Electrical Tech Note — 111
Biosystems & Agricultural Engineering Department
Michigan State University

Electrical Code Changes in Michigan[1]

(Based on Part 8, P.A. 230, the 2005 *NEC*® and the 2003 *MRC*)

This discussion of electrical code changes is based upon the *Part 8* Rules of Michigan *Public Act 230* that went into effect November 23, 2007 which adopts the 2005 *National Electrical Code* with some modifications. A discussion of the modifications is covered in Tech Note 107. The Michigan Electrical Code (MEC) applies to electrical installations in facilities other than one- and two-family dwellings. For one- and two-family dwellings the *Michigan Residential Code* (MRC) applies which at the time this document was prepared was based upon the 2003 edition of the *International Residential Code* (2003 *IRC*). The 2003 *IRC* is based upon the 2002 *NEC* and, therefore, differences exist between the present *Michigan Residential Code* and the Michigan Electrical Code. One major difference is the installation of arc-fault circuit-interrupters in one- and two-family dwellings and where ground-fault circuit-interrupter protected receptacles are required.

This Tech Note covers the majority of the electrical code changes that will result in the way wiring is to be installed in Michigan. This document is not intended as an official interpretation of the particular section discussed. Before making a decision with respect to any installation of electrical wiring or equipment the reader is instructed to study the specific reference in the *2005 National Electrical Code*®.

Here are some overall changes that occurred in the 2005 *NEC*. The rules for temporary installations were once again moved, this time to *Article 590*. In the previous edition of the Code it was *Article 527*, and before that it was *Article 305*. There was some reorganization and a nearly complete renumbering of *Articles 800, 810, 820,*. and *830*. There are three new articles that are particularly important, *Article 409* on industrial control panels, *Article 506* on Zone 20, 21, and 22 hazardous locations with dust and flyings, and *Article 682* dealing with electrical installations in natural and artificially made bodies of water. The common bonding grid for a permanent swimming pool is now called an equipotential bonding grid, and installation directions are much more specific. The walkway around the pool is now required to contain metal to reduce chances of step voltages. Even though the 2008 *NEC* is not in effect in Michigan, the rules on swimming pool bonding are easier to understand in that edition. *Article 220* was completely reorganized and renumbered, although the actual changes are minimal. Other significant changes are:

- grounding electrodes for services
- GFCI requirements
- new terminology used with AFCIs
- wiring on roofs exposed to the sun (see also *310.15(B)(2)(a)* in the 2008 *NEC*)
- new industrial control panel article (see *Art. 409*)
- new zone system for combustible dust and flyings (see *Art. 506*)
- swimming pool equipotential grid (see *680.26* in the 2008 *NEC*)
- new article on wiring at natural and artificial bodies of water (see *Art. 682*)

In *Article 100* there is a new definition of a **system bonding jumper** which is intended to apply to a separately derived system. A system bonding jumper is a connection between a grounded circuit conductor and the equipment grounding conductor of a separately derived system. At a service this is called the main bonding jumper. The system bonding jumper is permitted to be installed at the source of the separately derived system or at the first disconnecting means supplied by the system.

Also in *Article 100* a fine print note was added to the definition of **qualified person** that makes reference to NFPA 70E-2004 for electrical safety training requirements.

110.15: This section requires the phase conductor with the higher voltage to ground for a 4-wire delta,

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240/120 volt 3-phase system to be marked orange or identified by some other effective means at every point where connections are made and the grounded circuit conductor is present. The change is that only the phase with the higher voltage to ground is permitted to be labeled orange. Other conductors, if identified with a color must be identified with a color other than orange. This rule does not prohibit an orange marking on any ungrounded conductor of a different electrical system.

110.26(C)(2): Electrical equipment containing overcurrent, switching, or control devices and rated 1200 amperes or more and with a width of more than 6 ft, an exit is required at each end of the working space unless equipment is arranged so that the exit route is unobstructed from all parts of the room. These exit doors are also required to open out with pressure release door latches or panic bars. The change in this section is that the width requirement was deleted. It makes no difference how wide the equipment, if it is rated 1200 amperes or more, an exit at each end of the room is required.

Part V of *Article 110*: The entire *Part IV* of *Article 314* was moved to *Article 110*. This material provides requirements for manholes and other electric enclosures intended for personnel entry. There were essentially no changes made to *Part V*.

200.6(B): A grounded conductor with other than white or green insulation and larger than size 6 AWG is now permitted to be re-identified using gray tape as well as white tape that completely “encircles” the conductor. In the past, only white tape was permitted to re-identify a grounded conductor that did not have white or gray insulation.

200.6(D): If a premises is supplied by more than one wiring system, each with a grounded conductor, the grounded conductors of each system are required to be identified in such a manner they can be easily recognized when run in the same raceway, cable, box or other enclosure. One method was to have a colored strip on a white insulated wire. Now it is permitted to have a colored stripe on a gray insulated wire. The other change is that the means of identifying the grounded conductors is required to be permanently posted at each branch circuit panelboard. An example may be where a 208/120 volt 4-wire wye system supplies receptacles and lighting, and a 480/277 volt 4-wire system supplies electric discharge lighting. The neutral conductors if run in the same raceway or enclosure are required to be uniquely distinguishable from each other and the means of identification is now required to be posted at each panelboard.

200.7(C)(1): When cable is installed as a switch loop for lighting, the white or gray wire is required to be re-identified to indicate it is no longer a grounded conductor. The change is that this re-identification is required to be a color other than white, gray, or green, and that the identification shall “encircle” the conductor. In the past the identification was not required to completely encircle the conductor.

210.4(B): This section deals with rules relative to wiring a multi-wire branch circuit. This paragraph in the previous edition of the Code applied only to multi-wire branch circuits in dwellings. If the multi-wire branch circuit supplied more than one device or equipment on the same yoke, such as two receptacles, it was required to be able to disconnect power to all conductors simultaneously. A typical means of power disconnection to a multi-wire branch circuit was a 2-pole circuit breaker or two single-pole circuit breakers with handle ties. The change is that this section no longer applies just to dwellings. This rule applies to all multi-wire branch circuits in any building.

210.6(D)(2): This section specifies which utilization equipment is permitted to be supplied power at higher than nominal 277 volts to ground but not more than 600 volts line-to-line. Since luminaires were not specifically excluded from this section it was interpreted in some areas that HID luminaires were considered utilization equipment and were permitted to be installed inside and supplied from 480 volt delta systems. This was apparently not the intent and now it is specifically stated that luminaires are not included in this rule that permits utilization equipment to be supplied by circuits operating at more than 277 volts to ground but not more than 600 volts line-to-line.

210.7(B): The previous edition of the Code required that when more than one receptacle on the same strap or yoke are supplied from different branch circuits, the overcurrent device supplying the circuits was required to be of a type where all ungrounded conductors would be de-energized simultaneously. This required a multi-pole circuit breaker or single-pole circuit breakers with listed handle ties. The word receptacles was changed to devices. It is no longer required that there be only receptacles on the strap or yoke. Now this rule applies to devices such as a switch and receptacle on a single strap, or perhaps two switches on the same strap.

210.8(A)(7): All 125 volt, single-phase 15- and 20 ampere receptacles installed within 6 ft of the outside edge of a dwelling laundry, utility, or wet bar sink are required to be ground-fault circuit-interrupter protected. The change is that this rule now applies to laundry and utility sinks in a dwelling.

210.8(B)(2): The previous edition of the Code required ground-fault circuit-interrupter protection for 125 volt, single-phase, 15- and 20-ampere receptacles installed in non-dwelling kitchens. A definition of a kitchen was not provided which created differences of interpretation as to where this rule would apply. Now it is

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specified that the rule applies to commercial and institutional kitchens. There is now also a definition of a kitchen that is an area with a sink, and permanent facilities for food preparation and cooking. A counter space in a room with a sink, coffee maker, refrigerator, and space for a microwave oven would not qualify as a kitchen since permanent space for cooking is not provided. In the definition of a dwelling, space for a portable microwave oven is not considered permanent provisions for cooking.

210.8(B)(4): All 125 volt, single-phase, 15- or 20-ampere receptacles located outdoors in spaces "accessible to the public" for non-dwelling locations are required to be ground-fault circuit-interrupter protected.

210.8(B)(5): A 125 volt, single-phase, 15- or 20-ampere receptacle installed outdoors as the required receptacle within 25 ft of heating, air-conditioning, and refrigeration equipment is now required to be ground-fault circuit-interrupter protected. This rule now applies to all buildings where according to the previous edition of the Code GFCI protection was only required for outside rooftop receptacles installed to service this equipment.

