Mike Holt's

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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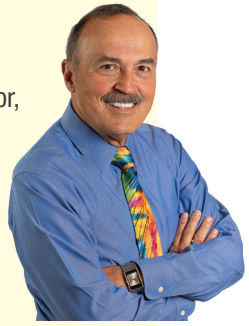

Mike Holt is an author, businessman, educator, speaker, publisher and *NEC®* expert. He has written hundreds of electrical training books and articles, founded three successful businesses, and has taught thousands of electrical *Code* seminars across the United States and internationally.

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 contains the requirements necessary for calculating demand loads for branch circuits, feeders, and services. The *Code* recognizes that not all demand for power will occur at the same time. This load diversity allows us to apply the rules contained in this article to reduce the required size of circuits and equipment. Some topics covered in our material for Article 220 include:

- Branch-circuit load calculations
- Existing installation load calculations
- Service load calculations
- Special application load calculations

This article consists of seven parts:

- Part I. General, lays out the requirement of Article 220 including a table showing where load calculations found outside of this article can be found in the *NEC*
- Part II. Branch-Circuit Load Calculations. This part contains branch-circuit calculation rules
- Part III. Feeder and Service Load Calculations, contains the "Standard Method" calculation rules
- Part IV. Optional Feeder and Service Load Calculations. This part contains "Optional Method" calculation rules
- Part V. Farm Load Calculations contains agricultural-specific calculation rules
- Part VI. Health Care Facility Load Calculations. This part contains healthcare-specific calculation rules
- Part VII. Marinas, Boatyards, Floating Buildings, and Docking Facility Calculations, contains the rules specific to these installations

As you work through Article 220, be sure to study the illustrations and review the examples in Annex D to help you fully understand this article's requirements.

220.87 Determining Existing Loads

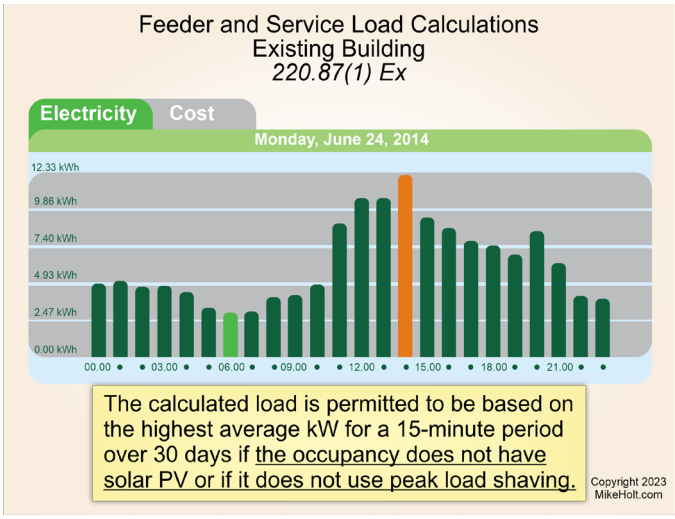
The feeder or service calculated load for an existing building must be in accordance with all the following:

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

Ex: If the maximum demand data for a one-year period is not available, the calculated load is permitted to be based on the highest average kW for a 15-minute period over 30 days. This calculation is not permitted if the occupancy has a renewable energy system (solar PV) or uses any form of peak load shaving. ▸Figure 220–45

(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.



▶Figure 220–45

ARTICLE

445 GENERATORS

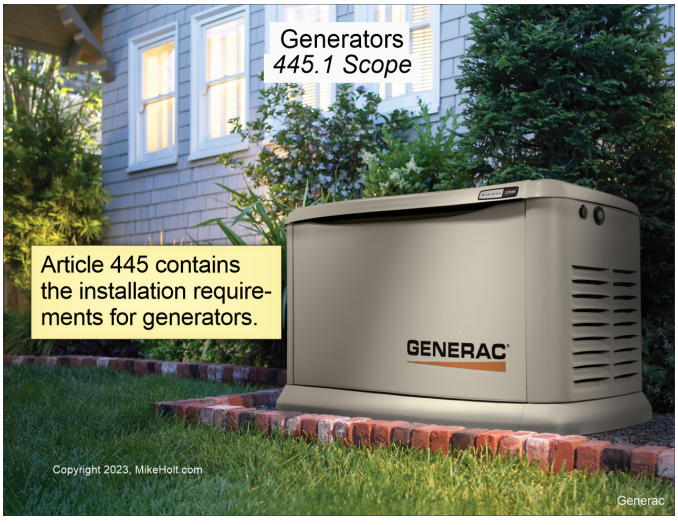
Introduction to Article 445—Generators

This article contains the installation and other requirements for generators and generator sets. Rules located here include such things as where generators can be installed, nameplate markings, conductor ampacity, transference of power, and disconnect requirements. Some topics covered in this material include:

- Installation locations
- Marking
- Overcurrent protection
- Conductor ampacity
- Disconnecting means and emergency shutdown
- Portable generators

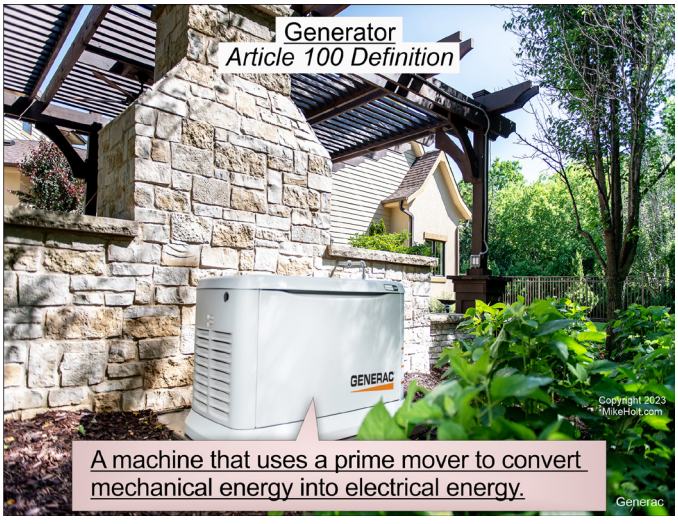
445.1 Scope

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



▸Figure 445–1

According to Article 100, "Generator" is a machine that converts mechanical energy into electrical energy by means of a prime mover. ▸Figure 455–2



▸Figure 445–2

According to Article 100, "Prime Mover" is a machine that supplies mechanical horsepower to a generator.

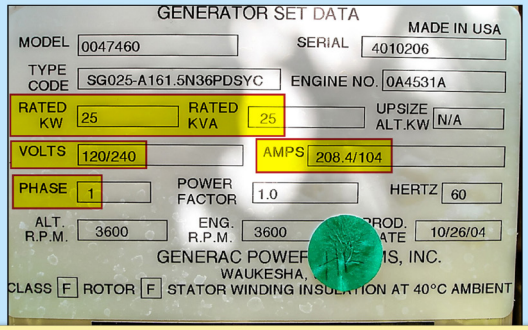
445.6 Listing

Stationary generators must be listed.

445.11 Marking

The generators nameplate must be accessible and give the manufacturer's name, rated frequency, number of phases, rating in kilowatts or kilovolt-amperes, power factor, and the volts and amperes corresponding to the rating. ▸Figure 445–3

Generators, Nameplate Marking
445.11



The generators nameplate must include the manufacturer's name, rated frequency, number of phases, rating in kW or kVA, power factor, volts, and amperes.

▸Figure 445–3

Markings by the manufacturer must indicate whether the neutral is bonded to the frame or not. If the manufacturer bonding is modified in the field, field marking is required to indicate if the neutral is bonded to the frame.

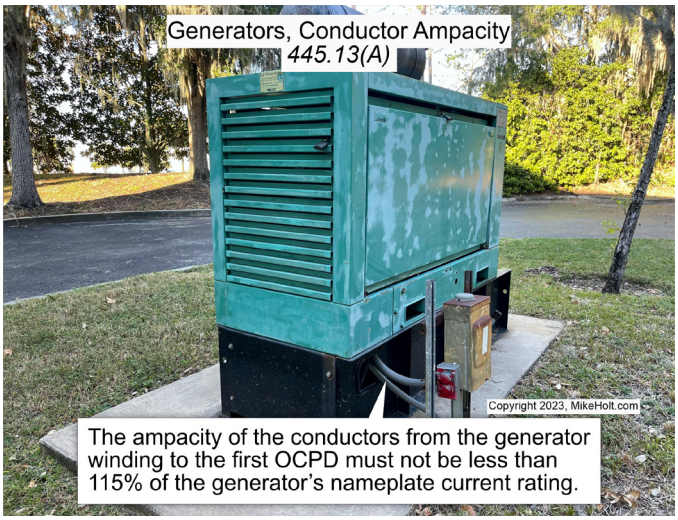
445.13 Conductor Ampacity

(A) General. The ampacity of the conductors from the generator winding to the first overcurrent protective device must not be less than 115 percent of the generator's nameplate current rating. ▸Figure 445–4

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 OCPD to the transfer switch are sized to the generator's overcurrent protective device rating in accordance with 240.4. ▸Figure 445–5

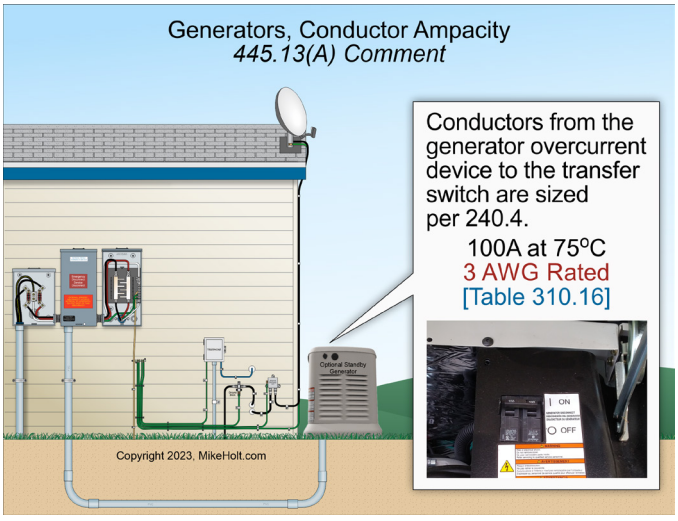
Generators, Conductor Ampacity
445.13(A)



The ampacity of the conductors from the generator winding to the first OCPD must not be less than 115% of the generator's nameplate current rating.

