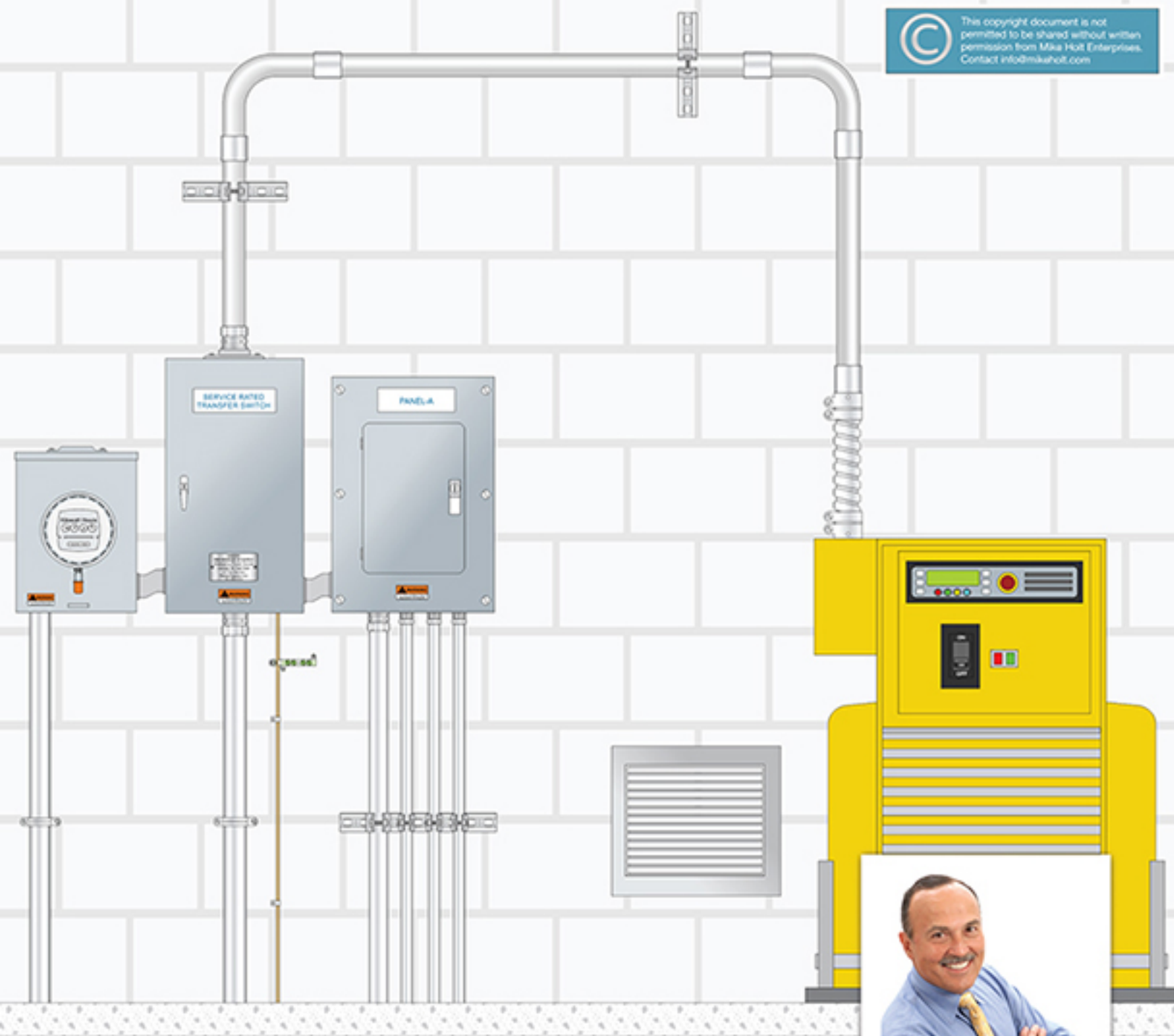




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Mike Holt's Illustrated Guide to

NEC[®] REQUIREMENTS FOR GENERATORS AND STANDBY POWER SYSTEMS

Extracted from Mike Holt's Understanding the National Electrical Code[®] - Volumes 1 & 2

Rule 220.87
Articles 445, 700, 701 and 702

Based on the 2017 NEC[®]

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ABOUT THE AUTHOR

Mike Holt worked his way up through the electrical trade. He began as an apprentice electrician and became one of the most recognized experts in the world as it relates to electrical power installations. He's worked as a journeyman electrician, master electrician, and electrical contractor. Mike's experience in the real world gives him a unique understanding of how the *NEC* relates to electrical installations from a practical standpoint.



You'll find his writing style to be direct, nontechnical, and powerful.

Did you know Mike didn't finish high school? So if you struggled in high school or didn't finish at all, don't let it get you down. However, realizing that success depends on one's continuing pursuit of education, Mike immediately attained his GED, and ultimately attended the University of Miami's Graduate School for a Master's degree in Business Administration.

Mike resides in Central Florida, is the father of seven children, has five grandchildren, and enjoys many outside interests and activities. He's a nine-time National Barefoot Water-Ski Champion (1988, 1999, 2005–2009, 2012–2013). He's set many national records and continues to train year-round at a World competition level (www.barefootwaterskier.com).

What sets him apart from some is his commitment to living a balanced lifestyle; placing God first, family, career, then self.

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



ARTICLE 220

BRANCH-CIRCUIT, FEEDER, AND SERVICE LOAD CALCULATIONS

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

This five-part article focuses on the requirements for calculating the minimum size of branch-circuit, feeder, and service conductors.

Part I describes the layout of Article 220 and provides a table of 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's 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 the article.

In many cases, either the standard method (Part III) or the optional method (Part IV) can be used; however, these two methods don't yield identical results. In fact, sometimes these two answers may be diverse enough to call for different service sizes. There's nothing to say that either answer is right or wrong. If taking an exam, read the instructions carefully to be sure which method the test wants you to use. As you work through Article 220, be sure to study the illustrations to help you fully understand it. Also be sure to review the examples in Annex D of the *NEC* to provide more practice with these calculations.

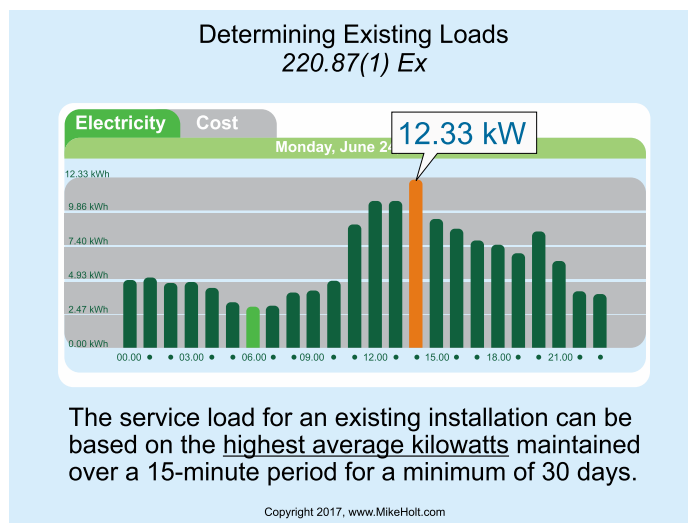
220.87 Determining Existing Loads

The calculation of a feeder or service load for an existing dwelling unit can use the actual maximum demand of the existing dwelling unit as follows:

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

Ex: If the maximum demand data for one year isn't available, the calculated service load can be based on the highest average kW maintained for a 15-minute period, over a recorded period of 30 days. ▶Figure 220–39

- (2) When adding loads to an existing dwelling unit, the feeder or service demand load isn't permitted to be less than 125 percent of the new loads and the maximum demand load [220.87(1)].



▶Figure 220–39

ARTICLE 445

GENERATORS

Introduction to Article 445—Generators

This article contains the electrical installation, and other requirements, for generators. These requirements include such things as where generators can be installed, nameplate markings, conductor ampacity, and disconnecting means.

Generators are basically motors that operate in reverse—they produce electricity when rotated, instead of rotating when supplied with electricity. Article 430, which covers motors, is the longest article in the *NEC*. Article 445, which covers generators, is one of the shortest. At first, this might not seem to make sense. But you don't need to size and protect conductors to a generator. You do need to size and protect them to a motor.

Generators need overload protection, and it's necessary to properly size the conductors that come from the generator. But these considerations are much more straightforward than the equivalent considerations for motors. Before you study Article 445, take a moment to read the definition of a "Separately Derived System" in Article 100.