210.8(C): A 125 volt, single-phase, 15- or 20-ampere outlet for the supply of a boat hoist at a dwelling location shall be provided with ground-fault circuit-interrupter protection.

210.12(B): Arc-fault circuit-interrupter protection in the case of a one- or two-family dwelling in Michigan remains the same as in the past since these installations are covered under the Michigan Residential Code. All bedroom outlets supplied from 120-volt, 15- or 20-ampere circuits are required to be protected by an arc-fault circuit-interrupter at the source of the circuit. There are two types of AFCIs available, but the 2003 *MRC* does not specify which type is required. If the 2006 *MRC* is adopted, the combination type AFCI will be required to be installed in one- and two-family dwellings. In the case of multi-family dwellings, the rule in the 2005 *NEC* will apply and a combination type AFCI is now required to be installed.

210.12(B) Exception: This new exception permits a receptacle-type (combination-type) AFCI device to be installed adjacent to the circuit panelboard. The receptacle-type AFCI provides arc-fault protection for lamps, equipment, and appliances plugged into the receptacle. The receptacle-type AFCI has feed-through capability so the remainder of the circuit will also be arc-fault protected. This type of AFCI is designed to be more sensitive to arc-faults, which could result in nuisance tripping. The exception required the length of circuit wire from the circuit breaker in the panelboard to the AFCI device to be not more than 6 ft in length. The circuit between the panelboard and the AFCI device is also required to be run in metal raceway or metallic sheathed cable.

210.18: This is a new section that requires guest rooms and guest suites with permanent provisions for cooking to meet the same receptacle requirements as a dwelling, but also must meet the branch circuit requirements of a dwelling. Two 20-ampere, 125 volt small appliance branch circuits are required to be provided that serve the counter space. The bathroom receptacles are required to be on a 20-ampere, 125 volt circuit that includes no other outlets, unless there is only one bathroom in which case all outlets in the bathroom are permitted to be on the 20-ampere circuit. Receptacle spacing shall be as required in *210.52*.

210.52(C)(1) Exception: This new exception now requires the wall space behind a sink or a counter-mounted cooking unit to be considered in receptacle spacing requirements if the back edge of the sink or cooking unit is 12 in. or more out from the wall. There is a similar requirement if the sink or cooking unit is installed in a corner of the kitchen counter. If the back edge of the sink or cooking unit is mounted so the distance to the corner is 18 in. or greater, then the wall space behind the sink or cooking unit is to be considered in the receptacle spacing requirements of *210.52(C)(1)*. If the space behind a sink or cooking unit are limited, then according to *210.52(C)(4)* the wall spaces are not considered as usable wall space.

210.52(C)(2): A new sentence was added to make it clear that when a counter-mounted cooking unit or a sink is located in an island kitchen counter, the ends of the counter are considered separated if the cooking unit or sink is mounted such that less than 12 in. of counter remains at the location of the sink or cooking unit. This would mean that a receptacle must be installed to serve the counter space at each end of the island if those counter spaces are at least 12 in. in both dimensions.

210.52(D) Exception: This is a new exception to the required placement of a receptacle on the wall or partition adjacent to and within 3 ft of the bathroom sink. The exception permits the receptacle to be installed on the face or side of the bathroom counter top and located not more than 12 in. below the top of the counter space and within 3 ft of the edge of the sink.

210.52(E): A new second sentence was added that now requires a receptacle to be installed accessible at grade level for each dwelling unit of a multi-family dwelling that is at grade level and has an individual entrance from the dwelling unit to the outside.

210.60: This section specifies receptacle placement in guest rooms and guest suites of hotels, motels, and similar occupancies. The previous edition of the Code required receptacle placement to be the same as

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for a dwelling if the guest room or guest suite met the definition of a dwelling mainly that permanent provisions were made for cooking. The definition of a dwelling also includes permanent provisions for eating which may not be the case with a guest room or guest suite. A specific dining area may not be provided. Now the requirement is simply that the guest room or guest suite is required to meet all of the appropriate receptacle requirements of *210.52* if there are permanent provisions for cooking.

210.70(B): In guest rooms and guest suites of hotels and motels, every habitable room and bathroom is now required to have a wall switch controlled lighting outlet. The term lighting outlet is interpreted as meaning a luminaire of some type permanently installed.

215.2(A)(1): A new sentence was added to the last paragraph in this section dealing with the minimum permitted size of grounded feeder conductor (neutral). Feeder conductor size, including the grounded conductor, is required to be not less than the load to be served as calculated according to the rules in *Article 220*. There are cases where the unbalanced load as calculated according to *220.61* only requires a small size grounded conductor (usually the neutral) compared to the size of the ungrounded conductors. There has never been a minimum size grounded conductor requirement for feeders. Now the grounded circuit conductor minimum size is to be not smaller than the size of equipment grounding conductor required for the feeder as determined by *Table 250.122*.

Example: A 200 ampere feeder has a calculated unbalanced load of only 30 amperes. Determine the minimum size copper grounded circuit conductor permitted for the feeder.

Solution: Based upon the calculated unbalance load of 30 amperes, *Table 310.16* would only require a size 10 AWG grounded conductor. Based upon *Table 250.122*, the actual minimum size copper grounded conductor is 6 AWG.

215.2(A)(2): This subsection from the previous edition of the Code was deleted and the remainder of the section was renumbered. The portion of the section that was deleted required a minimum feeder conductor rating of 30 amperes when the feeder supplied multiple branch circuits.

215.12(C): This is a new section that specifies the method of identifying the grounded conductor, equipment grounding conductors, and ungrounded conductors of different electrical systems that serve the same building or structure. The change is that the color coding method or other identification method to distinguish between the different electrical systems is now required to be permanently posted at each feeder panelboard or other distribution equipment such as a disconnect switch.

Article 220 was completely reorganized. A new *Figure 220.1* was added to give an overview of where information on branch circuit calculations, and feeder calculations can be found. Nearly all of the sections have different numbers than in the previous edition of the Code. The general method used to calculate the load on a feeder or service conductors was *Part II* in the previous edition of the Code and is now *Part III*.

220.14(K): This was *footnote b* to what was *Table 220.3(A)* and is now *Table 220.12* which gives the minimum general illumination load to be used for calculations for some occupancies. *Footnote b* stated that a minimum of 1 VA per sq. ft was required to be included in office buildings for the receptacle load. This section makes it clear that the minimum load that is required to be used for receptacles in an office building and now banks is 180 VA for each general use receptacle to be installed or 1 VA per sq. ft which ever is greater. This is not a change of intent, but now it is made clear in this section that the higher value is to be used for calculations.

220.61: This was *220.22* in the previous edition of the Code and explained how to calculate the minimum required load on a neutral conductor. There are no changes in the section, but it now consists of three main subsections which make the rule easier to follow.

Table 220.102: This was *Table 220.40* in the previous edition of the Code and the section deals with the method of calculating the load for a farm building. In *Table 220.40* of the previous edition of the Code the term load "without diversity" was used in the table to indicate those loads in a farm building that normally operate at the same time when the building is in use. Now *Table 220.102* uses the expression "loads expected to operate simultaneously." Other than a change in terminology to help improve understanding, there is no change in the method used to calculate the load for a farm building.

230.44: Cable trays are permitted to support service entrance conductors, and now there is a rule that only permits the cable tray to contain service conductors. There is an exception that permits other than service conductors to be installed in the cable tray provided there is a solid fixed barrier of material compatible with the cable tray material between the service conductors and other conductors in the same cable tray.

230.71(A): A service is permitted to consist of up to six separate disconnecting means either located in the same enclosure or located in a group. A disconnecting means for a transient voltage surge suppressor (TVSS) is now permitted to be installed in addition to the six service disconnects. There is now a new

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term to replace TVSS and that is surge protective device (SPD) which is covered in *Article 285*. There are several types of SPDs which are explained in the 2008 *NEC*.

230.82(3): A meter disconnect switch is permitted to be installed on the supply side of the service disconnecting means for a service operating at not more than 600 volts. Now there is an additional requirement that the meter disconnect switch have a short-circuit rating not less than the short-circuit current available at the service.

230.82(8): A transient voltage surge suppressor (TVSS) is now permitted to be tapped ahead of the service disconnecting means provided it is installed on the load side of separate service equipment. What this means is that a TVSS is permitted to be tapped to the service conductors, but it is required to have a disconnecting means, overcurrent protection, a main bonding jumper, and a grounding electrode conductor. The disconnecting means is also required to be suitable for use as service equipment.