▸Figure 445–4

Generators, Conductor Ampacity
445.13(A) Comment

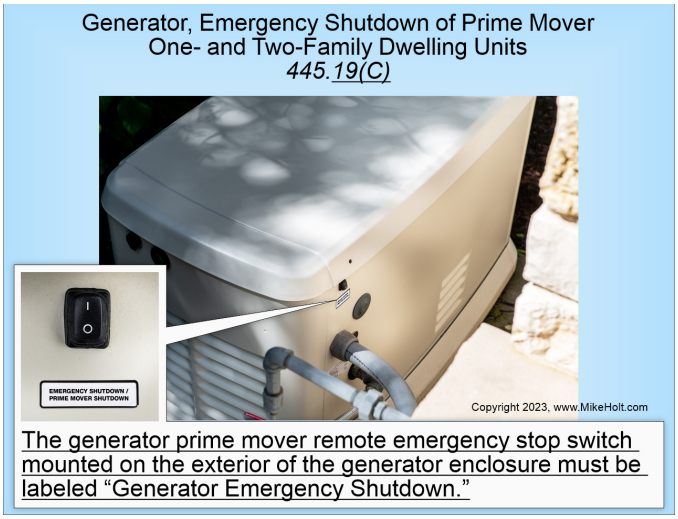


▸Figure 445–5

445.19 Emergency Shutdown of Prime Mover

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

(C) Emergency Shutdown in One- and Two-Family Dwelling Units. The generator prime mover remote emergency stop switch mounted on the exterior of the generator enclosure must be labeled "Generator Emergency Shutdown." ▸Figure 445–6


Generator, Emergency Shutdown of Prime Mover
One- and Two-Family Dwelling Units
445.19(C)
EMERGENCY SHUTDOWN / PRIME MOVER SHUTDOWN
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The generator prime mover remote emergency stop switch mounted on the exterior of the generator enclosure must be labeled “Generator Emergency Shutdown.”

▶Figure 445–6

ARTICLE

700 EMERGENCY SYSTEMS

Introduction to Article 700—Emergency Systems

This article covers the installation, operation, and maintenance of emergency systems consisting of circuits and equipment intended to supply power for illumination, fire detection, elevators, fire pumps, public safety, industrial processes where current interruption would produce serious life safety or health hazards, and similar functions. The authority having jurisdiction makes the determination as to whether such a system is necessary for a given facility and what it must be connected to it. Many of these rules are outside of the scope of this material, however, some of the topics we cover include the following:

- Scope
- Tests and Maintenance
- Capacity and Rating
- Signals
- Surge Protection
- Wiring to Emergency Loads
- Sources of Power
- Emergency Illumination
- Selective Coordination

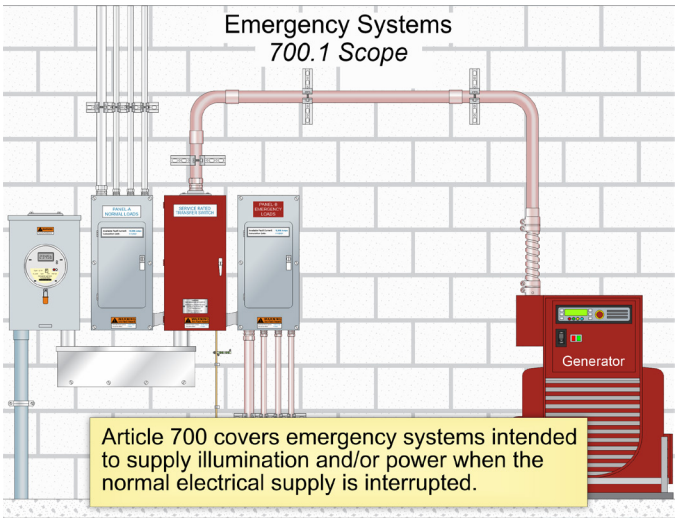
Article 700 consists of six parts:

- Part I. General
- Part II. Circuit Wiring
- Part III. Sources of Power
- Part IV. Emergency System Circuits for Lighting and Power
- Part V. Control (Not Covered)
- Part VI. Overcurrent Protection

Part I. General

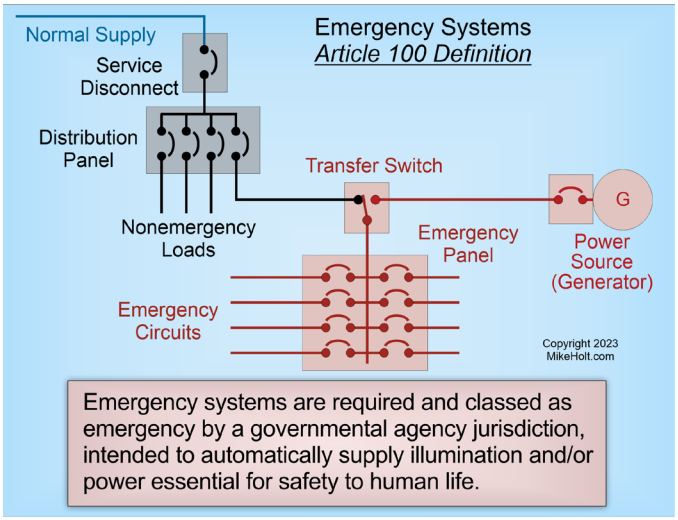
700.1 Scope

Article 700 covers the installation, operation, and maintenance of emergency systems consisting of circuits and equipment intended to supply illumination and power when the normal electrical supply is interrupted. ▸Figure 700–1



▸Figure 700–1

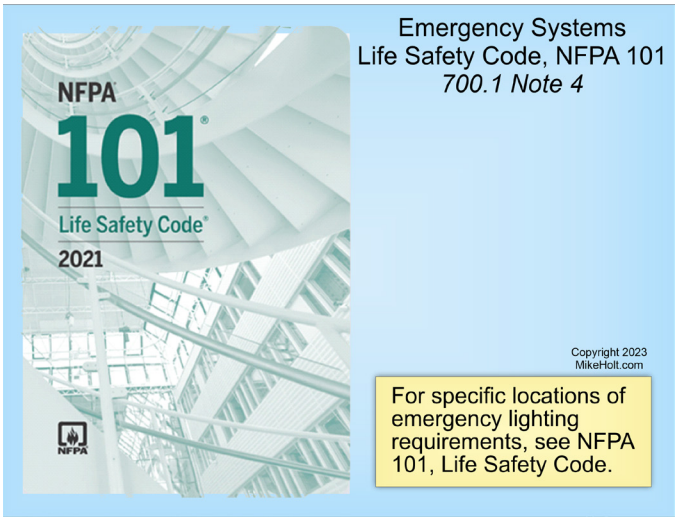
According to Article 100, "Emergency Systems" are those systems required and classed as emergency by a governmental agency having jurisdiction. These systems are intended to automatically supply illumination and/or power essential for safety to human life. ▸Figure 700–2



▸Figure 700–2

Note 1: Emergency systems are generally installed in places of assembly 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. Emergency systems may also provide power for such functions as ventilation where essential to maintain life, fire detection and alarm systems, elevators, fire pumps, public safety announcing systems, industrial processes where current interruption would produce serious life safety or health hazards, and similar functions.

Note 4: For specific locations of emergency lighting requirements, see NFPA 101, *Life Safety Code*. ▸Figure 700–3



▸Figure 700–3

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 5: For specific performance requirements of emergency power systems, see NFPA 110, *Standard for Emergency and Standby Power Systems*. ▸Figure 700–4

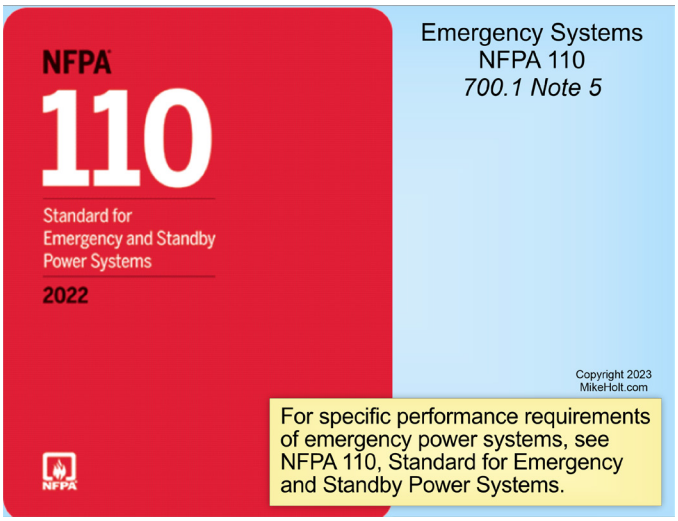


Figure 700–4

700.3 Tests and Maintenance

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

Note: See NECA 90, *Standard for Commissioning Building Electrical Systems*.

According to Article 100, "Commissioning" is the process, procedures, and testing used to set up and verify the initial performance, operational controls, safety systems, and sequence of operation of electrical devices and equipment prior to them being placed into active service.

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

The system capacity must be sufficient for the rapid load changes and transient power and energy requirements associated with any expected loads.

(B) Selective Load Management. The electric power production system is permitted to supply emergency, legally required standby, and optional standby system loads where a load management system includes automatic selective load pickup and load shedding to ensure adequate power to the following:

(1) Emergency circuits

(2) Legally required standby circuits

(3) Optional standby circuits

700.5 Transfer Switch

(A) General. Transfer switches must be automatic, listed, marked for emergency use, and approved by the authority having jurisdiction.

