
**REVISION RECORD
FOR THE STATE OF CALIFORNIA
SUPPLEMENT**

July 1, 2018

2016 Title 24, Part 3, California Electrical Code

General Information:

1. The date of this supplement is for identification purposes only. See the History Note Appendix on the accompanying page.
2. This supplement is issued by the California Building Standards Commission in order to provide new and or replacement pages containing recently adopted provision for California Code of Regulations, Title 24, Part 3, of the 2016 California Electrical Code. Instructions are provided below.
3. Health and Safety Code Section 18938.5, establishes that only building standards in effect at the time of the application for a building permit may be applied to the project plans and construction. This rule applies to both adoptions of building standards for Title 24 by the California Building Standards Commission, and local adoptions and ordinances imposing building standards. The new building standards provided with the enclosed blue supplement pages must not be enforced before the effective date.
4. Not all code text on the enclosed blue supplement pages is a new building standard. New, amended, or repealed building standards are identified by margin symbols. An explanation of margin symbols is provided in the code before the Table of Contents.
5. You may wish to retain the superseded material with this revision record so that the prior wording of any section can be easily ascertained.

Title 24, Part 3

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ARTICLE 100 - DEFINITIONS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHDPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article							X	X					
Adopt Entire Article as amended (amended sections listed below)	X		X	X	X				X	X	X	X	
Adopt only those sections that are listed below													
Article / Section													
Coordination (Selective)									X	X	X	X	
<i>Ballasted Solar Photovoltaic System</i>	X		X	X	X								

ARTICLE 110 – REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHDPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article							X	X					
Adopt Entire Article as amended (amended sections listed below)	X		X	X	X				X	X	X	X	
Adopt only those sections that are listed below													
Article / Section													
110.2									X	X	X	X	
110.13(C)									X	X	X	X	
110.13 <i>Exception</i>	X		X	X	X								

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ARTICLE 200 - USE AND IDENTIFICATION OF GROUNDED CONDUCTORS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 210 – BRANCH CIRCUITS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X			X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)			X										
Adopt only those sections that are listed below													X
Article / Section													
210.12(A)			X										
210.50(D), (E)													X

ARTICLE 215 - FEEDERS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 220- BRANCH-CIRCUIT, FEEDER, AND SERVICE CALCULATIONS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X		X	X	X	
Adopt Entire Article as amended (amended sections listed below)									X				
Adopt only those sections that are listed below													
Article / Section													
Table 220.42									X				

ARTICLE 225 – OUTSIDE BRANCH CIRCUITS AND FEEDERS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHDP				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 230 - SERVICES

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHDP				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 240 – OVERCURRENT PROTECTION

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHDP				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 250 – GROUNDING AND BONDING

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHDP				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

Exception No. 2 to (5): For receptacles located in patient bed locations of general care or critical care areas of health care facilities other than those covered under 210.8(B)(1), GFCI protection shall not be required.

- (6) Indoor wet locations
- (7) Locker rooms with associated showering facilities
- (8) Garages, service bays, and similar areas other than vehicle exhibition halls and showrooms

(C) Boat Hoists. GFCI protection shall be provided for outlets not exceeding 240 volts that supply boat hoists installed in dwelling unit locations.

(D) Kitchen Dishwasher Branch Circuit. GFCI protection shall be provided for outlets that supply dishwashers installed in dwelling unit locations.

210.9 Circuits Derived from Autotransformers. Branch circuits shall not be derived from autotransformers unless the circuit supplied has a grounded conductor that is electrically connected to a grounded conductor of the system supplying the autotransformer.

Exception No. 1: An autotransformer shall be permitted without the connection to a grounded conductor where transforming from a nominal 208 volts to a nominal 240-volt supply or similarly from 240 volts to 208 volts.

Exception No. 2: In industrial occupancies, where conditions of maintenance and supervision ensure that only qualified persons service the installation, autotransformers shall be permitted to supply nominal 600-volt loads from nominal 480-volt systems, and 480-volt loads from nominal 600-volt systems, without the connection to a similar grounded conductor.

210.10 Ungrounded Conductors Tapped from Grounded Systems. Two-wire dc circuits and ac circuits of two or more ungrounded conductors shall be permitted to be tapped from the ungrounded conductors of circuits that have a grounded neutral conductor. Switching devices in each tapped circuit shall have a pole in each ungrounded conductor. All poles of multipole switching devices shall manually switch together where such switching devices also serve as a disconnecting means as required by the following:

- (1) 410.93 for double-pole switched lampholders
- (2) 410.104(B) for electric-discharge lamp auxiliary equipment switching devices
- (3) 422.31(B) for an appliance
- (4) 424.20 for a fixed electric space-heating unit
- (5) 426.51 for electric deicing and snow-melting equipment
- (6) 430.85 for a motor controller
- (7) 430.103 for a motor

210.11 Branch Circuits Required. Branch circuits for lighting and for appliances, including motor-operated appliances, shall be provided to supply the loads calculated in accordance with 220.10. In addition, branch circuits shall be provided for specific loads not covered by 220.10 where required elsewhere in this *Code* and for dwelling unit loads as specified in 210.11(C).

(A) Number of Branch Circuits. The minimum number of branch circuits shall be determined from the total calculated load and the size or rating of the circuits used. In all installations, the number of circuits shall be sufficient to supply the load served. In no case shall the load on any circuit exceed the maximum specified by 220.18.

(B) Load Evenly Proportioned Among Branch Circuits. Where the load is calculated on the basis of volt-amperes per square meter or per square foot, the wiring system up to and including the branch-circuit panelboard(s) shall be provided to serve not less than the calculated load. This load shall be evenly proportioned among multioutlet branch circuits within the panelboard(s). Branch-circuit overcurrent devices and circuits shall be required to be installed only to serve the connected load.

(C) Dwelling Units.

(1) Small-Appliance Branch Circuits. In addition to the number of branch circuits required by other parts of this section, two or more 20-ampere small-appliance branch circuits shall be provided for all receptacle outlets specified by 210.52(B).

(2) Laundry Branch Circuits. In addition to the number of branch circuits required by other parts of this section, at least one additional 20-ampere branch circuit shall be provided to supply the laundry receptacle outlet(s) required by 210.52(F). This circuit shall have no other outlets.

(3) Bathroom Branch Circuits. In addition to the number of branch circuits required by other parts of this section, at least one 120-volt, 20-ampere branch circuit shall be provided to supply a bathroom receptacle outlet(s). Such circuits shall have no other outlets.

Exception: Where the 20-ampere circuit supplies a single bathroom, outlets for other equipment within the same bathroom shall be permitted to be supplied in accordance with 210.23(A)(1) and (A)(2).

210.12 Arc-Fault Circuit-Interrupter Protection. Arc-fault circuit-interrupter protection shall be provided as required in 210.12(A) (B), and (C). The arc-fault circuit interrupter shall be installed in a readily accessible location.

(A) Dwelling Units. All 120-volt, single-phase, 15- and 20-ampere branch circuits supplying outlets or devices installed in dwelling unit kitchens, family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, laundry areas, or similar rooms or areas shall be protected by any of the means described in 210.12(A)(1) through (6):

- (1) A listed combination-type arc-fault circuit interrupter, installed to provide protection of the entire branch circuit
- (2) A listed branch/feeder-type AFCI installed at the origin of the branch-circuit in combination with a listed outlet branch-circuit type arc-fault circuit interrupter installed at the first outlet box on the branch circuit. The first outlet box in the branch circuit shall be marked to indicate that it is the first outlet of the circuit.
- (3) A listed supplemental arc protection circuit breaker installed at the origin of the branch circuit in combination with a listed outlet branch-circuit type arc-fault circuit interrupter installed at the first outlet box on the branch circuit where all of the following conditions are met:
 - a. The branch-circuit wiring shall be continuous from the branch-circuit overcurrent device to the outlet branch-circuit arc-fault circuit interrupter.
 - b. The maximum length of the branch-circuit wiring from the branch-circuit overcurrent device to the first outlet shall not exceed 15.2 m (50 ft) for a 14 AWG conductor or 21.3 m (70 ft) for a 12 AWG conductor.
 - c. The first outlet box in the branch circuit shall be marked to indicate that it is the first outlet of the circuit.
- (4) A listed outlet branch-circuit type arc-fault circuit interrupter installed at the first outlet on the branch circuit in combination with a listed branch-circuit overcurrent protective device where all of the following conditions are met:
 - a. The branch-circuit wiring shall be continuous from the branch-circuit overcurrent device to the outlet branch-circuit arc-fault circuit interrupter.
 - b. The maximum length of the branch-circuit wiring from the branch-circuit overcurrent device to the first outlet shall not exceed 15.2 m (50 ft) for a 14 AWG conductor or 21.3 m (70 ft) for a 12 AWG conductor.
 - c. The first outlet box in the branch circuit shall be marked to indicate that it is the first outlet of the circuit.
 - d. The combination of the branch-circuit overcurrent device and outlet branch-circuit AFCI shall be identified as meeting the requirements for a system combination-type AFCI and shall be listed as such.
- (5) If RMC, IMC, EMT, Type MC, or steel-armored Type AC cables meeting the requirements of 250.118, metal wireways, metal auxiliary gutters, and metal outlet and junction boxes are installed for the portion of the branch circuit between the branch-circuit overcurrent device and the first outlet, it shall be permitted to install a listed outlet branch-circuit

type AFCI at the first outlet to provide protection for the remaining portion of the branch circuit.

- (6) Where a listed metal or nonmetallic conduit or tubing or Type MC cable is encased in not less than 50 mm (2 in.) of concrete for the portion of the branch circuit between the branch-circuit overcurrent device and the first outlet, it shall be permitted to install a listed outlet branch-circuit type AFCI at the first outlet to provide protection for the remaining portion of the branch circuit.

Exception: Where an individual branch circuit to a fire alarm system installed in accordance with 760.41(B) or 760.121(B) is installed in RMC, IMC, EMT, or steel-sheathed cable, Type AC or Type MC, meeting the requirements of 250.118, with metal outlet and junction boxes, AFCI protection shall be permitted to be omitted.

Informational Note No. 1: For information on combination-type and branch/feeder-type arc-fault circuit interrupters, see UL 1699-2011, *Standard for Arc-Fault Circuit Interrupters*. For information on outlet branch-circuit type arc-fault circuit interrupters, see UL Subject 1699A, *Outline of Investigation for Outlet Branch Circuit Arc-Fault Circuit-Interrupters*. For information on system combination AFCIs, see UL Subject 1699C, *Outline of Investigation for System Combination Arc-Fault Circuit Interrupters*.

Informational Note No. 2: See 29.6.3(5) of *NFPA 72-2013 2016, National Fire Alarm and Signaling Code*, for information related to secondary power-supply requirements for smoke alarms installed in dwelling units.

Informational Note No. 3: See 760.41(B) and 760.121(B) for power-supply requirements for fire alarm systems.

(B) Branch Circuit Extensions or Modifications — Dwelling Units. In any of the areas specified in 210.12(A), where branch-circuit wiring is modified, replaced, or extended, the branch circuit shall be protected by one of the following:

- (1) A listed combination-type AFCI located at the origin of the branch circuit
- (2) A listed outlet branch-circuit type AFCI located at the first receptacle outlet of the existing branch circuit

Exception: AFCI protection shall not be required where the extension of the existing conductors is not more than 1.8 m (6 ft) and does not include any additional outlets or devices.

(C) Dormitory Units. All 120-volt, single-phase, 15- and 20-ampere branch circuits supplying outlets installed in dormitory unit bedrooms, living rooms, hallways, closets, and similar rooms shall be protected by a listed arc-fault circuit interrupter meeting the requirements of 210.12(A)(1) through (6) as appropriate.

ARTICLE 358 – ELECTRICAL METALLIC TUBING: TYPE EMT

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 360 – FLEXIBLE METALLIC TUBING: TYPE FMT

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 362 – ELECTRICAL NONMETALLIC TUBING: TYPE ENT

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X			X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)			X										
Adopt only those sections that are listed below													
Article / Section													
362.10			X										

ARTICLE 366 – AUXILIARY GUTTERS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 368 – BUSWAYS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHDP				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 370 – CABLEBUS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHDP				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 372 – CELLULAR CONCRETE FLOOR RACEWAYS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHDP				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 374 – CELLULAR METAL FLOOR RACEWAYS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHDP				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

360.12 Uses Not Permitted. FMT shall not be used as follows:

- (1) In hoistways
- (2) In storage battery rooms
- (3) In hazardous (classified) locations unless otherwise permitted under other articles in this Code
- (4) Underground for direct earth burial, or embedded in poured concrete or aggregate
- (5) Where subject to physical damage
- (6) In lengths over 1.8 m (6 ft)

360.20 Size.

(A) Minimum. FMT smaller than metric designator 16 (trade size 1/2) shall not be used.

Exception No. 1: FMT of metric designator 12 (trade size 3/8) shall be permitted to be installed in accordance with 300.22(B) and (C).

Exception No. 2: FMT of metric designator 12 (trade size 3/8) shall be permitted in lengths not in excess of 1.8 m (6 ft) as part of a listed assembly or for luminaires. See 410.117(C).

(B) Maximum. The maximum size of FMT shall be metric designator 21 (trade size 3/4).

Informational Note: See 300.1(C) for the metric designators and trade sizes. These are for identification purposes only and do not relate to actual dimensions.

360.22 Number of Conductors.

(A) FMT — Metric Designators 16 and 21 (Trade Sizes 1/2 and 3/4). The number of conductors in metric designators 16 (trade size 1/2) and 21 (trade size 3/4) shall not exceed that permitted by the percentage fill specified in Table 1, Chapter 9.

Cables shall be permitted to be installed where such use is not prohibited by the respective cable articles. The number of cables shall not exceed the allowable percentage fill specified in Table 1, Chapter 9.

(B) FMT — Metric Designator 12 (Trade Size 3/8). The number of conductors in metric designator 12 (trade size 3/8) shall not exceed that permitted in Table 348.22.

360.24 Bends.

(A) Infrequent Flexing Use. When FMT is infrequently flexed in service after installation, the radii of bends measured to the inside of the bend shall not be less than specified in Table 360.24(A).

Table 360.24(A) Minimum Radii for Flexing Use

Metric Designator	Trade Size	Minimum Radii for Flexing Use	
		mm	in.
12	3/8	254.0	10
16	1/2	317.5	12½
21	3/4	444.5	17½

(B) Fixed Bends. Where FMT is bent for installation purposes and is not flexed or bent as required by use after installation, the radii of bends measured to the inside of the bend shall not be less than specified in Table 360.24(B).

Table 360.24(B) Minimum Radii for Fixed Bends

Metric Designator	Trade Size	Minimum Radii for Fixed Bends	
		mm	in.
12	3/8	88.9	3½
16	1/2	101.6	4
21	3/4	127.0	5

360.56 Splices and Taps. Splices and taps shall be made in accordance with 300.15.

360.60 Grounding. FMT shall be permitted as an equipment grounding conductor where installed in accordance with 250.118(7).

III. Construction Specifications

360.120 Marking. FMT shall be marked according to 110.21.

ARTICLE 362
Electrical Nonmetallic Tubing: Type ENT

I. General

362.1 Scope. This article covers the use, installation, and construction specifications for electrical nonmetallic tubing (ENT) and associated fittings.

362.2 Definition.

Electrical Nonmetallic Tubing (ENT). A nonmetallic, pliable, corrugated raceway of circular cross section with integral or associated couplings, connectors, and fittings for the installation of electrical conductors. ENT is composed of a material that is resistant to moisture and chemical atmospheres and is flame retardant. A pliable raceway is a raceway that can be bent by hand with a reasonable force but without other assistance.

362.6 Listing Requirements. ENT and associated fittings shall be listed.

II. Installation

362.10 Uses Permitted. For the purpose of this article, the first floor of a building shall be that floor that has 50 percent or more of the exterior wall surface area level with or above finished grade. One additional level that is the first level and not designed for human habitation and used only for vehicle parking, storage, or similar use shall be permitted. The use of ENT and fittings shall be permitted in the following:

- (1) In any building not exceeding three floors above grade as follows:
 - a. For exposed work, where not prohibited by 362.12
 - b. Concealed within walls, floors, and ceilings
- (2) In any building exceeding three floors above grade, ENT shall be concealed within walls, floors, and ceilings where the walls, floors, and ceilings provide a thermal barrier of material that has at least a 15-minute finish rating as identified in listings of fire-rated assemblies. The 15-minute-finish-rated thermal barrier shall be permitted to be used for combustible or noncombustible walls, floors, and ceilings.

Exception to (2): Where a fire sprinkler system(s) is installed in accordance with NFPA 13-~~2013~~ 2016, Standard for the Installation of Sprinkler Systems, on all floors, ENT shall be permitted to be used within walls, floors, and ceilings, exposed or concealed, in buildings exceeding three floors abovegrade.

Informational Note: A finish rating is established for assemblies containing combustible (wood) supports. The finish rating is defined as the time at which the wood stud or wood joist reaches an average temperature rise of 121°C (250°F) or an individual temperature of 163°C (325°F) as measured on the plane of the wood nearest the fire. A finish rating is not intended to represent a rating for a membrane ceiling.

- (3) In locations subject to severe corrosive influences as covered in 300.6 and where subject to chemicals for which the materials are specifically approved.
- (4) In concealed, dry, and damp locations not prohibited by 362.12.
- (5) Above suspended ceilings where the suspended ceilings provide a thermal barrier of material that has at least a 15-minute finish rating as identified in listings of fire-rated assemblies, except as permitted in 362.10(1)(a).

Exception to (5): ENT shall be permitted to be used above suspended ceilings in buildings exceeding three floors above grade where the building is protected throughout by a fire sprinkler system installed in accordance with NFPA 13-~~2013~~ 2016, Standard for the Installation of Sprinkler Systems.

- (6) Encased in poured concrete, or embedded in a concrete slab on grade where ENT is placed on sand or approved screenings, provided fittings identified for this purpose are used for connections.
 - (7) For wet locations indoors as permitted in this section or in a concrete slab on or belowgrade, with fittings listed for the purpose.
 - (8) Metric designator 16 through 27 (trade size ½ through 1) as listed manufactured prewired assembly.
- Informational Note: Extreme cold may cause some types of nonmetallic conduits to become brittle and therefore more susceptible to damage from physical contact.
- (9) Conductors or cables rated at a temperature higher than the listed temperature rating of ENT shall be permitted to be installed in ENT, if the conductors or cables are not operated at a temperature higher than the listed temperature rating of the ENT.

362.12 Uses Not Permitted. ENT shall not be used in the following:

- (1) In any hazardous (classified) location, except as permitted by other articles in this Code
- (2) For the support of luminaires and other equipment
- (3) Where subject to ambient temperatures in excess of 50°C (122°F) unless listed otherwise
- (4) For direct earth burial
- (5) Where the voltage is over 600 volts
- (6) In exposed locations, except as permitted by 362.10(1), 362.10(5), and 362.10(7)
- (7) In theaters and similar locations, except as provided in 518.4 and 520.5
- (8) Where exposed to the direct rays of the sun, unless identified as sunlight resistant
- (9) Where subject to physical damage

362.20 Size.

(A) Minimum. ENT smaller than metric designator 16 (trade size ½) shall not be used.

(B) Maximum. ENT larger than metric designator 53 (trade size 2) shall not be used.

Informational Note: See 300.1(C) for the metric designators and trade sizes. These are for identification purposes only and do not relate to actual dimensions.

362.22 Number of Conductors. The number of conductors shall not exceed that permitted by the percentage fill in Table 1, Chapter 9.

ARTICLE 511 – COMMERCIAL GARAGES, REPAIR AND STORAGE

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 513 – AIRCRAFT HANGARS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 514 – MOTOR FUEL DISPENSING FACILITIES

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 515 – BULK STORAGE PLANTS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 516 – SPRAY APPLICATION, DIPPING, COATING, AND PRINTING PROCESSES USING FLAMMABLE OR COMBUSTIBLE MATERIAL

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 517 – HEALTH CARE FACILITIES

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article							X	X					
Adopt Entire Article as amended (amended sections listed below)			X						X	X	X	X	
Adopt only those sections that are listed below													
Article / Section													
517.2									X	X	X	X	
517.4			X						X	X		X	
517.10.1									X	X	X	X	
517.12(A)									X	X		X	
517.18(A) w/Exc. 2 & 2.1									X	X	X	X	
517.18(B) Exc. 1									X	X	X	X	
517.18(B) Exc. 3									X	X	X		
517.18(B) Exc. 4									X				
517.18(D)									X	X		X	
517.22			X						X	X	X	X	
517.22(A), (C), & (D)									X	X	X	X	
517.22(B)									X	X	X	X	
517.22(B)(1)									X		X	X	
517.22(B)(2)										X			
517.24									X	X	X	X	
517.26									X	X	X	X	
517.30(A)									X	X	X	X	
517.30(B)(3)									X		X	X	
517.30(B)(5)									X	X	X	X	
517.30(D.1)									X	X	X	X	
517.30(E)									X			X	
517.33(A)(5)			X						X	X		X	
517.33(A)(7)			X										
517.33(A)(8)j. – n.									X				
517.33(A)(10)									X	X	X	X	
517.33(A)(11)									X			X	
517.34(A)(9)									X	X	X	X	
517.34(A)(10)									X	X	X	X	
517.34(B)(1.1)									X			X	
517.35(B)(4)			X						X	X		X	
517.35(C)									X	X			
517.40(A.1)									X	X		X	
517.41(B)									X	X		X	
517.41(E)										X		X	
517.42(C.3)			X						X	X		X	
517.42(C.3) With Exc.									X	X		X	
517.43(A)(6), (7)									X	X		X	
517.43(A)(8)									X	X	X	X	
517.43(A)(9)									X	X	X	X	
517.43(B)(1.1)									X	X		X	
517.44(B.1) w/Exc. 1									X	X		X	
517.44(B.1) Exc. 2			X						X	X		X	
517.45(D.1)									X	X	X	X	
517.45(E)											X	X	
517.45(F)									X		X	X	
517.45(G)									X	X	X	X	
517.123			X						X	X	X	X	
517.124									X			X	

1. This state agency adopts the entire article as amended except for those sections indicated by the following symbol: †

(B) Patient Bed Location Receptacles. Each patient bed location shall be provided with a minimum of eight receptacles. They shall be permitted to be of the single, duplex, or quadruplex type or any combination of the three. All receptacles shall be listed “hospital grade” and shall be so identified. The grounding terminal of each receptacle shall be connected to an insulated copper equipment grounding conductor sized in accordance with Table 250.122.

Exception No. 1: The requirements of 517.18(B) shall not apply to psychiatric, substance abuse, and rehabilitation hospitals meeting the requirements of 517.10(B)(2). [OSHPD 1, 2, 3, & 4] Section 517.10.1 Exception.

Exception No. 2: Psychiatric security rooms shall not be required to have receptacle outlets installed in the room.

Exception No. 3: [OSHPD 1, 2, & 3] Hospital grade receptacles shall not be required in patient sleeping areas in nursing homes.

Informational Note: It is not intended that there be a total, immediate replacement of existing non-hospital grade receptacles. It is intended, however, that non-hospital grade receptacles be replaced with hospital grade receptacles upon modification of use, renovation, or as existing receptacles need replacement.

Exception No. 4: [OSHPD 1] Psychiatric patient bedrooms shall not be required to have receptacle outlets installed in the room. If installed, the receptacles shall be tamper-resistant, controlled by a switch outside the room that is under the control of staff, and shall be protected by a ground-fault circuit interrupter.

(C) Designated General Care Pediatric Locations. Receptacles that are located within the patient rooms, bathrooms, playrooms, and activity rooms of pediatric units, other than nurseries, shall be listed tamper-resistant or shall employ a listed tamper-resistant cover. [99:6.3.2.2.6.2(F)]

(D) [OSHPD 1, 2, & 4] Nursery receptacles. One duplex receptacle shall be provided for every two bassinets.

517.19 Critical Care Areas.

(A) Patient Bed Location Branch Circuits. Each patient bed location shall be supplied by at least two branch circuits, one or more from the critical branch and one or more circuits from the normal system. At least one branch circuit from the critical branch shall supply an outlet(s) only at that bed location. All branch circuits from the normal system shall be from a single panelboard. Critical branch receptacles shall be identified and shall also indicate the panelboard and circuit number supplying them.

The branch circuit serving patient bed locations shall not be part of a multiwire branch circuit.

Exception No. 1: Branch circuits serving only special-purpose receptacles or equipment in critical care spaces shall be permitted to be served by other panelboards.

Exception No. 2: Critical care space served from two separate critical branch transfer switches shall not be required to have circuits from the normal system.

(B) Patient Bed Location Receptacles.

(1) Minimum Number and Supply. Each patient bed location shall be provided with a minimum of 14 receptacles, at least one of which shall be connected to either of the following:

- (1) The normal system branch circuit required in 517.19(A)
- (2) A critical branch circuit supplied by a different transfer switch than the other receptacles at the same patient bed location

(2) Receptacle Requirements. The receptacles required in 517.19(B)(1) shall be permitted to be single, duplex, or quadruplex type or any combination thereof. All receptacles shall be listed “hospital grade” and shall be so identified. The grounding terminal of each receptacle shall be connected to the reference grounding point by means of an insulated copper equipment grounding conductor.

(C) Operating Room Receptacles.

(1) Minimum Number and Supply. Each operating room shall be provided with a minimum of 36 receptacles, at least 12 of which shall be connected to either of the following:

- (1) The normal system branch circuit required in 517.19(A)
- (2) A critical branch circuit supplied by a different transfer switch than the other receptacles at the same location

(2) Receptacle Requirements. The receptacles required in 517.19(C)(1) shall be permitted to be of the single or duplex types or a combination of both.

All receptacles shall be listed hospital grade and so identified. The grounding terminal of each receptacle shall be connected to the reference grounding point by means of an insulated copper equipment grounding conductor.

(D) Patient Care Vicinity Grounding and Bonding (Optional).

A patient care vicinity shall be permitted to have a patient equipment grounding point. The patient equipment grounding point, where supplied, shall be permitted to contain one or more listed grounding and bonding jacks. An equipment bonding jumper not smaller than 10 AWG shall be used to connect the grounding terminal of all grounding-type receptacles to the patient equipment grounding point. The bonding conductor shall be permitted to be arranged centrally or looped as convenient.

Informational Note: Where there is no patient equipment grounding point, it is important that the distance between the reference grounding point and the patient care vicinity be as short as possible to minimize any potential differences.

