Mike Holt's Illustrated Guide to

NEC REQUIREMENTS FOR GENERATORS AND STANDBY POWER SYSTEMS

Rule 220.87, Articles 445, 700, 701 and 702

Extracted from Understanding the National Electrical Code® Volumes 1 & 2

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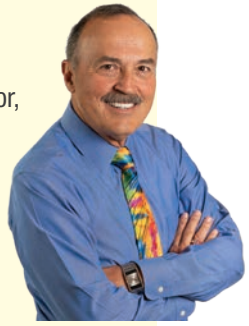

Mike Holt is an author, businessman, educator, speaker, publisher and *NEC®* expert. He has written hundreds of electrical training books and articles, founded three successful businesses, and has taught thousands of electrical *Code* seminars across the United States and internationally.

Mike's approach to electrical training is based on his own experience as an electrician, contractor, inspector and teacher. He's always felt a responsibility to his students and to the electrical industry to provide education beyond the scope of just passing an exam. This commitment, coupled with the lessons he learned at the University of Miami's MBA program, have helped him build one of the largest electrical training and publishing companies in the United States.

Mike's one-of-a-kind presentation style and his ability to simplify and clarify technical concepts explain his unique position as one of the premier educators and *Code* experts in the country. His passion for the electrical field drives his goal to increase electrical safety and improve lives.

Mike's commitment to pushing boundaries and setting high standards extends into his personal life. He's an eight-time Overall National Barefoot Waterski Champion with more than 20 gold medals, many national records, and he has competed in three World Barefoot Tournaments. In 2015, at the tender age of 64, he started a new adventure—competitive mountain bike racing. Every day he continues to find ways to motivate himself, both mentally and physically.

Mike and his wife, Linda, reside in New Mexico and Florida, and are the parents of seven children and six grandchildren. As his life has changed over the years, a few things have remained constant: his commitment to God, his love for his family, and doing what he can to change the lives of others through his products and seminars.

I dedicate this book to the
Lord Jesus Christ,
my mentor and teacher.
Proverbs 16:3

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ARTICLE

220

BRANCH-CIRCUIT, FEEDER, AND SERVICE LOAD CALCULATIONS

Introduction to Article 220—Branch-Circuit, Feeder, and Service Load Calculations

This article focuses on the requirements for calculating demand loads (including demand factors) in order to size branch circuits [210.19(A)(1)], feeders [215.2(A)(1)], and service conductors [230.42(A)].

Part I describes the layout of Article 220 and provides a table showing where other types of load calculations can be found in the *NEC*. Part II provides requirements for branch-circuit calculations and for specific types of branch circuits. Part III covers the requirements for feeder and service calculations using what is commonly called the "Standard Method of Calculation." Part IV provides optional calculations that can be used in place of the standard calculations provided in Parts II and III—if your installation meets certain requirements. "Farm Load Calculations" are discussed in Part V of this article.

In some cases, the *Code* provides an optional method (Part IV) for feeder and service calculations in addition to the standard method (Part III); however, they do not yield identical results. In fact, the optional method of calculation will often result in a smaller feeder or service. When taking an exam, read the instructions carefully to be sure which method the test question wants you to use. As you work through Article 220, be sure to study the illustrations to help you fully understand its article requirements. Also, be sure to review the examples in Annex D of the *NEC* to gain more practice with these calculations. The *Code* recognizes that not all demand for power will occur at the same time and it is because of this varying demand that certain demand factors are able to be applied.

220.87 Determining Existing Loads

The calculation of a feeder or service load for an existing dwelling unit must be in accordance with all the following:

(1) The maximum demand data for a 1-year period.

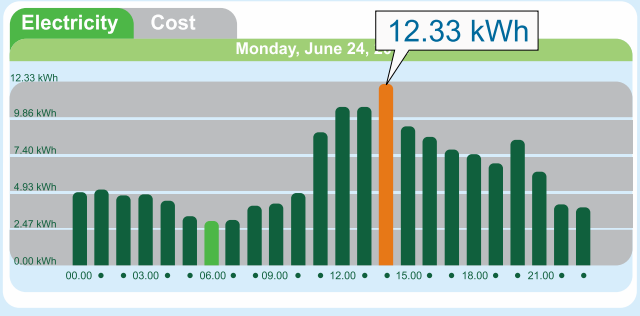
Ex: The highest average kW for a 15-minute period over a period of 30 days. ▸Figure 220–42

(2) The maximum demand at 125 percent plus the new load does not exceed the ampacity of the feeder or rating of the service.

(3) The feeder has overcurrent protection in accordance with 240.4, and the service has overload protection in accordance with 230.90.

Ex: This calculation method is not permitted if the feeder or service has any renewable energy system such as solar photovoltaic or wind electric systems or uses any form of peak load shaving.

Service and Feeder Load Calculations
Determining Existing Loads
220.87(1) Ex



The maximum demand data for one year or the average power demand for a 15-minute period over a minimum of 30 days can be used to size the electric power source.

▸Figure 220–42

ARTICLE 445 GENERATORS

Introduction to Article 445—Generators

This article contains the electrical installation and other requirements for generators. These rules include such things as where generators can be installed, nameplate markings, conductor ampacity, transference of power, and disconnect requirements.

445.1 Scope

Article 445 contains the installation and other requirements for generators. ▸Figure 445–1

▸Figure 445–1

Author's Comment:

- Generators, associated wiring, and equipment must be installed in accordance with the following requirements depending on their use:
  - Fire Pumps, Article 695
  - Emergency Systems, Article 700
  - Legally Required Standby Systems, Article 701
  - Optional Standby Systems, Article 702
  - Interconnected Electric Power Production Sources, Article 705

445.13 Ampacity of Conductors

(A) General. The ampacity of the conductors from the generator winding output terminals to the first overcurrent protective device must be not less than 115 percent of the nameplate current rating of the generator.

Author's Comment:

- Since the overcurrent protective device is typically part of the generator, this 115-percent rule applies to the generator manufacturer, not the field installer.
- Conductors from the load side of the generator are called feeder conductors and are sized to the generator's overcurrent protective device rating in accordance with 240.4.

▶ Example

Question: *What size feeder conductor is required from a 100A overcurrent protective device on a 20 kW, 120/240V, single-phase generator to the transfer switch if the generator and transfer switch terminals are rated 75ºC?* ▸Figure 445–3

(a) 4 AWG (b) 3 AWG (c) 2 AWG (d) 1 AWG

Solution:

3 AWG is rated 100A at 75°C [110.14(C)(1) and Table 310.16].

Answer: *(b) 3 AWG*

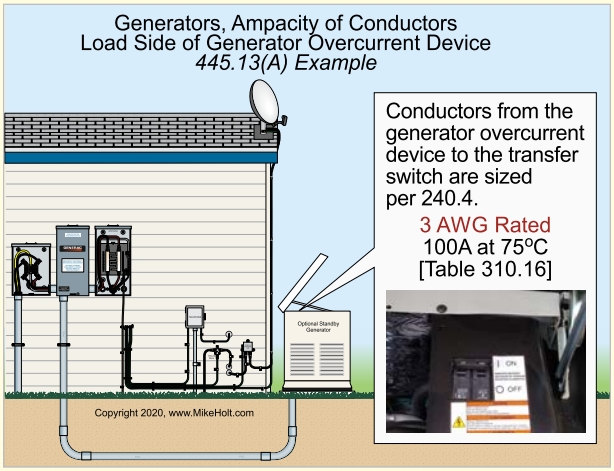


Figure 445–3

The generator's feeder neutral must be sized to carry the maximum unbalanced current as determined by 220.61. Figure 445–4

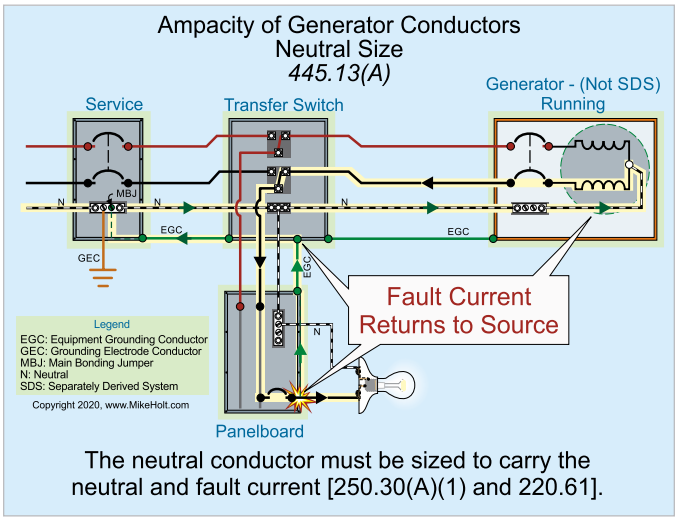


Figure 445–4

445.18 Disconnecting Means and Emergency Shutdown

(A) Disconnecting Means. Generators, other than cord-and-plug-connected portable generators, must have one or more disconnecting means and must be capable of being locked in the open position in accordance with 110.25. Figure 445–5

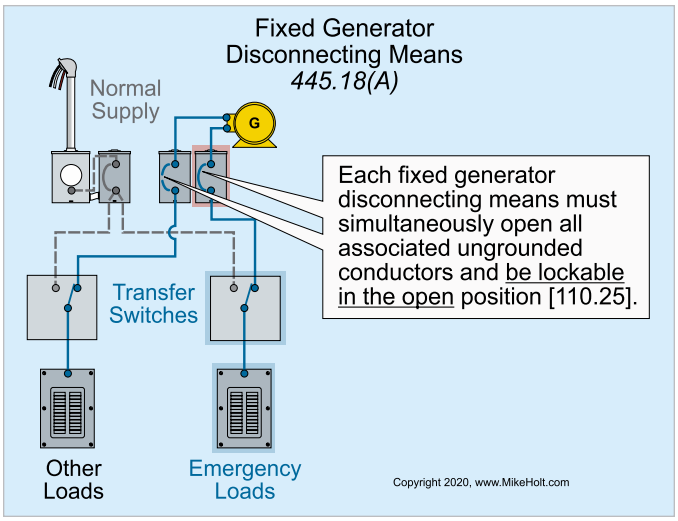


Figure 445–5

(B) Emergency Shutdown of Prime Mover. Generators must have provisions to shut down the prime mover. The means of shutdown must comply with all 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 is permitted to satisfy the requirements of 445.18(A) where the shutdown device is capable of being locked in the open position in accordance with 110.25.

