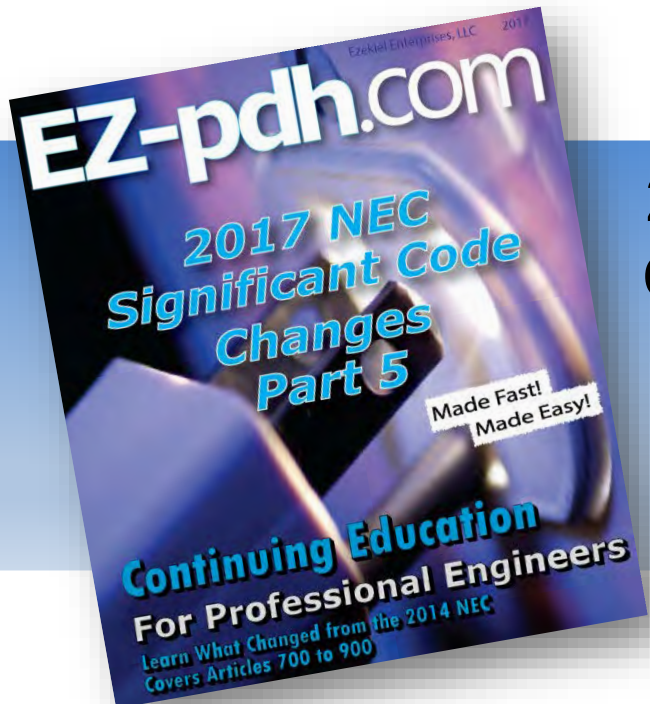

2017 NEC Significant Code Changes Part 5

Four (4) Continuing Education Hours
Course Approval #EE1005

Approved Continuing Education for Professional Engineers

Table of Contents

2017 NEC Significant Code Changes Part 5

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LEARNING OBJECTIVES

Upon completion of this course the student will be able to:

1. Become familiar with some of the significant changes including additions, deletions, and modification to the 2017 Edition of NFPA 70: National Electrical Code (NEC) from the 2014 Edition
2. Comprehend, after reviewing the significant changes and additions to the 2017 Edition of NFPA 70: National Electrical Code (NEC) the large scope of the changes to the code, thereby seeking additional and more thorough reviews of the entire code, following completion of this course.

INTRODUCTION

Every three years, the National Electrical Code® (NEC®) is revised and expanded. Initially the NFPA® received 4,012 public suggestions for changes, which resulted in 1,235 first revisions. There were 1,513 public comments submitted in response to these 1,235 first revisions, resulting in 559 second revisions. Changes included editorial clarification, expanded requirements, new requirements, deleted requirements, and the relocation of other requirements. Nine new articles were proposed, and five new articles were added to the 2017 NEC. With the fast pace of technology, it's more important than ever for anyone participating in the electrical industry to get up to speed with all the changes.

2017 National Electric Code (NEC)

- 5,525 Public Suggestions to 2014 NEC
- 1,794 Revisions Made
- Changes Included
  - Editorial Clarification,
  - Expanded Requirements,
  - New Requirements,
  - Deleted Requirements,
  - Relocation of Requirements
- Five New Articles Added

What to Expect

In this course the student will be presented an overview of the most significant changes found in the 2017 NEC.

This is part 1 of a series of courses covering the changes and will progress through each chapter and its articles presenting the many important changes.

The changes will be highlighted for easy recognition and a short synopsis of the reason for the change is presented as well.

DISCLAIMER:

Although every effort has been made to the accuracy of the material presented, by no means shall the student use or substitute this material for official 2017 NEC. Additionally, Ezekiel Enterprises, LLC shall not be liable for any special, incidental, consequential or exemplary damages resulting, in whole or in part, from the reader's uses of or reliance upon this material.

2017 NEC Major Additions

- Large-Scale Photovoltaic (PV) Electric Power Production Facility (New Article 691) covers systems that produce at least 5 megawatts (MW) of power, or enough to power 800+ U.S. homes.
- Energy Storage Systems (New Article 706) governs ESS installation, disconnection, shutdown, and safety labeling.
- Stand-Alone Systems (New Article 710) covers power production sources that are not connected to the grid, including PV and wind-powered systems.
- Direct Current Micrograds (New Article 712) concerns independent energy distribution networks that allow the utilization of power from dc sources to direct-current loads. Microgrids are on the rise worldwide

CHAPTER 7: SPECIAL CONDITIONS

ARTICLE 700

Emergency Systems

700.2 and 700.25 Branch Circuit Emergency Lighting Transfer Switch

700.2 Definitions. (Emergency Systems)

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

Informational Note: See ANSI/UL 1008, *Transfer Switch Equipment*, for information covering branch circuit emergency lighting transfer switches.

700.25 Branch Circuit Emergency Lighting Transfer Switch. Emergency lighting loads supplied by branch circuits rated at not greater than 20 amperes shall be permitted to be transferred from the normal branch circuit to an emergency branch circuit using a listed branch circuit emergency lighting transfer switch. The mechanically held requirement of 700.5(C) shall not apply to listed branch circuit emergency lighting transfer switches.

Reason for the Change

A new 700.25 titled, "Branch Circuit Emergency Lighting Transfer Switch" was added to allow these devices to be used to transfer emergency lighting loads supplied by branch circuits rated at not greater than 20 amperes from the normal branch circuit to an emergency branch circuit. A new definition for *Branch Circuit Emergency Lighting Transfer Switch* was also added at 700.2.

700.3(F) Temporary Source of Power for Maintenance or Repair of the Alternate Source of Power

700.3 Tests and Maintenance

(F) Temporary Source of Power for Maintenance or Repair of the Alternate Source of Power. If the emergency system relies on a single alternate source of power, which will be disabled for maintenance or repair, the emergency system shall include permanent switching means to connect a portable or temporary alternate source of power, which shall be available for the duration of the maintenance or repair. The permanent switching means to connect a portable or temporary alternate source of power shall comply with the following:

1. Connection to the portable or temporary alternate source of power shall not require modification of the permanent system wiring.

2. Transfer of power between the normal power source and the emergency power source shall be in accordance with 700.12.

3. The connection point for the portable or temporary alternate source shall be marked with the phase rotation and system bonding requirements.

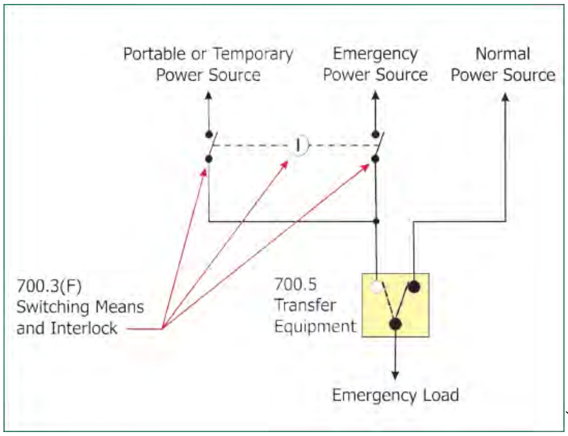
4. Mechanical or electrical interlocking shall prevent inadvertent interconnection of power sources.

5. The switching means shall include a contact point that shall annunciate at a location remote from the generator or at another facility monitoring system to indicate that the permanent emergency source is disconnected from the emergency system.

It shall be permissible to utilize manual switching to switch from the permanent source of power to the portable or temporary alternate source of power and to utilize the switching means for connection of a load bank.

Informational Note: There are many possible methods to achieve the requirements of 700.3(F). See Figure 700.3(F) for one example.

Figure 700.3(F)



Exception: The permanent switching means to connect a portable or temporary alternate source of power, for the duration of the maintenance or repair, shall not be required where any of the following conditions exists:

1. All processes that rely on the emergency system source are capable of being disabled during maintenance or repair of the emergency source of power.

2. The building or structure is unoccupied and fire suppression systems are fully functional and do not require an alternate power source.

3. Other temporary means can be substituted for the emergency system.

4. A permanent alternate emergency source, such as, but not limited to, a second on-site standby generator or separate electric utility service connection, capable of supporting the emergency system, exists.

Reason for the Change

A new first level subdivision is titled, "Temporary Source of Power for Maintenance or Repair of the Alternate Source of Power" was added at 700.3(F) calling for emergency systems that rely on a single alternate source of power to include a permanent switching means to connect a portable or temporary alternate source of power while the single alternate source of power is disabled for maintenance or repair. This permanent switching means must be available for the duration of the maintenance or repair. This new requirement comes with an exception with four conditions.

700.5(E) Transfer Equipment (Emergency Systems)

700.5 Transfer Equipment (Emergency Systems)

(E) Documentation. The short-circuit current 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.

Reason for the Change

A new requirement was added at 700.5(E) that will now require the short-circuit current rating of the transfer equipment to be field marked on the exterior of the transfer equipment. This short-circuit current rating will be based on the specific overcurrent protective device type and settings protecting the transfer equipment.

700.10(A) Wiring, Emergency System

700.10 Wiring, Emergency System.

(A) Identification. Emergency circuits shall be permanently marked so they will be readily identified as a component of an emergency circuit or system by the following methods:

(1) All boxes and enclosures (including transfer switches, generators, and power panels) for emergency circuits shall be permanently marked ~~so they will be readily identified~~ as a component of an emergency circuit or system.