(E) Equipment Grounding and Bonding. Where a grounded electrical distribution system is used and metal feeder raceway or Type MC or MI cable that qualifies as an equipment grounding conductor in accordance with 250.118 is installed, grounding of enclosures and equipment, such as panelboards, switchboards, and switchgear, shall be ensured by one of the following bonding means at each termination or junction point of the metal raceway or Type MC or MI cable:

- (1) A grounding bushing and a continuous copper bonding jumper, sized in accordance with 250.122, with the bonding jumper connected to the junction enclosure or the ground bus of the panel
- (2) Connection of feeder raceways or Type MC or MI cable to threaded hubs or bosses on terminating enclosures
- (3) Other approved devices such as bonding-type locknuts or bushings

C
A

C
A
C

C
A

(F) Additional Protective Techniques in Critical Care Spaces (Optional). Isolated power systems shall be permitted to be used for critical care spaces, and, if used, the isolated power system equipment shall be listed as isolated power equipment. The isolated power system shall be designed and installed in accordance with 517.160.

Exception: The audible and visual indicators of the line isolation monitor shall be permitted to be located at the nursing station for the area being served.

(G) Isolated Power System Equipment Grounding. Where an isolated ungrounded power source is used and limits the first-fault current to a low magnitude, the equipment grounding conductor associated with the secondary circuit shall be permitted to be run outside of the enclosure of the power conductors in the same circuit.

Informational Note: Although it is permitted to run the grounding conductor outside of the conduit, it is safer to run it with the power conductors to provide better protection in case of a second ground fault.

(H) Special-Purpose Receptacle Grounding. The equipment grounding conductor for special-purpose receptacles, such as the operation of mobile X-ray equipment, shall be extended to the reference grounding points of branch circuits for all locations likely to be served from such receptacles. Where such a circuit is served from an isolated ungrounded system, the grounding conductor shall not be required to be run with the power conductors; however, the equipment grounding terminal of the special-purpose receptacle shall be connected to the reference grounding point.

517.20 Wet Procedure Locations.

(A) Receptacles and Fixed Equipment. Wet procedure location patient care areas shall be provided with special protection against electric shock by one of the following means:

- (1) Power distribution system that inherently limits the possible ground-fault current due to a first fault to a low value, without interrupting the power supply
- (2) Power distribution system in which the power supply is interrupted if the ground-fault current does, in fact, exceed a value of 6 mA

Exception: Branch circuits supplying only listed, fixed, therapeutic and diagnostic equipment shall be permitted to be supplied from a grounded service, single- or 3-phase system, provided that

(a) Wiring for grounded and isolated circuits does not occupy the same raceway, and

(b) All conductive surfaces of the equipment are connected to an insulated copper equipment grounding conductor.

(B) Isolated Power Systems. Where an isolated power system is utilized, the isolated power equipment shall be listed as isolated power equipment, and the isolated power system shall be designed and installed in accordance with 517.160.

Informational Note: For requirements for installation of therapeutic pools and tubs, see Part VI of Article 680.

517.21 Ground-Fault Circuit-Interrupter Protection for Personnel. Ground-fault circuit-interrupter protection for

personnel shall not be required for receptacles installed in those critical care areas where the toilet and basin are installed within the patient room.

517.22 [OSHPD 1, 2, 3 & 4] Artificial Lighting.

(A) Rooms and Passageways. All rooms and passageways shall be provided with artificial illumination.

(B) Illumination.

(1) [OSHPD 1, 3 & 4] Illumination intensity. Illumination intensity values in each area shall meet the recommended values in the latest edition of the Illuminating Engineering Society of North America (IESNA) Lighting Handbook.

(2) [OSHPD 2] Minimum illuminance. Minimum maintained average illuminance in each area shall meet the recommended values in the latest edition of ANSI/IESNA RP-28, Recommended Practice for Lighting and the Visual Environment for Senior Living.

(C) Lamp Protection. Lamps in fixtures shall be protected against accidental breakage by means of an enclosing lens or diffuser.

Exception No. 1: Open bottom luminaries with a maximum opening or cell size of 64 square inches if the lamp is completely recessed above the ceiling or enclosure in accordance with its listing.

Exception No. 2: Wall mounted night lights with louvered covers with a maximum opening or cell size of 64 square inches provided they are completely recessed in the wall or enclosure in accordance with its listing.

Exception No. 3: Wire guards or plastic tube guards in service areas such as electrical rooms, equipment rooms, and janitor closets.

(D) Special Locations.

(1) The general illumination fixtures in nurseries, central sterilizing rooms, treatment rooms, surgical suites, intensive care units, recovery rooms, obstetrical suites, emergency rooms, and laboratories shall be smooth and easily cleanable.

(2) Lighting in intensive care nurseries shall be controlled by a dimmer or other means of multiple switching to provide varied lighting intensities. Lighting shall have the ability to provide 100 footcandles at each infant bed location when needed.

(3) Individual bed area lighting in intensive care and coronary care units shall be controlled by a dimmer or other means of multiple switching, to provide varied lighting intensities.

(4) Where a psychiatric care area is identified in the Patient Safety Risk Assessment as high- or medium-risk, lighting shall be tamper-resistant.

(5) Acute psychiatric patient bedrooms shall have general lighting and night lighting with at least one nightlight fixture in each bedroom that shall be controlled at the room entrance.

(6) Corridors in psychiatric nursing units shall have general illumination with provisions for reducing light levels at night.

517.24 [OSHPD 1, 2, 3, & 4] Mobile Medical Facilities.

(A) Feeder. The feeder shall be sized in accordance with the requirements of Article 220.

(B) Service Receptacle. The service receptacle shall be listed and rated for its use.

(C) Disconnect. A disconnecting means listed and rated for its use shall be located adjacent to and within sight of the service receptacle. It shall be capable of simultaneously disconnecting the ungrounded conductors which supply the service receptacle

III. Essential Electrical System

517.25 Scope. The essential electrical system for these facilities shall comprise a system capable of supplying a limited amount of lighting and power service, which is considered essential for life safety and orderly cessation of procedures during the time normal electrical service is interrupted for any reason. This includes clinics, medical and dental offices, outpatient facilities, nursing homes, limited care facilities, hospitals, and other health care facilities serving patients.

Informational Note: For information on the need for an essential electrical system, see NFPA 99-2012, *Health Care Facilities Code*.

517.26 Application of Other Articles. The life safety branch, [OSHPD 1, 2, 3, & 4] critical branch, and equipment branch of the essential electrical system shall meet the requirements of Article 700, except as amended by Article 517.

Informational Note No. 1: For additional information, see NFPA 110-2013, *Standard for Emergency and Standby Power Systems*.

Informational Note No. 2: For additional information, see 517.30 and NFPA 99-2012, *Health Care Facilities Code*.

517.30 Essential Electrical Systems for Hospitals.

(A) Applicability. The requirements of Part III, 517.30 through 517.35, shall apply to hospitals [OSHPD 1, 2 (facilities complying with Article 517.40(B), 3 & 4] correctional treatment centers providing optional services where an essential electrical system is required.

Informational Note No. 1: For performance, maintenance, and testing requirements of essential electrical systems in hospitals, see NFPA 99-2012, *Health Care Facilities Code*. For installation of centrifugal fire pumps, see NFPA 20-2013, *Standard for the Installation of Stationary Fire Pumps for Fire Protection*.

Informational Note No. 2: For additional information, see NFPA 99-2012, *Health Care Facilities Code*.

(B) General.

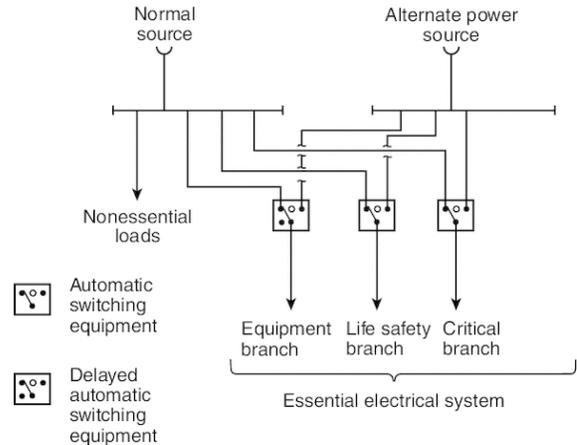
(1) Separate Branches. Essential electrical systems for hospitals shall be comprised of three separate branches capable of supplying a limited amount of lighting and power service that is considered essential for life safety and effective hospital operation during the time the normal electrical service is interrupted for any reason. The three branches are life safety, critical, and equipment.

(2) Transfer Switches. The number of transfer switches to be used shall be based on reliability, design, and load considerations. Each branch of the essential electrical system shall have one or more transfer switches. One transfer switch and downstream distribution system shall be permitted to serve one or more branches in a facility with a maximum demand on the essential electrical system of 150 kVA.

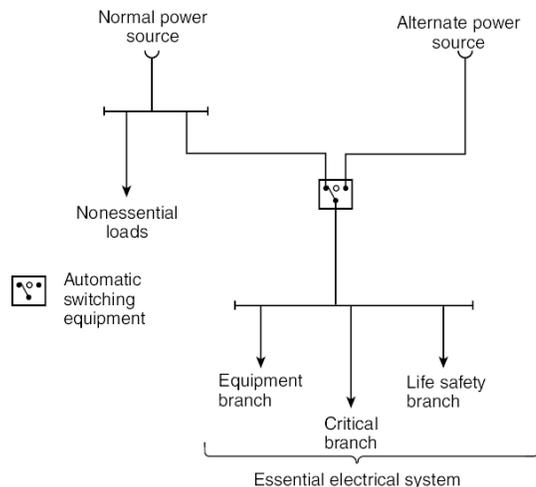
Informational Note No. 1: See NFPA 99-2012, *Health Care Facilities Code*, 6.4.3.2, Transfer Switches; 6.4.2.1.5, Automatic Transfer Switch Features; 6.4.2.1.5.15, Nonautomatic Transfer Switch Features; and 6.4.2.1.7, Nonautomatic Transfer Device Features.

Informational Note No. 2: See Informational Note Figure 517.30, No. 1.

Informational Note No. 3: See Informational Note Figure 517.30, No. 2.



Informational Note Figure 517.30, No. 1 Hospital — Minimum Requirement (greater than 150 kVA) for Transfer Switch Arrangement.



Informational Note Figure 517.30, No. 2 Hospital — Minimum Requirement (150 kVA or less) for Transfer Switch Arrangement.

(3) Optional Loads. Loads served by the generating equipment not specifically named in Article 517 shall be served by their own transfer switches such that the following conditions apply:

- (1) These loads shall not be transferred if the transfer will overload the generating equipment.
- (2) These loads shall be automatically shed upon generating equipment overloading.

(E) Receptacle Identification. The cover plates for the electrical receptacles [For OSHPD 1&4] and light switches or the electrical receptacles [For OSHPD 1&4] and light switches themselves supplied from the essential electrical system shall have a distinctive color or marking so as to be readily identifiable. [99:6.4.2.2.6.2(C)]

(F) Feeders from Alternate Power Source. A single feeder supplied by a local or remote alternate source shall be permitted to supply the essential electrical system to the point at which the life safety, critical, and equipment branches are separated. Installation of the transfer equipment shall be permitted at other than the location of the alternate power source.

(G) Coordination. Overcurrent protective devices serving the essential electrical system shall be coordinated for the period of time that a fault’s duration extends beyond 0.1 second.

Exception No. 1: Between transformer primary and secondary overcurrent protective devices, where only one overcurrent protective device or set of overcurrent protective devices exists on the transformer secondary.

Exception No. 2: Between overcurrent protective devices of the same size (ampere rating) in series.

Informational Note: The terms *coordination* and *coordinated* as used in this section do not cover the full range of overcurrent conditions.

517.31 Branches Requiring Automatic Connection. Those functions of patient care depending on lighting or appliances that are connected to the essential electrical system shall be divided into the life safety branch and the critical branch, as described in 517.32 and 517.33.

The life safety and critical branches shall be installed and connected to the alternate power source so that all functions supplied by these branches specified here shall be automatically restored to operation within 10 seconds after interruption of the normal source. [99:6.4.3.1]

517.32 Life Safety Branch. No functions other than those listed in 517.32(A) through (H) shall be connected to the life safety branch. The life safety branch of the essential electrical system shall supply power for the following lighting, receptacles, and equipment.

(A) Illumination of Means of Egress. Illumination of means of egress, such as lighting required for corridors, passageways, stairways, and landings at exit doors, and all necessary ways of approach to exits. Switching arrangements to transfer patient corridor lighting in hospitals from general illumination circuits to night illumination circuits shall be permitted, provided only one of two circuits can be selected and both circuits cannot be extinguished at the same time.

Informational Note: See NFPA 101-2012, *Life Safety Code*, Sections 7.8 and 7.9.

(B) Exit Signs. Exit signs and exit directional signs.

Informational Note: See NFPA 101-2012, *Life Safety Code*, Section 7.10.

(C) Alarm and Alerting Systems. Alarm and alerting systems including the following:

- (1) Fire alarms

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Informational Note: See NFPA 101-2012, *Life Safety Code*, Section 9.6 and 18.3.4.

- (2) Alarms required for systems used for the piping of nonflammable medical gases

Informational Note: See NFPA 99-2012, *Health Care Facilities Code*, 6.4.2.2.3.3.

- (3) Mechanical, control, and other accessories required for effective life safety systems operation shall be permitted to be connected to the life safety branch.

(D) Communications Systems. Hospital communications systems, where used for issuing instructions during emergency conditions.

(E) Generator Set and Transfer Switch Locations. Task illumination battery charger for battery-powered lighting unit(s) and selected receptacles at the generator set and essential transfer switch locations. [99:6.4.2.2.3.2(4)]

(F) Generator Set Accessories. Generator set accessories as required for generator performance. Loads dedicated to a specific generator, including the fuel transfer pump(s), ventilation fans, electrically operated louvers, controls, cooling system, and other generator accessories essential for generator operation, shall be connected to the life safety branch or to the output terminals of the generator with overcurrent protective devices.

(G) Elevators. Elevator cab lighting, control, communications, and signal systems.

(H) Automatic Doors. Automatically operated doors used for building egress. [99:4.4.2.2.2(7)]

517.33 Critical Branch.

(A) Task Illumination and Selected Receptacles. The critical branch of the essential electrical system shall supply power for task illumination, fixed equipment, selected receptacles, and special power circuits serving the following areas and functions related to patient care:

- (1) Critical care areas that utilize anesthetizing gases — task illumination, selected receptacles, and fixed equipment
- (2) The isolated power systems in special environments
- (3) Patient care areas — task illumination and selected receptacles in the following:
 - a. Infant nurseries
 - b. Medication preparation areas
 - c. Pharmacy dispensing areas
 - d. Selected acute nursing areas
 - e. Psychiatric bed areas (omit receptacles)
 - f. Ward treatment rooms
 - g. Nurses’ stations (unless adequately lighted by corridor luminaires)
- (4) Additional specialized patient care task illumination and receptacles, where needed
- (5) Nurse call systems [OSHPD 1, 2 & 4] *Exception: Battery-powered components of wireless emergency nurse call systems complying with the latest edition of ANSI/UL 1069, Standard for Hospital Signaling and Nurse Call Equipment.*
- (6) Blood, bone, and tissue banks
- (7) Telephone and data equipment rooms and closets

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- (8) Task illumination, selected receptacles, and selected power circuits for the following:
 - a. General care beds (at least one duplex receptacle in each patient bedroom)
 - b. Angiographic labs
 - c. Cardiac catheterization labs
 - d. Coronary care units
 - e. Hemodialysis rooms or areas
 - f. Emergency room treatment areas (selected)
 - g. Human physiology labs
 - h. Intensive care units
 - i. Postoperative recovery rooms (selected)

[Subsections j through n OSHPD 1]
j. Lithotripsy treatment rooms
k. Laser operating rooms
l. Electric clocks as required by Part 2, Title 24, C.C.R.
m. Food preparation areas, central supply, and utility rooms
n. Electrical and mechanical rooms

- (9) Additional task illumination, receptacles, and selected power circuits needed for effective hospital operation. Single-phase fractional horsepower motors shall be permitted to be connected to the critical branch. [99:4.4.2.2.2.3(9)]
- (10) [OSHPD 1, 2, 3, & 4] Sensor-operated fixtures when used to comply with Table 4-2, California Plumbing Code.
- (11) [OSHPD 1 & 4] Alarm systems for monitoring negative pressure isolation rooms and positive pressure isolation rooms.

(B) Subdivision of the Critical Branch. It shall be permitted to subdivide the critical branch into two or more branches.

Informational Note: It is important to analyze the consequences of supplying an area with only critical care branch power when failure occurs between the area and the transfer switch. Some proportion of normal and critical power or critical power from separate transfer switches may be appropriate.

517.34 Equipment Branch Connection to Alternate Power Source. The equipment branch shall be installed and connected to the alternate power source such that the equipment described in 517.34(A) is automatically restored to operation at appropriate time-lag intervals following the energizing of the essential electrical system. Its arrangement shall also provide for the subsequent connection of equipment described in 517.34(B). [99:6.4.2.2.5.2]

Exception: For essential electrical systems under 150 kVA, deletion of the time-lag intervals feature for delayed automatic connection to the equipment system shall be permitted.

(A) Equipment for Delayed Automatic Connection. The following equipment shall be permitted to be arranged for delayed automatic connection to the alternate power source:

- (1) Central suction systems serving medical and surgical functions, including controls. Such suction systems shall be permitted on the critical branch.

- (2) Sump pumps and other equipment required to operate for the safety of major apparatus, including associated control systems and alarms.
- (3) Compressed air systems serving medical and surgical functions, including controls. Such air systems shall be permitted on the critical branch.
- (4) Smoke control and stair pressurization systems, or both.
- (5) Kitchen hood supply or exhaust systems, or both, if required to operate during a fire in or under the hood.
- (6) Supply, return, and exhaust ventilating systems for airborne infectious/isolation rooms, protective environment rooms, exhaust fans for laboratory fume hoods, nuclear medicine areas where radioactive material is used, ethylene oxide evacuation, and anesthesia evacuation. Where delayed automatic connection is not appropriate, such ventilation systems shall be permitted to be placed on the critical branch. [99:6.4.2.2.5.3(A)(6) and (B)]
- (7) Supply, return, and exhaust ventilating systems for operating and delivery rooms.
- (8) Supply, return, exhaust ventilating systems and/or air-conditioning systems serving telephone equipment rooms and closets and data equipment rooms and closets.

(9) [OSHPD 1, 2, 3 (surgical clinics), & 4] All equipment listed in Section 321.0 of the California Plumbing Code.

(10) Where provided, UPS systems serving telephone, data, technology and telecommunications equipment rooms and closets.

Exception: Sequential delayed automatic connection to the alternate power source to prevent overloading the generator shall be permitted where engineering studies indicate it is necessary.

(B) Equipment for Delayed Automatic or Manual Connection. The following equipment shall be permitted to be arranged for either delayed automatic or manual connection to the alternate power source:

- (1) Heating equipment to provide heating for operating, delivery, labor, recovery, intensive care, coronary care, nurseries, infection/isolation rooms, emergency treatment spaces, and general patient rooms and pressure maintenance (jockey or make-up) pump(s) for water-based fire protection systems.

Exception: Heating of general patient rooms and infection/isolation rooms during disruption of the normal source shall not be required under any of the following conditions:

- (1) The outside design temperature is higher than -6.7°C (20°F).
- (2) The outside design temperature is lower than -6.7°C (20°F), and where a selected room(s) is provided for the needs of all confined patients, only such room(s) need be heated.
- (3) The facility is served by a dual source of normal power.

(1.1) [OSHPD 1 & 4] Heating, ventilating and cooling equipment as required by the California Mechanical Code.

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Informational Note No. 1: The design temperature is based on the 97½ percent design value as shown in Chapter 24 of the ASHRAE *Handbook of Fundamentals* (1997).

Informational Note No. 2: For a description of a dual source of normal power, see 517.35(C), Informational Note.

- (2) An elevator(s) selected to provide service to patient, surgical, obstetrical, and ground floors during interruption of normal power. In instances where interruption of normal power would result in other elevators stopping between floors, throw-over facilities shall be provided to allow the temporary operation of any elevator for the release of patients or other persons who may be confined between floors.
- (3) Hyperbaric facilities.
- (4) Hypobaric facilities.
- (5) Automatically operated doors
- (6) Minimal electrically heated autoclaving equipment shall be permitted to be arranged for either automatic or manual connection to the alternate source.
- (7) Controls for equipment listed in 517.34.
- (8) Other selected equipment shall be permitted to be served by the equipment system. [99:6.4.2.2.5.4(9)]

(C) AC Equipment for Nondelayed Automatic Connection.

Generator accessories, including but not limited to, the transfer fuel pump, electrically operated louvers, and other generator accessories essential for generator operation, shall be arranged for automatic connection to the alternate power source. [99:6.5.2.2.3.2]

517.35 Sources of Power.

(A) Two Independent Sources of Power. Essential electrical systems shall have a minimum of two independent sources of power: a normal source generally supplying the entire electrical system and one or more alternate sources for use when the normal source is interrupted. [99:6.4.1.1.4]

(B) Alternate Source of Power. The alternate source of power shall be one of the following:

- (1) Generator(s) driven by some form of prime mover(s) and located on the premises
- (2) Another generating unit(s) where the normal source consists of a generating unit(s) located on the premises
- (3) An external utility service when the normal source consists of a generating unit(s) located on the premises
- (4) A battery system located on the premises [99:6.4.1.2]

[OSHPD 1, 2 & 4] A battery system located on the premises is not permitted except as allowed in 517.33 (A)(5).

(C) Location of Essential Electrical System Components.

Careful consideration shall be given to the location of the spaces housing the components of the essential electrical system to minimize interruptions caused by natural forces common to the area (e.g., storms, floods, earthquakes, or hazards created by adjoining structures or activities). Consideration shall also be given to the possible interruption of normal electrical services resulting from similar causes as well as possible disruption of normal electrical service due to internal wiring and equipment failures. Consideration shall be given to the physical separation

of the main feeders of the alternate source from the main feeders of the normal electrical source to prevent possible simultaneous interruption. [OSHPD 1 & 2] Refer to California Building Code, Section 1616A.1.42.

Informational Note: Facilities in which the normal source of power is supplied by two or more separate central station-fed services experience greater than normal electrical service reliability than those with only a single feed. Such a dual source of normal power consists of two or more electrical services fed from separate generator sets or a utility distribution network that has multiple power input sources and is arranged to provide mechanical and electrical separation so that a fault between the facility and the generating sources is not likely to cause an interruption of more than one of the facility service feeders.

517.40 Essential Electrical Systems for Nursing Homes and Limited Care Facilities.

(A) Applicability. The requirements of Part III, 517.40(C) through 517.44, shall apply to nursing homes and limited care facilities.

Exception: The requirements of Part III, 517.40(C) through 517.44, shall not apply to freestanding buildings used as nursing homes and limited care facilities, provided that the following apply:

- (a) Admitting and discharge policies are maintained that preclude the provision of care for any patient or resident who may need to be sustained by electrical life-support equipment.
- (b) No surgical treatment requiring general anesthesia is offered.
- (c) An automatic battery-operated system(s) or equipment is provided that shall be effective for at least 1½ hours and is otherwise in accordance with 700.12 and that shall be capable of supplying lighting for exit lights, exit corridors, stairways, nursing stations, medical preparation areas, boiler rooms, and communications areas. This system shall also supply power to operate all alarm systems.

Informational Note: See NFPA 101-2012, *Life Safety Code*.

(A.1) [OSHPD 1, 2, & 4] Applicability. The requirements of Part C, Section 517.40 (C) through 517.44, shall apply to nursing homes, intermediate and skilled nursing facilities, and correctional treatment centers providing only basic services

(B) Inpatient Hospital Care Facilities. For those nursing homes and limited care facilities that admit patients who need to be sustained by electrical life support equipment, the essential electrical system from the source to the portion of the facility where such patients are treated shall comply with the requirements of Part III, 517.30 through 517.35.

(C) Facilities Contiguous or Located on the Same Site with Hospitals. Nursing homes and limited care facilities that are contiguous or located on the same site with a hospital shall be permitted to have their essential electrical systems supplied by that of the hospital.

Informational Note: For performance, maintenance, and testing requirements of essential electrical systems in nursing homes and limited care facilities, see NFPA 99-2012, *Health Care Facilities Code*.

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517.41 Essential Electrical Systems.

(A) General. Essential electrical systems for nursing homes and limited care facilities shall be comprised of two separate branches capable of supplying a limited amount of lighting and power service, which is considered essential for the protection of life safety and effective operation of the institution during the time normal electrical service is interrupted for any reason. These two separate branches shall be the life safety branch and the critical branch. [99: A.6.5.2.1.1]

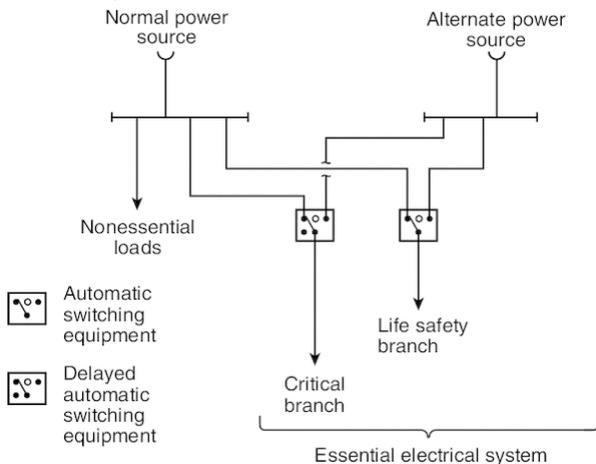
(B) Transfer Switches. The number of transfer switches to be used shall be based on reliability, design, and load considerations. Each branch of the essential electrical system shall be served by one or more transfer switches. One transfer switch shall be permitted to serve one or more branches or systems in a facility with a maximum demand on the essential electrical system of 150 kVA. [OSHPD 1, 2, & 4] *Transfer switches installed in skilled nursing facilities meeting the requirements of Article 517.40(B) shall comply with Article 517.30(B)(5).* [99:6.5.2.2.1]

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Informational Note No. 1: See NFPA 99-2012, *Health Care Facilities Code*, 6.5.3.2, Transfer Switch Operation Type II; 6.4.2.1.5, Automatic Transfer Switch Features; and 6.4.2.1.7, Nonautomatic Transfer Device Features.

Informational Note No. 2: See Informational Note Figure 517.41, No. 1.

Informational Note No. 3: See Informational Note Figure 517.41, No. 2.