(C) Remote Emergency Shutdown. Generators with a rating greater than 15 kW must be provided with a remote emergency stop switch to shut down the prime mover. The remote emergency stop switch must be located outside the equipment room or generator enclosure and must also meet the requirements of 445.18(B)(1) and (B)(2).

(D) Emergency Shutdown in One- and Two-Family Dwelling Units. For other than cord-and-plug-connected portable generators, an emergency shutdown device must be located outside the dwelling unit at a readily accessible location.

ARTICLE

700

EMERGENCY SYSTEMS

Introduction to Article 700—Emergency Systems

Emergency systems are often required as a condition of an operating permit for a given facility. According to NFPA 101, *Life Safety Code*, emergency power systems are generally installed where artificial illumination is required for safe exiting and for panic control in buildings subject to occupancy by large numbers of people such as high-rise buildings, jails, sports arenas, schools, health care facilities, and similar structures.

The authority having jurisdiction makes the determination as to whether such a system is necessary for a given facility and what it must entail. Sometimes an emergency system simply provides power for exit lighting and exit signs upon loss of the main power or in the case of fire. Its purpose is not to provide power for normal business operations, but rather to provide lighting and controls essential for human life safety.

The general goal is to keep the emergency operation as reliable as possible. The emergency system must be able to supply all emergency loads simultaneously. When the emergency supply also supplies power for other nonemergency loads, the emergency loads take priority over the others, and those other loads must be subject to automatic load pickup and load shedding to support the emergency loads if the emergency system does not have adequate capacity and rating for all loads simultaneously.

As you study Article 700, keep in mind that emergency systems are essentially lifelines for people. The entire article is based on keeping those lifelines from breaking.

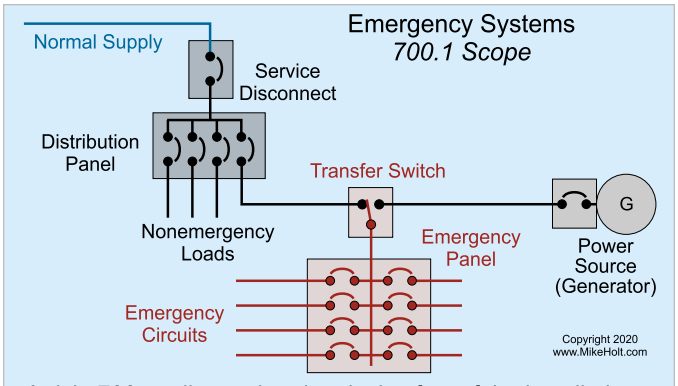
Part I. General

700.1 Scope

Article 700 applies to the electrical safety of the installation, operation, and maintenance of emergency power systems. These consist of circuits and equipment intended to supply illumination, power (or both) within 10 seconds [700.12] when the normal electrical supply is interrupted. ▸Figure 700–1

Some examples of circuits for which emergency power is required are those supplying egress lighting, exit signs, fire alarms, fire pumps, and voice evacuation.

Note 3: For specific locations of emergency lighting requirements, see NFPA 101, *Life Safety Code.*



▸Figure 700–1

Author's Comment:

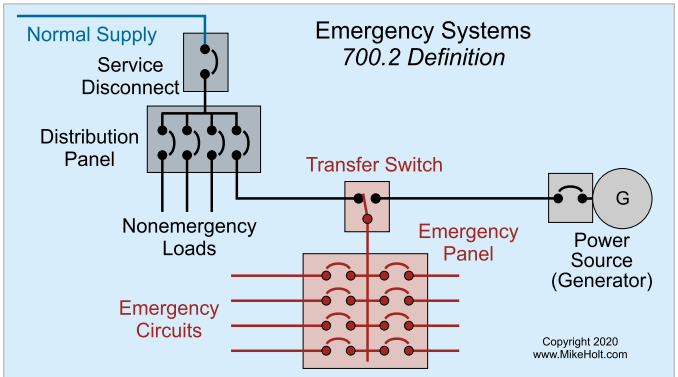
- According to NFPA 101, *Life Safety Code*, emergency power systems are generally installed where artificial illumination is required for safe exiting and for panic control in buildings subject to occupancy by large numbers of people. Some examples are high-rise buildings, jails, sports arenas, schools, health care facilities, and similar structures.

Note 4: For specific performance requirements of emergency power systems, see NFPA 110, *Standard for Emergency and Standby Power Systems.*

700.2 Definitions

This definition applies within this article and throughout the *Code*.

Emergency Systems. Emergency power systems are those systems legally required and classed as emergency by a governmental agency having jurisdiction. These systems are intended to automatically supply illumination and/or power essential for safety to human life. ▸Figure 700–2



▸Figure 700–2

Note: Emergency power systems may also provide power to maintain life, fire detection and alarm systems, elevators, fire pumps, public safety communications systems (twisted pair, antennas, and coaxial cable), industrial processes where current interruption would produce serious life safety or health hazards, and similar functions.

700.3 Tests and Maintenance

(A) Conduct or Witness Test. To ensure that the emergency power system meets or exceeds the original installation specifications, the authority having jurisdiction must conduct or witness an acceptance test of the emergency power system upon completion.

(B) Periodic Testing. Emergency power systems must be periodically tested on a schedule approved by the authority having jurisdiction to ensure adequate maintenance has been performed and the systems are in proper operating condition.

Author's Comment:

- Running the emergency power system under its maximum anticipated load and making sure power is transferred within 10 seconds is often considered an acceptable method of operational testing.

(C) Maintenance. Emergency system equipment must be maintained in accordance with manufacturer instructions and industry standards.

(D) Written Record. A written record of the acceptance test, periodic testing, and maintenance must be kept.

Author's Comment:

- The *NEC* does not specify the required record retention period.

700.4 Capacity and Rating

(A) Rating. An emergency power system must be suitable for the available fault current at its terminals.

(B) Capacity. An emergency power system must have adequate capacity in accordance with Article 220 or by another approved method.

700.5 Transfer Equipment

(A) General. Transfer equipment must be automatic, listed, and marked for emergency use, and approved by the authority having jurisdiction. The equipment must be designed to prevent the inadvertent interconnection of emergency and other power systems. ▸Figure 700–3

Meter-mounted transfer switches are not permitted for emergency system use.

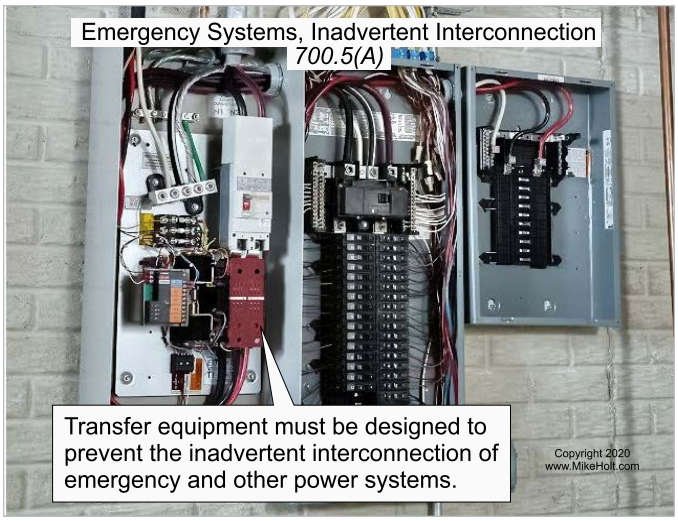


Figure 700–3

(C) Automatic Transfer Switches. Automatic transfer switches must be able to be electrically operated and mechanically held. They are not permitted to be reconditioned.

(D) Use. Transfer equipment must supply only emergency loads. Figure 700–4

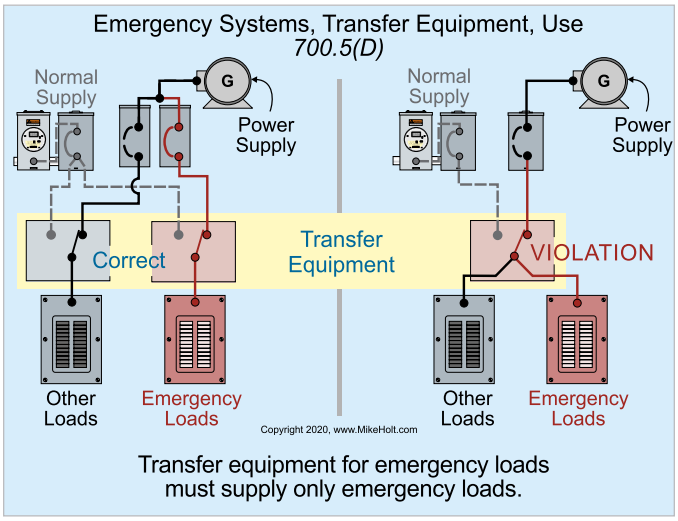


Figure 700–4

Author's Comment:

- Multiple transfer switches are required where a single generator is used to supply emergency loads, legally required standby loads, and optional loads.

