PDHonline Course E358 (3 PDH)

Revisions for the 2011 National Electrical Code® - Part 4

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PDH Course E358

Revisions for the 2011 *National Electrical Code*®
Part 4

Patrick S. Ouillette, P.E.

Introduction

Part 4 of this 4-part series covers Article 600 through Article 840. The course covers only major Code changes, but provides depth of coverage.

The layout and the method of presentation will enable new Code users to navigate through the changes. Those well experienced in the Code will find depth in the coverage. Through the heading(s) at the beginning of each Code change addressed in the document, the reader will readily identify the section affected by the change and the specific subject being discussed. The Significance section serves as an introduction to the Code change under discussion. An Analysis of the Code change follows, with explanation as necessary to help the student understand the revision, its background, and the logic of the change. Graphics, photographs, examples, or calculations are used to illustrate the change and to enhance learning. The Summary is a brief re-statement of the highlights of the Code change. An Application Question, with Answer and key to the correct answer, is included at the end of each Code section studied for exercise in applying the change and to broaden learning. Many of the sections analyzed contain a Code Refresher that addresses existing Code requirements related to the change. The author attempts to tie the entire *NEC*® together through the study of the changes.

Although there are many references to the 2011 *NEC*® throughout this document, the course and quiz can be completed without the need to refer to the *NEC*® itself. For further study on any Code section within this course, the 2011 *NEC*® should be consulted.

Disconnects

Significance

A disconnecting means installed according to *NEC* requirements is necessary for the safety of persons servicing electric signs and outline lighting systems.

Analysis

The required disconnecting means for signs or outline lighting is now prohibited from controlling any other load in addition to a sign or outline lighting. Also, new rules require the switch or circuit breaker to simultaneously open all ungrounded conductors on multiwire branch circuits in accordance with 210.4(B).

Revised Section 600.6 clarifies that the required branch circuit or feeder disconnect for signs and outline lighting systems applies also to skeleton tubing.

The requirements concerning the location of the sign disconnecting means are unchanged in the 2011 *NEC*. The disconnecting means is permitted on the structure of the sign, within sight of the sign, or out of sight of the sign if the disconnect is capable of being locked in the open position.

Summary

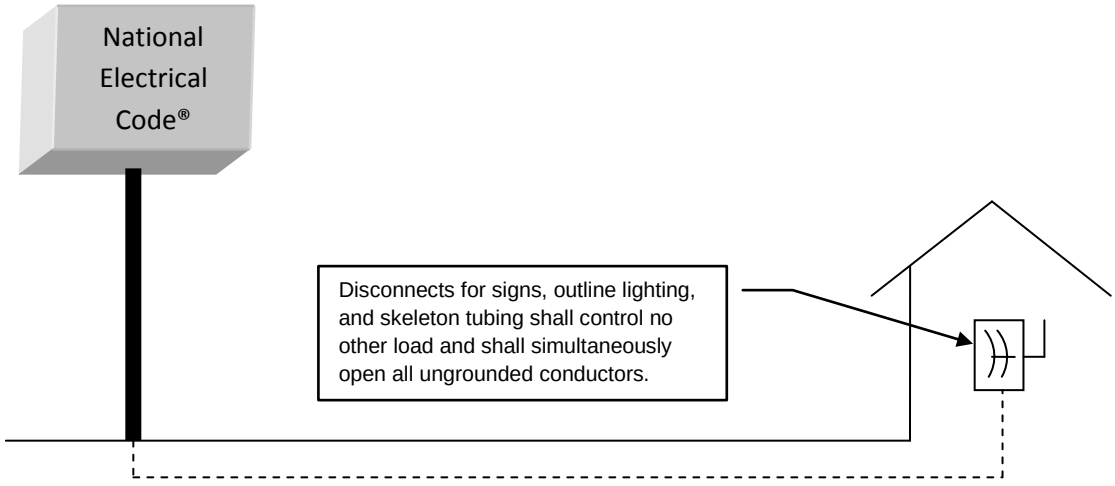
The required disconnecting means for signs, outline lighting, and skeleton tubing shall open all ungrounded conductors and shall control no other load. The disconnect shall open all ungrounded conductors of a multiwire circuit simultaneously in accordance with 210.4(B).

Application Question

T F Field-installed skeleton tubing and wiring addressed in Part II of Article 600 is not subject to the disconnect requirements of 600.6.

Answer

False. Section 600.30, Applicability, in Part II of Article 600 states that the requirements of Part II are in addition to the requirements of Part I.



LED Sign Illumination Systems, Secondary Wiring

Significance

Light-emitting diode (LED) sign systems are becoming increasingly popular. Installation requirements for Class 2 LED sign circuits are located in new Section 600.33.

Analysis

Since section signs and outline lighting are listed electrical utilization equipment, Class 2 LED sign circuits are not automatically subject to the requirements of Article 725 – Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits. Therefore, Class 2 LED sign circuit requirements are addressed in Article 600. New Section 600.33 contains some of the installation requirements for these special Class 2 circuits and references Part III of Article 725 for other requirements. Highlights of the rules are:

- Listed Class 2 cable that complies with Table 725.154(G) shall be installed on the load side of the Class 2 power source. The conductor ampacity shall be not less than the load and not smaller than 22 AWG.
- Class 2 cable used in a wet location shall be identified for use in wet locations or have a moisture-impervious metal sheath. In other than wet locations, any applicable cable permitted in Table 725.154(G) shall be permitted to be used.
- Exposed secondary wiring shall be supported by straps, staples, hangers, cable ties, or similar fittings designed and installed so as not to damage the cable. The installation shall comply with 300.4(D), Cables and Raceways Parallel to Framing Members and Furring Strips.
- Connections shall be made with listed insulating devices and shall be accessible after installation. Where made in a wall, connections shall be enclosed in a listed box.
- Where subject to physical damage, conductors shall be protected and installed in accordance with 300.4.
- Grounding and bonding shall be in accordance with the requirements in 600.7.

Electric sign components including LED units and LED power sources must comply with UL 879, *Electric Sign Components*. Recognized sign components can be found in the *Sign Components Manual (SAM)* published by UL and available at **www.ul.com/signs/mamual**.

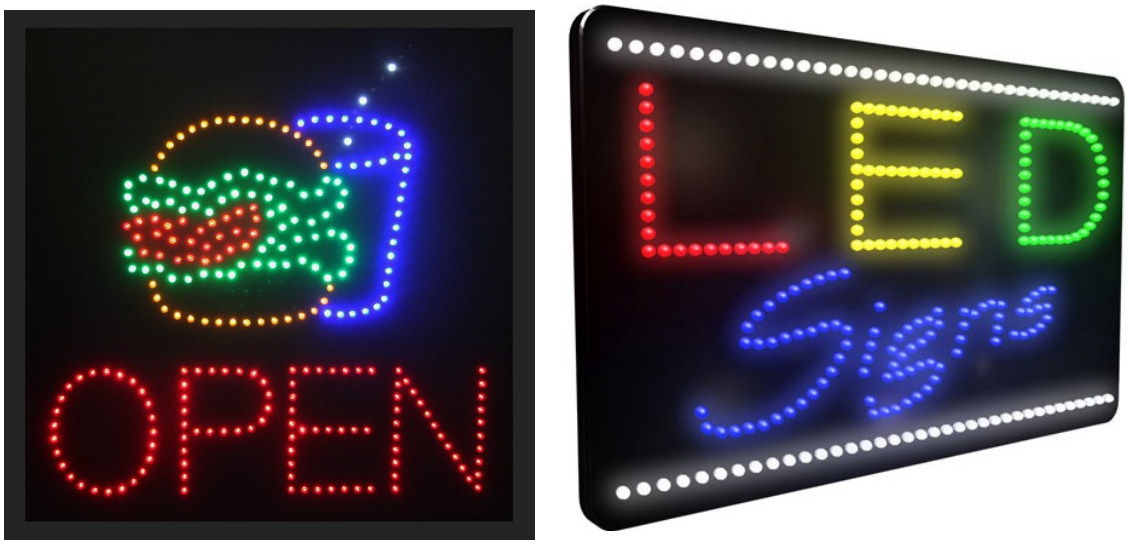
Even though many LEDs are designed to operate at relatively cool temperatures, sign installers should be aware that some power supplies for LED circuits can generate a significant amount of heat.

Summary

New Section 600.33 contains requirements for secondary wiring methods and materials for LED sign illumination systems.

Application Question

T F All requirements for Class 2 LED sign circuits are located in Article 725.



Light-emitting diode (LED) signs

Answer

False. Some of the requirements are in Article 600. Begin in Article 600. Use Article 725 when referred there from Article 600.

Definitions: Electric Vehicle, Plug-in Hybrid Electric Vehicle (PHEV), and Rechargeable Energy Storage System (RESS)

Significance

Article 625 is one of several Code articles that will see increasing use with the move toward alternative energy sources. With the increasing popularity of electric vehicles, more premises wiring installations will include charging provisions for electric vehicles.

Analysis

The definition of "electric vehicle" now includes electric motorcycles and plug-in hybrid electric vehicles (PHEV). For Code purposes, an electric vehicle is an automotive-type vehicle for on-road use, primarily powered by an electric motor, that draws current from a rechargeable storage battery, fuel cell, photovoltaic array, or other source of electric current. Off-road, self-propelled electric vehicles are not included in this Code article.

A definition for "plug-in hybrid electric vehicle" is new to the 2011 *NEC*. A PHEV is, "A type of electric vehicle intended for on-road use with the ability to store and use off-vehicle electrical energy in the rechargeable energy storage system, and having a second source of motive power." One of the advantages of the plug-in hybrid is the potential to supply backup power for premises wiring.

Plug-in hybrid electric vehicle Creative Commons license, author Mariordo Mario Roberto Duran Ortiz

A definition for "rechargeable energy storage system" is also new to the Code. A RESS is, "Any power source that has the ability to be charged and discharged."

Summary

Plug-in hybrid electric vehicles have similar charging systems to fully electric vehicles and are now included in the scope of Article 625. The vehicle's rechargeable energy storage system has the potential to be used as a backup supply for premises wiring.

Code Refresher

- ✓ Some electric vehicle charging systems installed indoors require ventilation. [625.15, .29]
- ✓ Overcurrent protection for branch circuits supplying electric vehicle supply equipment shall be rated at not less than 125% of the maximum load of the equipment. [625.21]

Hydromassage Bathtubs – Accessibility

Significance

There are new requirements for the location of a receptacle installed under a hydromassage bathtub to ensure safe access for servicing electrical equipment.

