CHAPTER – 9

SPECIAL CONDITIONS

Article 7.0
Emergency systems

Article 7.0 Emergency systems

7.0.1.1 Scope. This article applies to the electrical safety of the installation, operation, and maintenance of emergency system consisting of circuits and equipment intended to supply.

7.0.1.2 Definitions.

Branch Circuit Emergency Lighting Transfer Switch. A device connected on the load side of a branch circuit overcurrent protective device that transfer only emergency lighting loads from the normal supply to an emergency supply.

Emergency Systems. Those systems legally required and classed as emergency by municipal, or other codes, or by any governmental agency having jurisdiction : illumination essential for safety to human life.

Luminaire, Directly Controlled. An emergency luminaire that has a control input for an integral dimming or switching function that drives the luminaire to full illumination upon loss of normal power.

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Relay, Automatic Load Control. A device used to set normally dimmed or normally-off switched emergency lighting equipment to full power illumination.

7.0.1.3 Test and Maintenance

(A) Conduct and Witness Test. Test shall be conducted and witnessed on the complete system upon installation and periodically afterward.

(B) Tested Periodically. Shall be tested periodically on a set schedule to ensure the system are maintained in proper operating condition.

(C) Maintenance. Shall be maintained in accordance with manufacturer instructions and industry standards.

(D) 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.

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7.0.1.4 Capacity

(A) Capacity and Rating. Shall have adequate capacity and rating for all loads to be operated simultaneously.

(B) Selective Load Pickup, Load Shedding, and Peak Load Shaving. Shall be permitted to supply emergency, legally required standby and optional standby system.

7.0.1.5 Transfer Equipment

(A) General - Transfer equipment, including automatic transfer switches, shall be automatic, and identified for emergency use.

(B) Bypass Isolation Switches. Shall be permitted to bypass and isolate the transfer equipment .

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(C) Automatic Transfer Switches. Shall be electrically operated and mechanical held; Shall be listed for emergency use.

(D) Use. Transfer equipment shall supply only emergency loads.

(E) Documentation. Shall be field marked on the exterior of the transfer equipment.

7.0.1.6 Signals. Audible and visual signal devices shall be provided, where practicable for the purpose describe in (A) through (D).

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

(B) Carrying Load. To indicate that the battery is carrying load.

(C) Not Functioning. To indicate that the battery charger is not functioning.

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(D) Ground Fault. To indicate a ground fault in solidly grounded wye emergency systems of more that 150 volts ground and circuit protective devices rated 1000 amperes or more.

7.0.1.7 Signs.

(A) Emergency Sources. Shall be placed at the service entrance equipment, indicating type and location of on-site emergency power source.

(B) Grounding. Shall be installed at the normal power source equipment stating:

WARNING SHOCK HAZARD EXISTS IF GROUNDING ELECTRODE CONDUCTOR OR BONDING JUMPER CONNECTION IN THIS EQUIPMENT IS REMOVED WHILE ALTERNATE SOURCE IS ENERGIZED.

7.0.1.8 Surge Protection. Shall be installed in or all emergency system switchboards and panelboards.

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7.0.2 Circuit Wiring

7.0.2.1 Wiring Emergency System.

(A) Identification. Shall be permanently marked so they will be readily identified as a component of an emergency circuit or system.

(B) Wiring. Two or more emergency circuits supplied from the same source shall be permitted in the same raceway, cable, box or cabinet.

(C) Wiring Design and Location. Shall be designed and locate so as to minimize the hazards that might cause failure due to flooding, fire, vandalism, and other adverse conditions.

(D) Fire protection.

(1) Assembly occupancies for not less than 1000 persons.

Article 7.0 Emergency systems

7.0.3 Sources of power

7.0.3.1 General Requirements. Current supply shall be such that, in the event of failure of the normal supply to, or within. Shall be available within the time required for the application but not to exceed 10 seconds.

*Shall be designed and located so as to minimize the hazards that might cause complete failure due to flooding, fires, icing and vandalism.

(A) Storage Battery. Shall be suitable rating and capacity to supply and maintain the total load for minimum period of 1.5 hours.

(B) Generator Set.

Prime Mover- Driven, Internal combustion Engines as Prime Movers, Dual Supplies. Battery Power and Dampers, Auxiliary Power Supply, Outdoor Generator Sets.

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(C) Uninterruptible Power Supplies. Use to provide power emergency system shall comply with the applicable provisions of 7.0.3.1 (A) and (B).

(D) Separate Services. Shall be installed sufficiently remote electrically and physically from other services conditions to minimize the possibility of simultaneously interruption of supply.

(E) Fuel Cell System. Used as a source of power for emergency systems shall be suitable rating and capacity to supply and maintain he total load for not less than 2 hours of full-demand operation.

(F) Unit Equipment. Shall supply and maintain not less than 60% of the initial emergency illumination for a period of at least 1.5 hours.

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7.0.4 Emergency System Circuits for Lighting and Power

7.0.4.1 Loads on Emergency Branch Circuits. No appliances and no lamps, other than those specified as required for emergency use, shall be supplied by emergency lighting circuits.

7.0.4.2 Emergency Illumination. shall be include means of egress lighting, illuminated exit signs.

7.0.4.3 Branch Circuits for Emergency Lighting.

- Independent of the normal lighting supply
- Two or more branch circuits supplied from separate and complete systems with independent power sources.

7.0.4.4 Circuits for Emergency Power. Shall be emergency supply source to which the load will be transferred automatically upon thr failure of the normal supply.

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7.0.4.5 Multiwire Branch circuits. The Branch circuit serving emergency lighting and power circuits shall not be part of a multiwire branch circuit.

7.0.5.1 Control -- Emergency Lighting Circuits

7.0.5.1 Switch Requirements. Shall be arranged so that only authorized person have control of emergency lighting.

7.0.5.2 Switch Location. shall be in locations convenient to authorized persons responsible for their actuation.

7.0.5.3 Exterior Lights. Shall be permitted to be controlled by an automatic light-actuated device.

7.0.5.4 Dimmer and Relay Systems. Shall be permitted to be used as a control device for energizing emergency lighting circuits.

7.0.5.5 Directly Controlled Luminaires.

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7.0.5.6 Branch Circuit Emergency Lighting Transfer Switch. Emergency lighting loads supplied by branch circuits rated at not greater than 20 amperes.

7.0.5.7 Automatic Load Control Relay.

7.0.6 Overcurrent Protection

7.0.6.1 Accessibility. The branch circuit overcurrent devices in emergency circuits shall be accessible to authorized persons only.

7.0.6.2 Ground- Fault Protection of equipment.

7.0.6.3 Selective Coordination. Shall be selectively coordinated with all supply-side overcurrent protective devices.

ARTICLE 7.1 LEGALLY REQUIRED STANDBY SYSTEM

ARTICLE 7.1
LEGALLY REQUIRED STANDBY SYSTEM

7.1.1 General

7.1.1.1 Scope. The provision of this article apply to the electrical safety of the installation, operation, and maintenance of legally required standby systems distribute, and control electricity to required facilities for illumination or power, or both, when the normal electrical supply or the system is interrupted.

7.1.1.2 Definitions. Typically installed to serve loads, such as heating and refrigeration systems, communication systems, ventilation and smoke removal system and industrial process. that, when stopped during any interruption of the normal electrical supply, could create hazards or hamper rescue of fire-fighting operations.

ARTICLE 7.1
LEGALLY REQUIRED STANDBY SYSTEM

7.1.1.3 Test and Maintenance

A.) Conduct and Witness Test

B.) Tested Periodically

C.) Maintenance

D.) Written Record

E.) Testing Under Load

7.1.1.4 Capacity Rating. Shall have adequate capacity and rating for the supply of all equipment intended to be operated at one time.

WARNING: SHOCK HAZARD EXIST IF GROUNDING ELECTRODE CONDUCTOR OR BONDING JUMPER CONNECTION IN THIS EQUIPMENT IS REMOVED WHILE ALTERNATE SOURCES IS ENERGIZED.

7.1.2 Circuit Wiring

ARTICLE 7.1
LEGALLY REQUIRED STANDBY SYSTEM

7.1.2.1 Wiring Legally Required Standby Systems. Shall be permitted to occupy the same raceways, cables, boxes, and cabinets with other general wiring.

7.1.3 Sources of Power

7.1.3.1 General Requirements. Current supply shall be such that, in the event of failure of the normal supply to, or within, the building or group of building concerned, legally required standby power will be available with the time required for the application but not to exceed 60 seconds.

(A) Storage Battery. Shall be of suitable rating and capacity to supply and maintain the total load for a period of 1.5 hours without type voltage applied to the load falling below 87.5 percent of normal.

ARTICLE 7.1
LEGALLY REQUIRED STANDBY SYSTEM

(B) Generator Set.

(1) Prime Mover- Driven. Shall be provided for automatically starting the prime mover on failure of the normal service and for automatic transfer and operation of all required electrical circuits.

(2) Internal Combustion Engines as Prime Mover. Shall be provided with an on-premises fuel supply sufficient for not less than 2 hours of full-demand operation of the system.

(3) Dual Supplies. Shall not be solely dependent on a public utility gas system for their fuel supply or on a municipal water supply for their cooling systems.

(4) Battery Power. Shall be suitable for the purpose and shall be equipped with an automatic charging means independent of the generator set.

(5) Outdoor Generator sets. In accordance with 4.45.1.18

ARTICLE 7.1
LEGALLY REQUIRED STANDBY SYSTEM

(C) Uninterruptible Power Supplies. Shall be comply with the applicable provision of *7.1.3.1* (A) and (B).

(D) Separate Services. Shall be permitted as a legally required sources of standby power. In accordance with the applicable provision of *Article 2.30*

(E) Connection Ahead of Service Disconnecting Means. Located ahead of and not within the same cabinet, enclosure, vertical switchgear section, or vertical switchboard section as the service disconnecting means shall be permitted.

(F) Fuel Cell System. Used as a source of power for legally required standby systems shall be of suitable rating and capacity to supply and maintain the total load for not less than 2 hours of full-demand operation.

ARTICLE 7.1
LEGALLY REQUIRED STANDBY SYSTEM

7.1.4 Overcurrent Protection

7.1.4.1 Accessibility. The branch-circuit overcurrent devices in legally required standby circuits shall be accessible to authorized person only.

7.1.4.2 Ground- Fault Protection of Equipment. Shall not be required to provide ground-fault protection of equipment with automatic disconnecting means.

7.1.4.3 Selective Coordination. Shall be selected by a licensed professional electrical engineer or other qualified persons engaged primarily in the design, installation or maintenance of electrical systems.

ARTICLE 7.2 OPTIONAL STANDBY SYSTEM

ARTICLE 7.2 OPTIONAL STANDBY SYSTEM

7.2.1 General

7.2.1.1 Scope. The provisions of this article apply to the installation and operation of optional standby system.

The systems covered by this article consists of those that permanently installed in their entirely, including prime movers, and those that are arranged for a connection to a premises wiring system from a portable alternate power supply.

7.2.1.2 Definitions.

Optional Standby Systems. Those systems intended to supply power to public or private facilities or property where life safety does not depend on the performance of the system.

FPN: Typically installed to provide an alternate source of electric power for such facilities as industrial sand commercial building, farms, residences etc.

ARTICLE 7.2 OPTIONAL STANDBY SYSTEM

7.2.1 General.

7.2.1.1 Scope. The provision of this article apply to the installation and operation of optional standby systems.

The system covered by this article consist of those that are permanently installed in their entirely, including prime movers, and those that are arranged for a connection to a premises wiring system from a portable alternate power dupply.

7.2.1.2 Definition.

Optional Standby System. Those systems intended to supply power to public or private facilities or property where life does not depend on the performance of the system.

FPN: *Typically installed to provide an alternate source of electric power such facilities as industrial and commercial buildings, farms, and residences an to serve loads such as heating and refrigeration system and etc.*

ARTICLE 7.2 OPTIONAL STANDBY SYSTEM

7.2.1.4 Capacity and Rating.

(A) Available Short-Circuit Current. Optional standby system equipment shall be suitable for the maximum available short-circuit current at its terminals.

(B) **System Capacity.** The calculations of load on the standby source shall be made in accordance with *Article 2.20* or by another approved method.

(1) Manual Transfer Equipment. An optional standby system shall have adequate capacity and rating for the supply of all equipment intended to be operated at one time.

(2) Automatic Transfer Equipment. Where automatic transfer equipment is used, an optional standby system shall comply with (2)(a) and (2)(b).

a. Full Load. Shall be capable of supplying the full load that is transferred by the automatic transfer equipment.

ARTICLE 7.2 OPTIONAL STANDBY SYSTEM

b.) Load Management. Where a system is employed that will automatically manage the connected load.

7.2.1.5 Transfer Equipment. Shall be suitable for the intended used and design and installed so as to prevent the inadvertently interconnection of normal and alternate sources of supply in any operation of the transfer equipment

7.2.1.6 Signals. Audible and visual signal devices shall be provided, where practicable, for the following purpose specified in 7.0.1.6(A) and (B).

(A) Malfunction. To indicate malfunction of the optional standby source.

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

Exception: Signals shall not be required for portable standby power sources.

ARTICLE 7.2 OPTIONAL STANDBY SYSTEM

7.2.1.7 Signs.

(A) Standby. A sign shall be placed at the service entrance equipment that indicates the type and location of each on-site standby power source. A sign shall not be required for individual unit equipment for standby illumination.

(B) Grounding. Where removal of a grounding or bonding connection in normal power source equipment interrupts the grounding electrode conductor connection to the alternate power source(s) grounded conductor, a warning sign shall be installed at the normal power source equipment stating.

WARNING: SHOCK HAZARD EXISTS IF GROUNDING ELECTRODE CONDUCTOR OR BONDING JUMPER CONNECTION IN THIS EQUIPMENT IS REMOVED WHILE ALTERNATE SOURCE(S) IS ENERGIZED.

ARTICLE 7.2 OPTIONAL STANDBY SYSTEM

(C) Power Inlet. Where power inlet is used for a temporary connection to a portable generator, a warning sign shall be placed near the inlet to indicate the type of derived system that the system is capable of based on the wiring of the transfer equipment. The sign shall display one of the following warnings:

WARNING: FOR CONNECTION OF A SEPARATELY DERIVED (BONDED NEUTRAL) SYSTEM ONLY or FOR CONNECTION OF A NONSEPARATELY DERIVED (FLOATING NEUTRAL) SYSTEM ONLY.

7.2.2 Wiring

7.2.2.1 Wiring Optional Standby System. Shall be permitted to occupy the same raceways, cables, boxes, and cabinets with other general wiring.

ARTICLE 7.2 OPTIONAL STANDBY SYSTEM

7.2.2.2. Portable Generator grounding.

(A) Separately Derived System. Where a portable optional standby source is used as a separately derived system, it shall be grounded to a grounding electrode in accordance with 2.50.2.11.

(B) Non-separately Derived System. Where a portable optional standby source is used as a non-separately derived system, the equipment grounding conductor shall be bonded to the system grounding electrode.

7.2.2.3 Outdoor Generator Sets.

(A) Portable Generators Greater Than 15 kW and permanently installed Generators. Where an outdoor housed generator set is equipped with a readily accessible disconnecting means in accordance with 4.45.1.18, and the disconnecting means is located within sight of the building or structure supplied.

ARTICLE 7.2 OPTIONAL STANDBY SYSTEM

(B) Portable Generator 15 kW or Less. Where a portable generator, rated 15 kW or less, is installed using a flanged inlet or other cord- and plug-type connection, disconnecting means shall not be required where ungrounded conductors serve or pass through a building or structure.

(C) Power Inlet Rated at 100 Amperes or Greater, for Portable Generators. Equipment containing power inlets for the connection of a generator source shall be listed for the intended used. Systems with power inlets shall be equipped with an interlocked disconnecting means.

Exception No. 1: If the inlet device is rated as a disconnecting means.

INTERCONNECTED ELECTRICAL POWER PRODUCTION SERVICES

This article covers installation of one or more electric power production sources operating in parallel with a primary source(s) of electricity.

Definitions

INTERACTIVE INVERTER OUTPUT CIRCUIT

Conductors between the utility interactive inverter and the service equipment or another electric power production source, such as utility, for electrical production and distribution network.