(E) Documentation. The short-circuit current rating of the transfer equipment must be field marked on the exterior of the transfer equipment.

700.7 Signs

(A) Emergency Sources. A sign must be placed at service-entrance equipment indicating the type and location of each on-site emergency power source. Figure 700–5

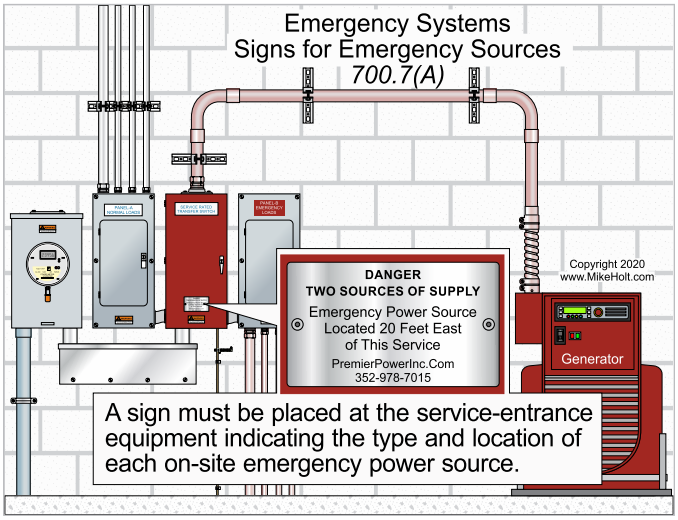


Figure 700–5

700.8 Surge Protection

A listed surge protective device must be installed for all emergency system panelboards and switchboards. Figure 700–6

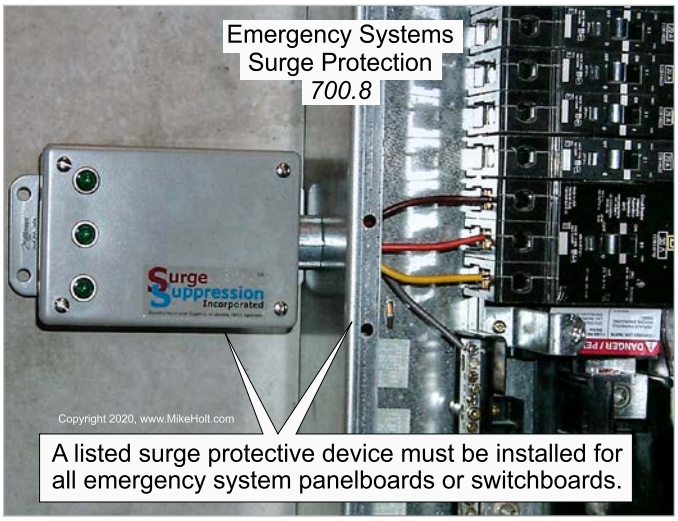


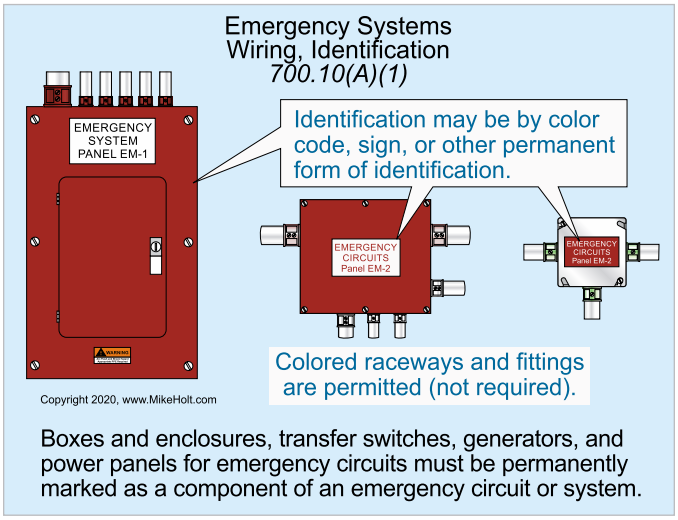
Figure 700–6

Part II. Circuit Wiring

700.10 Wiring

(A) Identification. Components of the emergency system must be permanently marked so they are easily identified as part of the emergency system.

(1) Boxes and enclosures, transfer switches, generators, and power panels for emergency circuits must be permanently marked as a component of an emergency circuit or system. ▸Figure 700–7



▸Figure 700–7

Author's Comment:

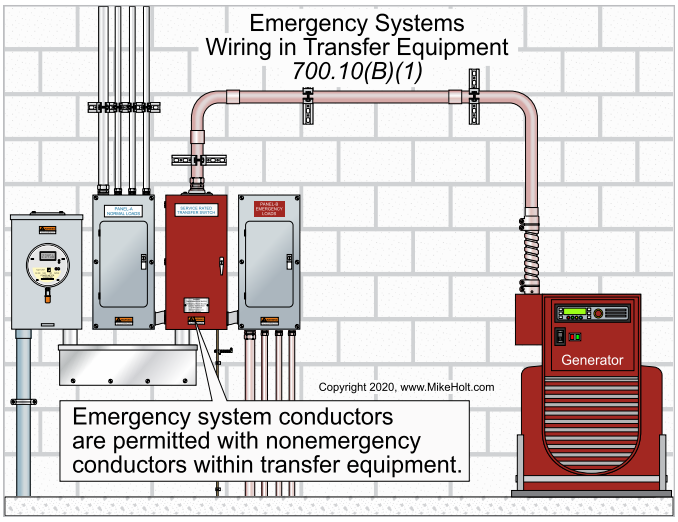
- The marking required by this section for enclosures, cables, and raceways can be by any approved method that identifies the component(s) as part of the emergency system, such as the words "Emergency System," "Emergency Circuits," or by color code such as the use of a red raceway or box cover. Colored raceways and fittings are permitted but not required.

(2) Cable and raceway systems must be permanently marked as part of the emergency system at intervals not exceeding 25 ft.

Receptacles connected to the emergency power system must be identified by having a distinctive color or marking on either the receptacle or receptacle cover plate.

(B) Wiring. Emergency system conductors cannot be installed within any enclosure, raceway, cable, or luminaire with nonemergency loads, except for the following:

(1) Wiring in transfer equipment. ▸Figure 700–8



▸Figure 700–8

(2) Luminaires and exit signs supplied from emergency and other sources of power.

(3) Wiring from two sources in a listed load control relay supplying exit or emergency luminaires, or in a common junction box, attached to exit or emergency luminaires

(4) Wiring within a common junction box attached to unit equipment, containing only the branch circuit supplying the unit equipment and the emergency circuit supplied by the unit equipment

(5) Wiring from an emergency system can supply emergency and other loads in accordance with the following:

a. Where the emergency and nonemergency loads are in separate vertical switchboard or switchgear sections or individual disconnects mounted in separate enclosures.

b. Where the bus is:

(i) Supplied by a feeder without overcurrent protection at the source.

(ii) Supplied by a feeder with overcurrent protection that is selectively coordinated with the next downstream overcurrent protective device in the nonemergency system.

c. Emergency circuits are not permitted to originate from the same vertical switchgear section, vertical switchboard section, panelboard enclosure, or individual disconnect enclosure as other circuits.

d. It is permitted to utilize single or multiple feeders to supply distribution equipment between an emergency source and the point where the emergency loads are separated from all other loads.

Note: See *NEC* Note Figure 700.10(B)(5)(b)(1) and Note Figure 700.10(B)(5)(b)(2) for additional information.

Author's Comment:

- Separation of the circuits served by a generator source for emergency, legally required, and optional standby circuits may be accomplished by running feeders from a single generator to individual overcurrent protective devices, or to a distribution switchboard that separates emergency circuits in different vertical sections from other loads.

(C) Wiring Design and Location. Emergency wiring circuits must be designed and located to minimize the hazards that might cause failure due to flooding, fire, icing, vandalism, and other adverse conditions.

Part III. Sources of Power

700.12 General Requirements

In the event of failure of the normal supply to the building, emergency power must be available within 10 seconds. Emergency equipment must be energized from different sources in case of normal power failure. The emergency power supply must be any of the following:

(A) Power Source Considerations. In selecting an emergency source of power, consideration must be given to the occupancy and the type of service to be rendered, whether of minimum duration, as for evacuation of a theater, or longer duration, as for supplying emergency power and lighting due to an indefinite period of current failure from trouble either inside or outside the building.

(B) Equipment Design and Location. Equipment must be designed and located so as to minimize the hazards that might cause complete failure due to flooding, fires, icing, and vandalism.

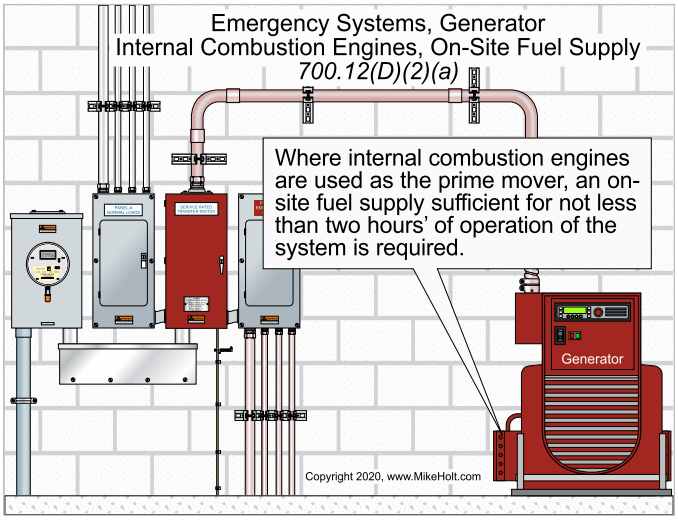
(C) Storage Battery. Storage batteries are permitted as the emergency power source if of suitable rating and capacity to supply and maintain the total load for a period of at least 90 minutes, without the voltage applied to the load falling below 87½ percent of normal. Automotive-type batteries are not permitted for this purpose. Automatic battery charging means must be provided.