(2) Where boxes or enclosures are not encountered, exposed cable or raceway systems shall be permanently marked to be identified as a component of an emergency circuit or system, at intervals not to exceed 7.6 m (25 ft). Receptacles supplied from the emergency system shall have a distinctive color or marking on the receptacle cover plates or the receptacles.

Reason for the Change

In addition to boxes and enclosures, these identification requirements have been expanded to exposed emergency system cables and raceway systems not associated with junction boxes or enclosures. Receptacles supplied from the emergency system are now required to be identified by a "distinctive color or marking" on the receptacle cover plates or the receptacle.

700.10(D) Wiring, Emergency System

700.10 Wiring, Emergency System.

(D) Fire Protection. Emergency systems shall meet the additional requirements in (D)(1) through (D)(3) in ~~assembly occupancies for not less than 1000 persons or in buildings above 23 m (75 ft) in height.~~ the following occupancies:

(1) Assembly occupancies for not less than 1000 persons

(2) Buildings above 23 m (75 ft) in height.

(3) Health care occupancies where persons are not capable of self preservation

(4) Educational occupancies with more than 300 occupants

Reason for the Change

Fire protection provisions for emergency system feeders were expanded to also include health care occupancies where persons are not capable of self-preservation and educational occupancies with more than 300 occupants (in addition to high-rise buildings and those buildings with large occupancy loads).

ARTICLE 701

Legally Required Standby Systems

701.6(D) Signals. (Legally Required Standby Systems)

701.6 Signals. (Legally Required Standby Systems)

Audible and visual signal devices shall be provided, where practicable, for the purposes described in 701.6(A), (B), (C), and (D).

(D) Ground Fault. To indicate a ground fault in solidly grounded wye, legally required standby systems of more than 150 volts to ground and circuit-protective devices rated 1000 amperes or more. The sensor for the ground-fault signal devices shall be located at, or ahead of, the main system disconnecting means for the legally required standby source, and the maximum setting of the signal devices shall be for a ground-fault current of 1200 amperes. Instructions on the course of action to be taken in event of indicated ground fault shall be located at or near the sensor location.

For systems with multiple emergency sources connected to a paralleling bus, the ground fault sensor shall be permitted at an alternate location.

Informational Note: For signals for generator sets, see NFPA 110-2013, *Standard for Emergency and Standby Power Systems.*

Reason for the Change

Code language was added to allow the ground-fault sensor to be located at an "alternate location" for systems with multiple emergency sources connected to a paralleling bus.

ARTICLE 702
Optional Standby Systems

702.12(C) Power Inlets Rated at 100 Amperes or Greater, for Portable Generators

702.12 Outdoor Generator Sets. (Optional Standby Systems)

(A) ~~Permanently Installed Generators and~~ Portable Generators Greater Than 15 kWand Permanently Installed Generators.

(C) Power Inlets 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 use. 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.

Exception No. 2: Supervised industrial installations where permanent space is identified for the portable generator located within line of sight of the power inlets shall not be required to have interlocked disconnecting means nor inlets rated as disconnects.

Reason for the Change

New language was added requiring optional standby equipment containing power inlets rated 100 amperes or more for the connection of a generator source to be listed for the intended use and be equipped with an interlocked disconnecting means. Two exceptions have been added after this new language to address instances where the inlet has been rated as a disconnecting means and for supervised industrial installations where permanent space has been identified for the portable generator to be located within line of sight of the power inlets.

ARTICLE 705
Interconnected Electric Power Production Sources

Article 705, Part IV Microgrid Systems

705.150 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.

705.160 Primary Power Source Connection. Connections to primary power sources that are external to the microgrid system shall comply with the requirements of 705.12.

705.165 Reconnection to Primary Power Source. Microgrid systems that reconnect to primary power sources shall be provided with the necessary equipment to establish a synchronous transition.

705.170 Microgrid Interconnect Devices (MID). Microgrid interconnect devices shall comply with the following:

(1) Be required for any connection between a microgrid system and a primary power 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

Informational Note: MID functionality is often incorporated in an interactive or multimode inverter, energy storage system, or similar device identified for interactive operation.

Reason for the Change

A new Part IV was added to Article 705 titled, "Microgrid Systems." Microgrid systems are sometimes referred to as "intentionally islanded systems" and "stand-alone systems." Micrograds are a way to add resiliency against loss of power in premises wiring systems.

ARTICLE 706
Energy Storage Systems

Article 706 Energy Storage Systems

The following is the new Article 706 titled, "Energy Storage Systems," which was added to the *NEC* pertaining to all permanently installed energy storage systems (ESS)

PART I. GENERAL
706.1 Scope.

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

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

(1) NFPA 111-2013, *Standard on Stored Electrical Energy Emergency and Standby Systems*

(2) IEEE 484-2008, *Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications*

(3) IEEE 485-1997, *Recommended Practice for Sizing Vented Lead-Acid Storage Batteries for Stationary Applications*

(4) IEEE 1145-2007, *Recommended Practice for Installation and Maintenance of Nickel-Cadmium Batteries for Photovoltaic (PV) Systems*

(5) IEEE 1187-2002, *Recommended Practice for Installation Design, and Installation of Valve-Regulated Lead-Acid Batteries for Stationary Applications*

(6) IEEE 1578-2007, *Recommended Practice for Stationary Battery Electrolyte Spill Containment and Management*

(7) IEEE 1635/ASHRAE 21-2012, *Guide for the Ventilation and Thermal Management of Stationary Battery Installations Batteries for Stationary Applications*

(8) UL 810A, *Electrochemical Capacitors*

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

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

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

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

706.2 Definitions.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Nominal Voltage (Battery or Cell). The value assigned to a cell or battery of a given voltage class for the purpose of convenient designation. The operating voltage of the cell or battery may vary above or below this value.

Sealed Cell or Battery. A cell or battery that has no provision for the routine addition of water or electrolyte or for external measurement of electrolyte specific gravity.

Informational Note: Some cells that are considered to be sealed under conditions of normal use, such as valve-regulated lead acid or some lithium cells, contain pressure relief valves.

Terminal. That part of a cell, container, or battery to which an external connection is made (commonly identified as a post, pillar, pole, or terminal post).

706.3 Other Articles.

Wherever the requirements of other articles of this Code and Article 706 differ, the requirements of Article 706 shall apply. If the ESS is capable of being operated in parallel with a primary source(s) of electricity, the requirements in 705.6, 705.12, 705.14, 705.16, 705.32, 705.40, 705.100, 705.143, and Part IV of Article 705 shall apply.

706.4 System Classification.

ESS shall be classified as one of the types described as follows:

(1) ESS, self-contained

Informational Note: Some self-contained systems may be listed.

(2) ESS, pre-engineered of matched components

(3) ESS, other

706.5 Equipment.

Monitors, controls, switches, fuses, circuit breakers, power conversion systems, inverters and transformers, energy storage components, and other components of the energy storage system other than lead-acid batteries, shall be listed. Alternatively, self contained ESS shall be listed as a complete energy storage system.

706.6 Multiple Systems.

Multiple ESSs shall be permitted to be installed in or on a single building or structure.

706.7 Disconnecting Means.

(A) ESS Disconnecting Means. A disconnecting means shall be provided for all ungrounded conductors derived from an ESS. A disconnecting means shall be readily accessible and located within sight of the ESS.

Informational Note: See 240.21(H) for information on the location of the overcurrent device for conductors.

(B) Remote Actuation. Where controls to activate the disconnecting means of an ESS are not located within sight of the system, the disconnecting means shall be capable of being locked in the open position, in accordance with 110.25, and the location of the controls shall be field marked on the disconnecting means.

(C) Busway. Where a dc busway system is installed, the disconnecting means shall be permitted to be incorporated into the busway.

(D) Notification. The disconnecting means shall be legibly marked in the field. The marking shall meet the requirements of 110.21(B) and shall include the following:

(1) Nominal ESS voltage

(2) Maximum available short-circuit current derived from the ESS

(3) The associated clearing time or arc duration based on the available short-circuit current from the ESS and associated overcurrent protective devices if applicable

(4) Date the calculation was performed

Exception: *The labeling in 706.7(D)(1) through (D)(4) shall not be required if an arc flash label is applied in accordance with acceptable industry practice.*

Informational Note No. 1: Industry practices for equipment labeling are described in NFPA 70E- 2015, Standard for Electrical Safety in the Workplace. This standard provides specific criteria for developing arc-flash labels for equipment that provides nominal system voltage, incident energy levels, arc-flash boundaries, minimum required levels of personal protective equipment, and so forth.

Informational Note No. 2: Battery equipment suppliers can provide information about short circuit current on any particular battery model.

(E) Partitions and Distance. Where energy storage system input and output terminals are more than 1.5 m (5 ft) from connected equipment, or where the circuits from these terminals pass through a wall or partition, the installation shall comply with the following:

(1) A disconnecting means shall be provided at the energy storage system end of the circuit. Fused disconnecting means or circuit breakers shall be permitted to be used.