240.20(B): This section was revised to make it clear that a circuit breaker is required to open all ungrounded conductors of a circuit both manually and automatically. For example it is not permitted to use two single-pole circuit breakers with a handle tie for a 240 volt circuit. The change is the addition of the word "automatically". This means multi-pole circuit breakers are required to be common-trip. Common-trip means when one pole opens, the other poles will also open. This section lists three cases where individual circuit breakers with or without handle ties are permitted to be used where all ungrounded poles of the circuit are not required to open simultaneously. An example is a multi-wire branch circuit with two or three ungrounded conductors and a neutral. The handle ties will act as a disconnecting means to open all ungrounded poles simultaneously, but will not necessarily insure that automatic trip caused by an overcurrent condition will open all ungrounded poles. Another change in this section is that identified handle ties are required not simply approved. The handle tie must be manufactured for the purpose and identified as acting as a handle tie for the circuit breaker.

240.21(C)(2)(1)c.: This is a new requirement for transformers that sets a minimum size for secondary tap conductors that are not more than 10 ft in length. The secondary tap conductors are not permitted to have an ampacity less than 10% of the transformer primary overcurrent device rating times the primary voltage over the secondary voltage.

$$\text{Minimum Tap Wire Ampacity} = \frac{\text{Primary Overcurrent Device Rating}}{10} \times \frac{\text{Primary Voltage}}{\text{Secondary Voltage}}$$

Example: A 3-phase, 112½ kVA transformer is 480 volts with wires protected by 150 ampere fuses. There are several taps from the 208Y/120 volt secondary each of which is not over 10 ft in length. One tap ends at a 30 ampere circuit breaker to supply a 5 horsepower, 3-phase, 208 volt motor. Determine the minimum size copper tap conductor between the transformer and the 30 ampere circuit breaker if the insulation and terminations are rated 75°C.

Answer: The tap conductor is required to have an ampacity not less than the rating of the overcurrent device at the end of the tap which is 30 amperes. From *Table 310.16* using the 75°C column, the minimum is size 10 AWG. Next check the minimum tap conductor ampacity permitted for this transformer regardless of the load to be served and find 35 amperes. Checking *Table 310.16* shows that a size 10 AWG is just large enough to also meet this requirement.

$$\text{Minimum Tap Wire Ampacity} = \frac{150\text{ A}}{10} \times \frac{480\text{ V}}{208\text{ V}} = 35\text{ A}$$

240.24(A): A new requirement was added that establishes a maximum height for the center of the operating handle of a switch or circuit breaker. The maximum height is 6 ft 7 in.

250.21: Ungrounded ac systems operating at 120 volts or more are now required to have ground detection. An ungrounded electrical system can be created by a separately derived system within the premises and ground detectors may be required.

250.28: The term system bonding jumper was added to this section. The main bonding jumper is understood to be at the service to the building or structure. When a separately derived system is created such as at a transformer, a bonding jumper is required between the grounded conductor and the equipment grounding terminal or bar. At a separately derived system, this bonding connection is called the system bonding jumper. Since this main bonding jumper was considered located at the service, there was no clear rule for sizing the system bonding jumper. Now the rules for sizing the main bonding jumper and the system bonding jumper are stated in this section.

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250.30(A)(4)(a): It is permitted to ground multiple separately derived systems to a common grounding electrode conductor run throughout a building or structure. Each separately derived system is then bonded to the common grounding electrode conductor. There is now one minimum size required for a common grounding electrode conductor used for two or more separately derived systems. The minimum size is 3/0 AWG copper or 250 kcmil aluminum. In many situations this is an increase in size as compared with the rule in the previous edition of the Code. For installations with low kVA ratings of separately derived systems it is more practical to ground each separately derived system rather than run a common grounding electrode conductor. The following examples will illustrate how such a common grounding electrode system is sized.

Example: Four single-phase transformers rated 3 kVA are installed in one area of a building and connected to a 480 volt supply to provide a 20 ampere, 120 volt circuit at each location. If all four transformers are grounded to a common copper grounding electrode conductor, determine the minimum size grounding electrode conductor permitted.

Solution: The common grounding electrode conductor is required to be not smaller than size 3/0 AWG copper according to *250.30(A)(4)(a)*. The grounding electrode conductor from each transformer to the common grounding electrode conductor is required in this case to be not smaller than size 8 AWG copper according to *250.30(A)(3)* using *Table 250.66* and knowing the transformer output conductors are size 12 AWG copper. The previous edition of the Code would have permitted a size 8 AWG copper common grounding electrode conductor for these transformers.

250.50: This section specifies the grounding electrode required for a service to a building or structure. The previous edition of the Code required that all of the electrodes described in *250.50(A)* that were "available" were required to be bonded together to form a grounding electrode system. The words "if available" were deleted and now all of the types of grounding electrodes described in *250.50(A)* are required to be used. The real issue is the concrete-encased electrode such as reinforcing steel in a foundation. If steel reinforcing is installed, it is now required to be used as a grounding electrode. This means the steel reinforcing in new construction, if installed, is required to be made available so it can be used as a grounding electrode.

250.50 Exception: This new exception only applies to existing buildings and structures. If it is not possible to get at reinforcing steel without penetrating the concrete, then it is not required to use the reinforcing steel as a grounding electrode.

250.52(A)(2): This subsection now specifies when the metal frame of a building is considered to be a grounding electrode. The previous edition of the Code required the building metal frame to be used as a grounding electrode when effectively grounded. Now the specific methods of effectively grounding the metal building frame are specified. At least 10 ft of the metal extends into the earth or is encased in concrete that is in contact with the earth. The metal building frame can be grounded by bonding to a ground rod, or pipe, or a metal plate. Other methods of grounding a metal building frame can also be used if approved. Bonding to a metal underground water piping system is not permitted as the means of grounding the reinforcing steel.

250.52(A)(7): An underground metal well casing that is not effectively bonded to a metal underground water piping system is now considered another local metal underground system acceptable to be used as a grounding electrode. A metal well casing is not considered to be a metal underground water piping system unless it is effectively bonded to the metal water pipe. Now a metal well casing can be used as the grounding electrode for a service, and a supplemental grounding electrode is not required since it is not considered to be a metal underground water piping system. If a metal well casing is installed and connected with nonmetallic water piping, the metal well casing is permitted to serve as the only grounding electrode.

250.64(C)(3): This section requires that the grounding electrode conductor be run as a continuous length from the grounding point at the service disconnecting means to the grounding electrode. There is a new paragraph that permits a copper or aluminum busbar with cross-section dimensions of not less than ¼ in. by 2 in. to be securely fastened in an accessible location as a common connecting point between grounding electrodes and grounding electrode conductors. Connections to the busbar are to be made using listed connectors or by exothermic welding. An example where this technique may be applicable is when there are several disconnecting means for a service and several grounding electrodes. Since an aluminum busbar is permitted for this purpose, a new paragraph (4) was added that requires aluminum busbars to be installed in accordance with *250.64(A)* which does not permit bare aluminum to be attached to a masonry surface or if installed outside, aluminum conductors are not to be terminated within 18 in. of the earth.

250.64(E): When a grounding electrode conductor is run through an enclosure or conduit for protection from

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physical damage, the grounding electrode conductor is required to be bonded to the enclosure or conduit at both ends. The issue is that steel (a ferrous metal) is a magnetic material and when a grounding electrode conductor carries lightning current, the steel envelope around the conductor creates an impedance that reduces the ability of the grounding electrode conductor to carry current if the steel is not bonded to the wire at both ends. The previous edition of the Code required bonding to the grounding electrode conductor for all metal enclosures and conduits. Now this section makes it clear that bonding is only required when the enclosure for the grounding electrode conductor is ferrous metal such as steel.

250.68(A) Exception 2: This section requires connections to grounding electrodes to be accessible. This new exception does not require the connection to a fire-proofed steel building frame to be accessible.

250.104(D)(3): When a common grounding conductor for multiple separately derived systems is run through a building or structure and there is a metal water pipe or exposed metal building frame in the area served by any of the separately derived systems, the common grounding conductor is required to be bonded to the metal water piping system and metal building frame. According to the exception it is not necessary to provide a bond at each separately derived system if the bonding is made to the common grounding conductor.

250.118: The Part 8 rules to the Michigan Electrical Code delete (5) and (6) from the Michigan Electrical Code. Flexible metal conduit and liquidtight flexible metal conduit are not permitted as equipment grounding means as stated in the *NEC*. A bonding jumper sized in accordance with the rating of the circuit or feeder is required to provide grounding continuity across the flexible conduit.