(D) Generator Set.

(1) Prime Mover-Driven. A generator approved by the authority having jurisdiction and sized in accordance with 700.4 is permitted as the emergency power source if it has means to automatically start the prime mover when the normal service fails.

(2) Internal Combustion Engines as Prime Movers.

(a) On-Site Fuel Supply. Where internal combustion engines are used as the prime mover, an on-site fuel supply must be provided with an on-premises fuel supply sufficient for not less than two hours' operation of the system. ▸Figure 700–9



▸Figure 700–9

(b) Fuel Transfer Pumps. Where power is needed for the operation of the fuel transfer pumps to deliver fuel to a generator set day tank, this pump must be connected to the emergency power system.

(c) Public Gas System, Municipal Water Supply. Prime movers must not be solely dependent on a public utility gas system for their fuel supply or municipal water supply for their cooling systems.

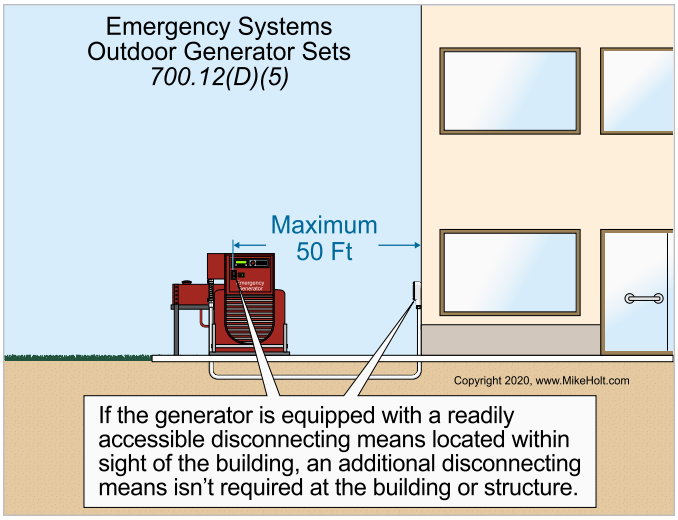
Ex: Where approved by the authority having jurisdiction, the use of other than on-site fuels is permitted where there is a low probability of a simultaneous failure of both the off-site fuel delivery system and power from the outside electrical utility company.

(d) Automatic Fuel Transfer. Where dual fuel supplies are used, means must be provided for automatically transferring from one fuel supply to another.

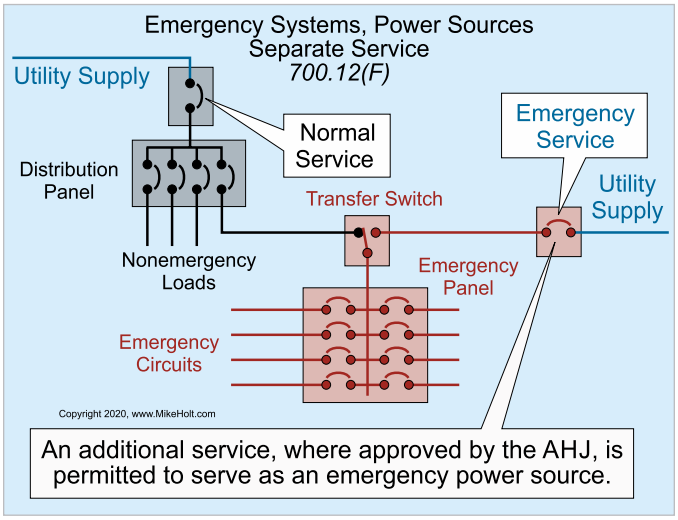
(5) Outdoor Generator Sets. If the generator is equipped with a readily accessible disconnecting means located within sight of the building, an additional disconnecting means is not required at the building or structure. ▸Figure 700–10

(E) Uninterruptible Power Supplies. Uninterruptible power supplies are permitted as the emergency power source if they comply with the applicable requirements of 700.12(B) and (C).

(F) Separate Service. An additional service is permitted as the emergency power source where approved by the authority having jurisdiction [230.2(A)] and the following: ▸Figure 700–11



▸Figure 700–10



▸Figure 700–11

(1) Separate service conductors are installed from the utility.

(2) The emergency service conductors are electrically and physically remote from other service conductors to minimize the possibility of simultaneous interruption of supply.

Author's Comment:

- To minimize the possibility of simultaneous interruption, the service disconnect for the emergency system must be located remotely from the other power system's service disconnect [230.72(B)].

(H) Direct-Current Microgrid Systems. Sources connected to a dc microgrid system are permitted where the system is capable of being isolated from all nonemergency sources. Direct-current microgrid systems used as a source of power for emergency systems must be of suitable rating and capacity to supply and maintain the total emergency load for not less than 2 hours of full-demand operation. Where a dc microgrid system source serves as the normal supply for the building or group of buildings concerned, it must not serve as the sole source of power for the emergency standby system.

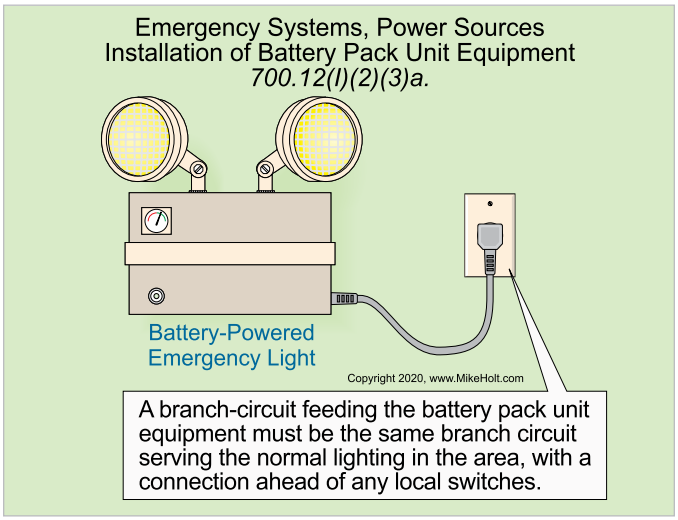
(I) Emergency Battery Pack Unit Equipment.

(1) Components of Unit Equipment. Individual emergency lighting battery pack unit equipment is permitted as the emergency power source.

(2) Installation of Unit Equipment. Unit equipment must be permanently fixed in place with any Chapter 3 wiring method, or a cord-and-plug connection with a flexible cord not longer than 3 ft in length.

(3) The branch-circuit wiring that supplies emergency battery pack equipment must be one of the following:

a. The same branch circuit serving the normal lighting in the area, with a connection ahead of any local switches. ▸Figure 700–12



▸Figure 700–12

Author's Comment:

- There are two reasons why the emergency battery pack unit equipment must be connected ahead of the switch controlling the normal area lighting: (1) in the event of a power loss to the lighting circuit, the emergency battery lighting packs will activate and provide emergency lighting for people to exit the building, and (2) the emergency lighting battery packs will not turn on when the switch controlling normal lighting is turned off.

b. Where the normal lighting circuit is served by one or more branch circuits, a separate branch circuit, provided with a lock-on feature, that originates from the same panelboard as the normal lighting circuits. The branch-circuit disconnecting means for this branch circuit must be provided with a lock-on feature.

(4) The branch circuit that feeds the emergency battery pack unit equipment must be clearly identified at the distribution panel.

Author's Comment:

- Identification and marking must be in accordance with 110.22(A) and 408.4(A).

(6) Power for remote heads providing the exterior lighting of an exit door can be supplied by the emergency battery pack unit equipment serving the area immediately inside the exit door.

Part IV. Emergency System Circuits for Lighting and Power

700.15 Loads on Emergency Branch Circuits

Emergency circuits must only supply emergency loads.

700.16 Emergency Illumination

(A) General. Emergency illumination must include means of egress lighting, illuminated exit signs, and all other luminaires specified as necessary to provide the required illumination.

(B) System Reliability. Emergency lighting systems must be designed and installed so that the failure of any illumination source will not leave in total darkness any space that requires emergency illumination. ▸Figure 700–13

Author's Comment:

- This means that a single remote head is never sufficient for an area. A minimum of two lighting heads is always required. This is the reason individual emergency battery pack unit equipment (sometimes called "Bugeyes" in the field) always has two lighting heads.

Control devices installed in emergency lighting systems must be listed for use in those systems. See 700.12(F).

▸Figure 700–13

Note: 700.23 through 700.26 provides requirements for applications for emergency system control devices.

(D) Disconnecting Means. When an emergency system is installed, emergency illumination is required for an indoor service disconnect. ▸Figure 700–14

▸Figure 700–14

700.19 Multiwire Branch Circuits

Multiwire branch circuits are not permitted to supply emergency system circuits. ▸Figure 700–15

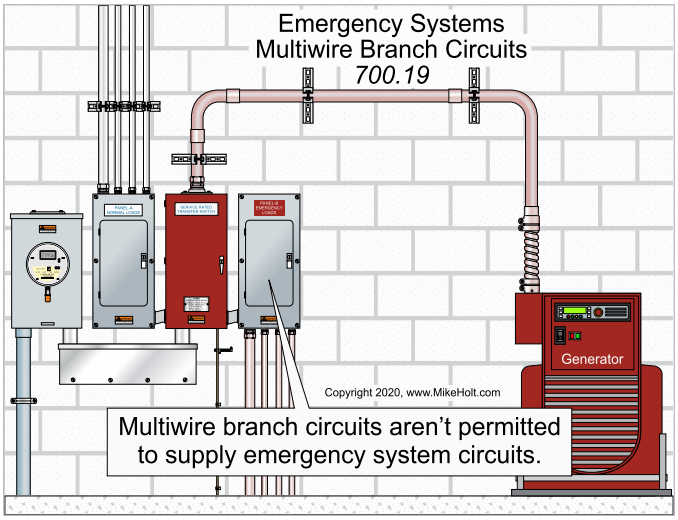


Figure 700–15

Part VI. Overcurrent Protection

700.30 Accessibility

The branch-circuit overcurrent devices for emergency circuits must be accessible to authorized persons only.

