



2017 NEC Significant Code Changes Part 2

Four (4) Continuing Education Hours
Course Approval #EE1002

Approved Continuing Education for Professional Engineers

Table of Contents

2017 NEC Significant Code Changes Part 2

Introduction 1

Chapter 4 Equipment for General Use	2
Article 404 Switches	2
Article 406 Receptacles, Cord Connectors, and Attachment Plugs (Caps).....	3
Article 408 Switchboards, Switchgear, and Panelboards.....	6
Article 409 Industrial Control Panels.....	7
Article 410 Luminaires, Lampholders, and Lamps.....	7
Article 411 Lighting Systems Operating at 30 Volts or Less and Lighting Equipment Connected to Class-2 Power Sources8	
Article 422 Appliances.....	8
Article 424 Fixed Electric Space-Heating Equipment.....	10
Article 425 Fixed Resistance and Electrode Industrial Process Heating Equipment.....	12
Article 426 Fixed Outdoor Electric Deicing and Snow- Melting Equipment	18
Article 430 Motors, Motor Circuits, and Controllers	18
Article 440 Air-Conditioning and Refrigerating Equipment	20
Article 445 Generators.....	20
Article 480 Storage Batteries.....	23
Access the Code	23
Quiz Questions.....	24

2017 NEC Significant Code Changes

Part 2

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

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

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.

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 2 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 the 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 Microgrids (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 4 EQUIPMENT FOR GENERAL USE

ARTICLE 404

Switches

404.2(C) Switch Connections

(C) Switches Controlling Lighting

Loads. The grounded circuit conductor for the controlled lighting circuit shall be ~~provided~~ installed at the location where switches control lighting loads that are supplied by a grounded general-purpose branch circuit serving bathrooms, hallways, stairways, or rooms suitable for human habitation or occupancy as defined in the applicable building code. Where multiple switch locations control the same lighting load such that the entire floor area of the room or space is visible from the single or combined switch locations, the grounded circuit conductor shall only be required at one location. ~~for other than the following~~ A grounded conductor shall not be required to be installed at lighting switch locations under any of the following conditions:

- (1) Where conductors enter the box enclosing the switch through a raceway, provided that the raceway is large enough for all contained conductors, including a grounded conductor
- (2) Where the box enclosing the switch is accessible for the installation of an additional or replacement cable without removing finish materials

(3) Where snap switches with integral enclosures comply with 300.15(E)

~~(4) Where a switch does not serve a habitable room or bathroom~~ [moved to parent text of 404.2(C)]

~~(5) Where multiple switch locations control the same lighting load such that the entire floor area of the room or space is visible from the single or combined switch locations~~ [moved to parent text of 404.2(C)]

~~(6)~~ (4) Where lighting in the area is controlled by automatic means

~~(7)~~ (5) Where a switch controls a receptacle load

The grounded conductor shall be extended to any switch location as necessary and shall be connected to switching devices that require line-to-neutral voltage to operate the electronics of the switch in the standby mode and shall meet the requirements of 404.22.

Exception: The connection requirement shall become effective on January 1, 2020. It shall not apply to replacement or retrofit switches installed in locations prior to local adoption of 404.2(C) and where the grounded conductor cannot be extended without removing finish materials. The number of electronic lighting control switches on a branch circuit shall not exceed five, and the number connected to any feeder on the load side of a system or main bonding jumper shall not exceed 25. For the purpose of this exception, a neutral busbar, in compliance with 200.2(B) and to which a main

or system bonding jumper is connected shall not be limited as to the number of electronic lighting control switches connected.

Informational Note: The provision for a (future) grounded conductor is to complete a circuit path for electronic lighting control devices.

■ Reason for the Change

The previous seven conditions in which a grounded conductor was not required to be installed at lighting switch locations has been revised and reduced to only five conditions.

Previous conditions (4) and (5) were moved to the parent text of 404.2(C) and reworded into positive language. Enforceable language was added to require the grounded conductor to be connected and used by the switching device rather than simply be “present” at the switch enclosure.

A new exception was also added to exclude replacement or retrofit switches installed in locations before the local adoption of 404.2(C) where the grounded conductor cannot be extended without removing finish materials. This new exception also puts a limit to the number of electronic lighting control switches on a branch circuit or feeder.

404.22 Branch-Circuit Voltage Limitations

404.22 Electronic Lighting Control Switches. Electronic lighting control switches shall be listed. Electronic lighting control switches shall not introduce current on the equipment grounding conductor during normal operation. The requirement to not introduce current on the equipment grounding conductor shall take effect on January 1, 2020.

Exception: Electronic lighting control switches that introduce current on the equipment grounding conductor shall be permitted for applications covered by 404.2(C), Exception. Electronic lighting control switches that introduce current on the equipment grounding conductor shall be listed and marked

for use in replacement or retrofit applications only.

■ Reason for the Change

In conjunction with revisions to 404.2(C), new text was added at 404.22 stating that electronic lighting control switching devices are required to be listed and “shall not introduce current on the equipment grounding conductor during normal operation.” This prohibition on introducing current on the equipment grounding conductor has a future effective date of January 1, 2020.

ARTICLE 406

Receptacles, Cord Connectors, and Attachment Plugs

406.2 Receptacles, Cord Connectors, and Attachment Plugs (Caps)

Outlet Box Hood. A housing shield intended to fit over a faceplate for flush-mounted wiring devices, or an integral component of an outlet box, or a faceplate for flush-mounted wiring devices. The hood does not serve to complete the electrical enclosure; it reduces the risk of water coming in contact with electrical components within the hood, such as attachment plugs, current taps, surge protective devices, direct plug-in transformer units, or wiring devices.

■ Reason for the Change

A clear and expressive definition for the term “outlet box hood” was added at 406.2.

406.3(E) Receptacle Rating and Type

(E) Controlled Receptacle Marking. All nonlocking-type, 125-volt, 15- and 20-ampere receptacles that are controlled by an automatic control device, or that incorporate control features that remove power from the receptacle outlet for the purpose of energy management or building automation, shall be marked with the symbol shown in Figure 406.3(E) and the word “controlled.” For receptacles controlled by an automatic control device, the marking shall be located on

the controlled receptacle outlet face where and visible after installation. In both cases where a multiple receptacle device is used, the required marking of the word “controlled” and symbol shall denote which contact device(s) are automatically controlled.

Figure 406.3(E) Controlled Receptacle Marking Symbol



Exception: The marking is not required for receptacles controlled by a wall switch that provide the required room lighting outlets as permitted by 210.70.

■ Reason for the Change

The word “Controlled” is now required to be placed on the controlled receptacle along with the previous symbol. The word “Controlled” was also added to Figure 406.3(E). The controlled receptacle symbol and the word “Controlled” are to be placed on the controlled receptacle face (not the faceplate or cover) and visible after installation.

406.3(F) Receptacle Rating and Type

(F) Receptacle with USB Charger. A 125-volt 15- or 20-ampere receptacle that additionally provides Class 2 power shall be listed and constructed such that the Class 2 circuitry is integral with the receptacle.

■ Reason for the Change

New provisions were added pertaining to 125-volt 15- or 20-ampere receptacle that additionally provides Class 2 power in the form of a USB charger. These new provisions require these devices to be listed and constructed such that the Class 2 circuitry is integral with the receptacle.

406.4(D)(4), Ex. No. 1 and Ex. No. 2 General Installation Requirements

(4) Arc-Fault Circuit-Interrupter

Protection. Where a receptacle outlet is supplied by a branch circuit that requires arc-fault circuit-interrupter protection as specified elsewhere in this Code located in any areas specified in 210.12(A) or (B), a replacement receptacle at this outlet shall be one of the following:

- (1) A listed outlet branch-circuit type arc-fault circuit-interrupter receptacle
- (2) A receptacle protected by a listed outlet branch-circuit type arc-fault circuit-interrupter type receptacle
- (3) A receptacle protected by a listed combination type arc-fault circuit-interrupter type circuit breaker

Exception No. 1: Arc-fault circuit-interrupter protection shall not be required where all of the following apply:

- (1) The replacement complies with 406.4(D)(2)(b).
- (2) It is impracticable to provide an equipment grounding conductor as provided by 250.130(C).
- (3) A listed combination type arc-fault circuit-interrupter circuit breaker is not commercially available.
- (4) GFCI/AFCI dual function receptacles are not commercially available.