MICROGRID INTERCONNECT DEVICE (MID)

A device that allows a microgrid system to separate from and reconnect to a primary power source.

Definitions

MICROGRID SYSTEM

A premises wiring system that has generation, energy storage, and loads, or any combination thereof, that includes the ability to disconnect from and parallel with the primary source.

MULTIMODE INVERTER

Equipment having the capabilities of both the interactive inverter and the stand-alone inverter.

Definitions

Power production equipment

The generating source, and all distribution equipment associated with it, that generates electricity from a source other than a utility.

FPN:

Examples of power production equipment include such items as generators, solar photovoltaic systems, and fuel cell systems.

Interconnected EPPS shall comply with this article and also with the applicable requirements of the articles in Table 7.5.1.3.

Table 7.5.1.3 Other Articles

Generators	4.45
Solar Photovoltaic Systems	6.90
Fuel Cell Systems	6.92
Wind Electric Systems	6.94
Emergency Systems	7.0
Legally Required Standby Systems	7.1
Optional Standby Systems	7.2
Energy Storage Systems	7.6
Stand-Alone Systems	7.10
DC Microgrids	7.12

All equipment shall be approved for intended use including but not limited to: interactive inverters, engine generators, energy storage equipment, and wind turbines shall be listed and or field labeled for the intended use of interconnection service.

Installation of EPPS operating in parallel with a primary sources of electricity shall be only by qualified persons.

A permanent plaque or directory denoting the location of all electric power source disconnecting means on or in the premises shall be installed at each service location capable of being interconnected.

7.5.1.12 Point of Connection

Supply Side

An EPPS shall be permitted to be connected to the supply side of service disconnecting means. The sum of all overcurrent devices connected to EPPS shall not exceed the rating of service

Load Side

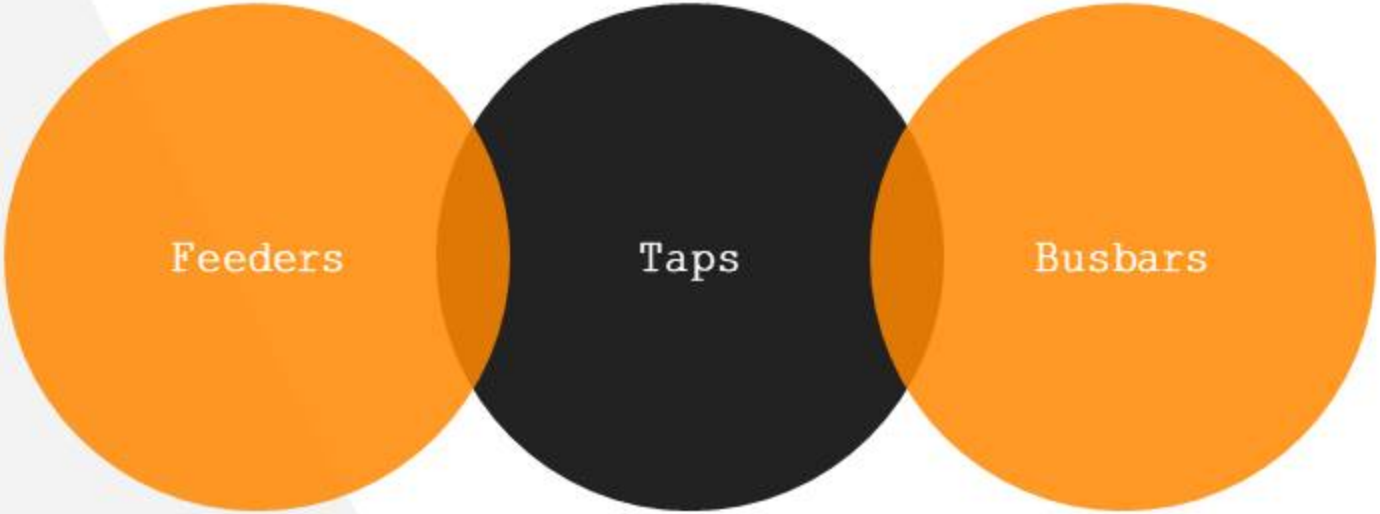
Output of an IEPPS shall be connected to the load side of the service disconnecting means of the other source at any distribution equipment.

DEDICATED OVERCURRENT AND DISCONNECT

Each source interconnection of one or more power sources installed in one system shall be made at a dedicated circuit breaker or fusible disconnecting means.

Bus or conductor ampere rating

125% of the power source output circuit shall be use in ampacity calculations for the following:



FEEDERS

Where the power source output connection is made to a feeder at a location other than the opposite end from the primary source overcurrent device, that portion of the feeder on the load side shall be protected by 1 of the ff:

a.) feeder ampacity > sum of the primary source overcurrent device and 125% of power output circuit current.

b.) an overcurrent device on the load side of the power source connection shall be rated not greater than ampacity of feeder.

TAPS

In systems where power source output connections are made at feeders, any taps shall be sized based on the sum of 125% of the power sources output circuit current and the rating of the overcurrent device protecting the feeder conductors as calculated in 2.40.2.2(B).

BUSBARS

One of the methods that follows shall be used to determine the ratings of busbars in panelboards.

a.) sum of 125% of the power sources output circuit current and the rating of the overcurrent device protecting the busbar shall not exceed the ampacity of the busbar.

b.) where two sources, one a primary power source and the other another power source are located at opposite ends of a busbar that contains loads, the sum of 125% of the power sources output circuit current and the rating of the overcurrent device protecting the busbar shall not exceed 120% of the ampacity. The busbar shall be sized for the loads connected in accordance

with Article 2.20. A permanent warning label shall be applied to the distribution equipment adjacent to the back-fed breaker from the power source that displays the following or equivalent wording:

WARNING:

POWER SOURCE OUTPUT CONNECTION:

DO NOT RELOCATE THIS OVERCURRENT DEVICE

c.) the sum of the ampere ratings of all overcurrent devices on panelboards, both load and supply devices, excluding the rating of the overcurrent device protecting the busbar shall not exceed the rating of the busbar. Permanent warning labels shall be applied to distribution equipment displays the following or equivalent wording:

BUSBARS

WARNING:

THIS EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES, EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE, SHALL NOT EXCEED AMPACITY OF BUSBAR.

d.) a connection at either end, but not both ends, of a center-fed panelboard in dwellings shall be permitted where the sum of 125% of the power source output circuit current and the rating of the overcurrent devices protecting the busbar does not exceed 120% of the current rating of the busbar.

BUSBARS

e.) connections shall be permitted on multiple ampacity busbars where designed under engineering supervision that includes available fault current and busbar load calculations.

MARKING

Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.

SUITABLE FOR BACKFEED

Circuit breakers, if backfeed, shall be suitable for such operation.

FPN: fused disconnects, unless otherwise marked, are suitable for backfeeding.

FASTENING

Listed plug-in-type circuit breakers backfed from electric power sources that are listed and identified as interactive shall be permitted to omit the additional fastener normally required by 4.8.3.7(D) for such operations.

7.5.1.14 Output Characteristics- *The output of a generator or other EPPS operating in parallel with an electrical supply shall be compatible with the voltage, wave shape, and frequency of the system to which it is connected.*

7.5.1.16 Interrupting and Short-Circuit Current Rating- *Consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment on interactive systems.*

7.5.1.20 Disconnecting Means, Sources- *Means shall be provided to disconnect all ungrounded conductors of an electric power production sources from all other conductors.*

7.5.1.21 Disconnecting Means, Equipment- *Means shall be provided to disconnect power production equipment, such as utility interactive inverters or transformers associated with a power production source, from all ungrounded conductors of all sources of supply. Equipment intended to be operated and maintained as an integral part of a power production source exceeding 1000 volts shall not be required to have a disconnecting means.*

7.5.1.22 Disconnect Device- *The disconnecting means for ungrounded conductors shall consist of a manual or power operated switches or circuit breakers that complies with the ff. features:*

a. Located where readily accessible
b. Externally operable without exposing the operator to contact with live parts and, if power operated, of a type that could be opened by hand in the event of a power-supply failure.
c. Plainly indicate whether in the open (off) or closed (on) position
d. Have ratings sufficient for the maximum circuit current, available short-circuit current, and voltage that is available at the terminals.
e. Where the line and load terminals are capable of being energized in the open position, marked in accordance with t warningin 6.90.3.1(B).

f. Simultaneous disconnect all ungrounded conductors of the circuit

g. Be lockable in the open (off) position in accordance with 1.10.1.25

7.5.1.23 Interactive System Disconnecting Means- *A readily accessible means shall be provided to disconnect the interactive system from all wiring systems including power systems, energy storage systems, and utilization equipment and its associated premises wiring.*

7.5.1.30 Overcurrent Protection- *Conductors shall be protected in accordance with Article 2.40. equipment and conductors connected to more than one electrical source shall have a sufficient number of overcurrent devices located so as to provide protection from all sources.*

a. Solar Photovoltaic Systems- shall be protected in accordance with Art. 6.90
b. Transformers- with a source on each side, overcurrent protection shall be provided in accordance with 4.50.1.3 by considering first one side of the transformer, then the other side of the transformer, as the primary.
c. Fuel Cell Systems- shall be protected in accordance with Article 6.92
d. Interactive Inverters- shall be protected in accordance with 7.5.2.6
e. Generators- shall be protected in accordance with 7.5.3.1

7.5.1.31 Location of Overcurrent Protection- *Overcurrent protection for electric power production source conductors, connected to the supply side of the service disconnecting means in accordance with 7.5.1.12(A), shall be located within 3000mm of the point where the electric power production source conductors are connected to the service.*

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7.5.1.32 Ground-Fault Protection- *Where ground-fault protection is used, the output of an interactive system shall be connected to the supply side of the ground-fault protection.*

7.5.1.40 Loss of Primary Source- *Upon loss of primary source, an electric power production source shall be automatically disconnected from all ungrounded conductors of the primary source and shall not be reconnected until the primary source is restored.*

Exception: A listed interactive inverter shall be permitted to automatically cease exporting power upon loss of primary source and shall not be required to automatically disconnect all ungrounded conductors from the primary sou[illegible].

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7.5.1.42 Loss of 3-Phase Primary Source- *A 3-phase EPPS shall be automatically disconnected from all ungrounded conductors of the interconnected systems when one of the phases of that source opens.*

7.5.1.50 Grounding- *Interconnected EPPS shall be grounded in accordance with Article 2.50*

Exception: For direct-current systems connected through an inverter directly to a grounded service, other methods that accomplish equivalent system protection and that utilize equipment listed and identified for the use shall be permitted.

7.5.2 Interactive Inverters

CIRCUIT SIZING AND CURRENT

CALCULATION OF MAXIMUM CIRCUIT CURRENT

The maximum current for the specific circuit shall be calculated in accordance with 7.5.2.1(A)(1) and (A)(2).

1.) **Inverter Input Circuit Currents-** The maximum current shall be the maximum rated input current of the inverter.

2.) **Inverter Output Circuit Current-** The maximum current shall be the inverter continuous output current rating.

7.5.2 Interactive Inverters

AMPACITY AND OVERCURRENT DEVICE RATINGS

Inverter system currents shall be considered to be continuous. The circuit conductors and overcurrent devices shall be sized to carry not less than 125% of the maximum currents as calculated in 7.5.21(A). The rating or setting of overcurrent devices shall be permitted in accordance with 2.40.1.4(B) and (C).

Exception: Circuits containing an assembly together with its overcurrent devices that is listed for continuous operation at 100% of its rating shall be permitted to be utilized at 100% of its rating.

7.5.2 Interactive Inverters

OVERCURRENT PROTECTION

CIRCUITS AND EQUIPMENT- Inverter input circuits, inverter output circuits, and storage battery circuit conductors and equipment shall be protected in accordance with the requirements of Article 2.40. Circuits connected to more than one electrical source shall have overcurrent devices located so as to provide overcurrent protection from all sources.

Exception: *An overcurrent device shall not be required for circuit conductors sized in accordance with 7.5.2.1(B).*

7.5.2 Interactive Inverters

POWER TRANSFORMERS- Overcurrent protection for a transformer with a sources on each side shall be provided in accordance with 4.50.1.3 by considering first one side of the transformer, then the other side of the transformer, as the primary.

CONDUCTOR AMPACITY- Power source output circuit conductors that are connected to a feeder, if smaller than the feeder conductors, shall be sized to carry not less than the larger of the current as calculated in 7.5.2.1(B)

7.5.2.11 Interactive Inverters Mounted in Not Readily Accessible Locations- *Interactive inverters shall be permitted to be mounted on roofs or other exterior areas that are not readily accessible. These installations shall comply with 1 through 4:*

1. A dc disconnecting means shall be mounted within sight of on in the inverter.
2. An ac disconnecting means shall be mounted within sight of or in the inverter.
3. An additional ac disconnecting means for the inverter shall comply with 7.5.1.22.
4. A plaque shall be installed in accordance with 7.[illegible]1.10.

7.5.2.21 **Utility-Interactive Power Systems Employing Energy Storage-** shall also be marked with the maximum operating voltage, including any equalization voltage, and the polarity of the grounded circuit conductor.

7.5.2.23 **Hybrid Systems-** shall be permitted to be interconnected with the interactive inverters.

7.5.2.36 **Ampacity of Neutral Conductor-** shall comply with either (A) or (B).

(A) **Neutral Conductor for Single Phase, 2-Wire Inverter Output-** If a single phase, 2-wire inverter output is connected to the neutral and one ungrounded conductor of a 3-wire system or 3-phase, 4-wire, wye connected system, the maximum load connected between the neutral and any one ungrounded conductor plus the inverter output rating shall not exceed the ampacity of the neutral conductor.

(B.) **Neutral Conductor for Instrumentation, Voltage Detection or Phase Detection-** A conductor used solely for instrumentation, voltage detection, or phase detection and connected to a single-phase or 3-phase interactive inverter, shall be permitted to be sized equal to or larger than the equipment grounding conductor.

7.5.2.41 UNBALANCED INTERCONNECTIONS

(A) **Single Phase-** shall be connected to three-phase power systems in order to limit unbalanced voltages to not more than 3%.

(B) **Three Phase-** 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.

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7.5.4.1 System Operation- Microgrid systems shall be permitted to disconnect from the primary source of power or other interconnected electric power production sources and operate as a separate microgrid system.

7.5.4.11 Primary Power Source Connection- that are external to the microgrid system shall comply with the requirements of 7.5.1.12

7.5.4.16 Reconnected to Primary Power Source- Microgrid systems that reconnected shall be provided with the necessary equipment to establish a synchronous transition.

7.5.4.21 Microgrid Interconnect Devices (MID)- shall comply:

1.) be required for any connection bet. a microgrid system and primary source.

2.) be listed or field labeled for the application

3.) have sufficient number of overcurrent devices located to provide overcurrent protection from all sources.

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ENERGY STORAGE SYSTEMS

7.6.1 GENERAL

This article applies to all permanently installed energy storage systems (ESS) operating at over 50 volts ac or60 volts dc that may be stand-alone or interactive with other electric power production sources.

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 hold 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 dc or ac loads or to an interconnected utility service.

Definitions

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 can include but is not limited to batteries, capacitors, and kinetic energy devices. 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, and alarm systems are assembled, installed and packaged into a singular energy storage container unit.

Definitions

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.

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.

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.

Definitions

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

Interier 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.

Definitions

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 ma 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.

Information 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.

Inverter Utilization Output Circuit- 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).

7.6.1.3 Other Articles- Wherever the requirements of other articles of this code and Article 7.6 differ, the requirements of Article 7.6 shall apply. If the ESS is capable of being operated in parallel with a primary sources of electricity, the requirements in 7.5.1.6, 7.5.1.12, 7.5.14, 7.5.1.16, 7.5.1.32, 7.5.1.40, 7.5.2.41, 7.5.3.14, and Part 7.5.4 shall apply.

7.6.1.4 System Classification- ESS shall be classified as on of the types described: a.) ESS, self-contained, b.) ESS, pre-engineered of matched components, c.) ESS, other.

7.6.1.5 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.

7.6.1.6 Multiple Systems- Multiple ESS shall be permitted to be installed in or on a single building or structure.

7.6.1.7 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.

