclosure. The remote emergency stop switch shall be labeled Generator Emergency Shutdown, and the label shall meet the requirements of 110.21(B).

Requiring shutdown of the prime mover for generators greater than 15 kilowatts is necessary to provide a remote shutdown means in the event of an emergency event such as a prime mover failure. This requirement aligns with 5.6.5.8 in NFPA 110, *Standard for Emergency and Standby Power Systems*, 2022 edition. However, unlike NFPA 110, which is mandatory only for Level 1 (Article 700) and Level 2 (Article 701) emergency and standby power systems, the requirement of 445.19(B) imposes the emergency shutdown requirement on all generators having a rating greater than 15 kilowatts regardless of the type of system or installation supplied by the generator.

- N (C) Emergency Shutdown in One- and Two-Family Dwelling Units.** For other than cord-and-plug-connected portable generators, an emergency shutdown device shall be located outside the dwelling unit at a readily accessible location and shall also meet the requirements of 445.19(A)(1) and (A)(2).

An emergency shutdown device mounted on the exterior of the generator enclosure shall be permitted to satisfy the requirements of this section. The shutdown device shall be marked as the Generator Emergency Shutdown, and the label shall meet the requirements of 110.21(B).

Where a stationary generator is used as the primary source of power or as the alternate source of power in an optional standby system installed at one- and two-family dwellings, an emergency prime mover shutdown device is required to be installed outside the dwelling unit at a readily accessible location. This rule aligns with similar emergency shutdown requirements for these types of occupancies in 230.85 for services, 480.7(B) for stationary battery systems, 706.15 for energy storage systems, and 690.12(C) for the rapid shutdown initiation device for solar photovoltaic systems. The NEC® requires only that these devices be installed at a readily accessible location outside the dwelling unit. Where multiple devices are required at a one- or two-family dwelling, there is no specific requirement to group them in one readily accessible location. However, because these devices are installed primarily to facilitate the shutdown of power supplies by first responders or other emergency personnel, it is advisable that the AHJ be consulted on where the devices should be installed.

- Δ 445.20 Ground-Fault Circuit-Interrupter Protection for Receptacles on 15-kW or Smaller Portable Generators.** Receptacle outlets that are a part of a 15-kW or smaller portable generator shall have listed ground-fault circuit-interrupter protection (GFCI) for personnel integral to the generator or receptacle as indicated in either 445.20(A) or (B):

**(A) Unbonded (Floating Neutral) Generators.** Unbonded generators with both 125-volt and 125/250-volt receptacle outlets shall have listed GFCI protection for personnel integral to the generator or receptacle on all 125-volt, 15- and 20-ampere receptacle outlets.

*Exception: GFCI protection shall not be required where the 125-volt receptacle outlet(s) is interlocked such that it is not available for use when any 125/250-volt receptacle(s) is in use.*

**(B) Bonded Neutral Generators.** Bonded generators shall be provided with GFCI protection on all 125-volt, 15- and 20-ampere receptacle outlets.

**Informational Note:** See 590.6(A)(3) for GFCI requirements for 15-kW or smaller portable generators used for temporary electric power and lighting.

*Exception to (A) and (B): If the generator was manufactured or remanufactured prior to January 1, 2015, listed cord sets or devices incorporating listed GFCI protection for personnel identified for portable use shall be permitted.*

Separate requirements for different configurations of portable generators address the design differences of integral ground-fault circuit-interpreter (GFCI) protection and interlocking features of unbonded versus bonded generators. The exception to 445.20(A) addresses the problems of proper operation of a GFCI-protected 125-volt receptacle on the generator when the 125/250-volt receptacle on the generator is connected into a grounded premises wiring system via a transfer device that employs a solid neutral connection and the generator neutral is floating (not bonded to the generator frame). This connection creates multiple paths for normal circuit operation neutral current that will result in tripping of the GFCI devices protecting receptacles on the generator. If the generator is connected to a premises wiring system using a 125/250-volt receptacle on the floating neutral generator, any 125-volt receptacles not having GFCI protection have to be interlocked so they cannot export power. Where the 125/250-volt receptacle(s) is not supplying use, the 125-volt receptacles can be used to supply cord-and-plug-connected portable loads, and under the conditions of the exception, GFCI protection is not required.

The Informational Note refers the user to additional GFCI requirements for receptacles on portable generators that are used for temporary electric power and lighting at construction sites and similar locations. GFCI protection is mandatory for certain receptacle configurations on portable generators regardless of whether the generator is of the floating neutral or bonded neutral type.