250.122(G): This is a new section that specifies the minimum size equipment grounding conductor required for a tap to a feeder. Since the equipment grounding conductor of the tap must be capable of opening the feeder overcurrent device in the case of a short-circuit or ground-fault, the minimum size is based on the rating of the feeder overcurrent device using *Table 250.122*. The equipment grounding conductor is not required to be larger than the ungrounded tap conductors.

> **Example:** A tap is made to a 3-phase, 480 volt feeder consisting of 600 kcmil copper conductors. The tap is 25 ft in length and ends at a disconnect containing 100 ampere time-delay fuses. The minimum size ungrounded tap conductors permitted is 1/0 AWG copper. If these tap conductors are run in Rigid Nonmetallic Conduit, determine the minimum size equipment grounding conductor required for this tap.
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> **Solution:** Look up the minimum size equipment grounding conductor based upon *Table 250.122,* but the size is not required to be larger than 1/0 AWG in this case. The minimum in this case is a size 3 AWG copper equipment grounding conductor.

250.146(A): When a metal box is surface mounted, direct metal-to-metal contact between a device yoke and the box is permitted to serve and the equipment grounding connection between the box and the device. This means the equipment grounding conductor, connected to the metal box, is not required to be connected to the grounding screw of the device. Devices that are not of the self-grounding type usually have a nonmetallic washer on each mounting screw to hold it in place. Sometimes this nonmetallic washer if not removed can prevent metal-to-metal contact between the box and the device yoke. Now it is required that at least one of the nonmetallic mounting screw washers be removed to insure contact between the device yoke and the metal box.

250.184(B): This section provides basic minimum guidelines for the design and installation of customer owned solidly grounded high voltage distribution systems. The previous edition of the Code only addressed multi-grounded distribution systems, but did not prohibit single-point distribution systems. This new subsection (B) provides basic installation requirements for single-point grounded distribution systems operating at 1000 volts and higher. A multi-grounded distribution system will likely result in some earth current flow and may cause significant current flow on metal piping and structures depending upon the particular circumstances. To prevent objectionable current flow, some customers and system designers utilize a single-point grounded distribution system. With the single-point grounded distribution system, an equipment grounding conductor is run to all load locations. The separate insulated neutral is only required to be run to locations where loads are connected line-to-neutral. A grounding electrode is provided at the source of the single-point grounded distribution system and bonded to the neutral and equipment grounding conductors at that point. At all other points along the system the neutral shall be insulated and isolated from the earth. The equipment grounding conductor is permitted to be grounded to the earth at locations along the system.

Article 280 on surge arresters in the 2008 *NEC* will deal only with those that are installed on electrical systems operating at over 1000 volts. Surge arresters that are to be installed on electrical systems operating at 1000 volts or less will be categorized as a Type 1 Surge Protective Device (SPD) and will

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be covered under *Article 285* which in the 2005 *NEC* is titled transient voltage surge suppressors.

280.4(A)(3): This is a new requirement for surge arresters installed on electrical systems operating at under 1000 volts. The surge arrester is required to be marked with a short-circuit current rating which is required to be higher than the available fault current at the installation location on the system.

285.3(2): The previous edition of the Code did not permit a transient voltage surge suppressor (TVSS) to be installed on an ungrounded electrical system. There are transient voltage surge suppressors listed for installation on ungrounded electrical systems. This paragraph now permits a TVSS listed for the specific purpose to be installed on an ungrounded electrical system, an impedance grounded electrical system, or a corner grounded electrical system.

285.21(A)(1): A transient voltage surge suppressor (TVSS) is permitted to be installed as a tap ahead of the service disconnecting means as permitted in *230.82(5)*. When this installation technique is used, a disconnecting means, overcurrent protection, and grounding is required to be provided for the TVSS that satisfies the requirements of a service.

300.4(A)(1) Exception 2:When cables and some raceways are installed through bored holes in wood members, a steel plate with a minimum thickness of 1/16 in. is required when the edge of the hold is less than 1¼ in. from the outer edge of the wood member. A listed steel plate of lesser thickness is now permitted.

300.4(A)(2): When cables or some raceways are installed through notched holes in wood members, the steel plate is now required to have sufficient length and width to completely cover the notched area of the wood member.

300.6(C): Nonmetallic boxes, equipment, and wiring materials are now required to be listed as sunlight resistant where installed exposed to sunlight. If nonmetallic materials are exposed to chemical deterioration, the equipment shall be inherently resistant to the particular chemical agent or be identified for use with the particular chemical agent.

300.11(A)(1): When wiring is installed in the space above a fire-rated suspended ceiling, the wiring is permitted to be supported by separate support wires that are identified to distinguish them form the ceiling support wires. The change is that it is now made clear that one end of the support wires for the electrical equipment is permitted to be attached to the ceiling grid.

300.22(B): Liquidtight Flexible Metal Conduit is no longer permitted to be installed in a duct or plenum for connection to equipment. The previous edition of the Code permitted lengths not to exceed 4 ft of Liquidtight Flexible Metal Conduit to be installed for the termination to equipment in ducts or plenums.

310.8(D)(3): Conductors and cables exposed to direct rays of the sun shall be listed as sunlight resistant. The change is that now included are coverings such as tape and sleeving that are required to be listed as sunlight resistant when installed outside exposed to direct rays of the sun and the weather.

310.10 FPN No. 2: Conductors installed in raceway outdoors in close proximity to a rooftop and exposed to direct rays of the sun are likely to experience a temperature in excess of the ambient temperature of the air. This fine print note indicates the conductors could experience a temperature rise of up to 30°F (17°C) above ambient. The implication, but not a requirement, is that 30°F (17°C) should be added to the expected highest ambient temperature for the purpose of applying the temperature adjustment factors at the bottom of the ampacity tables.

There are now specific rules dealing with raceway installations exposed to direct sunlight above roofs. These rules do not apply since they are in the 2008 *NEC*, but it is suggested they be considered. The section is *310.15(B)(2)(c)* and the following temperatures are suggested to be added to the maximum expected ambient temperature.

Distance raceway is mounted above flat roof	Temperature to be added
0 in. to ½ in.	60°F
above ½ in. up to 3½ in.	40°F
above 3½ in. up to 12 in.	30°F
above 12 in. up to 36 in.	25°F

Example: Assume the minimum copper wire ampacity required for a rooftop cooling unit is 40 amperes and the typical maximum summer ambient temperature is 110°F. EMT is run across a flat roof and mounted 2 in. above the roof and is exposed to direct sunlight. Determine the minimum wire size for this installation.

Solution: The suggested temperature to add for ampere adjustment purposes would be 40°F. The total temperature adjustment to use for this installation would be 150°F. If the insulation on

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the wires was 90°C rated, then the temperature adjustment factor from *Table 310.16* would be 0.58. The minimum wire size for this installation would be 6 AWG. (75 A × 0.58 = 43.5 A)

310.15(B)(2)(a): In the past there was a debate as to whether parallel conductors of the same phase installed in the same raceway were counted as one conductor or as multiple conductors for the purpose of applying the ampacity adjustment factors of *Table 310.15(B)(2)(a)*. It was the intent that each conductor was to be counted as a current carrying conductor. Now there is a new last sentence that clearly states that each conductor of a set is to be counted for the purpose of applying the adjustment factors of *Table 210.15(B)(2)(a)*.

312.4: This is a new section as it relates to flush mounted cabinets and cutout boxes. This is essentially the same language as in *314.21* for boxes. If a cabinet or cutout box is flush mounted in a wall, the maximum space permitted between the cabinet and the edge of the plaster is ⅛ in. Larger gaps are required to be filled. This rule applies in the case of cabinets or cutout boxes that are to be equipped with flush covers.

314.16(B)(1): A new sentence was added that deals with conductors passing through a box without being spliced. If the conductor is looped so that the length of conductor within the box is two times the minimum length required for attachment to a device, then the conductor is required to be counted as two conductors for the purpose of determining box conductor fill.

314.21: Repairing plaster or drywall around a box where a gap is greater than ⅛ in. only applies when the box is installed where flush-type covers or faceplates will be installed on the box.

314.23(B)(1): When screws are used to secure a box to a surface and the screws pass through the interior of the box, an approved method shall be used to prevent the exposed threads of the screw from causing abrasion of the conductor insulation.

314.27(D): This section specifies the conditions when a box is permitted to support a paddle fan. The requirements that were in *422.18* of the previous edition of the Code are now in this paragraph. The change is that when a box is listed to support a paddle fan weighing more than 35 lbs., but not more than 70 lbs., the maximum weight the box will support is required to be marked on the box.