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 1.10.1.25, 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 1.10.1.21 (B) and shall include the ff: **1.)** Nominal ESS voltage, **2.)** Maximum available short-circuit derived from the ESS, **3.)** The associated clearing time or arc duration based on the available short-circuit current, **4.)** Date the calculation was performed.

FPN 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.

FPN 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 1500mm 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 7.6.1.7(E)(1) is not within sight of the connected equipment.

FPN No. 1- For remote disconnect controls in information technology equipment rooms, see 6.45.1.10.

FPN No. 2- For overcurrent protection of batteries, see 2.40.2.1(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 explosives 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.

7.6.1.8 Connection to Other Energy Sources- Connection to other energy sources shall comply with requirements of 7.5.1.12

A.) Load disconnect- 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 7.5.1.40.

D.) Unbalanced Interconnections- Unbalanced connections between an energy storage system and electric power production sources shall be accordance with 7.5.2.41.

E.) Point of Connection- The point of connection between an energy storage system and electric power production sources shall be in accordance with 7.5.1.12

CRITICAL OPERATIONS POWER SYSTEMS (COPS)

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 in the event of disruption to elements of the normal system.

FPN 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 government authority.

FPN No. 2- For further information on disaster and emergency management, see NFPA 1600-2013, standard on Disaster/Emergency Management and Business Continuity Programs.

FPN No. 3- For further information regarding performance of emergency and standby power systems, see NFPA 110-2013

FPN No. 4- For further information regarding performance and maintenance of emergency systems in health care facilities, see NFPA 99-2015, Standard for Health Care Facilities.

FPN No. 5- For specification of locations where emergency lighting is considered essential to life safety, see NFPA 101-2015, Life Safety Code.

FPN No. 6- For further information regarding physical security, se NFPA 730-2014, Guide for premises Security.

FPN No. 7- Threats to facilities that may require transfer of operation to the critical systems include both naturally occurring hazards and human caused events.

Definitions

Commissioning- The acceptance testing, integrated system testing, operational tune-up, and start-up testing is the process 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.

Designated Critical Operations Areas (DCOA)- Areas within a facility or site designated as requiring critical operations power.

Definitions

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.

7.8.1.4 Risk Assessment- Risk assessment for critical operations power systems shall be documented and shall be conducted in accordance with 7.8.1.4(A) through (C).

A.) **Conducting 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-** a) Naturally occurring hazards (geological, meteorological, and biological), b) Human-caused events (accidental and intentional) [1600:5.3.2]

C.) **Developing Mitigation Strategy-** Strategy developed based on the results of the risk assessment and be implemented to mitigate hazards.

7.8.1.5 Physical Security- shall be provided for critical operations power systems in accordance with 7.8.1.5 (A) and (B)

A.) Risk Assessment- based on the results of 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.

7.8.1.6 Testing and Maintenance

A.) Conduct and Witness Test- Tests shall be conducted and witnessed on the complete system upon installation and periodically afterward.

B.) Tested Periodically- Systems shall be tested periodically on a set schedule to ensure the systems are maintained in proper operating condition.

C.) Maintenance- The office of the Building Official/EE shall require a documented preventive maintenance program for critical operations power systems.

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.

7.8.1.8 Commissioning

Commissioning Plan- shall be developed and documented.

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.

Baseline Test Result- A set of baseline test results shall be documented for comparison with future periodic maintenance testing to identify equipment deterioration.

Function 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.

7.8.2 Circuit Wiring and Equipment

7.8.2.1 Feeder and Branch Circuit

A) Identification

1.) **Boxes and Enclosure-** 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 closures (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 identified. Non-locking-type, 125-volt, 15- and 20 ampere receptacles supplied from the COPS shall have an illuminated face or an indicator light to indicate that there is power to the receptacle.

B.) **Wiring** – permitted in the same raceway, cable, box, or cabinet and shall be kept entirely independent.

C.) COPS Feeder Wiring Requirements:

Protection Against Physical Damage- shall only be permitted to have the following wiring methods: Rigid metal conduit, intermediate metal conduit, or Type MI cable. And in not less than 50 mm of concrete Flexible metal fittings, flexible metal conduit with listed fittings, and liquid-tight flexible metal conduit with listed fittings shall also be permitted.

Fire Protection for Feeders- shall meet one of the following: cable or raceway is protected by listed electrical circuit protective system with a minimum 2-hour fire rating, is a listed fire-resistive.

Floodplain Protection- COPS feeders are installed below the level of the 100-year floodplain, the insulated circuit conductors shall be listed for use in a wet location.

D.) COPS Branch Circuit Wiring

1.) Outside the DCOA. COPS branch circuits installed outside the DCOA shall comply with the physical and fire protection requirements of 7.8.2.1 C(1) through C3.

2.) Within the DCOA. Any of the wiring methods recognized in Chapter 3 of this Code shall be permitted within the DCOA.

7.8.2.2 Branch Circuit Distribution and Feeder Distribution Equipment

(A) Branch Circuit Distribution Equipment- shall be located within the same DCOA as the branch circuits it supplies.

(B) Feeder Distribution Equipment- shall comply the ff: Be located in spaces with a 2-hour fire resistance rating, and be located above 100-year floodplain.

7.8.2.3 Feeders and Branch Circuits Supplied by COPS- shall only supply the equipment specified as required for critical operations use.

7.8.2.5 Wiring of HVAC, Fire Alarm, Security, Emergency Communications, and Signaling Systems- all conductors or cables shall be installed using any or the metal wiring methods permitted by 7.8.2.1 C1 and, in addition, shall comply with 7.8.2.5(1) through (8)

1) All cables for fire alarm, security, signaling systems, and emergency communications shall be shielded twisted pair cables or installed to comply with the performance requirements of the system.

2) Shall be arranged in accordance with the manufacturer's published installation instructions.

3) Optical fiber cables shall be used for connections between two or more buildings on the property and under single management.

4) A listed primary protector shall be provided on all communications circuits. Listed secondary protectors shall be provided at the terminals of the communications circuits.

5) Conductors for all control circuits rated above 50 volts shall be rated not less than 600 volts.

6) Communications, fire alarm, and signaling circuits shall use relays with contact ratings that exceed circuit voltage and current ratings in the controlled circuit.

7) All cables for fire alarm, security, and signaling systems shall e riser-rated

and shall be a listed 2-hour electrical circuit protective system. Emergency communication cables and shall be Type CMR-CI or shall be riser-rated and shall be a listed 2-hour electrical circuit protective system.

8) Control, monitoring, and power wiring to HVAC systems shall be a listed 2-hour electrical circuit protective system.

7.8.3.1 Sources of Power

(A) General Requirements- in the event of failure of the normal supply critical operations power shall be available within the time required for the application.

(B) Fire Protection- where located within a building equipment for sources of power shall be installed either in spaces fully protected by approved automatic fire suppression systems.

(C) Grounding- all sources of power shall be grounded as a separately derived source

(D) Surge Protection Devices- shall be provided at all facility distribution voltage levels.

(E) Storage Battery- An automatic battery charging means shall be provided. Battery shall be compatible with the charger for that particular installation. Automotive-type batteries shall not be used.

(F) Generator Set

1. Prime Mover-Driven. Shall be provided with means for automatically starting the prime mover on failure of the normal service. Time-delay feature permitting a minimum of 15-minute setting.

2. Power for Fuel Transfer Pumps. Power is needed for the operation of the fuel transfer pumps to deliver fuel to generator set day tank, this pump shall be connected to the COPS.

3. Dual Supplies. Prime movers shall not be solely dependent on a public utility gas system for their fuel supply or municipal water supply for their cooling systems. Means shall be provided for automatically transferring from one fuel supply to another where dual fuel supplies are used.

4. Battery Power and Dampers. Where a storage battery is used for control or signal power or as means of starting the prime mover, it shall be suitable for the purpose and shall be equipped with an automatic charging means independent of the generator set.

5. Outdoor Generator Sets. *A) Permanently Installed Generators and Portable Generators Greater Than 15 kW. B) Portable Generators 15kW or Less.*

6. Means for Connecting Portable or Vehicle-Mounted Generator. Where the COPS is supplied by a single generator, a means to connect a portable or vehicle-mounted generator shall be provided.

7. On-Site Fuel Supply. Where internal combustion engines are used as the prime mover, an on-site fuel supply shall be provided.

(G) Uninterruptible Power Supplies. Used as the sole source of power for COPS shall comply the provisions of 7.8.1.3 E and F.

(H) Fuel Cell System. Installation of a fuel cell system shall meet the requirements of Parts 6.92.2 through 6.92.8

7.8.3.2 Ventilation. Adequate ventilation shall be provided for the alternate power source for continued operation under maximum anticipated ambient temperatures.

7.8.3.3 Capacity of Power Sources

(A) Capacity and Rating. COPS shall have capacity and rating for all loads to be operated simultaneously for continuous operation with variable load for an unlimited number of hours, except for required maintenance of the power source. A portable, temporary, or redundant alternate power source shall be available for use whenever the COPS power source is out of service.

(B) Selective Load Pickup, Load Shedding and Peak Load Shaving. The alternate power source shall be permitted to supply COPS emergency, legally required standby, and optional 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 COPS emergency circuits, (2) the legally required standby circuits, and the (3) the optional standby circuits, in that order of priority.

(C) Duration of COPS Operation. The alternate power source shall be capable of operating for a minimum of 72 hours at full load of DCOA with a steady-state voltage within ≠10 percent of nominal utilization voltage.

7.8.3.5 Transfer Equipment.

(A) General. Transfer equipment, including automatic transfer switches, shall be automatic and identified for emergency use. Transfer equipment shall be designed and installed to prevent the inadvertent interconnection of normal and critical operations sources of supply in any operation of the transfer equipment.

(B) Bypass Isolation Switches. Means shall be permitted to bypass and isolate the transfer equipment. Where bypass isolation switches are used, inadvertent parallel operation shall be avoided.

(C) Automatic Transfer Switches. Where used with sources that are not inherently synchronized, automatic transfer switches shall comply with C(1) and C(2).

(1) Automatic transfer switches shall be listed for emergency use.

(2) Automatic transfer switches shall be electrically operated and mechanically held.

(D) Use. Transfer equipment shall supply only COPS loads.

(E) Documentation. The short-circuit rating of the transfer equipment, based on the specific overcurrent protective device type and settings protecting the transfer equipment, shall be field marked on the exterior of the transfer equipment.

7.8.3.11 Branch Circuits Supplied by COPS. Branch circuits supplied by the COPS shall only supply equipment specified as required for critical operations use.

7.8.4 OVERCURRENT PROTECTION

7.8.4.1 Accessibility- the feeder and branch-circuit-over-current devices shall be accessible to authorized persons only.

7.8.4.3 Ground-Fault Protection of Equipment

(A) Applicability. The requirements of 7.8.4.3 shall apply to critical operations (including multiple occupancy buildings) with critical operation areas.

(B) Feeders. Where ground-fault protection is provided for operation of the service or feeder disconnecting means, an additional step of ground-fault protection shall be provided in all next level feeder disconnecting means downstream toward the load. Such protection shall consist of overcurrent devices and current transformers or other equivalent protective equipment.

7.8.4 OVERCURRENT PROTECTION

(C) Testing. When equipment ground-fault protection is first installed, each level shall be tested to ensure that ground-fault protection is operational.

(D) Selectivity. Ground-fault protection for operation of the service and feeder disconnecting means shall be fully selective such that the feeder device, but not the service device, shall open on ground faults on the load side of the feeder device.

7.8.4.5 Selective Coordination- critical operations power system(s) overcurrent devices shall be selectively coordinated with all supply-side overcurrent protective devices.

7.8.5 SYSTEM PERFORMANCE AND ANALYSIS

7.8.5.1 Emergency Operations Plan- a facility with a COPS shall have documented an emergency operations plan. The plan shall consider emergency operations and responds, recovery, and continuity or operations.

STAND-ALONE SYSTEMS

This article covers electric power production sources operating in stand-alone mode.

7.10.1.6 Equipment Approval- all equipment shall be listed or field labeled for the intended use.

7.10.1.15 General- premises wiring systems shall be adequate to meet the requirements of this code for similar installations supplied by a feeder or service. It shall comply with the requirements of this code, except as modified by:

A) Supply Output. Power supply to premises wiring systems shall be permitted to have less capacity than the calculated load. The capacity of the stand-alone supply shall be equal to or greater than the load posed by the largest single utilization equipment connected to the system. Calculated general lighting loads shall not be considered as a single-load.

B) Sizing and Protection. The circuit conductors between a stand-alone source and a building structure disconnecting means shall be sized based on the sum of the output ratings of the stand-alone sources.

C) Single 115-Volt Supply. Stand-alone systems shall be permitted to supply 115 volts to single-phase, 3 wire, 115/230-volt service equipment or distribution panels where there are no 230-volt outlets and where there are no multi-wire branch circuits. In all installations, the sum of the ratings of the power sources shall be less than the rating of the neutral bus in the service equipment. This equipment shall be marked with the following:

WARNING:

SINGLE 115-VOLT SUPPLY. DO NOT CONNECT MULTI-WIRE BRANCH CIRCUITS!

D) Energy Storage or Backup Power System Requirements. Energy storage or backup power supplies are not required.

E) Back-Fed Circuit Breakers. Plug-in type back-fed circuit breakers connected t an interconnected supply shall be secured in accordance with 4.8.3.7 D. circuit breakers marked "line" and "load" shall not be back-fed.

F) Voltage and Frequency Control. The stand-alone supply shall be controlled so that voltage and frequency remain within suitable limits for the connected loads.

Article 7.12 DIRECT CURRENT MICROGRIDS

GENERAL

- Scope: This article applies to direct current microgrid
- *Definitions : Direct current microgrid(DC microgrid). A direct current microgrid is a power distribution system consisting of more than one interconnected dc power source, supplying DC-DC converter(s), DC load(s) and/or AC load(s) powered by DC-AC inverter(s). A DC microgrid is typically not directly connected to an ac primary source of electricity, but some dc microgrid interconnect via one or more dc-ac bidirectional converters or dc-ac inverter.*

FPN: Direct current power sources include ac-dc converters (rectifiers) bidirectional dc-ac inverters/converters, photovoltaic systems, wind generator, energy storage systems (including batteries), and fuel cells.

GROUNDED TWO-WIRE DC SYSTEM

A system that has a solid connection or reference-ground between one of the current carrying conductors and the equipment grounding system.

GROUNDED THREE-WIRE DC SYSTEM

A system with a solid connection or reference-ground between the center point of a bipolar dc power source and the equipment grounding system.

NOMINAL VOLTAGE

A value assigned to a circuit or system for the purpose of conveniently designating its dc voltage class.

FPN: The actual voltage at which a circuit operates can vary from the nominal voltage within a range that permits satisfactory operation of equipment.

REFERENCE-GROUND DC SYSTEM

A system that is not solidly grounded but has a low-resistance electrical reference that maintains voltage to ground in normal operation.

RESISTIVELY GROUNDED

A system with a high-resistance connection between the current carrying conductors and the equipment grounding system.

PRIMARY DC SOURCE

A source that supplies the majority of the DC load in a microgrid.

UNGROUNDED DC SYSTEM

A system that has no direct or resistive connection between the current carrying conductors and the equipment grounding system.

7.12.1.3 Other Articles

Wherever the requirements of other articles of this *Code* and article 7.12 differ, the requirements of Article 7.12 shall apply. DC micro-grids interconnected through an inverter or bi-directional converter with AC electric power production sources shall comply with 7.5.

7.12.1.4 Listing and Labeling

Any equipment directory denoting all dc electric power sources operating to supply the dc microgrid shall be installed at each source location capable of acting as the primary dc source.

7.12.2 CIRCUIT REQUIREMENTS

7.12.2.1 Identification of Circuit Conductors

(A) Underground circuit conductors in dc micro-grids shall be identified according to the requirements of 2.10.1.5(C)(2) for branch circuits and 2.15.1.12(C)(2) for feeders.

(B) Undergrounded conductors of 14mm^2 or smaller shall be permitted to be identified by polarity at all termination, connection, and splice points by marking tape, tagging, or other approved means.

7.12.2.6 System Voltage

The system voltage of a dc micro-grid shall be determined by one of the following methods:

(1) The nominal voltage to ground for solidly grounded systems.

(2) The nominal voltage to ground for reference-grounded systems

(3) The highest nominal voltage between conductors for resistively grounded dc systems and undergrounded dc systems.