445.1 Scope

Article 445 contains the installation and other requirements for generators. ▶ **Figure 445-1**

Author's Comment:

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



▶ **Figure 445-1**

445.12 Overcurrent Protection

(A) Generators. Generators must be protected from overload by inherent design, circuit breakers, fuses, or other identified overcurrent protective means.

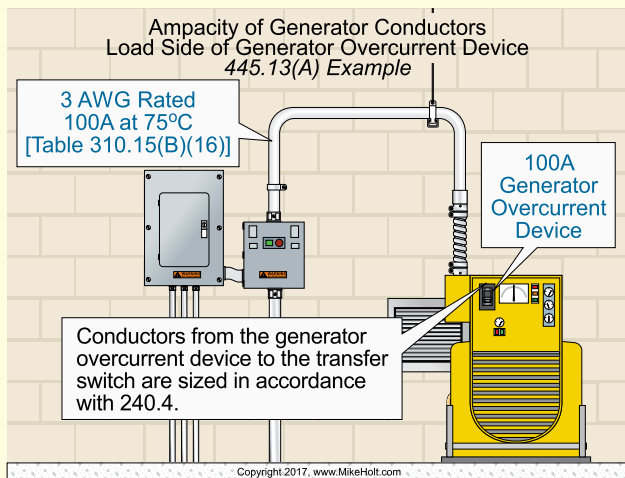
445.13 Ampacity of Conductors

(A) General. The ampacity of the conductors from the generator winding output terminals to the first overcurrent protection device, typically on the generator, must have an ampacity of not less than 115 percent of the nameplate current rating of the generator.

Author's Comment:

- Since the overcurrent protection device is typically part of the generator, this rule applies to the generator manufacturer, not the field installer.
- Conductors from the load side of the generator overcurrent protection device to the transfer switch are sized in accordance with 240.4.

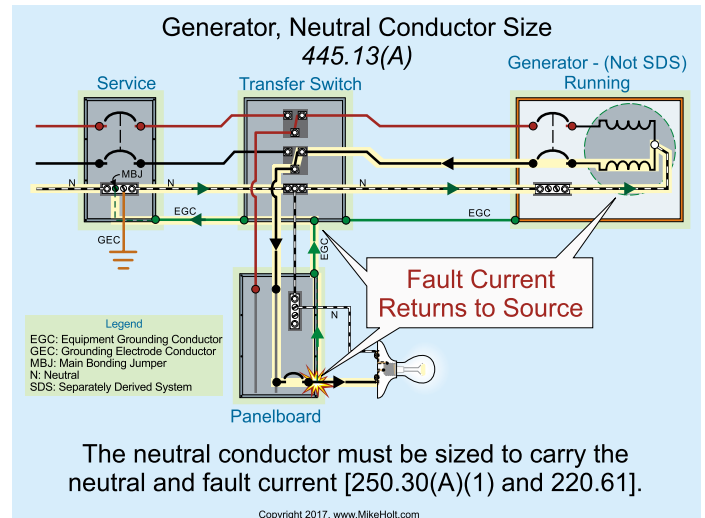
Example: What size conductor is required from a 100A overcurrent protection device on a 20 kW, 120/240V single-phase generator to a 200A service rated transfer switch if the terminals are rated for 75°C conductor sizing? ▶ **Figure 445-2**



▶ **Figure 445-2**

Answer: A 3 AWG conductor is required; Table 310.15(B)(16), rated 100A at 75°C [110.14(C)(1)(b)].

Generators that aren't a separately derived system must have the neutral conductor sized to carry the maximum unbalanced current as determined by 220.61, serve as part of the effective ground-fault current path, and not be smaller than required by 250.30. ▶ **Figure 445-3**



▶ **Figure 445-3**

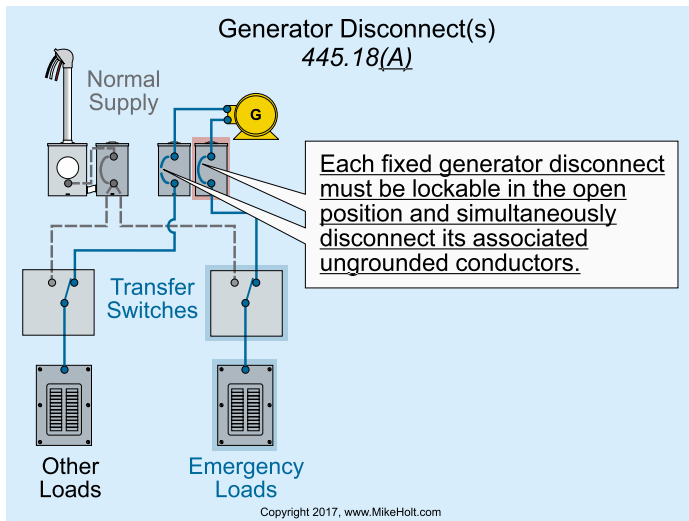
(B) Overcurrent Protection Provided. Conductors can be tapped from the load side of the generator overcurrent protected device in accordance with 240.21(B).

445.18 Disconnecting Means and Shutdown of Prime Mover

(A) Disconnecting Means. Each fixed generator disconnect must simultaneously disconnect all its associated ungrounded conductors and must be lockable in the open position in accordance with 110.25. ▶ **Figure 445-4**

(B) Shutdown of Prime Mover. Generators must have provisions to shut down the prime mover; shutdown must 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 can satisfy the requirements of 445.18(A) where the shutdown is capable of being locked in the open position in accordance with 110.25. Generators with greater than 15 kW rating must be provided with an additional shutdown means located outside the equipment room or generator and comply with 445.18(B)(1) and (B)(2).

►Figure 445-4

ARTICLE 700

EMERGENCY SYSTEMS

Introduction to Article 700—Emergency Systems

Emergency systems are legally required, often as a condition of an operating permit for a given facility. 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, it simply provides power for exit lighting and exit signs upon loss of the main power or in the case of fire. Its purpose isn't 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 doesn't 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

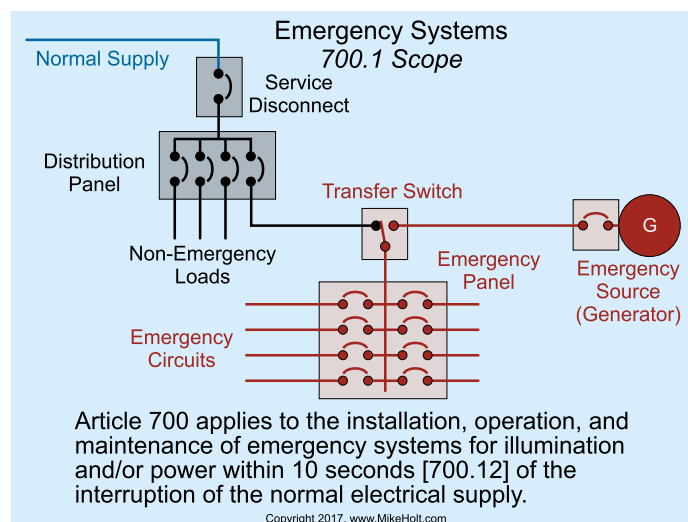
700.1 Scope

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

Note 3: For specific locations where emergency lighting is required, see NFPA 101, *Life Safety Code*.

Author's Comment:

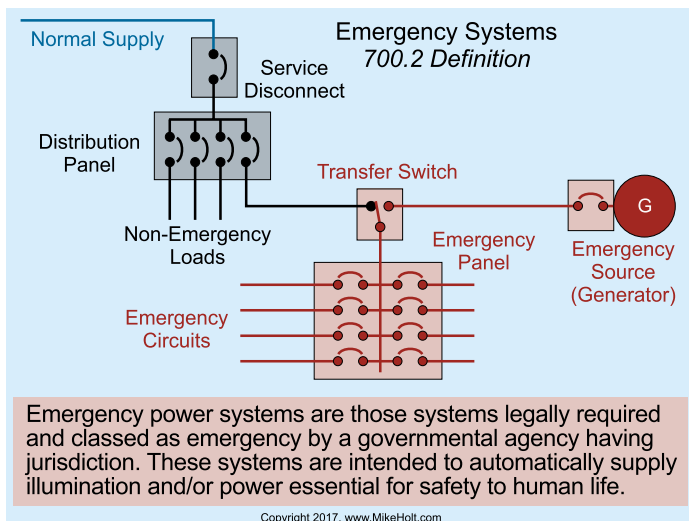
- Emergency power systems are generally installed where artificial illumination is required for safe exiting and for panic control in buildings subject to occupancy by large numbers of persons, such as hotels, theaters, sports arenas, health care facilities, and similar institutions.