Informational Note Figure 517.41, No. 1 Nursing Home and Limited Health Care Facilities — Minimum Requirement (greater than 150 kVA) for Transfer Switch Arrangement.

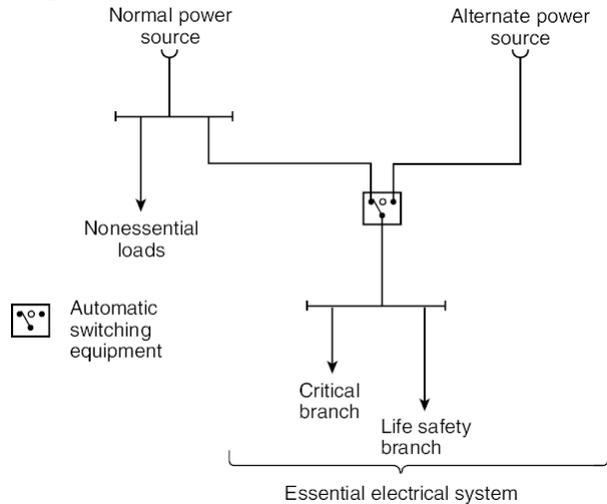
(C) Capacity of System. The essential electrical system shall have adequate capacity to meet the demand for the operation of all functions and equipment to be served by each branch at one time.

(D) Separation from Other Circuits. The life safety branch shall be kept entirely independent of all other wiring and equipment and shall not enter the same raceways, boxes, or cabinets with other wiring except as follows:

- (1) In transfer switches

- (2) In exit or emergency luminaires supplied from two sources
- (3) In a common junction box attached to exit or emergency luminaires supplied from two sources

The wiring of the critical branch shall be permitted to occupy the same raceways, boxes, or cabinets of other circuits that are not part of the life safety branch.



Informational Note Figure 517.41, No. 2 Nursing Home and Limited Health Care Facilities — Minimum Requirement (150 kVA or less) for Transfer Switch Arrangement.

(E) Receptacle Identification. The cover plates for the electrical receptacles [OSHPD 2 & 4] and light switches or the electrical receptacles [OSHPD 2 & 4] and light switches themselves supplied from the essential electrical system shall have a distinctive color or marking so as to be readily identifiable. [99:4.5.2.2.4.2]

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Nonlocking-type, 125-volt, 15- and 20-ampere receptacles shall have an illuminated face or an indicator light to indicate that there is power to the receptacle.

517.42 Automatic Connection to Life Safety Branch. The life safety branch shall be installed and connected to the alternate source of power so that all functions specified herein shall be automatically restored to operation within 10 seconds after the interruption of the normal source. No functions other than those listed in 517.42(A) through (G) shall be connected to the life safety branch. The life safety branch shall supply power for the following lighting, receptacles, and equipment.

(A) Illumination of Means of Egress. Illumination of means of egress as is necessary for corridors, passageways, stairways, landings, and exit doors and all ways of approach to exits. Switching arrangement to transfer patient corridor lighting from general illumination circuits shall be permitted, providing only one of two circuits can be selected and both circuits cannot be extinguished at the same time.

Informational Note: See NFPA 101-2012, *Life Safety Code*, Sections 7.8 and 7.9.

(B) Exit Signs. Exit signs and exit directional signs.

Informational Note: See NFPA 101-2012, *Life Safety Code*, Section 7.10.

(C) Alarm and Alerting Systems. Alarm and alerting systems, including the following:

- (1) Fire alarms

Informational Note: See NFPA 101-2012, *Life Safety Code*, Sections 9.6 and 18.3.4.

- (2) Alarms required for systems used for the piping of nonflammable medical gases

Informational Note: See NFPA 99-2012, *Health Care Facilities Code*, 6.5.2.2.2.1(3).

- (3) [OSHPD 1, 2, & 4] Nurse call system

Exception: [OSHPD 1, 2 & 4] Battery-powered components of wireless emergency nurse call systems complying with the latest edition of ANSI/UL 1069, *Standard for Hospital Signaling and Nurse Call Equipment*

(D) Communications Systems. Communications systems, where used for issuing instructions during emergency conditions.

(E) Dining and Recreation Areas. Sufficient lighting in dining and recreation areas to provide illumination to exit ways.

(F) Generator Set Location. Task illumination and selected receptacles in the generator set location.

(G) Elevators. Elevator cab lighting, control, communications, and signal systems. [99:6.4.2.2.3.2(5)]

517.43 Connection to Critical Branch. The critical branch shall be installed and connected to the alternate power source so that the equipment listed in 517.43(A) shall be automatically restored to operation at appropriate time-lag intervals following the restoration of the life safety branch to operation. Its arrangement shall also provide for the additional connection of equipment listed in 517.43(B) by either delayed automatic or manual operation. [99:6.5.2.2.3.1(A) and (B)]

Exception: For essential electrical systems under 150 kVA, deletion of the time-lag intervals feature for delayed automatic connection to the equipment branch shall be permitted.

(A) Delayed Automatic Connection. The following equipment shall be permitted to be connected to the critical branch and shall be arranged for delayed automatic connection to the alternate power source:

- (1) Patient care areas — task illumination and selected receptacles in the following:
 - a. Medication preparation areas
 - b. Pharmacy dispensing areas
 - c. Nurses’ stations (unless adequately lighted by corridor luminaires)
- (2) Sump pumps and other equipment required to operate for the safety of major apparatus and associated control systems and alarms
- (3) Smoke control and stair pressurization systems
- (4) Kitchen hood supply and/or exhaust systems, if required to operate during a fire in or under the hood
- (5) Supply, return, and exhaust ventilating systems for airborne infectious isolation rooms [99:6.5.2.2.3.3]

- (6) [OSHPD 1, 2, & 4] Selected receptacles in patient room corridors so that any patient bed can be reached with fifty (50) foot extension cord.

- (7) [OSHPD 1, 2, & 4] Task lighting and at least one receptacle in electrical and mechanical rooms.

- (8) [OSHPD 1, 2, 3, & 4] Sensor-operated fixtures when used to comply with Table 4-2, *California Plumbing Code*.

- (9) [OSHPD 1, 2, 3 (surgical clinics), & 4] All equipment listed in Section 321.0 of the *California Plumbing Code*.

(B) Delayed Automatic or Manual Connection. The following equipment shall be permitted to be connected to the critical branch and shall be arranged for either delayed automatic or manual connection to the alternate power source:

- (1) Heating equipment to provide heating for patient rooms.

Exception: Heating of general patient rooms during disruption of the normal source shall not be required under any of the following conditions:

- (1) The outside design temperature is higher than -6.7°C (20°F).

- (2) The outside design temperature is lower than -6.7°C (20°F) and where a selected room(s) is provided for the needs of all confined patients, only such room(s) need be heated.

- (3) The facility is served by a dual source of normal power as described in 517.44(C), Informational Note.

Informational Note: The outside design temperature is based on the 97½ percent design values as shown in Chapter 24 of the *ASHRAE Handbook of Fundamentals* (1997).

- (1.1) [OSHPD 1, 2, & 4] Heating, ventilating, and cooling equipment as required by *California Mechanical Code*.

- (2) Elevator service — in instances where disruption of power would result in elevators stopping between floors, throw-over facilities shall be provided to allow the temporary operation of any elevator for the release of passengers. For elevator cab lighting, control, and signal system requirements, see 517.42(G).

- (3) Additional illumination, receptacles, and equipment shall be permitted to be connected only to the critical branch.

[99:6.5.2.2.3.4(A), (B), and (C)]

517.44 Sources of Power.

(A) Two Independent Sources of Power. Essential electrical systems shall have a minimum of two independent sources of power: a normal source generally supplying the entire electrical system and one or more alternate sources for use when the normal source is interrupted. [99:6.5.1]

(B) Alternate Source of Power. The alternate source of power shall be a generator(s) driven by some form of prime mover(s) and located on the premises.

Exception No. 1: Where the normal source consists of generating units on the premises, the alternate source shall be either another generator set or an external utility service.

Exception No. 2: Nursing homes or limited care facilities meeting the requirement of 517.40(A) and other health care facilities meeting the requirement of 517.45 shall be permitted to use a battery system or self-contained battery integral with the equipment.

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(B.1) [OSHPD 1, 2 & 4] Alternate Source of Power. The alternate source of power shall be a generator(s) driven by some form of prime mover(s) and located on the premises.

Exception No. 1 [OSHPD 1, 2 & 4]: Where the normal source consists of generating units on the premises, the alternate source shall be either another generator set or an external utility service.

Exception No. 2: [OSHPD 1, 2 & 4] Battery-powered components of wireless emergency nurse call systems complying with the latest edition of ANSI/UL 1069, Standard for Hospital Signaling and Nurse Call Equipment need not have the wireless components connected to the alternate source of power.

(C) Location of Essential Electrical System Components. Careful consideration shall be given to the location of the spaces housing the components of the essential electrical system to minimize interruptions caused by natural forces common to the area (e.g., storms, floods, earthquakes, or hazards created by adjoining structures or activities). Consideration shall also be given to the possible interruption of normal electrical services resulting from similar causes as well as possible disruption of normal electrical service due to internal wiring and equipment failures.

Informational Note: Facilities in which the normal source of power is supplied by two or more separate central station-fed services experience greater than normal electrical service reliability than those with only a single feed. Such a dual source of normal power consists of two or more electrical services fed from separate generator sets or a utility distribution network that has multiple power input sources and is arranged to provide mechanical and electrical separation so that a fault between the facility and the generating sources will not likely cause an interruption of more than one of the facility service feeders.

517.45 Essential Electrical Systems for Other Health Care Facilities.

(A) Essential Electrical Distribution. The essential electrical distribution system shall be a battery or generator system.

Informational Note: See NFPA 99-2012, *Health Care Facilities Code*.

(B) Electrical Life Support Equipment. Where electrical life support equipment is required, the essential electrical distribution system shall be as described in 517.30 through 517.35.

(C) Critical Care Areas. Where critical care areas are present, the essential electrical distribution system shall be as described in 517.30 through 517.35.

(D) Power Systems. Battery systems shall be installed in accordance with the requirements of Article 700, and generator systems shall be as described in 517.30 through 517.35.

(D.1) [OSHPD 1, 2, 3, & 4] Ambulatory surgical clinics shall be provided with a generator with on-site fuel.

(E) [OSHPD 3 & 4] Receptacle and Light Switch Identification. The cover plates for the electrical receptacles and light switches or the electrical receptacles and light switches themselves, supplied from the emergency system, shall have a distinctive color or marking so as to be readily identifiable.

(F) [OSHPD 1, 3, & 4] Ambulatory Surgical Clinics. The essential electrical systems for Ambulatory Surgical Clinics shall be as described in 517.30 through 517.35.

(G) [OSHPD 1, 2, 3, & 4] Hemodialysis Clinic.

(1) Illumination for means of egress and exit lights shall be provided, using battery-operated equipment with a capacity to sustain its connected load for a minimum of 1 ½ hours after loss of the normal source.

IV. Inhalation Anesthetizing Locations

Informational Note: For further information regarding safeguards for anesthetizing locations, see NFPA 99-2012, *Health Care Facilities Code*.

517.60 Anesthetizing Location Classification.

Informational Note: If either of the anesthetizing locations in 517.60(A) or 517.60(B) is designated a wet procedure location, refer to 517.20.

(A) Hazardous (Classified) Location.

(1) Use Location. In a location where flammable anesthetics are employed, the entire area shall be considered to be a Class I, Division 1 location that extends upward to a level 1.52 m (5 ft) above the floor. The remaining volume up to the structural ceiling is considered to be above a hazardous (classified) location. [99: Annex E, E.1, and E.2]

(2) Storage Location. Any room or location in which flammable anesthetics or volatile flammable disinfecting agents are stored shall be considered to be a Class I, Division 1 location from floor to ceiling.

(B) Other-Than-Hazardous (Classified) Location. Any inhalation anesthetizing location designated for the exclusive use of nonflammable anesthetizing agents shall be considered to be an other-than-hazardous (classified) location.

517.61 Wiring and Equipment.

(A) Within Hazardous (Classified) Anesthetizing Locations.

(1) Isolation. Except as permitted in 517.160, each power circuit within, or partially within, a flammable anesthetizing location as referred to in 517.60 shall be isolated from any distribution system by the use of an isolated power system.

(2) Design and Installation. Where an isolated power system is utilized, the isolated power equipment shall be listed as isolated power equipment, and the isolated power system shall be designed and installed in accordance with 517.160.

(3) Equipment Operating at More Than 10 Volts. In hazardous (classified) locations referred to in 517.60, all fixed wiring and equipment and all portable equipment, including lamps and other utilization equipment, operating at more than 10 volts between conductors shall comply with the requirements of 501.1 through 501.25, and 501.100 through 501.150, and 501.30(A) and 501.30(B) for Class I, Division 1 locations. All such equipment shall be specifically approved for the hazardous atmospheres involved.

(4) Extent of Location. Where a box, fitting, or enclosure is partially, but not entirely, within a hazardous (classified) location(s), the hazardous (classified) location(s) shall be considered to be extended to include the entire box, fitting, or enclosure.

(5) Receptacles and Attachment Plugs. Receptacles and attachment plugs in a hazardous (classified) location(s) shall be listed for use in Class I, Group C hazardous (classified)

locations and shall have provision for the connection of a grounding conductor.

(6) Flexible Cord Type. Flexible cords used in hazardous (classified) locations for connection to portable utilization equipment, including lamps operating at more than 8 volts between conductors, shall be of a type approved for extra-hard usage in accordance with Table 400.4 and shall include an additional conductor for grounding.

(7) Flexible Cord Storage. A storage device for the flexible cord shall be provided and shall not subject the cord to bending at a radius of less than 75 mm (3 in.).

(B) Above Hazardous (Classified) Anesthetizing Locations.

(1) Wiring Methods. Wiring above a hazardous (classified) location referred to in 517.60 shall be installed in rigid metal conduit, electrical metallic tubing, intermediate metal conduit, Type MI cable, or Type MC cable that employs a continuous, gas/vaportight metal sheath.

(2) Equipment Enclosure. Installed equipment that may produce arcs, sparks, or particles of hot metal, such as lamps and lampholders for fixed lighting, cutouts, switches, generators, motors, or other equipment having make-and-break or sliding contacts, shall be of the totally enclosed type or be constructed so as to prevent escape of sparks or hot metal particles.

Exception: Wall-mounted receptacles installed above the hazardous (classified) location in flammable anesthetizing locations shall not be required to be totally enclosed or have openings guarded or screened to prevent dispersion of particles.

(3) Luminaires. Surgical and other luminaires shall conform to 501.130(B).

Exception No. 1: The surface temperature limitations set forth in 501.130(B)(1) shall not apply.

Exception No. 2: Integral or pendant switches that are located above and cannot be lowered into the hazardous (classified) location(s) shall not be required to be explosionproof.

(4) Seals. Listed seals shall be provided in conformance with 501.15, and 501.15(A)(4) shall apply to horizontal as well as to vertical boundaries of the defined hazardous (classified) locations.

(5) Receptacles and Attachment Plugs. Receptacles and attachment plugs located above hazardous (classified) anesthetizing locations shall be listed for hospital use for services of prescribed voltage, frequency, rating, and number of conductors with provision for the connection of the grounding conductor. This requirement shall apply to attachment plugs and receptacles of the 2-pole, 3-wire grounding type for single-phase, 120-volt, nominal, ac service.

(6) 250-Volt Receptacles and Attachment Plugs Rated 50 and 60 Amperes. Receptacles and attachment plugs rated 250 volts, for connection of 50-ampere and 60-ampere ac medical equipment for use above hazardous (classified) locations, shall be arranged so that the 60-ampere receptacle will accept either the 50-ampere or the 60-ampere plug. Fifty-ampere receptacles shall be designed so as not to accept the 60-ampere attachment plug. The attachment plugs shall be of the 2-pole, 3-wire design with a third contact connecting to the insulated (green or green

with yellow stripe) equipment grounding conductor of the electrical system.

(C) Other-Than-Hazardous (Classified) Anesthetizing Locations.

(1) Wiring Methods. Wiring serving other-than-hazardous (classified) locations, as defined in 517.60, shall be installed in a metal raceway system or cable assembly. The metal raceway system or cable armor or sheath assembly shall qualify as an equipment grounding conductor in accordance with 250.118. Type MC and Type MI cable shall have an outer metal armor, sheath, or sheath assembly that is identified as an acceptable equipment grounding conductor.

Exception: Pendant receptacle installations that employ listed Type SJO, or equivalent hard usage or extra-hard usage, flexible cords suspended not less than 1.8 m (6 ft) from the floor shall not be required to be installed in a metal raceway or cable assembly.

(2) Receptacles and Attachment Plugs. Receptacles and attachment plugs installed and used in other-than-hazardous (classified) locations shall be listed “hospital grade” for services of prescribed voltage, frequency, rating, and number of conductors with provision for connection of the grounding conductor. This requirement shall apply to 2-pole, 3-wire grounding type for single-phase, 120-, 208-, or 240-volt, nominal, ac service.

(3) 250-Volt Receptacles and Attachment Plugs Rated 50 Amperes and 60 Amperes. Receptacles and attachment plugs rated 250 volts, for connection of 50-ampere and 60-ampere ac medical equipment for use in other-than-hazardous (classified) locations, shall be arranged so that the 60-ampere receptacle will accept either the 50-ampere or the 60-ampere plug. Fifty-ampere receptacles shall be designed so as not to accept the 60-ampere attachment plug. The attachment plugs shall be of the 2-pole, 3-wire design with a third contact connecting to the insulated (green or green with yellow stripe) equipment grounding conductor of the electrical system.

517.62 Grounding. In any anesthetizing area, all metal raceways and metal-sheathed cables and all normally non-current-carrying conductive portions of fixed electrical equipment shall be connected to an equipment grounding conductor. Grounding and bonding in Class I locations shall comply with 501.30.

Exception: Equipment operating at not more than 10 volts between conductors shall not be required to be connected to an equipment grounding conductor.

517.63 Grounded Power Systems in Anesthetizing Locations.

(A) Battery-Powered Lighting Units. One or more battery-powered lighting units shall be provided and shall be permitted to be wired to the critical lighting circuit in the area and connected ahead of any local switches.

(B) Branch-Circuit Wiring. Branch circuits supplying only listed, fixed, therapeutic and diagnostic equipment, permanently installed above the hazardous (classified) location and in other-than-hazardous (classified) locations, shall be permitted to be supplied from a normal grounded service, single- or three-phase system, provided the following apply:

- (1) Wiring for grounded and isolated circuits does not occupy the same raceway or cable.
- (2) All conductive surfaces of the equipment are connected to an equipment grounding conductor.
- (3) Equipment (except enclosed X-ray tubes and the leads to the tubes) is located at least 2.5 m (8 ft) above the floor or outside the anesthetizing location.
- (4) Switches for the grounded branch circuit are located outside the hazardous (classified) location.

Exception: Sections 517.63(B)(3) and (B)(4) shall not apply in other-than-hazardous (classified) locations.

(C) Fixed Lighting Branch Circuits. Branch circuits supplying only fixed lighting shall be permitted to be supplied by a normal grounded service, provided the following apply:

- (1) Such luminaires are located at least 2.5 m (8 ft) above the floor.
- (2) All conductive surfaces of luminaires are connected to an equipment grounding conductor.
- (3) Wiring for circuits supplying power to luminaires does not occupy the same raceway or cable for circuits supplying isolated power.
- (4) Switches are wall-mounted and located above hazardous (classified) locations.

Exception: Sections 517.63(C)(1) and (C)(4) shall not apply in other-than-hazardous (classified) locations.

(D) Remote-Control Stations. Wall-mounted remote-control stations for remote-control switches operating at 24 volts or less shall be permitted to be installed in any anesthetizing location.

(E) Location of Isolated Power Systems. Where an isolated power system is utilized, the isolated power equipment shall be listed as isolated power equipment. Isolated power system equipment and its supply circuit shall be permitted to be located in an anesthetizing location, provided it is installed above a hazardous (classified) location or in an other-than-hazardous (classified) location.

(F) Circuits in Anesthetizing Locations. Except as permitted above, each power circuit within, or partially within, a flammable anesthetizing location as referred to in 517.60 shall be isolated from any distribution system supplying other-than-anesthetizing locations.

517.64 Low-Voltage Equipment and Instruments.

(A) Equipment Requirements. Low-voltage equipment that is frequently in contact with the bodies of persons or has exposed current-carrying elements shall comply with one of the following:

- (1) Operate on an electrical potential of 10 volts or less
- (2) Be approved as intrinsically safe or double-insulated equipment
- (3) Be moisture resistant

(B) Power Supplies. Power shall be supplied to low-voltage equipment from one of the following:

- (1) An individual portable isolating transformer (autotransformers shall not be used) connected to an

isolated power circuit receptacle by means of an appropriate cord and attachment plug

- (2) A common low-voltage isolating transformer installed in an other-than-hazardous (classified) location
- (3) Individual dry-cell batteries
- (4) Common batteries made up of storage cells located in an other-than-hazardous (classified) location

(C) Isolated Circuits. Isolating-type transformers for supplying low-voltage circuits shall have both of the following:

- (1) Approved means for insulating the secondary circuit from the primary circuit
- (2) The core and case connected to an equipment grounding conductor

(D) Controls. Resistance or impedance devices shall be permitted to control low-voltage equipment but shall not be used to limit the maximum available voltage to the equipment.

(E) Battery-Powered Appliances. Battery-powered appliances shall not be capable of being charged while in operation unless their charging circuitry incorporates an integral isolating-type transformer.

(F) Receptacles or Attachment Plugs. Any receptacle or attachment plug used on low-voltage circuits shall be of a type that does not permit interchangeable connection with circuits of higher voltage.

Informational Note: Any interruption of the circuit, even circuits as low as 10 volts, either by any switch or loose or defective connections anywhere in the circuit, may produce a spark that is sufficient to ignite flammable anesthetic agents.

V. X-Ray Installations

517.70 Applicability. Nothing in this part shall be construed as specifying safeguards against the useful beam or stray X-ray radiation.

Informational Note No. 1: Radiation safety and performance requirements of several classes of X-ray equipment are regulated under Public Law 90-602 and are enforced by the Department of Health and Human Services.

Informational Note No. 2: In addition, information on radiation protection by the National Council on Radiation Protection and Measurements is published as *Reports of the National Council on Radiation Protection and Measurement*. These reports are obtainable from NCRP Publications, P.O. Box 30175, Washington, DC 20014.

517.71 Connection to Supply Circuit.

(A) Fixed and Stationary Equipment. Fixed and stationary X-ray equipment shall be connected to the power supply by means of a wiring method complying with applicable requirements of Chapters 1 through 4 of this *Code*, as modified by this article.

Exception: Equipment properly supplied by a branch circuit rated at not over 30 amperes shall be permitted to be supplied through a suitable attachment plug and hard-service cable or cord.

(B) Portable, Mobile, and Transportable Equipment.

Individual branch circuits shall not be required for portable, mobile, and transportable medical X-ray equipment requiring a capacity of not over 60 amperes.

(C) Over 1000-Volt Supply. Circuits and equipment operated on a supply circuit of over 1000 volts shall comply with Article 490.

517.72 Disconnecting Means.

(A) Capacity. A disconnecting means of adequate capacity for at least 50 percent of the input required for the momentary rating or 100 percent of the input required for the long-time rating of the X-ray equipment, whichever is greater, shall be provided in the supply circuit.

(B) Location. The disconnecting means shall be operable from a location readily accessible from the X-ray control.

(C) Portable Equipment. For equipment connected to a 120-volt branch circuit of 30 amperes or less, a grounding-type attachment plug and receptacle of proper rating shall be permitted to serve as a disconnecting means.

517.73 Rating of Supply Conductors and Overcurrent Protection.

(A) Diagnostic Equipment.

(1) Branch Circuits. The ampacity of supply branch-circuit conductors and the current rating of overcurrent protective devices shall not be less than 50 percent of the momentary rating or 100 percent of the long-time rating, whichever is greater.

(2) Feeders. The ampacity of supply feeders and the current rating of overcurrent protective devices supplying two or more branch circuits supplying X-ray units shall not be less than 50 percent of the momentary demand rating of the largest unit plus 25 percent of the momentary demand rating of the next largest unit plus 10 percent of the momentary demand rating of each additional unit. Where simultaneous biplane examinations are undertaken with the X-ray units, the supply conductors and overcurrent protective devices shall be 100 percent of the momentary demand rating of each X-ray unit.

Informational Note: The minimum conductor size for branch and feeder circuits is also governed by voltage regulation requirements. For a specific installation, the manufacturer usually specifies minimum distribution transformer and conductor sizes, rating of disconnecting means, and overcurrent protection.

(B) Therapeutic Equipment. The ampacity of conductors and rating of overcurrent protective devices shall not be less than 100 percent of the current rating of medical X-ray therapy equipment.

Informational Note: The ampacity of the branch-circuit conductors and the ratings of disconnecting means and overcurrent protection for X-ray equipment are usually designated by the manufacturer for the specific installation.

517.74 Control Circuit Conductors.

(A) Number of Conductors in Raceway. The number of control circuit conductors installed in a raceway shall be determined in accordance with 300.17.

(B) Minimum Size of Conductors. Size 18 AWG or 16 AWG fixture wires as specified in 725.49 and flexible cords shall be permitted for the control and operating circuits of X-ray and auxiliary equipment where protected by not larger than 20-ampere overcurrent devices.

517.75 Equipment Installations. All equipment for new X-ray installations and all used or reconditioned X-ray equipment moved to and reinstalled at a new location shall be of an approved type.

517.76 Transformers and Capacitors. Transformers and capacitors that are part of X-ray equipment shall not be required to comply with Articles 450 and 460.

Capacitors shall be mounted within enclosures of insulating material or grounded metal.

517.77 Installation of High-Tension X-Ray Cables. Cables with grounded shields connecting X-ray tubes and image intensifiers shall be permitted to be installed in cable trays or cable troughs along with X-ray equipment control and power supply conductors without the need for barriers to separate the wiring.

517.78 Guarding and Grounding.

(A) High-Voltage Parts. All high-voltage parts, including X-ray tubes, shall be mounted within grounded enclosures. Air, oil, gas, or other suitable insulating media shall be used to insulate the high-voltage from the grounded enclosure. The connection from the high-voltage equipment to X-ray tubes and other high-voltage components shall be made with high-voltage shielded cables.