FPN : Examples of nominal dc systems voltages include but are not limited to 24,48,125,190/380 or 380 volts.

7.12.3 Disconnecting

7.12.3.1 DC source Disconnecting Means. The output of each dc source shall have a readily accessible, disconnecting means that is lockable in the open position and adjacent to the source.

7.12.3.2 Disconnection of Undergrounded Conductors. In solidly grounded two and three-wire systems, the disconnecting means shall simultaneously open all undergrounded conductors. In undergrounded, resistively grounded and reference-grounded systems, such devices shall open all current carrying conductors.

7.12.3.4 Directional Current Devices

Disconnecting means shall be listed, be marked for use in a single current direction, and only be used in the designed current direction.

FPN: Examples of directional current devices are magnetically quenched contractors and semiconductors switches in overcurrent devices.

7.12.4 Wiring Methods

7.12.4.1 System Grounding

(A) General: Direct-current microgrids shall be grounded in accordance with 2.50.8.3.

(B) Over 300 Volts: DC microgrids operating at voltages greater than 300 volts dc shall be reference-grounded dc systems or resistively grounded dc systems.

7.12.4.4 Ground Fault Detection Equipment

Undergrounded, reference grounded, or resistively grounded dc microgrids operating at greater than 60 volts dc shall have ground fault detection that indicates that a fault has occurred. The ground fault equipment shall be marked in accordance with 2.50.8.8(C).

7.12.4.6 Arc Fault Protection

Where required elsewhere in this *Code*, specific systems within the DC microgrid shall have arc fault protection. The arc fault protection equipment shall be listed.

FPN: Section 1.0.1.4 applies when suitable equipment for arc fault protection is not available.

7.12.5 Marketing

7.12.5.1 Distribution Equipment and Conductors

Distribution equipment and conductors shall be marked as required else-where in this *Code.*

7.12.5.4 Available DC Short-Circuit Current

(A) **Field Marketing.** The maximum available dc short-circuit current on the dc microgrid shall be field marked at the dc source(s). The field marking(s) shall include the date the short-circuit current calculation was performed and be of sufficient durability to withstand the environment involved.

7.12.5 Marketing

(B) **Modifications.** When modifications to the electrical installation occur that affect the maximum available short-circuit current at the dc source, the maximum available short-circuit shall be verified or recalculated as necessary to ensure the equipment ratings are sufficient for the maximum available short-circuit current at the line terminals of the equipment. The required field marking(s) in 7.12.5.4(A) shall indicate the new maximum available short-circuit current and date.

7.12.6 Protection

7.12.6.1 Overcurrent Protection. Equipment and conductors connected to more than one electrical source shall have overcurrent protective devices to provide protection from all sources.

7.12.6.3 Interrupting and Short-Circuit Current Ratings. Consideration shall be given to the contribution of short-circuit currents from all interconnected power sources for the interrupting ratings and short-circuit current ratings of equipment in the dc microgrid system(s). Overcurrent protective devices and equipment used within a dc microgrid shall have an interrupting rating at a nominal circuit voltage or short-circuit current rating sufficient for the available short circuit current at the line terminals of the equipment.

7.12.7 Systems over 1000 Volts

7.12.7.1 General

Systems with a maximum voltage between conductors of over 1000 volts dc shall comply with article 4.90 and other requirements in this *Code* applicable to installations rated over 1000 volts.

Article 7.20 — CIRCUIT AND EQUIPMENT OPERATING AT LESS THAN 50 VOLTS

7.20.1.1 Scope

This article covers installations operating at less than 50 volts, dc or ac.

7.20.1.2 Other Articles

Dc or ac installations operating at less than 50 volts, as covered in 4.11.1.1 through 4.11.1.8; Part 5,17.6; Part 5.51.2; Parts 5.52.1 and 5.52.3 and 5.52.5(B) of article; 6.50.1.1 through 6.50.1.8; 6.69.1.1 through 6.69.1.9; parts 6.90.8 and parts 7.25.1 and 7.25.3; or parts 7.60.1 and 7.60.3. shall not be required to comply with this article.

7.20.1.3 Hazardous (Classified) Locations

Installation within the scope of this article and installed in hazardous (classified) locations shall also comply with the appropriate provisions for hazardous (classified) locations in other applicable articles of this *Code*.

7.20.1.4 Conductors

Conductors shall not be smaller than 3.5mm^2 copper or equivalent. Conductors for appliance branch circuits supplying more than one appliance or appliance receptacle shall not be smaller than 5.5 mm^2 copper or equivalent.

7.20.1.5 Lampholders

Standard lampholders that have a rating of not less than 660 watts shall be used.

7.20.1.6 Receptacle Rating

Receptacles shall have a rating of not less than 15 amperes.

7.20.1.7 Receptacles Required

Receptacles of not less than 20 A rating shall be provided in kitchens, laundries and other locations where portable appliances are likely to be used.

7.20.1.9 Batteries

Installations of storage batteries shall comply with 4.80.1.1 through 4.80.1.6 and 4.80.1.9 through 4.80.1.11

7.20.1.11 Mechanical Execution of Work

Circuits operating at less than 50 volts shall be installed in a neat and workmanlike manner. Cables shall be supported by the building structure in such a manner that the cable will not be damaged by normal building use.

ARTICLE 7.25 – CLASS 1, CLASS 2, AND CLASS 3 REMOTE-CONTROL, SIGNALING, AND POWER-LIMITED CIRCUITS

7.25.1.1 Scope

This article covers remote-control, signaling, and power-limited circuits that are not an integral part of a device or appliance.

FPN: The circuits described herein are characterized by usage and electrical power limitations that differentiate them from electric light and power circuits; therefore, alternative requirements to those of chapter 1 through 4 are given with regard to minimum wire sizes, ampacity adjustment and correction factors, overcurrent protection, insulation requirements and wiring methods and materials.

7.25.1.2 Definitions

Abandoned class 2, class 3 and PLTC Cable. Installed class 2, class 3 and PLTC cable that is not terminated at equipment and not identified for future use with a tag.

Circuit Integrity (CI) Cable. Cables used for remote-control, signaling, or power-limited systems that supply critical circuits to ensure survivability for continued circuit operation for a specified time under fire conditions.

Class 1 Circuit. The portion of the wiring system between the load side of the overcurrent device or power-limited supply and the connected equipment.

FPN: see 7.25.2.1 for voltage and power limitations of class 1 circuits.

7.25.1.2 Definitions

Class 2 Circuit. The portion of the wiring system between the load side of a class 2 power source and the connected equipment. Due to its power limitations, a class 2 circuit considers safety from a fire initiation standpoint and provides acceptable protection from electric shock.

Class 3 Circuit. The portion of the wiring system between the load side of a class 3 power source and the connected equipment. Due to its power limitations, a class 3 circuit considers safety from a fire initiation standpoint. Since higher levels of voltage and current than for class 2 are permitted, additional safeguards are specified to provide protection from an electrical shock hazard that could be encountered.

7.25.1.2 Definitions

Power-Limited Tray Cable (PLTC). A factory assembly of two or more insulated conductors rated at 300V, with or without insulated bare or insulated equipment grounding conductors, under a nonmetallic jacket.

7.25.1.3 Other Articles

Circuits and equipment shall comply with the articles or sections listed in 7.25.1.3(A) through (L). Only those sections of article 3.0 referenced in this article shall apply to Class 1, Class 2, Class 3 circuits.

7.25.1.3 Other Articles

(A) Number and Size of Conductors in Raceways.

Section 3.0.1.17

(B) Spread of Fire or Products of Combustion

Installation of Class 1, Class 2, Class 3 circuits shall comply with 3.0.1.21.

(C) Ducts, Plenums, and Other Air-Handling Spaces

Class 1, Class 2, and Class 3 circuits installed in ducts, plenums, or other space used for environmental air shall comply with 3.0.1.22.

Exception No.1: Class 2 and Class 3 cables selected in accordance with Table 7.25.3.34 and installed in accordance with 7.25.3.15(B) and 3.0.1.22(B), Exception shall be permitted to be installed in ducts specifically fabricated for environmental air.

Exception No.2: Class 2 and Class 3 cables selected in accordance with Table 7.25.3.34 and installed in accordance with 7.25.3.15(C) shall be permitted to be installed in other spaces used for environmental air (plenums).

(D) Hazardous (Classified) Locations

Articles 5.0 through 5.16 and Part 5.17.4 where installed in hazardous (classified) locations.

(E) Cable Trays

Articles 3.92, where installed in cable tray.

(F) Motor Control Circuits

Part 4.30.6 where tapped from the load side of the motor branch-circuit protective device(s) as specified in 4.20.6.2(A).

(G) Instrumentation Tray Cable

See Article 7.27.

(H) Raceways Exposed to Different Temperatures

Installations shall comply with 3.0.1.7(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 3.0.1.19.

(J) Bushing

A bushing shall be installed where cables emerge from raceway used for mechanical support or protection in accordance with 3.0.1.15(C).

(K) Installation of Conductors with Other Systems

Installations shall comply with 3.0.1.8.

(L) Corrosive, Damp, or Wet Locations

Class 2 and Class 3 cables installed in corrosive, damp, or wet locations shall comply with the applicable requirements in 1.0.1.11.5(B), 3.0.1.6, 3.0.1.6, 3.0.1.9, and 3.10.2.1(G).

(M) Cable Routing Assemblies

Class 2, Class 3 and type PLTC cables shall be permitted to be installed in plenum cable routing assemblies, riser cable routing assemblies, and general-purpose cable routing assemblies selected in accordance with the Table 8.0.5.45(C), listed in accordance with the provisions of 8.0.6.13, and installed in accordance with 8.0.5.1(C) and 8.0.5.4.

(N) Communications Raceways

Class 2, Class 3, type PLTC cables shall be permitted to be installed in plenum communications raceways, riser communications raceways, and general-purpose communications raceways selected in accordance with 8.0.5.4(b), listed in accordance with 8.0.6.13 and installed in accordance with 8.0.5.4 and 3.62.2.15 through 3.62.47, where the requirements applicable to electrical nonmetallic tubing (ENT) apply.

7.25.1.21 Access to Electrical Equipment Behind Panels Designed to Allow Access

Access to electrical equipment shall not be denied by an accumulation of wires and cables that prevent removal of panels, including suspended ceiling panels.

7.25.1.25 Abandoned Cables

The accessible portion of abandoned Class 2, Class 3 and PLTC cables shall be removed. Where cables are identified for future use with a tag, the tag shall be of sufficient durability to withstand the environment involved.

7.25.1.24 Mechanical Execution of Work

Class 1, Class 2, and Class 3 circuits shall be installed in a neat and workmanlike manner, Cables and conductors installed exposed on the surface of ceilings and sidewalls shall be supported by the building structure in such a manner that the cable will not be damaged by normal building use. Such cables shall be supported by straps, staples, hangers, cable ties, or similar fittings designed and installed so as not to damage the cable. The installation shall also comply with 3.0.1.4(D).

7.25.1.30 Class 1, Class 2 and Class 3 Circuit Identification

Class 1, 2, 3 circuits shall be identified at terminal and junction locations in a manner that prevents unintentional interference with other circuits during testing and servicing.

7.25.1.31 Safety-Control Equipment

(A) Remote-Control Circuits

Remote-control circuits for safety-control equipment shall be classified as Class 1 if the failure of the equipment to operate introduces a direct fire or life hazard. Room thermostats, water temperature regulating devices, and similar controls used in conjunction with electrically controlled household heating and air conditioning shall not be considered safety-control equipment.

(B) Physical Protection

Where damage to remote-control circuits of a safety-control equipment would introduce a hazard, as covered in 7.26.1.31(A), all conductors of such remote-control circuits shall be installed in rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, electrical metallic tubing, Type MI cable, Type MC cable, or be otherwise suitably protected from physical damage.

7.25.1.35 Class 1, Class 2 and Class 3 Circuit Requirements

A remote-control, signaling, or power-limited circuit shall comply with the following parts of this article:

(1) Class 1 circuits: Parts 7.25.1 and 7.25.2

(2) Class 2 and 3 circuits: Parts 7.25.1 and 7.25.3

7.25.2 Class 1 Circuits

7.25.2.1 Class 1 Circuit Classification and Power Source Requirements

Class 1 circuits shall be classified as either class 1 power-limited circuits where they comply with the power limitations of 7.25.1(A) or as class 1 remote-control and signaling circuits where they are used for remote-control or signaling purposes and comply with the power limitations of 7.25.2.1(B).

(A) Class 1 Power-Limited Circuits. These circuits shall be supplied from a source that has a rated output of not more than 30 volts and 1000 volt-ampere.

(1) Class 1 Transformers. Transformers used to supply power-limited class 1 circuits shall comply with the applicable

(2) Other Class 1 Power Sources. Power sources other than transformer shall be protected by overcurrent devices rated at not more than 167 percent f the volt-ampere rating of the source divided by the rated voltage. The overcurrent devices shall not be interchangeable with overcurrent devices of higher ratings. The overcurrent device shall be permitted to be an integral part of the power supply.

(B) Class 1 Remote-Control and Signaling Circuits. These circuits shall not exceed 600 volts. The power output of the source shall not be required to be limited.

7.25.2.3 Class 1 Circuit Overcurrent Protection

Overcurrent protection for conductors 2.0 mm^2 and larger shall be provided in accordance with the conductor ampacity, without applying the ampacity adjustment and correction factors of 3.10.2.6 to the ampacity calculation. Overcurrent protection shall not exceed 7 amperes for 0.75 mm^2 conductors and 10 ampere for 1.25 mm^2.

Exception: Where other articles of this code permit or require other overcurrent protection.

FPN: For example, sec. 4.30.6.2 for motors, 6.10.6.3 for cranes and hoists and 5.17.5.4(B) and 6.60.1.9 for X-ray equipment.

7.25.2.5 Class 1 Overcurrent Device Location

Overcurrent devices shall be located as specified in 7.25.2.5(A),(B),(C),(D) or (E).

(A) Point of Supply. Overcurrent devices shall be located at the point where the conductor to be protected receives its supply.

(B) Feeder Taps. Class 1 circuit conductors shall be permitted to be tapped, without overcurrent device protection at the tap, where the overcurrent device protecting the circuit conductor is sized to protect the tap conductor.

(C) Branch-Circuit Taps. Class 1 circuit conductors 2.0 mm^2 and larger that are tapped from the load side of the overcurrent protective device(s) of a controlled light and power circuit shall require only short-circuit and ground-fault protection and shall be permitted to be protected by the branch-circuit overcurrent protective device(s) where the rating of the protective device(s) is not more than 300 percent of the ampacity of the class 1 circuit conductor.

(D) Primary Side of Transformer. Class 1 circuit conductors supplied by the secondary of a single-phase transformer having only a 2-wire secondary shall be permitted to be protected by overcurrent protection provided on the primary side of the transformer, provided this protection is in accordance with 4.50.1.3 and does not exceed the value determined by multiplying the secondary conductor ampacity by the secondary-to-primary transformer voltage ratio. Transformer secondary conductors other than 2-wire shall not be considered to be protected by the primary overcurrent protection.

(E) Input Side Electronic Power Source. Class 1 circuit conductors supplied by the output of a single-phase, listed electronic power source, other than a transformer, having only 2-wire output for connection to class 1 circuits shall be permitted to be protected by overcurrent protection provided on the input side of the electronic power source, provided this protection does not exceed the value determined by multiplying the class 1 circuit conductor ampacity by the output-to-input voltage ratio. Electronic power source outputs, other than 2-wire, shall not be considered to be protected by the primary overcurrent protection.

7.25.2.6 Class 1 Circuit Wiring Methods

Class 1 circuits shall be installed in accordance with part 3.0.1 and with the wiring methods from the appropriate articles in Chapter 3.

Exception No.1: The provisions of 7.25.2.8 through 7.25.2.11 shall be permitted to apply in installations of class 1 circuits.

Exception No.2: Methods permitted or required by other articles of this code shall apply to installations of class 1 circuits.