Figure 700–5

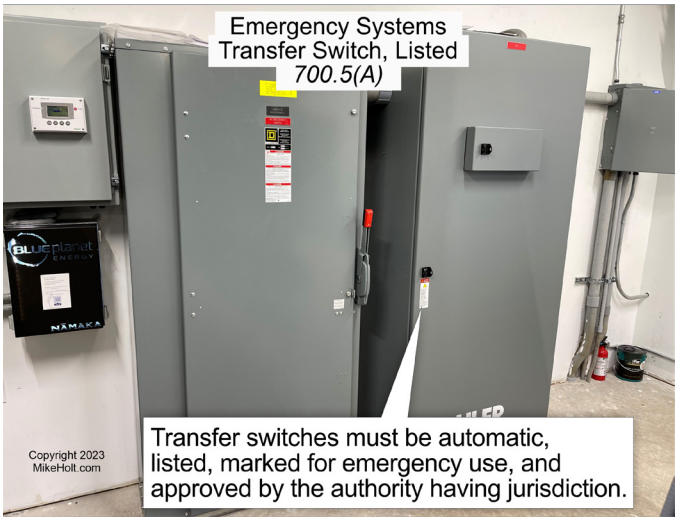
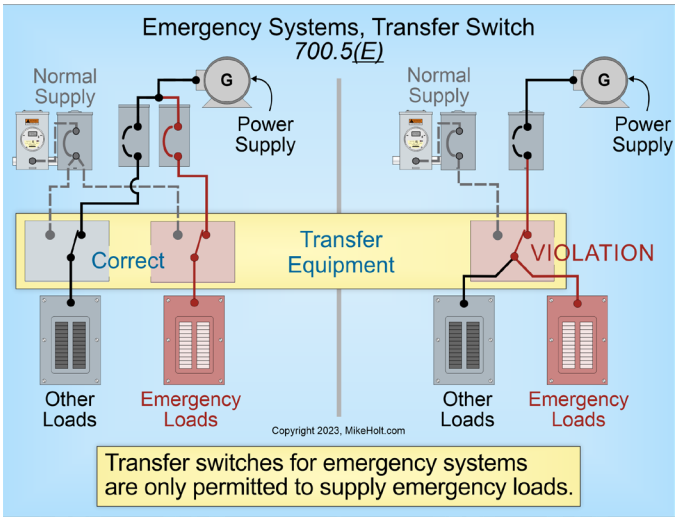


Figure 700–5

(C) Automatic Transfer Switches. Automatic transfer switches must be able to be electrically operated and mechanically held.

(E) Use. Transfer switches for emergency systems are only permitted to supply emergency loads. ▸Figure 700–6



▸Figure 700–6

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.

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

700.6 Signals

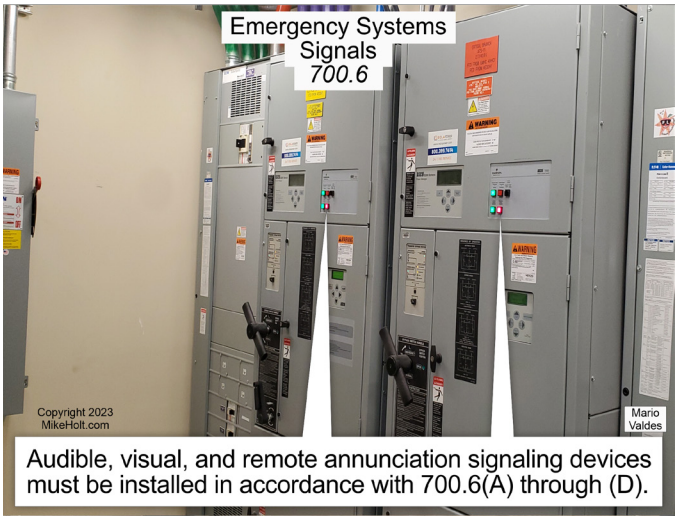
Audible, visual, and facility or network remote annunciation signaling devices must be installed where applicable for the purposes of: ▸Figure 700–7

(A) Malfunction Signal. To indicate a malfunction of the emergency source of power.

(B) Carrying Load Signal. To indicate that the emergency source is carrying load.

(C) Storage Battery Charging Malfunction Signal. To indicate that the battery charger is not functioning.

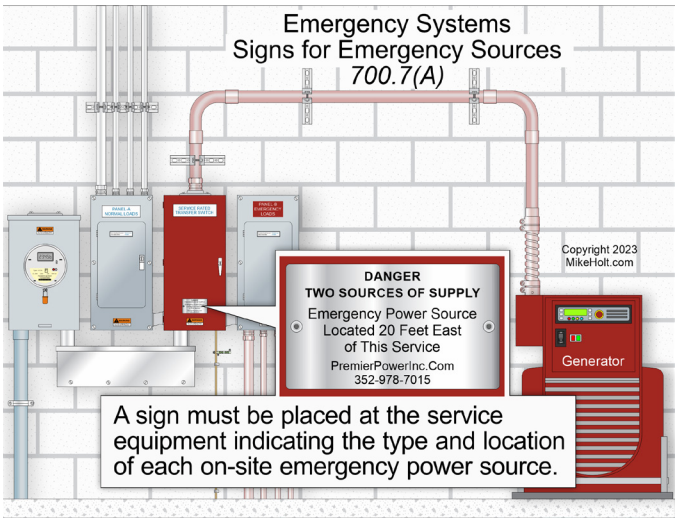
(D) Ground-Fault Signal. To indicate a ground fault in a 4-wire, three-phase, 277/480V wye-connected system rated 1000A or more.



▸Figure 700–7

700.7 Signs

(A) Emergency Sources. A sign must be placed at service equipment indicating the type and location of each on-site emergency power source. ▸Figure 700–8



▸Figure 700–8

700.8 Surge Protection

A listed surge-protective device must be installed for all emergency system switchgear, switchboards, and panelboards. ▸Figure 700–9

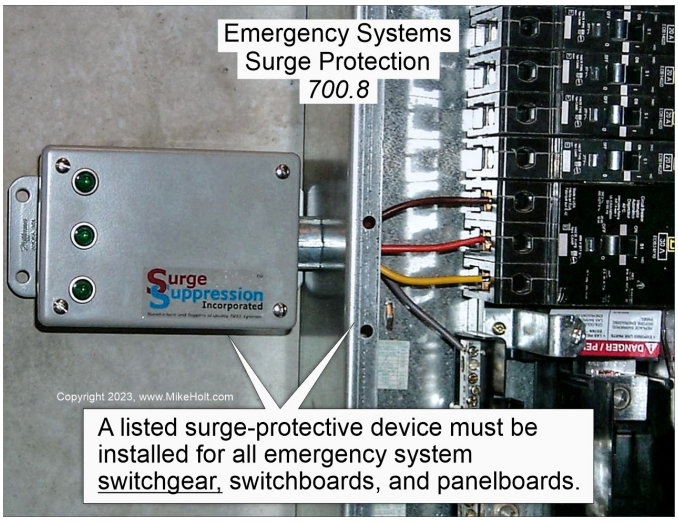


Figure 700–9

Part II. Circuit Wiring

700.10 Wiring to Emergency Loads

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

(1) Boxes, enclosures, transfer switches, generators, and panels containing emergency circuits must be marked as a component of an emergency system. Figure 700–10

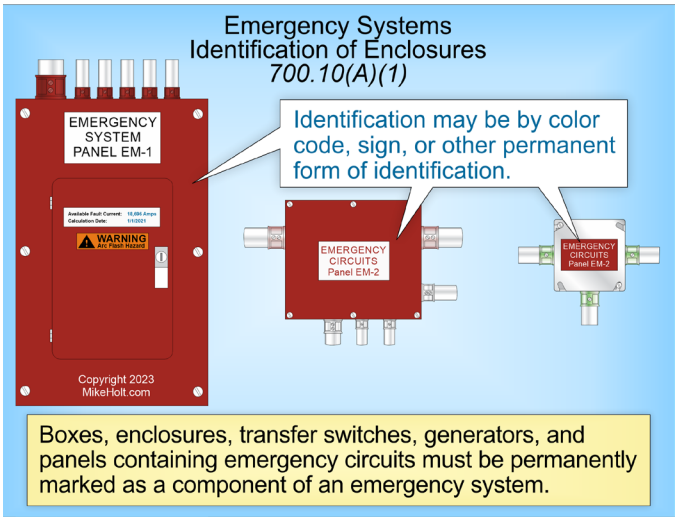


Figure 700–10

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 raceways must be marked as part of the emergency system at intervals not exceeding 25 ft. Figure 700–11

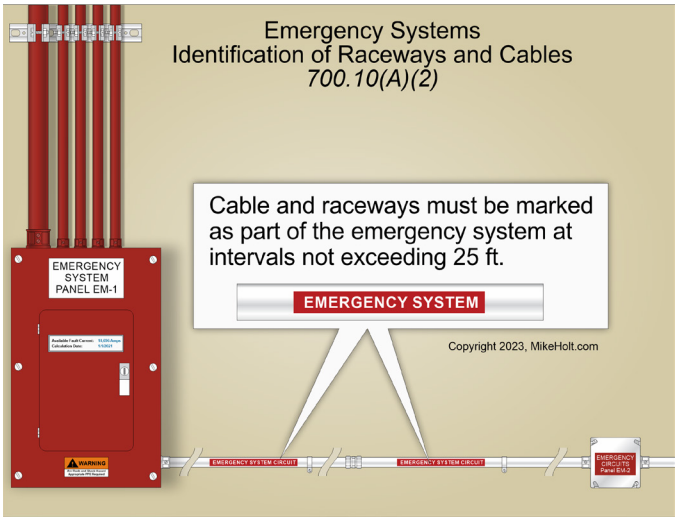


Figure 700–11

Receptacles connected to the emergency system must be identified by having a distinctive color or marking on either the receptacle or cover plate. Figure 700–12

(B) Independent Wiring. Emergency system conductors cannot be installed within any cabinet, enclosure, raceway, cable, or luminaire with nonemergency loads, except for the following: Figure 700–13

(1) Wiring in transfer switches. Figure 700–14

(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 within a traveling cable to an elevator.