(B) Low-Voltage Cables. Low-voltage cables connecting to oil-filled units that are not completely sealed, such as transformers, condensers, oil coolers, and high-voltage switches, shall have insulation of the oil-resistant type.

(C) Non-Current-Carrying Metal Parts. Non-current-carrying metal parts of X-ray and associated equipment (controls, tables, X-ray tube supports, transformer tanks, shielded cables, X-ray tube heads, etc.) shall be connected to an equipment grounding conductor in the manner specified in Part VII of Article 250, as modified by 517.13(A) and (B).

VI. Communications, Signaling Systems, Data Systems, Fire Alarm Systems, and Systems Less Than 120 Volts, Nominal

C threatening situation to summon assistance from outside the
A unit or department.

C (1) Call stations that initiate code call signals shall be as
A required in Table 1224.4.6.5, "Location of Nurse Call Devices"
C of the California Building Code.

A (2) The call station shall be equipped with a continuous audible
C or visual confirmation of activation to the person who initiated
C the code call.

A (3) Audible and visual code call signals shall be provided at the
C PBX operator or other continuously monitored location.

A (F) **Alarm in Psychiatric Nursing Units.** A nurse call is not
C required in psychiatric units, but if one is included the following
C shall apply:

A (1) Provisions shall be made for easy removal or for covering of
C call button outlets.

A (2) All hardware shall have tamper-resistant fasteners.

A (3) Cords at all call stations in rooms designated for psychiatric
C patient use shall be detachable.

**517.124 [OSHPD 1 & 4] Technology and Telecommunications
Rooms.** Where technology or telecommunications rooms are
provided in accordance with Section 1224.5 of the California
Building Code, the following requirements shall apply:

(A) **General.** Electrical equipment that is not directly
related to the support of the room shall not be installed in
or pass through the room. Non-lighting circuits serving
each room shall be dedicated to that room.

(B) **Grounding.**

(1) Grounding, bonding, and electrical protection shall meet
the requirements Article 250 and the latest version of
ANSI/TIA 607: Generic Telecommunications Bonding
and Commercial Building Grounding (Earthing) for
Customer Premises.

(2) Grounding bus bars shall be provided to meet the following
requirements:

- a. The ground bus bar shall be drilled with holes
according to NEMA standards to accommodate
bolted compression fittings
- b. All racks, cabinets, sections of cable tray, and metal
components of the technology system that do not carry
electrical current shall be grounded to the grounding
bus bar.
- c. Grounding bus bars shall be connected by a backbone
of insulated #6 to 3/0 AWG copper cable between all
technology rooms.
- d. Bonding conductors shall be colored green or be
labeled appropriately.
- e. The grounding bars shall be connected to the
telecommunications main grounding bus bar in the
telecommunications service entrance room. The
main grounding bar shall be bonded to the building
main electrical service ground, in accordance with
Article 250.94.

VII. Isolated Power Systems

517.160 Isolated Power Systems.

(A) **Installations.**

(1) **Isolated Power Circuits.** Each isolated power circuit shall
be controlled by a switch or circuit breaker that has a
disconnecting pole in each isolated circuit conductor to
simultaneously disconnect all power. Such isolation shall be
accomplished by means of one or more isolation transformers,
by means of generator sets, or by means of electrically isolated
batteries. Conductors of isolated power circuits shall not be
installed in cables, raceways, or other enclosures containing
conductors of another system.

(2) **Circuit Characteristics.** Circuits supplying primaries of
isolating transformers shall operate at not more than 600 volts
between conductors and shall be provided with proper
overcurrent protection. The secondary voltage of such
transformers shall not exceed 600 volts between conductors of
each circuit. All circuits supplied from such secondaries shall be
ungrounded and shall have an approved overcurrent device of
proper ratings in each conductor. Circuits supplied directly from
batteries or from motor generator sets shall be ungrounded and
shall be protected against overcurrent in the same manner as
transformer-fed secondary circuits. If an electrostatic shield is
present, it shall be connected to the reference grounding point.
[99:6.3.2.6.1]

(3) **Equipment Location.** The isolating transformers, motor
generator sets, batteries and battery chargers, and associated
primary or secondary overcurrent devices shall not be installed
in hazardous (classified) locations. The isolated secondary
circuit wiring extending into a hazardous anesthetizing location
shall be installed in accordance with 501.10.

(4) **Isolation Transformers.** An isolation transformer shall not
serve more than one operating room except as covered in
(A)(4)(a) and (A)(4)(b).

For purposes of this section, anesthetic induction rooms are
considered part of the operating room or rooms served by the
induction rooms.

(a) **Induction Rooms.** Where an induction room serves
more than one operating room, the isolated circuits of the
induction room shall be permitted to be supplied from the
isolation transformer of any one of the operating rooms served
by that induction room.

(b) **Higher Voltages.** Isolation transformers shall be
permitted to serve single receptacles in several patient areas
where the following apply:

- (1) The receptacles are reserved for supplying power to
equipment requiring 150 volts or higher, such as portable
X-ray units.
- (2) The receptacles and mating plugs are not
interchangeable with the receptacles on the local isolated
power system.

[99:13.4.1.2.6.6]

(5) **Conductor Identification.** The isolated circuit conductors
shall be identified as follows:

- (1) Isolated Conductor No. 1 — Orange with at least one
distinctive colored stripe other than white, green, or gray
along the entire length of the conductor

- (2) Isolated Conductor No. 2 — Brown with at least one distinctive colored stripe other than white, green, or gray along the entire length of the conductor

For 3-phase systems, the third conductor shall be identified as yellow with at least one distinctive colored stripe other than white, green, or gray along the entire length of the conductor. Where isolated circuit conductors supply 125-volt, single-phase, 15- and 20-ampere receptacles, the striped orange conductor(s) shall be connected to the terminal(s) on the receptacles that are identified in accordance with 200.10(B) for connection to the grounded circuit conductor.

(6) Wire-Pulling Compounds. Wire-pulling compounds that increase the dielectric constant shall not be used on the secondary conductors of the isolated power supply.

Informational Note No. 1: It is desirable to limit the size of the isolation transformer to 10 kVA or less and to use conductor insulation with low leakage to meet impedance requirements.

Informational Note No. 2: Minimizing the length of branch-circuit conductors and using conductor insulations with a dielectric constant less than 3.5 and insulation resistance constant greater than 6100 megohm-meters (20,000 megohm-feet) at 16°C (60°F) reduces leakage from line to ground, reducing the hazard current.

(B) Line Isolation Monitor.

(1) Characteristics. In addition to the usual control and overcurrent protective devices, each isolated power system shall be provided with a continually operating line isolation monitor that indicates total hazard current. The monitor shall be designed such that a green signal lamp, conspicuously visible to persons in each area served by the isolated power system, remains lighted when the system is adequately isolated from ground. An adjacent red signal lamp and an audible warning signal (remote if desired) shall be energized when the total hazard current (consisting of possible resistive and capacitive leakage currents) from either isolated conductor to ground reaches a threshold value of 5 mA under nominal line voltage conditions. The line monitor shall not alarm for a fault hazard of less than 3.7 mA or for a total hazard current of less than 5 mA.

Exception: A system shall be permitted to be designed to operate at a lower threshold value of total hazard current. A line isolation monitor for such a system shall be permitted to be approved, with the provision that the fault hazard current shall be permitted to be reduced but not to less than 35 percent of the corresponding threshold value of the total hazard current, and the monitor hazard current is to be correspondingly reduced to not more than 50 percent of the alarm threshold value of the total hazard current.

(2) Impedance. The line isolation monitor shall be designed to have sufficient internal impedance such that, when properly connected to the isolated system, the maximum internal current that can flow through the line isolation monitor, when any point of the isolated system is grounded, shall be 1 mA.

Exception: The line isolation monitor shall be permitted to be of the low-impedance type such that the current through the line isolation monitor, when any point of the isolated system is grounded, will not exceed twice the alarm threshold value for a period not exceeding 5 milliseconds.

Informational Note: Reduction of the monitor hazard current, provided this reduction results in an increased “not

alarm” threshold value for the fault hazard current, will increase circuit capacity.

(3) Ammeter. An ammeter calibrated in the total hazard current of the system (contribution of the fault hazard current plus monitor hazard current) shall be mounted in a plainly visible place on the line isolation monitor with the “alarm on” zone at approximately the center of the scale.

Exception: The line isolation monitor shall be permitted to be a composite unit, with a sensing section cabled to a separate display panel section on which the alarm or test functions are located.

Informational Note: It is desirable to locate the ammeter so that it is conspicuously visible to persons in the anesthetizing location.

ARTICLE 518 Assembly Occupancies

518.1 Scope. Except for the assembly occupancies explicitly covered by 520.1, this article covers all buildings or portions of buildings or structures designed or intended for the gathering together of 100 or more persons for such purposes as deliberation, worship, entertainment, eating, drinking, amusement, awaiting transportation, or similar purposes.

518.2 General Classification.

(A) Examples. Assembly occupancies shall include, but not be limited to, the following:

Armories	Exhibition halls
Assembly halls	Gymnasiums
Auditoriums	Mortuary chapels
Bowling lanes	Multipurpose rooms
Club rooms	Museums
Conference rooms	Places of awaiting transportation
Courtrooms	Places of religious worship
Dance halls	Pool rooms
Dining and drinking facilities	Restaurants
	Skating rinks

(B) Multiple Occupancies. Where an assembly occupancy forms a portion of a building containing other occupancies, Article 518 applies only to that portion of the building considered an assembly occupancy. Occupancy of any room or space for assembly purposes by less than 100 persons in a building of other occupancy, and incidental to such other occupancy, shall be classified as part of the other occupancy and subject to the provisions applicable thereto.

(C) Theatrical Areas. Where any such building structure, or portion thereof, contains a projection booth or stage platform or area for the presentation of theatrical or musical productions, either fixed or portable, the wiring for that area, including associated audience seating areas, and all equipment that is used in the referenced area, and portable equipment and wiring for use in the production that will not be connected to permanently installed wiring, shall comply with Article 520.

Informational Note: For methods of determining population capacity, see local building code or, in its absence, NFPA 101-2012, *Life Safety Code*.

518.3 Other Articles.

(A) Hazardous (Classified) Areas. Electrical installations in hazardous (classified) areas located in assembly occupancies shall comply with Article 500.

(B) Temporary Wiring. In exhibition halls used for display booths, as in trade shows, the temporary wiring shall be permitted to be installed in accordance with Article 590. Flexible cables and cords approved for hard or extra-hard usage shall be permitted to be laid on floors where protected from contact by the general public. The ground-fault circuit-interrupter requirements of 590.6 shall not apply. All other ground-fault circuit-interrupter requirements of this *Code* shall apply.

Where ground-fault circuit interrupter protection for personnel is supplied by plug-and-cord-connection to the branch circuit or to the feeder, the ground fault circuit interrupter protection shall be listed as portable ground fault circuit interrupter protection or provide a level of protection equivalent to a portable ground fault circuit interrupter, whether assembled in the field or at the factory.

Exception: Where conditions of supervision and maintenance ensure that only qualified persons will service the installation, flexible cords or cables identified in Table 400.4 for hard usage or extra-hard usage shall be permitted in cable trays used only for temporary wiring. All cords or cables shall be installed in a single layer. A permanent sign shall be attached to the cable tray at intervals not to exceed 7.5 m (25 ft). The sign shall read

CABLE TRAY FOR TEMPORARY WIRING ONLY

(C) Emergency Systems. Control of emergency systems shall comply with Article 700.

518.4 Wiring Methods.

(A) General. The fixed wiring methods shall be metal raceways, flexible metal raceways, nonmetallic raceways encased in not less than 50 mm (2 in.) of concrete, Type MI, MC, or AC cable. The wiring method shall itself qualify as an equipment grounding conductor according to 250.118 or shall contain an insulated equipment grounding conductor sized in accordance with Table 250.122.

Exception: Fixed wiring methods shall be as provided in

(a) Audio signal processing, amplification, and reproduction equipment — Article 640

(b) Communications circuits — Article 800

(c) Class 2 and Class 3 remote-control and signaling circuits — Article 725

(d) Fire alarm circuits — Article 760

(B) Nonrated Construction. In addition to the wiring methods of 518.4(A), nonmetallic-sheathed cable, Type AC cable, electrical nonmetallic tubing, and rigid nonmetallic conduit shall be permitted to be installed in those buildings or portions thereof that are not required to be of fire-rated construction by the applicable building code.

Informational Note: Fire-rated construction is the fire-resistive classification used in building codes.

(C) Spaces with Finish Rating. Electrical nonmetallic tubing and rigid nonmetallic conduit shall be permitted to be installed in club rooms, conference and meeting rooms in hotels or

motels, courtrooms, dining facilities, restaurants, mortuary chapels, museums, libraries, and places of religious worship where the following apply:

- (1) The electrical nonmetallic tubing or rigid nonmetallic conduit is installed concealed within walls, floors, and ceilings where the walls, floors, and ceilings provide a thermal barrier of material that has at least a 15-minute finish rating as identified in listings of fire-rated assemblies.
- (2) The electrical nonmetallic tubing or rigid nonmetallic conduit is installed above suspended ceilings where the suspended ceilings provide a thermal barrier of material that has at least a 15-minute finish rating as identified in listings of fire-rated assemblies.

Electrical nonmetallic tubing and rigid nonmetallic conduit are not recognized for use in other space used for environmental air in accordance with 300.22(C).

Informational Note: A finish rating is established for assemblies containing combustible (wood) supports. The finish rating is defined as the time at which the wood stud or wood joist reaches an average temperature rise of 121°C (250°F) or an individual temperature rise of 163°C (325°F) as measured on the plane of the wood nearest the fire. A finish rating is not intended to represent a rating for a membrane ceiling.

518.5 Supply. Portable switchboards and portable power distribution equipment shall be supplied only from listed power outlets of sufficient voltage and ampere rating. Such power outlets shall be protected by overcurrent devices. Such overcurrent devices and power outlets shall not be accessible to the general public. Provisions for connection of an equipment grounding conductor shall be provided. The neutral conductor of feeders supplying solid-state phase control, 3-phase, 4-wire dimmer systems shall be considered a current-carrying conductor for purposes of ampacity adjustment. The neutral conductor of feeders supplying solid-state sine wave, 3-phase, 4-wire dimming systems shall not be considered a current-carrying conductor for purposes of ampacity adjustment.

Exception: The neutral conductor of feeders supplying systems that use or may use both phase-control and sine-wave dimmers shall be considered as current-carrying for purposes of ampacity adjustment.

Informational Note: For definitions of solid-state dimmer types, see 520.2.

ARTICLE 520**Theaters, Audience Areas of Motion Picture and Television Studios, Performance Areas, and Similar Locations****I. General**

520.1 Scope. This article covers all buildings or that part of a building or structure, indoor or outdoor, designed or used for presentation, dramatic, musical, motion picture projection, or similar purposes and to specific audience seating areas within motion picture or television studios.

520.2 Definitions.

Border Light. A permanently installed overhead strip light.

Breakout Assembly. An adapter used to connect a multipole connector containing two or more branch circuits to multiple individual branch-circuit connectors.

Bundled. Cables or conductors that are tied, wrapped, taped, or otherwise periodically bound together.

Connector Strip. A metal wireway containing pendant or flush receptacles.

Drop Box. A box containing pendant- or flush-mounted receptacles attached to a multiconductor cable via strain relief or a multipole connector.

Footlight. A border light installed on or in the stage.

Grouped. Cables or conductors positioned adjacent to one another but not in continuous contact with each other.

Performance Area. The stage and audience seating area associated with a temporary stage structure, whether indoors or outdoors, constructed of scaffolding, truss, platforms, or similar devices, that is used for the presentation of theatrical or musical productions or for public presentations.

Portable Equipment. Equipment fed with portable cords or cables intended to be moved from one place to another.

Portable Power Distribution Unit. A power distribution box containing receptacles and overcurrent devices.

Proscenium. The wall and arch that separates the stage from the auditorium (house).

Solid-State Phase-Control Dimmer. A solid-state dimmer where the wave shape of the steady-state current does not follow the wave shape of the applied voltage, such that the wave shape is nonlinear.

Solid-State Sine Wave Dimmer. A solid-state dimmer where the wave shape of the steady-state current follows the wave shape of the applied voltage such that the wave shape is linear.

Stage Equipment. Equipment at any location on the premises integral to the stage production including, but not limited to, equipment for lighting, audio, special effects, rigging, motion control, projection, or video.

Stage Lighting Hoist. A motorized lifting device that contains a mounting position for one or more luminaires, with wiring devices for connection of luminaires to branch circuits, and integral flexible cables to allow the luminaires to travel over the lifting range of the hoist while energized.

Stage Switchboard. A switchboard, panelboard, or rack containing dimmers or relays with associated overcurrent protective devices, or overcurrent protective devices alone, used primarily to feed stage equipment.

Stand Lamp (Work Light). A portable stand that contains a general-purpose luminaire or lampholder with guard for the purpose of providing general illumination on the stage or in the auditorium.

Strip Light. A luminaire with multiple lamps arranged in a row.

Two-Fer. An adapter cable containing one male plug and two female cord connectors used to connect two loads to one branch circuit.

520.3 Motion Picture Projectors. Motion picture equipment and its installation and use shall comply with Article 540.

520.4 Audio Signal Processing, Amplification, and Reproduction Equipment. Audio signal processing, amplification, and reproduction equipment and its installation shall comply with Article 640.

520.5 Wiring Methods.

(A) General. The fixed wiring method shall be metal raceways, nonmetallic raceways encased in at least 50 mm (2 in.) of concrete, Type MI cable, MC cable, or AC cable containing an insulated equipment grounding conductor sized in accordance with Table 250.122.

Exception: Fixed wiring methods shall be as provided in Article 640 for audio signal processing, amplification, and reproduction equipment, in Article 800 for communications circuits, in Article 725 for Class 2 and Class 3 remote-control and signaling circuits, and in Article 760 for fire alarm circuits.

(B) Portable Equipment. The wiring for portable switchboards, stage set lighting, stage effects, and other wiring not fixed as to location shall be permitted with approved flexible cords and cables as provided elsewhere in Article 520. Fastening such cables and cords by uninsulated staples or nailing shall not be permitted.

(C) Nonrated Construction. Nonmetallic-sheathed cable, Type AC cable, electrical nonmetallic tubing, and rigid nonmetallic conduit shall be permitted to be installed in those buildings or portions thereof that are not required to be of fire-rated construction by the applicable building code.

520.6 Number of Conductors in Raceway. The number of conductors permitted in any metal conduit, rigid nonmetallic conduit as permitted in this article, or electrical metallic tubing for circuits or for remote-control conductors shall not exceed the percentage fill shown in Table 1 of Chapter 9. Where contained within an auxiliary gutter or a wireway, the sum of the cross-sectional areas of all contained conductors at any cross section shall not exceed 20 percent of the interior cross-sectional area of the auxiliary gutter or wireway. The 30-conductor limitation of 366.22 and 376.22 shall not apply.

520.7 Enclosing and Guarding Live Parts. Live parts shall be enclosed or guarded to prevent accidental contact by persons and objects. All switches shall be of the externally operable type. Dimmers, including rheostats, shall be placed in cases or cabinets that enclose all live parts.

520.8 Emergency Systems. Control of emergency systems shall comply with Article 700.

520.9 Branch Circuits. A branch circuit of any size supplying one or more receptacles shall be permitted to supply stage set lighting. The voltage rating of the receptacles shall be not less than the circuit voltage. Receptacle ampere ratings and branch-circuit conductor ampacity shall be not less than the branch-circuit overcurrent device ampere rating. Table 210.21(B)(2) shall not apply.

520.10 Portable Equipment Used Outdoors. Portable stage and studio lighting equipment and portable power distribution equipment not identified for outdoor use shall be permitted for temporary use outdoors, provided the equipment is supervised by qualified personnel while energized and barriered from the general public.

II. Fixed Stage Switchboards

520.21 General. Fixed stage switchboards shall comply with 520.21(1) through (4):

- (1) Fixed stage switchboards shall be listed.
- (2) Fixed stage switchboards shall be readily accessible but shall not be required to be located on or adjacent to the stage. Multiple fixed stage switchboards shall be permitted at different locations.
- (3) A fixed stage switchboard shall contain overcurrent protective devices for all branch circuits supplied by that switchboard.
- (4) A fixed stage switchboard shall be permitted to supply both stage and non-stage equipment.

520.25 Dimmers. Dimmers shall comply with 520.25(A) through (D).

(A) Disconnection and Overcurrent Protection. Where dimmers are installed in ungrounded conductors, each dimmer shall have overcurrent protection not greater than 125 percent of the dimmer rating and shall be disconnected from all ungrounded conductors when the master or individual switch or circuit breaker supplying such dimmer is in the open position.

(B) Resistance- or Reactor-Type Dimmers. Resistance- or series reactor-type dimmers shall be permitted to be placed in either the grounded or the ungrounded conductor of the circuit. Where designed to open either the supply circuit to the dimmer or the circuit controlled by it, the dimmer shall then comply with 404.2(B). Resistance- or reactor-type dimmers placed in the grounded neutral conductor of the circuit shall not open the circuit.

(C) Autotransformer-Type Dimmers. The circuit supplying an autotransformer-type dimmer shall not exceed 150 volts between conductors. The grounded conductor shall be common to the input and output circuits.

Informational Note: See 210.9 for circuits derived from autotransformers.

(D) Solid-State-Type Dimmers. The circuit supplying a solid-state dimmer shall not exceed 150 volts between conductors unless the dimmer is listed specifically for higher voltage operation. Where a grounded conductor supplies a dimmer, it shall be common to the input and output circuits. Dimmer chassis shall be connected to the equipment grounding conductor.

520.26 Type of Switchboard. A stage switchboard shall be either one or a combination of the types specified in 520.26(A), (B), (C), and (D).

(A) Manual. Dimmers and switches are operated by handles mechanically linked to the control devices.

(B) Remotely Controlled. Devices are operated electrically from a pilot-type control console or panel. Pilot control panels either shall be part of the switchboard or shall be permitted to be at another location.

(C) Intermediate. A stage switchboard with circuit interconnections is a secondary switchboard (patch panel) or panelboard remote to the primary stage switchboard. It shall contain overcurrent protection. Where the required branch-circuit overcurrent protection is provided in the dimmer panel, it shall be permitted to be omitted from the intermediate switchboard.

(D) Constant Power. A stage switchboard containing only overcurrent protective devices and no control elements.

520.27 Stage Switchboard Feeders.

(A) Type of Feeder. Feeders supplying stage switchboards shall be one of the types in 520.27(A)(1) through (A)(3).

(1) Single Feeder. A single feeder disconnected by a single disconnect device.

(2) Multiple Feeders to Intermediate Stage Switchboard (Patch Panel). Multiple feeders of unlimited quantity shall be permitted, provided that all multiple feeders are part of a single system. Where combined, neutral conductors in a given raceway shall be of sufficient ampacity to carry the maximum unbalanced current supplied by multiple feeder conductors in the same raceway, but they need not be greater than the ampacity of the neutral conductor supplying the primary stage switchboard. Parallel neutral conductors shall comply with 310.10(H).

(3) Separate Feeders to Single Primary Stage Switchboard (Dimmer Bank). Installations with separate feeders to a single primary stage switchboard shall have a disconnecting means for each feeder. The primary stage switchboard shall have a permanent and obvious label stating the number and location of disconnecting means. If the disconnecting means are located in more than one distribution switchboard, the primary stage switchboard shall be provided with barriers to correspond with these multiple locations.

(B) Neutral Conductor. For the purpose of ampacity adjustment, the following shall apply:

- (1) The neutral conductor of feeders supplying solid-state, phase-control 3-phase, 4-wire dimming systems shall be considered a current-carrying conductor.
- (2) The neutral conductor of feeders supplying solid-state, sine wave 3-phase, 4-wire dimming systems shall not be considered a current-carrying conductor.
- (3) The neutral conductor of feeders supplying systems that use or may use both phase-control and sine wave dimmers shall be considered as current-carrying.

(C) Supply Capacity. For the purposes of calculating supply capacity to switchboards, it shall be permissible to consider the maximum load that the switchboard is intended to control in a given installation, provided that the following apply:

- (1) All feeders supplying the switchboard shall be protected by an overcurrent device with a rating not greater than the ampacity of the feeder.
- (2) The opening of the overcurrent device shall not affect the proper operation of the egress or emergency lighting systems.

Informational Note: For calculation of stage switchboard feeder loads, see 220.40.

III. Fixed Stage Equipment Other Than Switchboards

520.40 Stage Lighting Hoists. Where a stage lighting hoist is listed as a complete assembly and contains an integral cable-handling system and cable to connect a moving wiring device to a fixed junction box for connection to permanent wiring, the extra-hard usage requirement of 520.44(C)(1) shall not apply.

520.41 Circuit Loads.

(A) Circuits Rated 20 Amperes or Less. Footlights, border lights, and proscenium sidelights shall be arranged so that no

branch circuit supplying such equipment carries a load exceeding 20 amperes.

(B) Circuits Rated Greater Than 20 Amperes. Where only heavy-duty lampholders are used, such circuits shall be permitted to comply with Article 210 for circuits supplying heavy-duty lampholders.

520.42 Conductor Insulation. Foot, border, proscenium, or portable strip lights and connector strips shall be wired with conductors that have insulation suitable for the temperature at which the conductors are operated, but not less than 125°C (257°F). The ampacity of the 125°C (257°F) conductors shall be that of 60°C (140°F) conductors. All drops from connector strips shall be 90°C (194°F) wire sized to the ampacity of 60°C (140°F) cords and cables with no more than 150 mm (6 in.) of conductor extending into the connector strip. Section 310.15(B)(3)(a) shall not apply.

Informational Note: See Table 310.104(A) for conductor types.

520.43 Footlights.

(A) Metal Trough Construction. Where metal trough construction is employed for footlights, the trough containing the circuit conductors shall be made of sheet metal not lighter than 0.81 mm (0.032 in.) and treated to prevent oxidation. Lampholder terminals shall be kept at least 13 mm (½ in.) from the metal of the trough. The circuit conductors shall be soldered to the lampholder terminals.

(B) Other-Than-Metal Trough Construction. Where the metal trough construction specified in 520.43(A) is not used, footlights shall consist of individual outlets with lampholders wired with rigid metal conduit, intermediate metal conduit, or flexible metal conduit, Type MC cable, or mineral-insulated, metal-sheathed cable. The circuit conductors shall be soldered to the lampholder terminals.

(C) Disappearing Footlights. Disappearing footlights shall be arranged so that the current supply is automatically disconnected when the footlights are replaced in the storage recesses designed for them.