▶Figure 700-1

700.2 Definitions

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 wire, 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 to ensure that adequate maintenance has been performed and that the systems are in proper operating condition.

Author's Comment:

- Running the emergency power system under load 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 must be kept of all required tests [700.4(A) and (B)] and maintenance [700.4(C)].

Author's Comment:

- The *NEC* doesn't specify the required record retention period.

700.4 Capacity

(A) Capacity and Rating. An emergency power system must have adequate capacity to carry all emergency loads expected to operate simultaneously.

(B) Load Shedding. If an alternate power supply has adequate capacity, it's permitted to supply emergency loads [Article 700], legally required standby loads [Article 701], and optional standby system loads [Article 702]. If the alternate power supply doesn't have adequate capacity to carry the entire load, it must have automatic selective load pickup and load shedding to ensure adequate power in the following order of priority:

- (1) The emergency circuits,
- (2) The legally required standby circuits, and
- (3) The optional standby circuits.

700.5 Transfer Equipment

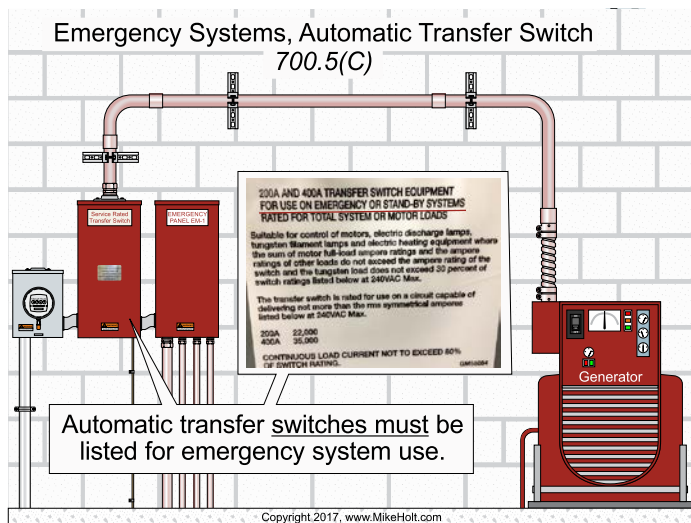
(A) General. Transfer equipment must be automatic and be installed to prevent the inadvertent interconnection of normal and alternate sources of supply.

(C) Automatic Transfer Switches. Automatic transfer switches must be listed for emergency power system use. ▶Figure 700–3

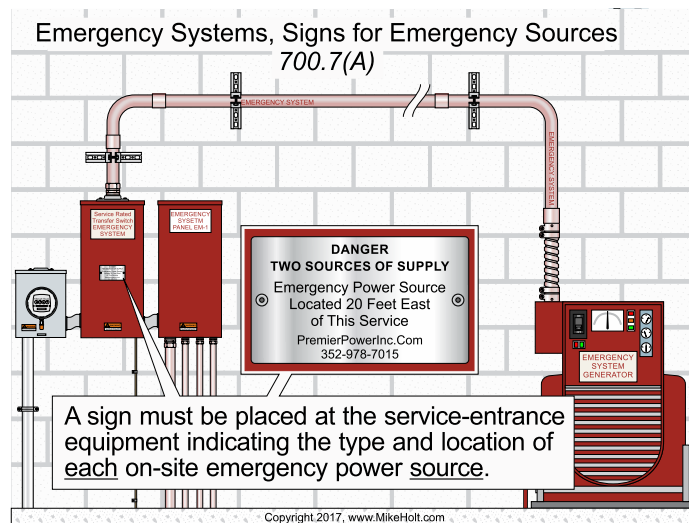
(D) Use. Transfer equipment must supply only emergency loads. ▶Figure 700–4

Author's Comment:

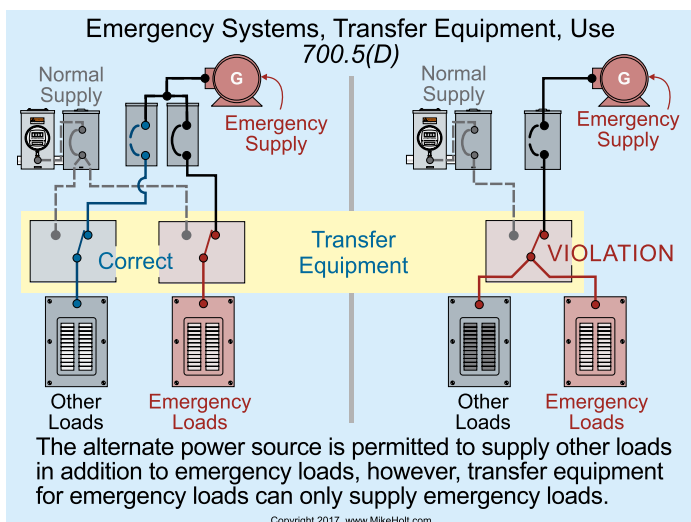
- Multiple transfer switches are required where a single generator is used to supply both emergency loads and other loads.



►Figure 700-3



►Figure 700-5



►Figure 700-4

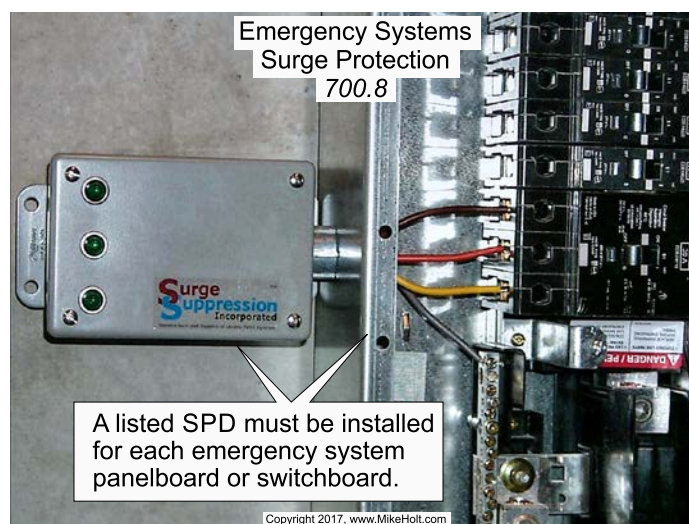
(E) Documentation. The short-circuit current rating of the transfer equipment must be field marked on the exterior of the transfer equipment.

700.7 Signs

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

700.8 Surge Protection

A listed SPD must be installed for all emergency system panelboards and switchboards. ►Figure 700-6



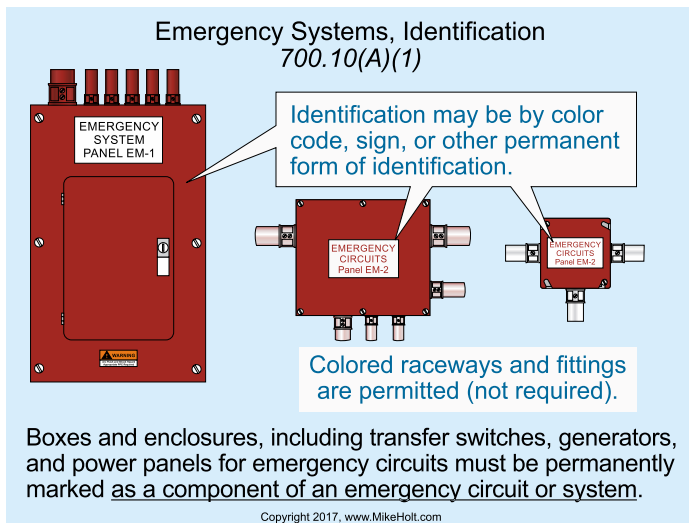
►Figure 700-6

Part II. Circuit Wiring

700.10 Wiring

(A) Identification. Emergency circuits must be permanently marked as components of an emergency circuit or system so they'll be readily identified by the following methods:

- (1) Boxes and enclosures, including 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**



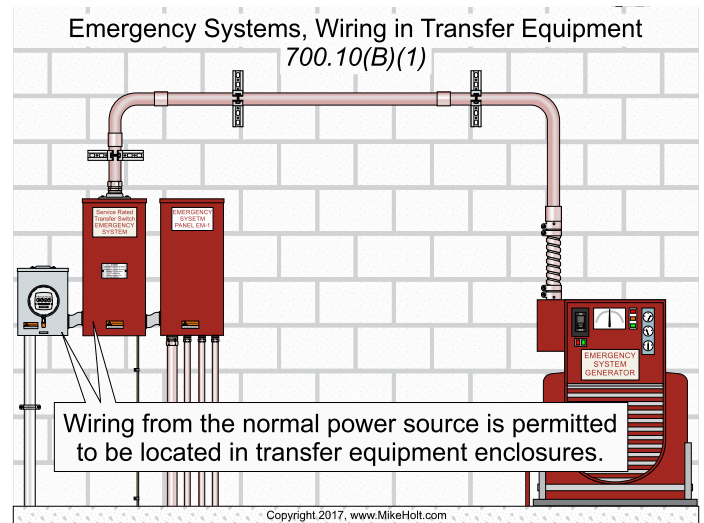
▶ **Figure 700-7**

- (2) Cable and raceway systems must be permanently marked, at intervals not exceeding 25 ft, as a component of the emergency circuit or system.