(2) A second disconnecting means located at the connected equipment shall be installed where the disconnecting means required by 706.7(E)(1) is not within sight of the connected equipment.

Informational Note No. 1: For remote disconnect controls in information technology equipment rooms, see 645.10.

Informational Note No. 2: For overcurrent protection of batteries, see 240.21(H).

(3) Where fused disconnecting means are used, the line terminals of the disconnecting means shall be connected toward the energy storage system terminals.

(4) Disconnecting means shall be permitted to be installed in energy storage system enclosures where explosive atmospheres can exist if listed for hazardous locations.

(5) Where the disconnecting means in (1) is not within sight of the disconnecting means in (2), placards or directories shall be installed at the locations of all disconnecting means indicating the location of all other disconnecting means.

706.8 Connection to Other Energy Sources.

Connection to other energy sources shall comply with the requirements of 705.12.

(A) Load Disconnect. A load disconnect that has multiple sources of power shall disconnect all energy sources when in the off position.

(B) Identified Interactive Equipment. Only inverters and ac modules listed and identified as interactive shall be permitted on interactive systems.

(C) Loss of Interactive System Power. Upon loss of primary source, an ESS with a utility interactive inverter shall comply with the requirements of 705.40.

(D) Unbalanced Interconnections. Unbalanced connections between an energy storage system and electric power production sources shall be in accordance with 705.100.

(E) Point of Connection. The point of connection between an energy storage system and electric power production sources shall be in accordance with 705.12.

706.10 Energy Storage System Locations.

Battery locations shall conform to 706.10(A), (B), and (C).

(A) Ventilation. Provisions appropriate to the energy storage technology shall be made for sufficient diffusion and ventilation of any possible gases from the storage device, if present, to prevent the accumulation of an explosive mixture. A pre-engineered or self-contained ESS shall be permitted to provide ventilation in accordance with the manufacturer's recommendations and listing for the system.

Informational Note No. 1: See NFPA 1-2015, Fire Code, Chapter 52, for ventilation considerations for specific battery chemistries.

Informational Note No. 2: Some storage technologies do not require ventilation.

Informational Note No. 3: A source for design of ventilation of battery systems is IEEE 1635-2012/ASHRAE Guideline 21-2012 Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications, and the UBC.

Informational Note No. 4: Fire protection considerations are addressed in NFPA 1-2015, Fire Code.

(B) Guarding of Live Parts. Guarding of live parts shall comply with 110.27.

(C) Spaces About ESS Components. Spaces about the ESS shall comply with 110.26. Working space shall be measured from the edge of the ESS modules, battery cabinets, racks, or trays. For battery racks, there shall be a minimum clearance of 25 mm (1 in.) between a cell container and any wall or structure on the side not requiring access for maintenance. ESS modules, battery cabinets, racks, or trays shall be permitted to contact adjacent walls or structures, provided that the battery shelf has a free air space for not less than 90 percent of its length. Pre-engineered and self-contained ESSs shall be permitted to have working space between components within the system in accordance with the manufacturer's recommendations and listing of the system.

Informational Note: Additional space is often needed to accommodate ESS equipment hoisting equipment, tray removal, or spill containment.

(D) Egress. A personnel door(s) intended for entrance to and egress from rooms designated as ESS rooms shall open in the direction of egress and shall be equipped with listed panic hardware.

(E) Illumination. Illumination shall be provided for working spaces associated with ESS and their equipment and components. Luminaires shall not be controlled by automatic means only. Additional luminaires shall not be required where the work space is illuminated by an adjacent light source. The location of luminaires shall not do either of the following:

(1) Expose personnel to energized system components while performing maintenance on the luminaires in the system space

(2) Create a hazard to the system or system components upon failure of the luminaire

706.11 Directory.

ESS shall be indicated by 706.11(A) and (B). The markings or labels shall be in accordance with 110.21(B).

(A) Directory. A permanent plaque or directory denoting all electric power sources on or in the premises shall be installed at each service equipment location and at locations of all electric power production sources capable of being interconnected.

***Exception:** Installations with large numbers of power production sources shall be permitted to be designated by groups.*

(B) Facilities with Stand-Alone Systems. Any structure or building with an ESS that is not connected to a utility service source and is a stand-alone system shall have a permanent plaque or directory installed on the exterior of the building or structure at a readily visible location acceptable to the authority having jurisdiction. The plaque or directory shall indicate the location of system disconnecting means and that the structure contains a stand-alone electrical power system.

PART II. CIRCUIT REQUIREMENTS

706.20 Circuit Sizing and Current.

(A) Maximum Rated Current for a Specific Circuit. The maximum current for the specific circuit shall be calculated in accordance with 706.20(A)(1) through (A)(5).

(1) Nameplate-Rated Circuit Current. The nameplate(s)- rated circuit current shall be the rated current indicated on the ESS nameplate(s) or system listing for pre-engineered or self contained systems of matched components intended for field assembly as a system.

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

(3) Inverter Input Circuit Current. The maximum current shall be the continuous inverter input current rating when the inverter is producing rated power at the lowest input voltage.

(4) Inverter Utilization Output Circuit Current. The maximum current shall be the continuous inverter output current rating when the inverter is producing rated power at the lowest input voltage.

(5) DC to DC Converter Output Current. The maximum current shall be the dc-to-dc converter continuous output current rating.

(B) Conductor Ampacity and Overcurrent Device Ratings. The ampacity of the feeder circuit conductors from the ESS(s) to the wiring system serving the loads to be serviced by the system shall not be less than the greater of the (1) nameplate(s) rated circuit current as determined in accordance with 706.20(A) or (2) the rating of the ESS(s) overcurrent protective device(s).

(C) Ampacity of Grounded or Neutral Conductor. If the output of a single-phase, 2-wire ESS output(s) is connected to the grounded or neutral conductor and a single ungrounded conductor of a 3-wire system or of a 3-phase, 4-wire, wye connected system, the maximum unbalanced neutral load current plus the ESS(s) output rating shall not exceed the ampacity of the grounded or neutral conductor.

706.21 Overcurrent Protection.

(A) Circuits and Equipment. ESS circuit conductors shall be protected in accordance with the requirements of Article 240. Protection devices for ESS circuits shall be in accordance with the requirements of 706.21(B) through (F).

Circuits shall be protected at the source from overcurrent.

(B) Overcurrent Device Ampere Ratings. Overcurrent protective devices, where required, shall be rated in accordance with Article 240 and the rating provided on systems serving the ESS and shall be not less than 125 percent of the maximum currents calculated in 706.20(A).

(C) Direct Current Rating. Overcurrent protective devices, either fuses or circuit breakers, used in any dc portion of an ESS shall be listed and for dc and shall have the appropriate voltage, current, and interrupting ratings for the application.

(D) Current Limiting. A listed and labeled current-limiting overcurrent protective device shall be installed adjacent to the ESS for each dc output circuit.

***Exception:** Where current-limiting overcurrent protection is provided for the dc output circuits of a listed ESS, additional current-limiting overcurrent devices shall not be required.*

(E) Fuses. Means shall be provided to disconnect any fuses associated with ESS equipment and components when the fuse is energized from both directions and is accessible to other than qualified persons. Switches, pullouts, or similar devices that are rated for the application shall be permitted to serve as a means to disconnect fuses from all sources of supply.

(F) Location. Where ESS input and output terminals are more than 1.5 m (5 ft) from connected equipment, or where the circuits from these terminals pass through a wall or partition, overcurrent protection shall be provided at the ESS.

706.23 Charge Control.

(A) General. Provisions shall be provided to control the charging process of the ESS. All adjustable means for control of the charging process shall be accessible only to qualified persons.

Informational Note: Certain types of energy storage equipment such as valve-regulated lead acid or nickel cadmium can experience thermal failure when overcharged.

(B) Diversion Charge Controller.

(1) Sole Means of Regulating Charging. An ESS employing a diversion charge controller as the sole means of regulating charging shall be equipped with a second independent means to prevent overcharging of the storage device.

(2) Circuits with Diversion Charge Controller and Diversion Load. Circuits containing a diversion charge controller and a diversion load shall comply with the following:

(1) The current rating of the diversion load shall be less than or equal to the current rating of the diversion load charge controller. The voltage rating of the diversion load shall be greater than the maximum ESS voltage. The power rating of the diversion load shall be at least 150 percent of the power rating of the charging source.

(2) The conductor ampacity and the rating of the overcurrent device for this circuit shall be at least 150 percent of the maximum current rating of the diversion charge controller.

(3) Energy Storage Systems Using Utility-Interactive Inverters. Systems using utilityinteractive inverters to control energy storage state-of-charge by diverting excess power into the utility system shall comply with 706.23(B)(3)(a) and (B)(3)(b).

(a) These systems shall not be required to comply with 706.23(B)(2).

(b) These systems shall have a second, independent means of controlling the ESS charging process for use when the utility is not present or when the primary charge controller fails or is disabled.

(C) Charge Controllers and DC-to-DC Converters. Where charge controllers and other DC-to-DC power converters that increase or decrease the output current or output voltage with respect to the input current or input voltage are installed, all of the following shall apply:

(1) The ampacity of the conductors in output circuits shall be based on the maximum rated continuous output current of the charge controller or converter for the selected output voltage range.