Analysis

Where hydromassage bathtub equipment is cord-and-plug connected, a receptacle is installed in the accessible area beneath the tub skirting. A 2011 revision to the Code requires that where the supply receptacle is accessible only through a service access opening, the receptacle shall be installed so that its face is within direct view from the access opening and not more than 1 ft from the opening. The primary purpose of this rule is to ensure safe access for persons servicing electrical equipment in the space under a hydromassage bathtub. Also, where a GFCI receptacle is installed under a hydromassage tub, the new rule will provide guidance in locating the receptacle so that it could be deemed "readily accessible," where other conditions of ready access are met. The requirement for a readily accessible GFCI supplying a hydromassage tub was introduced in Section 680.71 in the 2008 *NEC*. For some hydromassage bathtub installations, electrical equipment under the tub may not be readily accessible. If the authority having jurisdiction rules that a GFCI receptacle under a tub is not readily accessible, a GFCI device protecting the hydromassage bathtub will have to be installed in a readily accessible location.

Summary

Where a hydromassage tub is cord-and-plug connected to a receptacle accessible only through a service access opening, the receptacle shall be installed so that its face is within direct view from the access opening and not more than 1 ft from the opening.

Application Question

T F A GFCI receptacle installed under a hydromassage bathtub is readily accessible if it is installed with its face toward the access opening and is located not more than 1 ft from the opening.

Answer

False. Being within sight of and not more than 1 ft from the access opening has little to do with being readily accessible (see the definition in Article 100). There are other conditions such as the type of construction of the access or skirting that could render the electrical equipment not readily accessible.

Hydromassage Bathtubs – Bonding

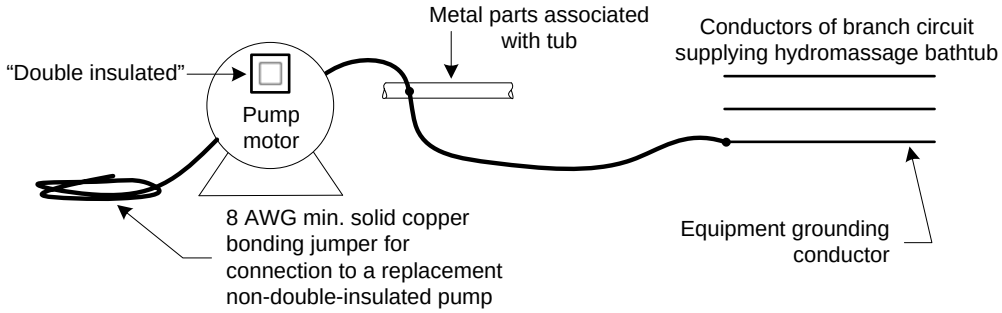
Significance

There are new requirements to provide for equipotential bonding where a double-insulated hydromassage bathtub pump motor is used.

Analysis

Interconnection of metal piping systems and other metal parts associated with a hydromassage bathtub's water recirculation system is required at the hydromassage bathtub location. An 8 AWG or larger solid copper bonding conductor is used to create the equipotential bond between the metal parts, including the pump motor. The 8 AWG bonding conductor is not required to run to the supply panelboard. Where the pump motor is not double insulated, this bonding conductor is not required to be directly connected to the equipment grounding conductor of the hydromassage tub supply circuit.

When a double-insulated pump motor is used, the 8 AWG copper bonding conductor is still required for interconnecting metal parts associated with the tub. The 2011 *NEC* requires that sufficient length of the 8 AWG or larger solid copper bonding conductor be left during the installation to make a bonding connection to a replacement motor, in the event that the replacement pump motor is not double insulated. This rule is similar to an existing rule in 680.26(B)(6)(a) that applies to pool pump motors. Also, when a double-insulated pump motor is used, the 8 AWG bonding conductor is required to connect to the equipment grounding conductor of the tub supply circuit.



Summary

When a double-insulated hydromassage pump motor is used, the 8 AWG solid copper bonding conductor required to interconnect metal parts at the hydromassage bathtub must connect to the equipment grounding conductor of the tub supply circuit and be of sufficient length to connect to a replacement non-double-insulated pump motor.

Application Question

T F Metal parts associated with the water recirculation system of a hydromassage tub must not connect to the supply panelboard grounding bus.

Answer

False. When a non-double-insulated pump is used, the bonding conductor connection to the pump effectively connects metal parts to the equipment grounding conductor. When a double-insulated pump is used, the Code change in 680.74 requires connection of metal parts to the equipment grounding conductor.

Installation – Identification and Grouping

Significance

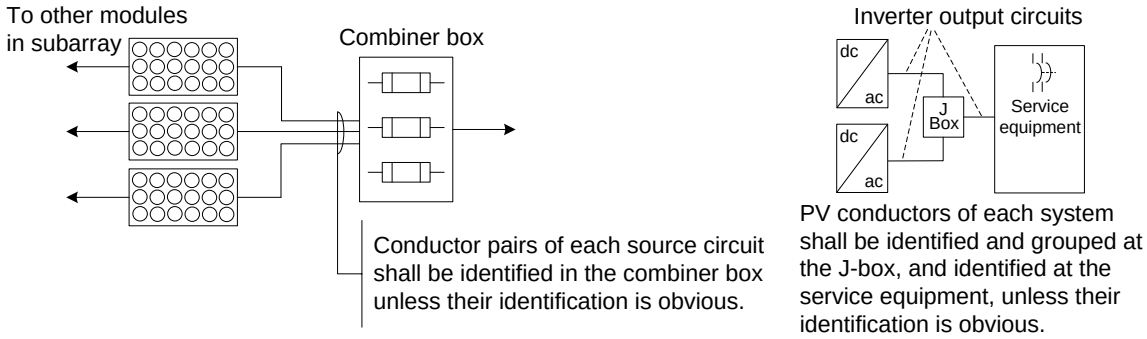
Photovoltaic system conductors are required to be identified at all termination, connection, and splice points. In some cases, grouping of conductors is required.

Analysis

Conductor identification is required at all termination, connection, and splice points. The means of identification shall be by separate color coding, marking tape, tagging, or other approved means. The requirement is for:

- Photovoltaic source circuits
- Photovoltaic output circuits
- Inverter input and output circuits
- PV system circuits, where conductors of more than one PV system occupy the same junction box, raceway, or equipment. If the identification of the conductors is evident by spacing or arrangement, no further identification is required.

Where the conductors of more than one PV system occupy the same junction box or raceway with a removable cover(s), the conductors of each system shall be grouped separately using wire ties or similar means. The interval between ties shall not exceed 6 ft. Grouping is not required if the circuit enters from a cable or raceway unique to the circuit that makes the grouping obvious.



Summary

Photovoltaic system conductors are required to be identified at all termination, connection, and splice points. Conductor grouping is required where the conductors of more than one PV system occupy the same junction box or raceway with a removable cover(s).

Application Question

For a PV installation using two inverters, a separate conduit is run from the inverter to the service equipment panel for each inverter output circuit. Is identification of PV conductors required at the service panel?

Answer No. Further identification is not required, since the conductors of the separate systems are installed in separate raceways, making identification obvious.

Installation – Wiring and Connections

Significance

The requirement that photovoltaic systems, along with associated equipment and wiring, be installed only by "qualified persons" is included in the new Code. Possession of an electrician's license or other certification is not sufficient proof that a person is a qualified person.

Analysis

Code users are familiar with the exceptions to certain rules that are applicable to industrial establishments, when it can be assured that only qualified persons will install and service an electrical installation. The 2011 Code requires that PV systems be installed only by qualified persons. Similar requirements are new for Articles 692 – Fuel Cell Systems, 694 – Small Wind Electric Systems, and 705 – Interconnected Electric Power Production Sources. In jurisdictions where the *NEC* is adopted as an enforcement document, the authority having jurisdiction can now cite the *NEC* if he deems the installation of an applicable alternative energy system is not installed by a qualified person. Obviously, these articles do not represent all of the types of electrical installations that should be installed by qualified persons.

The definition of "qualified person" was revised in the 2002 and 2008 *NEC*. A "qualified person" is, "One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved." The Occupational Safety and Health Administration (OSHA) has a similar definition for qualified person in 29 CFR, Part 1920.399. OSHA has issued two notes to the definition:

Note 1 to the definition of "qualified person:" Whether an employee is considered to be a "qualified person" will depend upon various circumstances in the workplace. For example, it is possible and, in fact, likely for an individual to be considered "qualified" with regard to certain equipment in the workplace, but "unqualified" as to other equipment. (See 1910.332(b)(3) for training requirements that specifically apply to qualified persons.)

Note 2 to the definition of "qualified person:" An employee who is undergoing on-the-job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training and who is under the direct supervision of a qualified person is considered to be a qualified person for the performance of those duties.

It is the responsibility of the employer to provide training in safety-related work practices, but the responsibility of the employee to implement them. Training in safety-related work practices is also required for unqualified persons. All persons involved in the installation, operation, or service of electrical equipment need to be familiar with NFPA 70E, *Standard for Electrical Safety in the Workplace*.

Summary

Electrical systems and equipment for photovoltaics, fuel cells, small wind turbines, and interconnected electric power production sources shall be installed only by qualified persons.

T F Implementation of safety-related work practices is the responsibility of the employer.
Answer: False. *Implementation* of safe work practices is the responsibility of the employee.

Installation – Circuit Routing

Significance

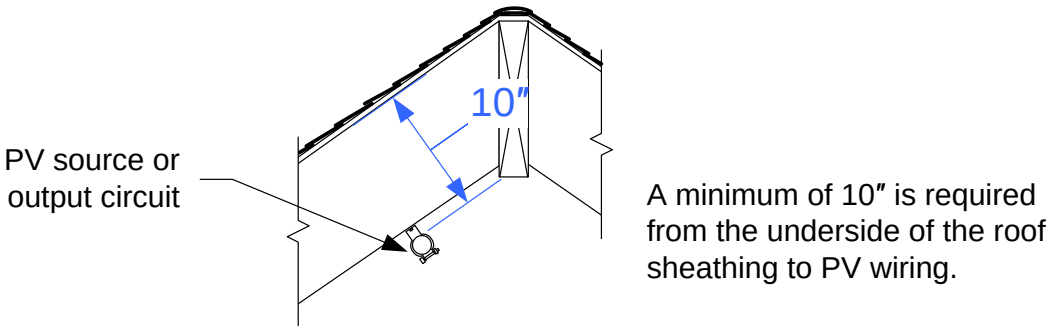
Firefighters have expressed concern about PV circuits embedded in roof materials or installed inside a building directly below the roof. The concern is that firefighters could accidentally make contact with live conductors while in the process of "venting" a fire by making a hole through the roof system.