700.32 Selective Coordination

Overcurrent devices for emergency power systems must be selectively coordinated with all supply-side overcurrent protective devices. The design must be made by an engineer or similarly qualified person and it must be documented and made available to those authorized to design, install, inspect, maintain, and operate the system.

Author's Comment:

- According to Article 100, "Selective Coordination" means the overcurrent protection scheme confines the interruption to a specific area rather than to the whole system. For example, if a short circuit or ground fault occurs with selective coordination, the only breaker/fuse that will open is the one protecting just the branch circuit involved. Without selective coordination, an entire floor of a building can go dark.

Note: See the *NEC* Note Figure 700.32 for an example of how emergency system overcurrent protective devices (OCPDs) selectively coordinate with all supply-side OCPDs.

NEC Note Figure 700.32 Emergency System Selective Coordination

- OCPD D selectively coordinates with OCPDs C, F, E, B, and A.
- OCPD C selectively coordinates with OCPDs F, E, B, and A.
- OCPD F selectively coordinates with OCPD E.
- OCPD B is not required to selectively coordinate with OCPD A because OCPD B is not an emergency system OCPD.

ARTICLE 701

LEGALLY REQUIRED STANDBY SYSTEMS

Introduction to Article 701—Legally Required Standby Systems

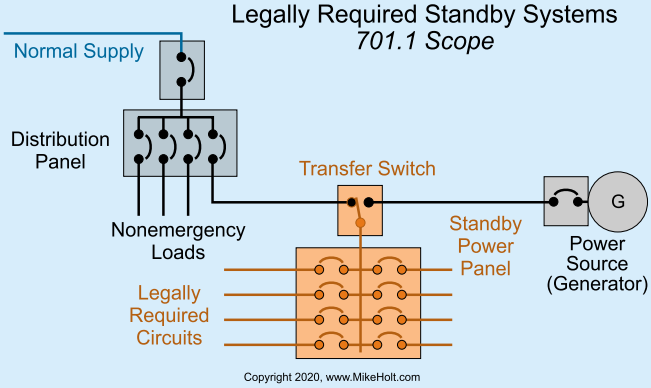
In the hierarchy of electrical systems, Article 700 Emergency Systems receives top priority. Taking the number two spot is Legally Required Standby Systems, which fall under Article 701. Legally required standby systems must supply standby power in 60 seconds or less after a power loss. Some examples of required standby circuits are those supplying fire command center power and lighting, ventilation and automatic fire detection, and egress elevators.

Article 700 basically applies to systems or equipment required to protect people who are in an emergency and trying to get out, while Article 701 addresses systems or equipment needed to help people responding to the emergency.

Part I. General

701.1 Scope

Article 701 applies to the installation, operation, and maintenance of legally required standby systems consisting of circuits and equipment intended to supply illumination or power when the normal electrical supply or system is interrupted. ▸Figure 701–1



Article 701 applies to the installation, operation, and maintenance of legally required standby systems consisting of circuits and equipment intended to supply illumination or power when the normal electrical supply or system is interrupted.

▸Figure 701–1

Author's Comment:

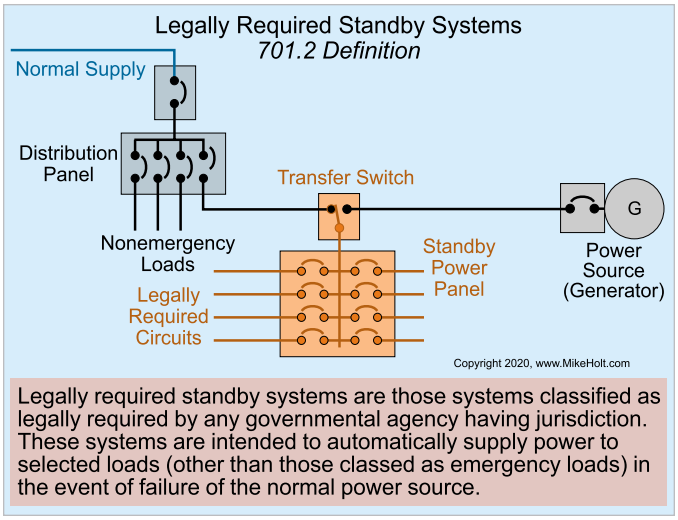
- Legally required standby systems provide electric power to aid in firefighting, rescue operations, control of health hazards, and similar operations.

701.2 Definition

The definition in this section applies throughout the *Code*.

Legally Required Standby Systems. Legally required standby systems are those systems classified as legally required by any governmental agency having jurisdiction. These systems are intended to automatically supply power to selected loads (other than those classed as emergency loads) in the event of failure of the normal power source. ▸Figure 701–2

Note: Legally required standby systems typically supply loads such as heating and refrigeration systems, communications systems (twisted pair, antennas, and coaxial cable), ventilation and smoke removal systems, sewage disposal, lighting systems, and industrial processes that, when stopped, could create hazards or hamper rescue or firefighting operations.



▸Figure 701–2

701.3 Tests and Maintenance

(A) Conduct or Witness Test. To ensure that the legally required standby system meets or exceeds the original installation specifications, the authority having jurisdiction must conduct or witness an acceptance test of the legally required system upon completion of the installation.

(B) Periodic Testing. Legally required standby systems must be periodically tested in a manner approved by the authority having jurisdiction to ensure adequate maintenance has been performed and the systems are in proper operating condition.

Author's Comment:

- Running the legally required standby system under the loads of the facility to make sure power transfers within 60 seconds is often considered an acceptable method of operational testing.

(C) Maintenance. Legally required standby system equipment must be maintained in accordance with the manufacturer's instructions and industry standards.

(D) Written Record. A written record must be kept of all required tests and maintenance.

Author's Comment:

- The *NEC* does not specify the required record retention period.

701.4 Capacity and Rating

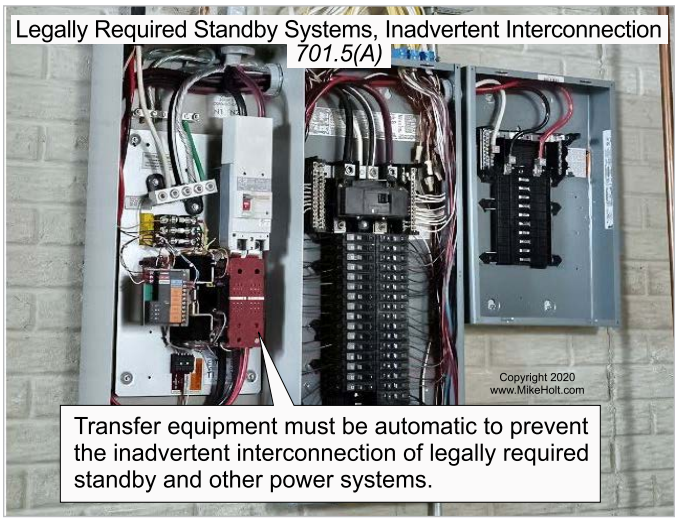
(A) Rating. Equipment for a legally required standby system must be suitable for the available fault current at its terminals.

(B) Capacity. The alternate power supply must have adequate capacity in accordance with Article 220 or by another approved method.

(C) Load Pickup, Load Shedding, and Peak Load Shaving. The legally required standby alternate power supply can supply legally required standby and optional standby system loads if there is adequate capacity or where automatic selective load pickup and load shedding are provided that will ensure adequate power to the legally required standby system circuits.

701.5 Transfer Equipment

(A) General. Transfer equipment must be automatic, listed, and marked for emergency system or legally required standby system use, and approved by the authority having jurisdiction. Transfer equipment must prevent the inadvertent interconnection of legally required standby and other power systems. ▸Figure 701–3



▸Figure 701–3

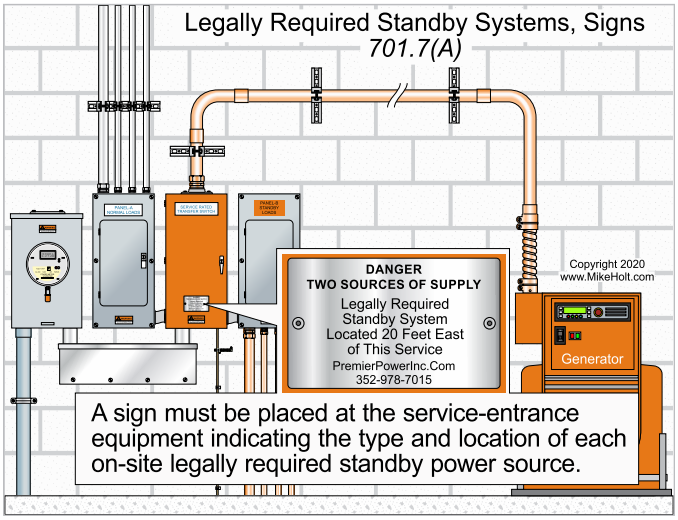
Meter-mounted transfer switches are not permitted for legally required standby system use.