(2) The voltage rating of the output circuits shall be based on the maximum voltage output of the charge controller or converter for the selected output voltage range.

PART III. ELECTROCHEMICAL ENERGY STORAGE SYSTEMS

Part III of this article applies to ESSs that are comprised of sealed and non-sealed cells or batteries or system modules that are comprised of multiple sealed cells or batteries that are not components within a listed product.

Informational Note: An energy storage component, such as batteries, that are integrated into a larger piece of listed equipment, such as an uninterruptible power supply (UPS), are examples of components within a listed product.

706.30 Installation of Batteries.

(A) Dwelling Units. An ESS for dwelling units shall not exceed 100 volts between conductors or to ground.

Exception: *Where live parts are not accessible during routine ESS maintenance, an ESS voltage exceeding 100 volts shall be permitted.*

(B) Disconnection of Series Battery Circuits. Battery circuits subject to field servicing, where exceeding 240 volts nominal between conductors or to ground, shall have provisions to disconnect the series-connected strings into segments not exceeding 240 volts nominal for maintenance by qualified persons. Non–load-break bolted or plug-in disconnects shall be permitted.

(C) Storage System Maintenance Disconnecting Means. ESS exceeding 100 volts between conductors or to ground shall have a disconnecting means, accessible only to qualified persons, that disconnects ungrounded and grounded circuit conductor(s) in the electrical storage system for maintenance. This disconnecting means shall not disconnect the grounded circuit conductor(s) for the remainder of any other electrical system. A non–load-break-rated switch shall be permitted to be used as a disconnecting means.

(D) Storage Systems of More Than 100 Volts. On ESS exceeding 100 volts between the conductors or to ground, the battery circuits shall be permitted to operate with ungrounded conductors, provided a ground-fault detector and indicator is installed to monitor for ground faults within the storage system.

706.31 Battery and Cell Terminations.

(A) Corrosion Prevention. Antioxidant material suitable for the battery connection shall be used when recommended by the battery or cell manufacturer.

Informational Note: The battery manufacturer's installation and instruction manual can be used for guidance for acceptable materials.

(B) Intercell and Intertier Conductors and Connections. The ampacity of field-assembled intercell and intertier connectors and conductors shall be of such cross-sectional area that the temperature rise under maximum load conditions and at maximum ambient temperature shall not exceed the safe operating temperature of the conductor insulation or of the material of the conductor supports.

Informational Note: Conductors sized to prevent a voltage drop exceeding 3 percent of maximum anticipated load, and where the maximum total voltage drop to the furthest point of connection does not exceed 5 percent, may not be appropriate for all battery applications. IEEE 1375-2003, Guide for the Protection of Stationary Battery Systems, provides guidance for overcurrent protection and associated cable sizing.

(C) Battery Terminals. Electrical connections to the battery and the cable(s) between cells on separate levels or racks shall not put mechanical strain on the battery terminals. Terminal plates shall be used where practicable.

706.32 Battery Interconnections.

Flexible cables, as identified in Article 400, in sizes 2/0 AWG and larger shall be permitted within the battery enclosure from battery terminals to a nearby junction box where they shall be connected to an approved wiring method. Flexible battery cables shall also be permitted between batteries and cells within the battery enclosure. Such cables shall be listed and identified as moisture resistant. Flexible, fine-stranded cables shall only be used with terminals, lugs, devices, or connectors in accordance with 110.14.

706.33 Accessibility.

The terminals of all cells or multicell units shall be readily accessible for readings, inspection, and cleaning where required by the equipment design. One side of transparent battery containers shall be readily accessible for inspection of the internal components.

706.34 Battery Locations.

Battery locations shall conform to 706.34 (A), (B), and (C).

(A) Live Parts. Guarding of live parts shall comply with 110.27.

(B) Top Terminal Batteries. Where top terminal batteries are installed on tiered racks or on shelves of battery cabinets, working space in accordance with the storage equipment manufacturer's instructions shall be provided between the highest point on a storage system component and the row, shelf, or ceiling above that point.

Informational Note: IEEE 1187 provides guidance for top clearance of VRLA batteries, which are the most commonly used battery in cabinets.

(C) Gas Piping. Gas piping shall not be permitted in dedicated battery rooms.

PART IV. FLOW BATTERY ENERGY STORAGE SYSTEMS

Part IV applies to ESSs composed of or containing flow batteries.

706.40 General.

All electrical connections to and from the system and system components shall be in accordance with the applicable provisions of Article 692. The system and system components shall also meet the provisions of Parts I and II of this article. Unless otherwise directed by this article, flow battery ESS shall comply with the applicable provisions of Article 692.

706.41 Electrolyte Classification.

The electrolyte(s) that are acceptable for use in the batteries associated with the ESS shall be identified by name and chemical composition. Such identification shall be provided by readily discernable signage adjacent to every location in the system where the electrolyte can be put into or taken out of the system.

706.42 Electrolyte Containment.

Flow battery systems shall be provided with a means for electrolyte containment to prevent spills of electrolyte from the system. An alarm system shall be provided to signal an electrolyte leak from the system. Electrical wiring and connections shall be located and routed in a manner that mitigates the potential for exposure to electrolytes.

706.43 Flow Controls.

Controls shall be provided to safely shut down the system in the event of electrolyte blockage.

706.44 Pumps and Other Fluid Handling Equipment.

Pumps and other fluid handling equipment are to be rated/specified suitable for exposure to the electrolytes.

PART V. OTHER ENERGY STORAGE TECHNOLOGIES

The provisions of Part V apply to ESSs using other technologies intended to store energy and when there is a demand for electrical power to use the stored energy to generate the needed power.

706.50 General.

All electrical connections to and from the system and system components shall be in accordance with the applicable provisions of this Code. Unless otherwise directed by this article, other energy storage technologies shall comply with the applicable provisions of Part III of Article 705.

■Reason for the Change

A new Article 706 titled, "Energy Storage Systems," was added to the *NEC* pertaining to all permanently installed energy storage systems (ESS).

ARTICLE 708

Critical Operations Power Systems (COPS)

708.10(A)(2) Receptacle Identification

708.10 Feeder and Branch Circuit Wiring. [Critical Operations Power Systems (COPS)]

(A) Identification.

(1) Boxes and Enclosures. In a building or at a structure where a critical operations power system and any other type of power system are present, all boxes and enclosures (including transfer switches, generators, and power panels) for critical operations power system circuits shall be permanently marked so they will be readily identified as a component of the critical operations power system.

(2) Receptacle Identification. In a building in which COPS are present with other types of power systems described in other sections in this article, the cover plates for the receptacles or the receptacles themselves supplied from the COPS shall have a distinctive color or marking so as to be readily identifiable. Nonlocking-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.

Exception: *If the COPS supplies power to a DCOA that is a stand-alone building, receptacle cover plates or the receptacles themselves shall not be required to have distinctive marking.*

■Reason for the Change

In addition to the distinctive color or marking requirement for COPS receptacles, all nonlocking-type, 125-volt, 15- and 20-ampere receptacles supplied from the COPS are now required to have an illuminated face or an indicator light to indicate that there is power to the receptacle.

ARTICLE 710

Stand-Alone Systems

Article 710 Stand-Alone Systems

The following is the new Article 710 titled, "Stand-Alone Systems," which put all stand-alone system requirements in one location.

710.1 Scope.

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

710.6 Equipment Approval.

All equipment shall be listed and labeled or field labeled for the intended use.

710.15 General.

Premises wiring systems shall be adequate to meet the requirements of this *Code* for similar installations supplied by a feeder or service. The wiring on the supply side of the building or structure disconnecting means shall comply with the requirements of this *Code*, except as modified by 710.15(A) through (F).

(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 or structure disconnecting means shall be sized based on the sum of the output ratings of the stand-alone sources.

(C) Single 120-Volt Supply.

Stand-alone systems shall be permitted to supply 120 volts to single-phase, 3-wire, 120/240-volt service equipment or distribution panels where there are no 240-volt outlets and where there are no multiwire 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 words or equivalent:

WARNING:
SINGLE 120-VOLT SUPPLY. DO NOT CONNECT MULTIWIRE 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 to an interconnected supply shall be secured in accordance with 408.36(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.

■Reason for the Change

The requirements of stand-alone systems were brought to one location and a new Article 710, Stand-Alone Systems, was created for the 2017 *NEC*.

ARTICLE 712
Direct Current Microgrids

Article 712 Direct Current Microgrids

The following is the new Article 712 titled, "Direct Current Microgrids," which was added for a power distribution system consisting of more than one interconnected dc power sources, supplying dc–dc converters(s), dc loads(s), and/or ac loads(s) powered by dc–ac inverters(s).

PART I. GENERAL
712.1 Scope.

This article applies to direct current microgrids.

712.2 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 microgrids interconnect via one or more dc-ac bidirectional converters or dc–ac inverters.

Informational Note: Direct current power sources include ac-dc converters (rectifiers), bidirectional dc-ac inverters/converters, photovoltaic systems, wind generators, 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.

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

Reference-Grounded 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 dc microgrid.