Analysis

Where structures have roof-mounted PV systems, firefighter safety must be addressed. Live conductors might be present on the roof, within the roofing materials, or directly below the roof. For some PV systems, circuit conductors are embedded in built-up, laminate, or membrane roofing materials. This new Code section requires that where conductors are embedded in roofing materials, in roof areas not covered by PV modules and associated equipment, that the location of the conductors be clearly marked. No specifications for the required marking are given. The rule applies to PV source and output circuits.

When venting a roof, fire service personnel could contact live PV conductors below the roof. A new subsection 690.31(E)(1) addresses the location of PV wiring beneath roofs. Wiring shall not be installed within 10″ of the roof decking or sheathing, except where directly below PV modules and associated equipment on the roof.

New Section 690.4(F) also addresses another aspect of circuit routing. The new rule requires photovoltaic source and output circuit conductors to be routed along building structural members. The general provisions for this familiar wiring practice are located in 300.4(D), Cables and Raceways Parallel to Framing Members and Furring Strips, and in 334.15(A) for NM cable applications. The new requirement applies to both cable and raceway wiring methods for PV source and output circuits installed inside buildings.



Summary

Where PV source and output circuit conductors are embedded in roofing materials, in roof areas not covered by PV modules and associated equipment, the locations of the conductors shall be clearly marked. Wiring beneath the roof shall not be installed within 10″ of the roof decking or sheathing, except where directly below PV modules and associated equipment on the roof. Source and output circuits installed within buildings shall be run along framing members.

Application Question

Is PV wiring permitted to be installed along the side of a 2″ x 8″ roof rafter, if there is no PV equipment on the roof directly above?

Answer

No. There can be no wiring within 10″ of the roof decking, except where a PV circuit penetrates the roof.

Installation – Multiple Inverters

Significance

This change to the 2011 Code permits the installation of multiple utility-interactive inverters on or in a single building or structure. This allows for flexibility in the design, installation, and selection of equipment for a PV system.

Analysis

It may be advantageous to install multiple utility-interactive inverters in the same building. An installer may elect to use two or more smaller inverters in lieu of a single inverter. The Code now clearly permits this practice. The inverters can be located inside or outside of a building. The point of interconnection of the PV electric source with the primary source shall be in accordance with Section 705.12. Where the inverters are not installed in the same location, a plaque or directory shall be posted at each PV system disconnecting means, and at the utility service disconnecting means, showing the locations of all PV system disconnects on the premises. This marking is in accordance with 705.10. A directory is not required where all the inverters and PV system disconnects are grouped at the utility service disconnecting means.

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Utility-interactive inverters

Summary

It is permissible to install multiple utility-interactive inverters on or in a single building or structure. Where the inverters are not installed in the same location, a plaque or directory shall be posted at each PV system disconnecting means, and at the utility service disconnecting means, showing the locations of all PV system disconnects on the premises.

Application Question: T F The marking provisions in 690.4(H) for multiple utility-interactive inverters installed in different locations include current and voltage markings.
Answer: False. The markings required in 690.4(H) (and 705.10) are for the *locations* of the disconnects for all power sources on the premises. A person at any of the PV system disconnecting means, or at the service location, must be able to determine the location of all PV disconnects and the utility service disconnect. Also, see Section 705.12(D)(4). Section 690.56(B) contains similar marking provisions where a premises is served by both a PV system and a utility service. The requirements for PV system voltage and current markings are in 690.54.

Stand-Alone Systems – Back-fed Circuit Breakers

Significance

Some plug-in type back-fed circuit breakers connected to a PV inverter output require additional fastening means to secure the breaker. Not all circuit breakers are suitable for back-feeding.

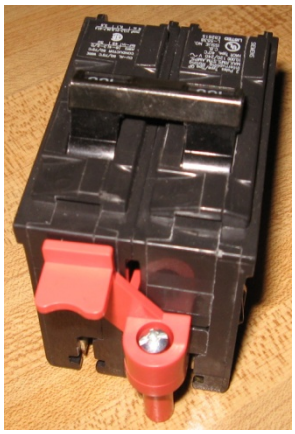
Analysis

The 2008 Code permitted a back-fed circuit breaker, connected to the output of a listed and identified interactive inverter, to be installed without the additional fastening means normally required by Section 408.36(D). This results in a safe installation, since the inverter's output will disconnect when the utility supply is lost, either by a power outage or by the breaker being turned off. This rule has been misapplied, as some installers omitted the additional fastening means on back-fed circuit breakers for stand-alone output circuits of utility-interactive (or multimode) inverters. The wording is revised in the new Code to clarify the intent of the rule. The revised text states that plug-in type back-fed circuit breakers connected to stand-alone outputs of stand-alone inverters or utility-interactive inverters shall have additional fastening means in accordance with Section 408.36(D).

When back-feeding circuit breakers, remember to check if the breaker terminals are marked "line" and "load." When the line and load terminals are marked on a circuit breaker, the device is not suitable for reverse-feed. The absence of the markings means the device is suitable for reverse-feed. Most GFCI, GFPE, and AFCI breakers are not suitable for back-feeding due to the configuration of the connection to the internal sensing circuitry. The line and load terminals of these breakers are clearly marked. Some of the larger molded case circuit breakers and low-voltage power circuit breakers are suitable for reverse-feed applications. Again, the line and load markings will be absent when suitable for reverse-feed.

Summary

Plug-in type back-fed circuit breakers connected to stand-alone outputs of stand-alone inverters or utility-interactive inverters shall have additional fastening means in accordance with Section 408.36(D). Circuit breakers that are marked "line" and "load" shall not be back-fed.



One type of fastening means for plug-in type circuit breakers

Application Question

A utility-interactive inverter connects to the utility grid, and, through stand-alone output terminals, is connected to a branch CB in a dedicated PV panel. Back-fed plug-in type breakers are used for both circuits. Is additional fastening required for the breakers?

Answer

Yes. Fastening is required at the PV panel, but not for the utility-interconnected circuit.

Arc-Fault Circuit Protection (Direct Current)

Significance

Fires have been reported due to the failure of various PV system components. This new Code section will require direct-current AFCI protection for systems with a maximum system voltage of 80 volts or greater. A listed PV type AFCI device was not available as of November 2010. However, Code-Making Panel 4 feels that this fire safety issue needs to be addressed as soon as a listed device becomes available.

Analysis

PV systems are exposed to extreme environmental conditions such as rain, wind, sun, and temperature extremes. Many systems are not regularly inspected and maintained. The intent of the AFCI requirement is to mitigate the effects of a series arc caused by the failure of a connection. Sustained arcing can occur in dc circuits, since, unlike ac, the voltage does not go to zero every 180 electrical degrees. The dc AFCI protection applies to PV systems that have dc source or output circuits on or penetrating a building, and that operate at a maximum system voltage of 80 volts or greater. The provision is performance based and allows for other listed system components to provide equivalent protection, e.g., the inverter. The PV arc-fault protection means must comply with several requirements:

- The system shall detect and interrupt arcing faults resulting from a failure in the intended continuity of a conductor, connection, module, or other system component in the dc source and output circuits.
- The system shall disable or disconnect system components within the arcing circuit, or, shall disable or disconnect inverters or charge controllers connected to the fault circuit.
- The equipment shall remain disabled or disconnected until manually restarted.
- The system shall have an annunciator that provides a visual indication that the circuit interrupter has operated. The indication shall not reset automatically.

The protection may be located at the modules, combiner box, disconnecting means, or inverter. The required protection need only address series arcing. However, it is likely that devices will become available that protect against the effects of both series and parallel arcing.

Summary

PV systems that have dc source or output circuits on or penetrating a building, and that operate at a maximum PV system voltage of 80 volts or greater, shall be protected by a listed dc AFCI, PV type, or other system components listed to provide equivalent protection.

Application Question

T F The *NEC* offers no guidance where unavailability of a product prevents compliance with the Code.

Answer: False. The last paragraph in Section 90.4 states: “This Code may require new products, constructions, or materials that may not yet be available at the time the Code is adopted. In such event, the authority having jurisdiction may permit the use of the products, constructions, or materials that comply with the most recent previous edition of this Code adopted by the jurisdiction.”

Methods Permitted – Direct-Current Photovoltaic Source and Output Circuits Inside a Building

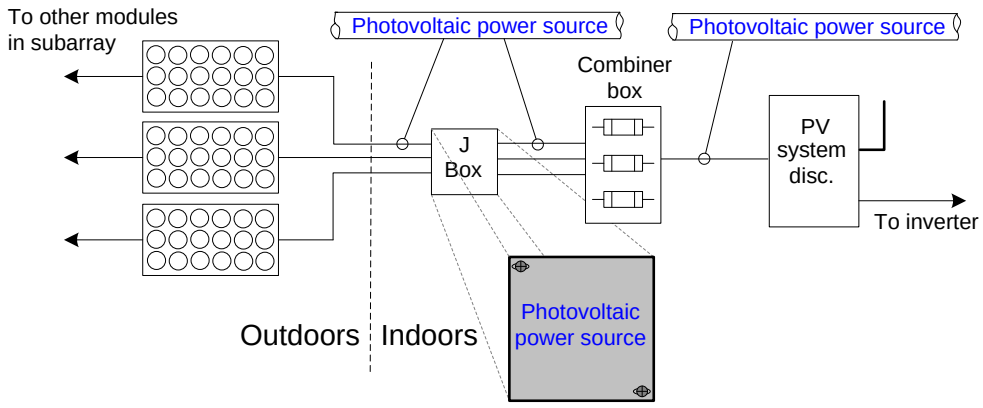
Significance

Even for one- and two-family dwellings, photovoltaic system voltages are permitted up to 600 volts, provided that fixtures, lampholders, and receptacles are not supplied. In contrast, Section 210.6 specifies a limit of 120 volts for dwelling unit luminaires and most cord-and-plug-connected loads. Precaution must be taken to alert persons of the presence of electric circuits of a nature different than common lighting and power circuits.

Analysis

Specific wiring methods are required for the protection of dc photovoltaic source and output circuits inside a building. In addition to metal raceways or metal enclosures permitted by the previous Code, metal-clad cable (Type MC) is now permitted for enclosing PV source and output circuits inside buildings. The metallic wiring method is required from the point of penetration of the building's surface to the first readily accessible disconnecting means. Where MC cable smaller than 1 in. in diameter or flexible metal conduit smaller than trade size ¾ in. containing PV power circuit conductors is run across ceilings or floor joists, the raceway or cable shall be protected by guard strips that are at least as high as the wiring. Where run exposed, these wiring methods shall closely follow the building surface or be protected from physical damage. Note that only MC, and not Type AC cable, has been added to the permitted wiring methods. Type AC cable with aluminum armor is not listed for use on dc circuits.