Exception No. 2: Section 210.12(B), Exception shall not apply to replacement of receptacles.

This requirement becomes effective January 1, 2014.

■ Reason for the Change

The main requirement of AFCI protection at replacement receptacles as described in the 2014 NEC holds true with two new exceptions added. The first new exception recognizes applications where an existing two-wire receptacle is replaced and no equipment grounding conductor can be installed. The second new exception stipulates that the exception to 210.12(B) does not apply when replacing existing receptacles.

406.4(D)(5) General Installation Requirements

(5) Tamper-Resistant

Receptacles. Listed tamper-resistant receptacles shall be provided where replacements are made at receptacle outlets that are required to be tamper-resistant elsewhere in this Code, except where a non-grounding receptacle is replaced with another non-grounding receptacle.

Reason for the Change

406.4(D)(5) still requires listed tamper-resistant receptacles where replacements are made at receptacle outlets that are required to be tamper-resistant elsewhere in the Code “except where a non-grounding receptacle is replaced with another non-grounding receptacle.” The tamper-resistant receptacle requirements at 406.12 remained basically the same for dwelling units, guest rooms and guest suites of hotels and motels, and for a child care facility.

406.6(D) Receptacle Faceplates (Cover Plates)

(D) Receptacle Faceplate (Cover Plates) with Integral Night Light and/or USB Charger. A flush device cover plate that additionally provides a night light and/or Class 2 output connector(s) shall be listed and constructed such that the night light and/or Class 2 circuitry is integral with the flush device cover plate.

Reason for the Change

New requirements were added at 406.6(D) about receptacle faceplates with integral night lights and/or USB chargers. These faceplates must be listed and constructed such that the night light and/or Class 2 circuitry is “integral with the flush device cover plate.”

406.9(B)(1) Receptacles in Damp or Wet Locations

(1) Receptacles of 15 and 20 Amperes in a Wet Location. Receptacles of 15 and 20 amperes, 125 and 250 volts installed in a wet location shall have an enclosure that is weatherproof whether or not the attachment plug cap is inserted. An outlet box hood installed for this purpose shall be listed and shall be identified as “extra duty.” Other listed products, enclosures, or assemblies providing weatherproof protection that do not utilize an outlet box hood need not be marked “extra duty.”

Informational Note No. 1: Requirements for extra-duty outlet box hoods are found in ANSI/UL 514D-2000 2013, Cover Plates for Flush-Mounted Wiring Devices. “Extra duty” identification and requirements are not applicable to listed receptacles, faceplates, outlet boxes, enclosures, or assemblies that are identified as either being suitable for wet locations or rated as one of the outdoor enclosure-type numbers of Table 110.28 that does not utilize an outlet box hood.

Exception: 15- and 20-ampere, 125- through 250-volt receptacles installed in a wet location and subject to routine high-pressure spray washing shall be permitted to have an enclosure that is weatherproof when the attachment plug is removed.

All 15- and 20-ampere, 125- and 250-volt nonlocking-type receptacles shall be listed and so identified as the weather-resistant type.

Informational Note No.

2: The types configuration of weather-resistant receptacles covered by this requirement are identified as 5-15, 5-20, 6-15, and 6-20 in ANSI/NEMA WD 6-2002 2012, Standard for Dimensions of Attachment Plugs and Receptacles Wiring Devices — Dimensional Specifications.

Reason for the Change

The previous requirements for 15- and 20-ampere, 125- and 250-volt receptacles installed in a wet location still holds true with language added to indicate that other listed products, enclosures, or assemblies providing weatherproof protection that do

not utilize an outlet box hood need not be marked “extra duty.”

406.12 Tamper-Resistant Receptacles

406.12 Tamper-Resistant Receptacles.

~~Tamper-resistant receptacles shall be installed as~~ All 15- and 20-ampere, 125- and 250-volt nonlocking-type receptacles in the areas specified in ~~406.12(A) through (C)~~ 406.12(1) through (7) shall be listed tamper-resistant receptacles.

- (1) Dwelling units in all areas specified in 210.52 and 550.13
- (2) Guest rooms and guest suites of hotels and motels
- (3) Child care facilities
- (4) Preschools and elementary education facilities
- (5) Business offices, corridors, waiting rooms and the like in clinics, medical and dental offices and outpatient facilities
- (6) Subset of assembly occupancies described in Article 518.2 to include places of waiting transportation, gymnasiums, skating rinks, and auditoriums
- (7) Dormitories

Informational Note: This requirement would include receptacles identified as 5-15, 5-20, 6-15, and 6-20 in ANSI/NEMA WD 6-2016, Wiring Devices — Dimensional Specifications.

Exception to ~~(A), (B), and (C)~~ (1), (2), (3), (4), (5), (6), and (7):

Receptacles in the following locations shall not be required to be tamper-resistant:

- (1) Receptacles located more than 1.7 m (5½ ft) above the floor
- (2) Receptacles that are part of a luminaire or appliance
- (3) A single receptacle or a duplex receptacle for two appliances located within the dedicated space for each appliance that, in normal use, is not easily moved from one place to another and that is cord-and-plug-connected in accordance with 400.10(A)(6), (A)(7), or (A)(8)

- (4) Nongrounding receptacles used for replacements as permitted in 406.4(D)(2)(a)

■ Reason for the Change

Along with the tamper-resistant receptacle requirements of the 2014 NEC, tamper-resistant receptacle requirements were expanded to mobile and manufactured homes, preschools and elementary education facilities, dormitories, business offices, corridors, waiting rooms and the like in clinics, medical and dental offices and outpatient facilities, assembly occupancies including places of waiting, transportation, gymnasiums, skating rinks, and auditoriums. The voltage rating at which tamper-resistant receptacle requirements are applicable was expanded to include both 125 volts and 250 volts.

406.15 Dimmer-Controlled Receptacles

~~406.15 Dimmer-Controlled Receptacles.~~

~~A receptacle supplying lighting loads shall not be connected to a dimmer unless the plug/receptacle combination is a nonstandard configuration type that is specifically listed and identified for each such unique combination.~~

■ Reason for the Change

The requirements for dimmer-controlled receptacles at 406.15 have been deleted. This section sought to correct incompatibilities between certain types of dimmers and certain cord-and-plug connected loads. Such incompatibilities are currently dealt with in the listing of specific load types and the listing of specific dimmer types.

ARTICLE 408 Switchboards, Switchgear, and Panelboards

408.3(A)(2) Support and Arrangement of Busbars and Conductors. (Switchboards, Switchgear, and Panelboards)

(2) Service Switchboards and Switchgear. Barriers shall be placed in all service panelboards, switchboards, and switchgear such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations.

Exception: This requirement shall not apply to service panelboards with provisions for more than one service disconnect within a single enclosure as permitted in 408.36, Exceptions No. 1, 2, and 3.

■ **Reason for the Change**

The barrier requirements of 408.3(A)(2) were expanded to all service panelboards as well as service switchboards and switchgear. An exception also was added eliminating the barriers at panelboards installed to comply with the requirements of 408.36, Ex. No. 1, 2, and 3.

ARTICLE 409

Industrial Control Panels

409.22(B) Short-Circuit Current Rating. (Industrial Control Panels)

(A) Installation. An industrial control panel shall not be installed where the available fault short-circuit current exceeds its short-circuit current rating as marked in accordance with 409.110(4).

(B) Documentation. If an industrial control panel is required to be marked with a short-circuit current rating in accordance with 409.110(4), the available short-circuit current at the industrial control panel, and the date the short-circuit current calculation was performed shall be documented and made available to those authorized to inspect the installation.

■ **Reason for the Change**

The missing companion component for documentation of the available short-circuit current (fault current) at industrial control panels was added at 409.22(B). This new requirement also required documentation of

the date the short-circuit current calculation was performed.

ARTICLE 410

Luminaires, Lampholders, and Lamps

410.62(C)(1) Cord-Connected Lampholders and Luminaires

(C) Electric-Discharge and LED

Luminaires. Electric-discharge and LED luminaires shall comply with (1), (2), and (3) as applicable.

(1) Cord-Connected Installation. A luminaire or a listed assembly in compliance with any of the conditions in (a) through (c) shall be permitted to be cord connected if the following conditions apply: provided the luminaire is located directly below the outlet or busway, the flexible cord meets all the following: is not subject to strain or physical damage, and the cord is visible over its entire length outside the luminaire except at terminations.