520.44 Borders, Proscenium Sidelights, Drop Boxes, and Connector Strips.

(A) General. Borders and proscenium sidelights shall be as follows:

- (1) Constructed as specified in 520.43
- (2) Suitably stayed and supported
- (3) Designed so that the flanges of the reflectors or other adequate guards protect the lamps from mechanical damage and from accidental contact with scenery or other combustible material

(B) Connector Strips and Drop Boxes. Connector strips and drop boxes shall be as follows:

- (1) Suitably stayed and supported
- (2) Listed as stage and studio wiring devices

(C) Cords and Cables for Border Lights, Drop Boxes, and Connector Strips.

(1) General. Cords and cables for supply to border lights, drop boxes, and connector strips shall be listed for extra-hard usage. The cords and cables shall be suitably supported. Such cords and cables shall be employed only where flexible conductors

are necessary. Ampacity of the conductors shall be as provided in 400.5.

(2) Cords and Cables Not in Contact with Heat-Producing Equipment. Listed multiconductor extra-hard-usage-type cords and cables not in direct contact with equipment containing heat-producing elements shall be permitted to have their ampacity determined by Table 520.44. Maximum load current in any conductor with an ampacity determined by Table 520.44 shall not exceed the values in Table 520.44.

(3) Identification of Conductors in Multiconductor Extra-hard Usage Cords and Cables. Grounded (neutral) conductors shall be white without stripe or shall be identified by a distinctive white marking at their terminations. Grounding conductors shall be green with or without yellow stripe or shall be identified by a distinctive green marking at their terminations.

520.45 Receptacles. Receptacles for electrical equipment on stages shall be rated in amperes. Conductors supplying receptacles shall be in accordance with Articles 310 and 400.

520.46 Connector Strips, Drop Boxes, Floor Pockets, and Other Outlet Enclosures. Receptacles for the connection of portable stage-lighting equipment shall be pendant or mounted in suitable pockets or enclosures and shall comply with 520.45. Supply cables for connector strips and drop boxes shall be as specified in 520.44(C).

520.47 Backstage Lamps (Bare Bulbs). Lamps (bare bulbs) installed in backstage and ancillary areas where they can come in contact with scenery shall be located and guarded so as to be free from physical damage and shall provide an air space of not less than 50 mm (2 in.) between such lamps and any combustible material.

Exception: Decorative lamps installed in scenery shall not be considered to be backstage lamps for the purpose of this section.

520.48 Curtain Machines. Curtain machines shall be listed.

520.49 Smoke Ventilator Control. Where stage smoke ventilators are released by an electrical device, the circuit operating the device shall be normally closed and shall be controlled by at least two externally operable switches, one switch being placed at a readily accessible location on stage and the other where designated by the authority having jurisdiction. The device shall be designed for the full voltage of the circuit to which it is connected, no resistance being inserted. The device shall be located in the loft above the scenery and shall be enclosed in a suitable metal box having a tight, self-closing door.

IV. Portable Switchboards on Stage

520.50 Road Show Connection Panel (A Type of Patch Panel). A panel designed to allow for road show connection of portable stage switchboards to fixed lighting outlets by means of permanently installed supplementary circuits. The panel, supplementary circuits, and outlets shall comply with 520.50(A) through (D).

Table 520.44 Ampacity of Listed Extra-Hard-Usage Cords and Cables with Temperature Ratings of 75°C (167°F) and 90°C (194°F)* [Based on Ambient Temperature of 30°C (86°F)]

Size (AWG)	Temperature Rating of Cords and Cables		Maximum Rating of Overcurrent Device
	75°C (167°F)	90°C (194°F)	
14	24	28	15
12	32	35	20
10	41	47	25
8	57	65	35
6	77	87	45
4	101	114	60
2	133	152	80

*Ampacity shown is the ampacity for multiconductor cords and cables where only three copper conductors are current-carrying as described in 400.5. If the number of current-carrying conductors in a cord or cable exceeds three and the load diversity factor is a minimum of 50 percent, the ampacity of each conductor shall be reduced as shown in the following table:

Number of Conductors	Percent of Ampacity
4–6	80
7–24	70
25–42	60
43 and above	50

Note: Ultimate insulation temperature. In no case shall conductors be associated together in such a way with respect to the kind of circuit, the wiring method used, or the number of conductors such that the temperature limit of the conductors is exceeded.

A neutral conductor that carries only the unbalanced current from other conductors of the same circuit need not be considered as a current-carrying conductor.

In a 3-wire circuit consisting of two phase conductors and the neutral conductor of a 4-wire, 3-phase, wye-connected system, the neutral conductor carries approximately the same current as the line-to-neutral currents of the other conductors and shall be considered to be a current-carrying conductor.

On a 4-wire, 3-phase wye circuit where the major portion of the load consists of nonlinear loads, there are harmonic currents in the neutral conductor. Therefore, the neutral conductor shall be considered to be a current-carrying conductor.

(A) Load Circuits. Circuits shall originate from grounding-type polarized inlets of current and voltage rating that match the fixed-load receptacle.

(B) Circuit Transfer. Circuits that are transferred between fixed and portable switchboards shall have all circuit conductors transferred simultaneously.

(C) Overcurrent Protection. The supply devices of these supplementary circuits shall be protected by branch-circuit overcurrent protective devices. Each supplementary circuit, within the road show connection panel and theater, shall be protected by branch-circuit overcurrent protective devices installed within the road show connection panel.

(D) Enclosure. Panel construction shall be in accordance with Article 408.

520.51 Supply. Portable switchboards shall be supplied only from power outlets of sufficient voltage and ampere rating. Such power outlets shall include only externally operable, enclosed fused switches or circuit breakers mounted on stage or at the permanent switchboard in locations readily accessible from the stage floor. Provisions for connection of an equipment grounding conductor shall be provided. For the purposes of conductor derating, the requirements of 520.27(B) shall apply.

520.52 Overcurrent Protection for Branch Circuits. Portable switchboards shall contain overcurrent protection for branch circuits. The requirements of 210.23 shall not apply.

520.53 Construction and Feeders. Portable switchboards and feeders for use on stages shall comply with 520.53(A) through (P).

(A) Enclosure. Portable switchboards shall be placed within an enclosure of substantial construction, which shall be permitted to be arranged so that the enclosure is open during operation. Enclosures of wood shall be completely lined with sheet metal of not less than 0.51 mm (0.020 in.) and shall be well galvanized, enameled, or otherwise properly coated to prevent corrosion or be of a corrosion-resistant material.

(B) Energized Parts. There shall not be exposed energized parts within the enclosure.

(C) Switches and Circuit Breakers. All switches and circuit breakers shall be of the externally operable, enclosed type.

(D) Circuit Protection. Overcurrent devices shall be provided in each ungrounded conductor of every circuit supplied through the switchboard. Enclosures shall be provided for all overcurrent devices in addition to the switchboard enclosure.

(E) Dimmers. The terminals of dimmers shall be provided with enclosures, and dimmer faceplates shall be arranged such that accidental contact cannot be readily made with the faceplate contacts.

(F) Interior Conductors.

(1) Type. All conductors other than busbars within the switchboard enclosure shall be stranded. Conductors shall be approved for an operating temperature at least equal to the approved operating temperature of the dimming devices used in the switchboard and in no case less than the following:

- (1) Resistance-type dimmers — 200°C (392°F); or
- (2) Reactor-type, autotransformer, and solid-state dimmers — 125°C (257°F)

(2) Protection. Each conductor shall have an ampacity not less than the rating of the circuit breaker, switch, or fuse that it supplies. Circuit interrupting and bus bracing shall be in accordance with 110.9 and 110.10. The short-circuit current rating shall be marked on the switchboard.

Conductors shall be enclosed in metal wireways or shall be securely fastened in position and shall be bushed where they pass through metal.

(G) Pilot Light. A pilot light shall be provided within the enclosure and shall be connected to the circuit supplying the board so that the opening of the master switch does not cut off the supply to the lamp. This lamp shall be on an individual branch circuit having overcurrent protection rated or set at not over 15 amperes.

(H) Supply Conductors.

(1) General. The supply to a portable switchboard shall be by means of listed extra-hard usage cords or cables. The supply cords or cables shall terminate within the switchboard enclosure in an externally operable fused master switch or circuit breaker or in an **identified connector assembly**. The supply cords or cable (and connector assembly) shall have current ratings not less than the total load connected to the switchboard and shall be protected by overcurrent devices.

(2) Single-Conductor Cables. Single-conductor portable supply cable sets shall be not smaller than 2 AWG conductors. The equipment grounding conductor shall not be smaller than 6 AWG conductor. Single-conductor grounded neutral cables for a supply shall be sized in accordance with 520.53(O)(2). Where single conductors are paralleled for increased ampacity, the paralleled conductors shall be of the same length and size. Single-conductor supply cables shall be grouped together but not bundled. The equipment grounding conductor shall be permitted to be of a different type, provided it meets the other requirements of this section, and it shall be permitted to be reduced in size as permitted by 250.122. Grounded (neutral) and equipment grounding conductors shall be identified in accordance with 200.6, 250.119, and 310.110. Grounded conductors shall be permitted to be identified by marking at least the first 150 mm (6 in.) from both ends of each length of conductor with white or gray. Equipment grounding conductors shall be permitted to be identified by marking at least the first 150 mm (6 in.) from both ends of each length of conductor with green or green with yellow stripes. Where more than one nominal voltage exists within the same premises, each ungrounded conductor shall be identified by system.

(3) Supply Conductors Not Over 3.0 m (10 ft) Long. Where supply conductors do not exceed 3.0 m (10 ft) in length between supply and switchboard or supply and a subsequent overcurrent device, the supply conductors shall be permitted to be reduced in size where all of the following conditions are met:

- (1) The ampacity of the supply conductors shall be at least one-quarter of the current rating of the supply overcurrent protective device.
- (2) The supply conductors shall terminate in a single overcurrent protective device that will limit the load to the ampacity of the supply conductors. This single overcurrent device shall be permitted to supply additional overcurrent devices on its load side.
- (3) The supply conductors shall not penetrate walls, floors, or ceilings or be run through doors or traffic areas. The supply

conductors shall be adequately protected from physical damage.

- (4) The supply conductors shall be suitably terminated in an approved manner.
- (5) Conductors shall be continuous without splices or connectors.
- (6) Conductors shall not be bundled.
- (7) Conductors shall be supported above the floor in an approved manner.

(4) Supply Conductors Not Over 6.0 m (20 ft) Long. Where supply conductors do not exceed 6.0 m (20 ft) in length between supply and switchboard or supply and a subsequent overcurrent protection device, the supply conductors shall be permitted to be reduced in size where all of the following conditions are met:

- (1) The ampacity of the supply conductors shall be at least one-half of the current rating of the supply overcurrent protective device.
- (2) The supply conductors shall terminate in a single overcurrent protective device that limits the load to the ampacity of the supply conductors. This single overcurrent device shall be permitted to supply additional overcurrent devices on its load side.
- (3) The supply conductors shall not penetrate walls, floors, or ceilings or be run through doors or traffic areas. The supply conductors shall be adequately protected from physical damage.
- (4) The supply conductors shall be suitably terminated in an approved manner.
- (5) The supply conductors shall be supported in an approved manner at least 2.1 m (7 ft) above the floor except at terminations.
- (6) The supply conductors shall not be bundled.
- (7) Tap conductors shall be in unbroken lengths.

(5) Supply Conductors Not Reduced in Size. Supply conductors not reduced in size under provisions of 520.53(H)(3) or (H)(4) shall be permitted to pass through holes in walls specifically designed for the purpose. If penetration is through the fire-resistant-rated wall, it shall be in accordance with 300.21.

(I) Cable Arrangement. Cables shall be protected by bushings where they pass through enclosures and shall be arranged so that tension on the cable is not transmitted to the connections. Where power conductors pass through metal, the requirements of 300.20 shall apply.

(J) Number of Supply Interconnections. Where connectors are used in a supply conductor, there shall be a maximum number of three interconnections (mated connector pairs) where the total length from supply to switchboard does not exceed 30 m (100 ft). In cases where the total length from supply to switchboard exceeds 30 m (100 ft), one additional interconnection shall be permitted for each additional 30 m (100 ft) of supply conductor.

(K) Single-Pole Separable Connectors. Where single-pole portable cable connectors are used, they shall be listed and of the locking type. Sections 400.10, 406.7, and 406.8 shall not apply to listed single-pole separable connectors and single-conductor cable assemblies utilizing listed single-pole separable connectors. Where paralleled sets of current-carrying, single-pole separable connectors are provided as input devices, they shall be prominently labeled with a warning indicating the presence of internal parallel connections. The use of single-pole separable connectors shall comply with at least one of the following conditions:

- (1) Connection and disconnection of connectors are possible only where the supply connectors are interlocked to the source and it is not possible to connect or disconnect connectors when the supply is energized.
- (2) Line connectors are of the listed sequential-interlocking type so that load connectors shall be connected in the following sequence:
 - a. Equipment grounding conductor connection
 - b. Grounded circuit conductor connection, if provided
 - c. Ungrounded conductor connection, and that disconnection shall be in the reverse order
- (3) A caution notice shall be provided adjacent to the line connectors indicating that plug connection shall be in the following order:
 - a. Equipment grounding conductor connectors
 - b. Grounded circuit conductor connectors, if provided
 - c. Ungrounded conductor connectors, and that disconnection shall be in the reverse order

The warning sign(s) or label(s) shall comply with 110.21(B).

(L) Protection of Supply Conductors and Connectors. All supply conductors and connectors shall be protected against physical damage by an approved means. This protection shall not be required to be raceways.

(M) Flanged Surface Inlets. Flanged surface inlets (recessed plugs) that are used to accept the power shall be rated in amperes.

(N) Terminals. Terminals to which stage cables are connected shall be located so as to permit convenient access to the terminals.

(O) Neutral Conductor.

(1) Neutral Terminal. In portable switchboard equipment designed for use with 3-phase, 4-wire with ground supply, the current rating of the supply neutral terminal, and the ampacity of its associated busbar or equivalent wiring, or both, shall have an ampacity equal to at least twice the ampacity of the largest ungrounded supply terminal.

Exception: Where portable switchboard equipment is specifically constructed and identified to be internally converted in the field, in an approved manner, from use with a balanced 3-phase, 4-wire with ground supply to a balanced single-phase, 3-wire with ground supply, the supply neutral terminal and its associated busbar,

equivalent wiring, or both, shall have an ampacity equal to at least that of the largest ungrounded single-phase supply terminal.

(2) Supply Neutral Conductor. The power supply conductors for portable switchboards utilizing solid-state phase-control dimmers shall be sized considering the neutral conductor as a current-carrying conductor for ampacity adjustment purposes. The power supply conductors for portable switchboards utilizing only solid-state sine wave dimmers shall be sized considering the neutral conductor as a non-current-carrying conductor for ampacity adjustment purposes. Where single-conductor feeder cables, not installed in raceways, are used on multiphase circuits feeding portable switchboards containing solid-state phase-control dimmers, the neutral conductor shall have an ampacity of at least 130 percent of the ungrounded circuit conductors feeding the portable switchboard. Where such feeders are supplying only solid-state sine wave dimmers, the neutral conductor shall have an ampacity of at least 100 percent of the ungrounded circuit conductors feeding the portable switchboard.

(P) Qualified Personnel. The routing of portable supply conductors, the making and breaking of supply connectors and other supply connections, and the energization and de-energization of supply services shall be performed by qualified personnel, and portable switchboards shall be so marked, indicating this requirement in a permanent and conspicuous manner.

Exception: A portable switchboard shall be permitted to be connected to a permanently installed supply receptacle by other than qualified personnel, provided that the supply receptacle is protected for its current rating by an overcurrent device of not greater than 150 amperes, and where the receptacle, interconnection, and switchboard comply with all of the following:

- (a) Employ listed multipole connectors suitable for the purpose for every supply interconnection
- (b) Prevent access to all supply connections by the general public
- (c) Employ listed extra-hard usage multiconductor cords or cables with an ampacity not less than the load and not less than the ampere rating of the connectors.

V. Portable Stage Equipment Other Than Switchboards

520.61 Arc Lamps. Arc lamps, including enclosed arc lamps and associated ballasts, shall be listed. Interconnecting cord sets and interconnecting cords and cables shall be extra-hard usage type and listed.

520.62 Portable Power Distribution Units. Portable power distribution units shall comply with 520.62(A) through (E).

(A) Enclosure. The construction shall be such that no current-carrying part will be exposed.

(B) Receptacles and Overcurrent Protection.

Receptacles shall comply with 520.45 and shall have branch-circuit overcurrent protection in the box. Fuses and circuit breakers shall be protected against physical damage. Flexible cords or cables supplying pendant receptacles or cord connectors shall be listed for extra-hard usage.

(C) Busbars and Terminals. Busbars shall have an ampacity equal to the sum of the ampere ratings of all the circuits connected to the busbar. Lugs shall be provided for the connection of the master cable.

(D) Flanged Surface Inlets. Flanged surface inlets (recessed plugs) that are used to accept the power shall be rated in amperes.

(E) Cable Arrangement. Cables shall be adequately protected where they pass through enclosures and be arranged so that tension on the cable is not transmitted to the terminations.

520.63 Bracket Fixture Wiring.

(A) Bracket Wiring. Brackets for use on scenery shall be wired internally, and the fixture stem shall be carried through to the back of the scenery where a bushing shall be placed on the end of the stem. Externally wired brackets or other fixtures shall be permitted where wired with cords designed for hard usage that extend through scenery and without joint or splice in canopy of fixture back and terminate in an approved-type stage connector located, where practical, within 450 mm (18 in.) of the fixture.

(B) Mounting. Fixtures shall be securely fastened in place.

520.64 Portable Strips. Portable strips shall be constructed in accordance with the requirements for border lights and proscenium sidelights in 520.44(A). The supply cable shall be protected by bushings where it passes through metal and shall be arranged so that tension on the cable will not be transmitted to the connections.

Informational Note No. 1: See 520.42 for wiring of portable strips.

Informational Note No. 2: See 520.68(A)(3) for insulation types required on single conductors.

520.65 Festoons. Joints in festoon wiring shall be staggered. Where such lampholders have terminals of a type that puncture the insulation and make contact with the conductors, they shall be attached only to conductors of the stranded type. Lamps enclosed in lanterns or similar devices of combustible material shall be equipped with guards.

520.66 Special Effects. Electrical devices used for simulating lightning, waterfalls, and the like shall be constructed and located so that flames, sparks, or hot particles cannot come in contact with combustible material.

520.67 Multipole Branch-Circuit Cable Connectors.

Multipole branch-circuit cable connectors, male and female, for flexible conductors shall be constructed so that tension on the cord or cable is not transmitted to the connections. The female half shall be attached to the load end of the power supply cord or cable. The connector shall be rated in amperes and designed so that differently rated devices cannot be connected together; however, a 20-ampere T-slot receptacle shall be permitted to accept a 15-ampere attachment plug of the same voltage rating. Alternating-current multipole connectors shall be polarized and comply with 406.7 and 406.10.

Informational Note: See 400.10 for pull at terminals.

520.68 Conductors for Portables.**(A) Conductor Type.**

(1) General. Flexible conductors, including cable extensions, used to supply portable stage equipment shall be listed extra-hard usage cords or cables.

(2) Stand Lamps. Listed, hard usage cord shall be permitted to supply stand lamps where the cord is not subject to physical damage and is protected by an overcurrent device rated at not over 20 amperes.

(3) Luminaire Supply Cords. Listed hard usage supply cords shall be permitted to supply luminaires when all of the following conditions are met:

(1) The supply cord is not longer than 1.0 m (3.3 ft).

(2) The supply cord is attached at one end to the luminaire or a luminaire-specific listed connector that mates with a panel-mounted inlet on the body of the luminaire.

(3) The supply cord is protected by an overcurrent protective device of not more than 20 amperes.

(4) The luminaire is listed.

(5) The supply cord is not subject to physical damage.

(4) High-Temperature Applications. A special assembly of conductors in sleeving not longer than 1.0 m (3.3 ft) shall be permitted to be employed in lieu of flexible cord if the individual wires are stranded and rated not less than 125°C (257°F) and the outer sleeve is glass fiber with a wall thickness of at least 0.635 mm (0.025 in.).

Portable stage equipment requiring flexible supply conductors with a higher temperature rating where one end is permanently attached to the equipment shall be permitted to employ alternate, suitable conductors as determined by a qualified testing laboratory and recognized test standards.

ARTICLE 600 – ELECTRIC SIGNS AND OUTLINE LIGHTING

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 604 – MANUFACTURED WIRING SYSTEMS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 605 – OFFICE FURNISHINGS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 610 – CRANES AND HOISTS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

**ARTICLE 620 – ELEVATORS, DUMBWAITERS, ESCALATORS, MOVING
WALKS, PLATFORM LIFTS, AND STAIRWAY CHAIRLIFTS**

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X			X	X					X	X	X	
Adopt Entire Article as amended (amended sections listed below)			X				X	X	X				
Adopt only those sections that are listed below													
Article / Section													
620.21 (A)(5)									X				
620.71			X				X	X					

ARTICLE 625 – ELECTRIC VEHICLE CHARGING SYSTEM

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X						X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)			X ¹	X ¹	X ¹								
Adopt only those sections that are listed below		X											
Article / Section													
625.1.1		X	X										
625.52 (B)			†										
625.52 (C)			X	◆	◆								

1. This state agency adopts the entire article as amended except for those sections indicated by the following symbol: †
The ◆ designation indicates that the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures subject to HCD 1 and/or HCD 2.

ARTICLE 626 – ELECTRIFIED TRUCK PARKING SPACES

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X					
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 630 – ELECTRIC WELDERS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 640 – AUDIO SIGNAL PROCESSING, AMPLIFICATION, AND REPRODUCTION EQUIPMENT

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X						X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)			X										
Adopt only those sections that are listed below													
Article / Section													
640.3(J)			X										
640.9(B)			X										
640.9(C)			X										

ARTICLE 645 – INFORMATION TECHNOLOGY EQUIPMENT

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X						X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)			X										
Adopt only those sections that are listed below													
Article / Section													
645.10(B)(3)			X										

ARTICLE 646 – MODULAR DATA CENTERS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 647 – SENSITIVE ELECTRONIC EQUIPMENT

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 650 – PIPE ORGANS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 660 – X-RAY EQUIPMENT

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 665 – INDUCTION AND DIELECTRIC HEATING EQUIPMENT

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 668 – ELECTROLYTIC CELLS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 669 – ELECTROPLATING

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 670 – INDUSTRIAL MACHINERY

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 675 – ELECTRICALLY DRIVEN OR CONTROLLED IRRIGATION MACHINES

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 680 – SWIMMING POOLS, FOUNTAINS, AND SIMILAR INSTALLATIONS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													X
Article / Section													
680.13													X
680.14													X

ARTICLE 682 – NATURALLY AND ARTIFICIALLY MADE BODIES OF WATER

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 685 – INTEGRATED ELECTRICAL SYSTEMS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 690 – SOLAR PHOTOVOLTAIC (PV) SYSTEMS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 692 – FUEL CELL SYSTEMS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHDP				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 694 – WIND ELECTRIC SYSTEMS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHDP				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 695 – FIRE PUMPS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHDP				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X				X	X					
Adopt Entire Article as amended (amended sections listed below)									X	X		X	
Adopt only those sections that are listed below													
Article / Section													
695.3 (F)(1)									X	X		X	

630.33 Disconnecting Means. A switch or circuit breaker shall be provided by which each resistance welder and its control equipment can be disconnected from the supply circuit. The ampere rating of this disconnecting means shall not be less than the supply conductor ampacity determined in accordance with 630.31. The supply circuit switch shall be permitted as the welder disconnecting means where the circuit supplies only one welder.

630.34 Marking. A nameplate shall be provided for each resistance welder, giving the following information:

- (1) Name of manufacturer
- (2) Frequency
- (3) Primary voltage
- (4) Rated kilovolt-amperes (kVA) at 50 percent duty cycle
- (5) Maximum and minimum open-circuit secondary voltage
- (6) Short-circuit secondary current at maximum secondary voltage
- (7) Specified throat and gap setting

IV. Welding Cable

630.41 Conductors. Insulation of conductors intended for use in the secondary circuit of electric welders shall be flame retardant.

630.42 Installation. Cables shall be permitted to be installed in a dedicated cable tray as provided in 630.42(A), (B), and (C).

(A) Cable Support. The cable tray shall provide support at not greater than 150-mm (6-in.) intervals.

(B) Spread of Fire and Products of Combustion. The installation shall comply with 300.21.

(C) Signs. A permanent sign shall be attached to the cable tray at intervals not greater than 6.0 m (20 ft). The sign shall read as follows:

CABLE TRAY FOR WELDING CABLES ONLY

ARTICLE 640

Audio Signal Processing, Amplification, and Reproduction Equipment

I. General

640.1 Scope.

(A) Covered. This article covers equipment and wiring for audio signal generation, recording, processing, amplification, and reproduction; distribution of sound; public address; speech input systems; temporary audio system installations; and electronic organs or other

electronic musical instruments. This also includes audio systems subject to Article 517, Part VI, and Articles 518, 520, 525, and 530.

Informational Note: Examples of permanently installed distributed audio system locations include, but are not limited to, restaurant, hotel, business office, commercial and retail sales environments, churches, and schools. Both portable and permanently installed equipment locations include, but are not limited to, residences, auditoriums, theaters, stadiums, and movie and television studios. Temporary installations include, but are not limited to, auditoriums, theaters, stadiums (which use both temporary and permanently installed systems), and outdoor events such as fairs, festivals, circuses, public events, and concerts.

(B) Not Covered. This article does not cover the installation and wiring of fire and burglary alarm signaling devices.

640.2 Definitions. For purposes of this article, the following definitions apply.

Abandoned Audio Distribution Cable. Installed audio distribution cable that is not terminated at equipment and not identified for future use with a tag.

Audio Amplifier or Pre-Amplifier. Electronic equipment that increases the current or voltage potential, or both, of an audio signal intended for use by another piece of audio equipment. *Amplifier* is the term used to denote an audio amplifier within this article.

Audio Autotransformer. A transformer with a single winding and multiple taps intended for use with an amplifier loudspeaker signal output.

Audio Signal Processing Equipment. Electrically operated equipment that produces, processes, or both, electronic signals that, when appropriately amplified and reproduced by a loudspeaker, produce an acoustic signal within the range of normal human hearing (typically 20–20 kHz). Within this article, the terms *equipment* and *audio equipment* are assumed to be equivalent to audio signal processing equipment.