314.30: This is a new section that provides requirements for handhole enclosures and enclosure covers. Paragraph (A) specifies the method of determining the minimum size of enclosure. Paragraph (B) does not require a conduit or cable entering a handhole enclosure to be secured to the handhold enclosure. Paragraph (C) requires the purpose of the handhole, such as electric, to be marked on the outside of the handhole cover, and if the cover weighs less than 100 lbs. it must be of a type that requires tools to remove. These are similar requirements that apply to manhole covers, *110.75(D)*.

334.10(2): Nonmetallic-Sheathed Cables are permitted to be installed in for multi-family dwellings of all construction types. Part 8 of the Michigan Electrical Code deletes the reference to types of construction from *334.10(2)*. See Tech Note 107 for more details.

334.10(3): Nonmetallic-Sheathed Cables are permitted to be installed in buildings other than dwellings that are not more than one floor in height and are not required to be installed within fire-rated walls, floors, and ceilings. Part 8 of the Michigan Electrical Code modifies the language in 334.10(3). See Tech Note 107 for more details.

334.80: A new paragraph was added calling attention to an abnormal heating condition that can be encountered when nonmetallic-sheathed cables are bundled together as multiple cables and pass through a hole in building materials where the hole is sealed to prevent fire spread. If more than three current carrying conductors pass through the same hole that is sealed with thermal insulation or foam fire blocking, then the ampacity adjustment factors of *Table 310.15(B)(2)(a)* are required to be applied. Since the insulation on the conductors is rated at 90°C, the ampacity in the 90°C column of *Table 310.16* can be used for the purpose of derating.

338.10(B)(2) Exception: The neutral in Type SE cable is permitted to be uninsulated for the purpose of supplying feeders from one building to another as permitted in *250.32* and *Part II* of *Article 225*. This means that Type SE Style U with an uninsulated conductor is permitted to be used for a feeder from one building to another. Consider the case where Type SE cable, Style U is installed from the service panel in one building to the overhead triplex cable. Type SE cable, Style U is then used at the second building from the overhead conductor to the panelboard in the second building. According to the previous edition of the Code, the grounded conductor (neutral) was required to be insulated for this application thus requiring Style R when Type UF cable was used as a part of the feeder run. Style R has three insulated conductors and a bare equipment grounding conductor.

338.10(B)(b): Type USE cable is not required to have a flame-retardant outer covering and is not permitted to enter a building even to terminate. The previous edition of the Code permitted Type USE cable to emerge from the ground outside and enter a building for termination provided it was terminated within 6 ft after entering the building.

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342.22: In the second paragraph that makes reference to cables installed in IMC, it now states where not prohibited by the respective cable article. The words not prohibited replace the word permitted. If the cable article did not specifically permit the installation of cable in IMC then some interpreted this as meaning it was not permitted. With the new working, the cable article must specifically prohibit the use of the cable in IMC. Unless specifically prohibited, cables are permitted to be installed in any type of raceway.

342.42(A): A new sentence was added that requires IMC threadless connectors and couplings installed in wet locations to meet the requirements of *300.15(A)*. This means that threadless connectors and couplings are to be installed in such a manner that moisture does not accumulate into boxes, and enclosures from outside. This does not necessarily mean that threadless connectors are required to be listed for use in wet locations.

348.30(A) Ex. 2: Installations of Flexible Metal Conduit are to be secured within 12 in. of terminations and at intervals not to exceed 4½ ft. This exception permits short lengths to be installed supported only by the connectors for termination at equipment such as electric motors. In the past the maximum length to be installed supported only by the connectors was 3 ft. The distances involved with large electric motors in particular makes 3 ft length of flexible metal conduit impractical. Now it is permitted to install larger trades sizes of Flexible Metal Conduit in longer lengths supported only by the connectors. Trades sizes ½ (16) through 1¼(35) the maximum length is still 3 ft. Now trades sizes 1½(41) through 2(53) is permitted to be installed in lengths up to 4 ft supported only by the connectors. For trades sizes 2½(63) through 4(103) the maximum length permitted is 5 ft.

348.30(A) Ex 4: *Exception 3* permitted 6 ft lengths of Flexible Metal Conduit supported only by the connectors to be installed in a suspended ceiling for connecting to a luminarie. This rule did not apply for connections to other equipment installed in suspended ceilings. This new exception permits Flexible Metal Conduit to be installed in lengths up to 6 ft from the last point of support to the termination at the luminaire or equipment. This was generally the practice in the past, but because it was not specifically stated, in some areas this practice was not permitted.

This is a new Article covering an existing product that has special installation requirements, but was not specifically covered in the previous edition of the Code. High Density Polyethylene Conduit is a rigid nonmetallic conduit that is flexible enough to be handled as a coil and is often placed on a reel. It is intended for direct burial in the earth. It can be placed directly into a trench as a continuous length form a reel. It is not permitted to be installed where exposed, or within a building. The cross-sectional area of HDPE Conduit is close enough to PVC Rigid Nonmetallic Conduit that they are both included in the same conductor fill tables, *Table 4, Table C10* and *Table C10A*.

356.30(1): This paragraph only applies when Liquidtight Flexible Nonmetallic Conduit is installed in lengths longer than 6 ft. It is required to be secured at intervals not to exceed 3 ft and within 12 in. of a box, enclosure, or fitting. If a piece of LFNC is not more than 6 ft in length, then it is not required to be supported except by the connectors. This could be a 6 ft piece of LFNC in a conduit run where the flexible section is needed to traverse an irregularity on a wall.

358.42: When installed in a wet location, EMT couplings and connectors are required to meet the requirements of *300.15(A)*. The previous edition of the Code required connectors and couplings installed in wet locations to be raintight. Now by referencing *300.15(A)*, the requirement is that moisture not be permitted to enter the wiring system. This means that connectors and couplings that are not raintight are permitted to be used in locations such as on the underside of an enclosure.

376.23(A): When conductors enter a metal wireway and bend to run through the wireway, there is a minimum distance required from the raceway or cable entry to the opposite side of the wireway based upon the size of wire involved. The distance is determined from *Table 312.6(A)* for wires connected to terminals. It is now specified that the minimum distance is determined using the one-conductor per terminal column of *Table 312.6(A)*.

386.70: This section places requirements on Surface Metal Raceway that contains both signaling and light and power conductors. The signaling wires must be kept separated from the light and power wires and each is run through the raceway in a separate compartment. In the past the different compartments were required to be color coded. Now they are permitted to be color coded, stamped or imprinted with an identification.

It was also required in the past that the compartment for signaling wires and the compartment for light and power wires be maintained in the same relative position with respect to each other for the complete Surface Metal Raceway system. That requirement was deleted.

392.10(A)(1): It was not clear in the previous edition of the Code when single conductor cables were required to be installed in a single layer in a cable tray and when they were permitted to be installed in multiple layers. There was a new sentence added to this section that applies to single conductor cables size

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1000 kcmil and larger. It is now clearly stated these conductors are to be installed in a single layer unless permitted to be bundled to form a set of conductors.

392.11(B)(3)Exception: This is a new exception that applies to single conductor cables installed in uncovered solid bottom cable tray where a space is maintained between the cables of not less than one cable diameter. The previous edition of the Code permitted the conductor ampacity to be determined using *Table 310.17* for single conductors in free air. With a solid bottom in the cable tray, free air movement between the conductors is restricted. Now the ampacity of the conductors is required to be determined by an engineer using the provisions of *310.15(C)*. Applying logic to this situation for field evaluation of conductor ampacity, if the conductors were installed in raceway the ampacity would be determined using *Table 310.16*. Even though the cable tray has a soled bottom, with the conductors spaced a minimum on one cable diameter apart, there will be air circulation and conductor cooling with the open top. This would mean the conductor ampacity of the conductors in the solid bottom cable tray would not be greater than the value given in *Table 310.16*, but less than the value given in *Table 310.17*. A complicating factor to determination of conductor ampacity for solid bottom cable trays is dirt accumulation on the conductors and in the spaces between the conductors. According to *392.3(B)*, single conductors are permitted to be installed in solid bottom cable trays in industrial areas.

400.5: There is now a requirement that in the case of determining allowable ampacity for flexible cords, an adjustment must be made for ambient temperatures above 30°C (86°F). The temperature correction factors to be used are to be from *Table 310.16* for the appropriate temperature column for the type of cable. Flexible cord temperature is marked on the jacket. There may be one temperature for the cord when operated in a dry area and another where the cable is operated in a wet area. The following example will illustrate how flexible cord ampacity is adjusted for a high ambient temperature.