(a) A luminaire shall be permitted to be connected with a cord terminating terminated in a grounding-type attachment plug or busway plug.

(b) A luminaire assembly equipped with a strain relief and canopy shall be permitted to use a cord connection between the luminaire assembly and the canopy. The canopy shall be permitted to include a section of raceway having a maximum not over 152 mm (6 in.) in length and intended to facilitate the connection to an outlet box mounted above a suspended ceiling.

(c) Listed luminaires connected using listed assemblies that incorporate manufactured wiring system connectors in accordance with 604.6(C) 604.100(C) shall be permitted to be cord connected.

■ **Reason for the Change**

The same basic requirements still apply to cord-connected electric-discharge and LED luminaires with the information re-organized into an easier to understand list format that improves the clarity of the content.

ARTICLE 411

~~Lighting Systems Operating at 30 Volts or Less and Lighting Equipment Connected to Class 2 Power Sources~~

Article 411 Low-Voltage Lighting

~~Article 411 Low-Voltage Lighting Systems Operating at 30 Volts or Less and Lighting Equipment Connected to Class 2 Power Sources.~~

411.1 Scope. This article covers lighting systems and their associated components operating at no more than 30 volts or less and their associated components. This article also covers lighting equipment connected to a Class 2 power source ac or 60 volts dc. Where wet contact is likely to occur, the limits are 15 volts ac or 30 volts dc.

Informational Note: Refer to Article 680 for applications involving immersion.

- 411.3 Low-Voltage Lighting Systems.
- 411.4 Listing Required.
- 411.5 Specific Location Requirements.
- 411.6 Secondary Circuits.
- 411.8 Hazardous (Classified) Locations.

Reason for the Change

The limitations of 411.3(A) and (B) for low-voltage lighting systems operating at 30 volts or less and the limitations of Class 2 low-voltage lighting systems conforming to NEC Chapter 9, Table 11(A) or Table 11(B) was removed for the 2017 NEC. These low-voltage lighting systems addressed by Article 411 are now basically limited by the maximum rating of 25 amperes for the output circuits of the power supply under all load conditions.

ARTICLE 422

Appliances

422.2 Definition. (Appliances)

Vending Machine. Any self-service device that dispenses products or merchandise without the necessity of replenishing the device between each vending operation and is designed to require insertion of coin, paper currency, token, card, key, or receipt of payment by other means.

Reason for the Change

Vending machines are still required to be GFCI-protected, but the requirement has been relocated to 422.5(A)(5). All appliances operating at 50 volts or more are now required be listed (see new 422.6). In determining what constitutes a vending machine, the user of the Code will need to rely on the listing and the product standards for vending machines.

422.5 Ground-Fault Circuit-Interrupter (GFCI) Protection for Personnel

422.5 Ground-Fault Circuit-Interrupter (GFCI) Protection for Personnel.

The device providing GFCI protection required in this article shall be readily accessible.

(A) General. Appliances identified in 422.5(A)(1) through (5) rated 250 volts or less and 60 amperes or less, single- or 3-phase, shall be provided with GFCI protection for personnel. Multiple GFCI protective devices shall be permitted but shall not be required.

- (1) Automotive vacuum machines provided for public use
- (2) Drinking fountains water coolers
- (3) High-pressure spray washing machines — cord- and plug-connected
- (4) Tire inflation machines provided for public use
- (5) Vending machines

(B) Type. The GFCI shall be readily accessible, listed, and located in one or more of the following locations:

- (1) Within the branch circuit overcurrent device
- (2) A device or outlet within the supply circuit
- (3) An integral part of the attachment plug
- (4) Within the supply cord not more than 300 mm (12 in.) from the attachment plug
- (5) Factory installed within the appliance

■ Reason for the Change

The five appliances requiring GFCI protection in Article 422 were grouped together, and the GFCI requirements for these appliances were relocated to one location at 422.5(A). A new 422.5(B) was also added allowing five options for the location and type of GFCI protective device provided to deliver GFCI protection to the specific appliances listed at 422.5(A).

422.6 Listing Required. (Appliances)

422.6 Listing Required. (Appliances)

All appliances operating at 50 volts or more shall be listed.

■ Reason for the Change

A new section has been added to Article 422 requiring that all appliances operating at 50 volts or more must be listed.

422.14 Infrared Lamp Industrial Heating Appliances

~~422.14 Infrared Lamp Industrial Heating Appliances.~~

~~In industrial occupancies, infrared heating appliance lampholders shall be permitted to be operated in series on circuits of over 150 volts to ground, provided the voltage rating of the lampholders is not less than the circuit voltage.~~

~~Each section, panel, or strip carrying a number of infrared lampholders (including the internal wiring of such section, panel, or strip) shall be considered an appliance. The terminal connection block of each such assembly shall be considered an individual outlet.~~

■ Reason for the Change

Section 422.14 titled, “Infrared Lamp Industrial Heating Appliances,” was deleted and the information relocated to new Article 425 at 425.14.

422.16(B)(2) Flexible Cords. (Appliances)

(2) Built-in Dishwashers and Trash Compactors.

Built-in dishwashers and trash compactors shall be permitted to be cord- and plug-connected with a flexible cord identified as suitable for the purpose in the installation instructions of the appliance manufacturer where all of the following conditions are met:

- (1) The flexible cord shall be terminated with a grounding-type attachment plug.

Exception: A listed dishwasher or trash compactor distinctly marked to identify it as protected by a system of double insulation, ~~or its equivalent~~, shall not be required to be terminated with a grounding-type attachment plug.

- (2) For a trash compactor, ~~the~~ length of the cord shall be 0.9 m to 1.2 m (3 ft to 4 ft) measured from the face of the attachment plug to the plane of the rear of the appliance.

- (3) For a built-in dishwasher, the length of the cord shall be 0.9 m to 2.0 m (3 ft to 6.5 ft) measured from the face of the attachment plug to the plane of the rear of the appliance.

- (4) Receptacles shall be located to ~~avoid~~ protect against physical damage to the flexible cord.

- (5) The receptacle for a trash compactor shall be located in the space occupied by the appliance or adjacent thereto.

- (6) The receptacle for a built-in dishwasher shall be located in the space adjacent to the space occupied by the dishwasher.

- (7) The receptacle shall be accessible.

■ Reason for the Change

Dishwashers are now only permitted to have the receptacle outlet for a cord- and plug-connected built-in dishwasher to be located in the space adjacent to the space occupied

by the dishwasher. The maximum length of a cord for a built-in dishwasher was extended from the previous maximum length of 1.2 m (4 ft) to 2.0 m (6.5 ft) measured from the face of the attachment plug to the plane of the rear of the appliance. Other requirements for dishwashers and trash compactors remain the same as in the 2014 NEC.

422.16(B)(4) Flexible Cords. (Appliances) Range Hoods

(4) Range Hoods. Range hoods shall be permitted to be cord- and plug-connected with a flexible cord identified as suitable for use on range hoods in the installation instructions of the appliance manufacturer, where all of the following conditions are met:

(1) The flexible cord is terminated with a grounding-type attachment plug.

Exception: A listed range hood distinctly marked to identify it as protected by a system of double insulation, or its equivalent, shall not be required to be terminated with a grounding-type attachment plug.

(2) The length of the cord is not less than 450 mm (18 in.) and not over ~~900 mm (36 in.)~~ 1.2 m (4 ft).

(3) Receptacles are located to ~~avoid~~ protect against physical damage to the flexible cord.

(4) The receptacle is accessible.

(5) The receptacle is supplied by an individual branch circuit.

■ Reason for the Change

The requirements for a cord- and plug-connected range hood are much the same as the 2014 NEC with the length of the flexible cord expanded to 1.2 m (4 ft). The language pertaining to the receptacle needing to be located to “avoid” physical damage was changed to “protect against” physical damage to incorporate more enforceable language.

ARTICLE 424 Fixed Electric Space-Heating Equipment

Article 424 Part V Fixed Electric Space-Heating Equipment

The following article title texts have been updated:

424.41 Ceiling Installation of Heating Cables on Dry Board, in Plaster, and on Concrete Ceilings.

424.45 ~~Inspection and Tests.~~ Installation of Cables Under Floor Covering.