Another revision to this subsection requires marking for wiring methods and enclosures that contain PV power source conductors. The wiring system shall be marked with the wording "Photovoltaic Power Source." The labels or markings shall appear on every section of the wiring system that is separated by enclosures, walls, ceilings, or floors. Space between markings shall not exceed 10 ft.



The marking shall apply to

- Exposed raceways, cable trays, and other wiring methods
- Covers or enclosures of pull boxes and junction boxes

- Conduit bodies in which any of the available conduit openings are unused

Summary

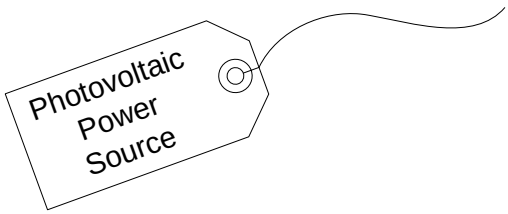
Type MC cable is now permitted for enclosing direct-current PV source and output circuits inside buildings. Smaller sizes of metal-clad cable and flexible metal conduit run across joists shall be protected by guard strips. Exposed runs of MC and FMC shall closely follow the building surface or be protected from physical damage. Wiring methods and enclosures for PV power source conductors inside buildings shall be marked with the wording “Photovoltaic Power Source.”

Application Question

T F Type MC cable used indoors for exposed dc photovoltaic source or output circuits shall be marked or labeled.

Answer

True. Marking or labeling is required by 690.31(E)(3)(1). The marking shall be by means of permanently affixed labels or other approved permanent marking. The labels shall be suitable for the environment where they are installed.



Small Wind Electric Systems – Part I. General

Significance

Article 694 – Small Wind Electric Systems is a new article in the 2011 Code. This article will provide needed guidance for the safe installation of small wind turbines. With the increased use of alternative energy systems, these new *NEC* rules will find wide use.

Analysis

The provisions of this article apply to small wind electric systems that consist of one or more wind generators (turbines) with individual generators rated up to and including 100 kW. The systems may be stand-alone, or interactive with other power production sources or the eletric utility. Small wind electric systems can have a dc or ac output, with or without electrical energy storage. These systems can include generators, alternators, inverters, and conntrollers. When small wind systems operate in parallel with a primary source(s) of electricity, e.g., a utility service, the systems shall also meet the requirements of Article 705 – Interconnected Electric Power Production Sources.

The format of Article 694 is similar to that of Article 690 – Solar Photovoltaic (PV) Systems. Definitions used in Article 694 for *charge controller, diversion charge controller*, and *inverter output circuit* are similar to the definitions in Article 690. Other definitions specific to this article are as follows:

> **Diversion Load.** A load connected to a diversion charge controller or diversion load controller, also known as a dump load.
>
> **Diversion Load Controller.** Equipment that regulates the output of a wind generator by diverting power from the generator to dc or ac loads or to an interconnected utility service.
>
> **Guy.** A cable that mechanically supports a wind turbine tower.
>
> **Maximum Output Power.** The maximum 1 minute average power output a wind turbine produces in normal steady-state operation (instantaneous power output can be higher).
>
> **Maximum Voltage.** The maximum voltage the wind turbine produces in operation including open circuit conditions.
>
> **Nacelle.** An enclosure housing the alternator and other parts of a wind turbine.
>
> **Rated Power.** The wind turbine's output power at a wind speed of 11 m/s (24.6 mph). If a turbine produces more power at lower wind speeds, the rated power is the wind turbine's output power at a wind speed less than 11 m/s that produces the greatest output power.
>
> **Tower.** A pole or other structure that supports a wind turbine.
>
> **Wind Turbine.** A mechanical device that converts wind energy to electrical energy.
>
> **Wind Turbine Output Circuit.** The circuit conductors between the internal components of a small wind turbine (which might include an alternator, integrated rectifier, controller, and/or inverter) and other equipment.
>
> **Wind Turbine System.** A small wind electric generating system.

Important installation requirements include:

- Small wind systems shall be installed only by "qualified persons" (see definition in Article 100).
- A small wind electric system(s) is permitted to supply a building or other structure in addition to any services of another electricity supply system.
- Inverters used in small wind electric systems shall be identified and listed for the application.
- A surge protective device (SPD) shall be installed in accordance with Part II of Article 285 between a small wind electric system and any loads served by the premises electrical system. The SPD is permitted to be a Type 3 SPD on a dedicated branch circuit serving a small wind electric system or a Type 2 SPD located anywhere on the load side of the service disconnect.

Application Question

Article 694 covers wind turbines rated up to and including _____.

A. 10 kW
B. 100 kW
C. 1 MW
D. 10 MW

Answer

B. 100 kW. See 694.1, Scope.

Application Question

T F Unless a wind turbine produces greater output power at lower wind speeds, the turbine's rated power is determined at a wind speed of 11 meters/second (24.6 mph).

Answer

True.

A "small wind" electric system turbine

Small Wind Electric Systems – Part II. Circuit Requirements

Significance

Rules for the maximum operating voltage, conductor sizing, and overcurrent protection for small wind electric systems and circuits are important to ensure safe installations that will protect persons and property from electrical hazards. Conductors of these systems are often run on and inside of buildings. Some wind systems are mounted on buildings.

Analysis

Systems connected to one- and two-family dwellings shall be permitted to have wind turbine output circuits operating up to a maximum 600 volts. For other than one- and two-family dwellings, systems over 600 volts are permitted. Installation over 600 volts are covered in Part IX of this article, and must comply with Part IX and with Article 490 – Equipment Over 600 Volts.

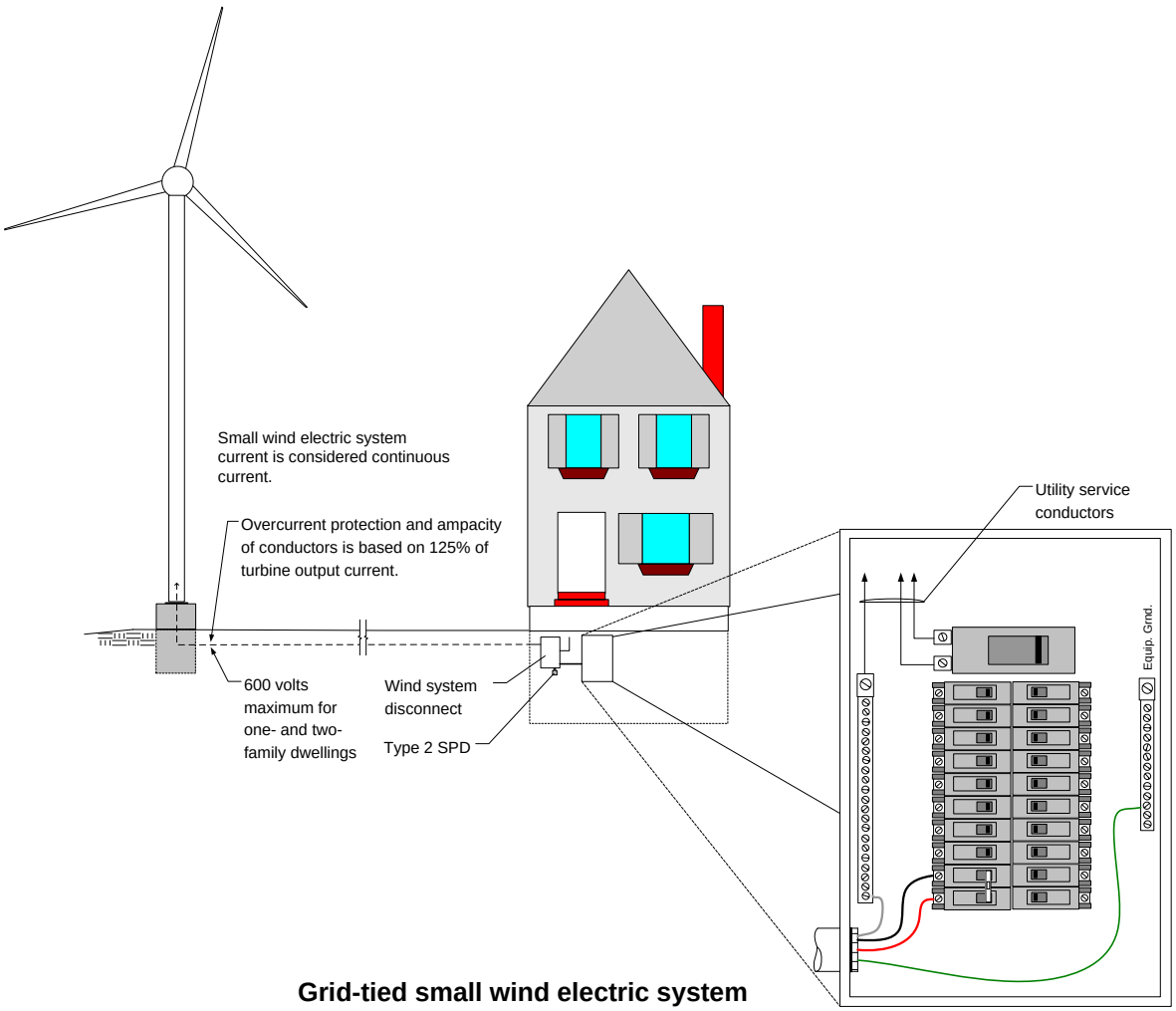
When the inverter is part of the nacelle assembly, the wind system current is the maximum output current of the turbine operating at maximum output power. When the inverter is a separate assembly, there are two currents to consider: the maximum output current of the turbine, and the inverter continuous output current rating. For a stand-alone inverter, the maximum input current is the stand-alone continuous inverter input current rating of the inverter producing rated power at the lowest input voltage. Conductors and overcurent protection for turbine output circuits, inverter output circuits, and stand-alone inverter input circuits shall be sized to carry 125% of the current determined for these circuits. The next higher standard size overcurrent device is permitted in accordance with 240.4(B) and (C) when 125% does not correspond with a standard size.

In addition, turbine output circuits, inverter output circuits, and storage battery conductors and equipment shall be protected in accordance with Article 240 – Overcurrent Protection. Circuits connected to more than one source, e.g., inverters operating in reverse, require overcurrent devices located to provide overcurrent protection from all sources. Turbine output conductors and inverter input and output conductors do not require overcurrent protection if the maximum current from all sources does not exceed the ampacity of the conductors. Fuses or circuit breakers used in any dc circuit of a small wind electric system shall be listed for use in dc circuits and shall be rated for the appropriate voltage, current, and interrupting current.