Example: A SOW flexible cord with size 12 AWG copper wires supplies 3-phase equipment in a dry location rated at 90°C where the ambient temperature when the equipment is operating is likely to be 120°F. Determine the ampacity of the flexible cord under these conditions.

Solution: Since this is 3-phase equipment there will be three current-carrying conductors in the cable and the ampacity is found in column A of *Table 400.5* as 20 amperes. A temperature adjustment factor of 0.82 is found at the bottom of the 90°C copper column of *Table 310.16*. The ampacity of the flexible cord under these conditions is 16.4 amperes.

404.7 Exception 2: A center pivot handle for a busway tap switch is permitted to be down when the tap is energized such as the case where a busway tap switch is activated by pulling a rope, chain, or cable to turn-on and turn-off the tap. The on and off labels are required to be clearly visible from the point of operation of the tap switch.

404.8(B): This section requires a barrier between snap switches installed in the same box and supplied by different phases of a 480/277 volt system controlling electric discharge luminaires. The previous edition of the Code required permanently installed barriers between adjacent devices. Now the barrier is required to be identified for the purpose and securely installed. Barrier plates are manufactured for field installation for the purpose of installation between adjacent devices. The barrier plates are not necessarily listed, and they are secure after installation, but they are not a permanent part of the box.

406.8(B)(1): The word “outdoor” was deleted so this rule now applied to receptacles installed either inside or outside in wet locations. A 125-volt, 15- or 20-ampere receptacle installed in a wet location is now required to be equipped with a cover that is weatherproof with or without the plug inserted. This means that so called “in-use” covers are now required for inside wet locations as well as outside wet locations. In *Article 100*, a wet location is defined as an area subject to saturation with water or other liquids, or unprotected areas exposed to the weather. Inside areas where water is sprayed would be an example of a wet location.

408.4: It is now required to put sufficient details on the panelboard or switchboard directory to identify the specific location of outlets on each circuit.

408.7: A new section was added that requires unused openings for circuit breakers and switches to be closed with a device listed for the purpose. The requirement in *110.12(A)* deals with closing unused openings for cable and raceway entries not openings in panel covers for circuit breakers and switches.

Article 409 is new. An industrial control panel is defined in *409.2* and it is a single enclosure or group of attached sectional enclosures that direct the control of equipment as well as contain controllers. The key difference between a motor control center and an industrial control panel is the industrial control panel contains actual controllers and carries the main current to the loads.

410.4(E): This is a new section placing specifications on the type of mercury vapor and metal halide lumnaires permitted to be installed for indoor sports and similar facilities where the luminaires may be exposed to physical damage. If the outer glass lamp envelope is broken and the arc tube continues to operate, persons exposed to direct light from the lamp will be exposed to short wavelength ultraviolet

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radiation which can cause eye irritation and potentially burning of the skin. The glass envelope blocks short wavelength ultraviolet radiation from escaping the lamp. Mercury vapor and metal halide luminaires subject to physical damage and installed in playing and spectator seating areas of indoor sports and similar facilities are required to be equipped with glass or plastic lenses. The lense will block short wavelength ultraviolet radiation in the event the lamp envelope is broken and the lamp continues to operate. Mercury vapor and metal halide lamps that have broken glass outer envelopes and continue to operate should be shut-off immediately and replaced.

410.18(B) Exception 2: This section only permits a luminaire with no exposed metallic parts to be installed at a location where an equipment grounding conductor is not present. The new exception, permits luminaires with exposed metallic parts to be installed at a location where an equipment grounding conductor is not present if the luminaire is protected with a ground-fault circuit-interrupter.

410.73(F)(5): This is a new paragraph that deals with the potential problem of metal halide lamp end-of-life violent arc tube failure. A potential fire exists if a metal-halide lamp ruptures and showers flammable materials with hot lamp debris. The metal-halide luminaire is required to be provided with a containment barrier that encloses the lamp except for thick-glass PAR lamps and Type O lamps. The Type O lamp has a built in arc-tube containment feature. A closed luminaire with a plastic or glass diffuser will meet this requirement. Only Type O and thick-glass PAR metal-halide lamps are permitted to be installed in open luminaires where the lamp is exposed.

410.73(G): For indoor locations other than dwellings and associated buildings, fluorescent luminaires that use double-ended lamps (tubular type) and contain a ballast are required to be provided with an integral disconnecting means, accessible to qualified persons, to disconnect all conductors from the ballast. This requirement became effective January 1, 2008. There are several exceptions to this new rule. This new rule does not apply to fluorescent luminaires installed in hazardous locations or are for emergency illumination. This rule will not apply to cord and plug connected luminaires with an accessible receptacle. The rule does not apply to industrial locations where only qualified personnel will service the luminaires. A switch in the room that opens all conductors to the luminaires can serve in place of a disconnect in the luminaire provided the luminaires are not supplied by multi-wire circuits, and there are more than one circuit serving the space. One way to provide this disconnect is a connector device installed in the supply wires to the ballast (ungrounded and neutral wire) and pulls apart to disconnect power to the ballast.

410.110: This is a new *Part XVI* on decorative lighting and associated accessories. The section requires decorative lighting and accessories used for holiday lighting to be listed products when used in accordance with *590.3(B)* which means they are installed for a period of not more than 90 days.

422.16(B)(4): Range hoods are now permitted to be cord and plug connected. The cord must be identified as suitable for use with a range hood. The cord must terminate at a grounded plug unless the range hood is listed as double insulated. The cord is to be not less than 18 in. nor more than 36 in. in length. The receptacle must be accessible and supplied by an individual branch circuit.

422.31(B): A permanently connected appliance rated over 300 VA or ⅛ horsepower is permitted to have a disconnect such as a circuit breaker located out-of-sight of the appliance if the disconnect is capable of being locked in the open position. A locking device that is installed on a switch or circuit breaker is to be of a type that will remain in place even if the lock is removed. There are add-on locking devices that will only stay in place if the lock is attached. That type of locking device is not permitted to satisfy this requirement.

422.51: Cord and plug connected vending machines starting January 1, 2005 are required to either have integral GFCI protection in the machine power cord, or be connected to a branch circuit that is GFCI protected.

Design E motor references deleted: The design E high efficiency motor was never built for production and instead the premium efficiency design B motor has achieved the characteristics intended for the design E motor. All references to the design E motor were deleted.

430.7(A)(15): Resistance heaters are sometimes installed inside motors to keep the inside of the motor warm enough to prevent condensation when not in operation. Accumulation of moisture can lead to internal corrosion and deterioration of winding insulation. This is a new requirement that if a motor is equipped with an internal condensation prevention heater, the heater voltage, phase, and rated power is required to be marked on the motor. Condensation prevention electric resistance heaters are usually installed at one or both ends of the stator windings.

430.109(A)(7): This is a new paragraph the provides rules for the installation of system isolation equipment. This is a magnetically operable switch that can be controlled from multiple remote locations and locked in the open position at those remote locations. System isolation equipment is required to be listed for disconnection purposes. It is also required to be installed on the load side of the circuit or feeder

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overcurrent protection and disconnecting means. The disconnecting means permitted on the line side of system isolation equipment is a motor circuit switch, circuit breaker, or molded-case switch.

Part X: This is a new part in *Article 430* that provides rules for the installation of adjustable speed drives for the operation of an electric motor. There are considerations related to the installation of circuit components for an adjustable speed drive that are different than a typical motor circuit that were not covered in the Code. The drive unit is a power converter and controller. The drive unit provides overload protection for the motor. The drive unit may also be capable of providing thermal protection for the motor by connecting to a temperature sensor in the motor. Depending upon the specific conditions involved, the adjustable speed drive may be mounted in an enclosure that requires forced ventilation. Installation requirements and safeguards for the ventilation circuit are not covered in the Code. Note: The adjustable speed drive output power to the motor is not usually a sine wave, and a true rms reading ammeter is required to accurately measure current to the motor.

430.122: The previous edition of the Code provided a rule for sizing the conductors supplying a power conversion unit in *430.22 Exception 2*. That same rule is now in *430.122(A)* and sets the minimum conductor ampere rating at 1.25 times the rated input current of the power conversion unit. There is no rule stated in *Part X* for sizing the conductors between the power conversion unit and the motor. Those wires should then be sized using *430.22* which is 1.25 times the full-load current of the motor in most cases using the current from *Table 430.250* for the rated voltage and horsepower of the motor.