Informational Note: This equipment includes, but is not limited to, loudspeakers; headphones; pre-amplifiers; microphones and their power supplies; mixers; MIDI (musical instrument digital interface) equipment or other digital control systems; equalizers, compressors, and other audio signal processing equipment; and audio media recording and playback equipment, including turntables, tape decks and disk players (audio and multimedia), synthesizers, tone generators, and electronic organs. Electronic organs and synthesizers may have integral or separate amplification and loudspeakers. With the exception of amplifier outputs, virtually all such equipment is used to process signals

(utilizing analog or digital techniques) that have nonhazardous levels of voltage or current potential.

Audio System. Within this article, the totality of all equipment and interconnecting wiring used to fabricate a fully functional audio signal processing, amplification, and reproduction system.

Audio Transformer. A transformer with two or more electrically isolated windings and multiple taps intended for use with an amplifier loudspeaker signal output.

Equipment Rack. A framework for the support, enclosure, or both, of equipment; may be portable or stationary.

Informational Note: See ANSI/EIA/310-D-1992, *Cabinets, Racks, Panels and Associated Equipment*.

Loudspeaker. Equipment that converts an ac electric signal into an acoustic signal. The term *speaker* is commonly used to mean *loudspeaker*.

Maximum Output Power. The maximum power delivered by an amplifier into its rated load as determined under specified test conditions.

Informational Note: The maximum output power can exceed the manufacturer's rated output power for the same amplifier.

Mixer. Equipment used to combine and level match a multiplicity of electronic signals, such as from microphones, electronic instruments, and recorded audio.

• **Portable Equipment.** Equipment fed with portable cords or cables intended to be moved from one place to another.

• **Rated Output Power.** The amplifier manufacturer's stated or marked output power capability into its rated load.

• **Technical Power System.** An electrical distribution system with grounding in accordance with 250.146(D), where the equipment grounding conductor is isolated from the premises grounded conductor except at a single grounded termination point within a branch-circuit panelboard, at the originating (main breaker) branch-circuit panelboard, or at the premises grounding electrode.

Temporary Equipment. Portable wiring and equipment intended for use with events of a transient or temporary nature where all equipment is presumed to be removed at the conclusion of the event.

640.3 Locations and Other Articles. Circuits and equipment shall comply with 640.3(A) through (M), as applicable.

(A) Spread of Fire or Products of Combustion. Section 300.21 shall apply.

(B) Ducts, Plenums, and Other Air-Handling Spaces. See 300.22 for circuits and equipment installed in ducts or plenums or other space used for environmental air.

Informational Note: NFPA 90A-2012, *Standard for the Installation of Air Conditioning and Ventilation Systems*, 4.3.10.2.6.5, permits loudspeakers, loudspeaker assemblies, and their accessories listed in accordance with UL 2043-2008, *Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces*, to be installed in other spaces used for environmental air (ceiling cavity plenums).

(C) Cable Trays. Cable trays shall be used in accordance with Article 392.

Informational Note: See 725.154(C) for the use of Class 2, Class 3, and Type PLTC cable in cable trays.

(D) Hazardous (Classified) Locations. Equipment used in hazardous (classified) locations shall comply with the applicable requirements of Chapter 5.

(E) Assembly Occupancies. Equipment used in assembly occupancies shall comply with Article 518.

(F) Theaters, Audience Areas of Motion Picture and Television Studios, and Similar Locations. Equipment used in theaters, audience areas of motion picture and television studios, and similar locations shall comply with Article 520.

(G) Carnivals, Circuses, Fairs, and Similar Events. Equipment used in carnivals, circuses, fairs, and similar events shall comply with Article 525.

(H) Motion Picture and Television Studios. Equipment used in motion picture and television studios shall comply with Article 530.

(I) Swimming Pools, Fountains, and Similar Locations. Audio equipment used in or near swimming pools, fountains, and similar locations shall comply with Article 680.

(J) Combination Systems. Where the authority having jurisdiction permits audio systems for paging or music, or both, to be combined with fire alarm systems, the wiring shall comply with Article 760.

Informational Note: For installation requirements for such combination systems, refer to NFPA 72-2013 2016, *National Fire Alarm and Signaling Code*, and NFPA 101-2012, *Life Safety Code*.

(K) Antennas. Equipment used in audio systems that contain an audio or video tuner and an antenna input shall comply with Article 810. Wiring other than antenna wiring that connects such equipment to other audio equipment shall comply with this article.

(L) Generators. Generators shall be installed in accordance with 445.10 through 445.12, 445.14 through 445.16, and 445.18. Grounding of portable and vehicle-mounted generators shall be in accordance with 250.34.

(M) Organ Pipes. Additions of pipe organ pipes to an electronic organ shall be in accordance with 650.4 through 650.8.

640.4 Protection of Electrical Equipment. Amplifiers, loudspeakers, and other equipment shall be so located or protected as to guard against environmental exposure or physical damage, such as might result in fire, shock, or personal hazard.

640.5 Access to Electrical Equipment Behind Panels Designed to Allow Access. Access to equipment shall not be denied by an accumulation of wires and cables that prevents removal of panels, including suspended ceiling panels.

640.6 Mechanical Execution of Work.

(A) Neat and Workmanlike Manner. Audio signal processing, amplification, and reproduction equipment, cables, and circuits shall be installed in a neat workmanlike manner.

(B) Installation of Audio Distribution Cables. Cables installed exposed on the surface of ceilings and sidewalls shall be supported in such a manner that the audio distribution cables will not be damaged by normal building use. Such cables shall be secured by straps, staples, cable ties, hangers, or similar fittings designed and installed so as not to damage the cable. The installation shall conform to 300.4 and 300.11(A).

(C) Abandoned Audio Distribution Cables. The accessible portion of abandoned audio distribution cables shall be removed.

(D) Installed Audio Distribution Cable Identified for Future Use.

(1) Cables identified for future use shall be marked with a tag of sufficient durability to withstand the environment involved.

(2) Cable tags shall have the following information:

- (1)** Date cable was identified for future use
- (2)** Date of intended use
- (3)** Information related to the intended future use of cable

640.7 Grounding.

(A) General. Wireways and auxiliary gutters shall be connected to an equipment grounding conductor(s), to an equipment bonding jumper, or to the grounded conductor where permitted or required by 250.92(B)(1) or 250.142. Where the wireway or auxiliary gutter does not contain power-supply wires, the equipment grounding conductor shall not be required to be larger than 14 AWG copper or its equivalent. Where the wireway or auxiliary gutter contains power-supply wires, the equipment grounding conductor shall not be smaller than specified in 250.122.

(B) Separately Derived Systems with 60 Volts to Ground. Grounding of separately derived systems with 60 volts to ground shall be in accordance with 647.6.

(C) Isolated Ground Receptacles. Isolated grounding-type receptacles shall be permitted as described in 250.146(D), and for the implementation of other technical power systems in compliance with Article 250. For separately derived systems with 60 volts to ground, the branch-circuit equipment grounding conductor shall be terminated as required in 647.6(B).

Informational Note: See 406.3(D) for grounding-type receptacles and required identification.

640.8 Grouping of Conductors. Insulated conductors of different systems grouped or bundled so as to be in close physical contact with each other in the same raceway or other enclosure, or in portable cords or cables, shall comply with 300.3(C)(1).

640.9 Wiring Methods.

(A) Wiring to and Between Audio Equipment.

(1) Power Wiring. Wiring and equipment from source of power to and between devices connected to the premises wiring systems shall comply with the requirements of Chapters 1 through 4, except as modified by this article.

(2) Separately Derived Power Systems. Separately derived systems shall comply with the applicable articles of this *Code*, except as modified by this article. Separately derived systems with 60 volts to ground shall be permitted for use in audio system installations as specified in Article 647.

(3) Other Wiring. All wiring not connected to the premises wiring system or to a wiring system separately derived from the premises wiring system shall comply with Article 725.

(B) Auxiliary Power Supply Wiring. Equipment that has a separate input for an auxiliary power supply shall be wired in compliance with Article 725. Battery installation shall be in accordance with Article 480. This section shall not apply to the use of uninterruptible power supply (UPS) equipment, or other sources of supply, that are intended to act as a direct replacement for the primary circuit power source and are connected to the primary circuit input.

Informational Note: Refer to *NFPA 72-2013 2016, National Fire Alarm and Signaling Code*, where equipment is used for a fire alarm system.

(C) Output Wiring and Listing of Amplifiers. Amplifiers with output circuits carrying audio program signals shall be permitted to employ Class 1, Class 2, or Class 3 wiring where the amplifier is listed and marked for use with the specific class of wiring method. Such listing shall ensure the energy output is equivalent to the shock and fire risk of

the same class as stated in Article 725. Overcurrent protection shall be provided and shall be permitted to be inherent in the amplifier.

Audio amplifier output circuits wired using Class 1 wiring methods shall be considered equivalent to Class 1 circuits and shall be installed in accordance with 725.46, where applicable.

Audio amplifier output circuits wired using Class 2 or Class 3 wiring methods shall be considered equivalent to Class 2 or Class 3 circuits, respectively. They shall use conductors insulated at not less than the requirements of 725.179 and shall be installed in accordance with 725.133 and 725.154.

Informational Note No. 1: ANSI/UL 1711-2006, *Amplifiers for Fire Protective Signaling Systems*, contains requirements for the listing of amplifiers used for fire alarm systems in compliance with *NFPA 72-2013 2016, National Fire Alarm and Signaling Code*.

Informational Note No. 2: Examples of requirements for listing amplifiers used in residential, commercial, and professional use are found in ANSI/UL 813-1996, *Commercial Audio Equipment*; ANSI/UL 1419-2011, *Professional Video and Audio Equipment*; ANSI/UL 1492-2010, *Audio-Video Products and Accessories*; ANSI/UL 6500-2006, *Audio/Video and Musical Instrument Apparatus for Household, Commercial, and Similar Use*; and UL 62368-1-2012, *Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements*.

(D) Use of Audio Transformers and Autotransformers. Audio transformers and autotransformers shall be used only for audio signals in a manner so as not to exceed the manufacturer's stated input or output voltage, impedance, or power limitations. The input or output wires of an audio transformer or autotransformer shall be allowed to connect directly to the amplifier or loudspeaker terminals. No electrical terminal or lead shall be required to be grounded or bonded.

640.10 Audio Systems Near Bodies of Water. Audio systems near bodies of water, either natural or artificial, shall be subject to the restrictions specified in 640.10(A) and (B).

Exception: This section does not include audio systems intended for use on boats, yachts, or other forms of land or water transportation used near bodies of water, whether or not supplied by branch-circuit power.

Informational Note: See 680.27(A) for installation of underwater audio equipment.

(A) Equipment Supplied by Branch-Circuit Power. Audio system equipment supplied by branch-circuit power shall not be placed horizontally within 1.5 m (5 ft) of the inside wall of a pool, spa, hot tub, or fountain, or within 1.5 m (5 ft) of the prevailing or tidal high water mark. The equipment shall be provided with branch-circuit power

protected by a ground-fault circuit interrupter where required by other articles.

(B) Equipment Not Supplied by Branch-Circuit Power. Audio system equipment powered by a listed Class 2 power supply or by the output of an amplifier listed as permitting the use of Class 2 wiring shall be restricted in placement only by the manufacturer's recommendations.

Informational Note: See 640.10(A) for placement of the power supply or amplifier if supplied by branch-circuit power.

II. Permanent Audio System Installations

640.21 Use of Flexible Cords and Cables.

(A) Between Equipment and Branch-Circuit Power. Power supply cords for audio equipment shall be suitable for the use and shall be permitted to be used where the interchange, maintenance, or repair of such equipment is facilitated through the use of a power-supply cord.

(B) Between Loudspeakers and Amplifiers or Between Loudspeakers. Cables used to connect loudspeakers to each other or to an amplifier shall comply with Article 725. Other listed cable types and assemblies, including optional hybrid communications, signal, and composite optical fiber cables, shall be permitted.

(C) Between Equipment. Cables used for the distribution of audio signals between equipment shall comply with Article 725. Other listed cable types and assemblies, including optional hybrid communications, signal, and composite optical fiber cables, shall be permitted. Other cable types and assemblies specified by the equipment manufacturer as acceptable for the use shall be permitted in accordance with 110.3(B).

(D) Between Equipment and Power Supplies Other Than Branch-Circuit Power. The following power supplies, other than branch-circuit power supplies, shall be installed and wired between equipment in accordance with the requirements of this *Code* for the voltage and power delivered:

- (1) Storage batteries
- (2) Transformers
- (3) Transformer rectifiers
- (4) Other ac or dc power supplies

Informational Note: For some equipment, these sources such as in items (1) and (2) serve as the only source of power. These could, in turn, be supplied with intermittent or continuous branch-circuit power.

(E) Between Equipment Racks and Premises Wiring System. Flexible cords and cables shall be permitted for the electrical connection of permanently installed equipment racks to the premises wiring system to facilitate

645.6 Cables Not in Information Technology Equipment Room. Cables extending beyond the information technology equipment room shall be subject to the applicable requirements of this *Code*.

645.10 Disconnecting Means. An approved means shall be provided to disconnect power to all electronic equipment in the information technology equipment room or in designated zones within the room. There shall also be a similar approved means to disconnect the power to all dedicated HVAC systems serving the room or designated zones and shall cause all required fire/smoke dampers to close. The disconnecting means shall comply with either 645.10(A) or (B).

Exception: Installations qualifying under the provisions of Article 685.

(A) Remote Disconnect Controls.

(1) Remote disconnect controls shall be located at approved locations readily accessible in case of fire to authorized personnel and emergency responders.

(2) The remote disconnect means for the control of electronic equipment power and HVAC systems shall be grouped and identified. A single means to control both systems shall be permitted.

(3) Where multiple zones are created, each zone shall have an approved means to confine fire or products of combustion to within the zone.

(4) Additional means to prevent unintentional operation of remote disconnect controls shall be permitted.

Informational Note: For further information, see NFPA 75-2013, *Standard for the Protection of Information Technology Equipment*.

(B) Critical Operations Data Systems. Remote disconnecting controls shall not be required for critical operations data systems when all of the following conditions are met:

(1) An approved procedure has been established and maintained for removing power and air movement within the room or zone.

(2) Qualified personnel are continuously available to meet emergency responders and to advise them of disconnecting methods.

(3) A smoke-sensing fire detection system is in place.

Informational Note: For further information, see NFPA 72-2013 2016, *National Fire Alarm and Signaling Code*.

(4) An approved fire suppression system suitable for the application is in place.

(5) Cables installed under a raised floor, other than branch-circuit wiring, and power cords are installed in compliance with 645.5(E)(2) or (E)(3), or in compliance with 300.22(C), 725.135(B), and Table 725.154; 770.113(C) and Table 770.154(a); 800.113(C) and Table 800.154(a); or 820.113(C) and Table 820.154(a).

645.11 Uninterruptible Power Supplies (UPSs). Except for installations and constructions covered in 645.11(1) or (2), UPS systems installed within the information technology equipment room, and their supply and output circuits, shall comply with 645.10. The disconnecting means shall also disconnect the battery from its load.

(1) Installations qualifying under the provisions of Article 685

(2) Power sources limited to 750 volt-amperes or less derived either from UPS equipment or from battery circuits integral to electronic equipment

645.14 System Grounding. Separately derived power systems shall be installed in accordance with the provisions of Parts I and II of Article 250. Power systems derived within listed information technology equipment that supply information technology systems through receptacles or cable assemblies supplied as part of this equipment shall not be considered separately derived for the purpose of applying 250.30.

645.15 Equipment Grounding and Bonding. All exposed non-current-carrying metal parts of an information technology system shall be bonded to the equipment grounding conductor in accordance with Parts I, V, VI, VII, and VIII of Article 250 or shall be double insulated. Power systems derived within listed information technology equipment that supply information technology systems through receptacles or cable assemblies supplied as part of this equipment shall not be considered separately derived for the purpose of applying 250.30. Where signal reference structures are installed, they shall be bonded to the equipment grounding conductor provided for the information technology equipment. Any auxiliary grounding electrode(s) installed for information technology equipment shall be installed in accordance with 250.54.

Informational Note No. 1: The bonding requirements in the product standards governing this listed equipment ensure that it complies with Article 250.

Informational Note No. 2: Where isolated grounding-type receptacles are used, see 250.146(D) and 406.3(D).

645.16 Marking. Each unit of an information technology system supplied by a branch circuit shall be provided with a manufacturer's nameplate, which shall also include the input power requirements for voltage, frequency, and maximum rated load in amperes.

645.17 Power Distribution Units. Power distribution units that are used for information technology equipment shall be permitted to have multiple panelboards within a single cabinet if the power distribution unit is utilization equipment listed for information technology application.

645.25 Engineering Supervision. As an alternative to the feeder and service load calculations required by Parts III and IV of Article 220, feeder and service load calculations for new or existing loads shall be permitted to be used if provided by qualified persons under engineering supervision.

645.27 Selective Coordination. Critical operations data system(s) overcurrent protective devices shall be selectively coordinated with all supply-side overcurrent protective devices.

ARTICLE 646 Modular Data Centers

I. General

646.1 Scope. This article covers modular data centers.

Informational Note No. 1: Modular data centers include the installed information technology equipment (ITE) and support equipment, electrical supply and distribution, wiring and protection, working space, grounding, HVAC, and the like, that are located in an equipment enclosure.

Informational Note No. 2: For further information, see NFPA 75-2013, *Standard for the Protection of Information Technology Equipment*, which covers the requirements for the protection of information technology equipment and systems in an information technology equipment room.

646.2 Definitions. The definitions in 645.2 shall apply. For the purposes of this article, the following additional definition applies.

Modular Data Center (MDC). Prefabricated units, rated 600 volts or less, consisting of an outer enclosure housing multiple racks or cabinets of information technology equipment (ITE) (e.g., servers) and various support equipment, such as electrical service and distribution equipment, HVAC systems, and the like.

Informational Note No. 1: A typical construction may use a standard ISO shipping container or other structure as the outer enclosure, racks or cabinets of ITE, service-entrance equipment and power distribution components, power storage such as a UPS, and an air or liquid cooling system. Modular data centers are intended for fixed installation, either indoors or outdoors, based on their construction and resistance to environmental conditions. MDCs can be configured as an all-in-one system housed in a single equipment enclosure or as a system with the

support equipment housed in separate equipment enclosures.

Informational Note No. 2: For information on listing requirements for both information technology equipment and communications equipment, see UL 60950-1-2011, *Information Technology Equipment — Safety — Part 1: General Requirements*, and UL 62368-1-2012, *Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements*.

Informational Note No. 3: *Modular data centers* as defined in this article are sometimes referred to as containerized data centers.

Informational Note No. 4: Equipment enclosures housing only support equipment (e.g., HVAC or power distribution equipment) that are not part of a specific modular data center are not considered a modular data center as defined in this article.

646.3 Other Articles. Circuits and equipment shall comply with 646.3(A) through (N) as applicable. Wherever the requirements of other articles of this *Code* and Article 646 differ, the requirements of Article 646 shall apply.

(A) Spread of Fire or Products of Combustion. Sections 300.21, 770.26, 800.26, and 820.26 shall apply to penetrations of a fire-resistant room boundary, if provided.

(B) Plenums. Sections 300.22(C)(1), 725.154(A), 760.53(B)(2), 760.154(A), 770.113(C), 800.113(C), and Table 725.154, Table 760.154, Table 770.154(a), Table 800.154(a), and Table 820.154(a) shall apply to wiring and cabling in other spaces used for environmental air (plenums).

Informational Note: Environmentally controlled working spaces, aisles, and equipment areas in an MDC are not considered a plenum.

(C) Grounding. Grounding and bonding of an MDC shall comply with Article 250. The non-current-carrying conductive members of optical fiber cables in an MDC shall be grounded in accordance with 770.114. Grounding and bonding of communications protectors, cable shields, and non-current-carrying metallic members of cable shall comply with Part IV of Article 800.

(D) Electrical Classification of Data Circuits. Section 725.121(A)(4) shall apply to the electrical classification of listed information technology equipment signaling circuits. Sections 725.139(D)(1) and 800.133(A)(1)(b) shall apply to the electrical classification of Class 2 and Class 3 circuits in the same cable with communications circuits.

(E) Fire Alarm Equipment. The provisions of Parts I, II, and III of Article 760 shall apply to fire alarm system equipment installed in an MDC, where provided.

(F) Communications Equipment. Parts I, II, III, IV, and V of Article 800 shall apply to communications equipment installed in an MDC.

ARTICLE 700 – EMERGENCY SYSTEMS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X			X	X		X	X					
Adopt Entire Article as amended (amended sections listed below)			X						X	X	X	X	
Adopt only those sections that are listed below													
Article / Section													
700.3(A)									X	X	X	X	
700.3(B)									X				
700.5(C)									X	X	X	X	
700.12(B)(2) w/Exc. 1,2, & 3			X						X	X	X	X	

ARTICLE 701 – LEGALLY REQUIRED STANDBY SYSTEMS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	◆	◆		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

The ◆ designation indicates that the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures subject to HCD 1 and/or HCD 2.

ARTICLE 702 – OPTIONAL STANDBY SYSTEMS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 705 – INTERCONNECTED ELECTRIC POWER PRODUCTION SOURCES

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 706 – ENERGY STORAGE SYSTEMS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article			X										
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 708 – CRITICAL OPERATIONS POWER SYSTEMS (COPS)

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article			X	X			X	X					
Adopt Entire Article as amended (amended sections listed below)									X	X	X	X	
Adopt only those sections that are listed below													
Article / Section													
708.1									X	X	X	X	

ARTICLE 720 – CIRCUITS AND EQUIPMENT OPERATING AT LESS THAN 50 VOLTS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

**ARTICLE 725 – CLASS 1, CLASS 2, AND CLASS 3 REMOTE-CONTROL,
SIGNALING, AND POWER-LIMITED CIRCUITS**

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 727 – INSTRUMENTATION TRAY CABLE: TYPE ITC

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 728 – FIRE-RESISTIVE CABLE SYSTEMS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article			X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 750 – ENERGY MANAGEMENT SYSTEMS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHPD				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article			X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

ARTICLE 760 – FIRE ALARM SYSTEMS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHDP				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X			◆	◆		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)			X										
Adopt only those sections that are listed below						X	X	X					
Article / Section													
760 FPN						X							
760.1			X										
760.1.1			X										
760.176 (F)(2)			X										
760.179 (G)(2)			X										

The ◆ designation indicates that the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures subject to HCD 1 and/or HCD 2.

ARTICLE 770 – OPTICAL FIBER CABLES AND RACEWAYS

Adopting Agency	BSC	BSC- CG	SFM	HCD		DSA			OSHDP				DPH
				1	2	AC	SS	SS/CC	1	2	3	4	
Adopt Entire Article	X		X	X	X		X	X	X	X	X	X	
Adopt Entire Article as amended (amended sections listed below)													
Adopt only those sections that are listed below													
Article / Section													

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Chapter 7 Special Conditions

ARTICLE 700 Emergency Systems

I. General

700.1 Scope. The provisions of this article apply to the electrical safety of the installation, operation, and maintenance of emergency systems consisting of circuits and equipment intended to supply, distribute, and control electricity for illumination, power, or both, to required facilities when the normal electrical supply or system is interrupted.

Informational Note No. 1: For further information regarding wiring and installation of emergency systems in health care facilities, see Article 517.

Informational Note No. 2: For further information regarding performance and maintenance of emergency systems in health care facilities, see NFPA 99-2012, *Health Care Facilities Code*.

Informational Note No. 3: For specification of locations where emergency lighting is considered essential to life safety, see NFPA 101-2012, *Life Safety Code*.

Informational Note No. 4: For further information regarding performance of emergency and standby power systems, see NFPA 110-2013, *Standard for Emergency and Standby Power Systems*.

700.2 Definitions.

Emergency Systems. Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction. These systems are intended to automatically supply illumination, power, or both, to designated areas and equipment in the event of failure of the normal supply or in the event of accident to elements of a system intended to supply, distribute, and control power and illumination essential for safety to human life. (See Figure 700.2.)

Informational Note: 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 communications systems, industrial processes where current interruption would produce serious life safety or health hazards, and similar functions.

Relay, Automatic Load Control. A device used to set normally dimmed or normally-off switched emergency lighting equipment to full power illumination levels in the event of a loss of the normal supply by bypassing the dimming/switching controls, and to return the emergency lighting equipment to normal status when the device senses the normal supply has been restored.

Informational Note: See ANSI/UL 924, *Emergency Lighting and Power Equipment*, for the requirements covering automatic load control relays.

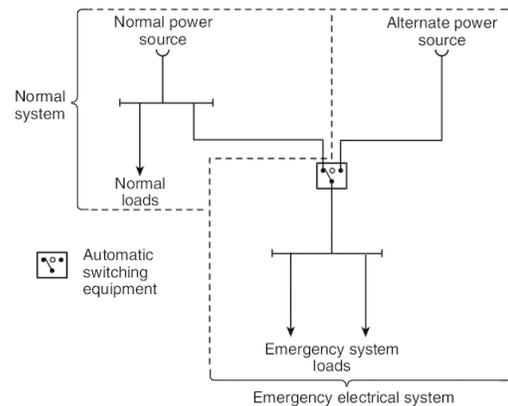


Figure 700.2 Emergency Systems.

700.3 Tests and Maintenance.

(A) Conduct or Witness Test. The authority having jurisdiction shall conduct or witness a test of the complete system upon installation and periodically afterward.

[OSHPD 1, 2, 3 & 4] Permanently installed on-site generator sets for health care facilities shall be tested in accordance with NFPA 110, *Standard for Emergency and Standby Power Systems*, Section 7.13, *Installation Acceptance*.

(B) Tested Periodically. Systems shall be tested periodically on a schedule acceptable to the authority having jurisdiction to ensure the systems are maintained in proper operating condition. [OSHPD 1] The authority having jurisdiction is Department of Public Health, Licensing and Certification.

(C) Battery Systems Maintenance. Where battery systems or unit equipments are involved, including batteries used for starting, control, or ignition in auxiliary engines, the authority having jurisdiction shall require periodic maintenance.

(D) Written Record. A written record shall be kept of such tests and maintenance.

(E) Testing Under Load. Means for testing all emergency lighting and power systems during maximum anticipated load conditions shall be provided.

Informational Note: For information on testing and maintenance of emergency power supply systems (EPSSs), see NFPA 110-2013, *Standard for Emergency and Standby Power Systems*.