(C) Automatic Transfer Switch. Automatic transfer switches must able to be electrically operated and mechanically held, and they are not permitted to be reconditioned.

(D) Documentation. The short-circuit current rating of the transfer equipment must be field marked on the exterior of the transfer equipment.

701.7 Signs

(A) Mandated Standby. A sign must be placed at the service-entrance equipment indicating the type and location of on-site legally required standby power systems. ▸Figure 701–4



▸Figure 701–4

Part II. Circuit Wiring

701.10 Wiring

Legally required standby system wiring is permitted to be in the same raceways, boxes, and cabinets with other general wiring.

Part III. Sources of Power

701.12 General Requirements

If the normal supply fails, legally required standby power must be available within 60 seconds. The supply system for the legally required standby power supply is permitted to be one or more of the following:

(A) Power Source Considerations. In selecting a legally required standby source of power, consideration must be given to the type of service to be rendered, whether of short-time duration or long duration.

(B) Equipment Design and Location. Consideration must be given to the location or design, or both, of all equipment to minimize the hazards that might cause complete failure due to floods, fires, icing, and vandalism.

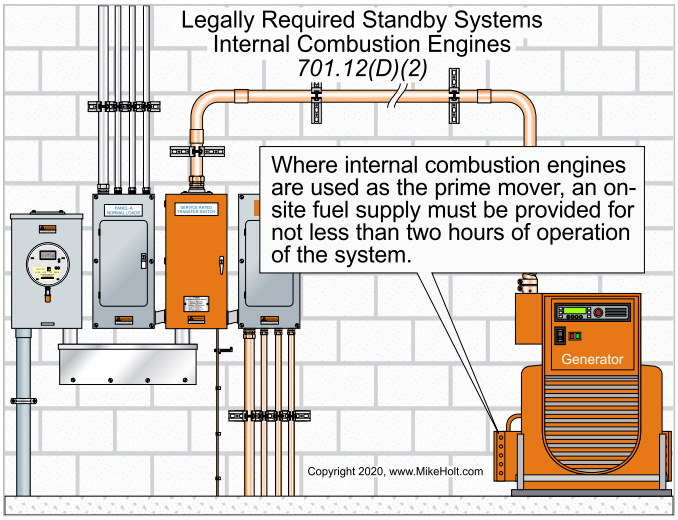
Note: For further information, see ANSI/IEEE 493, *Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems*.

(C) Storage Battery. Storage batteries must be of suitable rating and capacity to supply and maintain the total load for a minimum period of 90 minutes without the voltage applied to the load falling below 87½ percent of normal. Automotive-type batteries are not permitted. Automatic battery charging means must be provided.

(D) Generator Set.

(1) Prime Mover-Driven. A generator approved by the authority having jurisdiction and sized in accordance with 701.4 is permitted as the legally required power source if it has the means to automatically start the prime mover on failure of the normal service.

(2) Internal Combustion Engines as Prime Mover. Where internal combustion engines are used as the prime mover, an on-site fuel supply must be provided for not less than two hours of operation of the system. ▸Figure 701–5



▸Figure 701–5

(5) Outdoor Generator Sets. If the generator is equipped with a readily accessible disconnecting means located within sight of the building, an additional disconnecting means is not required at the building or structure. ▸Figure 701–6

(E) Uninterruptible Power Supplies. Uninterruptible power supplies are permitted as the legally required power source and must comply with 701.12(B) and (C).

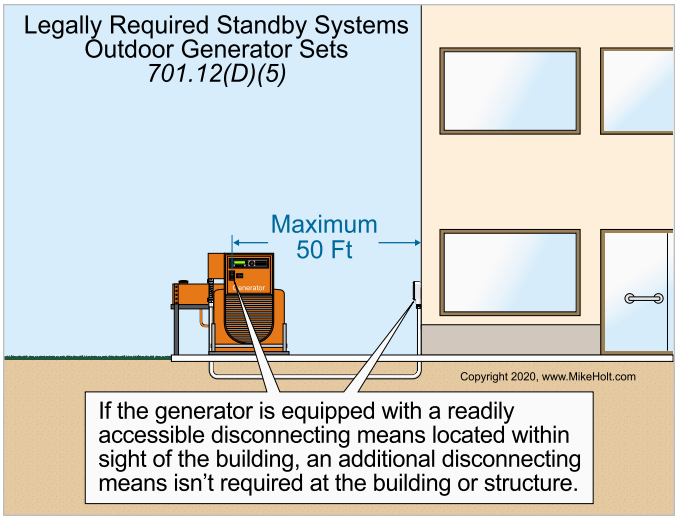


Figure 701–6

(F) Separate Service. An additional service is permitted as the legally required power source where approved by the authority having jurisdiction [230.2(A)] and separate service conductors are installed from the utility. Figure 701–7

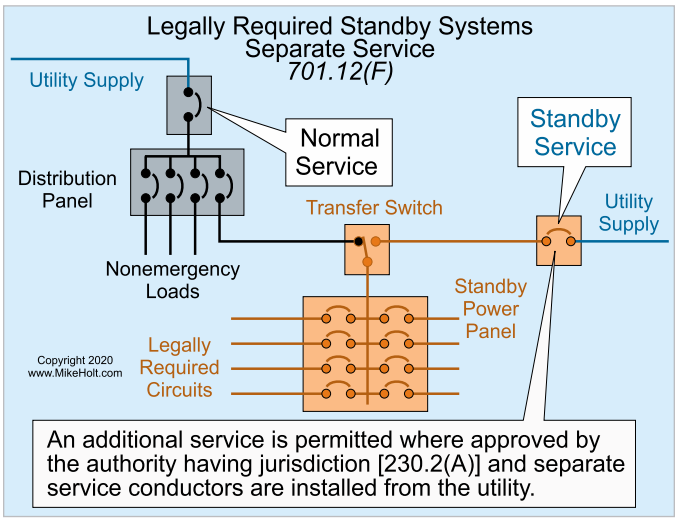


Figure 701–7

The legally required service conductors must be electrically and physically remote from other service conductors to minimize the possibility of simultaneous interruption of supply.

Author's Comment:

- To minimize the possibility of simultaneous interruption, the service disconnect for the legally required power system must be located remotely from the other power system's service disconnect [230.72(B)].

(G) Connection Ahead of Service Disconnecting Means. If approved by the authority having jurisdiction, connection ahead of, but not within, the same cabinet, enclosure, or vertical switchboard or switchgear section is permitted as the legally required power source. See 230.82(5) for additional information. Figure 701–8

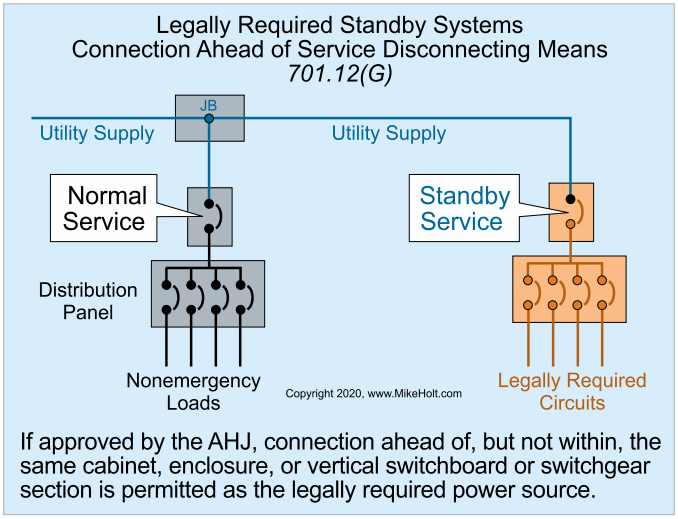


Figure 701–8

To minimize the possibility of simultaneous interruption, the disconnect for the legally required power system must be located remotely from other power system service disconnects.

Part IV. Overcurrent Protection

701.30 Accessibility

The branch-circuit overcurrent devices for legally required standby circuits must be accessible to authorized persons only.

701.32 Selective Coordination

Overcurrent devices for legally required standby systems must be selectively coordinated with all supply-side overcurrent protective devices. The design must be made by an engineer or similarly qualified person and it must be documented and made available to those authorized to design, install, inspect, maintain, and operate the system.

Author's Comment:

- According to Article 100, "Selective Coordination" means the overcurrent protection scheme confines the interruption to a specific area rather than to the whole system. For example, if a short circuit or ground fault occurs with selective coordination, the only breaker/fuse that will open is the one protecting just the branch circuit involved. Without selective coordination, an entire floor of a building can go dark.

Note: See the *NEC* Note Figure 701.32 for an example of how legally required standby system overcurrent protective devices (OCPDs) selectively coordinate with all supply-side OCPDs.

NEC Note Figure 701.32 Emergency System Selective Coordination

- OCPD D selectively coordinates with OCPDs C, F, E, B, and A.
- OCPD C selectively coordinates with OCPDs F, E, B, and A.
- OCPD F selectively coordinates with OCPD E.
- OCPD B is not required to selectively coordinate with OCPD A because OCPD B is not a legally required standby system OCPD.

ARTICLE

702

OPTIONAL STANDBY SYSTEMS

Introduction to Article 702—Optional Standby Systems

Taking third priority after Emergency and Legally Required Systems, Optional Standby Systems protect public or private facilities or property where life safety does not depend on the performance of the system. These systems are not required for rescue operations.

Suppose a glass plant loses power. Once glass hardens in the equipment (which it will do when process heat is lost) the plant is going to suffer a great deal of downtime and expense before it can resume operations. An optional standby system can prevent this loss.