7.25.2.8 Conductors of Different Circuits in the Same Cable, Cable Tray, Enclosure, or Raceway.

Class 1 circuits shall be permitted to be installed with other circuits as specified in 7.25.2.8(A) and (B)

(A) Two or More Class 1 Circuits. Class 1 circuits shall be permitted to occupy the same cable, cable tray, enclosure, or raceway without regard to whether the individual circuits are alternating current or direct current, provided all conductors are insulated for the maximum voltage of any conductor in the cable, cable tray enclosure or raceway.

(B) Class 1 Circuits with Power-Supply Circuits. Class 1 circuits shall be permitted to be installed with power-supply conductors as specified in 7.25.2.8(B)(1) through (B)(4)

(1) In a Cable, Enclosure, or Raceway. Class 1 circuits and power supply circuits shall be permitted to occupy the same cable, enclosure, or raceway only where the equipment powered is functionally associated.

(2) In Factory- or Field-Assembled Control Centers. Class 1 circuits and power supply circuits shall be permitted to be installed in factory- or field-assembled control centers.

(3) In a Manhole. Class 1 circuits and power-supply circuits shall be permitted to be installed as underground conductors in a manhole in accordance with one of the following:

a) the power-supply or class 1 circuit conductors are in a metal-enclosed cable or type UF cable.

b) the conductors are permanently separated from the power-supply conductors by a continuous firmly fixed nonconductor, such as flexible tubing, in addition to the insulation on the wire.

c) the conductors are permanently and effectively separated from the power supply conductors and securely fastened to racks, insulators, or other approved supports.

(4) In Cable Trays. Installations in cable trays shall comply with 7.25.2.8.(B)(4)(a) or (B)(4)(b).

a) Class 1 circuit conductors and power-supply conductors not functionally associated with the class 1 circuit conductors shall be separated by a solid fixed barrier of a material compatible with the cable tray.

b) Class 1 circuit conductors and power-supply conductors not functionally associated with the class 1 circuit conductors shall be permitted to be installed in a cable tray without barriers where all of the conductors are installed with separate multiconductor type AC, type MC, type MI, or type TC cables and all the conductors in the cables are insulated at 600 volts or greater.

7.25.2.9 Class 1 Circuit Conductor

(A) Sizes and Use. Conductors of sizes 0.75 mm^2 and 1.25 mm^2 shall be permitted to be used, provided they supply loads that do not exceed the ampacities given in 4.2.1.5 and are installed in a raceway, an approved enclosure or a listed cable. Conductors larger that 1.25 mm^2 shall not supply loads greater that the ampacities given in 3.10.2.6. Flexible cords shall comply with article 4.0.

(B) Insulation. Insulation on conductors shall be rated for the system voltage and not less than 600 volts. Conductors larger than 1.25 mm^2 shall comply with article 3.10. Conductors in 0.75 mm^2 and 1.25 mm^2 shall be Type FFH-2, KFF-2, PAF, PAFF, PF, PFF, PGFF, PTF, PTFF, RHF-2, RFHH-2, RFHH-3, SF-2, SFF-2, TF, TFF, TFFN, TFN, ZF or ZFF. Conductors with other types and thicknesses of insulation shall be permitted if listed for class 1 circuit use.

7.25.2.11 Number of Conductors in Cable Trays and Raceway, and Ampacity Adjustment

(A) Class 1 Circuit Conductors. Where only Class 1 circuit conductors are in a raceway, the number of conductors shall be determined in accordance with 3.0.1.17. The ampacity adjustment factors given in 3.10.2.6(b)(3)(a) shall apply only if such conductors carry continuous loads in excess of 10 percent of the ampacity of each conductors.

(B) Power-Supply Conductors and Class 1 Circuit Conductors. Where power-supply conductors and class 1 circuit conductors are permitted in a raceway in accordance with 7.25.2.8, the number of conductors shall be determined in accordance with 3.0.1.17. The ampacity adjustment factors given in 3.10.2.6(b)(3)(a) shall apply as follows:

(1) To all conductors where the class 1 circuit conductors carry continuous loads in excess of 10 percent of the ampacity of each conductor and where the total number of conductors is more than three.

(2) To the power-supply conductors only, where the class 1 circuit conductors do not carry continuous loads in excess of 10 percent of the ampacity of each conductor and where the number of power-supply conductors is more than three.

(C) Class 1 Circuit Conductors in Cable Trays. Where class 1 circuit conductors are installed in cable trays, they shall comply with the provisions of 3.92.2.13 and 3.92.2.71(A).

7.25.2.12 Circuits Extending Beyond One Building

Class 1 circuits that extend aerially beyond one building shall also meet the requirements of Article 2.25

7.25.3 Class 2 and Class 3 Circuits

7.25.3.1 Power Sources for Class 2 and Class 3 Circuits

(A) Power Source. The power source for a class 2 or a class 3 circuit shall be as specified in 7.25.3.1(A)(1), (A)(2), (A)(3), (A)(4), or (A)(5):

FPN No.1: FPN figure 7.25.3.1 No.1 illustrates the relationships between class 2 or class 3 power sources, their supply, and the class 2 or class 3 circuits.

FPN No.2: Table 10.1.1.11(A) and Table 10.1.1.11(B) provide the requirements for listed class 2 and class 3 power sources.

7.25.3.1 Power Sources for Class 2 and Class 3 Circuits

(1) A listed Class 2 or 3 transformer

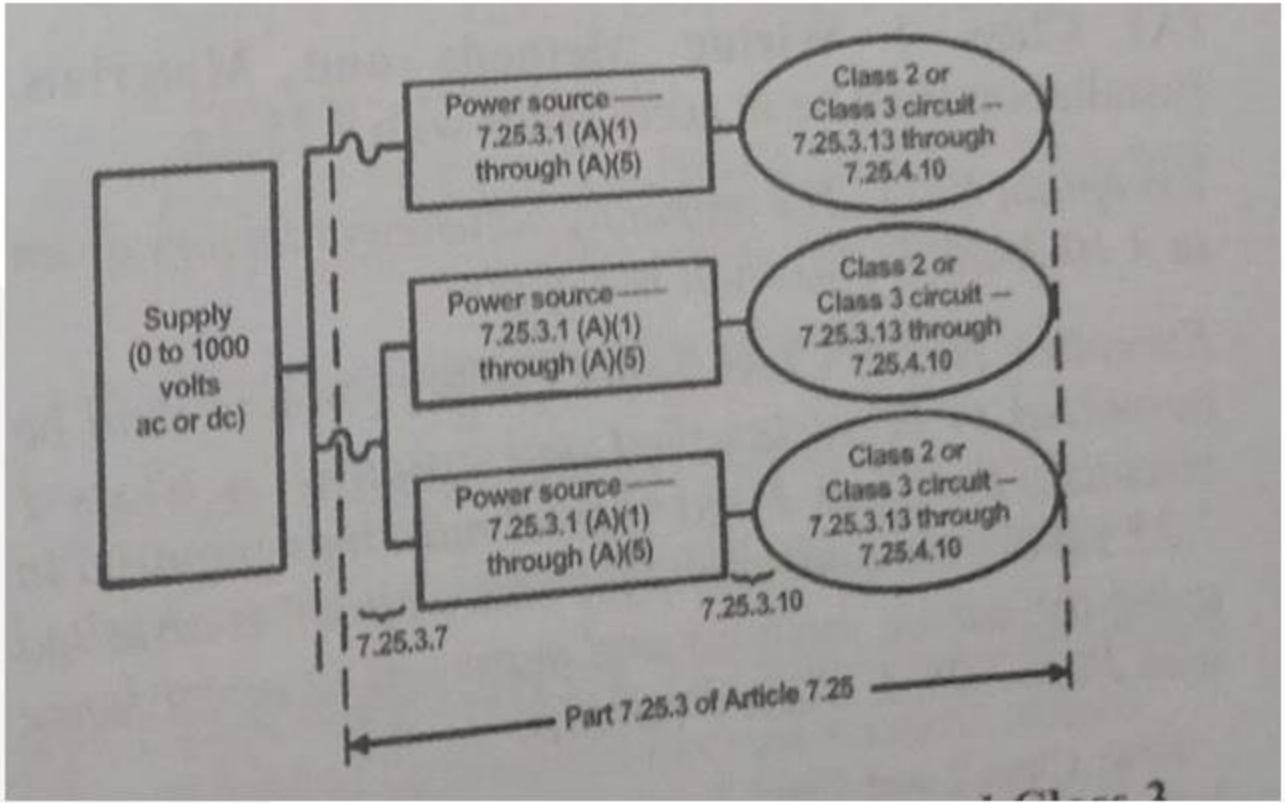
(2) A listed Class 2 or 3 power supply

(3) Other listed equipment marked to identify the class 2 or class 3 power source.

Exception No.1 to (3): Thermocouples shall not require listing as a class 2 power source.

Exception No.2 to (3): Limited power circuits of listed equipment where these circuits have energy levels rated at or below the limits established in Table 10.1.1.11(A) and Table 10.1.1.11(B).

FPN FIGURE 7.25.3.1, No.1 Class 2 and Class 3 Circuits.



(B) Interconnection of Power Sources. Class 2 or Class 3 power sources shall not have the output connections paralleled or otherwise interconnected unless listed for such interconnection.

(C) Marking. The power sources for limited power circuits in 7.25.3.1(A)(3) and limited power circuits for listed audio/video information technology (equipment) and listed industrial equipment in 7.25.3.1(A)(4) shall have a label indicating the maximum voltage and current output for each connection point. The effective date shall be January 1, 2018.

7.25.3.4 Circuit Marking

The equipment supplying the circuits shall be durably marked where plainly visible to indicate each circuit that is a Class 2 or Class 3 circuit.

7.25.3.7 Wiring Methods on Supply Side of the Class 2 or Class 3 Power Source

Conductors and equipment on the supply side of the power source shall be installed in accordance with the appropriate requirements of chapters 1 through 4. Transformers or other devices supplied from electric light or power circuits shall be protected by an overcurrent device rated not over 20 A.

Exception: The input leads of a transformers or other power source supplying class 2 and class 3 circuits shall be permitted to be smaller than 2.0 mm^2, but not smaller than 0.75 mm^2 if they are not over 300 mm long and if they have insulation that complies with 7.25.2.9(B).

7.25.3.10 Wiring Methods and Materials on Load Side of the Class 2 or Class 3 Power Source

Class 2 and Class 3 circuits on the load side of the power source shall be permitted to be installed using wiring methods and materials in accordance with either 7.25.3.10(A) or (B).

(A) Class 1 Wiring Methods and Materials. Installations shall be in accordance with 7.25.2.6.

Exception No. 1: The ampacity adjustment factors given in 3.10.2.6(B)(3)(a) shall not apply.

Exception No. 2: Class 2 and 3 circuits shall be permitted to be reclassified and installed as Class 1 circuits if the class 2 and 3 markings required in 7.25.3.4 are eliminated and the entire circuits is installed using the wiring methods and materials in accordance with Part 7.25.2, Class 1 circuits.

FPN: Class 2 and 3 circuits reclassified and installed as class 1 circuits are no longer class 2 or 3 circuits, regardless of the continued connection to a class 2 or 3 power source.

(B) Class 2 and Class 3 Wiring Methods. Conductors on the load side of the power source shall be insulated at not less than the requirements of 7.25.4.10 and shall be installed in accordance with 7.25.3.13 and 7.25.3.34.

Exception No. 1: As provided for in 6.20.3.1 for elevators and similar equipment.

Exception No. 2: Other wiring methods and materials installed in accordance with the requirements of 7.25.1.3 shall be permitted to extend or replace the conductors and cables described in 7.25.4.10 and permitted by 7.25.3.10(B)

Exception No. 3: Bare Class 2 conductors shall be permitted as part of a listed intrusion protection system where installed in accordance with the listing instruction for the system.

7.25.3.13 Installation Of Conductors and Equipment in Cables, Compartments, Cable Trays, Enclosures, Manholes, Outlet Boxes, Device Boxes, Raceways, and Cable Routing Assemblies for Class 2 and Class 3 Circuits.

Conductors and equipment for class 2 and class 3 circuits shall be installed in accordance with 7.25.3.15 through 7.25.3.24.

7.25.3.15 Installation of Class 2, Class 3, and PLTC Cable

Installation of Class 2, 3 and PLTC cables shall comply with 7.25.3.15(A) through (M)

(A) Listing. Class 2, 3 and PLTC cables installed in buildings shall be listed.

(B) Ducts Specifically Fabricated for Environmental Air. The following wires and cables shall be permitted in ducts specifically fabricated for environmental air as described in 3.0.1.22(B) in directly associated with the air distribution system:

(1) Types of CL2P and CL3P cables in lengths as short as practicable to perform the required function.

(2) Types CL2P, CL3P, CL2R, CL3R, CL2, CL3, CL2X, CL3X, and PLTC cables installed in raceways that are installed in compliance with 3.0.1.22(B)

FPN: For information on fire protection of wiring installed in fabricated ducts, see 4.3.4.1 and 4.3.11.3.3 of NFPA 90A-2015, standard for installation of air-conditioning and ventilation systems.

7.25.3.15 Installation of Class 2, Class 3, and PLTC Cable

(C) Other Spaces Used for Environmental Air (Plenums). The following cables shall be permitted in other spaces used for environmental air as described in 3.0.1.22(C):

(1) Types CL2P and CL3P cables

(2) Types CL2P and CL3P cables installed in plenum communications raceways

(3) Types CL2P and CL3P cables installed in routing assemblies

(4) Types CL2P and CL3P cables installed in raceways that are installed in compliance with 3.0.1.22(C)

(5) Types CL2P, CL3P, CL2R, CL3R, CL2, CL3, CL2X, CL3X, and PLTC cables supported by solid bottom metal cable trays with solid metal covers in other spaces used for environmental air (plenums) as described in 3.0.1.22(C)

(6) Types CL2P, CL3P, CL2R, CL3R, CL2, CL3, CL2X, CL3X, and PLTC cables installed in plenum communications raceways, riser communications raceways, and general-purpose communications raceways supported by solid bottom metal cable trays with solid covers In other spaces used for environmental air (Plenums) as described in 3.0.1.22(C)

(D) Risers- Cables in Vertical Runs. The following cables shall be permitted in vertical runs penetrating one or more floors and in vertical runs in a shaft:

(1) Types CL2P, CL3P, CL2R, and CL3R cables.

(2) Types CL2P, CL3P, CL2R, and CL3R cables installed in the following:

a. Plenum communication raceways

b. Plenum cable routing assemblies

c. Riser communication raceways

d. Riser cable routing assemblies

FPN: See 3.0.1.21 for firestop requirements for floor penetrations.

(E) Risers — Cables in Metal Raceways. The following cables shall be permitted in metal raceways in a riser having firestops at each floor:

(1) Types CL2P, CL3P, CL2R, and CL3R cables.

(2) Types CL2P, CL3P, CL2R, CL3R, CL2, CL3, CL2X, CL3X and PLTC cables installed in the following:

a. Plenum communication raceways

b. Riser communication raceways

c. General-purpose communications raceways

FPN: See 3.0.1.21 for firestop requirements for floor penetrations.

(F) Risers – Cables in Fireproof Shafts. The following shall be permitted to be installed in fireproof riser having firestops at each floor:

(1) Types CL2P, CL3P, CL2R, and CL3R cables.

(2) Types CL2P, CL3P, CL2R, CL3R, CL2, CL3, CL2X, CL3X and PLTC cables installed in the following:

a. Plenum communication raceways

b. Plenum cable routing assemblies

c. Riser communication raceways

d. Riser cable routing assemblies

e. General-purpose communications raceways

f. General-purpose cable routing assemblies

(G) Risers — One- and Two-Family Dwellings. The following cables shall be permitted in one- and two-family dwellings:

(1) Types CL2P, CL3P, CL2R, and CL3R cables.