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

712.3 Other Articles.

Wherever the requirements of other articles of this Code and Article 712 differ, the requirements of Article 712 shall apply. DC microgrids interconnected through an inverter or bi-directional converter with ac electric power production sources shall comply with Article 705 .

712.4 Listing and Labeling .

Any equipment used in the dc circuits of a direct-current micro grid shall be listed and labeled for dc use.

712.10 Directory.

A permanent 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.

PART II. CIRCUIT REQUIREMENTS

712.25 Identification of Circuit Conductors

(A) Ungrounded circuit conductors in dc microgrids shall be identified according to the requirements of 210.5(C)(2) for branch circuits and 215.12(C)(2) for feeders.

(B) Ungrounded conductors of 6 AWG 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.

712.30 System Voltage.

The system voltage of a dc microgrid 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 ungrounded dc systems.

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

PART III. DISCONNECTING MEANS

712.34 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.

712.35 Disconnection of Ungrounded Conductors.

In solidly grounded two- and three-wire systems, the disconnecting means shall simultaneously open all ungrounded conductors. In ungrounded, resistively grounded and reference-grounded systems, such devices shall open all current-carrying conductors.

712.37 Directional Current Devices.

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

Informational Note: Examples of directional current devices are magnetically quenched contactors and semiconductor switches in overcurrent devices.

PART IV. WIRING METHODS

712.52 System Grounding.

(A) General. Direct-current microgrids shall be grounded in accordance with 250.162 .

(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.

712.55 Ground Fault Detection Equipment.

Ungrounded, 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 250.167(C) .

712.57 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 .

Informational Note: Section 90.4 applies when suitable equipment for arc fault protection is not available.

PART V. MARKING

712.62 Distribution Equipment and Conductors .

Distribution equipment and conductors shall be marked as required elsewhere in this Code.

712.65 Available DC Short-Circuit Current.

(A) Field Marking. 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.

(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 current 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 712.65(A) shall indicate the new maximum available short-circuit current and date .

PART VI. PROTECTION

712.70 Overcurrent Protection.

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

712.72 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 shortcircuit 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 nominal circuit voltage or a short-circuit current rating sufficient for the available short-circuit current at the line terminals of the equipment.

PART VII. SYSTEMS OVER 1000 VOLTS
712.80 General.

Systems with a maximum voltage between conductors of over 1000 volts dc shall comply with Article 490 and other requirements in this Code applicable to installations rated over 1000 volts.

■Reason for the Change

A new Article 712 for dc microgrids was added for a power distribution system consisting of more than one interconnected dc power sources, supplying dc–dc converters(s), dc loads(s), and/or ac loads(s) powered by dc–ac inverters(s).

ARTICLE 725
Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits

725.3(M) and (N) Other Articles (Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits)

725.3 Other Articles (Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits)

Circuits and equipment shall comply with the articles or sections listed in 725.3(A) through ~~(L)~~ (N). Only those sections of Article 300 referenced in this article shall apply to Class 1, Class 2, and Class 3 circuits.

(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 provisions of Table 800.154(c), listed in accordance with the provisions of 800.182, and installed in accordance with the provisions of 800.110(C) and 800.113.

(N) Communications Raceways. Class 2, Class 3 and 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 the provisions of Table 800.154(b), listed in accordance with the provisions of 800.182, and installed in accordance with the provisions of 800.113 and 362.24 through 362.56, where the requirements applicable to electrical nonmetallic tubing (ENT) apply.

■Reason for the Change

New 725.3(M) and (N) were added for “Other Articles” to provide guidance in the selection, listing and installation requirements for cable routing assemblies and communication raceways used for Class 2, Class 3 and PLTC cables.

725.135(K)(6), (L)(6) and (M)(6) Installation of Class 2, Class 3, and PLTC Cables

725.135 Installation of Class 2, Class 3, and PLTC Cables.

Installation of Class 2, Class 3, and PLTC cables shall comply with 725.135(A) through (M).

(K) Other Building Locations. The following wires and cables shall be permitted to be installed in building locations other than the locations covered in 725.135(B) through (I):

(See NEC text at 725.135(K)(1) through (6) for complete list of wiring methods)

(6) Type CMUC undercarpet communications wires and cables installed under carpet, modular 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 725.135(B) through (I):

(See *NEC* text at 725.135(L)(1) through (6) for complete list of wiring methods)

(6) Type CMUC undercarpet communications 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 725.135(B) through (I):
(See *NEC* text at 725.135(M)(1) through (6) for complete list of wiring methods)

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

Reason for the Change

New *Code* language was introduced at 725.135(K), (L), and (M) to clearly indicate that Type CMUC undercarpet communications wires and cables can be installed under modular flooring and planks, as well as under carpet.

725.144, Table 725.144 Transmission of Power and Data. (Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits)

725.144 Transmission of Power and Data. (Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits)

The requirements of 725.144(A) and (B) shall apply to Class 2 and Class 3 circuits that transmit power and data to a powered device. The requirements of Parts I and III of Article 725 and 300.11 shall apply to Class 2 and Class 3 circuits that transmit power and data. The conductors that carry power for the data circuits shall be copper. The current in the power circuit shall not exceed the current limitation of the connectors.

Informational No. 1: One example of the use of cables that transmit power and data is the connection of closed-circuit TV cameras (CCTV).

Informational Note No. 2: The 8P8C connector is in widespread use with powered communications systems. These connectors are typically rated at 1.3 amperes maximum.

Table 725.144 Ampacities of Each Conductor in Amperes in 4-Pair Class 2 or Class 3 Data Cables Based on Copper Conductors at an Ambient Temperature of 30°C (86° F) with All Conductors in All Cables Carrying Current, 60°C (140°F), 75°C (167°F), and 90°C (194°F) Rated Cables

(See NEC and illustration provided for complete text of Table 725.144)

(A) Use of Class 2 or Class 3 Cables to Transmit Power and Data.

Where Types CL3P, CL2P, CL3R, CL2R, CL3, or CL2 transmit power and data, the following shall apply, as applicable:

(1) The ampacity ratings in Table 725.144 shall apply at an ambient temperature of 30°C (86°F).

(2) For ambient temperatures above 30°C (86°F), the correction factors of 310.15(B)(2) shall apply.

Informational Note: One example of the use of Class 2 cables is a network of closed- circuit TV cameras using 24 AWG, 60°C rated, Type CL2R, Category 5e local area network (LAN) cables.

(B) Use of Class 2-LP or Class 3-LP Cables to Transmit Power and Data. Types CL3P-LP, CL2P-LP, CL3R-LP, CL2R-LP, CL3-LP, or CL2-LP shall be permitted to supply power to equipment at a current level up to the marked ampere limit located immediately following the suffix LP and shall be permitted to transmit data to the equipment. The Class 2-LP and Class 3-LP cables shall comply with the following, as applicable:

Informational Note 1: The "(xxA)" following the suffix -LP indicates the ampacity of each conductor in a cable.

Informational Note 2: An example of a limited power (LP) cable is a cable marked Type CL2-LP(0.5A), 23 AWG. A Type CL2-LP (0.5), 23 AWG could be used in any location where a Type CL2 could be used; however, the LP cable would be suitable for carrying up to 0.5 A per conductor, regardless of the number of cables in a bundle. If used in a 7-cable bundle, the same cable could carry up to 1.2 amperes per conductor.

(1) Cables with the suffix "-LP" shall be permitted to be installed in bundles, raceways, cable trays, communications raceways, and cable routing assemblies.

(2) Cables with the suffix "-LP" and a marked ampere level shall follow the substitution hierarchy of Table 725.154 and Figure 725.154(A) for the cable type without the suffix "LP" and without the marked ampere level.

(3) System design shall be permitted by qualified persons under engineering supervision.

Reason for the Change

New provisions were added at 725.144 and Table 725.144 pertaining to remote powering over local area networking (LAN) cable. Additional information was introduced concerning new Type LP cable.

ARTICLE 727

Instrumentation Type Cable: Type ITC

727.4(5) Ex. to (5) Uses Permitted. (Instrumentation Tray Cable: Type ITC)

727.4 Uses Permitted. (Instrumentation Tray Cable: Type ITC)

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 501.10, 502.10, 503.10, 504.20, 504.30, 504.80, and 505.15.

(4) Enclosed in a smooth metallic sheath, continuous corrugated metallic sheath, or interlocking tape armor applied over the nonmetallic sheath in accordance with 727.6. The cable shall be supported and secured at intervals not exceeding 1.8 m (6 ft).

(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 1.8 m (6 ft).

Exception: *Where not subject to physical damage, Type ITC-ER shall be permitted to transition between cable trays and between cable trays and utilization equipment or devices for a distance not to exceed 1.8 m (6 ft) 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 floors in information technology equipment rooms in accordance with 645.5(E)(5)(b).

Reason for the Change

The same exception that exists for power and control tray cable (Type TC-ER) at 336.10(7) has been added at 727.4(5) for instrumentation tray cable (Type ITC-ER).