Receptacles supplied from the emergency system must have a distinctive color or marking on the receptacle or receptacle cover plate.

(B) Wiring. To ensure that a fault on the normal wiring circuits won't affect the performance of emergency wiring or equipment, all wiring to emergency loads must be kept entirely independent of all other wiring, except:

- (1) Wiring in transfer equipment. ▶ **Figure 700-8**
- (2) Luminaires supplied from two sources of power.
- (3) A junction box attached to luminaires supplied from two sources of power.



▶ **Figure 700-8**

- (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 source can supply emergency and other (nonemergency) loads as follows:
 - a. Separate vertical switchboard or switchgear sections or from individual disconnects mounted in separate enclosures must be used to separate emergency circuits from all other nonemergency circuits.
 - b. The common bus of separate sections of the switchgear, separate sections of the switchboard, or the individual enclosures must be either of the following:
 - i. Supplied by single or multiple feeders with overcurrent protection at the source.
 - ii. Supplied by single or multiple feeders with overcurrent protection, provided that the overcurrent protection that's common to an emergency system and any non-emergency system(s) is selectively coordinated with the next downstream overcurrent protective device in the non-emergency system(s).
 - c. Emergency circuits must not originate from the same vertical switchboard or switchgear section, panelboard enclosure, or individual disconnect enclosure as other circuits.

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 protection 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 designed and located so as to minimize the hazards that might cause complete failure due to flooding, fires, icing, and vandalism. The emergency power supply must be any of the following:

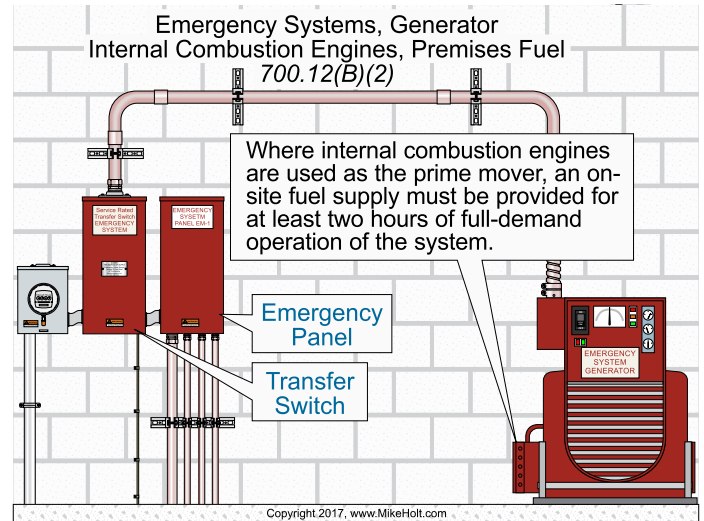
(A) Storage Battery. Storage batteries must be of suitable rating and capacity to supply and maintain the total load for a period of at least 1½ hours, without the voltage applied to the load falling below 87½ percent of normal. Automotive-type batteries aren't permitted for this purpose.

(B) Generator Set.

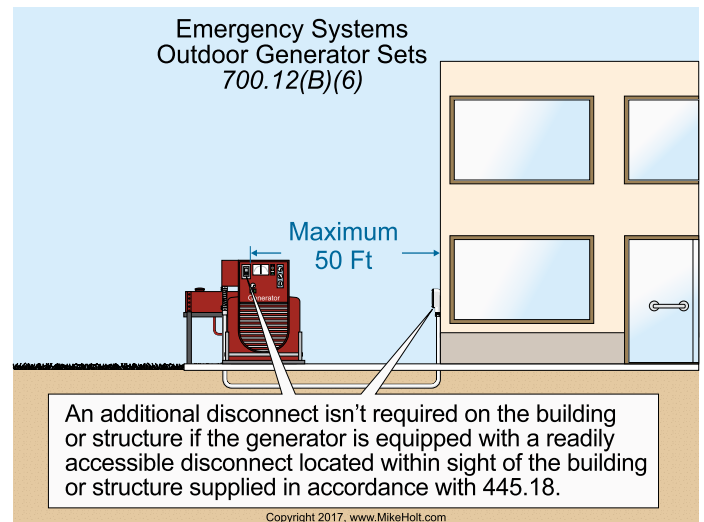
(1) Prime Mover-Driven. A generator approved by the authority having jurisdiction and sized in accordance with 700.4 must have means to automatically start the prime mover when the normal service fails.

(2) Internal Combustion Engines as Prime Movers. If internal combustion engines are used as the prime mover, an on-site fuel supply must be provided for not less than two hours of full-demand operation of the system. ▶ **Figure 700–9**

(6) Outdoor Generator Sets. If a generator located outdoors is equipped with a readily accessible disconnect located within sight of the building in accordance with 445.18, an additional disconnect isn't required on or at the building for the generator feeder conductors that serve or pass through the building. ▶ **Figure 700–10**



▶ **Figure 700–9**



▶ **Figure 700–10**

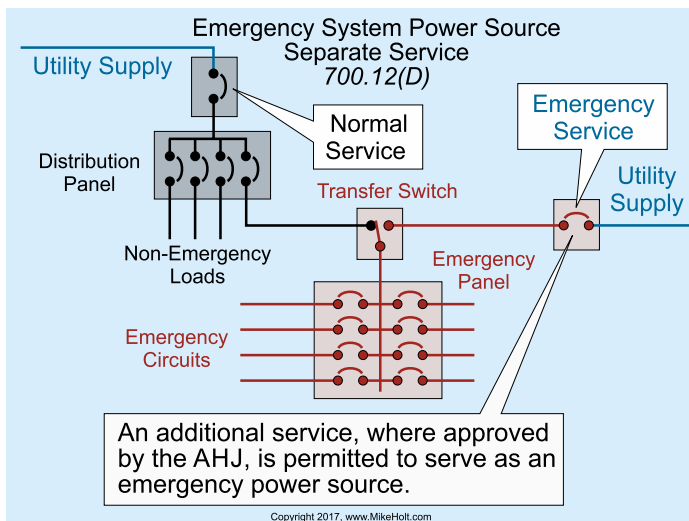
Author's Comment:

- According to Article 100, "Within Sight" means that it's visible and not more than 50 ft from one to the other.

Ex: Where conditions of maintenance and supervision ensure that only qualified persons will monitor and service the installation and where documented safe switching procedures are established and maintained for disconnection, the generator disconnect isn't required to be located within sight of the building or structure served.

(C) Uninterruptible Power Supplies. Uninterruptible power supplies serving as the emergency power source must comply with the applicable requirements of 700.12(A) and (B).

(D) Separate Service. An additional service is permitted where approved by the authority having jurisdiction and the following: ▶ **Figure 700-11**

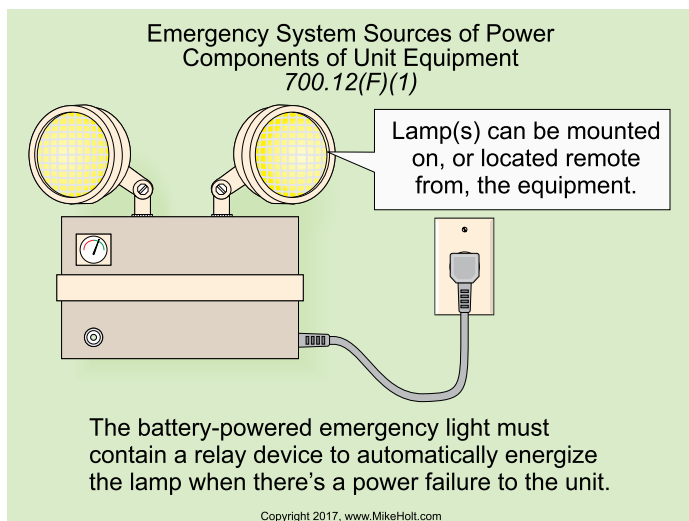


▶ **Figure 700-11**

(2) The service conductors must be sufficiently remote electrically and physically from any other service conductors to minimize the possibility of simultaneous interruption of supply.