424.46 Inspection and Test.

424.47 Label Provided by Manufacturer.

■ Reason for the Change

Part V of Article 424 was revised for simpler interpretation and application. Two new sections were added. These sections (424.45 and 424.47) address proper installations of cables under floor coverings and labels provided by the manufacturer. The previous edition of the Code did not properly address these added items in Part V.

424.45 Installation of Cables Under Floor Coverings

424.45 Installation of Cables Under Floor Coverings.

(A) Identification. Heating cables for installation under floor covering shall be identified as suitable for installation under floor covering.

(B) Expansion Joints. Heating cables shall not be installed where they bridge expansion joints unless provided with expansion and contraction fittings applicable to the manufacture of the cable.

(C) Connection to Conductors. Heating cables shall be connected to branch-circuit and supply wiring by wiring methods described in the installation instructions or as recognized in Chapter 3.

(D) Anchoring. Heating cables shall be positioned or secured in place under the floor covering, per the manufacturer's instructions.

(E) Ground-Fault Circuit-Interrupter Protection. Ground-fault circuit-interrupter protection for personnel shall be provided.

(F) Grounding Braid or Sheath. Grounding means, such as copper braid, metal sheath, or other approved means, shall be provided as part of the heated length.

■ **Reason for the Change**

New requirements were added at 424.45 (Part V of Article 424) to give direction for the installation of heating cables installed under floor coverings.

424.47 Label Provided by Manufacturer

424.47 Label Provided by Manufacturer.

The manufacturers of electric space-heating cables shall provide marking labels that indicate that the space-heating installation incorporates electric space-heating cables, and instructions that the labels shall be affixed to the panelboards to identify which branch circuits supply the circuits to those space-heating installations. If the electric space-heating cable installations are visible and distinguishable after installation, the labels shall not be required to be provided and affixed to the panelboards.

■ **Reason for the Change**

New requirements for manufacturer's labels were added at 424.47 in Part V of Article 424 for application to electric space-heating cables. The manufacturer's label requirements for heating panels and panel sets at 424.92(D) remained the same.

Article 424 Part X Fixed Electric Space-Heating Equipment

Part X. Low-Voltage Fixed Electric Space-Heating Equipment

424.100 Scope. Low-voltage fixed electric space-heating equipment shall consist of an

isolating power supply, low-voltage heaters, and associated equipment that are all identified for use in dry locations.

424.101 Energy Source.

(A) Power Unit. The power unit shall be an isolating type with a rated output not exceeding 25 amperes, 30 volts (42.4 volts peak) ac, or 60 volts dc under all load conditions.

(B) Alternate Energy Sources. Listed low-voltage fixed electric space-heating equipment shall be permitted to be supplied directly from an alternate energy source such as solar photovoltaic (PV) or wind power. When supplied from such a source, the source and any power conversion equipment between the source and the heating equipment and its supply shall be listed and comply with the applicable section of the *NEC* for the source used. The output of the source shall meet the limits of 424.101(A).

424.102 Listed Equipment. Low-voltage fixed electric space-heating equipment shall be listed as a complete system.

424.103 Installation.

(A) General. Equipment shall be installed per the manufacturer's installation instructions.

(B) Ground. Secondary circuits shall not be grounded.

(C) Ground-Fault Protection. Ground-fault protection shall not be required.

424.104 Branch Circuit.

(A) Equipment shall be permitted to be supplied from branch circuits rated not over 30 amperes.

(B) The equipment shall be considered a continuous duty load.

■ **Reason for the Change**

To address products identified as low-voltage fixed electric space-heating equipment, a new Part X was added to Article 424 for the 2017 *NEC*.

ARTICLE 425

Fixed Resistance and Electrode Industrial Process Heating Equipment

Note: Article 425 is one of the major additions to the 2017 NEC. The entire article is as follows.

Part I. General

425.1 Scope. This article covers fixed industrial process heating employing electric resistance or electrode heating technology. For the purpose of this article, heating equipment shall include boilers, electrode boilers, duct heaters, strip heaters, immersion heaters, process air heaters, or other approved fixed electric equipment used for industrial process heating. This article shall not apply to heating and room air conditioning for personnel spaces covered by Article 424, fixed heating equipment for pipelines and vessels covered by Article 427, and induction and dielectric heating equipment covered by Article 665, and industrial furnaces incorporating silicon carbide, molybdenum, or graphite process heating elements.

425.2 Other Articles. Fixed industrial process heating equipment incorporating a hermetic refrigerant motor-compressor shall also comply with Article 440.

425.3 Branch Circuits.

(A) Branch-Circuit Requirements. Individual branch circuits shall be permitted to supply any volt-ampere or wattage rating of fixed industrial process heating equipment for which they are rated.

(B) Branch-Circuit Sizing. Fixed industrial process heating equipment and motors shall be considered continuous loads.

425.6 Listed Equipment. Fixed industrial process heating equipment shall be listed.

Part II. Installation

425.8 General.

(A) Location. Fixed industrial process heating equipment shall be located with respect to building construction and other equipment so as to permit access to the equipment. Sufficient clearance shall be maintained to permit replacement of controls and heating elements and for adjusting and cleaning of controls and other parts requiring such attention.

(B) Working Space. Working space about electrical enclosures for fixed industrial process heating equipment that require examination, adjustment, servicing, or maintenance while energized shall be accessible, and the work space for personnel shall comply with 110.26 and 110.34, based upon the utilization voltage to ground.

***Exception:** With special permission, in industrial establishments only, where conditions of maintenance and supervision ensure that only qualified persons will service the installation, working space less than that required in 110.26 or 110.34 shall be permitted.*

(C) Above Grade Level, Floor, or Work Platform. Where the enclosure is located above grade, the floor, or a work platform, all of the following shall apply:

- (1) The enclosure shall be accessible.
- (2) The width of the working space shall be the width of the enclosure or a minimum of 762 mm (30 in.), whichever is greater.
- (3) The depth of the workspace shall comply with 110.26(A) or 110.34 based upon the voltage to ground.
- (4) All doors or hinged panels shall open to at least 90 degrees.

425.9 Approval. All fixed industrial process heating equipment and systems installed by methods other than covered by this article shall be permitted only by special permission.

425.10 Special Permission. Fixed industrial process heating equipment and systems installed by methods other than covered by this article shall be permitted only by special permission.

425.11 Supply Conductors. Fixed industrial process heating equipment requiring supply conductors with over 60°C insulation shall be clearly and permanently marked. This marking shall be plainly visible after installation and shall be permitted to be adjacent to the field connection box.

425.12 Locations.

(A) Exposed to Physical Damage.

Where subject to physical damage, fixed industrial process heating equipment shall be protected in an approved manner.

(B) Damp or Wet Locations.

Fixed industrial process heating equipment installed in damp or wet locations shall be listed for such locations and shall be constructed and installed so that water or other liquids cannot enter or accumulate in or on wired sections, electrical components, or ductwork.

Informational Note: See 110.11 for equipment exposed to deteriorating agents.

425.13 Spacing from Combustible

Materials. Fixed industrial process heating equipment shall be installed to provide the required spacing between the equipment and adjacent combustible material, unless it is listed to be installed in direct contact with combustible material.

425.14 Infrared Lamp Industrial

Heating Equipment. In industrial occupancies, infrared industrial process heating equipment lampholders shall be permitted to be operated in series on circuits of over 150 volts to ground, provided the voltage rating of the lampholders is not less than the circuit voltage.

Each section, panel, or strip carrying a number of infrared lampholders, including the terminal wiring of such section, panel, or strip, shall be considered as infrared industrial heating equipment. The terminal connection block of each assembly shall be considered an individual outlet.

Part III. Control and Protection of Fixed Industrial Process Heating Equipment

425.19 Disconnecting Means. Means shall be provided to simultaneously disconnect the heater, motor controller(s), and supplementary overcurrent protective device(s) of all fixed industrial process heating equipment from all ungrounded conductors. Where heating equipment is supplied by more than one source, feeder, or branch circuit, the disconnecting means shall be grouped and identified as having multiple disconnecting means. Each disconnecting means shall simultaneously disconnect all ungrounded conductors that it controls. The disconnecting means specified in 425.19(A) and (B) shall have an ampere rating not less than 125 percent of the total load of the motors and the heaters and shall be lockable in accordance with 110.25

(A) Heating Equipment with Supplementary Overcurrent

Protection. The disconnecting means for fixed industrial process heating equipment with supplementary overcurrent protection shall be within sight from the supplementary overcurrent protective device(s), on the supply side of these devices, if fuses, and, in addition, shall comply with either 425.19(A)(1) or (A)(2).