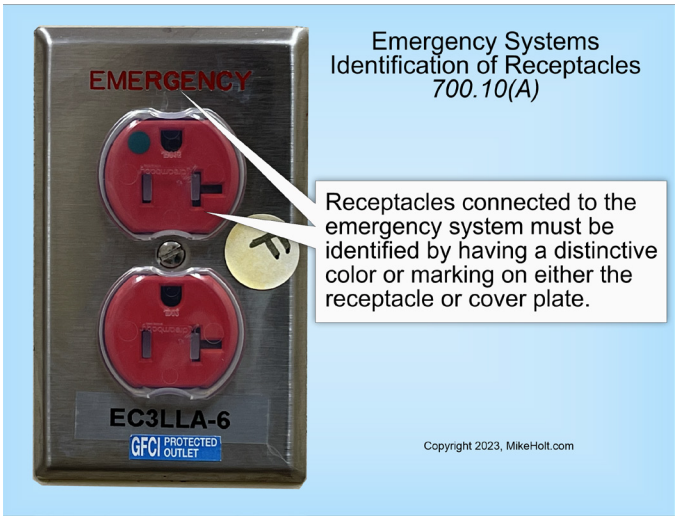


Figure 700–12

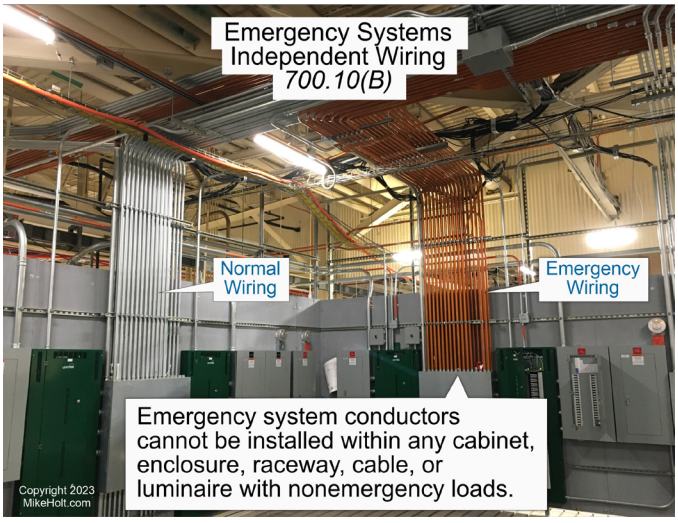


Figure 700–13

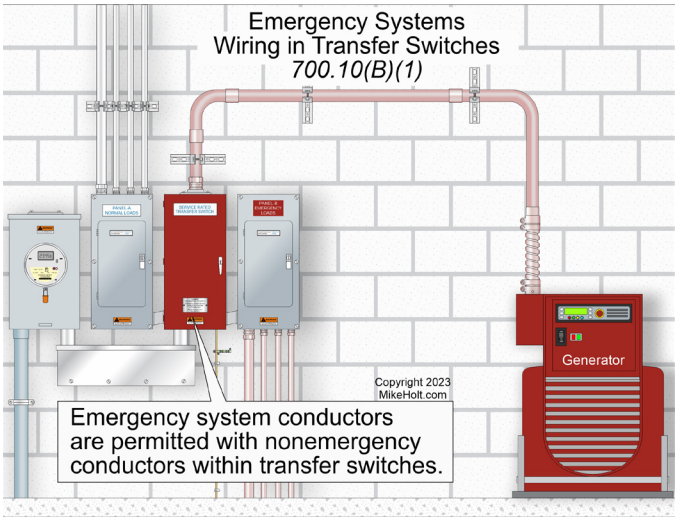


Figure 700–14

(6) 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, 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.

e. At the emergency power source, such as a generator, multiple integral overcurrent protective devices are permitted to supply a designated emergency or a designated nonemergency load, provided there is complete separation between emergency and nonemergency loads beginning immediately after the overcurrent protective device line-side connections. Figure 700–15

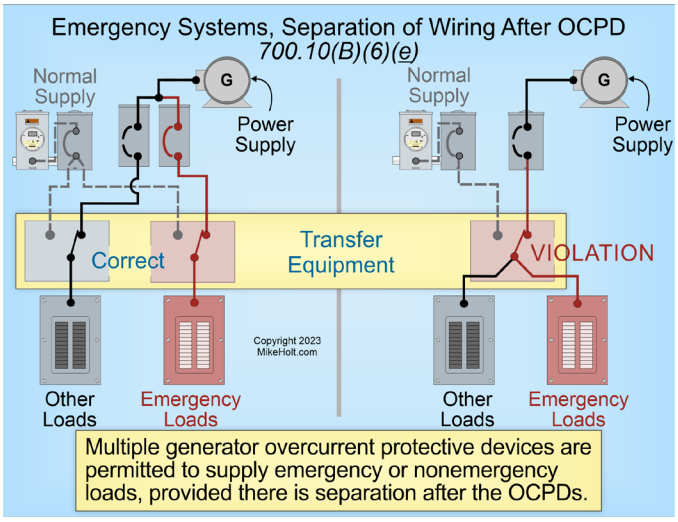


Figure 700–15

Wiring of two or more emergency circuits supplied from the same source can be installed in the same raceway, cable, box, or cabinet.

Author's Comment:

- Separation of the circuits served by a generator source for emergency 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.

700.11 Wiring, Class 2-Powered Emergency Lighting Systems

(A) General. Line voltage supply wiring and Class 2 power-limited emergency lighting control devices must comply with 700.10.

Class 2 power-limited emergency circuits must comply with 700.11(B) through (D).

(B) Identification. Class 2 power-limited emergency circuits must be marked so they will be readily identified as a component of an emergency circuit or system by the following methods:

(1) All boxes and enclosures for Class 2 power-limited emergency circuits must be marked as a component of an emergency circuit or system.

(2) Exposed cable, cable tray, or raceways systems must be marked to be identified as a component of an emergency circuit or system within 3 ft of each connector and at intervals not to exceed 25 ft.

(C) Separation of Circuits. Class 2 power-limited emergency circuits must be wired in a listed, jacketed cable or with one of the wiring methods of Chapter 3. If installed alongside nonemergency Class 2 power-limited circuits that are bundled, Class 2 power-limited emergency circuits must be bundled separately. If installed alongside nonemergency Class 2 power-limited circuits that are not bundled, Class 2 power-limited emergency circuits must be separated by a nonconductive sleeve or nonconductive barrier from all other Class 2 power-limited circuits. Separation from other circuits must comply with 725.136.

(D) Protection. Wiring must comply with the requirements of 300.4 and be installed in a raceway, armored or metal-clad cable, or cable tray.

Ex 1: Section 700.11(D) does not apply to wiring that does not exceed 6 ft in length and that terminates at an emergency luminaire or an emergency lighting control device.

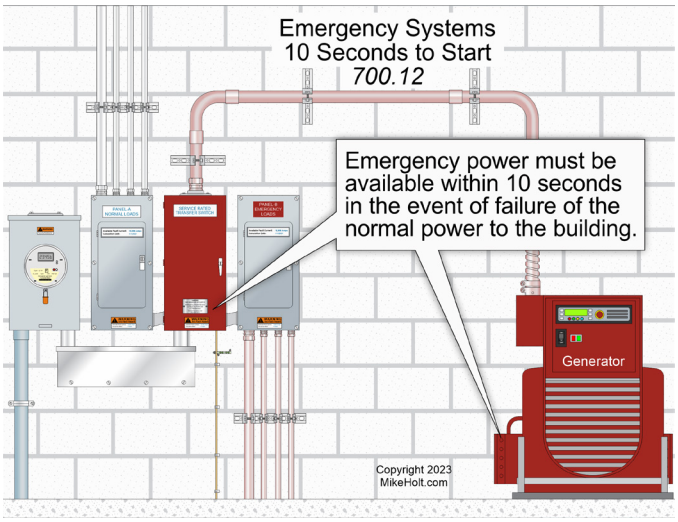
Ex 2: Section 700.11(D) does not apply to locked rooms or locked enclosures that are accessible only to qualified persons.

Note: Locked rooms accessible only to qualified persons include locked telecommunications rooms, locked electrical equipment rooms, or other access-controlled areas.

Part III. Sources of Power

700.12 General Requirements

Emergency power must be available within 10 seconds in the event of failure of the normal power to the building. ▸Figure 700–16



▸Figure 700–16

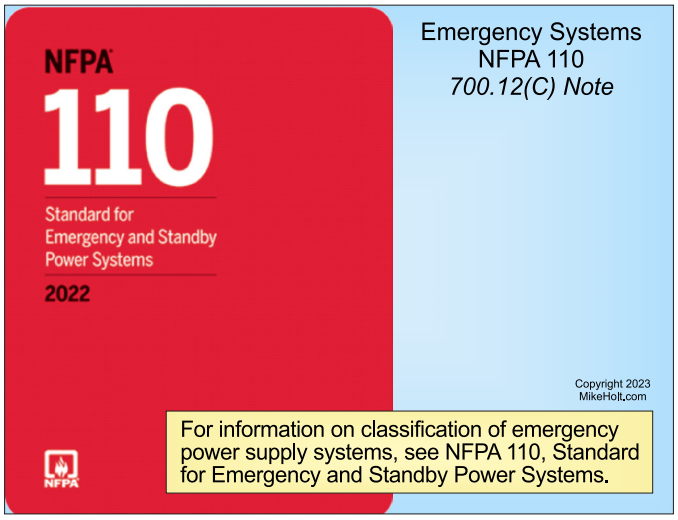
The emergency power supply must be any of the following:

(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 to minimize the hazards that might cause complete failure due to flooding, fires, icing, and vandalism.

(C) Supply Duration. The emergency power source must be of suitable rating and capacity to supply and maintain the total load for the duration determined by the system design. In no case can the duration be less than 2 hours of system operation unless used for emergency illumination in 700.12(C)(4) or unit equipment in 700.12(I).

Note: For information on classification of emergency power supply systems, see NFPA 110, *Standard for Emergency and Standby Power Systems*. ▸Figure 700–17



▸Figure 700–17

(4) Storage Battery and UPS Systems. Storage batteries and uninterruptible power supply (UPS) systems used to supply emergency illumination must be of suitable rating and capacity to supply and maintain the total load for a period of not less than 90 minutes, without the voltage applied to the load falling below 87½ percent of the nominal voltage. Automotive-type batteries are not permitted for this purpose. Automatic battery charging means must be provided.