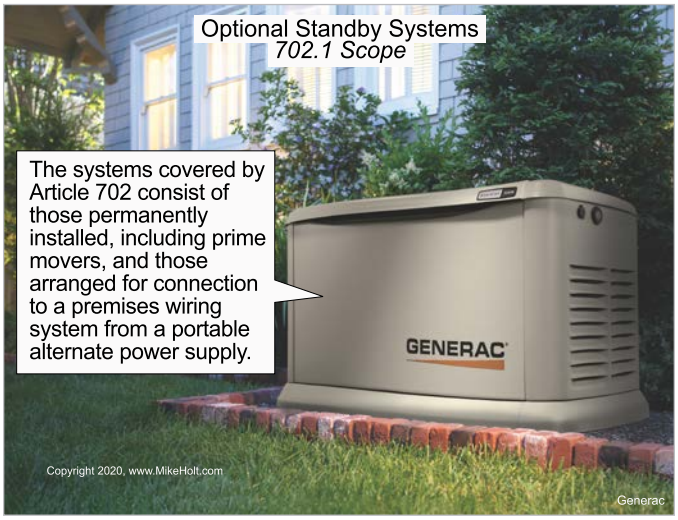
You will see these systems in facilities where loss of power can cause economic loss or business interruptions. Data centers can lose millions of dollars from a single minute of lost power. A chemical or pharmaceutical plant can lose an entire batch from a single momentary power glitch. In many cases, the lost revenue cannot be recouped.

This article also applies to the installation of optional standby generators in homes, farms, small businesses, and many other applications where standby power is not legally required.

Part I. General

702.1 Scope

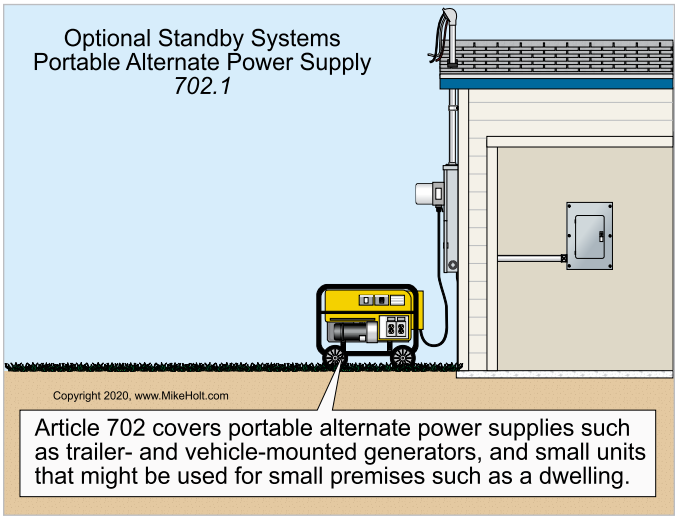
The systems covered by Article 702 consist of those permanently installed, including prime movers, and those arranged for connection to a premises wiring system from a portable alternate power supply. ▸Figure 702–1



▸Figure 702–1

Author's Comment:

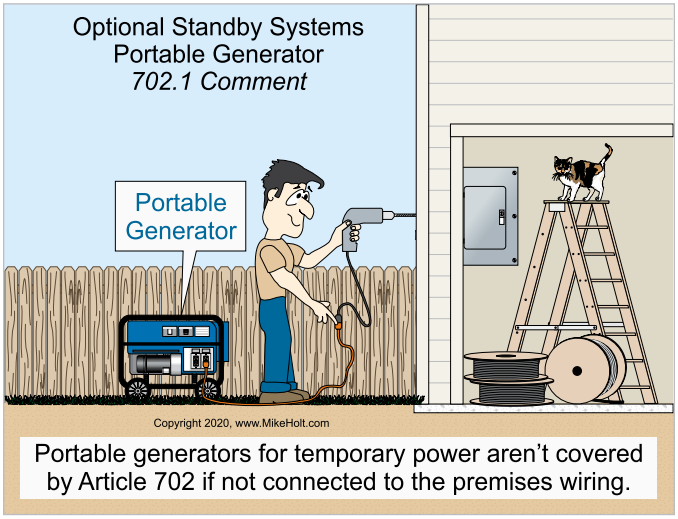
- Article 702 covers portable alternate power supplies such as trailer- and vehicle-mounted generators, and small units that might be used for a small premises such as a dwelling. ▸Figure 702–2



▸Figure 702–2

Author's Comment:

- Portable generators for temporary power are not covered by Article 702 if they are not connected to the premises wiring. ▸Figure 702–3

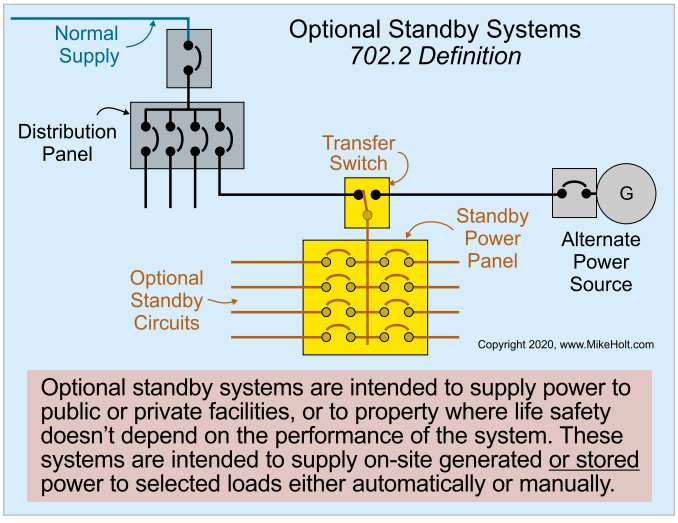


▸Figure 702–3

702.2 Definition

The definition in this section applies throughout the *Code*.

Optional Standby Systems. Optional standby systems are intended to supply power to public or private facilities, or to property where life safety does not depend on the performance of the system. These systems are intended to supply on-site generated or stored power to selected loads either automatically or manually. ▸Figure 702–4



▸Figure 702–4

Note: Optional standby systems are typically installed to provide an alternate source of electric power for such facilities as industrial and commercial buildings, farms, and residences and to serve loads such as heating and refrigeration systems, data processing and communications systems (twisted pair and coaxial cable), and industrial processes that, when stopped during any power outage, can cause discomfort, economic loss, serious interruption of the process, damage to the product or process, or the like.

702.4 Capacity and Rating

(A) Available Fault Current. Optional standby system equipment must be suitable for the available fault current at its terminals.

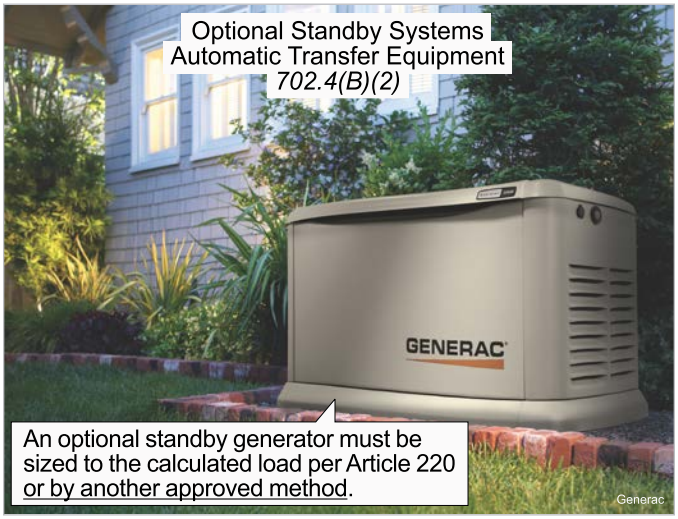
(B) System Capacity.

(1) Manual Transfer Equipment. Where manual transfer equipment is used, an optional standby system must be capable of supplying all of the equipment intended to be operated at one time. The user of the optional standby system is permitted to select the load connected to the system.

Author's Comment:

- When a manual transfer switch is used, the user of the optional standby system selects the loads to be connected to the system, which determines the system's kVA/kW rating.

(2) Automatic Transfer Equipment. An optional standby generator must be sized to the calculated load in accordance with Article 220 or by another approved method. ▸Figure 702–5



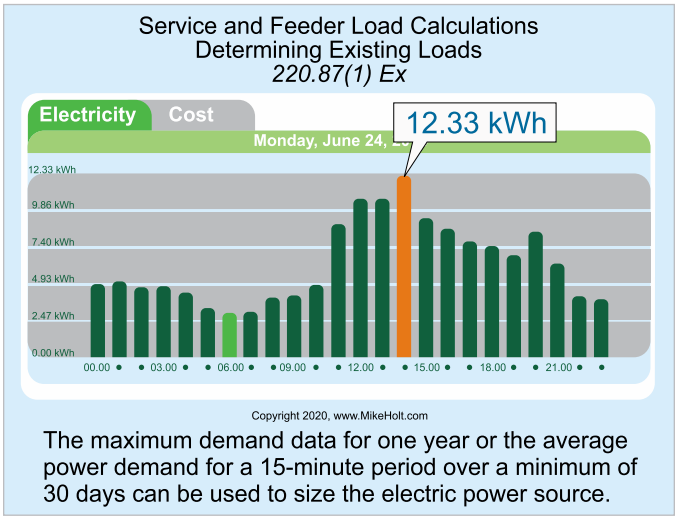
▸Figure 702–5

(a) Full Load. The standby source must be capable of supplying the full load upon automatic transfer.

(b) Load Management. Where an automatic load management system is employed, the standby system must be capable of supplying the full load that will be connected.