(F) Unit Equipment.

(1) Components of Unit Equipment. Individual unit equipment (an emergency lighting battery pack) must consist of the following: ▶ **Figure 700-12**

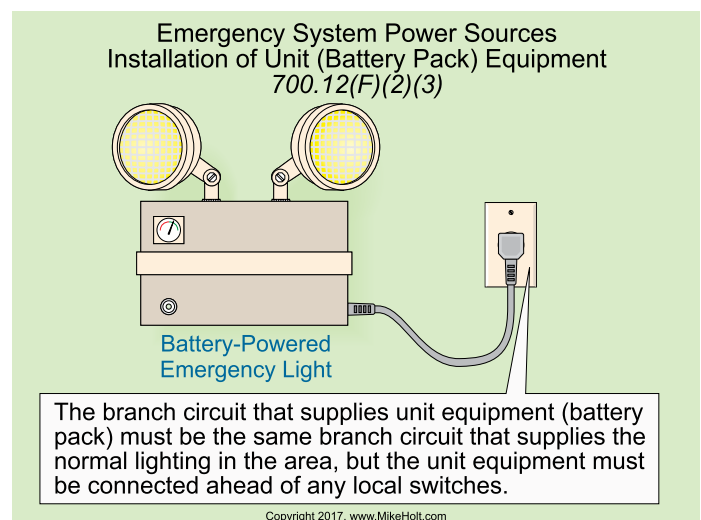


▶ **Figure 700-12**

- (1) A rechargeable battery
- (2) A battery charging means
- (3) Provisions for one or more lamps mounted on the equipment, or terminals for remote lamps, or both
- (4) A relaying device arranged to energize the lamps automatically upon failure of the supply to the unit equipment

(2) Installation of Unit (Battery Pack) Equipment. The installation of battery pack equipment must meet the following:

- (1) The batteries must be of suitable rating and capacity to supply and maintain the total lamp load:
 - (a) For a period of at least 1½ hours without the voltage falling below 87½ percent of normal battery voltage, or
 - (b) Supply not less than 60 percent of the initial emergency illumination for a period of at least 1½ hours.
- (2) Emergency lighting battery pack equipment must be permanently fixed in place. Flexible cord-and-plug connection (a locking receptacle isn't required) is permitted for emergency lighting battery pack equipment designed for this purpose, provided the flexible cord doesn't exceed 3 ft in length.
- (3) The branch-circuit wiring that supplies emergency lighting battery pack equipment must be the same branch-circuit wiring that supplies the normal lighting in the area, but the emergency lighting battery pack equipment must be connected ahead of any local switches. ▶ **Figure 700-13**



▶ **Figure 700-13**

Ex: In a separate and uninterrupted area supplied by at least three normal lighting circuits that aren't part of a multiwire branch circuit, a separate branch circuit for unit equipment is allowed if it originates from the same panelboard as the normal lighting circuits and is provided with a lock-on feature.

Author's Comment:

- There are two reasons why the emergency lighting battery packs 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 won't turn on when the switch controlling normal lighting is turned off.



CAUTION: Individual unit equipment must not be connected to the emergency circuit, because it won't operate when normal power is lost, since the equipment is being supplied by the emergency power system.

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

Part IV. Circuits for Lighting and Power

700.15 Loads on Emergency Branch Circuits

Emergency circuits must supply only emergency loads.

700.16 Emergency Illumination

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

Emergency lighting systems must be designed and installed so that the failure of any individual lighting element, such as the burning out of a lamp, won't leave in total darkness any space that requires emergency illumination.

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 unit equipment (sometimes called "lunchboxes" in the field) always has two lighting heads.

When an emergency system is installed, emergency illumination must be provided to illuminate the service or building disconnect, if the disconnect is located indoors. ▶ **Figure 700-14**

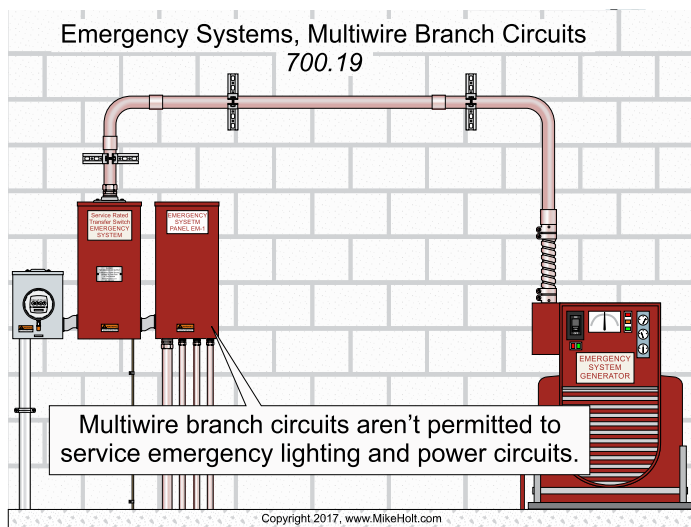


▶ **Figure 700-14**

700.19 Multiwire Branch Circuits

Multiwire branch circuits aren't allowed for emergency systems.

►Figure 700–15



►Figure 700–15

700.25 Branch Circuit Emergency Lighting Transfer Switch

Emergency lighting supplied by branch circuits rated not greater than 20A can use a listed branch circuit emergency lighting transfer switch.

Part VI. Overcurrent Protection

700.30 Accessibility

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

700.31 Ground-Fault Protection of Equipment

The alternate power supply for emergency systems isn't required to have ground-fault protection of equipment, but 700.6(D) requires ground-fault indication of the emergency power supply if ground-fault protection of equipment with automatic disconnecting means isn't provided.

700.32 Selective Coordination

Overcurrent protection devices for emergency power systems must be selectively coordinated with all supply-side overcurrent protection 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:

- 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.
- See Article 100 for the definition of the term "Coordination, Selective."

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 first 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, instead of the 10 seconds or less required for emergency power systems.

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 basically applies to systems or equipment needed to aid the people responding to the emergency. For example, Article 700 lighting provides an exit path. But, Article 701 might control the elevator used by fire fighters to reach the applicable floor.

Part I. General

701.1 Scope

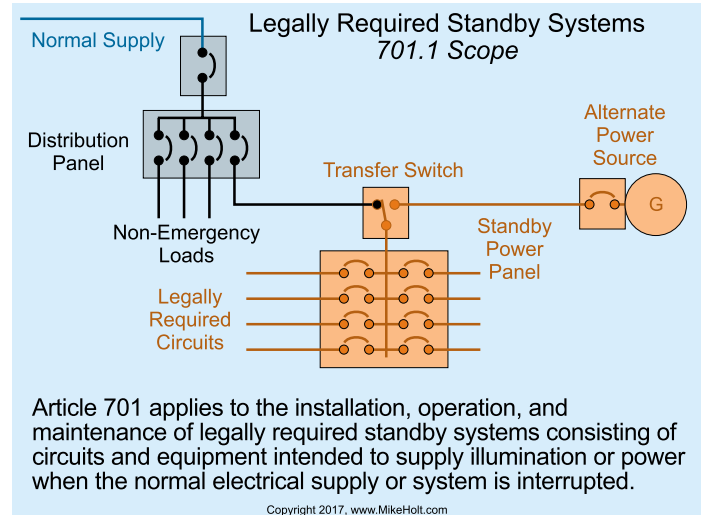
Article 701 applies to the installation, operation, and maintenance of legally required standby systems consisting of circuits and equipment intended to supply illumination or power when the normal electrical supply or system is interrupted. ▶Figure 701–1

Author's Comment:

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

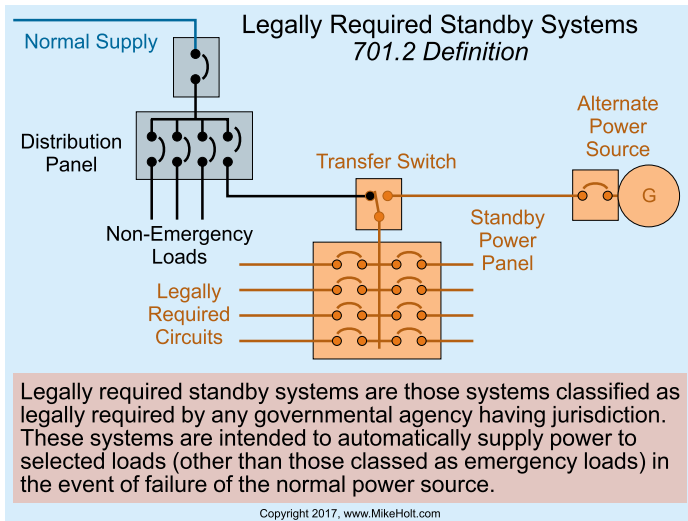
701.2 Definitions

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



▶Figure 701–1

Note: Legally required standby systems typically supply loads such as heating and refrigeration systems, communications systems (twisted wire, 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 to ensure that adequate maintenance has been performed and that the systems are in proper operating condition.