(2) Types CL2X and CL3X cables less than 6mm in diameter

(3) Types CL2P, CL3P, CL2R, CL3R, CL2, CL3, CL2X, CL3X and PLTC cables installed in the following:

a. Plenum communication raceways

b. Plenum cable routing assemblies

c. Riser communication raceways

d. Riser cable routing assemblies

(H) Cable Trays. Cables installed in cable trays outdoors shall be type PLTC. The following cables shall be permitted to be supported by cable trays in building:

(1) Types CM CL2P, CL3P, CL2R, CL3R, CL2 CL3 and PLTC cables

(2)) Types CL2P, CL3P, CL2R, CL3R, CL2, CL3, CL2X, CL3X and PLTC cables installed in the following:

a. Plenum communication raceways

b. Riser communication raceways

c. General-purpose communications raceways

(I) Cross-Connect Arrays. The following cables shall be permitted to be installed in cross-connect arrays:

(1) Types CL2P, CL3P, CL2R, CL3R, CL2, CL3 and PLTC cables

(2) Types CL2P, CL3P, CL2R, CL3R, CL2, CL3 and PLTC cables installed in the following:

a. Plenum communication raceways

b. Plenum cable routing assemblies

c. Riser communication raceways

d. Riser cable routing assemblies

e. General-purpose communications raceways

f. General-purpose cable routing assemblies

(J) Industrial Establishments. In industrial establishments where conditions of maintenance and supervision ensure that only qualified persons service the installation, type PLTC cable shall be permitted in accordance with either (1) or (2) as follows:

(1) Where the cable is not subject to physical damage, type PLTC cable that complies with the crush and impact requirements of type MC cable and is identified as PLTC-ER for such use shall be permitted to be exposed between the cable tray and the utilization equipment or device. The cable shall be continuously supported and protected against physical damage using mechanical protection such as dedicated struts, angles, or channels. The cable shall be supported and secured at intervals not exceeding 1800 mm. Where not subject to physical damage, type PLTC-ER cable shall be permitted to transition between cable trays and between cable trays and utilization equipment or devices for a distance not to exceed 1800 mm without continuous support. The cable shall be mechanically supported where exiting the cable tray to ensure that the minimum bending radius is not exceeded.

(2) Type PLTC cable, with a metallic sheath or armor in accordance with 7.25.4.10(E), shall be permitted to be installed exposed. The cable shall be continuously supported and protected against physical damage using mechanical protection such as dedicated struts, angles, or channels. The cable shall be secured at intervals not exceeding 1800 mm.

(K) Other Building Locations. The following wires and cables shall be permitted to be installed in building locations other than the locations covered in 7.25.3.15(B) through (I):

(1) Types CL2P, CL3P, CL2R, CL3R, CL3 and PLTC cables

(2) A maximum of 3000 mm of exposed type CL2X wires and cables in nonconcealed spaces

(3) A maximum of 3000 mm of exposed types CL3X wires and cables in nonconcealed spaces

(1) Types CL2P, CL3P, CL2R, CL3R, CL3 and PLTC cables

(2) A maximum of 3000 mm of exposed type CL2X wires and cables in nonconcealed spaces

(3) A maximum of 3000 mm of exposed types CL3X wires and cables in nonconcealed spaces

(4) Types CL2P, CL3P, CL2R, CL3R, CL2, CL3, and PLTC cables installed in the following:

a. Plenum communication raceways

b. Plenum cable routing assemblies

c. Riser communication raceways

d. Riser cable routing assemblies

e. General-purpose communications raceways

f. General-purpose cable routing assemblies

(5) Types CL2P, CL3P, CL2R, CL3R, CL2, CL3, CL2X, CL3X, and PLTC cables installed in raceways recognized in Chapter 3

(6) Types CMUC under carpet communication wires and cables installed under carpet, module, flooring, and planks.

(L) Multifamily Dwellings. The following wires and cables shall be permitted to be installed in multifamily dwellings in locations other than the locations covered in 7.253.15(B) through (I):

(1) Types CL2P, CL3P, CL2R, CL3R, CL2, CL3 and PLTC wires and cables

(2) Type CL2X wires and cables less than 6 mm in diameter in nonconcealed spaces

(3) Type CL3X wires and cables less than 6 mm in diameter in nonconcealed spaces

(4) Types CL2P, CL3P, CL2R, CL3R, CL2, CL3 and PLTC wires and cables installed in the following:

a. Plenum communication raceways

b. Plenum cable routing assemblies

c. Riser communication raceways

d. Riser cable routing assemblies

e. General-purpose communications raceways

f. General-purpose cable routing assemblies

(5) Types CL2P, CL3P, CL2R, CL3R, CL2, CL3, CL2X, CL3X, and PLTC wires and cables installed in raceways recognized in Chapter 3.

(6) Type CMUC under carpet communication wires and cables installed under carpet, modular flooring, and planks.

(M) One- and Two-Family Dwellings. The following wires and cables shall be permitted to be installed in one- and two-family dwellings in locations other than the locations covered in 7.25.3.15(B) through (I)

(1) Types CL2P, CL3P, CL2R, CL3R, CL2, CL3 and PLTC wires and cables.

(2) Type CL2X wires and cables less than 6mm in diameter

(3) Type CL3X wire and cables less than 6mm in diameter

(4) Communications wire and types CL2P, CL3P, CL2R, CL3R, CL2, CL3 and PLTC cables installed in the following:

a. Plenum communication raceways

b. Plenum cable routing assemblies

c. Riser communication raceways

d. Riser cable routing assemblies

e. General-purpose communications raceways

f. General-purpose cable routing assemblies

(5) Types CL2P, CL3P, CL2R, CL3R, CL2, CL3, CL2X, CL3X, and PLTC wires and cables installed in raceways recognized in chapter 3.

(6) Type CMUC under carpet communications wires and cables installed under carpet, modular flooring, and planks.

7.25.3.16 Separation from Electric Light, Power, Class 1, Non-Power-Limited Fire Alarm Circuit Conductors, and Medium-Power Network-Powered Broadband Communications Cables.

(A) General. Cables and conductors of class 2 and 3 circuits shall not be placed in any cable, cable tray, compartment, enclosure, manhole, outlet box, device box, raceway, or similar fitting with conductors of electric light, power, class 1, non-power-limited fire alarm circuits, and medium-power network-powered broadband communications circuits unless permitted by 7.25.3.16(B) through (I)

(B) Separated by Barriers. Class 2 and 3 circuits shall be permitted to be installed together with the conductors of electric light, power, class 1, non-power-limited fire alarm and medium power network-powered broadband communications circuits where they are separated by a barrier.

(C) Raceways Within Enclosure. In enclosure, class 2 and 3 circuits shall be permitted to be installed in a raceways to separate them from class 1, non-power-limited fire alarm and medium-power network-powered broadband communications circuits.

(D) Associated Systems Within Enclosures. Class 2 and 3 circuit conductors in compartments, enclosures, device boxes, outlet boxes, or similar fitting shall be permitted to be installed with electric light, power, class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuits where they are introduced solely to connect the equipment connected to class 2 and 3 circuits and where (1) or (2) applies:

(1) The electric light, power, class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuit conductor are routed to maintain a minimum of 6 mm separation from the conductors and cables class 2 and 3 circuits.

(2) The circuit conductors operate at 150 volts or less to ground and also comply with one of the following:

a. The class 2 and 3 circuits are installed using type CL3, CL3P or permitted substitute cables, provided these class 3 cable conductors extending beyond the jacket are separated by a minimum of 6 mm or by a nonconductive sleeve or nonconductive barrier from all other conductors. b. The class 2 and 3 circuit conductors are installed as a Class 1 circuit in accordance with 7.25.2.1

(E) Enclosure with Single Opening. Class 2 and 3 circuit conductors entering compartments, enclosures, device boxes, outlet boxes, or similar fittings shall be permitted to be installed with class 1, non-power-limited fire alarm and medium-power network-powered broadband communications circuits where they are introduced solely to connect the equipment connected to Class 2 and Class 3 circuits. Where class 2 and class 3 circuit conductors must enter an enclosure that is provided with a single opening, they shall be permitted to enter through a single fitting , provided the conductors are separated from the conductors of the other circuits by a continuous and firmly fixed nonconductor, such as flexible tubing.

(F)Manholes. Underground class 2 and 3 circuit conductors in a manhole shall be permitted to be installed with class 1, non-power-limited fire alarm and medium-power network-powered broadband communications circuits where one of the following conditions is met:

(1)The electric light, power, class 1, non-power-limited fire alarm and medium-power network-powered broadband communications circuit conductors are in a metal-enclosed cable or type UF cable.

(2) The class 2 and 3 circuit conductors are permanently and effectively separated from the conductors of other circuits by a continuous and firmly fixed nonconductor, such as flexible tubing, in addition to the insulation or covering on the wire.

(3) The class 2 and 3 circuit conductor are permanently and effectively separated from conductors of the other circuits and securely fastened to racks, insulators, or other approved support.

(G) Cable Trays. Class 2 and Class 3 circuit conductors shall be permitted to be installed in cable trays, where the conductors of the electric light, class 1, and non-power-limited fire alarm circuits are separated by a solid fixed barrier of a material compatible with the cable tray or where the class 2 or class 3 circuits are installed in type MC cable.

(H) In Hoist ways. In hoist ways, class 2 or class 3 circuit conductors shall be installed in rigid metal conduit, rigid nonmetallic conduit, intermediated metal conduit, liquid tight flexible nonmetallic conduit, or electrical metallic tubing. For elevators or similar equipment, these conductors shall be permitted to be installed as provided in 6.20.3.1.

(I) Other Applications. For other applications, conductors of class 2 and 3 circuits shall be separated by at least 50 mm from conductors of any electric light, power, class 1, non-power-limited fire alarm or medium power network-powered broadband communications circuits unless one of the following condition is met:

(1) Either (A) all of the electric light, power, class 1, non-power-limited fire alarm and medium-power network-powered broadband communications circuit conductors or (B) all of the Class 2 and 3 circuit conductors are in a raceway or in metal-sheathed, metal-clad, non- metallic-sheathed or type UF cables.

(2) All of the electric light, power, class 1, non-power-limited fire alarm and medium-power network-powered broadband communications circuit conductors are permanently separated from all of the Class 2 and 3 circuit conductor by a continuous and firmly fixed nonconductor, such as porcelain tubes or flexible tubing, in addition to the insulation on the conductors.

7.25.3.19 Installation of Conductors of Different Circuits in the Same Cable, Enclosure, Cable Tray, Raceway, or Cable Routing Assembly

(A) Two or More Class 2 Circuits. Conductor of two or more class 2 circuits shall be permitted within the same cable, enclosure, raceway, or cable routing assembly.

(B) Two ore more Class 3 Circuits. Conductor of two or more class 3 circuits shall be permitted within the same cable, enclosure, raceway, or cable routing assembly.

(C) Class 2 Circuits with Class 3 Circuits. Conductors of one or more Class 2 circuits shall be permitted within the same cable, enclosure, raceway, or cable routing assembly with conductors of Class 3 circuits, provided that the insulation of the class 2 circuit conductors in the cable, enclosure, raceways, or cable routing assembly is at least that required for class 3 circuits.

(D) Class 2 and Class 3 Circuits with Communications Circuits.

(1) Classified as Communications Circuits. Class 2 and class 3 circuit conductors shall be permitted in the same cable with communications circuits, in which case the Class 2 and Class 3 circuits shall be classified as communication circuits and shall be installed in accordance with the requirements of Article 8.0. The cables shall be listed as communications cables.

(2) Composite Cables. Cable constructed of individually listed Class 2, Class 3 and Communications cables under a common jacket shall be permitted to be classified as communications cables. The fire resistance rating of the composite cable shall be determined by the performance of the composite cable.

(E) Class 2 or Class 3 Cables with Other Circuit Cables. Jacketed cables of Class 2 or Class 3 circuits shall be permitted in the same enclosure, cable tray, raceway, or cable routing assembly with jacketed cables of any of the following:

(1) Power-limited fire alarm systems in compliance with parts 7.60.1 and 7.60.3

(2) Nonconductive and conductive optical fiber cables in compliance with Parts 7.70.1 and 7.70.4

(3) Communications circuits in compliance with Parts 8.0.1 and 8.0.4

(4) Community antenna television and radio distribution systems in compliance with parts 8.20.1 and 8.20.4

(5) Low-power, network-powered broadband communications in compliance with parts 8.30.1 and 8.30.4.

(F) Class 2 or Class 3 Conductors or Cables and Audio System Circuits. Audio system circuits described in 6.40.1.9(C) and installed using class 2 or 3 wiring methods in compliance with 7.25.3.13 and 7.25.3.34, shall no be permitted to be installed in the same cable, raceway, or cable routing assembly with class 2 or 3 conductors or cables.

7.25.3.21 Installation of Circuit Conductors Extending Beyond One Building

Where class 2 or class 3 circuit conductors extend beyond one building and are run so as to be subject to accidental contact with electric light or power conductors operating over 300 volts to ground, or are exposed to lightning on interbuilding circuits on the same premises, the requirements of the following shall also apply:

(1)Sections 8.0.2.1, 8.0.2.7, 8.0.2.10, 8.0.3.4, 8.0.4.1, 8.0.6.1(A), and 8.0.6.1(B) for other coaxial conductors.

(2) Sections 8.20.2.1, 8.20.3.1, and 8.20.4.1 for coaxial conductors.

7.25.3.23 Support of Conductors

Class 2 or Class 3 circuit conductors shall not be strapped, taped or attached by any means to exterior of any conduit or other raceway as a means of support. These conductors shall be permitted to be installed as permitted by 3.0.1.11(C)(2).

7.25.3.24 Transmission of Power and Data

The requirements of 7.25.3.24(A) and (B) shall apply to class 2 and class 3 circuits that transmit power and data to a powered device. The requirements of 7.25.1 and 7.25.3 and 3.0.1.11 shall apply to class 2 and class 3 circuits that transmit power and data. The conductors that carry power for the data circuit shall be copper. The current in the power circuit shall bot exceed the current limitation of the connectors.

7.25.3.34 Applications of Listed Class 2, Class 3, and PLTC Cables

Class 2, Class 3 and PLTC cables shall comply with any of the requirements described in 7.25.3.34(A) through (C) and as indicated in Table 7.25.3.34.

(A) Class 2 and Class 3 Cable Substitutions. The substitutions for Class 2 and Class 3 cables listed in table 7.25.3.3(A) and illustrated in Figure 7.25.3.34(A) shall be permitted. Where substitute cables are installed, the wiring requirements of Parts 7.25.1 and 7.25.3 shall apply.

FPN: For information on Type CMP, CMR, CM and CMX see 8.0.6.10

(B) Class 2, Class 3, PLTC Circuit Integrity (CI) Cable or Electrical Circuit Protective System. Circuit integrity (CI) cable or a listed electrical circuit protective system shall be permitted for use in remote control, signaling, or power-limited systems that supply critical circuits to ensure survivability for continued circuit operation for a specified time under fire condition.

(C) Thermocouple Circuits. Conductors in Type PLTC cables used for Class 2 thermocouple circuits shall be permitted to be any of the materials used for thermocouple extension wire.

7.25.4 Listing Requirements

7.25.4.1 Listing and Marking of Equipment for Power and Data Transmission

The listed power source for circuits intended to provide power and data over Class 2 cables to remote equipment shall be as specified in 7.25.3.1(A)(1), (A)(2), (A)(3), or (A)(4). In accordance with 7.25.3.1(B), the power sources shall not have the output connections paralleled or otherwise interconnected, unless listed for such interconnection. Powered devices connected to a circuit supplying data and power shall be listed. Marking of equipment output connections shall be in accordance with 7.25.3.1(C).

7.25.4.10 Listing and Marking of Class 2, Class 3, and Type PLTC Cables

Class 2, Class 3 and Type PLTC cables, installed as wiring methods within buildings shall be listed as being resistant to the spread of fire and other criteria in accordance with 7.25.4.10(A) through (I) and shall be marked in accordance with 7.25.4.10(J).

7.25.4.10 Listing and Marking of Class 2, Class 3, and Type PLTC Cables

(A) Types CL2P and CL3P. Types of CL2P and CL3P plenum cable shall be listed as suitable for use in ducts, plenums, and other space for environmental air and shall also be listed as having adequate fire-resistant and low-smoke producing characteristic.

(B) Types CL2R and CL3R. Types CL2R and CL3R riser cables shall be marked as type CL2R or CL3R respectively, and be listed as suitable for use in a vertical run in a shaft or from floor to floor and shall be listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.

(C) Types CL2 and CL3. types CL2 and CL3 cables shall be marked as type CL2 or CL3, respectively, and be listed as suitable for general-purpose use, with the exception of risers, ducts, plenums, and other space used for environmental air, and shall be listed as resistant to the spread of fire.