The premises wiring system supplied by a stand-alone system must meet the provisions of the *NEC* for a similar installation supplied by a utility service. Wiring on the supply side of the building or structure disconnecting means shall comply with the *NEC* except as modified by these provisions:

- A stand-alone system may supply ac current to a building or structure disconnecting means at a current level less than the calculated load connected to the disconnect.

- The inverter output rating or the rating of a wind system source shall not be less than the largest single load connected to the system. Calculated general lighting loads are not considered a single load.
- Circuit conductors between the inverter output and the building disconnecting means shall be sized based on the output rating of the inverter and shall be protected in accordance with Article 240. The overcurrent protection shall be located at the inverter output.
- The inverter output of a stand-alone small wind electric system is 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 no multiwire branch circuits. Equipment shall be marked: WARNING.
  SINGLE 120-VOLT SUPPLY.
  DO NOT CONNECT MULTIWIRE BRANCH CIRCUITS.



Grid-tied small wind electric system

Application Question
For a small wind electric system with separate inverter, the ampacity of the conductors between the wind turbine and the inverter shall be sized based on _____% of the turbine output current at maximum output power.

A. 80
B. 100
C. 125
D. 150

Answer
C. 125. See 694.12(A)(1) and 694.12(B)(2).

Application Question
For a small wind electric system connected to a single-family dwelling, the turbine output circuit is permitted to operate at a maximum voltage of _____ volts.

A. 30
B. 50
C. 250
D. 600

Answer
D. 600. See 694.10(A).

Code Refresher

✓ Wind turbines and systems for "large wind," over 100 kW, are not covered by a separate Code article as are small wind electric systems. However, large wind systems are covered by the *NEC*. Many large wind system installations are not under the exclusive control of an electric utility, and are thus required to meet certain requirements of the *NEC*. Some of the articles that are typically applicable to large wind systems are:

Article 225 – Outside Branch Circuits and Feeders
Article 240 – Overcurrent Protection
Article 250 – Grounding and Bonding
Article 300 – Wiring Methods
Article 310 – Conductors for General Wiring
Article 399 – Outdoor Overhead Conductors over 600 Volts
Article 445 – Generators
Article 490 – Equipment, Over 600 Volts, Nominal
Article 705 – Interconnected Power Production Sources

Small Wind Electric Systems – Part III. Disconnecting Means

Significance

A disconnecting means is required that will disconnect the source circuit conductors of a small wind electric system from all other conductors of a building or structure. Because of the nature of small wind electric systems, there are additional provisions that must be met that are not generally required of disconnecting means.

Analysis

A disconnecting means shall be provided to disconnect all current-carrying conductors of a small wind electric system power source from all other conductors in a building or structure. However, for a wind turbine that uses the turbine output circuit for regulating turbine speed, a disconnecting means is not required in the turbine output circuit. The disconnecting means is not required to be suitable for use as service equipment. It shall be located where readily accessible. Where both the line and load terminals of a disconnect are capable of being energized in the open position, a warning sign shall be mounted on or adjacent to the disconnecting means. The sign shall read the equivalent of:

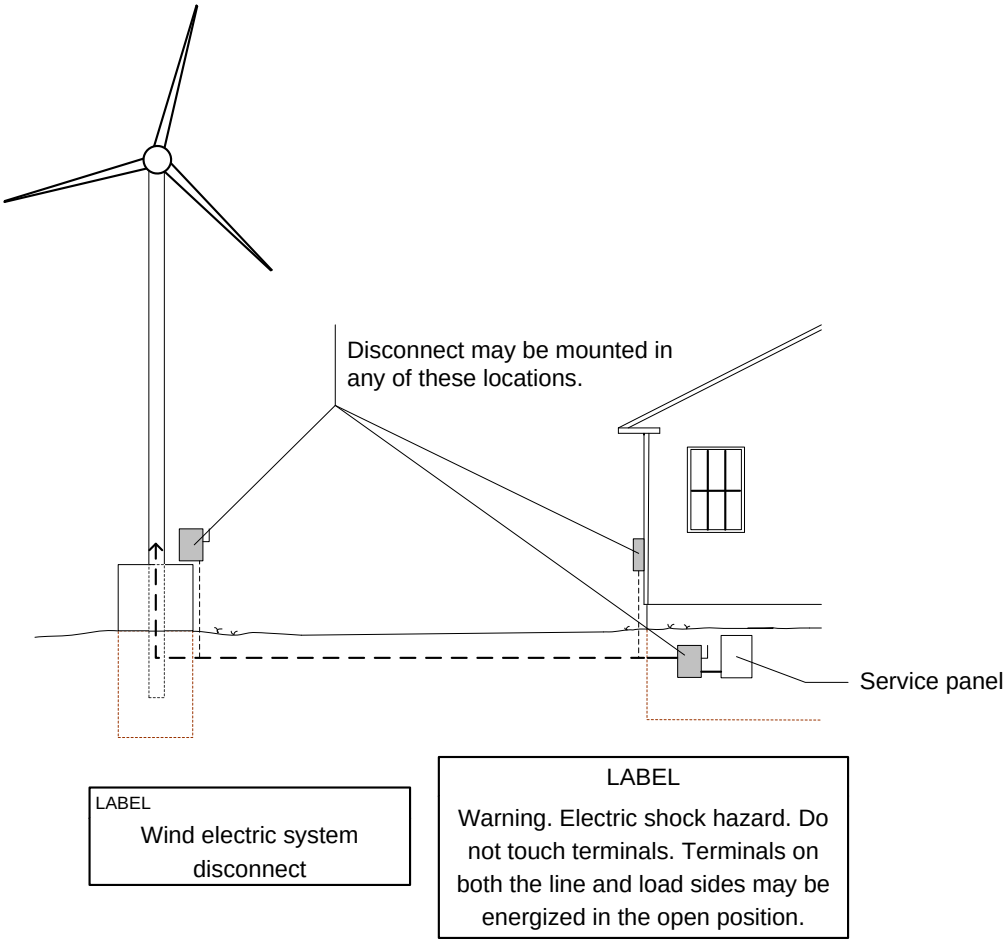
WARNING. ELECTRIC SHOCK HAZARD. DO NOT TOUCH TERMINALS. TERMINALS ON BOTH THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION.

Also, each turbine system disconnecting means shall be permanently marked to identify it as a small wind electric system disconnect. Furthermore, Section 705.10 requires that the service equipment be marked to identify all electric power production sources in or on the premises. Equipment such as rectifiers, controllers, output circuit isolating and shorting switches, and overcurrent devices shall be permitted on the wind turbine side of the disconnect.

Where the inverter is a separate unit from the nacelle, and/or where storage batteries are used, additional *equipment* disconnects are required. Disconnecting means shall be provided to disconnect equipment such as inverters, batteries, and charge controllers from all ungrounded conductors of all sources. A grid-tied inverter that is not part of the nacelle requires a disconnecting means on both sides of the inverter. Battery systems require a disconnecting means if the system voltage exceeds 48 volts, nominal.

Summary

A small wind electric system disconnecting means may be mounted at the tower, on the building, or inside the building at the point of entrance of the wind system conductors.



Electric wind system disconnect location and labeling

Application Question

The disconnecting means for a utility-interactive wind electric system is capable of being energized on both the line and load sides when the disconnect is in the off position. How many field labels are required at the disconnect location?

A. 1
B. 2
C. 3

Answer

B. 2 labels. Both of the labels shown in the diagram above are required. A third label/directory is required at the service location per Section 705.10, denoting the presence of a wind power source on the premises.

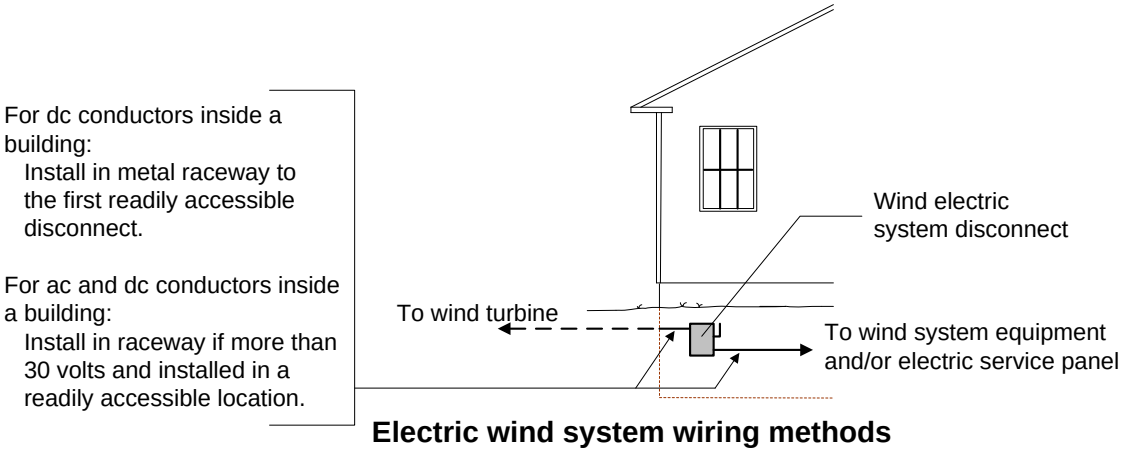
Small Wind Electric Systems – Part IV. Wiring Methods

Significance

All raceway and cable wiring methods included in the *NEC* that are appropriate for small wind electric systems are permitted to be used, but certain specific rules relating to wiring methods must be complied with.

Analysis

In addition to raceway and cable wiring methods included in the Code, other wiring systems and fittings specifically identified for use on wind turbines shall be permitted. Turbine output circuit wiring operating at over 30 volts and installed in a readily accessible location shall be installed in a raceway. Cables installed exposed along the surface of a wall, or installed on building framing or running boards, and within reach of persons is an example of wiring that must be installed in raceways. Direct-current turbine output circuits installed inside of a building shall be enclosed in metal raceways or enclosures from the point of penetration of the building surface to the first readily accessible disconnecting means. This requirement applies to all dc voltages. Flexible cords and cables where used to connect the moving parts of turbines, or used for ready removal for maintenance and repair, shall comply with Article 400, shall be hard service cord or portable power cable, shall be listed for outdoor use, and shall be water resistant.



Electric wind system wiring methods

Summary

Turbine output circuits operating at more than 30 volts and installed in readily accessible locations shall be installed in raceways. Direct-current turbine output circuits of any voltage shall be installed in metal raceways from the point of entrance into the building to the first readily accessible disconnecting means.