Author's Comment:

- For existing facilities, the maximum demand data for one year or the average power demand for a 15-minute period over a minimum of 30 days can be used to size the electric power source [220.87]. ▸Figure 702–6



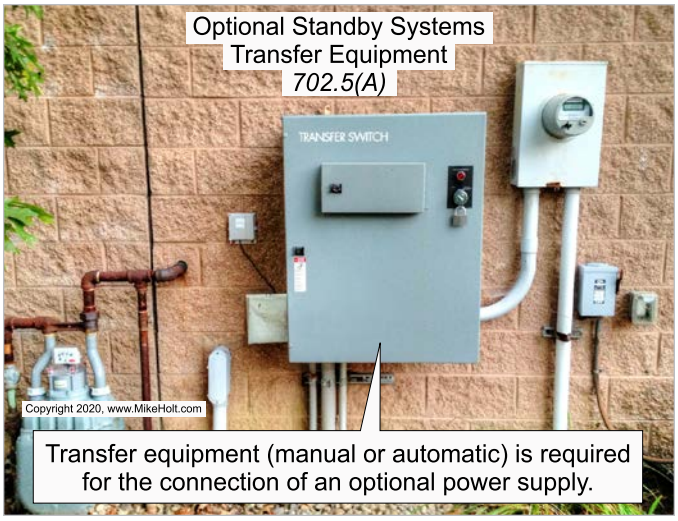
▸Figure 702–6

702.5 Transfer Equipment

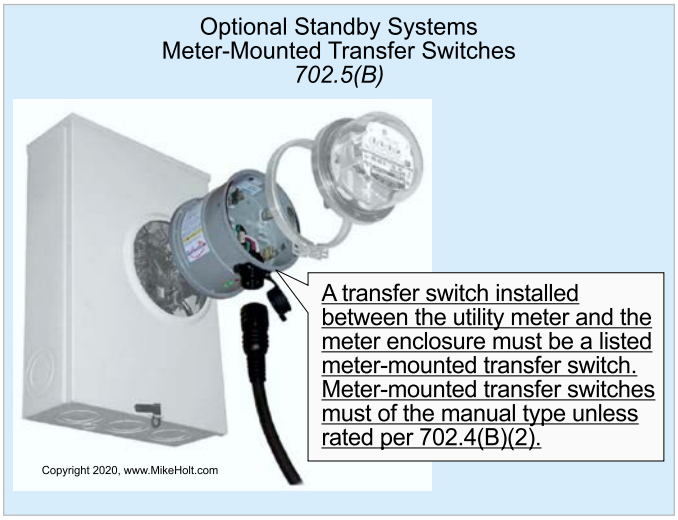
(A) General. Transfer equipment (manual or automatic) is required for the connection of an optional power supply. ▸Figure 702–7

Ex: Temporary connection of a portable generator without transfer equipment is permitted where conditions of maintenance and supervision ensure that only qualified persons will service the installation, and where the normal supply is physically isolated by a lockable disconnect or by the disconnection of the normal supply conductors.

(B) Meter-Mounted Transfer Switches. A transfer switch installed between the utility meter and the meter enclosure must be a listed meter-mounted transfer switch. Meter-mounted transfer switches must be of the manual type unless rated in accordance with 702.4(B)(2). ▸Figure 702–8



▸Figure 702–7



▸Figure 702–8

(C) Documentation. In other than dwelling units, the short-circuit current rating of the transfer equipment must be field marked on the exterior of the transfer equipment.

(D) Inadvertent Interconnection. Transfer equipment must be suitable for the intended use and must be listed, designed, and installed so as to prevent the inadvertent interconnection of all sources of supply in any operation of the transfer equipment. ▸Figure 702–9

(E) Parallel Installation. Transfer equipment and electric power production systems installed to permit operation in parallel with the normal source must also meet the requirements of Article 705.

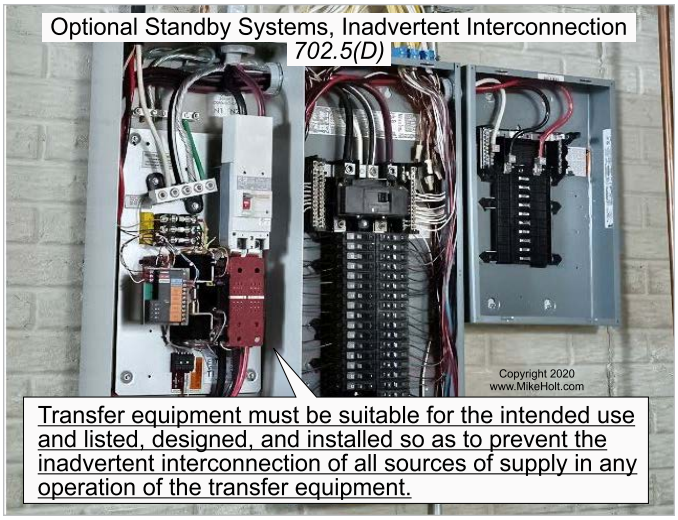


Figure 702–9

702.7 Signs

(A) Optional Power Sources. A sign is required at service equipment for commercial and industrial installations that indicates the type and location of each on-site optional standby power source.

For one- and two-family dwelling units, a sign is required at the emergency disconnect switch mandated in 230.85 that indicates the location of each permanently installed on-site optional standby power source disconnect or means to shut down the prime mover as required in 445.18(D). Figure 702–10

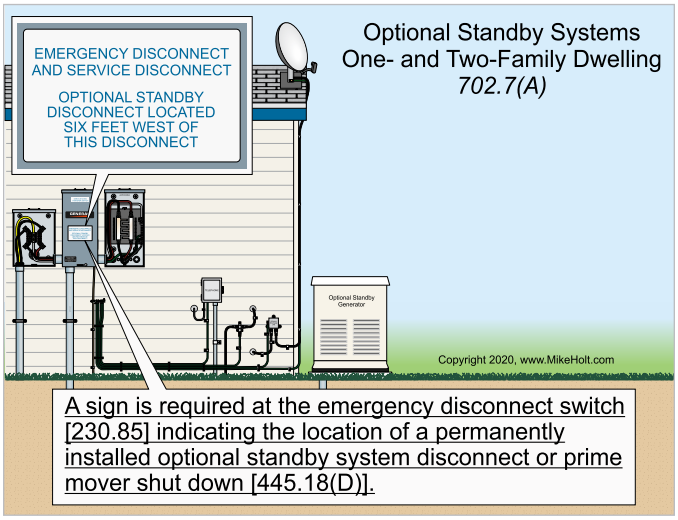


Figure 702–10

(C) Power Inlet. Where a power inlet is used for a temporary connection to a portable generator, a warning sign must be placed near the inlet to indicate the type of transformer permitted to be connected to the inlet stating: Figure 702–11

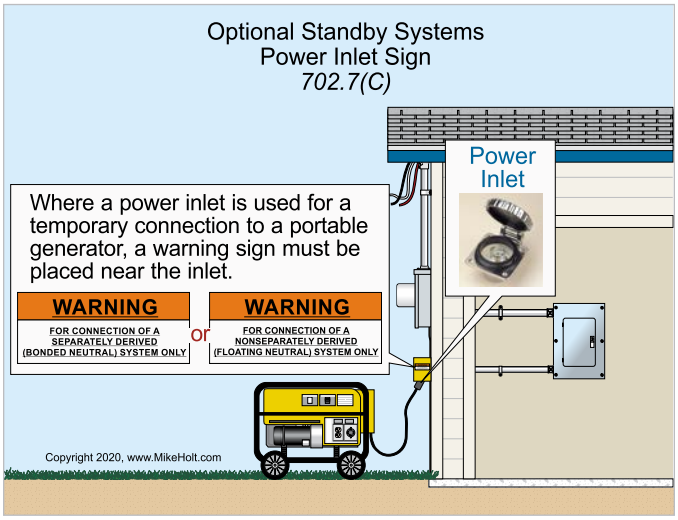


Figure 702–11

WARNING—FOR CONNECTION OF A SEPARATELY DERIVED (BONDED NEUTRAL) SYSTEM ONLY
OR
WARNING—FOR CONNECTION OF A NONSEPARATELY DERIVED (FLOATING NEUTRAL) SYSTEM ONLY

Part II. Circuit Wiring

702.10 Wiring

Optional standby system wiring can occupy the same raceways, cables, boxes, and cabinets with other wiring.

702.12 Outdoor Generator Sets

(A) Portable Generators Greater Than 15 kW and Permanently Installed Generators. Where an outdoor generator set is equipped with a readily accessible disconnecting means located within sight of the building or structure supplied, an additional disconnecting means is not required for the building. Figure 702–13

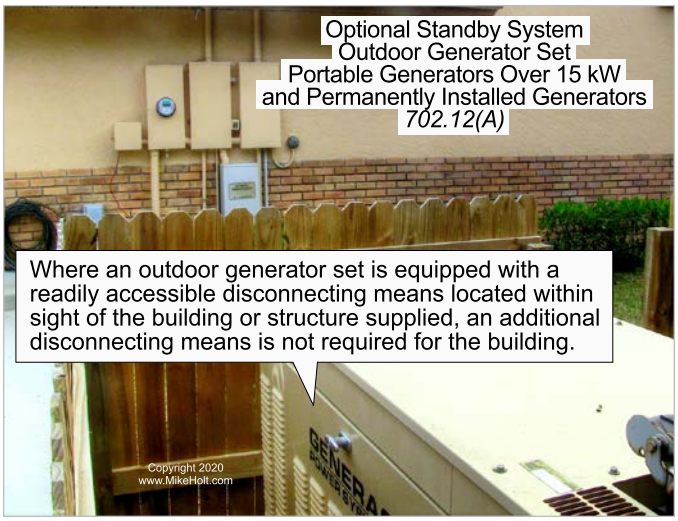


Figure 702–13

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