Table 7.25.3.24 Ampacities of Each Conductor in 4-Pair Class 2 or Class 3 Data Cables Based on Copper Conductors at an Ambient Temperature of 30 degree Celsius with All Conductors in All Cables Carrying Current 60 , 75, and 90 degree Celsius Rated Cables

	Number of 4-Pair Cables in a Bundle																				
	1			2-7			8-19			20-37			38-61			62-91			92-192		
	Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating		
mm² (AWG)	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
0.13 (26)	1	1	1	1	1	1	0.7	0.8	1	0.5	0.6	0.7	0.4	0.5	0.6	0.4	0.5	0.6	NA	NA	NA
0.21 (24)	2	2	2	1	1.4	1.6	0.8	1	1.1	0.6	0.7	0.9	0.5	0.6	0.7	0.4	0.5	0.6	0.3	0.4	0.5
0.26 (23)	2.5	2.5	2.5	1.2	1.5	1.7	0.8	1.1	1.2	0.6	0.8	0.9	0.5	0.7	0.8	0.5	0.7	0.8	0.4	0.5	0.6
0.33 (22)	3	3	3	1.4	1.8	2.1	1	1.2	1.4	0.7	0.8	1.1	0.6	0.8	0.9	0.6	0.8	0.9	0.5	0.6	0.7

Note 1: For bundle sizes over 192 cables, or for conductor sizes smaller than 0.14 mm², ampacities shall be permitted to be determined by qualified personnel under engineering supervision.

Note 2: Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.

FPN: The conductor sizes in data cables in wide-spread use are typically 0.14 - 0.34 mm².

Note 2: Where only half of the conductors in each cable are typically 0.14 - 0.34 mm².

FPN: The conductor sizes in data cables in wide-spread use are typically 0.14 - 0.34 mm².

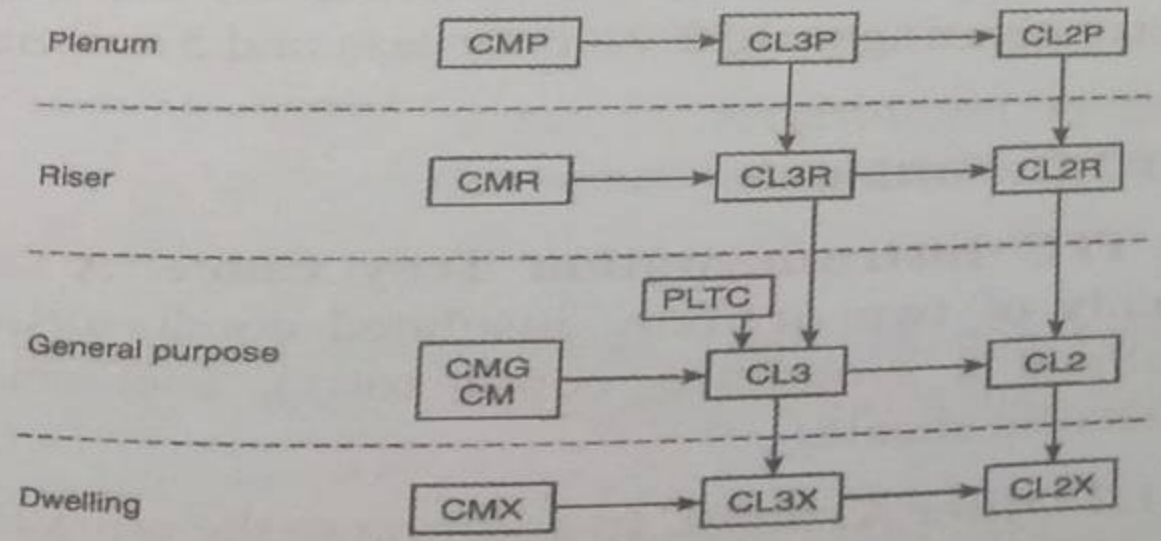
Table 7.25.3.34 Applications of Listed Class 2, Class 3, CMUC and PLTC Cables in Buildings

Applications		Cable Type					
		CL2P & CL3P	CL2R & CL3R	CL2 & CL3	CL2X & CL3X	CMUC	PLTC
In fabricated ducts as described in 3.0.1.22(B)	In fabricated ducts	Y*	N	N	N	N	N
	In metal raceway that complies with 3.0.1.22(B)	Y*	Y*	Y*	Y*	N	Y*
In other spaces used for environmental air as described in 3.0.1.22(C)	In other spaces used for environmental air	Y*	N	N	N	N	N
	In metal raceway that complies with 3.0.1.22(C)	Y*	Y*	Y*	Y*	N	Y*
	In plenum communications raceway	Y*	N	N	N	N	N
	In plenum cable routing assemblies	Y*	N	N	N	N	N
	Supported by open metal cable trays	Y*	N	N	N	N	N
	Supported by solid bottom metal cable trays with solid metal covers	Y*	Y*	Y*	Y*	N	N
In risers	In vertical runs	Y*	Y*	N	N	N	N
	In metal raceways	Y*	Y*	Y*	Y*	N	Y*
	In firestop shafts	Y*	Y*	Y*	Y*	N	Y*
	In plenum communications raceways	Y*	Y*	N	N	N	N
	In plenum cable routing assemblies	Y*	Y*	N	N	N	N
	In riser communications raceways	Y*	Y*	N	N	N	N
	In riser cable routing assemblies	Y*	Y*	N	N	N	N
	In one- and two-family dwellings	Y*	Y*	Y*	Y*	N	Y*
Within building in other than air-handling spaces and risers	General	Y*	Y*	Y*	Y*	N	Y*
	In one- and two-family dwellings	Y*	Y*	Y*	Y*	Y*	Y*
	In multifamily dwellings	Y*	Y*	Y*	Y*	Y*	Y*
	In nonconcealed spaces	Y*	Y*	Y*	Y*	Y*	Y*
	Supported by cable trays	Y*	Y*	Y*	N	N	Y*
	Under carpet	N	N	N	N	Y*	N
	In cross-connects arrays	Y*	Y*	Y*	N	N	Y*
	In any raceway recognized in Chapter 3	Y*	Y*	Y*	Y*	N	Y*
	In plenum communications raceways	Y*	Y*	Y*	N	N	N
	In plenum cable routing assemblies	Y*	Y*	Y*	N	N	N
	In riser communications raceways	Y*	Y*	Y*	N	N	N
	In riser cable routing assemblies	Y*	Y*	Y*	N	N	N
	In general-purpose communications raceways	Y*	Y*	Y*	N	N	N
	In general-purpose cable routing assemblies	Y*	Y*	Y*	N	N	N

Note: "N" indicates that the cable type shall not be permitted to be installed in the application.
"Y*" indicates that the cable type shall be permitted to be installed in the application, subject to the

Table 7.25.3.34(A) Cable Substitutions

Cable Type	Permitted Substitutions
CL3P	CMP
CL2P	CMP, CL3P
CL3R	CMP, CL3P, CMR
CL2R	CMP, CL3P, CL2P, CMR, CL3R
PLTC	
CL3	CMP, CL3P, CMR, CL3R, CMG, CM, PLTC
CL2	CMP, CL3P, CL2P, CMR, CL3R, CL2R, CMG, CM, PLTC, CL3
CL3X	CMP, CL3P, CMR, CL3R, CMG, CM, PLTC, CL3, CMX
CL2X	CMP, CL3P, CL2P, CMR, CL3R, CL2R, CMG, CM, PLTC, CL3, CL2, CMX, CL3X



Type CM—Communications wires and cables
Type CL2 and CL3—Class 2 and Class 3 remote-control, signaling, and power-limited cables
Type PLTC—Power-limited tray cable

A → B Cable A shall be permitted to be used in place of Cable B.

Table 7.25.3.34(A) Cable Substitutions Hierarchy

(D) Types CL2X and CL3X. Types CL2X and CL3X limited-use cables shall be marked as type CL2X or CL3X and be listed as suitable for use in dwellings and raceway and shall be listed as resistant to flame spread.

FPN: One method of determining that cable resistant to flame spread is by testing the to the VW-1 (vertical wire) flame test in ANSI/UL 1581-2011, reference standard for electrical wires, cables and flexible cords.

(E) Type PLTC. Type PLTC nonmetallic-sheathed, power-limited tray cable shall be listed as being suitable for cable trays and shall consist of a factory assembly of two or more insulated conductors shall be 0.325 mm^2 through 3.5 mm^2. The cable core shall be two or more parallel conductors, one or more group assemblies of twisted or parallel conductors, or a combination thereof. A metallic shield or a metallized foil shield with drain wires shall be permitted to be applied over the cable core, over groups of conductors, or both. The cable shall be listed as resistant to the spread of fire. The outer jacket shall be a sunlight- and moisture-resistant non-metallic material. Type PLTC cable used in a wet location shall be listed for use in wet locations or have a moisture-impervious metal sheath.

Exception No. 1: Conductors in PLTC cables used for class 2 thermocouple circuits shall be permitted to be any of the material used for thermocouple extensions wire.

(F) Circuit Integrity (CI) Cable or Electrical Circuit Protective System. Cables that are used for survivability of critical circuits under fire conditions shall meet either 7.25.4.10(F)(1) or (F)(2) as follows:

(1) Circuits Integrity (CI) Cables. Circuit Integrity cables, specified in 7.25.4.10(A), (B), (C), and (E), used for survivability of critical circuits, shall have the additional classification using the suffix "CI". Circuit Integrity 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 7.25.4.10(F)(2).

(2) Electrical Circuit Protective System. Cables specified in 7.25.4.10(A), (B), (C), (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.

(G) Class 2 and Class 3 Cable Voltage Ratings. Class 2 cables shall have a voltage rating of not less than 150 volts. Class 3 cables shall have a voltage rating of not less than 300 volts. Class 2 and class 3 cables shall have a temperature rating of not less than 60 degrees Celsius.

(H) Class 3 Single Conductors. Class 3 single conductors used as other wiring within building shall not be smaller than 0.75 mm^2 and shall be type CL3. conductor types described in 7.25.2.9(B) that are also listed as type CL3 shall be permitted.

(I) Limited Power (LP) Cables. Limited power cables shall be listed as suitable for carrying power and data circuits up to a specified current limit for each conductor without exceeding the temperature rating of the cable where the cable is installed in cable bundles in free air or installed within raceway, cable tray, or cable routing assembly. The cables shall be marked with the suffix "-LP" with the ampere limit located immediately following the suffix LP, where the current limit is in amperes per conductor.

(J) Marking. Cables shall be marked in accordance with 3.10.3.17(A)(2), (A)(3), (A)(4), (A)(5) and Table 7.25.4.10(A) Voltage ratings shall not be marked on the cables.

FPN: Voltage markings 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 a voltage marking is required for one or more of the listings.

FPN: Class 2 and Class 3 cable type are listed in descending order of fire resistance rating, and class 3 cables are listed above class 2 cables because class 3 cables can substitute for class 2 cables.

ARTICLE 7.27 – INSTRUMENTATION TRAY CABLE: TYPE ITC

7.27.1.1 Scope

This article cover the use, installation and construction specifications of instrumentation tray cable for application to instrumentation and control circuits operating at 150 volts or less and 5 amperes or less.

7.27.1.2 Definition

Type ITC Instrumentation tray Cable. A factory assembly of two or more insulated conductors, with or without a grounding conductor(s), enclosed in a nonmetallic sheath.

7.27.1.3 Other Articles

In addition to the provisions of this article, installation of type ITC cable shall comply with other applicable articles of this Codes.

7.27.1.4 Uses Permitted

Type ITC cable shall be permitted to be used as follows in industrial establishments where the conditions of maintenance and supervision ensure that only qualified persons service the installation:

(1) In cable trays.

(2) In raceways.

(3) In hazardous locations as permitted in 5.1.2.1, 5.2.2.1, 5.3.2.1, 5.4.1.20, 5.4.1.30, 5.4.1.80, and 5.5.1.15

(4) Enclosed in a smooth metallic sheath, continuous corrugated metallic sheath, or interlocking tape armor applied over the nonmetallic sheath in accordance with 7.27.1.6. The cable shall be supported and secured at intervals not exceeding 1800 mm.

(5) Cable, without a metallic sheath or armor, that complies with the crush and impact requirements of type MC cable and is identified for such use with the marking ITC-ER shall be permitted to be installed exposed. The cable shall be continuously supported and protected against physical damage using mechanical protection such as dedicated struts, angles, or channels. The cable shall be secured at intervals not exceeding 1800mm.

Exception to (5): Where not subject to physical damage. Type ITC-ER shall be permitted to transition between cable trays and utilization equipment or devices for a distance not to exceed 1800 mm without continuous support. The cable shall be mechanically supported where exiting the cable tray to ensure that the minimum bending radius is not exceeded

(6) As aerial cable on a messenger.

(7) Direct buried where identified for the use.

(8) Under raised floors in rooms containing industrial process control equipment and rack rooms where arranged to prevent damage to the cable.

(9) Under raised floor in information technology equipment rooms in accordance with 6.45.1.5(E)(5)(b).

Type ITC cable shall not be installed on circuits operating at more than 150 volts or more than 5 amperes.

Installation of type ITC cable with other cables shall be subject to the stated provisions of the specific articles for the other cables. Where the governing articles do not contain stated provisions for installation with Type ITC cable, the installation of type ITC cable with the other cables shall not be permitted.

Type ITC cable shall not be installed with power, lighting, Class 1 circuits that are not power-limited or non-power-limited circuits.

Exception No. 1: *Where terminated within equipment or junction boxes and separations are maintained by insulating barriers or other means.*

Exception No. 2: *Where a metallic sheath or armor is applied over the nonmetallic sheath of the Type ITC cable.*

7.27.1.6 Construction

The insulated conductors of Type ITC cable shall be in sizes 0.325 mm^2 through 3.5 mm^2. The conductor material shall be copper or thermocouple alloy. Insulation on the conductors shall be rated 300 volts. Shielding shall be permitted.

The cable shall be listed as being resistant to the spread of fire. The outer jacket shall be sunlight and moisture resistant.

Where a smooth metallic sheath, continuous corrugated metallic sheath, or interlocking tape armor is applied over the nonmetallic sheath, an overall nonmetallic jacket shall be require.

7.27.1.7 Marking

The cable shall be marked in accordance with 3.10.3.17(A)(2), (A)(3), (A)(4) and (A)(5). Voltage ratings shall not be marked on the cable.

7.27.1.8 Allowable Ampacity

The allowable ampacity of the conductors shall be 5 amperes, except for 0.325 mm^2 conductors, which shall have an allowable ampacity of 3 amperes.

7.27.1.9 Overcurrent Protection

Overcurrent protection shall not exceed 5 amperes for 0.5 mm^2 and larger conductors, and 3 amperes for 0.325 mm^2 conductors.

7.27.1.10 Bends

Bends in Type ITC cables shall be made so as not to damage the cable.

SPECIAL CONDITIONS

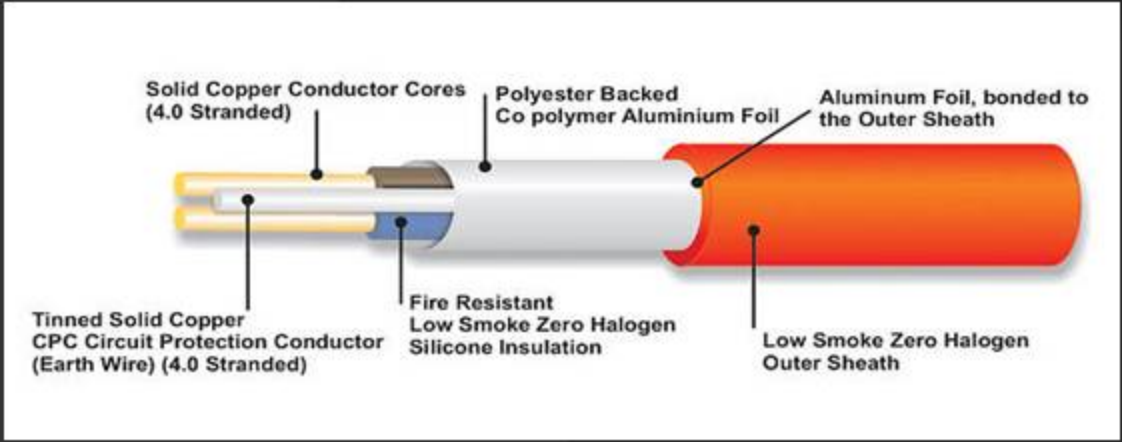
7.28 FIRE-RESISTIVE CABLE SYSTEMS

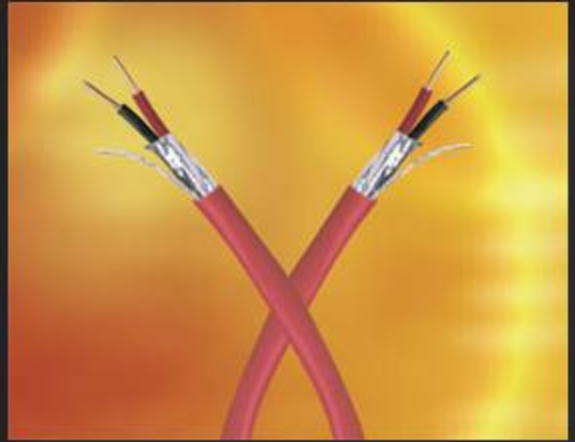
Scope

This article covers the installation of fire-resistive cables, fire-resistive conductors, and other system components used for survivability of critical circuits to ensure continued operation during a specified time under fire conditions are required in this *Code*.