430.122(B): Some adjustable speed drive systems are equipped with a bypass device to shunt power around the adjustable speed drive unit. In this case, normal 3-phase power is supplied directly to the motor which will then only run at a fixed speed. If a bypass device is provided, then the conductors supplying the power conversion unit and bypass device is required to be sized at not less than 1.25 times the motor full-load current or 1.25 times the power conversion unit rated current, whichever is greater.

Tables: The tables listing the full-load current for different types and sizes of motors were renumbered. For example, *Table 430.150* gives the full-load current of 3-phase motors. Now the table is numbered *Table 430.250*. The other tables at the end of *Article 430* are numbered in a similar manner.

440.32: A 3-phase delta connected motor that has all six leads available can be reduced voltage started by connecting the windings in a wye configuration during starting then switching the windings to a delta configuration when the motor reaches nearly full speed. This is called wye-delta starting. Since there are six leads between the controller and the motor, each lead does not carry the full-load current of the motor. Once the motor is running at full speed and the windings are in delta configuration, each lead carries 58% of the full-load current of the motor. The previous edition of the Code permitted the leads between the controller and the motor to be sized at 58% of the motor full-load current. In *430.22* the motor circuit conductors are required to be sized at 125% of the current, and this was not factored into the 58%. Multiplying 58% by 1.25 gives 72%. Now the leads between the controller and the motor of a wye-delta motor are required to be sized not smaller than 72% of the motor full-load current.

Wye-delta motor starting is permitted for applications other than air-conditioning and refrigeration. The same rule applies for sizing the conductors between the controller and the motor for other applications in *430.22(C)*. The same change that was made in *440.32* was not made to *430.22(C)*. The conductors between the controller and the motor for wye-delta operation in *430.22(C)* should also be sized with an ampacity not less than 72% of the motor full-load speed. Part-winding motor starting involves two parallel sets of phase conductors between the controller and motor as indicated in *430.22(D)*. The wires between the controller and the motor each carry half of the motor full-load current. It is necessary to multiply the 50% full-load current by 1.25 for part-winding motors so that each winding is required to have an ampacity not less than 63% of motor full-load current.

445.18: A generator is now permitted to have more than one disconnect so it can supply more than one feeder. Previous edition of the Code limited the generator disconnect to only one.

500.8(D): A new sentence was added to this section that establishes the requirements for threaded connections for wiring in classified locations. Connections into explosionproof equipment are to be made up with 5 threads fully engaged. This 5 thread requirement in the previous edition of the Code was in *501.4(A)* and *505.9(E)*. The 5 thread requirement only applied in Class I, Division 1 locations.

There was a renumbering of some of the sections in *Articles 501, 502,* and *503* to establish a similarity to the numbering and subjects covered.

501.10(A)(1) Exception: This exception permits Rigid Nonmetallic Conduit to be installed encased in 2 in. of concrete and buried not less than 24 in. below grade level in a Class I, Division 1 location. In the case of wiring supplying a gasoline dispensing unit and bulk storage areas the 2 in. encasement of concrete is not required. The change in this exception is the deletion of a reference to wiring installed beneath the floor of a service area of a commercial garage because that area is classified as Class I, Division 2 not Division 1.

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501.15(B)(2): An explosionproof seal is not required at the boundary between a Class I, Division 2 area and an unclassified area. The seal needs only to be identified for the purpose. The wording of this paragraph was changed to make this clear. An explosionproof seal was usually required at this location because the meaning was not clear. The purpose of this seal is to prevent vapor from passing from the classified area into the unclassified area, not to contain an explosion. Seals for this purpose are available that permit the conductors to be removed at a later date for remodeling and resealed. The sealing compound is not required to be permanent, but it must be identified for the purpose.

The following is a discussion of the key points covered in new *Article 506* to assist in finding information relative to an installation. This article does not apply to metal dusts. This article is permitted as an alternative means of installation in place of *Articles 502* and *530.*

506.1: This scope statement points out this is an alternative method to the methods of *Article 502* and *Article 503* for installing wiring and electrical equipment in areas where a hazard exists due to the presence in sufficient quantity of combustible dusts, ignitible fibers, or ignitible flyings. Depending upon the degree of hazard, the locations are subdivided into Zone 20, Zone, 21, and Zone 22. A Class II or Class III, Division 1 area is subdivided into Zone 20 or Zone 21 depending upon whether the hazard exists for extended periods of time. A Class II or Class III, Division 2 area is equivalent to Zone 22.

506.6(A): Qualified personnel are required to design the wiring system and select equipment. Qualified personnel are also required to supervise the installation of wiring and electrical equipment as well as inspect the installation.

506.9: This section provides the required markings for equipment that is to be installed in Zone 20, Zone 21, or Zone 22. A class marking is not required and an ambient temperature range for which the equipment is suitable must be provided on the equipment.

506.15: The wiring methods that are permitted in the three zones are described in this section. Rules that are acceptable for a Class II area are required to be applied to Class III areas. There are some differences between the wiring methods permitted using the Zone system as compared to using the rules of *Article 502* and *Article 503*.

506.16: Sealing requirements are in this section and seals and materials used are required to be identified. Explosionproof and flameproof seals are not required, and seals are only required where necessary to prevent entry of dust, fibers, or flyings. There is considerable room for judgement and interpretation with respect to installation of seals.

506.20: Installation of equipment such as lighting, motors, transformers, and other equipment is covered in this section. Surface temperature requirements in *506.20(E)* are essentially the same as for equipment installed according to *Article 502* and *Article 503*. The equipment requirements are much more extensively described in *Article 502* and *Article 503* then they are in *506.20*.

506.25: Grounding and bonding requirements are specified in this section which is essentially the same as the rules in *502.30* and *503.30*.

There was a reorganization in *Article 511* of the section dealing with classification of areas in a commercial garage or a storage garage. There is no longer a reference to *Table 514.3(B)(1)* for specifications on ventilation for an underfloor service area where only minor repairs are conducted. That material in *Article 514* was moved to this section. *511.3(A)* describes areas that are unclassified, and *511.3(B)* describes the areas that are classified.

511.4(A)(1): This section in the previous edition of the Code was deleted. This paragraph stated that raceway embedded in a masonry wall adjacent to a Class I area, or buried under a concrete floor above which is a Class I area is considered to also be in the Class I area. Since this statement no longer exists in *Article 511*, those areas are no longer considered to be in the Class I area. As a result there was no need for an exception, and the *Exception* to *511.4(A)(1)* was also deleted. Rigid nonmetallic conduit is permitted to be run under the floor of the auto repair area of a commercial garage and there is no depth requirement. Rigid Nonmetallic Conduit is not permitted to be installed in a Class I, Division 2 hazardous area. If a run of Rigid Nonmetallic Conduit emerges up through the concrete floor above which is a Class I, Division 2 area, that portion of the conduit run must be Rigid Metal Conduit or Intermediate Metal Conduit.

511.7(A)(1): Now Type AC cable is permitted to be installed in spaces above a Class I area of a commercial garage.

513.12: All 125 volt, 15- and 20-ampere receptacles located in a hangar and intended for powering diagnostic equipment, electrical hand tools, or portable lighting are now required to be ground-fault circuit-interrupter protected.

Table 514.3(B)(1) Footnote 1: A new footnote was added to the table to establish the equivalent of grade level in the case of fuel dispensing equipment for water craft. Grade level is the surface of the pier down to the water level.

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514.8: The earth below a Class I hazardous location of a motor fuel dispensing facility is no longer considered to be a Class I hazardous location. There is, however, a requirement that any conduit emerging from the ground be sealed within 10 ft of the point of emergence. Also there shall be no coupling, fitting, box, or union between the point of emergence and the seal, except a listed explosionproof reducer at the seal is permitted. The wiring is required to be threaded Rigid Metal Conduit or threaded steel Intermediate Metal Conduit. *Exception 2* does permit Rigid Nonmetallic Conduit for the portion of the run that is at least 2 ft below grade, the same as permitted by the previous edition of the Code.

517.14: When a patient location is supplied circuits from the critical branch panelboard and the normal power panelboard, the grounding bus of each panelboard is required to be bonded together with a continuous insulated copper wire not smaller than size 10 AWG. Some patient locations, such as a critical care area, may be supplied circuits from two separate emergency systems and no circuits from the normal power system. A new sentence was added to require the grounding bus of separate emergency panelboards to be bonded together when they both provide circuits to the same patient location.