Author's Comment:

- Uninterruptible power supplies (UPS) generally include a rectifier, a storage battery, and an inverter to convert direct-current (dc) to alternating-current (ac).

(D) Generators.

(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 power source fails.

(E) Stored-Energy Power Supply Systems.

(1) Types. Stored-energy power supply systems must be one of the following types:

(1) Uninterruptible power supply (UPS)

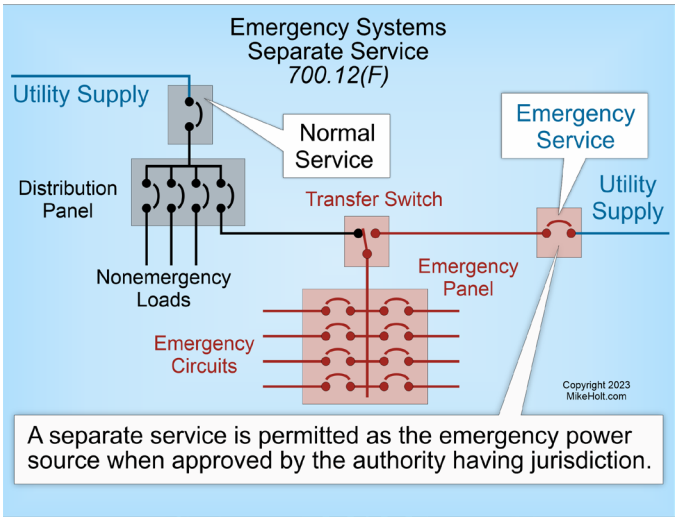
(2) Fuel cell system

(3) Energy storage system

(4) Storage battery

(5) Other approved equivalent stored energy sources that comply with 700.12

(F) Separate Service. A separate service is permitted as the emergency power source where approved by the authority having jurisdiction [230.2(A)] and the following: ▸Figure 700–18



▸Figure 700–18

(1) Separate service conductors are installed from the electric 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)].

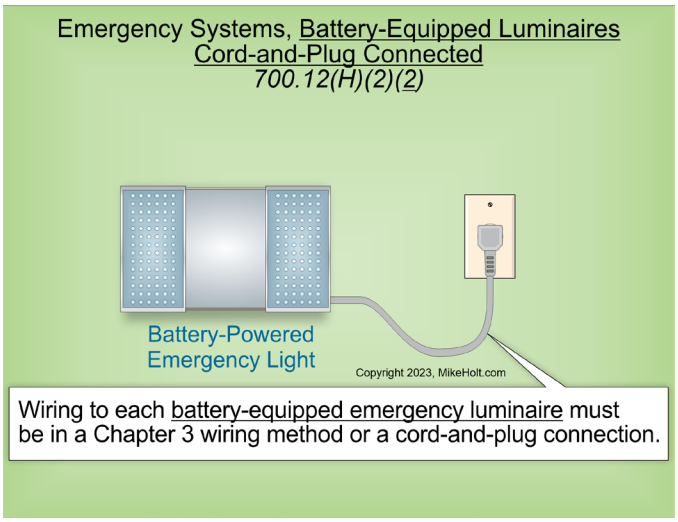
(H) Battery-Equipped Emergency Luminaires.

(1) Listing. All battery-equipped emergency luminaires must be listed.

(2) Installation of Battery-Equipped Emergency Luminaires.

(1) Battery-equipped emergency luminaires must be fixed in place (not portable).

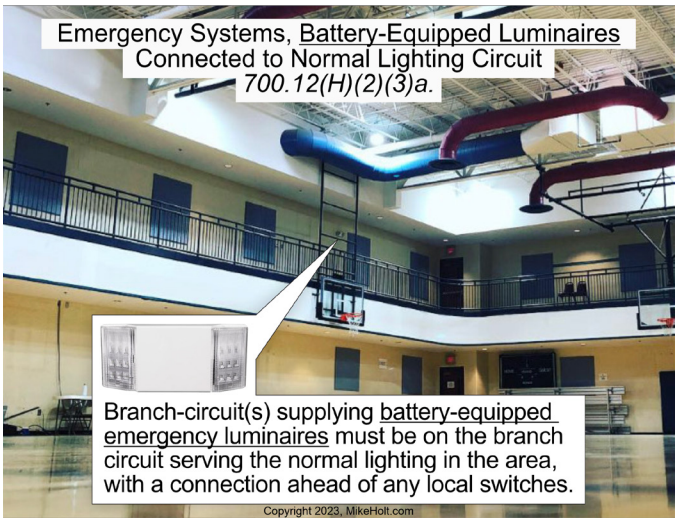
(2) Wiring to each luminaire must be installed in accordance with any Chapter 3 wiring method, or a cord-and-plug connection with a flexible cord not more than 3 ft in length. Flexible cord, with or without a plug, for unit equipment is permitted for battery-equipped emergency luminaires installed in accordance with 410.62(C)(1). ▸Figure 700–19



▸Figure 700–19

(3) The branch-circuit(s) wiring that supplies battery-equipped emergency luminaires must be one of the following:

a. The branch circuit serving the normal lighting in the area, with a connection ahead of any local switches. ▸Figure 700–20



▸Figure 700–20

b. The branch circuits serving the normal lighting in the area, if that branch circuit is equipped with means to monitor the status of the area's normal lighting branch circuit ahead of any local switches.

c. A separate branch circuit originating from the same panelboard as the normal lighting circuits that is provided with a lock-on feature.

Author's Comment:

- There are two reasons why the battery-equipped emergency luminaire (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 battery-equipped emergency luminaire lighting packs will activate and provide emergency lighting for people to exit the building, and (2) the battery-equipped emergency luminaire will not turn on when the switch controlling normal lighting is turned off.

(4) The branch circuit that feeds the battery-equipped emergency luminaires 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 luminaries providing the exterior lighting of an exit door can be supplied by the battery-equipped emergency luminaires 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

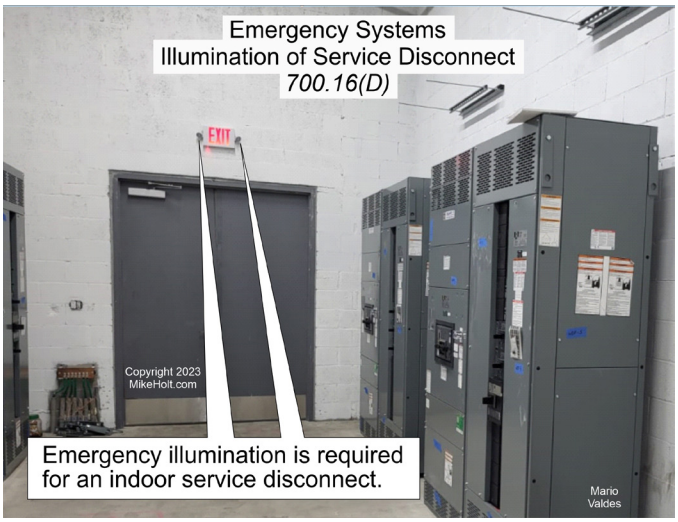
(A) General. Emergency illumination include means of egress lighting, illuminated exit signs, and all other luminaires specified as necessary to provide the required illumination.

(B) System Reliability. Emergency illumination 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.

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

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

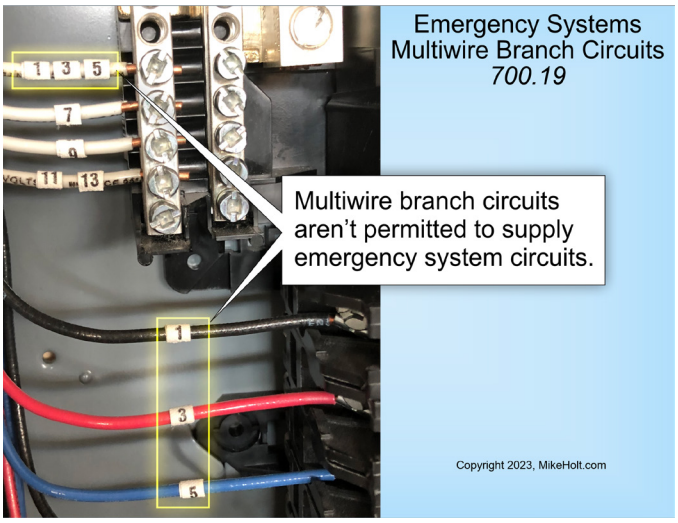
(D) Disconnecting Means. When an emergency system is installed, emergency illumination is required for an indoor service disconnect. ▸Figure 700–21



▸Figure 700–21

700.19 Multiwire Branch Circuits

Multiwire branch circuits are not permitted to supply emergency system circuits. ▸Figure 700–22



▸Figure 700–22

700.27 Class 2 Powered Emergency Lighting Systems

Devices that combine control signals with Class 2 emergency power on a single circuit must be listed as emergency lighting control devices.

Note: An example of a device combining control signals with Class 2 emergency power sources is a Power over Ethernet (PoE) switch.

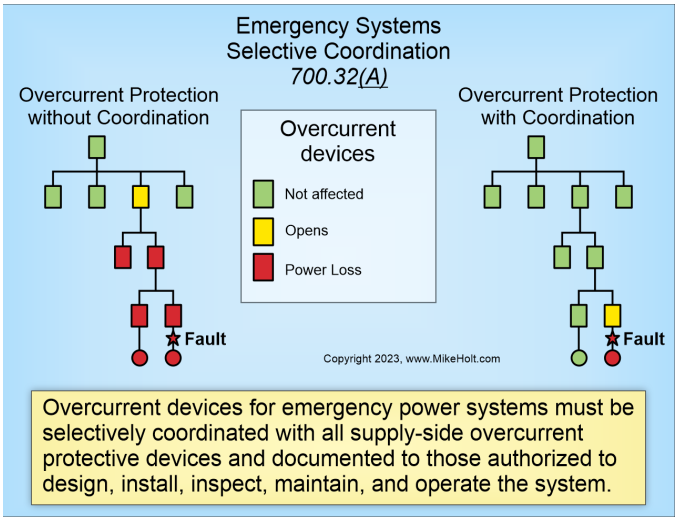
Part VI. Overcurrent Protection

700.30 Accessibility

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

700.32 Selective Coordination

(A) General. Overcurrent devices for emergency power systems must be selectively coordinated with all supply-side and load-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. ▸Figure 700–23



▸Figure 700–23

(B) Replacements. If emergency system overcurrent protective devices are replaced, they must be reevaluated to ensure that selective coordination is maintained.