Application Question

Turbine output conductors operating at over 30 volts are installed outdoors in a readily accessible location. Are the conductors required to be installed in a raceway?

Answer

Yes. The requirement applies to both indoor and outdoor *wind turbine output circuits*. Also, the rule may apply beyond the first disconnecting means.

Small Wind Electric Systems – Part V. Grounding

Significance

Proper grounding of the wind electric system equipment in or on the tower is necessary to protect the equipment from damage. Grounding of a metal tower is critically important for the safety of anyone who can access the tower.

Analysis

Exposed non–current-carrying metal parts of towers, nacelles, conductor enclosures, and other equipment shall be connected to an equipment grounding conductor, regardless of voltage. The equipment grounding conductor must connect the turbine to the premises grounding system. Guy wires used for tower support are not required to be connected to equipment grounding conductors. Turbine blades and tails that have no source of electrical energization shall not be required to be connected to equipment grounding conductors.

Wind turbine towers shall be connected to one or more auxiliary grounding electrodes to limit voltage imposed by lighting. A tower foundation that includes a concrete-encased electrode meeting the requirements of 250.52(A)(3) is usually an effective electrode. If a ground rod(s) is installed in close proximity to galvanized tower foundation or anchor components in the soil, a galvanized grounding electrode shall be used, rather than a copper electrode. This is to prevent galvanic corrosion caused by dissimilar metals electrically connected above grade, with the soil completing the circuit. This caution should be observed for any grounding system where steel electrodes, such as galvanized underground water piping, could be in close proximity to copper electrodes. A potential of about 0.38 volts will exist underground between these dissimilar metals. The resulting current will be greater in low resistance soils, causing greater corrosion.

New Article 694 also addresses electrodes for the tower's lightning protection system. The *NEC* does not mandate a lightning protection system, nor specify system components. The auxiliary electrode(s) for tower grounding, although installed to limit voltages imposed by lightning, does not constitute a lightning protection system. However, the auxiliary electrodes are permitted to be used as part of the lightning protection system if they meet other applicable requirements (not *NEC* requirements). The Code does require that lightning protection system electrodes, where present, be bonded to the auxiliary grounding electrode system. Rods, concrete-encased electrodes, and ground rings are among the electrode types that could qualify as effective electrodes for a lightning protection system.

Summary

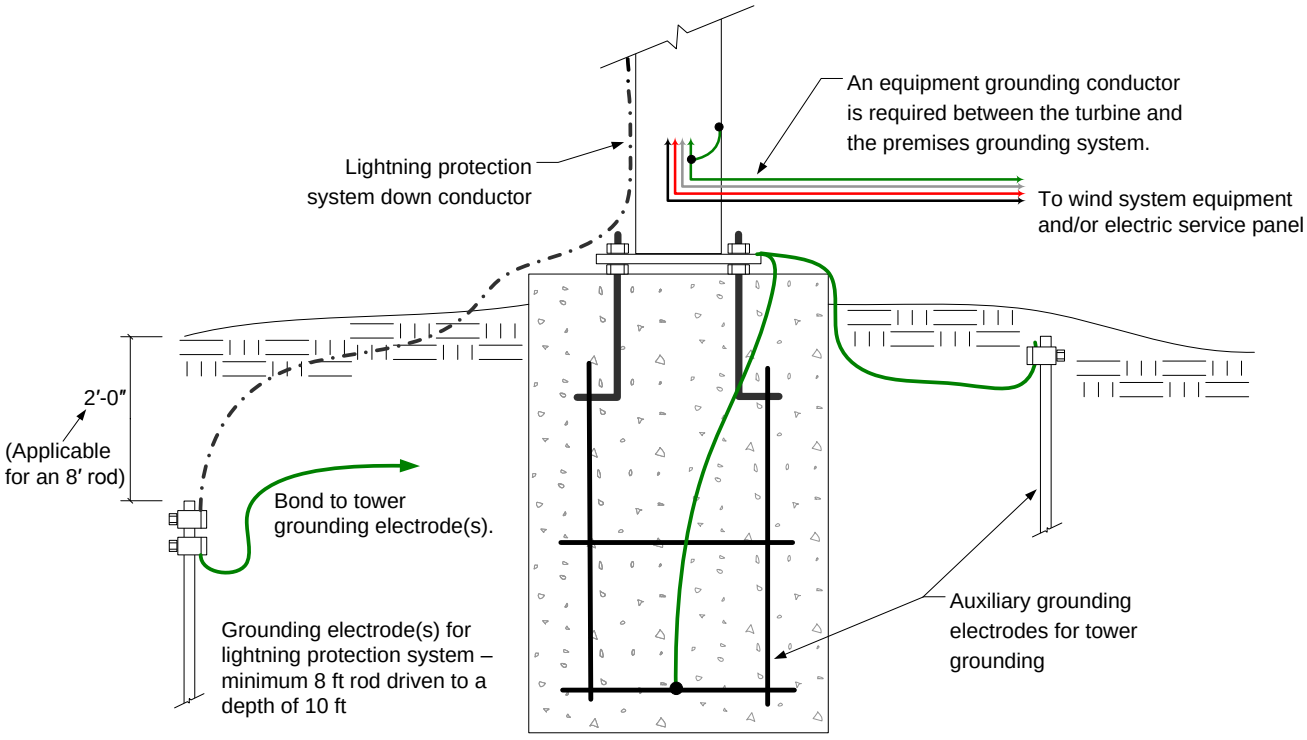
Small wind electric system towers shall be grounded to an auxiliary grounding electrode system. If separate electrodes are used for the tower lightning protection system, the electrodes shall be bonded to the tower auxiliary grounding electrode system. An equipment grounding conductor shall be run between a turbine and the premises grounding system.

Application Question

What are the 3 items/types of grounding that must be considered for a small wind electric system tower?

Answer

Article 694, Part V. Grounding contains rules for: 1) installation of an equipment grounding conductor run from the premises grounding system for the tower and tower equipment, 2) grounding of the tower to an auxiliary grounding electrode system, and 3) bonding lightning protection system electrodes to the auxiliary grounding electrode system.



Grounding at wind electric system tower

More on Lightning Protection Systems

The manufacturer of the tower should include instructions for installing a lightning protection system. A lightning risk assessment should be conducted in order to determine the "Lightning Protection Level" needed to protect the tower equipment. The control system is the most vulnerable of the tower equipment. Protection levels are classified as Level 1 through Level 4, Level 1 providing the highest level of protection. Factors including "Lightning Flash Density" (N_g), "Lightning Strike Frequency" (N_d), and "Tolerable Lightning Frequency" (N_c) are considered in determining the protection level needed. Other considerations like the topography of the site are also considered. A Lightning Flash Density map is provided by the U.S. National Lightning Detection Network ™. NFPA 780, *Standard for the Installation of Lightning Protection Systems*, is available as a standard to provide for the safeguarding of persons and property from hazards arising from exposure to lightning.

Small Wind Electric Systems – Marking, Connection to Other Sources, Storage Batteries, and Systems over 600 Volts

Significance

Parts VI through IX of Article 694, Marking, Connection to Other Systems, Storage Batteries, and Systems over 600 Volts, are very similar to the requirements in Parts VI through IX of Article 690 – Solar Photovoltaic (PV) Systems. However, there are some differences that need to be understood. These rules complete the basic safety requirements for the safe installation of small wind electric systems.

Analysis

Below are some of the key points of Parts VI through IX.

Part VI. Marking

- For an interactive system, all points of interconnection with other sources, along with the wind system's rated ac output current and nominal operating ac voltage, shall be marked at the disconnect for the wind system.
- Small wind systems employing energy storage shall be marked with the maximum operating voltage, any equalization voltage, and the polarity of the grounded circuit conductor. An equalization voltage is a higher than normal charging voltage that serves to equalize the electrolyte, restoring the battery to full capacity.
- For a building or structure not connected to a utility source, but served by a stand-alone wind electric system, a plaque or directory shall be posted on the exterior of the structure in a readily visible location. The plaque shall indicate that the premises is served by a stand-alone electric system and indicate the location of the system disconnect.
- For buildings or structures served by both a utility service and a small wind electric system, there shall be a plaque or directory indicating the location of the service disconnecting means and the small wind electric system disconnecting means.
- A plaque shall be installed at or adjacent to the turbine location providing instructions for disabling the turbine.

Part VII. Connection to Other Sources

- Only inverters listed and identified as interactive are permitted in interactive systems.
- Small wind electric systems, where connected to utility electric sources, shall comply with Article 705 – Interconnected Electric Power Production Sources.
- The point of interconnection of a wind system and a utility service shall be in accordance with the requirements of Section 705.12.

Part VIII. Storage Batteries

- Storage batteries used in small wind electric systems shall comply with the provisions of Article 480 – Storage Batteries.
- For dwellings, storage batteries shall be connected to operate at less than 50 volts nominal. Lead-acid storage batteries shall have no more than twenty-four 2-volt cells

- connected in series (48 volts, nominal). Where live parts are not accessible during routine battery maintenance, higher voltages are permitted that comply with 694.10.
- Live parts of all battery systems shall be guarded to prevent accidental contact by persons or objects. See the definition of "guarded" in Article 100.
- Disconnect for series-connected battery strings – For battery installations of more than twenty-four 2-volt cells connected in series, and where the battery circuits are subject to field servicing, a disconnecting means shall be installed to disconnect series-connected cells into segments of 24 cells or less. The disconnect is for maintenance by qualified persons.
- Maintenance disconnect – For battery installations of more than twenty-four 2-volt cells connected in series, a disconnecting means accessible only to qualified persons shall be installed to disconnect the *grounded* circuit conductors in the battery system for maintenance.

Part IX. Systems over 600 Volts

- Small wind electric systems operating at over 600 volts ac or dc shall comply with Article 490 – Equipment over 600 Volts, and other requirements of the Code that apply to installations over 600 volts.

Summary

Plaques or other effective means of marking shall indicate the presence of a wind system (for stand-alone systems), the points of interconnection and rated wind system output (for interconnected systems), the locations of the wind system disconnect and the utility disconnect, instructions for disabling the turbine, the voltage of any battery system, and the polarity of the grounded circuit conductor of a battery system. Inverters used in interactive systems shall be listed and identified as interactive. Where connected to utility electric sources, small wind electric systems shall comply with Article 705. Generally, the storage battery system voltage for dwellings is limited to 48 volts. Live parts of battery systems shall be guarded. Disconnects for maintenance by qualified persons shall be installed for systems over 48 volts. Small wind electric systems operating at over 600 volts shall comply with Article 490 and other Code requirements pertaining to installations over 600 volts.