(1) Heater Containing No Motor Rated over 1/8 Horsepower.

The disconnecting means specified in 425.19 or unit switches complying with 425.19(C) shall be permitted to serve as the required disconnecting means for both the motor controller(s) and heater under either of the following conditions:

- (1) The disconnecting means provided is also within sight from the motorcontroller(s) and the heater.
- (2) The disconnecting means is lockable in accordance with 110.25.

(2) Heater Containing a Motor(s) Rated over 1/8 Horsepower.

The above disconnecting means shall be permitted to serve as the required disconnecting means for both the motor controller(s) and heater under either of the following conditions:

- (1) The disconnecting means is in sight from the motor controller(s) and the heater and complies with Part IX of Article 430.

(2) Motor(s) of more than 1/8 hp and the heater are provided with a single unit switch that complies with 422.34(A), (B), (C), or (D), the disconnecting means shall be permitted to be out of sight from the motor controller.

(B) Heating Equipment Without Supplementary Overcurrent Protection.

(1) Without Motor or with Motor Not over 1/8 Horsepower. For fixed industrial process heating equipment without a motor rated over 1/8 hp, the branch-circuit switch or circuit breaker shall be permitted to serve as the disconnecting means where the switch or circuit breaker is within sight from the heater or is lockable in accordance with 110.25.

(2) Over 1/8 Horsepower. For motor-driven fixed industrial process heating equipment with a motor rated over 1/8 hp, a disconnecting means shall be located within sight from the motor controller or shall be permitted to comply with the requirements in 425.19(A)(2).

(C) Unit Switch(es) as Disconnecting Means. A unit switch(es) with a marked “off” position that is part of a fixed heater and disconnects all ungrounded conductors shall be permitted as the disconnecting means required by this article. The branch circuit switch or circuit breaker, where readily accessible for servicing of the fixed heater, shall be permitted as the other disconnecting means.

425.21 Switch and Circuit Breaker to Be Indicating. Switches and circuit breakers used as disconnecting means shall be of the indicating type.

425.22

(A) Branch-Circuit Devices. Fixed industrial process heating equipment other than such motor operated equipment as required by Articles 430 and 440 to have additional overcurrent protection shall be permitted to be protected against overcurrent where supplied by one of the branch circuits in Article 210.

(B) Resistance Elements. Resistance-type heating elements in fixed industrial process heating equipment shall be protected at not more than 60 amperes. Equipment rated more than 48 amperes and employing such elements shall have the heating elements subdivided, and each subdivided load shall not exceed 48 amperes. Where a subdivided load is less than 48 amperes, the rating of the supplementary overcurrent protective device shall comply with 425.3(B). A boiler employing resistance-type immersion heating elements contained in an ASME-rated and stamped vessel shall be permitted to comply with 425.72(A).

(C) Overcurrent Protective Devices. The supplementary overcurrent protective devices for the subdivided loads specified in 425.22(B) shall be (1) factory installed within or on the heater enclosure or supplied for use with the heater as a separate assembly by the heater manufacturer; (2) accessible, but shall not be required to be readily accessible; and (3) suitable for branch-circuit protection.

Informational Note No. 1: See 240.10.

Where cartridge fuses are used to provide this overcurrent protection, a single disconnecting means shall be permitted to be used for the several subdivided loads.

Informational Note No. 2: For supplementary overcurrent protection, see 240.10.

Informational Note No. 3: disconnecting means for cartridge fuses in circuits of any voltage, see 240.40.

(D) Branch-Circuit Conductors. The conductors supplying the supplementary overcurrent protective devices shall be considered branch-circuit conductors.

Where the heaters are rated 50 kW or more, the conductors supplying the supplementary overcurrent protective devices specified in 425.22(C) shall be permitted to be sized at not less than 100 percent of the nameplate rating of the heater, provided all of the following conditions are met:

(1) The heater is marked with a minimum conductor size.

(2) The conductors are not smaller than the marked minimum size.

(3) A temperature-actuated device controls the cyclic operation of the equipment.

(E) Conductors for Subdivided Loads.

Field-wired conductors between the heater and the supplementary overcurrent protective devices for fixed industrial process heating equipment shall be sized at not less than 125 percent of the load served. The supplementary overcurrent protective devices specified in 425.22(C) shall protect these conductors in accordance with 240.4. Where the heaters are rated 50 kW or more, the ampacity of field-wired conductors between the heater and the supplementary overcurrent protective devices shall be permitted to be not less than 100 percent of the load of their respective subdivided circuits, provided all of the following conditions are met:

(1) The heater is marked with a minimum conductor size.

(2) The conductors are not smaller than the marked minimum size.

(3) A temperature-activated device controls the cyclic operation of the equipment.

Part IV. Marking of Heating Equipment

425.28 Nameplate.

(A) Marking Required. Fixed industrial process heating equipment shall be provided with a nameplate giving the identifying name and the normal rating in volts and watts or in volts and amperes. Fixed industrial process heating equipment intended for use on alternating current only, direct current only, or both shall be marked to so indicate. The marking of equipment consisting of motors over 1/8 hp and other loads shall specify the rating of the motor in volts, amperes, and frequency and the heating load in volts and watts or in volts and amperes.

(B) Location. This nameplate shall be located so as to be visible or easily accessible after installation.

425.29 Marking of Heating Elements.

All heating elements that are replaceable in the field and are part of industrial process heating equipment shall be legibly marked with the ratings in volts or watts or in volts or amperes.

425.45 Concealed Fixed Industrial Heating Equipment — Inspection and Tests.

Concealed fixed industrial heating equipment installations shall be made with due care to prevent damage to the heating equipment and shall be inspected and approved before heating equipment is covered or concealed.

Part V. Fixed Industrial Process Duct Heaters

425.57 General. Part V shall apply to any heater mounted in the airstream of a forced-air system where the air-moving unit is not provided as an integral part of the equipment.

425.58 Identification. Heaters installed in an air duct shall be identified as suitable for the installation.

425.59 Airflow. Means shall be provided to ensure uniform airflow over the face of the heater in accordance with the manufacturer's instructions.

Informational Note: Some heaters installed within 1.2 m (4 ft) of the outlet of an air-moving device, elbows, baffle plates, or other obstructions in ductwork use turning vanes, pressure plates, or other devices on the inlet side of the duct heater to ensure an even distribution of air over the face of the heater.

425.60 Elevated Inlet Temperature.

Duct heaters intended for use with elevated inlet air temperature shall be identified as suitable for use at the elevated temperatures.

425.63 Fan Circuit Interlock. Means shall be provided to ensure that the fan circuit, where present, is energized when any heater circuit is energized. However, time- or temperature-controlled delay in energizing the fan motor shall be permitted.

425.64 Limit Controls. Each duct heater shall be provided with an approved, integral, automatic-reset temperature limiting control or controllers to de-energize the circuit or circuits. In addition, an integral independent supplementary control or controllers shall be provided in each duct heater that disconnects a sufficient number of conductors to interrupt current flow. This device shall be manually resettable or replaceable.

425.65 Location of Disconnecting Means. Duct heater controller equipment shall be either accessible with the disconnecting means installed at or within sight from the controller or as permitted by 425.19(A).

Part VI. Fixed Industrial Process Resistance-Type Boilers

425.70 Scope. The provisions in Part VI of this article shall apply to boilers employing resistance-type heating elements. Electrode-type boilers shall not be considered as employing resistance-type heating elements. See Part VII of this article.

425.71 Identification. Resistance-type boilers shall be identified as suitable for the installation.

425.72 Overcurrent Protection.

(A) Boiler Employing Resistance-Type Immersion Heating Elements in an ASME-Rated and Stamped Vessel. A boiler employing resistance-type immersion heating elements contained in an ASME-rated and stamped vessel shall have the heating elements protected at not more than 150 amperes. Such a boiler rated more than 120 amperes shall have the heating elements subdivided into loads not exceeding 120 amperes. Where a subdivided load is less than 120 amperes, the rating of the overcurrent protective device shall comply with 425.3(B).