(C) Modifications. If modifications, additions, or deletions to the emergency system(s) occur, selective coordination of the emergency system overcurrent protective devices must be re-evaluated.

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(C) for an example of how emergency system overcurrent protective devices (OCPDs) selectively coordinate with all supply-side OCPDs.

NEC Note Figure 700.32(C) 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

This article covers 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 is interrupted to aid in firefighting, rescue operations, control of health hazards, and similar operations. Many of these rules are outside of the scope of this material, however, some of the topics we cover include the following:

- Scope
- Commissioning and Maintenance
- Capacity and Rating
- Transfer Switches
- Wiring
- Sources of Power
- Selective Coordination

Article 701 consists of four parts:

- Part I. General
- Part II. Circuit Wiring
- Part III. Sources of Power
- Part IV. Overcurrent Protection

Part I. General

701.1 Scope

Article 701 covers 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 is interrupted. ▸Figure 701–1

According to Article 100, "Legally Required Standby Systems" are classified as legally required by a governmental agency, intended to automatically supply power to selected loads in the event of failure of the normal power source. ▸Figure 701–2

Note 4: Legally required standby systems typically supply loads such as heating and refrigeration systems, ventilation and smoke removal systems, sewage disposal, lighting systems, and industrial processes that, when stopped, could create hazards or hamper rescue or firefighting operations.

Author's Comment:

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

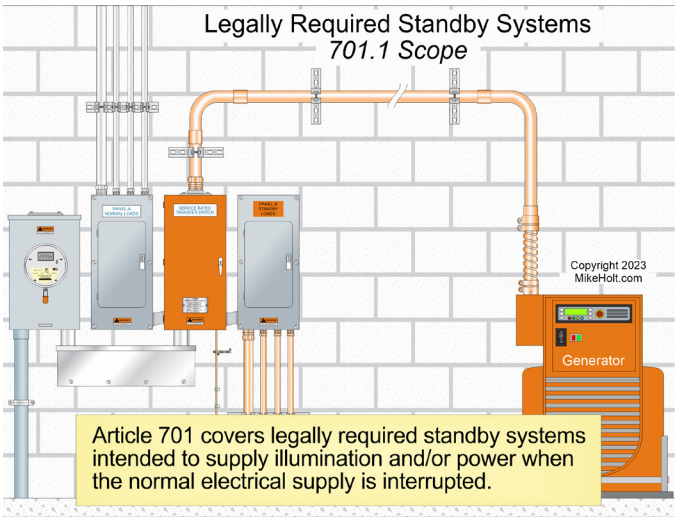


Figure 701–1

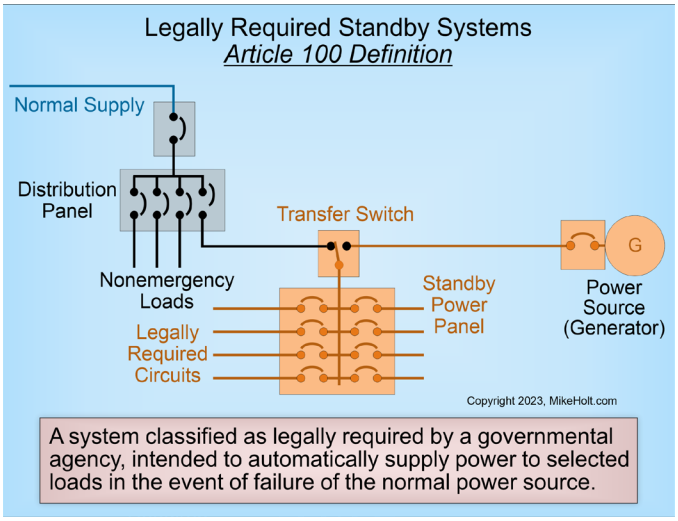


Figure 701–2

701.3 Commissioning and Maintenance

(A) Commissioning 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 the commissioning 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 Parts I through IV of Article 220 or by another approved method. The system capacity must be sufficient for the rapid load changes, and transient power and energy requirements associated with any expected loads.

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

701.5 Transfer Switches

(A) General. Transfer switches must be automatic, listed, and marked for emergency system or legally required standby system use. Meter-mounted transfer switches are not permitted for legally required standby system use.

(C) Automatic Transfer Switches. Automatic transfer switches must be able to be electrically operated and mechanically held.

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

701.6 Signals

Audible and visual signal devices must be installed where practicable for the purposes of:

(A) Malfunction Signals. To indicate a malfunction of the standby source of power.

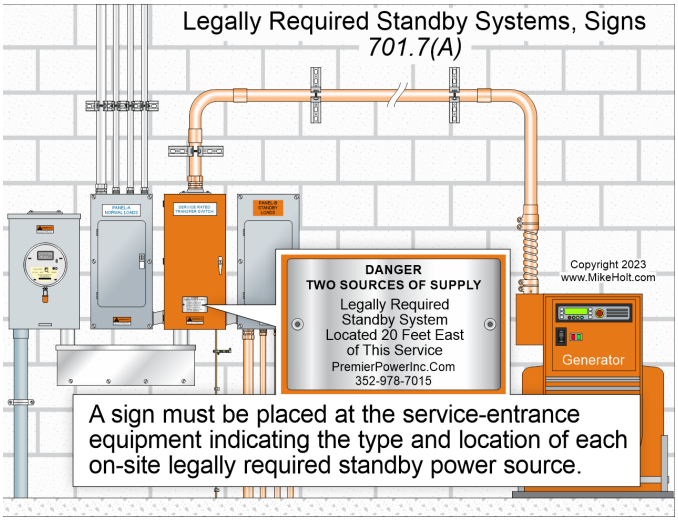
(B) Carrying Load Signals. To indicate that the standby source is carrying load.

(C) Battery Charging Malfunction Signals. To indicate that the battery charger is not functioning.

(D) Ground-Fault Signals. To indicate a ground fault in a 4-wire, three-phase, 277/480V wye-connected system rated 1000A or more.

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 701–3



▸Figure 701–3

Part II. Circuit Wiring

701.10 Wiring

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

Author's Comment:

- Unlike wiring for emergency systems, which must be kept entirely independent of other wiring, the wiring for legally required standby systems may be installed with other (normal) wiring because legally required standby system loads are not essential for life safety.

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*.

(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 power source.

(E) Stored-Energy Power Supply Systems.

(1) Types. Stored-energy power supply systems must consist of one the following types:

(1) Uninterruptible power supply

(2) Fuel cell system

(3) Energy storage system

(4) Storage battery

(5) Other approved equivalent stored energy sources that comply with 701.12

(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 the following additional requirements:

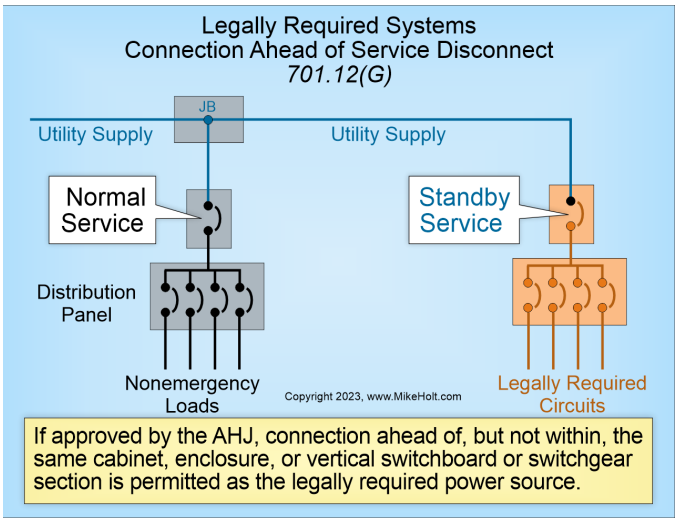
(1) Separate service conductors are installed from the electric utility.

(2) 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 remotely located 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 701–4



▸Figure 701–4

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

Part IV. Overcurrent Protection

701.30 Accessibility

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

701.32 Selective Coordination

(A) General. Overcurrent devices for legally required standby systems must be selectively coordinated with all supply-side and load-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.

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.

(B) Replacements. If legally required standby system overcurrent protective devices are replaced, they must be re-evaluated to ensure selective coordination is maintained.

(C) Modifications. If modifications, additions, or deletions to the legally required standby system(s) occur, selective coordination is required of the legally required system(s).