Application Question

The instructions for disabling the turbine shall be located at the _____.

A. turbine, or adjacent to the turbine
B. small wind system disconnecting means
C. utility service disconnection means

Answer

A. A plaque shall be installed at or adjacent to the turbine location providing instructions for disabling the turbine (see Section 694.56). This location will probably be at the base of the tower. It may be that the wind system disconnecting means is also located at the tower base.

Power Wiring

Significance

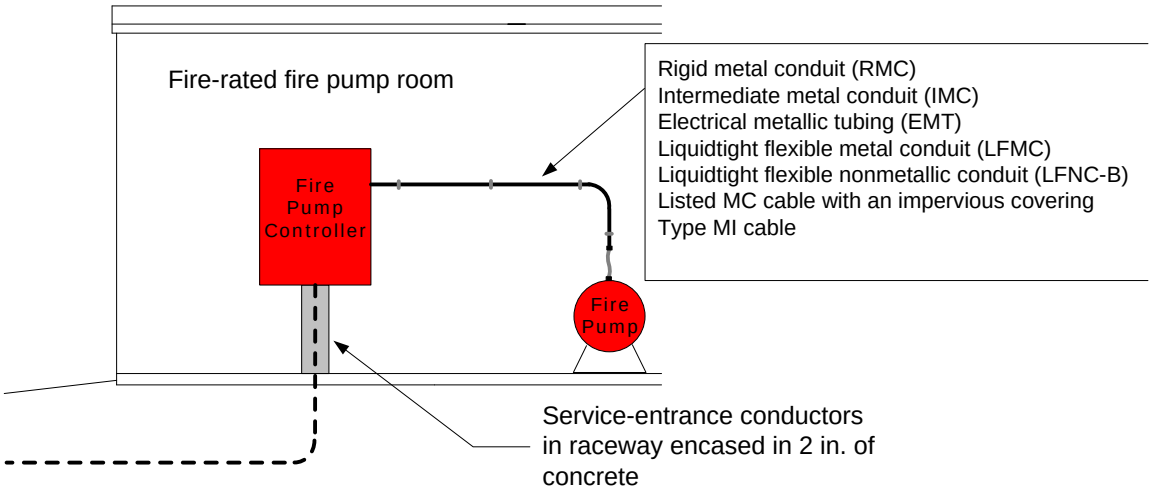
An additional wiring method is permitted in the new Code for the wiring from a fire pump controller to a fire pump.

Analysis

A fire pump installation is designed to remain operational as long as possible during a fire for the purpose of fire fighting. The fire pump room must be separated from all other spaces of the building by 2-hour fire-rated construction, or 1-hour fire-rated construction if the building is fully sprinkled with a NFPA 13 system.

Service conductors and conductors supplied from an on-site power production facility must be routed outside of the building as much as possible. The supply for the fire pump installation in the diagram below is connected from the utility service directly to the fire pump controller, without an intervening disconnect. If a disconnect cannot be avoided, the feeder conductors (on the load side of the supervised disconnect) inside the building must be either 1) encased in a minimum 2 in. of concrete, 2) protected by a fire-rated assembly listed to achieve a fire rating of 2 hours and dedicated to the fire pump circuit(s), or 3) be a listed electrical circuit protective system with a minimum 2-hour fire rating. The fire rating is accomplished using tested systems of fire-rated building materials or other components, fire-rated cables, or combinations of both. Products for use in fire protection of fire pump circuits can be found in UL categories (FHIT), electrical circuit protective systems; (FHIY), electrical circuit protective materials; and (FHJR), fire-resistive cables.

Electrical metallic tubing (EMT) has been added to the list of permitted wiring methods for wiring between a fire pump controller and a fire pump.



Section 695.6 has been revised for clarity and usability. Excerpts from NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, have been added as new subsections (E), Loads Supplied by Controllers and Transfer Switches; (H), Listed Electrical Circuit Protective System to Controller Wiring; (I), Junction Boxes; and (J), Raceway Terminations.

Summary

Electrical metallic tubing (EMT) has been added to the list of permitted wiring methods for wiring between a fire pump controller and a fire pump. Requirements from NFPA 20 have been added to the *NEC*.

Application Question

T F If EMT is used to supply a fire pump from a fire pump controller, the EMT must have protection from fire.

Answer

False. The pump wiring requires only physical protection, since the pump room is protected from fire. However, conductors within the building on the supply side of the controller require both physical protection and fire protection.

Wiring, Emergency System – Fire Protection – Feeder-Circuit Wiring

Significance

The minimum 1-hour fire rating required for emergency feeder circuits in certain occupancies has increased to a minimum 2-hour fire rating.

Analysis

Proper operation of emergency electrical systems is critical in densely populated occupancies and in high-rise occupancies. Fire protection for emergency wiring and electrical equipment is required in assembly occupancies for not less than 1000 persons, or in buildings above 75 ft in height for assembly, educational, residential, detention and correctional, business, and mercantile occupancy classes. Emergency system feeder-circuit wiring shall be fire protected by one of the following methods:

- Be installed in spaces or areas that are fully protected by an approved automatic fire suppression system
- Be a listed electrical circuit protective system with a minimum 2-hour fire rating – UL product category (FHIT), and category (FHJR) for fire resistive cables
- Be protected by a listed thermal barrier system for electrical system components with a minimum 2-hour fire rating – UL product category (XCLF)
- Be protected by a listed fire-rated assembly that has a minimum 2-hour fire rating and contains only emergency circuits – UL product category (BXUV)
- Be encased in a minimum of 2 in. of concrete

Extending the time the emergency circuits will operate allows more time for occupants to exit the building and gives fire fighters additional time to operate fire fighting equipment once people have exited the building.

This Code change also affects subsection (2), Feeder-Circuit Equipment, and subsection (3), Generator Control Wiring. Transfer switches, transformers, panelboards, and other equipment for emergency feeder circuits shall be located in spaces that are protected by approved automatic fire suppression systems or in spaces with a 2-hour fire resistance rating. Generator control conductors between the transfer equipment and the emergency generator shall have a fire resistance rating by employing one of the methods specified for feeder-circuit wiring protection.

Summary

Feeder-circuit wiring for emergency circuits shall be installed in spaces protected by an automatic fire suppression system, be encased in 2 in. of concrete, or be protected by a fire-rated system or assembly that has a minimum 2-hour fire rating.

Application Question

T F Protection from fire exposure is not required for emergency feeder-circuit wiring installed in spaces or areas that are fully protected by an approved automatic fire suppression system.

Answer: True. [700.10(D)(1)(1)]

Point of Connection

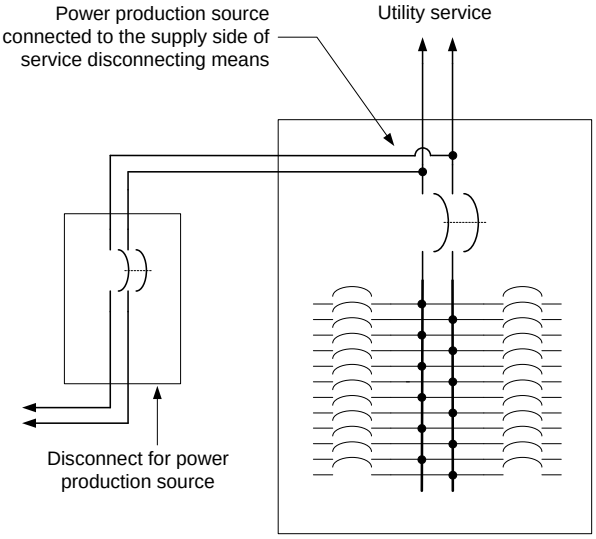
Significance

There have been revisions to the rules for connecting power production sources to the supply side of a service disconnecting means and for connecting utility-interactive inverter outputs to the load side of a service disconnect.

Analysis

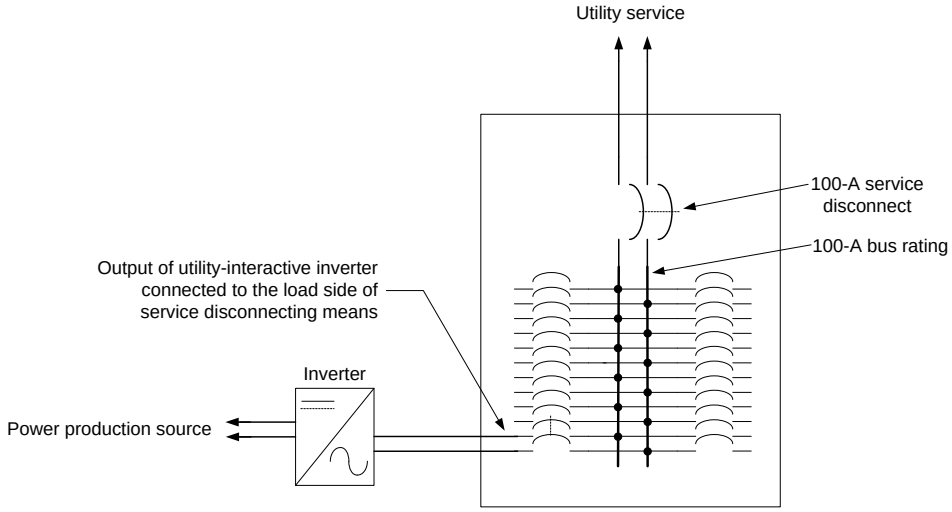
Some electric power production sources are too large to meet the *NEC* provisions in 705.12(D)(2) for connection to the load side of a service disconnect, due to an insufficient busbar rating. These larger systems are connected to the supply side of the service in accordance with 230.82(6). The 2011 Code requires that the sum of the ratings of all overcurrent devices connected to power production sources not exceed the rating of the service.

There are many Code requirements to consider where a source is connected on the line side of the service disconnecting means. The tap rules in 240.21 do not apply in situations where there are two sources of power, except that 240.21(D) is applicable and references 230.91. Section 230.91 requires the service overcurrent device to be integral with, or immediately adjacent to, the service disconnect. The conductors on the utility side of the power production source along with the source's disconnect constitute a service. This service equipment must be capable of withstanding the available fault current as required in 110.9. Service sizing is according to 230.79 and will likely fall under the requirements of subsection (D), 60 amperes, although the AHJ might permit a service as small as 15 amperes. The 60-A ampacity of the service-entrance conductors make the conductors better suited to withstand fault current than smaller conductors. The 60-A overcurrent device must be capable of interrupting the available fault current. The overcurrent device should have an interrupting rating at least as high as the utility service overcurrent protective device. Fuses may more easily accommodate this protection than circuit breakers. Depending on the size of the equipment connected, it may be necessary to install smaller overcurrent devices in the 60-A rated disconnect enclosure.