(B) Boiler Employing Resistance-Type Heating Elements Rated More Than 48 Amperes and Not Contained in an ASME-Rated and Stamped Vessel. A

boiler employing resistance-type heating elements not contained in an ASME-rated and stamped vessel shall have the heating elements protected at not more than 60 amperes. Such a boiler rated more than 48 amperes shall have the heating elements subdivided into loads not exceeding 48 amperes. Where a subdivided load is less than 48 amperes, the rating of the overcurrent protective device shall comply with 425.3(B).

(C) Supplementary Overcurrent Protective Devices. The supplementary overcurrent protective devices for the subdivided loads as required by 425.72(A) and (B) shall be as follows:

(1) Factory-installed within or on the boiler enclosure or provided as a separate assembly by the boiler manufacturer.

(2) Accessible, but need not be readily accessible.

(D) Suitable for Branch-Circuit Protection. Where cartridge fuses are used to provide this overcurrent protection, a single disconnecting means shall be permitted for the several subdivided circuits. See 240.40.

(E) Conductors Supplying Supplementary Overcurrent Protective Devices. The conductors supplying these supplementary overcurrent protective devices shall be considered branch circuit conductors. Where the heaters are rated 50 kW or more, the conductors supplying the overcurrent protective device specified in 424.72(C) shall be permitted to be sized at not less than 100 percent of the nameplate rating of the heater, provided all of the following conditions are met:

(1) The heater is marked with a minimum conductor size.

(2) The conductors are not smaller than the marked minimum size.

(3) A temperature- or pressure-actuated device controls the cyclic operation of the equipment.

(F) Conductors for Subdivided Loads. Field-wired conductors between the heater and

the supplementary overcurrent protective devices shall be sized at not less than 125 percent of the load served. The supplementary overcurrent protective devices specified in 425.72(C) shall protect these conductors in accordance with 240.4. Where the heaters are rated 50 kW or more, the ampacity of field-wired conductors between the heater and the supplementary overcurrent protective devices shall be permitted to be not less than 100 percent of the load of their respective subdivided circuits, provided all of the following conditions are met:

- (1) The heater is marked with a minimum conductor size.
- (2) The conductors are not smaller than the marked minimum size.
- (3) A temperature-activated device controls the cyclic operation of the equipment.

425.73 Overtemperature Limit

Control. Each boiler designed so that in normal operation there is no change in state of the heat transfer medium shall be equipped with a temperature sensitive limiting means. It shall be installed to limit maximum liquid temperature and shall directly or indirectly disconnect all ungrounded conductors to the heating elements. Such means shall be in addition to a temperature-regulating system and other devices protecting the tank against excessive pressure.

425.74 Overpressure Limit Control.

Each boiler designed so that in normal operation there is a change in state of the heat transfer medium from liquid to vapor shall be equipped with a pressure-sensitive limiting means. It shall be installed to limit maximum pressure and shall directly or indirectly disconnect all ungrounded conductors to the heating elements. Such means shall be in addition to a pressure-regulating system and other devices protecting the tank against excessive pressure.

Part VII. Fixed Industrial Process Electrode-Type Boilers

425.80 Scope. The provisions in Part VII of this article shall apply to boilers for operation at

600 volts, nominal, or less, in which heat is generated by the passage of current between electrodes through the liquid being heated.

425.81 Identification. Electrode-type boilers shall be identified as suitable for the installation.

425.82 Branch-Circuit Requirements.

The size of branch circuit conductors and overcurrent protective devices shall be calculated on the basis of 125 percent of the total load (motors not included). A contactor, relay, or other device, approved for continuous operation at 100 percent of its rating, shall be permitted to supply its full-rated load. See 210.19(A).

Exception: The provisions of this section shall not apply to conductors that form an integral part of an approved boiler. Where an electrode boiler is rated 50 kW or more, the conductors supplying the boiler electrode(s) shall be permitted to be sized at not less than 100 percent of the nameplate rating of the electrode boiler, provided all the following conditions are met:

- (1) The electrode boiler is marked with a minimum conductor size.
- (2) The conductors are not smaller than the marked minimum size.
- (3) A temperature- or pressure-actuated device controls the cyclic operation of the equipment.

425.83 Over temperature Limit

Control. Each boiler, designed so that in normal operation there is no change in state of the heat transfer medium, shall be equipped with a temperature sensitive limiting means. It shall be installed to limit maximum liquid temperature and shall directly or indirectly interrupt all current flow through the electrodes. Such means shall be in addition to the temperature regulating system and other devices protecting the tank against excessive pressure.

425.84 Overpressure Limit Control.

Each boiler, designed so that in normal operation there is a change in state of the heat transfer medium from liquid to vapor, shall be equipped with a pressure-sensitive limiting means. It shall be installed to limit maximum

pressure and shall directly or indirectly interrupt all current flow through the electrodes. Such means shall be in addition to a pressure-regulating system and other devices protecting the tank against excessive pressure.

425.85 Grounding. For those boilers designed such that fault currents do not pass through the pressure vessel, and the pressure vessel is electrically isolated from the electrodes, all exposed non-current-carrying metal parts, including the pressure vessel, supply, and return connecting piping, shall be grounded. For all other designs, the pressure vessel containing the electrodes shall be isolated and electrically insulated from ground.

425.86 Markings. All electrode-type boilers shall be marked to show the following:

- (1) The manufacturer's name.
- (2) The normal rating in volts, amperes, and kilowatts.
- (3) The electrical supply required specifying frequency, number of phases, and number of wires.
- (4) The marking "Electrode-Type Process Heating Boiler."
- (5) A warning marking, "All Power Supplies Shall Be Disconnected Before Servicing, Including Servicing the Pressure Vessel." A field-applied warning marking or label shall comply with 110.21(B).

The nameplate shall be located so as to be visible after installation.

■ Reason for the Change

New Article 425 (Fixed Resistance and Electrode Industrial Process Heating Equipment) has been incorporated into the 2017 NEC. In previous editions, the NEC did not adequately address requirements for industrial process heating equipment. Section 422.14, which covered appliances with infrared heat lamps, has been relocated to new Article 425 at 425.14.

ARTICLE 426

Fixed Outdoor Electric Deicing and Snow-Melting Equipment

426.32 Voltage Limitations. (Fixed Outdoor Electric Deicing and Snow-Melting Equipment)

426.32 Voltage Limitations. (Fixed Outdoor Electric Deicing and Snow-Melting Equipment)

~~Unless protected by ground fault circuit-interrupter protection for personnel,~~ The secondary winding of the isolation transformer connected to the impedance heating elements shall not have an output voltage greater than 30 volts ac.

~~Where ground fault circuit-interrupter protection for personnel is provided, the voltage shall be permitted to be greater than 30 but not more than 80 volts.~~

■ Reason for the Change

The secondary winding of an isolation transformer connected to an impedance heating element cannot have an output voltage greater than 30 volts ac. The allowance for voltage output greater than 30 volts ac if the system is provided with Class A GFCI protection has been deleted.

ARTICLE 430

Motors, Motor Circuits, and Controllers

430.2 and 430.4 Definitions. (Motors, Motor Circuits, and Controllers)

430.2 Part-Winding Motors. A part-winding start induction or synchronous motor is one that is arranged for starting by first energizing part of its primary (armature) winding and, subsequently, energizing the remainder of this winding in one or more steps. A standard part-winding start induction motor is arranged so that one-half of its primary

winding can be energized initially, and, subsequently, the remaining half can be energized, both halves then carrying equal current. A hermetic refrigerant compressor motor shall not be considered a standard part-winding start induction motor.

430.4 Part-Winding Motors. ~~A part-winding start induction or synchronous motor is one that is arranged for starting by first energizing part of its primary (armature) winding and, subsequently, energizing the remainder of this winding in one or more steps. A standard part-winding start induction motor is arranged so that one-half of its primary winding can be energized initially, and, subsequently, the remaining half can be energized, both halves then carrying equal current. A hermetic refrigerant compressor motor shall not be considered a standard part-winding start induction motor.~~

Where separate overload devices are used with a standard part-winding start induction motor, each half of the motor winding shall be individually protected in accordance with 430.32 and 430.37 with a trip current one-half that specified.

Each motor-winding connection shall have branch-circuit short-circuit and ground-fault protection rated at not more than one-half that specified by 430.52.

Exception: *A short-circuit and ground-fault protective device shall be permitted for both windings if the device will allow the motor to start. Where time-delay (dual-element) fuses are used, they shall be permitted to have a rating not exceeding 150 percent of the motor full-load current.*

■ Reason for the Change

The definition of a part-winding motor was moved from 430.4 to its proper location at 430.2.