ARTICLE 760

Fire Alarm Systems

760.176(G) and 760.179(I) Listing and Marking of NPLFA Cables and Listing and Marking of PLFA Cables and Insulated Continuous Line-Type Fire Detectors

Part IV. Listing Requirements (Fire Alarm Systems)

760.176 Listing and Marking of NPLFA Cables. Non-power-limited fire alarm cables installed as wiring within buildings shall be listed in accordance with 760.176(A) and (B) and as being resistant to the spread of fire in accordance with 760.176(C) through (F), and shall be marked in accordance with 760.176(G). Cable used in a wet location shall be listed for use in wet locations or have a moisture-impervious metal sheath.

(G) NPLFA Cable Markings. Multiconductor non-power-limited fire alarm cables shall be marked in accordance with Table 760.176(G). Non–power-limited fire alarm circuit cables shall be permitted to be marked with a maximum usage voltage rating of 150 volts. Cables that are listed for circuit integrity shall be identified with the suffix "CI" as defined in 760.176(F). Temperature rating shall be marked on the jacket of NPLFA cables that have a temperature rating exceeding 60°C (140°F). The jacket of NPLFA cables shall be marked with the conductor size.

Informational Note: Cable types are listed in descending order of fire resistance rating.

760.179 Listing and Marking of PLFA Cables and Insulated Continuous Line-Type Fire Detectors. PLFA cables installed as wiring within buildings shall be listed as being resistant to the spread of fire and other criteria in accordance with 760.179(A) through (H) and shall be marked in accordance with 760.179(I). Insulated continuous line-type fire detectors shall be listed in accordance with 760.179(J). Cable used in a wet location shall be listed for use in wet locations or have a moisture-impervious metal sheath.

(I) Cable Marking. The cable shall be marked in accordance with Table 760.179(I). The voltage rating shall not be marked on the cable. Cables that are listed for circuit integrity shall be identified with the suffix CI as defined in 760.179(G). Temperature rating shall be marked on the jacket of PLFA cables that have a temperature rating exceeding 60°C (140°F). The jacket of PLFA cables shall be marked with the conductor size.

Informational Note: Voltage ratings on cables may be misinterpreted to suggest that the cables may be suitable for Class 1, electric light, and power applications.

Exception: *Voltage markings shall be permitted where the cable has multiple listings and voltage marking is required for one or more of the listings.*

■Reason for the Change

New temperature rating marking requirements were added for fire alarm circuits requiring the jacket of NPLFA and PLFA cables that have a temperature rating exceeding 60°C (140°F) to be marked with the appropriate temperature rating. The jacket of these fire alarm cables must also be marked with the conductor size as well.

ARTICLE 770

Optical Fiber Cables and Raceways

770.44 Overhead (Aerial) Optical Fiber Cables

770.44 Overhead (Aerial) Optical Fiber Cables.

Overhead optical fiber cables containing a non–current-carrying metallic member entering buildings shall comply with 840.44(A) and (B).

(A) 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 conditions described in 770.44(A)(1) through (A)(4) shall be met.

(1) Relative Location. Where practicable, the outside plant optical fiber cables shall be located below the electric light or power conductors.

(2) Attachment to Cross-Arms. Attachment of outside plant optical fiber cables to a cross-arm that carries electric light or power conductors shall not be permitted.

(3) Climbing Space. The climbing space through outside plant optical fiber cables shall comply with the requirements of 225.14(D).

(4) Clearance. Supply service drops and sets of overhead service conductors of 0 to 750 volts running above and parallel to optical fiber cable service drops shall have a minimum separation of 300 mm (12 in.) at any point in the span, including the point of their attachment to the building. Clearance of not less than 1.0 m (40 in.) shall be maintained between the two services at the pole.

(B) Above Roofs. Outside plant optical fiber cables shall have a vertical clearance of not less than 2.5 m (8 ft) from all points of roofs above which they pass.

Exception No. 1: *The requirement of 770.44(B) shall not apply to auxiliary buildings such as garages and the like.*

Exception No. 2: *A reduction in clearance above only the overhanging portion of the roof to not less than 450 mm (18 in.) shall be permitted if (a) not more than 1.2 m (4 ft) of optical fiber cable service drop cable passes above the roof overhang, and (b) the cable is terminated at a through- or above-the-roof raceway or approved support.*

Exception No. 3: *Where the roof has a slope of not less than 100 mm in 300 mm (4 in. in 12 in.), a reduction in clearance to not less than 900 mm (3 ft) shall be permitted.*

Informational Note: For additional information regarding overhead wires and cables, see ANSI/IEEE C2-2012, *National Electric Safety Code, Part 2, Safety Rules for Overhead Lines.*

Reason for the Change

A new 770.44 was added under Part II of Article 770 titled, "Overhead (Aerial) Optical Fiber Cables." This section contains needed information for the installation of overhead (aerial) optical fiber cables to buildings directly for Article 770.

770.48(A) and (B) Optical Fiber Cables Entering Building

770.48 Unlisted Cables and Raceways Entering Buildings. (Optical Fiber Cables and Raceways)

(A) Conductive and Nonconductive Cables. Unlisted conductive and nonconductive outside plant optical fiber cables shall be permitted to be installed in building spaces, other than risers, ducts used for environmental air, plenums used for environmental air, and other spaces used for environmental air, where the length of the cable within the building, measured from its point of entrance, does not exceed 15 m (50 ft) and the cable enters the building from the outside and is terminated in an enclosure.

The point of entrance shall be permitted to be extended from the penetration of the external wall or floor slab by continuously enclosing the entrance optical fiber cables in rigid metal conduit (RMC) or intermediate metal conduit (IMC) to the point of emergence.

Informational Note No. 1: Splice cases or terminal boxes, both metallic and plastic types, typically are used as enclosures for splicing or terminating optical fiber cables.

Informational Note No. 2: See 770.2 for the definition of Point of Entrance.

(B) Nonconductive Cables in Raceway. Unlisted nonconductive outside plant optical fiber cables shall be permitted to enter the building from the outside and shall be permitted to be installed in any of the following raceways:

(1) Intermediate metal conduit (IMC)

(2) Rigid metal conduit (RMC)

(3) Rigid polyvinyl chloride conduit (PVC)

(4) Electrical metallic tubing (EMT)

Unlisted nonconductive outside plant cables installed in rigid polyvinyl chloride conduit (PVC) or electrical metallic tubing (EMT) shall not be permitted to be installed in risers, ducts used for environmental air, plenums used for environmental air, and other spaces used for environmental air.

Reason for the Change

The point of entrance is now permitted to be extended from the penetration of the external wall or floor slab by continuously enclosing the entrance optical fiber cables in RMC or IMC to the point of emergence. *Code* language was also added to clarify that unlisted nonconductive outside plant optical fiber cables installed in PVC or EMT cannot be installed in risers, ducts used for environmental air, plenums used for environmental air, and other spaces used for environmental air.

770.49 Metallic Entrance Conduit Grounding

Code Language: 770.49 Metallic Entrance Conduit Grounding. (Optical Fiber Cables and Raceways)

~~Rigid metal conduit (RMC) or intermediate metal conduit (IMC)~~ Metallic conduit containing optical fiber entrance cable shall be connected by a bonding conductor or grounding electrode conductor to a grounding electrode in accordance with 770.100(B).

Reason for the Change

The reference to RMC and IMC was removed and replaced with "metallic conduit" as all metallic conduits containing optical fiber entrance cables should require a bonding connection to a grounding electrode (not just RMC and IMC).

770.100(B)(3)(2) Lightning Protection Systems Conductors

770.100 Entrance Cable Bonding and Grounding. (Optical Fiber Cables and Raceways)

Where required, the non–current-carrying metallic members of optical fiber cables entering buildings shall be bonded or grounded as specified in 770.100(A) through (D).

(B) Electrode. The bonding conductor and grounding electrode conductor shall be connected in accordance with 770.100(B)(1), (B)(2), or (B)(3).

(1) In Buildings or Structures with an Intersystem Bonding Termination. If the building or structure served has an intersystem bonding termination as required by 250.94, the bonding conductor shall be connected to the intersystem bonding termination.

~~**Informational Note:** See Part I of Article 100 for the definition of Intersystem Bonding Termination.~~

(2) In Buildings or Structures with Grounding Means. If an intersystem bonding termination is established, 250.94(A) shall apply. If the building or structure served has no intersystem bonding termination, the bonding conductor or grounding electrode conductor shall be connected to the nearest accessible location on one of the following:

(1) The building or structure grounding electrode system as covered in 250.50

(2) The grounded interior metal water piping system, within 1.5 m (5 ft) from its point of entrance to the building, as covered in 250.52

(3) The power service accessible means external to enclosures using the options identified in 250.94(A), Exception ~~as covered in 250.94~~

(4) The nonflexible metallic power service raceway

(5) The service equipment enclosure

(6) The grounding electrode conductor or the grounding electrode conductor metal enclosure of the power service~~, or~~

(7) The grounding electrode conductor or the grounding electrode of a building or structure disconnecting means that is grounded to an electrode as covered in 250.32

(3) In Buildings or Structures Without Intersystem Bonding Termination or

Grounding Means. If the building or structure served has no intersystem bonding termination or grounding means, as described in 770.100(B)(2), the grounding electrode conductor shall be connected to either of the following:

(1) To any one of the individual grounding electrodes described in 250.52(A)(1), (A)(2), (A)(3), or (A)(4).