Author's Comment:

- Running the legally required standby system to power the loads of the facility is often considered an acceptable method of operational testing.

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

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

Author's Comment:

- The NEC doesn't specify the required record retention period.

701.4 Capacity and Rating

A legally required standby system must have adequate capacity to carry all loads expected to operate simultaneously. The legally required standby alternate power supply can supply legally required standby and optional standby system loads if:

- The alternate power supply has adequate capacity to handle all connected loads
- There's automatic selective load pickup and load shedding to ensure adequate power to the legally required standby circuits

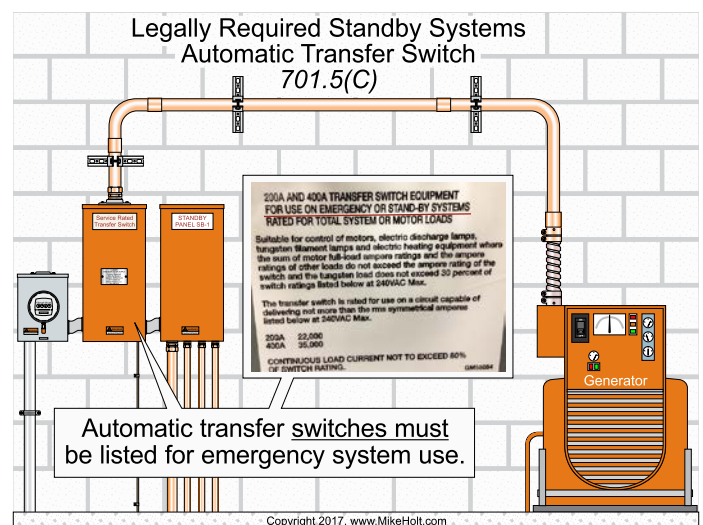
701.5 Transfer Equipment

(A) General. Transfer equipment must be automatic and be installed to prevent the inadvertent interconnection of normal and alternate sources of supply.

Author's Comment:

- Legally required standby systems and optional standby systems can be on the same transfer switch, but emergency power systems must have their own [700.6(D)].

(C) Automatic Transfer Switch. Automatic transfer switches must be listed for emergency use. ►Figure 701–3

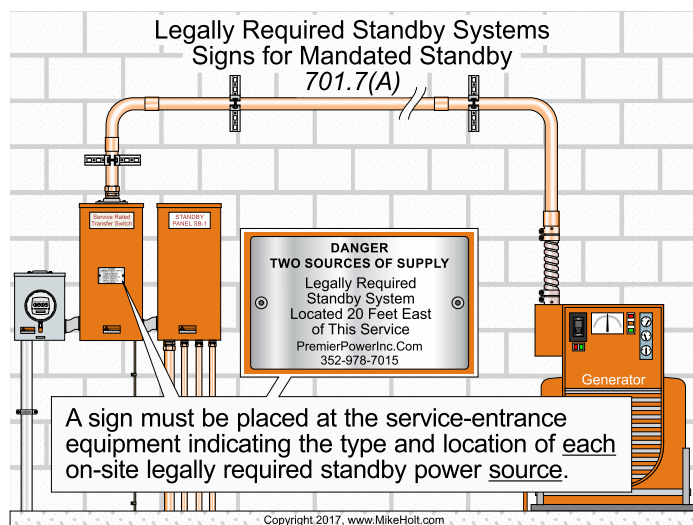


►Figure 701–3

(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 each on-site legally required standby power source. ▶Figure 701-4



▶Figure 701-4

Part II. Circuit Wiring

701.10 Wiring

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

Part III. Sources of Power

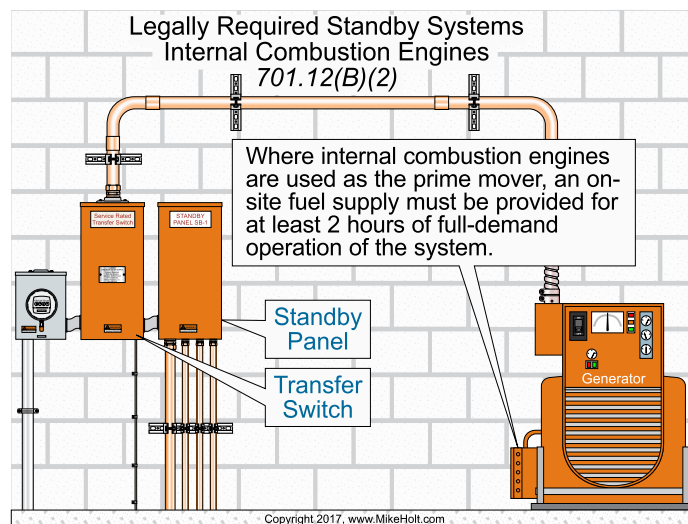
701.12 General Requirements

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 must be any of the following:

(B) Generator Set.

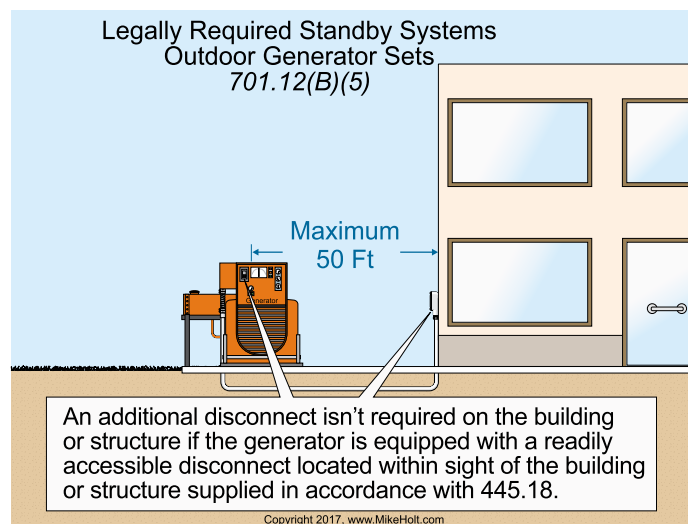
(1) Prime Mover-Driven. A generator approved by the authority having jurisdiction and sized in accordance with 701.4 must have the means to automatically start the prime mover on failure of the normal service.

(2) Internal Combustion Engines as Prime Movers. If internal combustion engines are used as the prime mover, an on-site fuel supply must be provided for not less than 2 hours of full-demand operation of the system. ▶Figure 701-5



▶Figure 701-5

(5) Outdoor Generator Sets. If a generator located outdoors is equipped with a readily accessible disconnect located within sight of the building, in accordance with 445.18, an additional disconnect isn't required on or at the building for the generator feeder conductors that serve or pass through the building. ▶Figure 701-6



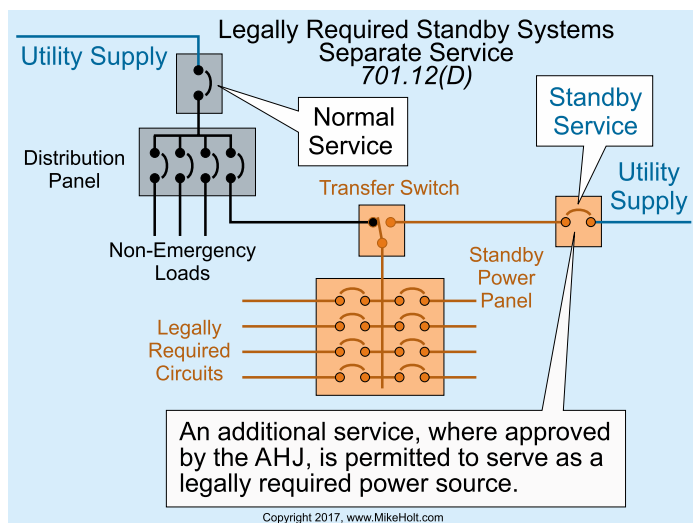
▶Figure 701-6

Author's Comment:

- According to Article 100, "Within Sight" means that it's visible and not more than 50 ft from one to the other.