700.4 Capacity.

(A) Capacity and Rating. An emergency system shall have adequate capacity and rating for all loads to be operated simultaneously. The emergency system equipment shall be suitable for the maximum available fault current at its terminals.

(B) Selective Load Pickup, Load Shedding, and Peak Load Shaving. The alternate power source shall be permitted to supply emergency, legally required standby, and optional standby system loads where the source has adequate capacity or where automatic selective load pickup and load shedding is provided as needed to ensure adequate power to (1) the emergency circuits, (2) the legally required standby circuits, and (3) the optional standby circuits, in that order of priority.

(B) Three Phase. Three-phase inverters and 3-phase ac modules in interactive systems shall have all phases automatically de-energized upon loss of, or unbalanced, voltage in one or more phases unless the interconnected system is designed so that significant unbalanced voltages will not result.

III. Generators

705.130 Overcurrent Protection. Conductors shall be protected in accordance with Article 240. Equipment and conductors connected to more than one electrical source shall have overcurrent devices located so as to provide protection from all sources. Generators shall be protected in accordance with 445.12.

705.143 Synchronous Generators. Synchronous generators in a parallel system shall be provided with the necessary equipment to establish and maintain a synchronous condition.

ARTICLE 706 Energy Storage Systems

Part I. General

706.1 Scope. This article applies to all permanently installed energy storage systems (ESS) operating at over 50 volts ac or 60 volts dc that may be stand-alone or interactive with other electric power production sources.

Informational Note: The following standards are frequently referenced for the installation of energy storage systems:

- (1) NFPA 111-2013, *Standard on Stored Electrical Energy Emergency and Standby Systems*
- (2) IEEE 484-2008, *Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications*
- (3) IEEE 485-1997, *Recommended Practice for Sizing Vented Lead-Acid Storage Batteries for Stationary Applications*
- (4) IEEE 1145-2007, *Recommended Practice for Installation and Maintenance of Nickel-Cadmium Batteries for Photovoltaic (PV) Systems*
- (5) IEEE 1187-2002, *Recommended Practice for Installation Design, and Installation of Valve-Regulated Lead-Acid Batteries for Stationary Applications*
- (6) IEEE 1578-2007, *Recommended Practice for Stationary Battery Electrolyte Spill Containment and Management*
- (7) IEEE 1635/ASHRAE 21-2012, *Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications*
- (8) UL 810A, *Electrochemical Capacitors*

(9) UL 1973, *Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications*

(10) UL 1989, *Standard for Standby Batteries*

(11) UL Subject 2436, *Spill Containment For Stationary Lead Acid Battery Systems*

(12) UL Subject 9540, *Safety of Energy Storage Systems and Equipment*

706.2 Definitions.

Battery. Two or more cells connected together electrically in series, in parallel, or a combination of both to provide the required operating voltage and current levels.

Cell. The basic electrochemical unit, characterized by an anode and a cathode, used to receive, store, and deliver electrical energy.

Container. A vessel that holds the plates, electrolyte, and other elements of a single unit, comprised of one or more cells, in a battery. It can be referred to as a jar or case.

Diversion Charge Controller. Equipment that regulates the charging process of an ESS by diverting power from energy storage to direct-current or alternating-current loads or to an interconnected utility service.

Electrolyte. The medium that provides the ion transport mechanism between the positive and negative electrodes of a cell.

Energy Storage System (ESS). One or more components assembled together capable of storing energy for use at a future time. ESS(s) can include but is not limited to batteries, capacitors, and kinetic energy devices (e.g., flywheels and compressed air). These systems can have ac or dc output for utilization and can include inverters and converters to change stored energy into electrical energy.

Energy Storage System, Self-Contained. Energy storage systems where the components such as cells, batteries, or modules and any necessary controls, ventilation, illumination, fire suppression, or alarm systems are assembled, installed, and packaged into a singular energy storage container or unit.

Informational Note: Self-contained systems will generally be manufactured by a single entity, tested and listed to safety standards relevant to the system, and readily connected on site to the electrical system and in the case of multiple systems to each other.

Energy Storage System, Pre-Engineered of Matched Components. Energy storage systems that are not self-contained systems but instead are pre-engineered and field-assembled using separate components supplied as a system by a singular entity that are matched and intended to be assembled as an energy storage system at the system installation site.

Informational Note: Pre-engineered systems of matched components for field assembly as a system will generally be designed by a single entity and comprised of components that are tested and listed separately or as an assembly.

Energy Storage System, Other. Energy storage systems that are not self-contained or pre-engineered systems of matched components but instead are composed of individual components assembled as a system.

Informational Note: Other systems will generally be comprised of different components combined on site to create an ESS. Those components would generally be tested and listed to safety standards relevant to the application.

Flow Battery. An energy storage component similar to a fuel cell that stores its active materials in the form of two electrolytes external to the reactor interface. When in use, the electrolytes are transferred between reactor and storage tanks.

Informational Note: Two commercially available flow battery technologies are zinc bromine and vanadium redox, sometimes referred to as pumped electrolyte ESS.

Intercell Connector. An electrically conductive bar or cable used to connect adjacent cells.

Intertier Connector. In a battery system, an electrical conductor used to connect two cells on different tiers of the same rack or different shelves of the same rack.

Inverter Input Circuit. Conductors between the inverter and the ESS in stand-alone and multimode inverter systems.

Inverter Output Circuit. Conductors between the inverter and another electric power production source, such as a utility for an electrical production and distribution network.

Inverter Utilization Output Circuit. Conductors between the multimode or standalone inverter and utilization equipment.

Nominal Voltage (Battery or Cell). The value assigned to a cell or battery of a given voltage class for the purpose of convenient designation. The operating voltage of the cell or battery may vary above or below this value.

Sealed Cell or Battery. A cell or battery that has no provision for the routine addition of water or electrolyte or for external measurement of electrolyte specific gravity.

Informational Note: Some cells that are considered to be sealed under conditions of normal use, such as valve-regulated lead-acid or some lithium cells, contain pressure relief valves.

Terminal. That part of a cell, container, or battery to which an external connection is made (commonly identified as a post, pillar, pole, or terminal post).

706.3 Other Articles. Wherever the requirements of other articles of this Code and Article 706 differ, the requirements of Article 706 shall apply. If the ESS is capable of being operated in parallel with a primary source(s) of electricity, the requirements in 705.6, 705.12, 705.14, 705.16, 705.32, 705.40, 705.100, 705.143, and Part IV of Article 705 shall apply.

706.4 System Classification. ESS shall be classified as one of the types described as follows:

(1) ESS, self-contained

Informational Note: Some self-contained systems may be listed.

(2) ESS, pre-engineered of matched components

(3) ESS, other

706.5 Equipment. Monitors, controls, switches, fuses, circuit breakers, power conversion systems, inverters and transformers, energy storage components, and other components of the energy storage system other than lead-acid batteries, shall be listed. Alternatively, self-contained ESS shall be listed as a complete energy storage system.

706.6 Multiple Systems. Multiple ESSs shall be permitted to be installed in or on a single building or structure.

706.7 Disconnecting Means.

(A) ESS Disconnecting Means. A disconnecting means shall be provided for all ungrounded conductors derived from an ESS. A disconnecting means shall be readily accessible and located within sight of the ESS.

Informational Note: See 240.21(H) for information on the location of the overcurrent device for conductors.

(B) Remote Actuation. Where controls to activate the disconnecting means of an ESS are not located within sight of the system, the disconnecting means shall be capable of being locked in the open position, in accordance with 110.25, and the location of the controls shall be field marked on the disconnecting means.

(C) Busway. Where a dc busway system is installed, the disconnecting means shall be permitted to be incorporated into the busway.

(D) Notification. The disconnecting means shall be legibly marked in the field. The marking shall meet the requirements of 110.21(B) and shall include the following:

(1) Nominal ESS voltage

(2) Maximum available short-circuit current derived from the ESS

(3) The associated clearing time or arc duration based on the available short-circuit current from the ESS and associated overcurrent protective devices if applicable

(4) Date the calculation was performed

Exception: The labeling in 706.7(D)(1) through (D)(4) shall not be required if an arc flash label is applied in accordance with acceptable industry practice.

Informational Note No. 1: Industry practices for equipment labeling are described in NFPA 70E-2015,

Standard for Electrical Safety in the Workplace. This standard provides specific criteria for developing arc-flash labels for equipment that provides nominal system voltage, incident energy levels, arc-flash boundaries, minimum required levels of personal protective equipment, and so forth.

Informational Note No. 2: Battery equipment suppliers can provide information about short-circuit current on any particular battery model.

(E) Partitions and Distance. Where energy storage system input and output terminals are more than 1.5 m (5 ft) from connected equipment, or where the circuits from these terminals pass through a wall or partition, the installation shall comply with the following:

- (1) A disconnecting means shall be provided at the energy storage system end of the circuit. Fused disconnecting means or circuit breakers shall be permitted to be used.
- (2) A second disconnecting means located at the connected equipment shall be installed where the disconnecting means required by 706.7(E)(1) is not within sight of the connected equipment.

Informational Note No. 1: For remote disconnect controls in information technology equipment rooms, see 645.10.

Informational Note No. 2: For overcurrent protection of batteries, see 240.21(H).

- (3) Where fused disconnecting means are used, the line terminals of the disconnecting means shall be connected toward the energy storage system terminals.
- (4) Disconnecting means shall be permitted to be installed in energy storage system enclosures where explosive atmospheres can exist if listed for hazardous locations.
- (5) Where the disconnecting means in (1) is not within sight of the disconnecting means in (2), placards or directories shall be installed at the locations of all disconnecting means indicating the location of all other disconnecting means.

706.8 Connection to Other Energy Sources. Connection to other energy sources shall comply with the requirements of 705.12.

(A) Load Disconnect. A load disconnect that has multiple sources of power shall disconnect all energy sources when in the off position.

(B) Identified Interactive Equipment. Only inverters and ac modules listed and identified as interactive shall be permitted on interactive systems.

(C) Loss of Interactive System Power. Upon loss of primary source, an ESS with a utility interactive inverter shall comply with the requirements of 705.40.

(D) Unbalanced Interconnections. Unbalanced connections between an energy storage system and electric power production sources shall be in accordance with 705.100.

(E) Point of Connection. The point of connection between an energy storage system and electric power production sources shall be in accordance with 705.12.

706.10 Energy Storage System Locations. Battery locations shall conform to 706.10(A), (B), and (C).

(A) Ventilation. Provisions appropriate to the energy storage technology shall be made for sufficient diffusion and ventilation of any possible gases from the storage device, if present, to prevent the accumulation of an explosive mixture. A pre-engineered or self-contained ESS shall be permitted to provide ventilation in accordance with the manufacturer's recommendations and listing for the system.

Informational Note No. 1: See NFPA 1-2015, Fire Code, Chapter 52, for ventilation considerations for specific battery chemistries.

Informational Note No. 2: Some storage technologies do not require ventilation.

Informational Note No. 3: A source for design of ventilation of battery systems is IEEE 1635-2012/ASHRAE Guideline 21-2012 Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications, and the UBC.

Informational Note No. 4: Fire protection considerations are addressed in NFPA 1-2015, Fire Code.

(B) Guarding of Live Parts. Guarding of live parts shall comply with 110.27.

(C) Spaces About ESS Components. Spaces about the ESS shall comply with 110.26. Working space shall be measured from the edge of the ESS modules, battery cabinets, racks, or trays. For battery racks, there shall be a minimum clearance of 25 mm (1 in.) between a cell container and any wall or structure on the side not requiring access for maintenance. ESS modules, battery cabinets, racks, or trays shall be permitted to contact adjacent walls or structures, provided that the battery shelf has a free air space for not less than 90 percent of its length. Pre-engineered and self-contained ESSs shall be permitted to have working space between components within the system in accordance with the manufacturer's recommendations and listing of the system.

Informational Note: Additional space is often needed to accommodate ESS equipment hoisting equipment, tray removal, or spill containment.

(D) Egress. A personnel door(s) intended for entrance to and egress from rooms designated as ESS rooms shall open in the direction of egress and shall be equipped with listed panic hardware.

(E) Illumination. Illumination shall be provided for working spaces associated with ESS and their equipment and components. Luminaires shall not be controlled by automatic means only. Additional luminaires shall not be required where the work space is illuminated by an

adjacent light source. The location of luminaires shall not do either of the following:

- (1) Expose personnel to energized system components while performing maintenance on the luminaires in the system space
- (2) Create a hazard to the system or system components upon failure of the luminaire

706.11 Directory. ESS shall be indicated by 706.11(A) and (B). The markings or labels shall be in accordance with 110.21(B).

(A) Directory. A permanent plaque or directory denoting all electric power sources on or in the premises shall be installed at each service equipment location and at locations of all electric power production sources capable of being interconnected.

Exception: Installations with large numbers of power production sources shall be permitted to be designated by groups.

(B) Facilities with Stand-Alone Systems. Any structure or building with an ESS that is not connected to a utility service source and is a stand-alone system shall have a permanent plaque or directory installed on the exterior of the building or structure at a readily visible location acceptable to the authority having jurisdiction. The plaque or directory shall indicate the location of system disconnecting means and that the structure contains a stand-alone electrical power system.

Part II. Circuit Requirements

706.20 Circuit Sizing and Current.

(A) Maximum Rated Current for a Specific Circuit.

The maximum current for the specific circuit shall be calculated in accordance with 706.20(A)(1) through (A)(5).

(1) Nameplate-Rated Circuit Current. The nameplate(s)-rated circuit current shall be the rated current indicated on the ESS nameplate(s) or system listing for pre-engineered or self-contained systems of matched components intended for field assembly as a system.

(2) Inverter Output Circuit Current. The maximum current shall be the inverter continuous output current rating.

(3) Inverter Input Circuit Current. The maximum current shall be the continuous inverter input current rating when the inverter is producing rated power at the lowest input voltage.

(4) Inverter Utilization Output Circuit Current. The maximum current shall be the continuous inverter output current rating when the inverter is producing rated power at the lowest input voltage.

(5) DC to DC Converter Output Current. The maximum current shall be the dc-to-dc converter continuous output current rating.

(B) Conductor Ampacity and Overcurrent Device Ratings. The ampacity of the feeder circuit conductors from the ESS(s) to the wiring system serving the loads to be serviced by the system shall not be less than the greater of the (1) nameplate(s) rated circuit current as determined in accordance with 706.20(A) or (2) the rating of the ESS(s) overcurrent protective device(s).

(C) Ampacity of Grounded or Neutral Conductor. If the output of a single-phase, 2-wire ESS output(s) is connected to the grounded or neutral conductor and a single ungrounded conductor of a 3-wire system or of a 3-phase, 4-wire, wye-connected system, the maximum unbalanced neutral load current plus the ESS(s) output rating shall not exceed the ampacity of the grounded or neutral conductor.

706.21 Overcurrent Protection.

(A) Circuits and Equipment. ESS circuit conductors shall be protected in accordance with the requirements of Article 240. Protection devices for ESS circuits shall be in accordance with the requirements of 706.21(B) through (F). Circuits shall be protected at the source from overcurrent.

(B) Overcurrent Device Ampere Ratings. Overcurrent protective devices, where required, shall be rated in accordance with Article 240 and the rating provided on systems serving the ESS and shall be not less than 125 percent of the maximum currents calculated in 706.20(A).

(C) Direct Current Rating. Overcurrent protective devices, either fuses or circuit breakers, used in any dc portion of an ESS shall be listed and for dc and shall have the appropriate voltage, current, and interrupting ratings for the application.

(D) Current Limiting. A listed and labeled current-limiting overcurrent protective device shall be installed adjacent to the ESS for each dc output circuit.

Exception: Where current-limiting overcurrent protection is provided for the dc output circuits of a listed ESS, additional current-limiting overcurrent devices shall not be required.

(E) Fuses. Means shall be provided to disconnect any fuses associated with ESS equipment and components when the fuse is energized from both directions and is accessible to other than qualified persons. Switches, pullouts, or similar devices that are rated for the application shall be permitted to serve as a means to disconnect fuses from all sources of supply.

(F) Location. Where ESS input and output terminals are more than 1.5 m (5 ft) from connected equipment, or where the circuits from these terminals pass through a wall or partition, overcurrent protection shall be provided at the ESS.

706.23 Charge Control.

(A) General. Provisions shall be provided to control the charging process of the ESS. All adjustable means for control of the charging process shall be accessible only to qualified persons.

Informational Note: Certain types of energy storage equipment such as valve-regulated lead acid or nickel cadmium can experience thermal failure when overcharged.

(B) Diversion Charge Controller.

(1) Sole Means of Regulating Charging. An ESS employing a diversion charge controller as the sole means of regulating charging shall be equipped with a second independent means to prevent overcharging of the storage device.

(2) Circuits with Diversion Charge Controller and Diversion Load. Circuits containing a diversion charge controller and a diversion load shall comply with the following:

- (1) The current rating of the diversion load shall be less than or equal to the current rating of the diversion load charge controller. The voltage rating of the diversion load shall be greater than the maximum ESS voltage. The power rating of the diversion load shall be at least 150 percent of the power rating of the charging source.
- (2) The conductor ampacity and the rating of the overcurrent device for this circuit shall be at least 150 percent of the maximum current rating of the diversion charge controller.

(3) Energy Storage Systems Using Utility-Interactive Inverters. Systems using utility-interactive inverters to control energy storage state-of-charge by diverting excess power into the utility system shall comply with 706.23(B)(3)(a) and (B)(3)(b).

(a) These systems shall not be required to comply with 706.23(B)(2).

(b) These systems shall have a second, independent means of controlling the ESS charging process for use when the utility is not present or when the primary charge controller fails or is disabled.

(C) Charge Controllers and DC-to-DC Converters.

Where charge controllers and other DC-to-DC power converters that increase or decrease the output current or output voltage with respect to the input current or input voltage are installed, all of the following shall apply:

- (1) The ampacity of the conductors in output circuits shall be based on the maximum rated continuous output current of the charge controller or converter for the selected output voltage range.

- (2) The voltage rating of the output circuits shall be based on the maximum voltage output of the charge controller or converter for the selected output voltage range.

Part III. Electrochemical Energy Storage Systems

Part III of this article applies to ESSs that are comprised of sealed and non-sealed cells or batteries or system modules that are comprised of multiple sealed cells or batteries that are not components within a listed product.

Informational Note: An energy storage component, such as batteries, that are integrated into a larger piece of listed equipment, such as an uninterruptible power supply (UPS), are examples of components within a listed product.

706.30 Installation of Batteries.

(A) Dwelling Units. An ESS for dwelling units shall not exceed 100 volts between conductors or to ground.

Exception: Where live parts are not accessible during routine ESS maintenance, an ESS voltage exceeding 100 volts shall be permitted.

(B) Disconnection of Series Battery Circuits. Battery circuits subject to field servicing, where exceeding 240 volts nominal between conductors or to ground, shall have provisions to disconnect the series-connected strings into segments not exceeding 240 volts nominal for maintenance by qualified persons. Non-load-break bolted or plug-in disconnects shall be permitted.

(C) Storage System Maintenance Disconnecting Means. ESS exceeding 100 volts between conductors or to ground shall have a disconnecting means, accessible only to qualified persons, that disconnects ungrounded and grounded circuit conductor(s) in the electrical storage system for maintenance. This disconnecting means shall not disconnect the grounded circuit conductor(s) for the remainder of any other electrical system. A non-load-break-rated switch shall be permitted to be used as a disconnecting means.

(D) Storage Systems of More Than 100 Volts. On ESS exceeding 100 volts between the conductors or to ground, the battery circuits shall be permitted to operate with ungrounded conductors, provided a ground-fault detector and indicator is installed to monitor for ground faults within the storage system.

706.31 Battery and Cell Terminations.

(A) Corrosion Prevention. Antioxidant material suitable for the battery connection shall be used when recommended by the battery or cell manufacturer.

Informational Note: The battery manufacturer's installation and instruction manual can be used for guidance for acceptable materials.

(B) Intercell and Intertier Conductors and Connections. The ampacity of field-assembled intercell and intertier connectors and conductors shall be of such cross-sectional area that the temperature rise under maximum load conditions and at maximum ambient temperature shall not exceed the safe operating temperature of the conductor insulation or of the material of the conductor supports.

Informational Note: Conductors sized to prevent a voltage drop exceeding 3 percent of maximum anticipated load, and where the maximum total voltage drop to the furthest point of connection does not exceed 5 percent, may not be appropriate for all battery applications. IEEE 1375-2003, *Guide for the Protection of Stationary Battery Systems*, provides guidance for overcurrent protection and associated cable sizing.

(C) Battery Terminals. Electrical connections to the battery and the cable(s) between cells on separate levels or racks shall not put mechanical strain on the battery terminals. Terminal plates shall be used where practicable.

706.32 Battery Interconnections. Flexible cables, as identified in Article 400, in sizes 2/0 AWG and larger shall be permitted within the battery enclosure from battery terminals to a nearby junction box where they shall be connected to an approved wiring method. Flexible battery cables shall also be permitted between batteries and cells within the battery enclosure. Such cables shall be listed and identified as moisture resistant. Flexible, fine-stranded cables shall only be used with terminals, lugs, devices, or connectors in accordance with 110.14.

706.33 Accessibility. The terminals of all cells or multicell units shall be readily accessible for readings, inspection, and cleaning where required by the equipment design. One side of transparent battery containers shall be readily accessible for inspection of the internal components.

706.34 Battery Locations. Battery locations shall conform to 706.34(A), (B), and (C).

(A) Live Parts. Guarding of live parts shall comply with 110.27.

(B) Top Terminal Batteries. Where top terminal batteries are installed on tiered racks or on shelves of battery cabinets, working space in accordance with the storage equipment manufacturer's instructions shall be provided between the highest point on a storage system component and the row, shelf, or ceiling above that point.

Informational Note: IEEE 1187 provides guidance for top clearance of VRLA batteries, which are the most commonly used battery in cabinets.

(C) Gas Piping. Gas piping shall not be permitted in dedicated battery rooms.

Part IV. Flow Battery Energy Storage Systems

Part IV applies to ESSs composed of or containing flow batteries.

706.40 General. All electrical connections to and from the system and system components shall be in accordance with the applicable provisions of Article 692. The system and system components shall also meet the provisions of Parts I and II of this article. Unless otherwise directed by this article, flow battery ESS shall comply with the applicable provisions of Article 692.

706.41 Electrolyte Classification. The electrolyte(s) that are acceptable for use in the batteries associated with the ESS shall be identified by name and chemical composition. Such identification shall be provided by readily discernable signage adjacent to every location in the system where the electrolyte can be put into or taken out of the system.

706.42 Electrolyte Containment. Flow battery systems shall be provided with a means for electrolyte containment to prevent spills of electrolyte from the system. An alarm system shall be provided to signal an electrolyte leak from the system. Electrical wiring and connections shall be located and routed in a manner that mitigates the potential for exposure to electrolytes.

706.43 Flow Controls. Controls shall be provided to safely shut down the system in the event of electrolyte blockage.

706.44 Pumps and Other Fluid Handling Equipment. Pumps and other fluid handling equipment are to be rated/specified suitable for exposure to the electrolytes.

Part V. Other Energy Storage Technologies

The provisions of Part V apply to ESSs using other technologies intended to store energy and when there is a demand for electrical power to use the stored energy to generate the needed power.

706.50 General. All electrical connections to and from the system and system components shall be in accordance with the applicable provisions of this Code. Unless otherwise directed by this article, other energy storage technologies shall comply with the applicable provisions of Part III of Article 705.

ARTICLE 708

Critical Operations Power Systems (COPS)

Informational Note: Text that is followed by a reference in brackets has been extracted from *NFPA 1600-2013, Standard on Disaster/Emergency Management and Business Continuity Programs*. Only editorial changes were made to the extracted text to make it consistent with this *Code*.

I. General

708.1 Scope. The provisions of this article apply to the installation, operation, monitoring, control, and maintenance of the portions of the premises wiring system intended to supply, distribute, and control electricity to designated critical operations areas (DCOA) in the event of disruption to elements of the normal system.

Critical operations power systems are those systems so classed by municipal, state, federal, or other codes by any governmental agency having jurisdiction or by facility engineering documentation establishing the necessity for such a system. These systems include but are not limited to power systems, HVAC, fire alarm, security, communications, and signaling for designated critical operations areas.

Informational Note No. 1: Critical operations power systems are generally installed in vital infrastructure facilities that, if destroyed or incapacitated, would disrupt national security, the economy, public health or safety; and where enhanced electrical infrastructure for continuity of operation has been deemed necessary by governmental authority.

Informational Note No. 2: For further information on disaster and emergency management, see *NFPA 1600-2013, Standard on Disaster/Emergency Management and Business Continuity Programs*.

Informational Note No. 3: For further information regarding performance of emergency and standby power systems, see *NFPA 110-2013, Standard for Emergency and Standby Power Systems*.

Informational Note No. 4: For further information regarding performance and maintenance of emergency systems in health care facilities, see *NFPA 99-2012, Standard for Health Care Facilities*.

Informational Note No. 5: For specification of locations where emergency lighting is considered essential to life safety, see *NFPA 101-2012, Life Safety Code*, or the applicable building code.

Informational Note No. 6: For further information regarding physical security, see *NFPA 730-2011, Guide for Premises Security*.

Informational Note No. 7: Threats to facilities that may require transfer of operation to the critical systems

include both naturally occurring hazards and human-caused events. See also A.5.3.2 of *NFPA 1600-2013*.

Informational Note No. 8: See Informative Annex F, Availability and Reliability for Critical Operations Power Systems; and Development and Implementation of Functional Performance Tests (FPTs) for Critical Operations Power Systems.

Informational Note No. 9: See Informative Annex G, Supervisory Control and Data Acquisition (SCADA).

708.2 Definitions.

Commissioning. The acceptance testing, integrated system testing, operational tune-up, and start-up testing is the process by which baseline test results verify the proper operation and sequence of operation of electrical equipment, in addition to developing baseline criteria by which future trend analysis can identify equipment deterioration.

Critical Operations Power Systems (COPS). Power systems for facilities or parts of facilities that require continuous operation for the reasons of public safety, emergency management, national security, or business continuity. (See *Figure 708.2*.)

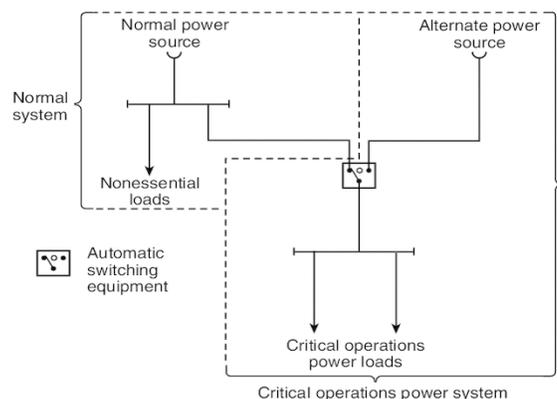


Figure 708.2 Critical Operations Power Systems.