(2) If the building or structure served has no grounding means, as described in 770.100(B)(2) or (B)(3)(1), to any one of the individual grounding electrodes described in 250.52(A)(7) and (A)(8) or to a ground rod or pipe not less than 1.5 m (5 ft) in length and 12.7 mm (1/2 in.) in diameter, driven, where practicable, into permanently damp earth and separated from lightning protection system conductors as covered in 800.53 and at least 1.8 m (6 ft) from electrodes of other systems. Steam ~~or~~ hot water pipes or ~~air terminal conductors (lightning-rod conductors)~~ lightning protection system conductors shall not be employed as electrodes for non-current-carrying metallic members.

■Reason for the Change

The term *air terminal conductors (lightning-rod conductors)* was replaced with the broader term *lightning protection system conductors* to clarify that no lightning protection system conductors should not be used as a part of the grounding electrode conductor or as a grounding electrode for optical fiber systems.

CHAPTER 8: COMMUNICATIONS SYSTEMS

ARTICLE 810
Radio and Television Equipment

810.15 Grounding of Radio and TV Equipment

810.15 Grounding. (Radio and Television Equipment)
Masts and metal structures supporting antennas shall be grounded in accordance with 810.21 unless the antenna and its related supporting mast or structure are within a zone of protection defined by a 46 m (150 ft) radius rolling sphere.

Informational Note: See 4.8.3.1 of NFPA 780-2014, *Standard for the Installation of Lightning Protection Systems*, for the application of the term "rolling sphere."

■Reason for the Change

Grounding of masts and metal supporting structures for radio and television antennas can be eliminated when the antenna and its related supporting mast or structure are within a zone of protection defined by a 46 m (150 ft) radius "rolling sphere" described in NFPA 780-2014, *Standard for the Installation of Lightning Protection Systems.*

ARTICLE 840
Premises-Powered Broadband Communications Systems

840.2 Network Terminals

840.2 Definitions (Premises-Powered Broadband Communications Systems) Optical Network Terminal (ONT). A device that converts ~~an optical signal~~ network-provided signals (optical, electrical, or wireless) into component signals, including voice, audio, video, data, wireless, optical, and interactive ~~service electrical~~ services, and is considered ~~to be~~ a network ~~interface equipment~~ device on the premises that it is connected to a communications service provider and is powered at the premises.

■Reason for the Change

The scope of Article 840 now advises that the article covers premises-powered broadband communications systems that consist of an optical fiber, twisted pair, or coaxial cable to the premises supplying a broadband signal to a network terminal. The term *Network Terminal* is defined at 840.2 and replaces the term, *Optical Network Terminal (ONT)*.

840.48 Unlisted Wires and Cables Entering Building

840.48 Unlisted Wires and Cables and ~~Raceways~~ Entering Buildings. (Premises-Powered Broadband Communications Systems)

~~The requirements of 770.48 shall apply~~ Installations of unlisted cables entering buildings shall comply with 840.48(A), (B), or (C), as applicable.

(A) Optical Fiber Cables. Installations of unlisted optical fiber cables entering buildings shall comply with 770.48.

(B) Communications Wires and Cables. Installations of unlisted communications wires and unlisted multipair communications cables entering buildings shall comply with 800.48.

(C) Coaxial Cables. Installations of unlisted coaxial cables entering buildings shall comply with 820.48.

■Reason for the Change

Premises-powered broadband communications system wires and cables will now be required to comply with 770.48 for unlisted optical fiber cables entering buildings, 800.48 for unlisted communications wires and unlisted multipair communications cables entering buildings, and 820.48 for unlisted coaxial cables entering buildings.

840.160 Powering Circuits

Part VI. Premises Powering of Communications Equipment over Communications Cables (Premises-Powered Broadband Communications Systems)

840.160 Powering Circuits.

Communications cables, in addition to carrying the communications circuit, shall also be permitted to carry circuits for powering communications equipment. Where the power supplied over a communications cable to communications equipment is greater than 60 watts, communication cables and the power circuit shall comply with 725.144 where communications cables are used in place of Class 2 and Class 3 cables.

■Reason for the Change

New requirements were added at 840.160 giving permission for communication cables to carry circuits for powering communications equipment. This section goes on to indicate that where the power supplied over a communications cable is greater than 60 watts, communication cables and the power circuit must comply with new 725.144 where communications cables are used in place of Class 2 and Class 3 cables.

CHAPTER 9: TABLES AND ANNEX D

Chapter 9 Tables Chapter 9, Notes to Tables, Note 9

Chapter 9 Tables Notes to Tables

(9) A multiconductor cable, optical fiber cable, or flexible cord of two or more conductors shall be treated as a single conductor for calculating percentage conduit or tubing fill area. For cables that have elliptical cross sections, the cross-sectional area calculation shall be based on using the major diameter of the ellipse as a circle diameter. Assemblies of single insulated conductors without an overall covering shall not be considered a cable when determining conduit or tubing fill area. The conduit or tubing fill for the assemblies shall be calculated based upon the individual conductors.

■Reason for the Change

New text was added to Note 9 of the Chapter 9 tables to clearly specify that assemblies of single insulated conductors without an overall covering are not to be considered a cable when determining conduit or tubing fill area. The conduit or tubing fill for the assemblies is to be calculated based upon the individual conductors.

Informative Annex D Example D3 Store Building

A store 50 ft by 60 ft, or 3000 ft2, has 30 ft of show window. There are a total of 80 duplex receptacles. The service is 120/240 V, single phase 3-wire service. Actual connected lighting load is 8500 VA.

Calculated Load *(see 220.40)*

Noncontinuous Loads			
Receptacle Load *(see 220.44)*	80 receptacles at 180 VA		14,400 VA
10,000 VA at 100%			10,000 VA
14,400 VA − 10,000 VA = 4400 at 50%			2,200 VA
		Subtotal	12,200 VA
Continuous Loads			
General Lighting*	3000 ft² at 3 VA/ft²		9,000 VA
Show Window Lighting Load	30 ft at 200 VA/ft *[see 220.14(G)]*		6,000 VA
Outside Sign Circuit *[see 220.14(F)]*			1,200 VA
		Subtotal	16,200 VA
		Subtotal from noncontinuous	12,200 VA
		Total noncontinuous loads + continuous loads =	28,400 VA

*In the example, ~~125% of~~ the actual connected lighting load (8500 VA ~~× 1.25 = 10,625 VA~~) is less than ~~125% of~~ the load from Table 220.12, so the minimum lighting load from Table 220.12 is used in the calculation. Had the actual lighting load been greater than the value calculated from Table 220.12, ~~125% of~~ the actual connected lighting load would have been used.

Informative Annex D, Example D3

A store 50 ft by 60 ft, or 3000 ft2, has 30 ft of show window. There are a total of 80 duplex receptacles. The service is 120/240 V, single phase 3-wire service. Actual connected lighting load is 8500 VA.

*In the example, ~~125% of~~ the actual connected lighting load (8500 VA ~~× 1.25 = 10,625 VA~~) is less than ~~125% of~~ the load from Table 220.12, so the minimum lighting load from Table 220.12 is used in the calculation. Had the actual lighting load been greater than the value calculated from Table 220.12, ~~125% of~~ the actual connected lighting load would have been used.

Minimum Size Feeder (or Service) Overcurrent Protection

[see 215.3 or 230.90]

32,450 VA ÷ 240 V = 135 A

The next higher standard size is 150 A (see 240.6).

Reason for the Change

The "125%" for the actual connected lighting load has been removed as continuous loads are calculated at 125% in the "Minimum Size Feeder (or Service) Overcurrent Protection."

Informative Annex D, Example D7

Sizing of Service Conductors for Dwelling(s)

Example D7 Sizing of Service Conductors for Dwelling(s) [see310.15(B)(7)]

Service conductors and feeders for certain dwellings are permitted to be sized in accordance with 310.15(B)(7).

With No Required Adjustment or Correction Factors

If a 175-ampere service rating is selected, a service conductor is then sized as follows:

175 amperes × 0.83 = 145.25 amperes per 310.15(B)(7).

If no other adjustments or corrections are required for the installation, then, in accordance with Table 310.15(B)(16), a 1/0 AWG Cu or a 3/0 AWG Al meets this rating at 75°C (167°F).

With Required Temperature Correction Factor

If a 175-ampere service rating is selected, a service conductor is then 175 amperes × 0.83 = 145.25 amperes per 310.15(B)(7).

If the conductors are installed in an ambient temperature of 40°C (104°F), the conductor ampacity must be multiplied by the appropriate correction factor in Table 310.15(B)(2)(a). In this case, we will use an XHHW-2 conductor, so we use a correction factor of 0.91 to find the minimum conductor ampacity and size:

145.25 x .91 = 159.6 amperes

In accordance with Table 310.15(B)(16), a 2/0 AWG CU or a 4/0 AWG AL would be required.

If no temperature correction or ampacity adjustment factors are required, the following table includes conductor sizes calculated using the requirements in 310.15(B)(7). This table is based on 75°C terminations and without any adjustment or correction factors.