(C) Uninterruptible Power Supplies. Uninterruptible power supplies serving as the legally required standby power source must comply with 701.12(A) and (B).

(D) Separate Service. If approved by the authority having jurisdiction, an additional service installed in accordance with Article 230 can serve as a legally required source of power. ▶Figure 701-7



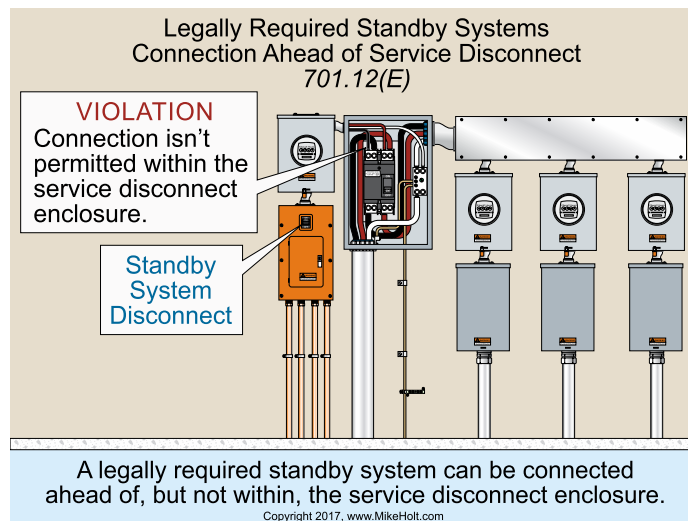
▶Figure 701-7

To minimize the possibility of simultaneous interruption of the legally required standby supply, a separate service drop, service lateral, or a separate set of overhead or underground service conductors must be electrically and physically separated from all other service conductors.

(E) Connection Ahead of Service Disconnect. If approved by the authority having jurisdiction, connection ahead of, but not within, the same cabinet, enclosure, or vertical switchboard or switchgear section as the service disconnecting means is permitted. ▶Figure 701-8

To prevent simultaneous interruption of supply, the legally required standby service disconnect must be sufficiently separated from the normal service disconnecting means.

Note: See 230.82 for equipment permitted on the supply side of a service disconnect.



▶Figure 701-8

Part IV. Overcurrent Protection

701.25 Accessibility

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

701.26 Ground-Fault Protection of Equipment

The alternate source for legally required standby systems isn't required to have ground-fault protection of equipment but 701.6(D) requires ground-fault indication. If ground-fault protection of equipment is provided, and the equipment automatically disconnects during the fault, the indication isn't required.

701.27 Selective Coordination

Overcurrent protection devices for legally required standby systems must be selectively coordinated with all supply-side overcurrent protection 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:

- See the definition of "Coordination, Selective" in Article 100.

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 doesn't depend on the performance of the system. These systems aren't 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'll 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 can't 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 isn't legally required.

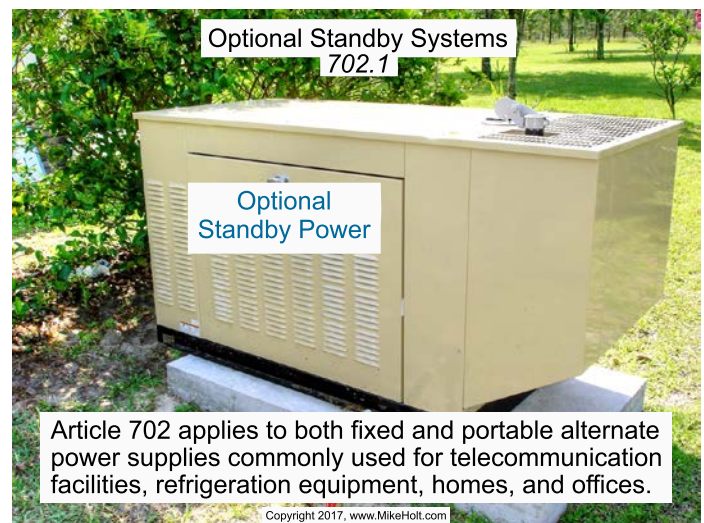
Part I. General

702.1 Scope

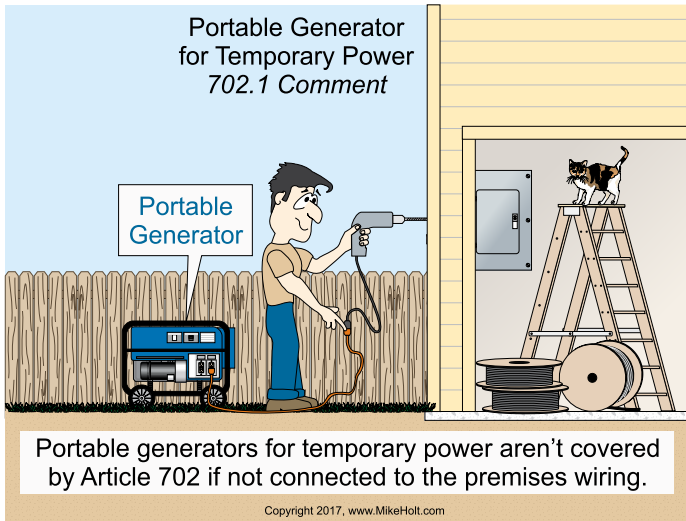
The systems covered by Article 702 consist of those permanently installed, including prime movers, and those arranged for a connection to a premises wiring system from a portable alternate power supply. ▶Figure 702-1 and ▶Figure 702-2

702.2 Definition

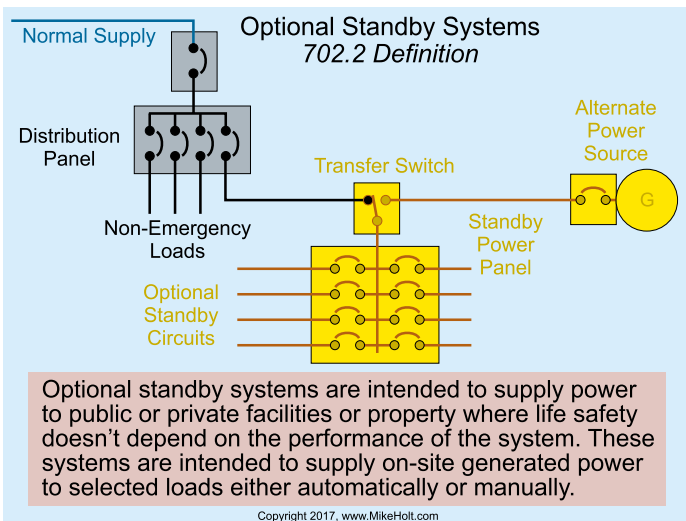
Optional Standby Systems. Optional standby systems are intended to supply power to public or private facilities or property where life safety doesn't depend on the performance of the system. These systems are intended to supply on-site generated power to selected loads either automatically or manually. ▶Figure 702-3



▶Figure 702-1



►Figure 702-2



►Figure 702-3

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 wire, antennas, 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

(B) System Capacity. The calculated load on the standby source must be in accordance with Article 220 or by another method approved by the authority having jurisdiction.

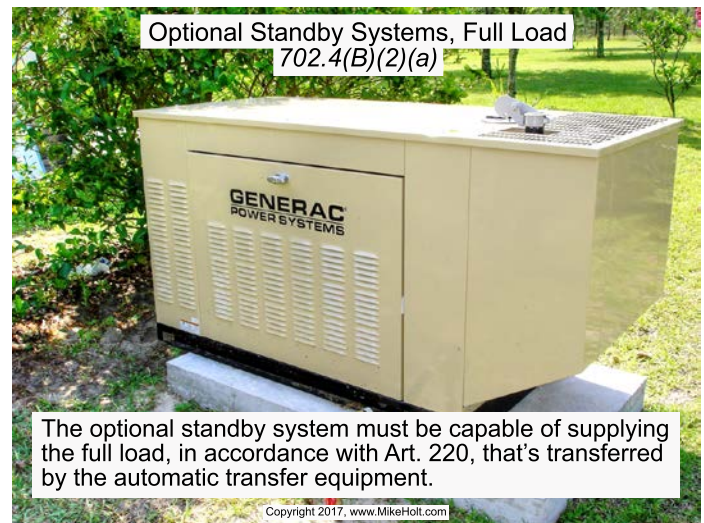
(1) Manual Transfer Equipment. The optional standby power source must have adequate capacity for all equipment intended to operate at one time as determined by the user.