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

ARTICLE

702 OPTIONAL STANDBY SYSTEMS

Introduction to Article 702—Optional Standby Systems

This article covers the installation requirements for permanent and portable optional standby power systems intended to supply power where life safety does not depend on the system's performance. You will see these systems in facilities where the loss of electricity can cause economic loss, business interruptions, or personal inconvenience. Many of these rules are outside of the scope of this material, however, some of the topics we cover include the following:

- Capacity and Rating
- Interconnection or Transfer Equipment
- Wiring

Article 702 consists of two parts:

- Part I. General
- Part II. Wiring

Part I. General

702.1 Scope

Article 702 covers permanently installed and portable optional standby power systems. ▸Figure 702–1

According to Article 100, "Optional Standby System" is a system intended to supply power where life safety does not depend on the performance of the system. ▸Figure 702–2 and ▸Figure 702–3

Author's Comment:

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

▸Figure 702–1

- Article 702 also covers portable and trailer- or vehicle-mounted generators that might be used for a dwelling. ▸Figure 702–4

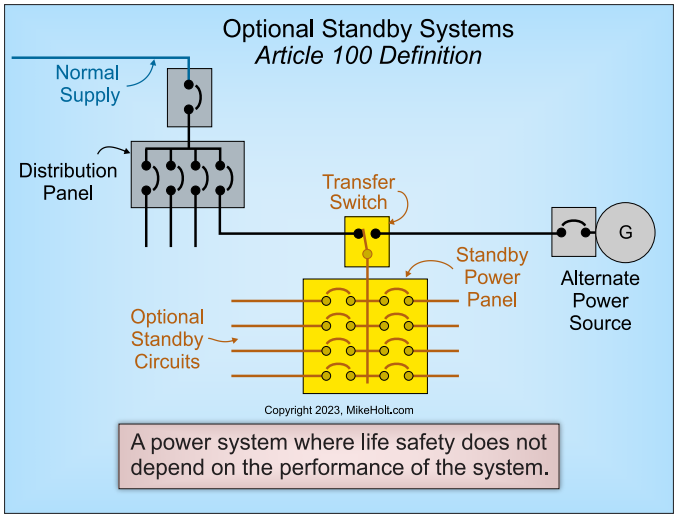


Figure 702–2

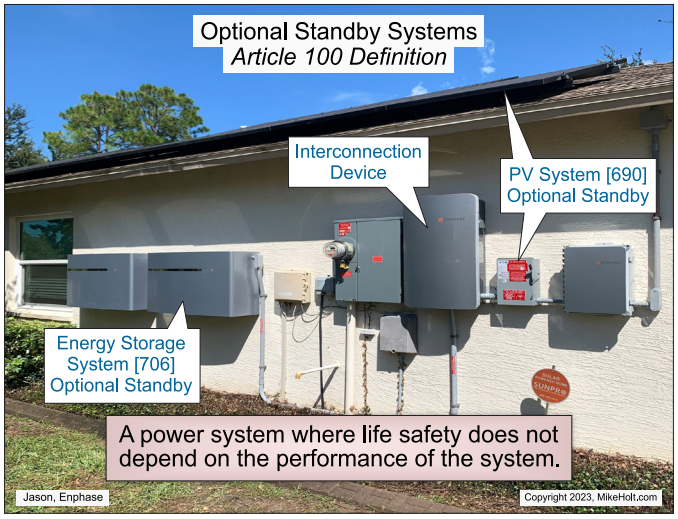


Figure 702–3

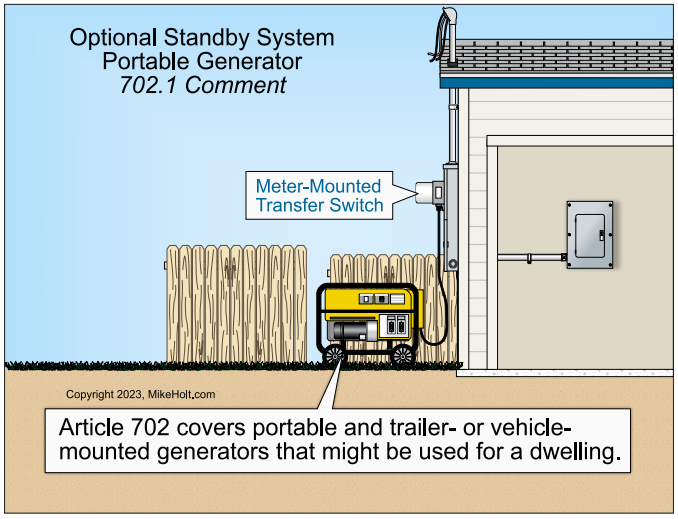


Figure 702–4

702.4 Capacity and Rating

(A) System Capacity.

(1) Manual and Nonautomatic Load Connection. If the connection of the loads to the optional standby system is manual or nonautomatic, the optional standby system must be sized to supply all the loads selected by the user intended to be operated at one time. Figure 702–5

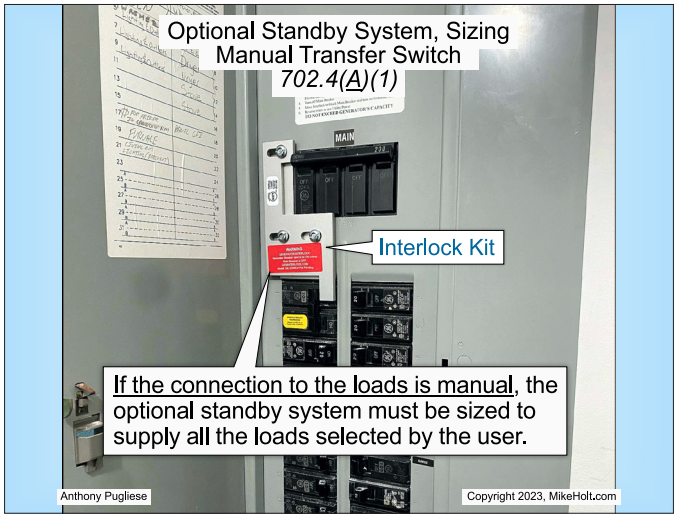


Figure 702–5

Note: Manual and nonautomatic transfer switches require human intervention.

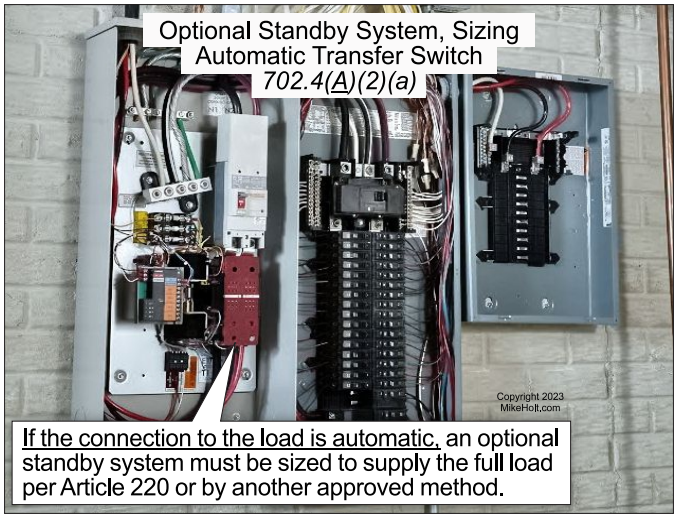
(2) Automatic Load Connection. If the connection for a load to the optional standby system is automatic, the optional standby system must be sized as follows:

(a) Full Load. The optional standby source must be capable of supplying the full load that is automatically connected as determined by Article 220 or another approved method. Figure 702–6

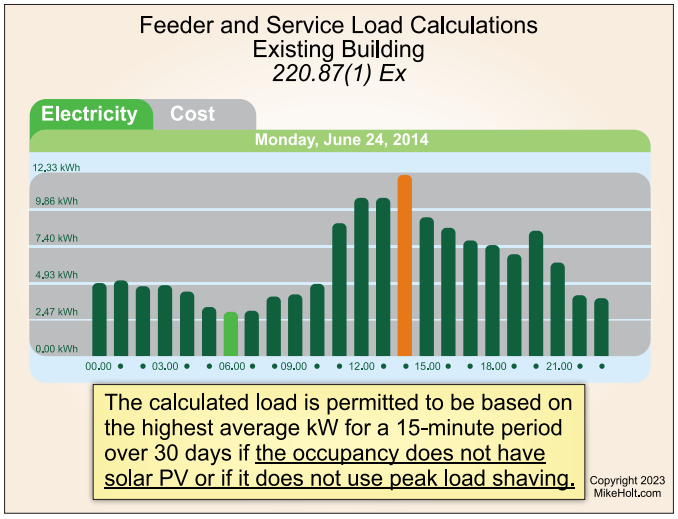
Author's Comment:

- For existing facilities, the 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 702–7

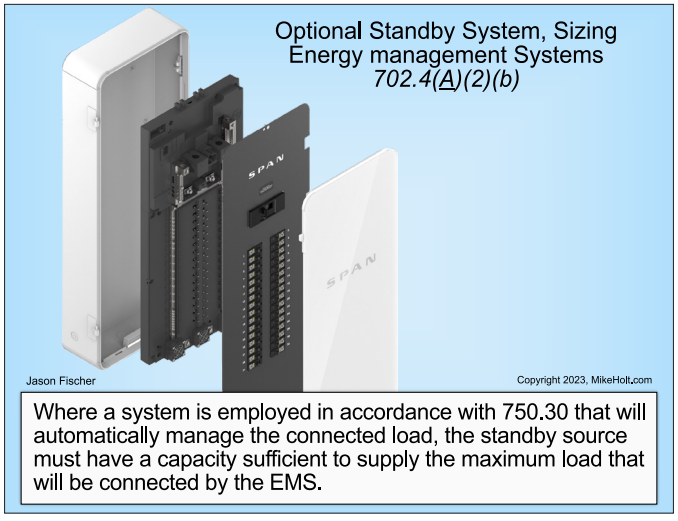
(b) Energy Management System (EMS). Where a system is employed in accordance with 750.30 that will automatically manage the connected load, the standby source must have a capacity sufficient to supply the maximum load that will be connected by the EMS. Figure 702–8