Designated Critical Operations Areas (DCOA). Areas within a facility or site designated as requiring critical operations power.

Supervisory Control and Data Acquisition (SCADA). An electronic system that provides monitoring and controls for the operation of the critical operations power system. This can include the fire alarm system, security system, control of the HVAC, the start/stop/monitoring of the power supplies and electrical distribution system, annunciation and communications equipment to emergency personnel, facility occupants, and remote operators.

708.4 Risk Assessment. Risk assessment for critical operations power systems shall be documented and shall be conducted in accordance with 708.4(A) through (C).

Informational Note: Chapter 5 of *NFPA 1600-2013, Standard on Disaster/Emergency Management and Business Continuity Programs*, provides additional guidance concerning risk assessment and hazard analysis.

(A) Conducting Risk Assessment. In critical operations power systems, risk assessment shall be performed to identify hazards, the likelihood of their occurrence, and the vulnerability of the electrical system to those hazards.

(B) Identification of Hazards. Hazards to be considered at a minimum shall include, but shall not be limited to, the following:

- (1) Naturally occurring hazards (geological, meteorological, and biological)
- (2) Human-caused events (accidental and intentional) [1600:5.3.2]

(C) Developing Mitigation Strategy. Based on the results of the risk assessment, a strategy shall be developed and implemented to mitigate the hazards that have not been sufficiently mitigated by the prescriptive requirements of this *Code*.

708.5 Physical Security. Physical security shall be provided for critical operations power systems in accordance with 708.5(A) and (B).

(A) Risk Assessment. Based on the results of the risk assessment, a strategy for providing physical security for critical operations power systems shall be developed, documented, and implemented.

(B) Restricted Access. Electrical circuits and equipment for critical operations power systems shall be accessible to qualified personnel only.

708.6 Testing and Maintenance.

(A) Conduct or Witness Test. The authority having jurisdiction shall conduct or witness a test of the complete system upon installation and periodically afterward.

(B) Tested Periodically. Systems shall be tested periodically on a schedule acceptable to the authority having jurisdiction to ensure the systems are maintained in proper operating condition.

(C) Maintenance. The authority having jurisdiction shall require a documented preventive maintenance program for critical operations power systems.

Informational Note: For information concerning maintenance, see *NFPA 70B-2013, Recommended Practice for Electrical Equipment Maintenance*.

(D) Written Record. A written record shall be kept of such tests and maintenance.

(E) Testing Under Load. Means for testing all critical power systems during maximum anticipated load conditions shall be provided.

Informational Note: For information concerning testing and maintenance of emergency power supply systems (EPSSs) that are also applicable to COPS, see *NFPA 110-2013, Standard for Emergency and Standby Power Systems*.

708.8 Commissioning.

(A) Commissioning Plan. A commissioning plan shall be developed and documented.

Informational Note: For further information on developing a commissioning program see *NFPA 70B-2013, Recommended Practice for Electrical Equipment Maintenance*.

(B) Component and System Tests. The installation of the equipment shall undergo component and system tests to ensure that, when energized, the system will function properly.

(C) Baseline Test Results. A set of baseline test results shall be documented for comparison with future periodic maintenance testing to identify equipment deterioration.

(D) Functional Performance Tests. A functional performance test program shall be established, documented, and executed upon complete installation of the critical system in order to establish a baseline reference for future performance requirements.

Informational Note: See Informative Annex F for more information on developing and implementing a functional performance test program.

II. Circuit Wiring and Equipment

708.10 Feeder and Branch Circuit Wiring.

(A) Identification.

(1) Boxes and Enclosures. In a building or at a structure where a critical operations power system and any other type of power system are present, all boxes and enclosures (including transfer switches, generators, and power panels) for critical operations power system circuits shall be permanently marked so they will be readily identified as a component of the critical operations power system.

(2) Receptacle Identification. In a building in which COPS are present with other types of power systems described in other sections in this article, the cover plates for the receptacles or the receptacles themselves supplied from the COPS shall have a distinctive color or marking so as to be readily identifiable.

system, and shall not be interchangeable between systems. Fire-resistive cables, conductors, and components shall be approved.

Informational Note No. 1: One method of defining the fire rating is by testing the system in accordance with UL 2196-2012, *Standard for Tests of Fire Resistive Cables*.

Informational Note No. 2: Fire-resistive cable systems are considered part of an electrical circuit protective system.

728.5 Installations. Fire-resistive cable systems installed outside the fire-rated rooms that they serve, such as the electrical room or the fire pump room, shall comply with the requirements of 728.5(A) through (H) and all other installation instructions provided in the listing.

(A) Mounting. The fire-resistive cable system shall be secured to the building structure in accordance with the listing and the manufacturer's installation instructions.

(B) Supports. The fire-resistive system shall be supported in accordance with the listing and the manufacturer's installation instructions.

Informational Note: The supports are critical for survivability of the system. Each system has its specific support requirements.

(C) Raceways and Couplings. Where the fire-resistive system is listed to be installed in a raceway, the raceways enclosing the system, any couplings, and connectors shall be listed as part of the fire-rated system.

(D) Cable Trays. Cable trays used as part of a fire-resistive system shall be listed as part of the fire-resistive system.

(E) Boxes. Boxes or enclosures used as part of a fire-resistive system shall be listed as part of the fire-resistive system and shall be secured to the building structure independently of the raceways or cables listed in the system.

(F) Pulling Lubricants. Fire-resistive cable systems installed in a raceway shall only use pulling lubricants listed as part of the fire-resistive cable system.

(G) Vertical Supports. Cables and conductors installed in vertical raceways shall be supported in accordance with the listing of the fire-resistive cable system.

(H) Splices. Only splices that are part of the listing for the fire-resistive cable system shall be used. Splices shall have manufacturer's installation instructions.

728.60 Grounding. Fire-resistive systems installed in a raceway requiring an equipment grounding conductor shall use the same fire-rated cable described in the system, unless alternative equipment grounding conductors are listed with the system. Any alternative equipment grounding conductor shall be marked with the system number. The system shall specify a permissible equipment grounding conductor. If not specified, the equipment grounding conductor shall be the same as the fire-rated cable described in the system.

728.120 Marking. In addition to the marking required in 310.120, system cables and conductors shall be surface marked with the suffix "FRR" (fire-resistive rating), along with the circuit integrity duration in hours, and with the system identifier.

ARTICLE 750

Energy Management Systems

750.1 Scope. This article applies to the installation and operation of energy management systems.

Informational Note: Performance provisions in other codes establish prescriptive requirements that may further restrict the requirements contained in this article.

750.2 Definitions. For the purpose of this article, the following definitions shall apply.

Control. The predetermined process of connecting, disconnecting, increasing, or reducing electric power.

Energy Management System. A system consisting of any of the following: a monitor(s), communications equipment, a controller(s), a timer(s), or other device(s) that monitors and /or controls an electrical load or a power production or storage source.

Monitor. An electrical or electronic means to observe, record, or detect the operation or condition of the electric power system or apparatus.

750.20 Alternate Power Sources. An energy management system shall not override any control necessary to ensure continuity of an alternate power source for the following:

- (1) Fire pumps
- (2) Health care facilities
- (3) Emergency systems
- (4) Legally required standby systems
- (5) Critical operations power systems

750.30 Load Management. Energy management systems shall be permitted to monitor and control electrical loads unless restricted in accordance with 750.30(A) through (C).

(A) Load Shedding Controls. An energy management system shall not override the load shedding controls put in place to ensure the minimum electrical capacity for the following:

- (1) Fire pumps
- (2) Emergency systems
- (3) Legally required standby systems
- (4) Critical operations power systems

(B) Disconnection of Power. An energy management system shall not be permitted to cause disconnection of power to the following:

- (1) Elevators, escalators, moving walks, or stairway lift chairs

- (2) Positive mechanical ventilation for hazardous (classified) locations
- (3) Ventilation used to exhaust hazardous gas or reclassify an area
- (4) Circuits supplying emergency lighting
- (5) Essential electrical systems in health care facilities

(C) Capacity of Branch Circuit, Feeder, or Service. An energy management system shall not cause a branch circuit, feeder, or service to be overloaded at any time.

750.50 Field Markings. Where an energy management system is employed to control electrical power through the use of a remote means, a directory identifying the controlled device(s) and circuit(s) shall be posted on the enclosure of the controller, disconnect, or branch-circuit overcurrent device.

Informational Note: The use of the term *remote* is intended to convey that a controller can be operated via another means or location through communications without a direct operator interface with the controlled device.

ARTICLE 760
Fire Alarm Systems

C *Note:* For applications listed in Section 1.9.1 of the California
 A Building Code, regulated by the Division of the State Architect—
 C Access Compliance see California Code of Regulations, Title 24, Part
 A 2 (California Building Code), California Chapter 1 (Division 1
 C California Administration) under authority cited by Government Code
 A Section 4450 and in reference cited by Government Code Sections
 C 4450, through 4461, 12955.1 and Health and Safety Code Sections
 A 18949.1, 19952 through 19959.

I. General

760.1 Scope. This article covers the installation of wiring and equipment of fire alarm systems including all circuits controlled and powered by the fire alarm system.

Informational Note No. 1: Fire alarm systems include fire detection and alarm notification, guard’s tour, sprinkler waterflow, and sprinkler supervisory systems. Circuits controlled and powered by the fire alarm system include circuits for the control of building systems safety functions, elevator capture, elevator shutdown, door release, smoke doors and damper control, fire doors and damper control and fan shutdown, but only where these circuits are powered by and controlled by the fire alarm system. For further information on the installation and monitoring for integrity requirements for fire alarm systems, refer to the *NFPA 72-2013-2016, National Fire Alarm and Signaling Code*.

Informational Note No. 2: Class 1, 2, and 3 circuits are defined in Article 725.

C **760.1.1 Equipment and Systems.** [SFM] Fire alarm
 A equipment and systems required to be installed in any
 C occupancy within the scope of these regulations shall conform
 A to the applicable performance and construction standards
 || specified in NFPA 72-2016.

760.2 Definitions.

Abandoned Fire Alarm Cable. Installed fire alarm cable that is not terminated at equipment other than a connector and not identified for future use with a tag.

Fire Alarm Circuit. The portion of the wiring system between the load side of the overcurrent device or the power-limited supply and the connected equipment of all circuits powered and controlled by the fire alarm system. Fire alarm circuits are classified as either non-power-limited or power-limited.

Fire Alarm Circuit Integrity (CI) Cable. Cable used in fire alarm systems to ensure continued operation of critical circuits during a specified time under fire conditions.

Non-Power-Limited Fire Alarm Circuit (NPLFA). A fire alarm circuit powered by a source that complies with 760.41 and 760.43.

Power-Limited Fire Alarm Circuit (PLFA). A fire alarm circuit powered by a source that complies with 760.121.

760.3 Other Articles. Circuits and equipment shall comply with 760.3(A) through (K). Only those sections of Article 300 referenced in this article shall apply to fire alarm systems.

(A) Spread of Fire or Products of Combustion. See 300.21.

(B) Ducts, Plenums, and Other Air-Handling Spaces. Section 300.22, where installed in ducts or plenums or other spaces used for environmental air.

Exception: As permitted in 760.53(B)(1) and (B)(2) and **Table 760.154**.

(C) Hazardous (Classified) Locations. Articles 500 through 516 and Article 517, Part IV, where installed in hazardous (classified) locations.

(D) Corrosive, Damp, or Wet Locations. Sections 110.11, **300.5(B)**, 300.6, **300.9**, and 310.10(G), where installed in corrosive, damp, or wet locations.

(E) Building Control Circuits. Article 725, where building control circuits (e.g., elevator capture, fan shutdown) are associated with the fire alarm system.

(F) Optical Fiber Cables. Where optical fiber cables are utilized for fire alarm circuits, the cables shall be installed in accordance with Article 770.

(G) Installation of Conductors with Other Systems. Installations shall comply with 300.8.

(H) Raceways or Sleeves Exposed to Different Temperatures. Installations shall comply with 300.7(A).

(I) Vertical Support for Fire Rated Cables and Conductors. Vertical installations of circuit integrity (CI) cables and conductors installed in a raceway or conductors and cables of electrical circuit protective systems shall be installed in accordance with 300.19.

(C) Type NPLFP. Type NPLFP non–power-limited fire alarm cable for use in other space used for environmental air shall be listed as being suitable for use in other space used for environmental air as described in 300.22(C) and shall also be listed as having adequate fire-resistant and low smoke–producing characteristics.

Informational Note: One method of defining a cable that is low-smoke producing cable and fire-resistant cable is that the cable exhibits a maximum peak optical density of 0.50 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.52 m (5 ft) or less when tested in accordance with NFPA 262-2011, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*.

(D) Type NPLFR. Type NPLFR non–power-limited fire alarm riser cable shall be listed as being suitable for use in a vertical run in a shaft or from floor to floor and shall also be listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.

Informational Note: One method of defining fire-resistant characteristics capable of preventing the carrying of fire from floor to floor is that the cables pass ANSI/UL 1666-2012, *Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts*.

(E) Type NPLF. Type NPLF non–power-limited fire alarm cable shall be listed as being suitable for general-purpose fire alarm use, with the exception of risers, ducts, plenums, and other space used for environmental air, and shall also be listed as being resistant to the spread of fire.

Informational Note: One method of defining *resistant to the spread of fire* is that the cables do not spread fire to the top of the tray in the “UL Flame Exposure, Vertical Tray Flame Test” in ANSI/UL 1685-2010, *Standard for Safety for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*. The smoke measurements in the test method are not applicable.

Another method of defining *resistant to the spread of fire* is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the CSA “Vertical Flame Test — Cables in Cable Trays,” as described in CSA C22.2 No. 0.3-M-2001, *Test Methods for Electrical Wires and Cables*.

(F) Fire Alarm Circuit Integrity (CI) Cable or Electrical Circuit Protective System. Cables that are used for survivability of critical circuits under fire conditions shall meet either 760.176(F)(1) or (F)(2) as follows:

(1) Circuit Integrity (CI) Cables. Circuit integrity (CI) cables, specified in 760.176(C), (D), and (E), and used for survivability of critical circuits, shall have an additional classification using the suffix “CI.” Circuit integrity (CI) cables shall only be permitted to be installed in a raceway where specifically listed and marked as part of an electrical circuit protective system as covered in 760.176(F)(2).

(2) Electrical Circuit Protective System. Cables specified in 760.176(C), (D), (E), and (F)(1), that are part of an electrical circuit protective system, shall be identified with the protective system number and hourly rating printed on the outer jacket of the cable and installed in accordance with the listing of the protective system.

Informational Note No. 1: Fire alarm circuit integrity (CI) cable and electrical circuit protective systems may be used for fire alarm circuits to comply with the survivability requirements of NFPA 72-2013 2016, *National Fire Alarm and Signaling Code*, 24.4.2.8.5.3 and 24.4.2.8.5.4, that the circuit maintain its electrical function during fire conditions for a defined period of time.

Informational Note No. 2: One method of defining circuit integrity (CI) cable or an electrical circuit protective system is by establishing a minimum 2-hour fire-resistive rating for the cable when tested in accordance with UL 2196-2012, *Standard for Tests of Fire Resistive Cables*.

Informational Note No. 3: UL guide information for electrical circuit protective systems (FHIT) contains information on proper installation requirements for maintaining the fire rating.

(G) NPLFA Cable Markings. Multiconductor non–power-limited fire alarm cables shall be marked in accordance with Table 760.176(G). Non–power-limited fire alarm circuit cables shall be permitted to be marked with a maximum usage voltage rating of 150 volts. Cables that are listed for circuit integrity shall be identified with the suffix “CI” as defined in 760.176(F).

Informational Note: Cable types are listed in descending order of fire resistance rating.

Table 760.176(G) NPLFA Cable Markings

Cable Marking	Type	Reference
NPLFP	Non–power-limited fire alarm circuit cable for use in “other space used for environmental air”	760.176(C) and (G)
NPLFR	Non–power-limited fire alarm circuit riser cable	760.176(D) and (G)
NPLF	Non–power-limited fire alarm circuit cable	760.176(E) and (G)

Note: Cables identified in 760.176(C), (D), and (E) and meeting the requirements for circuit integrity shall have the additional classification using the suffix “CI” (for example, NPLFP-CI, NPLFR-CI, and NPLF-CI).

760.179 Listing and Marking of PLFA Cables and Insulated Continuous Line-Type Fire Detectors. PLFA cables installed as wiring within buildings shall be listed as being resistant to the spread of fire and other criteria in accordance with 760.179(A) through (H) and shall be

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marked in accordance with 760.179(I). Insulated continuous line-type fire detectors shall be listed in accordance with 760.179(J). Cable used in a wet location shall be listed for use in wet locations or have a moisture-impervious metal sheath.

(A) Conductor Materials. Conductors shall be solid or stranded copper.

(B) Conductor Size. The size of conductors in a multiconductor cable shall not be smaller than 26 AWG. Single conductors shall not be smaller than 18 AWG.

(C) Ratings. The cable shall have a voltage rating of not less than 300 volts.

(D) Type FPLP. Type FPLP power-limited fire alarm plenum cable shall be listed as being suitable for use in ducts, plenums, and other space used for environmental air and shall also be listed as having adequate fire-resistant and low smoke-producing characteristics.

Informational Note: One method of defining a cable that is low-smoke producing cable and fire-resistant cable is that the cable exhibits a maximum peak optical density of 0.50 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.52 m (5 ft) or less when tested in accordance with NFPA 262-2011, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*.

(E) Type FPLR. Type FPLR power-limited fire alarm riser cable shall be listed as being suitable for use in a vertical run in a shaft or from floor to floor and shall also be listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.

Informational Note: One method of defining fire-resistant characteristics capable of preventing the carrying of fire from floor to floor is that the cables pass the requirements of ANSI/UL 1666-2012, *Standard Test for Flame Propagation Height of Electrical and Optical-Fiber Cable Installed Vertically in Shafts*.

(F) Type FPL. Type FPL power-limited fire alarm cable shall be listed as being suitable for general-purpose fire alarm use, with the exception of risers, ducts, plenums, and other spaces used for environmental air, and shall also be listed as being resistant to the spread of fire.

Informational Note: One method of defining *resistant to the spread of fire* is that the cables do not spread fire to the top of the tray in the “UL Flame Exposure, Vertical Tray Flame Test” in ANSI/UL 1685-2012, *Standard for Safety for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*. The smoke measurements in the test method are not applicable.

Another method of defining *resistant to the spread of fire* is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the CSA “Vertical Flame Test — Cables in Cable Trays,” as described in CSA C22.2 No. 0.3-M-2001, *Test Methods for Electrical Wires and Cables*.

(G) Fire Alarm Circuit Integrity (CI) Cable or Electrical Circuit Protective System. Cables that are used for survivability of critical circuits under fire conditions shall meet either 760.179(G)(1) or (G)(2) as follows:

(1) Circuit Integrity (CI) Cables. Circuit integrity (CI) cables specified in 760.179(D), (E), (F), and (H), and used for survivability of critical circuits, shall have an additional classification using the suffix “CI.” Circuit integrity (CI) cables shall only be permitted to be installed in a raceway where specifically listed and marked as part of an electrical circuit protective system as covered in 760.179(G)(2).

(2) Electrical Circuit Protective System. Cables specified in 760.179(D), (E), (F), (H), and (G)(1), that are part of an electrical circuit protective system, shall be identified with the protective system number and hourly rating printed on the outer jacket of the cable and installed in accordance with the listing of the protective system.

Informational Note No. 1: Fire alarm circuit integrity (CI) cable and electrical circuit protective systems may be used for fire alarm circuits to comply with the survivability requirements of *NFPA 72-2013 2016, National Fire Alarm and Signaling Code*, ~~12.4.3 24.4.2.8.5.3~~ 24.4.8.5.3 and ~~12.4.4 24.4.2.8.5.4~~ 24.4.8.5.4, that the circuit maintain its electrical function during fire conditions for a defined period of time.

Informational Note No. 2: One method of defining circuit integrity (CI) cable or an electrical circuit protective system is by establishing a minimum 2-hour fire-resistive rating for the cable when tested in accordance with UL 2196-2012, *Standard for Tests of Fire Resistive Cables*.

Informational Note No. 3: UL guide information for electrical circuit protective systems (FHIT) contains information on proper installation requirements for maintaining the fire rating.

(H) Coaxial Cables. Coaxial cables shall be permitted to use 30 percent conductivity copper-covered steel center conductor wire and shall be listed as Type FPLP, FPLR, or FPL cable.

(I) Cable Marking. The cable shall be marked in accordance with Table 760.179(I). The voltage rating shall not be marked on the cable. Cables that are listed for circuit integrity shall be identified with the suffix CI as defined in 760.179(G).

Informational Note: Voltage ratings on cables may be misinterpreted to suggest that the cables may be suitable for Class 1, electric light, and power applications.

Exception: Voltage markings shall be permitted where the cable has multiple listings and voltage marking is required for one or more of the listings.

(J) Insulated Continuous Line-Type Fire Detectors. Insulated continuous line-type fire detectors shall be rated in accordance with 760.179(C), listed as being resistant to the spread of fire in accordance with 760.179(D) through (F), marked in accordance with 760.179(I), and the jacket compound shall have a high degree of abrasion resistance.

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only after all systems are completely installed. If the electrical contractor (or subcontractor) implements the FPTs, a witness must initial each step of the test. The electrical contractor cannot employ the witness directly or indirectly.

(2) Perform Tests (FPTs). If the system fails the test, the problem must be resolved and the equipment or system retested or the testing requirements re-analyzed until successful tests are witnessed. Once the system or equipment passes testing, it is verified by designated commissioning official.

(3) Customer Receives System. After all tests are completed (including the “pull the plug” test), the system is turned over to the customer.

Informative Annex G Supervisory Control and Data Acquisition (SCADA)

This informative annex is not a part of the requirements of this NFPA document, but is included for informational purposes only.

(A) General. Where provided, the general requirements in (A)(1) through (A)(11) shall apply to SCADA systems. The SCADA system for the COPS loads shall be separate from the building management SCADA system. No single point failure shall be able to disable the SCADA system.

- (1) The SCADA system for the COPS loads shall be separate from the building management SCADA system.
- (2) No single point failure shall be able to disable the SCADA system.
- (3) The SCADA system shall be permitted to provide control and monitor electrical and mechanical utility systems related to mission critical loads, including, but not limited to the following:
 - a. The fire alarm system
 - b. The security system
 - c. Power distribution
 - d. Power generation
 - e. HVAC and ventilation (damper position, airflow speed and direction)
 - f. Load shedding
 - g. Fuel levels or hours of operation
- (4) Before installing or employing a SCADA system, an operations and maintenance analysis and risk assessment shall be performed to provide the maintenance parameter data
- (5) A redundant system shall be provided in either warm or hot standby.
- (6) The controller shall be a programmable logic controller (PLC).
- (7) The SCADA system shall utilize open, not proprietary, protocols.
- (8) The SCADA system shall be able to assess the damage and determine system integrity after the “event.”
- (9) The monitor display shall provide graphical user interface for all major components monitored and controlled by the SCADA system, with color schemes readily recognized by the typical user.
- (10) The SCADA system shall have the capability to provide storage of critical system parameters at a 15-minute rate or more often when out-of-limit conditions exist.
- (11) The SCADA system shall have a separate data storage facility not located in the same vicinity.

(B) Power Supply. The SCADA system power supply shall comply with (B)(1) through (B)(3):

- (1) The power supply shall be provided with a direct-current station battery system, rated between 24 and 125 volts dc, with a 72-hour capacity.
- (2) The batteries of the SCADA system shall be separate from the batteries for other electrical systems.
- (3) The power supply shall be provided with a properly installed surge-protective device (TVSS) at its terminals with a direct low-impedance path to ground. Protected and unprotected circuits shall be physically separated to prevent coupling.

(C) Security Against Hazards. Security against hazards shall be provided in accordance with (C)(1) through (C)(6):

- (1) Controlled physical access by authorized personnel to only the system operational controls and software shall be provided.
- (2) The SCADA system shall be protected against dust, dirt, water, and other contaminants by specifying enclosures appropriate for the environment.
- (3) Conduit and tubing shall not violate the integrity of the SCADA system enclosure.
- (4) The SCADA system shall be located in the same secure locations as the secured systems that they monitor and control.
- (5) The SCADA system shall be provided with dry agent fire protection systems or double interlocked preaction sprinkler systems using cross-zoned detection, to minimize the threat of accidental water discharge into unprotected equipment. The fire protection systems shall be monitored by the fire alarm system in accordance with *NFPA 72-2013, 2016 National Fire Alarm and Signaling Code*.
- (6) The SCADA system shall not be connected to other network communications outside the secure locations without encryption or use of fiber optics.

(D) Maintenance and Testing. SCADA systems shall be maintained and tested in accordance with (D)(1) and (D)(2).

(1) Maintenance. The maintenance program for SCADA systems shall consist of the following components:

- (1) A documented preventive maintenance program
- (2) Concurrent maintenance capabilities, to allow the testing, troubleshooting, repair, and/or replacement of a component or subsystem while redundant component(s) or subsystem(s) are serving the load



HISTORY NOTE APPENDIX

California Electrical Code

Title 24, Part 3, California Code of Regulations

Notes

For prior history, see the History Note Appendix to the *California Electrical Code*, 2013 Triennial Edition, effective January 1, 2014.

1. (BSC 01/14, HCD 01/14, DSA-SS 01/14, OSHPD 01/14, SFM 01/14,) Adoption by reference of the *2014 National Electrical Code (NEC)* with necessary state amendments and repeal of the 2011 edition of the *NEC*; effective on January 1, 2017.

2. Errata to correct editorial errors within the preface as well as throughout various chapters in this code. Effective January 1, 2017.

3. 2016 Intervening Cycle update (SFM 03/16) Adoption of amendments to the 2016 California Electrical Code (CEC). Adopted by the California Building Standards Commission on June 20, 2017, published on January 1, 2018, effective on July 1, 2018.

4. 2016 Intervening Cycle update (OSHPD 03/16) Adoption of amendments to the 2016 California Electrical Code (CEC). Adopted by the California Building Standards Commission on August 14, 2017, published on January 1, 2018, effective on July 1, 2018.