Another Code change in this section addresses the connection of a PV system inverter on the load side of a service disconnecting means. Generally, the sum of the ampere ratings of overcurrent devices in circuits supplying power to a busbar or wire shall not exceed 120% of the rating of the busbar or wire. A new exception for PV systems that have energy storage for stand-alone operation permits the value used in the busbar or conductor calculation to be 125% of the rated utility-interactive current from the inverter.

For the load-side connection shown below, the largest overcurrent device permitted in the panelboard for connection to the inverter output is 20 amperes (100 + 20 = not more than 120% of the bus rating). If the power production source in the diagram below is a PV system with energy storage for stand-alone operation, the inverter output rating cannot exceed 16 amperes ((16 x 125%) + 100 = not more than 120% of the bus rating).



Summary

The sum of the ratings of all overcurrent devices connected to power production sources shall not exceed the rating of the service. A new exception for PV systems that have energy storage for stand-alone operation permits the value used in the busbar or conductor calculation in 705.12(D)(2) to be 125% of the rated current from the inverter.

Application Question

A utility-interactive inverter is connected to the load side of a 200-A service disconnecting means. The service panelboard has a 200-A rated bus. For compliance with 705.12(D), the maximum permitted rated output current of the inverter is _____ amperes.

A. 20
B. 24
C. 32
D. 40

Answer

C. 32 amperes [(32 x 125%) + 200 = not more than 240 A (200 x 120%)]

Non–Power-Limited Fire Alarm (NPLFA) Circuit Power Source Requirements

Significance

New revisions to the power source requirements for fire alarm circuits correlate with the requirements of NFPA 72, *National Fire Alarm and Signaling Code*.

Analysis

The changes address provisions for locking, marking, and for a dedicated branch circuit in order to correlate with NFPA 72 and provide consistency in enforcement. A new rule permits the fire alarm circuit disconnect to be secured in the "on" position. This provides correlation with NFPA 72, which requires the disconnecting means to be accessible only to authorized personnel.

The requirement that a fire alarm system be connected to an individual branch circuit has been revised. Instead, the requirement is that the branch circuit supplying fire alarm equipment shall supply no other loads. This change is to clarify that a branch circuit for fire alarm equipment may supply more than one fire alarm control unit, power supply, and associated equipment. An "individual branch circuit" is defined in the *NEC* as a branch circuit that supplies only one utilization equipment. Thus, the intent of the rule could easily be misinterpreted using the existing Code language.

The location of the branch-circuit overcurrent protective device shall be identified at the fire alarm control unit(s). The circuit disconnecting means shall have red identification and shall be marked "FIRE ALARM CIRCUIT." Further, the circuit disconnecting means shall be accessible only to qualified personnel.

These revisions have also been applied to power-limited fire alarm (PLFA) circuits in 760.121(B).

Summary

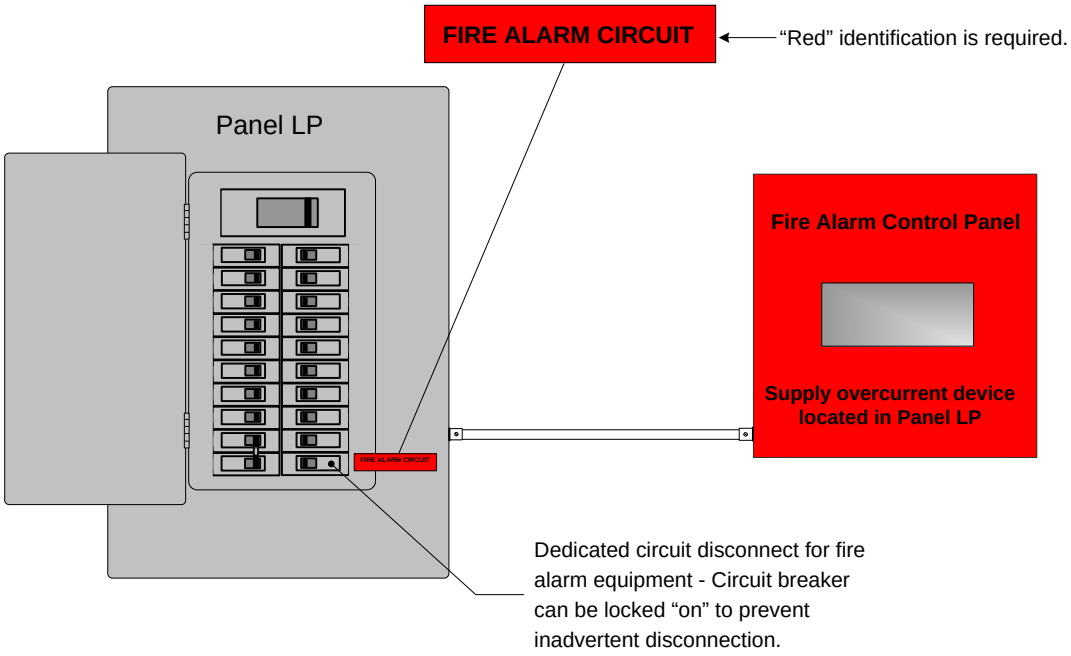
The location of the branch-circuit overcurrent protective device supplying fire alarm equipment shall be identified at the fire alarm control unit(s). The circuit disconnecting means shall have red identification and be marked "FIRE ALARM CIRCUIT." The disconnecting means shall be accessible only to qualified personnel and is permitted to be secured in the "on" position.

Application Question

T F The circuit disconnecting means is the same as the branch-circuit overcurrent protective device.

Answer

False. The branch-circuit overcurrent protective device will be located in a panelboard or loadcenter. The disconnecting means could be in a separate enclosure or the overcurrent device in the panel could also serve as the disconnecting means, where permitted.



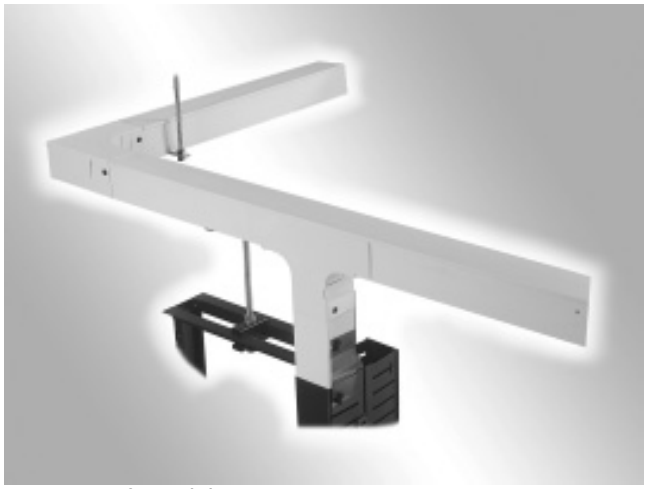
Installation of Optical Fiber Cables and Raceways, and Cable Routing Assemblies

Significance

Rules for the installation and application of cable routing assemblies have been included in Article 770.

Analysis

Section 770.2 contains a definition for "cable routing assembly": "A single channel or connected multiple channels, as well as associated fittings, forming a structural system that is used to support, route, and protect high densities of wires and cables, typically communications wires and cables, optical fiber and data (Class 2 and Class 3) cables associated with information technology and communications equipment." This *channel* is not a form of cable tray. Neither is a cable routing assembly a raceway, since a cover is not a necessary component of this assembly.



Courtesy of Panduit

Cable Routing Assemblies

A new standard, UL 2024A, *Cable Routing Assemblies*, provides a safety standard for this new generation of cable routing systems. The assemblies are designed for use with conductive or nonconductive optical fiber, communications cable, community antenna television cable, and low-power network-powered broadband communications cable.

Installation rules in 770.113 and application rules in 770.154 have been revised to include cable routing assemblies. New subsections 800.3(G) and 820.3(H) make the definition in 770.2, the applications in 770.154, and the installation rules in 770.113 applicable to Articles 800 and 820.

Article 770 has been reorganized to improve usability. Installation rules have been grouped in 770.113. New Table 770.154(a) summarizes the applications for listed optical fiber cables and raceways, and cable routing assemblies in buildings. Articles 800 and 820 have undergone similar reorganization and contain new applications tables.

Summary

Installation rules in 770.113 and application rules in 770.154 have been revised to include cable routing assemblies. The definition in 770.2, the installation rules in 770.113, and the applications in 770.154 apply also to Articles 800 and 820.

Application Question

T F A cable routing assembly is a type of nonmetallic raceway.

Answer

False. A cable routing assembly is not considered a raceway, since these assemblies are available with or without covers. Without a cover, the assembly does not fully enclose conductors. Cable trays are also not considered raceways. They are support systems for wiring methods.

Premises-Powered Broadband Communications Systems

Significance

This is a new article for the 2011 *NEC* that addresses a new technology.

Analysis

Existing Article 830 contains requirements for *network-powered* broadband communications systems. New Article 840 has been added to the *NEC* to address the increased demand for *premises-powered* optical fiber-based broadband communications systems. The power for these systems is provided locally rather than being supplied with the network service. The service is provided by an optical cable termed Fiber-to-the-Premises (FTTP) terminated in an Optical Network Terminal (ONT). The service provider's interface equipment, the ONT, converts an optical signal into component signals including voice, audio, video, data, wireless, and interactive service. The output circuits derived from the ONT shall comply with the requirements of the following:

- Installations of premises communications circuits – Article 800
- Installations of premises community antenna television and radio distribution circuits – Article 820
- Installations of optical fiber cables – Article 770
- Installations of Class 2 and Class 3 circuits – Article 725
- Installations of power-limited fire alarm circuits – Article 760

Article 840 is arranged similarly to Article 830. Both articles contain six Parts: General, Cables Outside and Entering Buildings, Protection, Grounding Methods, Installation Methods Within Buildings, and Listing Requirements.

Summary

New Article 840 addresses premises-powered broadband communications systems supplied through an optical cable. System power is provided by local ac power (at the premises) rather than through the network.

Application Question

T F Installation of premises-powered broadband communications systems are subject to the requirements in Chapters 1 through 7 of the *NEC*.

Answer: False. Chapter 8 stands alone. Chapter 8 is not subject to the requirements of Chapters 1 through 7 except where the requirements are specifically referenced in Chapter 8. [90.3, Code Arrangement]