430.53(D)(4) Several Motors or Loads on One Branch Circuit

(D) Single Motor Taps. For group installations described above, the conductors of any tap supplying a single motor shall not be required to have an individual branch-circuit

short-circuit and ground-fault protective device, provided they comply with one of the following:

- (1) No conductor to the motor shall have an ampacity less than that of the branch-circuit conductors.
- (2) No conductor to the motor shall have an ampacity less than one-third that of the branch-circuit conductors, with a minimum in accordance with 430.22. The conductors from the point of the tap to the motor overload device shall be not more than 7.5 m (25 ft) long and be protected from physical damage by being enclosed in an approved raceway or by use of other approved means.
- (3) Conductors from the point of the tap from the branch circuit short-circuit and ground-fault protective device to a listed manual motor controller additionally marked "Suitable for Tap Conductor Protection in Group Installations," or to a branch-circuit protective device, shall be permitted to have an ampacity not less than one-tenth the rating or setting of the branch-circuit short-circuit and ground-fault protective device. The conductors from the controller to the motor shall have an ampacity in accordance with 430.22. The conductors from the point of the tap to the controller(s) shall (1) be suitably protected from physical damage and enclosed either by an enclosed controller or by a raceway and be not more than 3 m (10 ft) long or (2) have an ampacity not less than that of the branch-circuit conductors.
- (4) Conductors from the point of the tap from the branch circuit to a listed manual motor controller additionally marked "Suitable for Tap Conductor Protection in Group Installations," or to a branch-circuit protective device, shall be permitted to have an ampacity not less than one-third that of the branch-circuit conductors. The conductors from the controller to the motor shall have an ampacity in accordance with 430.22. The conductors from the point of the tap to the controller(s) shall (1) be suitably protected from physical damage and enclosed either by an enclosed controller or by a raceway and be not more than 7.5 m (25 ft) long or (2) have an ampacity not less than that of the branch-circuit conductors.

Reason for the Change

New 430.53(D)(4) increases the maximum length of the conductors of any tap supplying a single motor to 7.5 m (25 ft) when the ampacity is not less than one-third that of the branch-circuit conductors.

430.99 Available Fault Current. (Motors, Motor Circuits, and Controllers)

430.99 Available Fault Current. (Motors, Motor Circuits, and Controllers)

The available short-circuit current at the motor control center and the date the short-circuit current calculation was performed shall be documented and made available to those authorized to inspect the installation.

Reason for the Change

New provisions were added at 430.99 requiring documentation of the available short-circuit current (fault current) at motor control centers along with the date the short-circuit current calculation was performed.

ARTICLE 440

Air-Conditioning and Refrigerating Equipment

440.9 Grounding and Bonding. (Air- Conditioning and Refrigerating Equipment)

440.9 Grounding and Bonding. (Air- Conditioning and Refrigerating Equipment)

Where multimotor and combination-load equipment is installed outdoors on a roof, an equipment grounding conductor of the wire type shall be installed in outdoor portions of metallic raceway systems that use non-threaded fittings.

Reason for the Change

The outdoor portions of metallic raceway systems that use non-threaded fittings are

now required to contain a wire-type equipment grounding conductor when installed outdoors on a roof to supply multimotor and combination-load equipment.

440.65 Branch-Circuit Receptacle Requirements

440.65 ~~Leakage-Current Detector- Interrupter (LCDI) and Arc-Fault Circuit Interrupter (AFCI) Protection Devices.~~

Single-phase cord- and plug-connected room air conditioners shall be provided with one of the following factory-installed LCIDI or AFCI protection devices:

- (1) Leakage-current detector-interrupter (LCDI)
- (2) Arc-fault circuit interrupter (AFCI)
- (3) Heat detecting circuit interrupter (HDCI)

The LCIDI or AFCI protection device shall be an integral part of the attachment plug or be located in the power supply cord within 300 mm (12 in.) of the attachment plug.

Reason for the Change

In addition to the previously allowed protection for single-phase, cord- and plug-connected room air conditioners of LCIDI or AFCI protection, a new form of protection was introduced at 440.65 allowing heat detecting circuit interrupter (HDCI) protection for room air conditioners. These three forms of protection for room air conditioners were placed in a list format for better clarity to the user of the Code.

ARTICLE 445

Generators

445.11 Marking. (Generators)

445.11 Marking. (Generators)

Each generator shall be provided with a nameplate giving the manufacturer's name, the rated frequency, the number of phases if of ac, the rating in kilowatts or kilovolt-amperes, the

power factor, the normal volts and amperes corresponding to the rating, ~~the rated revolutions per minute~~, and the rated ambient temperature, ~~or and~~ rated temperature rise.

Nameplates or manufacturer's instructions shall provide the following information for all stationary generators and portable generators rated more than 15 kW: ~~shall also give the power factor, the subtransient and transient impedances, the insulation system class, and the time rating.~~

- (1) Subtransient, and transient, synchronous, and zero sequence ~~impedances~~ reactances
- (2) Power ~~time~~ rating category
- (3) Insulation system class
- (4) Indication if the generator is protected against overload by inherent design, an overcurrent protective relay, circuit breaker, or fuse
- (5) Maximum short-circuit current for inverter-based generators, in lieu of the synchronous, subtransient, and transient reactances

Marking shall be provided by the manufacturer to indicate whether or not the generator neutral is bonded to the generator frame. Where the bonding of a generator is modified in the field, additional marking shall be required to indicate whether the generator neutral is bonded to the generator frame.

■ Reason for the Change

This section involving a generator's nameplate marking was revised into a list format for stationary and portable generators rated more than 15 kW. The word "impedance" was replaced with the word "reactance." Generators rated more than 15 kW are now also required to be marked with the maximum short-circuit current for inverter-based generators. The requirement for the nameplate to provide the "power factor" for all stationary and portable generators rated more than 15 kW has been moved to the first sentence of 445.11 so as to apply to all sizes of generators. For stationary and portable generators rated more than 15 kW, the term "time rating" was replaced with "power rating category."

445.13(B) Ampacity of Conductors. (Generators)

445.13 Ampacity of Conductors.

(A) General. The ampacity of the conductors from the generator output terminals to the first distribution device(s) containing overcurrent protection shall not be less than 115 percent of the nameplate current rating of the generator. It shall be permitted to size the neutral conductors in accordance with 220.61. Conductors that must carry ground-fault currents shall not be smaller than required by 250.30(A). Neutral conductors of dc generators that must carry ground-fault currents shall not be smaller than the minimum required size of the largest conductor.

Exception: Where the design and operation of the generator prevent overloading, the ampacity of the conductors shall not be less than 100 percent of the nameplate current rating of the generator.

(B) Overcurrent Protection

Provided. Where the generator set is equipped with a listed overcurrent protective device, including or a combination of a current transformer and overcurrent relay, conductors shall be permitted to be tapped from the load side of the protected terminals in accordance with 240.21(B).

Tapped conductors shall not be permitted for portable generators rated 15 kW or less where field wiring connection terminals are not accessible.

■ Reason for the Change

The existing provisions of the 2014 *NEC* for ampacity of conductors for generators were carried forward for the 2017 *NEC* and reassigned to 445.13(A) and exception. New provisions were added at 445.13(B) to clarify that the feeder tap rules of 240.21(B) can be used if the generator or generator set is equipped with an overcurrent relay or other overcurrent device, unless the tapped conductors are for portable generators rated 15 kW or less where field wiring connection terminals are not accessible.

445.18 Disconnecting Means and Shutdown of Prime Mover

445.18 Disconnecting Means Required for Generators and Shutdown of Prime Mover.

Generators shall be equipped with a disconnect(s), lockable in the open position by means of which the generator and all protective devices and control apparatus are able to be disconnected entirely from the circuits supplied by the generator except where the following conditions apply:

- (1) Portable generators are cord- and plug-connected, or
- (2) Both of the following conditions apply:
 - a. The driving means for the generator can be readily shut down, is rendered incapable of restarting, and is lockable in the OFF position in accordance with 110.25.
 - b. The generator is not arranged to operate in parallel with another generator or other source of voltage.

Informational Note: See UL 2200-2012, Standard for Safety of Stationary Engine Generator Assemblies.

(A) Disconnecting

Means. Generators other than cord- and plug-connected portable shall have one or more disconnecting means. Each disconnecting means shall simultaneously open all associated ungrounded conductors. Each disconnecting means shall be lockable in the open position in accordance with 110.25.