Informative Annex Example D7 Sizing of Service Conductors for Dwelling(s) [Former Table 310.15(B)(7)]

Service or Feeder Rating (Amperes)	Conductor (AWG or kcmil) Copper	Aluminum or Copper-Clad Aluminum
100	4	2
110	3	1
125	2	1/0
150	1	2/0
175	1/0	3/0
200	2/0	4/0
225	3/0	250
250	4/0	300
300	250	350
350	350	500
400	400	600

Reason for the Change

Informative Annex Example D7 was revised to give two examples for sizing dwelling unit service conductors. The previous D7 is identified as an example with no required adjustment or correction factors, and a new example was added to illustrate the method used when temperature correction factors are involved. The new example calculates the size for dwelling unit service conductors with the allowed 310.15(B)(7) eighty-three percent adjustment along with a temperature correction factor from Table 310.15(B)(2)(a).

Informative Annex D, Example D8 Motor Circuit Conductors, Overload Protection, and Short-Circuit and Ground-Fault Protection

Example D8 Motor Circuit Conductors, Overload Protection, and Short-Circuit and Ground-Fault Protection

(see 240.6, 430.6, 430.22, 430.23, 430.24, 430.32, 430.52, and 430.62, Table 430.52, and Table 430.250)

Determine the minimum required conductor ampacity, the motor overload protection, the branch-circuit short-circuit and ground-fault protection, and the feeder protection, for three induction-type motors on a 480-V, 3-phase feeder, as follows:

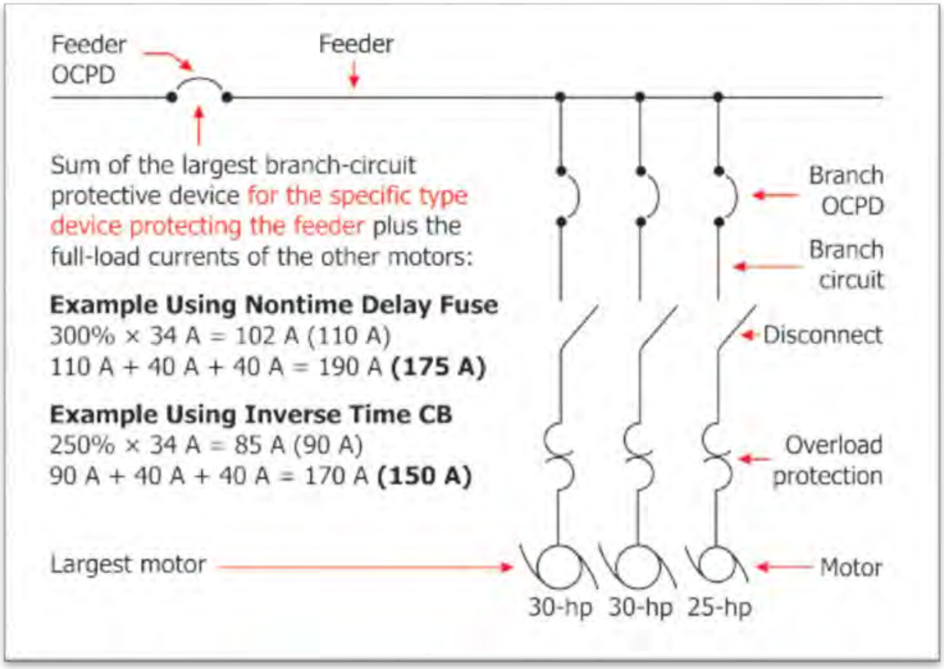
(a) One 25-hp, 460-V, 3-phase, squirrel-cage motor, nameplate full-load current 32 A, Design B, Service Factor 1.15

(b) Two 30-hp, 460-V, 3-phase, wound-rotor motors, nameplate primary full-load current 38 A, nameplate secondary full-load current 65 A, 40°C rise.

Feeder Short-Circuit and Ground-Fault Protection

(a) Example Using Nontime Delay Fuse. The rating of the feeder protective device is based on the sum of the largest branch-circuit protective device ~~(example is 110 A)~~ for the specific type of device protecting the feeder: 300% × 34 A = 102 A (therefore the next largest standard size, 110 A, would be used) plus the sum of the full-load currents of the other motors, or 110 A + 40 A + 40 A = 190 A. The nearest standard fuse that does not exceed this value is 175 A *[see 240.6 and 430.62(A)]*.

(b) Example Using Inverse Time Circuit Breaker. The largest branch-circuit protective device for the specific type of device protecting the feeder, 250% × 34 A = 85 A. The next larger standard size is 90 A, plus the sum of the full-load currents of the other motors, or 90 A + 40 A + 40 A = 170 A. The nearest standard inverse time circuit breaker that does not exceed this value is 150 A *[see 240.6 and 430.62(A)]*



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Reason for the Change

Example D8 has been revised for the "Feeder Short-Circuit and Ground-Fault Protection" portion to show (a) an example using non-time delay fuse and (b) an example using inverse time circuit breaker.

ACCESS THE CODE

The complete 2017 NEC can be accessed online for free at the following link. Be sure to select "Free access to the 2017 edition of NFPA 70"

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Additional, the code can be purchased in both a book and pdf from the same link.

T

Quiz Questions

The following twenty (20) question quiz will test the student's comprehension of the course. The student must past this online quiz with a score greater than 70%.

1. **Branch circuit emergency lighting transfer switch refers to loads supplied by branch circuits at not great than how many amperes?**

- 20
- 15
- 30
- 25

2. True or False. If an emergency system relies on a single alternate source of power, which will be disabled for maintenance or repair, the emergency system shall include permanent switching means to connect a portable or temporary alternate source of power, which shall be available for the duration of the maintenance or repair.

- True
- False

3. **What new requirement was added to section 700.5?**

- GFCI protection on the transfer equipment
- The transfer equipment must be installed at least 18 inches above the floor level
- AFCI protection on the transfer equipment
- The short-circuit current rating of the transfer equipment to be field marked on the exterior of the transfer equipment

4. True or False? Emergency circuits shall be permanently marked so they will be readily identified as a component of an emergency circuit or system.

- True
- False

5. **For systems with multiple emergency sources connected to a paralleling bus, the ground fault sensor shall be permitted at________.**

- o an alternate location
- o each emergency source
- o any emergency control panel
- o near the sensor location

6. **What is meant by MID?**

- o Manufacture's Interrupter Device
- o Motion Infra-Red Detection
- o Megagrid Interconnect Devices
- o Microgrid Interconnect Devices

7. **What is the title of the new article 706 added to the 2017 NEC?**

- o Flow Battery Energy Storage
- o Stand-Alone Systems
- o Interconnected Electric Power Production Sources
- o Energy Storage Systems (ESS)

8. **The operating voltage of a battery or cell may vary __________________ its nominal voltage.**

- o above
- o below
- o above or below
- o extremely above

9. **In reference to 706.8, the point of connection between an energy storage system and electric power production sources shall be in accordance with ____________?**

- o 706.8
- o 706.8 (E)
- o 705.12
- o Article 300

10. **For an ESS, overcurrent protection should not be less than ____________ of the maximum current rating calculated in 706.20(A).**

- 100%
- 75%
- 95%
- 125%

11. **What is a UPS?**

- Uninterruptible Power Supply
- United Protection Services
- Universal Power Supply
- Units Per Second

12. **Critical operations power systems (COPS), when installed in buildings with other power systems, require an illuminated face or light on what types of receptacles?**

- All non-locking type 250 volt, 30 & 50 ampere
- All twist-locking type 125 volt, 15 & 20 ampere
- All locking type 125 volt, 15 & 20 ampere
- All non-locking type 125 volt, 15 & 20 ampere

13. **In stand-alone systems, the sum of the ratings of the power sources shall be ______ than the rating of the neutral bus in the service equipment.**

- one-half
- equal
- more
- less

14. **What section should be referenced for system voltage requirements on a direct current microgrid.**

- 712.70
- 712.80
- 712.52
- 712.30

15. True or False? DC microgrids with a maximum voltage between conductors of over 1000 volts dc shall comply with Article 490 and other requirements in this Code applicable to installations rated over 1000 volts.

- True
- False

16. **When a cable is marked "LP", what does this mean?**

- Lifetime Protection
- Liquid propane
- Limited Power
- Licensed Product

17. **Outside plant optical fiber cables shall have a vertical clearance of not less than _______ from all points of roofs above which they pass.**

- 24 inches
- 12 inches
- 3 feet
- 8 feet

18. **In section 770.100(B)(3), the term "lightning protection system" replaced what term?**

- Base terminal conductors
- Weather protection conductors
- Air terminal conductors
- Electrical Storm Protection

19. **When do radio and television masts supporting antennas not require to be grounded?**

- When located within a zone of protection defined by a 150 ft radius rolling sphere
- When located within a zone of protection defined by a 50 ft radius rolling sphere
- When located within a curtain of protection defined by a 1000 ft diameter sphere
- When located within a curtain of protection defined by a 150 ft x 150 ft area

20. True or False? Communications cables, in addition to carrying the communications circuit, shall also be permitted to carry circuits for powering communications equipment.

- True
- False