▸Figure 702–6



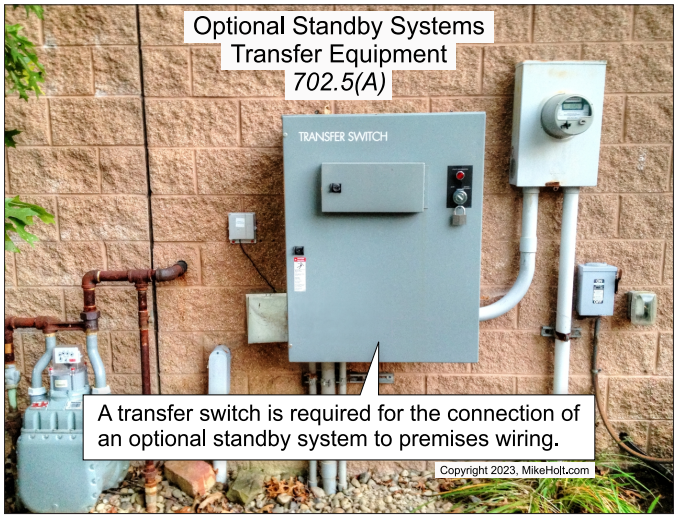
▸Figure 702–7



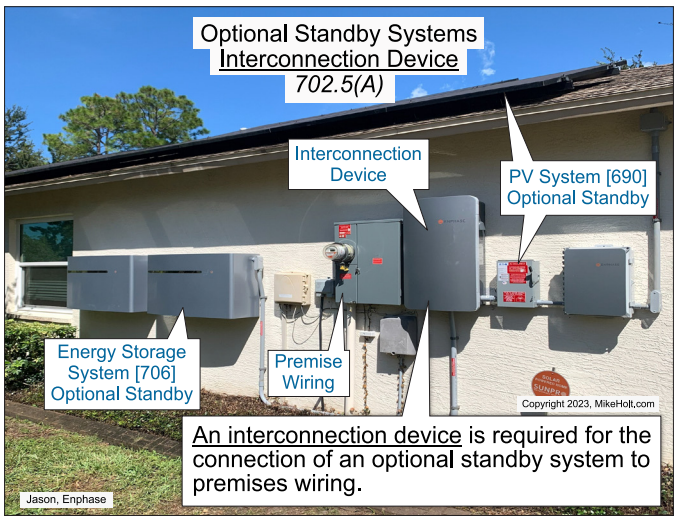
▸Figure 702–8

702.5 Interconnection Equipment or Transfer Equipment

(A) General. Interconnection equipment or a transfer equipment is required for the connection of an optional standby system to premises wiring. ▸Figure 702–9 and ▸Figure 702–10



▸Figure 702–9



▸Figure 702–10

According to Article 100, a "Transfer Switch" is an automatic or nonautomatic device used to transfer loads from one power source to another. ▸Figure 702–11

Interconnection equipment and transfer switch must be listed and installed to prevent the inadvertent interconnection of all sources of supply.

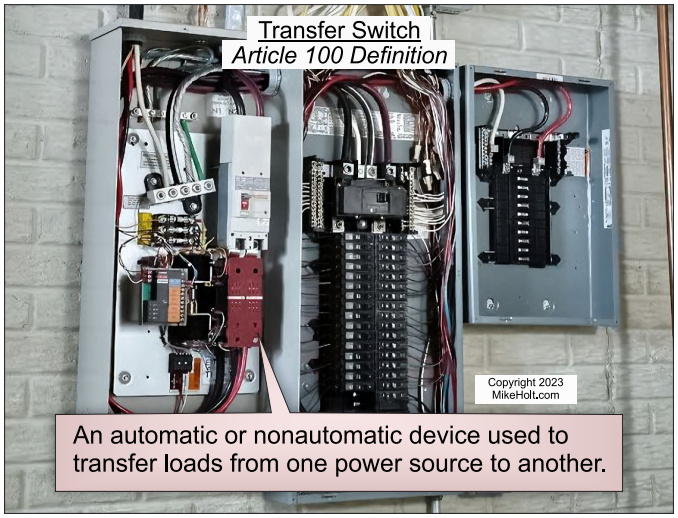


Figure 702–11

(B) Meter-Mounted Transfer Switches. A listed meter-mounted transfer switch installed between the electric utility meter and the meter enclosure in accordance with 230.82(11) must be listed. Figure 702–12

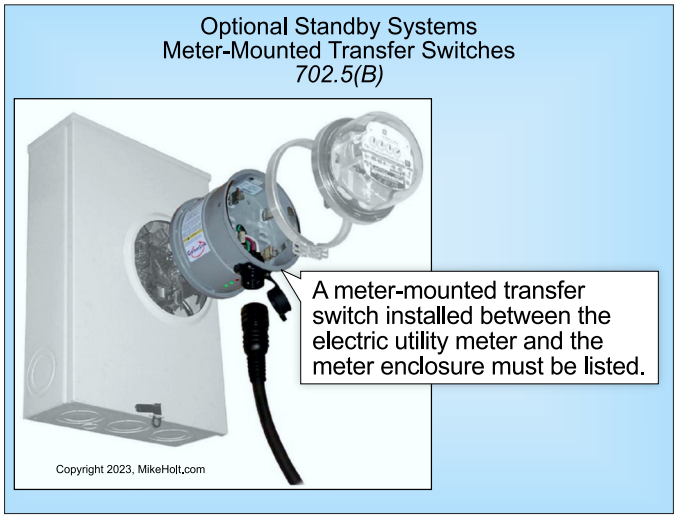


Figure 702–12

(C) Documentation. In other than dwelling units, the short-circuit current rating of the transfer equipment, based on the specific overcurrent protective device type and settings protecting the transfer equipment, must be field marked on the exterior of the transfer equipment.

(D) Parallel Installation. Optional standby systems installed in parallel with other power production sources must comply with Parts I or II of Article 705. Figure 702–13

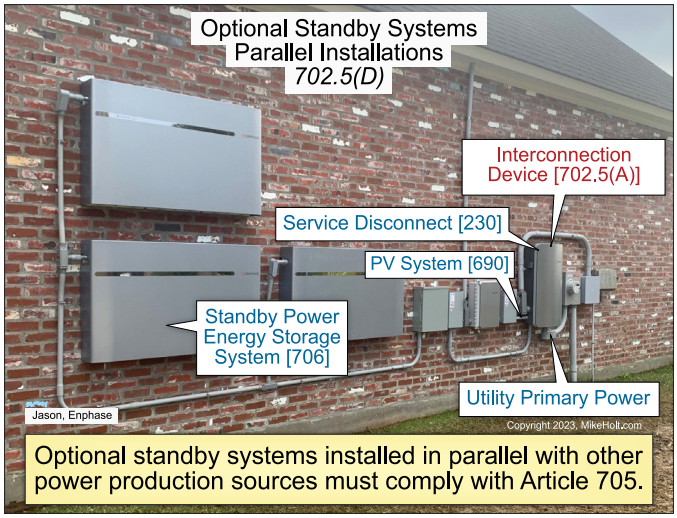


Figure 702–13

702.7 Signs

(A) Optional Power Sources.

Commercial and Industrial Installations. A sign indicating the location of each optional standby power system is required at the service disconnect. Figure 702–14

Figure 702–14

One- and Two-Family Dwellings. A sign indicating the location of the optional standby power system disconnect is required at the emergency shutoff disconnect [230.85]. Figure 702–15

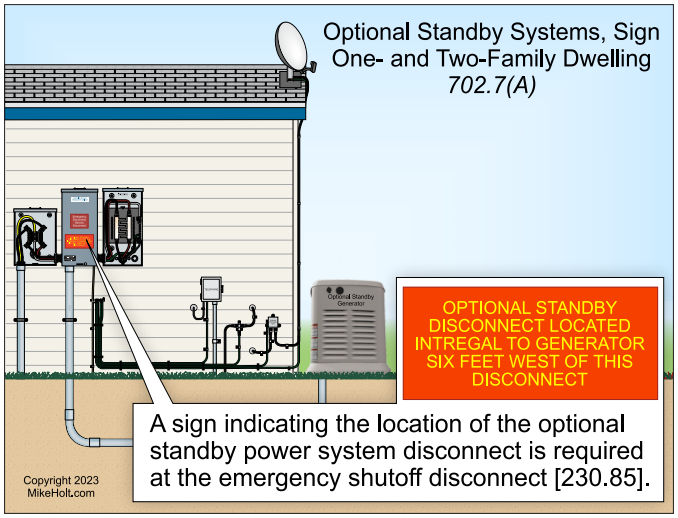


Figure 702–15

(C) Power Inlet. Where a power inlet is used for the connection of a portable generator, a warning sign must be placed near the power inlet to indicate the type of generator permitted to be connected to the inlet. The warning sign must state: Figure 702–16

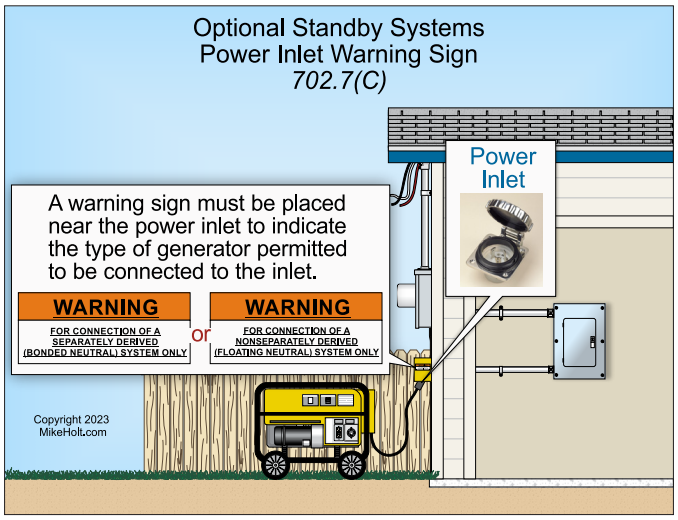


Figure 702–16

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, enclosures, and cabinets with other wiring.

702.12 Outdoor Generators

(B) Flanged Inlet. The flanged inlet for a portable generator must be located outside a building or structure. Figure 702–17

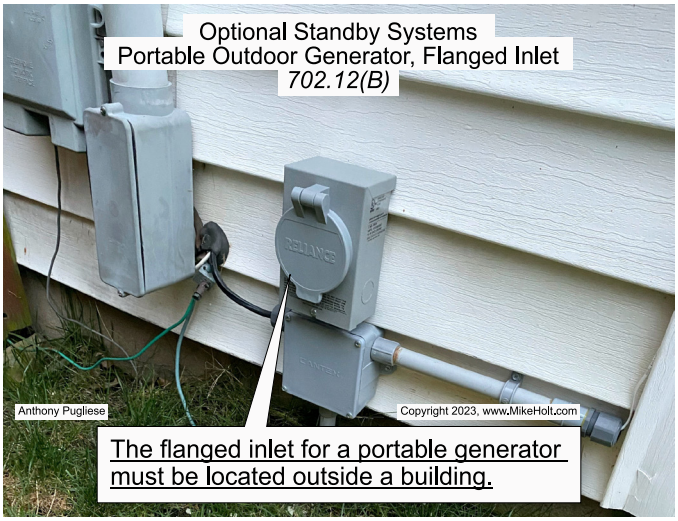


Figure 702–17

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