(B) Shutdown of Prime

Mover. Generators shall have provisions to shut down the prime mover. The means of shutdown shall comply with all of the following:

- (1) Be equipped with provisions to disable all prime mover start control circuits to render the prime mover incapable of starting
- (2) Initiate a shutdown mechanism that requires a mechanical reset

The provisions to shut down the prime mover shall be permitted to satisfy the requirements of 445.18(A) where it is capable of being locked in the open position in accordance with 110.25.

Generators with greater than 15 kW rating shall be provided with an additional requirement to shut down the prime mover. This additional shutdown means shall be located outside the equipment room or generator enclosure and shall also meet the requirements of 445.18(B)(1) and (B)(2).

(C) Generators Installed in

Parallel. Where a generator is installed in parallel with other generators, the provisions of 445.18(A) shall be capable of isolating the generator output terminals from the paralleling equipment. The disconnecting means shall not be required to be located at the generator.

■ Reason for the Change

Revisions and new requirements were incorporated into 445.18 by installing three subsections for disconnecting means for a generator. The provisions of 445.18(A) retain the existing requirements, with revisions, for a disconnecting means for a generator. New 445.18(B) adds requirements for the shutdown of the prime mover for a generator or generator set.

New 445.18(C) was added to clarify that when generators are installed in parallel, it is not necessary to provide a disconnecting means at each generator and the paralleling equipment as long as the generator is capable of isolating the generator output terminals from the paralleling equipment.

445.20 Ground-Fault Circuit-Interrupter Protection for Receptacles on 15-kW or Smaller Portable Generators

445.20 Ground-Fault Circuit-Interrupter Protection for Receptacles on 15-kW or Smaller Portable Generators.

All 125-volt, single-phase, 15- and 20-ampere receptacle outlets that are a part of a 15-kW or

smaller portable generator ~~either shall have listed ground-fault circuit-interrupter protection (GFCI) for personnel integral to the generator or receptacle or shall not be available for use when the 125/250-volt locking-type receptacle is in use. If the generator does not have a 125/250-volt locking-type receptacle, this requirement shall not apply.~~ as indicated in either (A) or (B):

(A) Unbonded (Floating Neutral)

Generators. Unbonded generators with both 125-volt and 125/250-volt receptacle outlets shall have listed GFCI protection for personnel integral to the generator or receptacle on all 125-volt and 15- and 20-ampere receptacle outlets.

Exception: GFCI protection shall not be required where the 125-volt receptacle outlets(s) is interlocked such that it is not available for use when any 125/250-volt receptacle(s) is in use.

(B) Bonded Neutral Generators. Bonded generators shall be provided with GFCI protection on all 125-volt and 15- and 20-ampere receptacle outlets.

Informational Note: Refer to 590.6(A)(3) for GFCI requirements for 15-kW or smaller portable generators used for temporary electric power and lighting.

Exception to (A) and (B): If the generator was manufactured or remanufactured prior to January 1, 2015, listed cord sets or devices incorporating listed ~~ground-fault circuit-interrupter~~ GFCI protection for personnel identified for portable use shall be permitted. (See 2014 NEC TIA 14-2)

■ Reason for the Change

The requirements of 445.20 were revised to separate GFCI requirements for unbonded (floating neutral) generators at 445.20(A) and bonded neutral generators at 445.20(B). Unbonded (floating neutral) generators requires GFCI protection at all 125-volt, 15- and 20-ampere receptacles, but only where both 125-volt and 125/250-volt receptacles exist on the generator. An exception to 445.20(A) eliminates GFCI protection where the 125-volt receptacle outlets(s) is

interlocked such that it is not available for use when any 125/250-volt receptacle(s) is in use.

New 445.20(B) requires all 125-volt, 15- and 20-ampere receptacles on bonded neutral generators to be provided with GFCI protection. An exception to 445.20(A) and (B) permits GFCI protection in the form of listed cord sets or devices incorporating listed GFCI protection if the generator was manufactured or remanufactured prior to January 1, 2015.

ARTICLE 480 Storage Batteries

480.3 Equipment. (Storage Batteries)

480.3 Equipment. (Storage Batteries)

Storage batteries and battery management equipment shall be listed. This requirement shall not apply to lead-acid batteries.

■ Reason for the Change

New listing requirement was added at 480.3, which will require storage batteries and battery management equipment to be listed. This listing requirement does not apply to lead-acid batteries.

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”

<http://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards?mode=code&code=70>

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

•

Quiz Questions

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

1. **Where multiple switch locations control the same lighting load such that the entire floor area of the room or space is visible from the single or combined switch locations, the grounded circuit conductor shall _____.**

- only be required at two switch locations
- only be required at one location
- not be required
- not be required if located outside of the space, such as in adjoining hallway

2. **How many conditions exist in which a grounded conductor is not required to be installed at a lighting switch location?**

- Six
- Five
- Seven
- Four

3. **Electronic lighting control switches that introduce current on the equipment grounding conductor shall be**

- Allowed after January 1, 2020
- Disallowed for conditions covered by 404.2
- Listed and Marked
- Never allowed

4. **What is the definition of an "Outlet Box Hood"?**

- A temporary housing shield intended to fit over a faceplate to comply with OSHA requirements
- None of the above
- A hooded shield intended to inhibit rodent infestation of a building's electrical systems
- A housing shield intended to fit over a faceplate for flush-mounted wiring devices

5. **Article 406.4 added two new exceptions to the code. What were these exceptions pertaining to?**

- Replacing receptacles
- Installing receptacles
- Removing receptacles
- Recycling receptacles

6. **A receptacle requiring to be tamper-resistant shall be replaced with a tamper-resistant receptacle except?**

- Where a grounding receptacle is replaced with a USB receptacle
- Where a non-grounding receptacle is replaced with another grounding receptacle
- Where a non-grounding receptacle is replaced with a USB receptacle
- Where a non-grounding receptacle is replaced with another non-grounding receptacle

7. **The term “Extra-Duty” is required identification for which of the following?**

- Service vehicles
- Submerged receptacles
- Class 2 circuitry
- Outlet box hood

8. **Tamper-Resistant receptacles are required at which of the following?**

- Child care facilities
- Hotel guest rooms
- Dormitories
- All of the above

9. **A low-voltage lighting system operates at no more than _____.**

- 30 volts
- 20 volts
- 15 volts
- 25 volts

10. In regards to the 2017 NEC, a “vending machine” is what?

- Designed to require insertion of a coin
- Any self-service device that dispenses products
- Definition deleted from 2017 NEC, falls under Appliances now
- None of the above

11. What is the new maximum length of a flexible cord for a built-in dishwasher?

- 4 feet
- 6 feet
- 5 feet
- No maximum length requirement

12. In regards to article 424.45, when installing heating cables that bridge expansion joints, what should be installed?

- Floor coverings
- Spacers
- Contraction fittings
- Wall coverings

13. The new article 425 to the 2017 NEC is about what type of equipment?

- Fixed Resistance and Electrode Industrial Process Heating Equipment
- Variable Resistance and Industrial Waste Process Heating Equipment
- Variable Resistance and Electrode Industrial Process Cooling Equipment
- Fixed Resistance Cooling Equipment

14. What part of article 425 will be the requirements for Fixed Industrial Process Resistance Type Boilers?

- Part VI
- Part III
- Part IV
- Part V

15. Article 430.53(D)(4) increases the maximum length of the conductors of any tap supplying a single motor to _____ feet when the ampacity is not less than one-third that of the branch-circuit conductors.

- 50
- 70
- 90
- 25

16. What is a HDCI?

- high discharge circuit interrupter
- high detector circuit interrupter
- heat discharge circuit interrupter
- heat detecting circuit interrupter

17. A generator is required to be labeled with which of the following?

- Power rating category
- Insulation system class
- Sub transient, and transient, synchronous, and zero sequence reactance's
- All of the above

18. True or False? For stationary and portable generators rated more than 15 kW, the term "power rating category" was replaced with "time rating."

- True
- False

19. Generators with greater than 15 kW rating shall be provided with an additional requirement to?

- Shut down the prime mover
- Perform emergency shut-down
- Have isolated grounding straps
- Have multiple shut-down points

20. True or False? The new listing requirement in article 480.3 applies to lead-acid batteries.

True

False