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 kVA/kW rating.

(2) Automatic Transfer Equipment.

(a) Full Load. The optional standby power source must have adequate capacity to supply the full load transferred. ►Figure 702-4



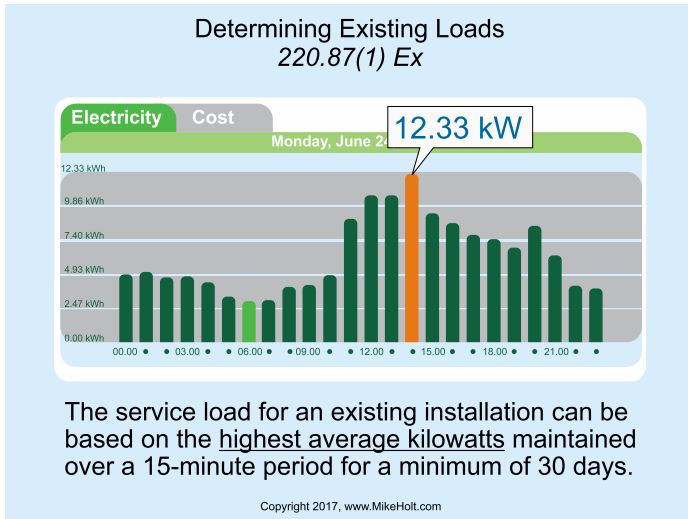
►Figure 702-4

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 702-5

702.5 Transfer Equipment

Transfer equipment must be suitable for the intended use and designed and installed to prevent the inadvertent interconnection of normal and alternate sources of supply in any operation of the transfer equipment. ►Figure 702-6



►Figure 702-5



►Figure 702-6

Transfer equipment is required for all fixed or portable optional standby systems. ►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.

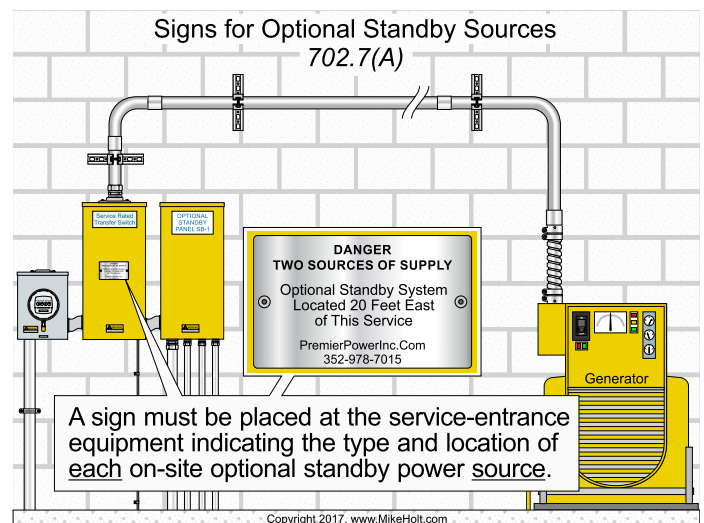
The short-circuit current rating of the transfer equipment must be field marked on the exterior of the transfer equipment.



►Figure 702-7

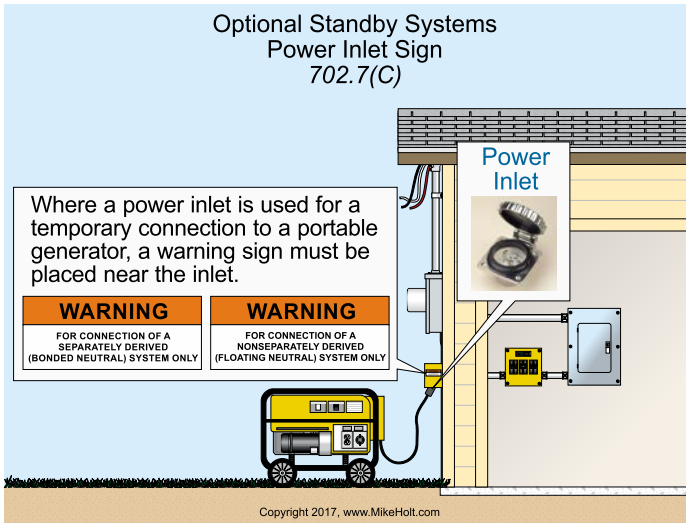
702.7 Signs

(A) Standby Power Sources. A sign that indicates the type and location of each on-site optional standby power source must be placed at service-entrance equipment. ►Figure 702-8



►Figure 702-8

(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 derived system permitted to be connected to the inlet stating: ►Figure 702-9



►Figure 702-9

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

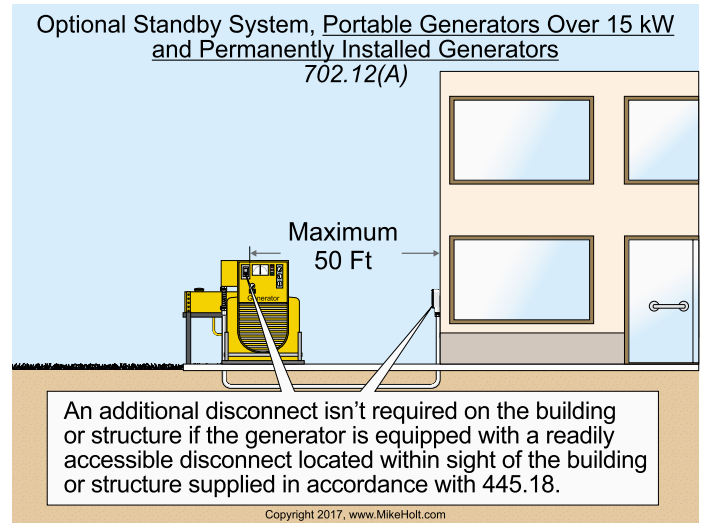
Optional standby system wiring can occupy the same raceways, cables, boxes, and cabinets with other general wiring.

702.12 Outdoor Generator Sets

(A) Portable Generators Greater Than 15 kW and Permanently Installed Generators. If a generator located outdoors is equipped with a readily accessible disconnect located within sight of the building, in accordance with 445.18, an additional disconnect isn't required on or at the building for the generator feeder conductors that serve or pass through the building. ►Figure 702-10

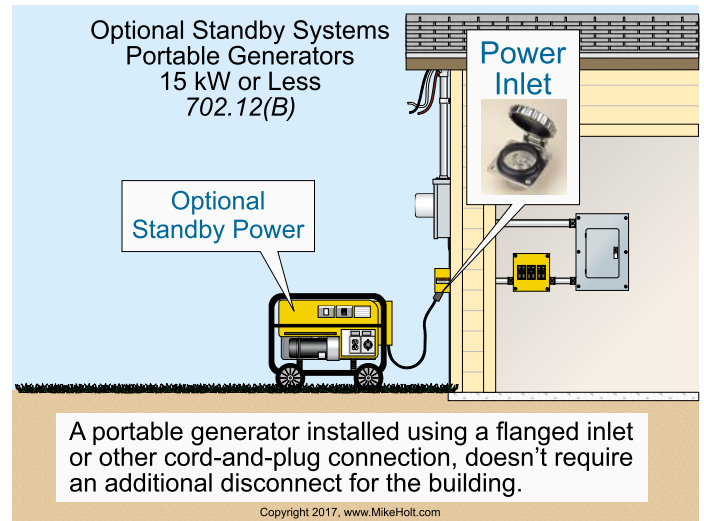
Author's Comment:

- According to Article 100, "Within Sight" means that it's visible and not more than 50 ft from one to the other.



►Figure 702-10

(B) Portable Generators 15 kW or Less. Where a portable generator, rated 15 kW or less, is installed using a flanged inlet or other cord-and-plug type connection, an additional disconnect isn't required for the building. ►Figure 702-11



►Figure 702-11

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