❑ Fire-Resistive Cable System

A cable and components used to ensure survivability of critical circuits for a specified time under fire conditions.





❑ General

Fire-resistive cables, fire-resistive conductors, and components shall be tested and listed as a complete system, shall be designated for use in a specific fire-rated system, and shall not be interchangeable between systems.

FPN No. 1: Defining fire rating in accordance with UL 2196-2012, *Standard for Tests of Fire Resistive Cables*

FPN No. 2: Fire-resistive cable system are considered part of an electrical circuit protective system.

❑ Installations

Fire-resistive cables system installed outside the fire-rated rooms that they serve, such as the electrical room or the fire pump room shall comply requirements and other installation instruction provided in the listing.

(A) Mounting and (B) Supports. The FRCS shall be secured to the building structure and supported in accordance with the listing and the manufacturer's installation instructions.

FPN: 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 coupling, and connectors shall be listed as part of the fire-rated system.

(D) Cable Trays. It is used as part of a fire-resistive system and shall be listed as also part of the system.

(E) Boxes or enclosures. Listed as part of the system and shall be secured to the building structure independently of the raceways or cables.

(F) Pulling Lubricants. FRCS installed in a raceway shall only use pulling lubricants listed as part of the system.

Vertical supports and splices are also part of the FRCS listing.

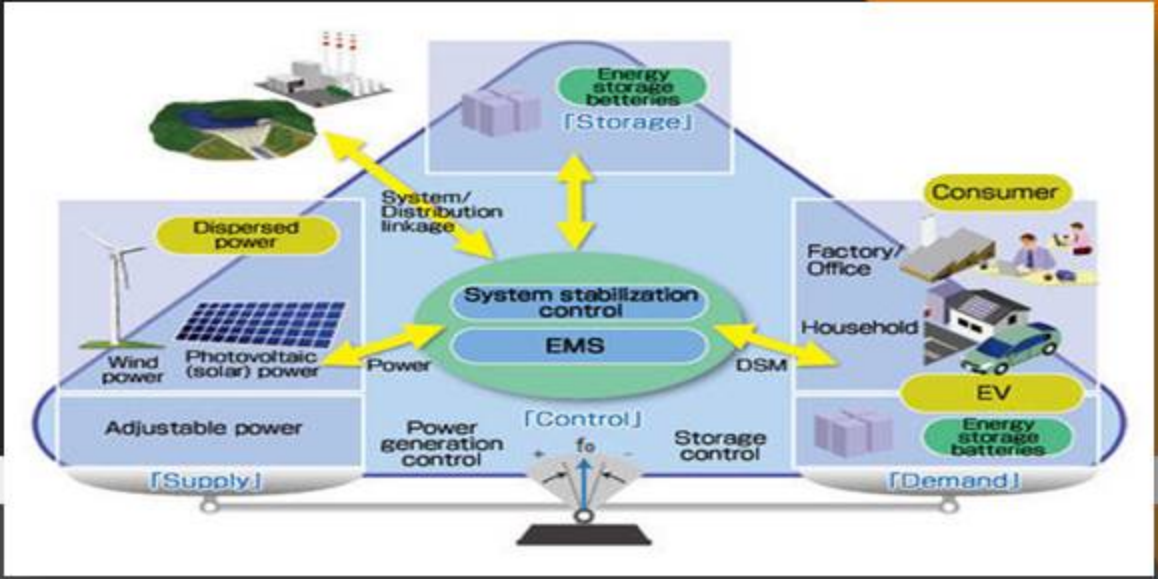
Grounding

Fire-resistive systems installed in a raceway requiring an equipment grounding conductor shall used 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.

❑ Marking

In addition to the marking required, 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.

7.50- ENERGY MANAGEMENT SYSTEMS



❑ Scope

- ✓ This article applies to the installation and operation of energy management system.

FPN: Performance provisions in other codes establish prescriptive requirements that may further restrict the requirements contained in this article.

❑ 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 devices that monitor 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.

❑ Alternate Power Sources

✓ An energy management system shall not override any control necessary to ensure continuity of an alternative power source of the following:

1. Fire Pumps
2. Health care facilities
3. Emergency systems
4. Legally required standby systems
5. Critical operations power systems

❑ Load Management

- Energy management systems shall be permitted to monitor and control electrical loads unless restricted in accordance with 7.50.1.30 (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 operations
4. Critical operations power systems

(B) Disconnection of Power

- ✓ An energy management system shall not 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.

- FPN: 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.

7.60- FIRE ALARM SYSTEMS

❑ Scope

- ✓ FPN 1: Fire alarm systems include fire detection and alarm notification, guard's tour, sprinkler water flow, and sprinkler supervisory system. 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 fire alarm system. (NFPA 72-2013, *National Fire Alarm and Signaling Code).*
- ✓ FPN 2: Class 1, 2 and 3 circuits are defined in Article 7.25.

❑ 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.**

❑ Definitions

- ✓ 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 7.60.2.1 and 7.60.2.3.
- ✓ Power-Limited Fire Alarm Circuit (PLFA) – A fire alarm circuit powered by a source that complies with 7.60.3.1.

❑ Abandoned Cables

- ✓ The accessible portion of abandoned fire alarm cables shall be removed. Where cables are identified for future use with a tag, the tag shall be sufficient durability to withstand the environment involved.

❑ Fire Alarm Circuit Identification

- ✓ Fire alarm circuits shall be identified at terminal and junction locations in manner that helps to prevent unintentional signals on fire alarm system circuits during testing and servicing of other systems.

❑ Non-Power-Limited Alarm (NPLFA) Circuit

- ✓ (A) Power Source – Shall comply with chapters 1 through 4, and the output voltage shall be not more than 600 volts, nominal. The fire alarm circuit disconnect shall be permitted to be secured in the "on" position.
- ✓ (B) Branch Circuit – Shall supply no other loads. The location of the BC overcurrent protective device shall be permanently identified at the fire alarm control unit. The circuit disconnecting means shall have red identification, shall be identified as "FIRE ALARM CIRCUIT".

❑ NPLFA Circuit Overcurrent Protection

- ✓ Overcurrent protection for conductors 2.0 mm^2 and larger shall be provided in accordance with the conductor ampacity without applying the ampacity adjustment and correction factors of 3.10.2.6. to the ampacity calculation. Overcurrent protection shall not exceed 7 A for 0.75 mm^2 conductors and 10 A for 1.25 mm^2 conductors.

❑ NPLFA Circuit Overcurrent Device Location

- ✓ Overcurrent devices shall be located at the point where the conductor to be protected receives its supply.
- ✓ Exception No. 1: Where the overcurrent device protecting the larger conductor also protects the smaller conductor.
- ✓ Exception No. 2: *Transformer secondary conductors.* Non-power-limited fire alarm circuit conductors supplied by the secondary of a single-phase transformer that has only 2-wire (single voltage) secondary shall be permitted to be protected by overcurrent protection provided by the primary (supply) side of the transformer.

❑ NPLFA Circuit Overcurrent Device Location

- ✓ Exception No. 3: *Electronic power source output conductors.* Non-power-limited circuit conductors supplied by the output of single-phase, listed electronic power source, other than a transformer, having only 2-wire (single voltage) output for connection to non-power-limited circuits shall be permitted to be protected by overcurrent protection provided on the input side of the electronic power source.

❑ NPLFA Circuit Conductors

- ✓ Sizes and Use – Only copper conductors shall be permitted to be used for fire alarm systems. Size 0.75 mm^2 and 1.25 mm^2 conductors shall be permitted to be used provided they supply loads that do not exceed the ampacities. Conductors larger than 1.25 mm^2 shall not supply loads greater than the ampacities.
- ✓ Conductor Materials – Conductors shall be solid or stranded copper.

❑ NPLFA Circuit Conductors

- ✓ Insulation – Insulation on conductors shall be rated for the system voltage and not less than 600 volts. Conductors larger than 1.25 mm^2 shall comply with the Article 3.10. Conductors 0.75 mm^2 and 1.25 mm^2 shall be type KF-2, KFF-2. PAFF, PF, PFF, PGF, PGFF, RFH-2, RFHH-2, RFHH-3, SF-2, SFF-2, TF, TFF, TFN, TFFN or ZFF. Conductors with other types and thickness of insulation shall be permitted if listed for non-power-limited fir alarm circuit use.

❑ Applications of Listed NPLFA Cables

- ✓ **Ducts Specifically Fabricated for Environmental Air**
  – Multi-conductor non-power-limited fire alarm circuit cables, Types NPLFP, NPLFR, and NPLF, shall not be installed exposed in ducts.

- ✓ **Other Spaces Used for Environmental Air (Plenums)**
  – Cables installed in other spaces used for environmental air shall be type NPLFP.

❑ Applications of Listed NPLFA Cables

- ✓ Riser – Cables installed in vertical runs and penetrating one or more floors, or cables installed in vertical runs in a shaft, shall be type NPLFR. Floor penetrations requiring type NPLFR shall contain only cables suitable for riser or plenum use.

❑ Power-Limited Fire Alarm (PLFA) Circuits

- PLFA Wiring Methods and Materials

✓ In raceways, exposed on ceilings or sidewalks, or fished in concealed spaces – Cables splices or terminations shall be made in listed fittings, boxes, enclosures, fire alarm devices, or utilization equipment. Where located within 2100 mm of the floor, cables shall be securely fastened in an approved manner at intervals of not more than 450 mm.

❑ Power-Limited Fire Alarm (PLFA) Circuits

- PLFA Wiring Methods and Materials

✓ Passing through a floor or wall – Cables shall be installed in metal raceways or rigid nonmetallic conduit where passing through a floor or wall to a height of 2100 mm above the floor, unless adequate protection can be afforded by building construction such as detailed or unless an equivalent solid guard is provided.

❑ Power-Limited Fire Alarm (PLFA) Circuits

- PLFA Wiring Methods and Materials

✓ In Hoistways – Cables shall be installed in rigid metal conduit, rigid nonmetallic conduit, intermediate medal conduit, or electrical metallic tubing where installed in hoistways.

❑ Current-carrying Continuous Line-Type Fire Detectors

- ✓ Application – Listed continuous line-type fire detectors, including insulated copper tubing of pneumatically operated detectors, employed for both detection and carrying signaling currents shall be permitted to be used in power-limited circuits.
- ✓ Fire Alarm Cable Substitution – The substitutions for fire alarm cables listed and illustrated shall be permitted.

❑ Listing Requirements

- Listing and Marking of NPLF Cables – **Non-power limited fire alarm cables** installed as wiring within buildings shall be listed and as being resistant to the spread of fire. Cables used in a wet location shall be listed for use in wet locations or have a moisture-impervious metal sheath. It shall have a temperature rating of not less than 60ºC.
- (A). NPLFA Conductor Material – Conductors shall be 0.75 mm^2 or larger solid or stranded copper.

❑ Listing Requirements

- Type NPLFP – A non-power limited alarm cable used for environmental air and other space and shall be listed as having adequate fire-resistant and low smoke-producing characteristics.
- Type NPLFR - A non-power limited fire alarm riser cable use in a vertical run in a shaft or from floor to floor and shall also be listed as having fire-resistant characteristics.
- Type NPLF – A non-power limited fire alarm cable suitable for general-purpose fire alarm use, with the exception of risers, ducts, plenums and other space used for environmental air.

❑ Listing Requirements

- Type FPLP – A power-limited fire alarm plenum cable suitable for use in ducts, plenums and other environmental air space also having adequate fire-resistant and low smoke-producing characteristics.
- Type FPLR – A power-limited fire alarm cable suitable for use in a vertical run in a shaft or from floor to floor also having fire-resistant characteristics.
- Type FPL – A power-limited fire alarm cable suitable for general-purpose fire alarm use with exception of risers, ducts, plenums.

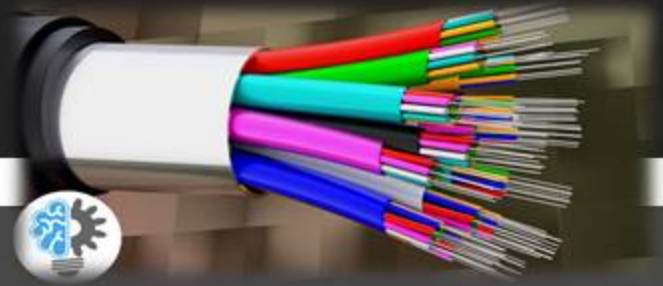
Table 7.60.4.1(G) NPLFA Cable Markings

Cable Marking	Type
NPLFP	Non-power limited fire alarm circuit cable for use in "other space used for environmental air"
NPLFR	Non-power limited fire alarm circuit riser cable
NPLF	Non-power limited fire alarm circuit cable

Table 7.60.4.4(I) Cable Markings

Cable Marking	Type
FPLP	Power-limited fire alarm plenum cable
FPLR	Power-limited fire alarm riser cable
FPL	Power-limited fire alarm cable

7.70-OPTICAL FIBER CABLES AND RACEWAYS



❑ Definitions

- Abandoned Optical Fiber Cable – Installed optical fiber cable is not terminated at equipment other than a connector and not identified for future use with a tag.
- Cable Sheath – A covering over the optical fiber assembly that includes one or more jackets and may include one or more metallic members or strength members.

❑ Definitions

- Exposed (to Accidental Contact) – A conductive optical fiber cable in such a position that, in case of failure of supports or insulation, contact between the cable's non-current carrying conductive members and an electrical circuit may result. Other forms are; **Exposed (as applied to live parts)** and **Exposed (as applied to wiring method).**
- Point of Entrance – The point within a building at which the optical fiber cable emerges from an external wall, from a concrete floor slab.

❑ Overhead (Aerial) Optical Fiber Cables

- On Poles and In-Span – Where outside plant optical fiber cables and electric light or power conductors are supported by the same pole or are run parallel to each other in-span. The following shall be met;

1) Relative Location
2) Attachment to Cross-Arms
3) Climbing Space
4) Clearance

❑ Listing Requirements

- Optical Fiber Cables – Shall have a temperature rating of not less than 60°C. Temperature rating shall be marked on the jacket of optical fiber cables that have a temperature rating exceeding 60°C.

Table 7.70.6.1 Cable Markings

Cable Marking	Type
OFNP	Nonconductive optical fiber plenum cable
OFCP	Conductive optical fiber plenum cable
OFNR	Nonconductive optical fiber riser cable
OFCR	Conductive optical fiber riser cable
OFNG	Nonconductive optical fiber general-purpose cable
OFCG	Conductive optical fiber general-purpose cable
OFN	Nonconductive optical fiber general-purpose cable
OFC	Conductive optical fiber general-purpose cable

❑ Listing Requirements

- Types OFNP and OFCP – A nonconductive and conductive cable optical fiber plenum cables use in ducts, plenums and other environmental air space.
- Types OFNR and OFCR – A nonconductive and conductive optical fiber riser cables suitable used in vertical run in a shaft or from floor to floor.
- Types OFNG and OFCG – A nonconductive and conductive general-purpose optical fiber cables suitable for general-purpose with exception of risers and plenums.

THANK YOU!