517.17(A): A solidly grounded electrical system operating at more than 150 volts to ground and rated 1000 amperes or more is required to be provided with equipment ground-fault protection. For a hospital it was also required to provide equipment ground-fault protection on the down line feeders rated operating at more than 150 volts to ground. The purpose of this procedure was to limit an outage due to a ground-fault to the feeder involved and not the entire hospital. This new subsection *(A)* points out that this requirement is intended to apply only to hospitals and similar facilities with critical care areas or electrical life support equipment.

518.1: The scope of this article in previous editions of the Code was somewhat vague. The scope was completely reworded giving examples of the types of facilities that are considered to be assembly occupancies. Live performance theaters and audience areas of television studios are not covered as they are covered in *Article 520*.

518.2(A): This section contains a list of the type of facilities that are to be included as assembly occupancies. Auditorium was deleted as they are covered under *Article 520*. Drinking facilities was added to the list. The term church chapels was considered to be too narrow description, and it was replaced by places of religious worship.

518.2(B): A new first sentence was added that makes it clear that in buildings of multiple use where a portion of the building is considered an assembly occupancy, the other portions of the building are not considered a part of the assembly occupancy. This is only true if there is a fire barrier between the two types of occupancies.

518.4(C): Rigid Nonmetallic Conduit (RNC) and Electrical Nonmetallic Tubing (ENT) are no longer permitted to be installed concealed in walls and ceilings that have a 15-minute finish fire rating in college and university classrooms, drinking establishments, or passenger stations and terminals for air, ground transportation, subways, or marine transportation. Assembly occupancies inwhich RNC and ENT is permitted to be installed concealed behind a 15-minute finish fire rated surface are listed in this section.

525.11: If amusement rides and public attractions are supplied power from different sources, the grounded conductor of each source is to be bonded to the same grounding electrode system if the rides or attractions are separated by a distance of less than 12 ft.

525.23(A): It is now made very clear which receptacles are required to be ground-fault circuit-interrupter protected. All 125 volt, 15- and 20-ampere non-locking receptacles used for assembly or disassembly, or are otherwise readily accessible to the general public. Now other receptacles are not required to be GFCI protected.

Article 547 is not part of the Michigan Electrical Code. The changes discussed for this article are only for information purposes.

547.2: Site-isolating device is now defined as a disconnecting means located at the distribution point for the purpose of disconnecting the ungrounded conductors to a group of buildings for maintenance and emergencies, or to facilitate the connection of optional standby power. The requirements for the site isolating device are given in *547.9(A)*. The grounded circuit conductor is required to be connected to a grounding electrode and the rating is to be determined according to *220.103*. Overcurrent protection is not required to be provided at the site-isolating device. A site-isolating device may also serves as a transfer switch for an optional standby generator.

547.5(G): All 125 volt, 15- and 20-ampere general-purpose receptacles installed in dirt confinement areas of agricultural buildings are required to be ground-fault circuit-interrupter protected. It is assumed that confinement area means livestock confinement.

547.9: This new sentence places a restriction on underground feeders from a central distribution point to individual agricultural buildings. If the feeders are run overhead only a site-isolation device is required at

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the central distribution point. Providing individual overcurrent protection is optional. If the feeders are run underground, it is now required that overcurrent protection be provided at the central distribution point. A single disconnecting means with overcurrent protection can be installed with the feeders run as outside taps according to *240.21(B)(5)*.

547.9(D): An equipment grounding conductor run underground was required to be insulated or covered copper according to the previous edition of the Code when supplying a building or structure housing livestock. The word "underground" was replaced with "direct-burial" which means that a bare equipment grounding conductor is permitted to be run underground in a cable or raceway. Only when the conductors are direct-burial is the equipment grounding conductor required to be insulated or covered copper.

547.10(B): This paragraph in the previous edition of the Code was deleted. Equipment likely to be energized and installed in a dirt confinement area, such as an electrically heated livestock watering device, was required to be protected with a ground-fault circuit-interrupter if an equipotential plane was not installed in the dirt floor. With the deletion of the subsection, it is no longer required to provide GFCI protection for livestock watering devices and other electrical operated equipment installed in dirt confinement areas.

551.46(E) Exception 3: A recreational vehicle that is also adapted for transporting livestock such as horses is now permitted to have the electrical point of entrance on either side of the vehicle. Typical recreational vehicles have the power entrance point on the drivers side of the vehicle. Vehicles intended for the transport of livestock must be able to accommodate the loading and unloading of livestock and it is necessary to locate the power supply cord and point of entry on the side away from normal livestock traffic. For a recreational vehicle that is also used to transport livestock, the power supply is permitted to be located on the passenger side of the vehicle. Exhibition areas that have electrical power available for recreational vehicles are usually structured to allow for power entrance to a recreational vehicle from either side of the vehicle.

590.4(B): Use of Type NM and Type NMC cables for temporary light and power feeders during construction of a building is permitted in a building of any type of construction and a building of any height. It is now made clear that NM and NMC cables are not required to be concealed within fire-rated construction when used as temporary wiring in any type of building of any height.

590.4(C): Use of Type NM and Type NMC cables for temporary light or power branch circuits during construction of a building is permitted in a building of any type of construction and a building of any height. It is now made clear that NM and NMC cables are not required to be concealed within fire-rated construction when used as temporary wiring in any type of building of any height.

590.4(J) Exception: It is not permitted to support overhead spans of temporary branch circuits and feeders with live vegetation according to *590.4(D)*. This new exception does permit live vegetation as support for overhead spans of feeders and branch circuits if for a period of not more than 90 days for holiday decorative lighting and similar purposes. Strain relief is required to be installed to protect the cable from movement of the vegetation. The exception also applies to overhead spans for light and power during emergencies and for testing.

590.5: This new section requires decorative lighting and accessories used for 90 day temporary holiday lighting to be listed.

600.1: The scope was expanded beyond just electric signs and outline lighting to include neon tubes used as art forms and decorative elements.

600.2: A new definition of a section sign was added. It is a sign that consists of suctions that must be electrically connected when assembled at the intended location.

604.6(F): This is a new subsection that permits luminaires to be supplied with flexible cord-type manufactured wiring systems provided that installation meets the requirements of *410.30(C)* which permits a luminaire to be mounted directly below an outlet and the flexible cord is visible for the entire length. There was also a change made in *410.30(C)(1)(2)* that recognizes a flexible cord with manufactured wiring system connectors. The previous edition of the Code did not have this provision. The real change is that now it is permitted to supply a luminaire with a flexible cord-type manufactured wiring system that has wires smaller than size 12 AWG. The wires to the luminaire must be sized at not less than 125% of the luminaire full-load current and meet the circuit tap requirements of *240.5* for flexible cords. Cord-type manufactured wiring systems with size 16 AWG wire will most likely be common.

605.6: Pre-wired office partitions that are fixed in place or secured to building surfaces are required to be connected to power with a permanent wiring method. If the fixed office partition is supplied by a multi-wire branch circuit, it is now required to be able to disconnect power to all ungrounded conductors simultaneously. This means a 2-pole or a 3-pole circuit breaker at the supply panelboard is required

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when the fixed office partition is supplied with a multi-wire branch circuit.

605.7: Pre-wired office partitions that are free standing are permitted to be supplied power with a cord and plug or by a permanent wiring method. If a permanent wiring method is used to supply a free standing office partition, and the office partition is supplied by a multi-wire branch circuit, it is now required to be able to disconnect power to all ungrounded conductors simultaneously. This means a 2-pole or a 3-pole circuit breaker is required at the panelboard.

620.2: **Control Room** is now defined as a space that can be entered by personnel and contains controls and associated equipment, but not elevator driving machinery. This space is not permitted to be in the hoistway.

620.2: **Control Space** is now defined as an area that is not required to be capable of being entered by personnel and contains controls and associated equipment, but not driving machinery. This space is permitted to be part of the hoistway.

620.2: **Machine Room** is now defined as a space separate from the hoistway and intended for the driving machinery. This room must be capable of being entered by personnel.

620.2: **Machinery Space** is now defined as a space that is permitted to be a part of the hoistway that contains the driving machinery. This space is not required to permit full entry by personnel.

620.22: Required elevator car lighting now is not permitted to be supplied from the load side of a ground-fault circuit-interrupter.

645.17: This is a new section that recognizes power distribution units for information technology equipment. A convenient way to obtain individual control of equipment is by means of circuit breakers at a panelboard. It is easy to exceed the circuit breaker capacity of an individual panelboard, thus creating the need for multiple panelboards. This new section permits multiple panelboards to be installed in a single cabinet provided no panelboard has more than 42 circuit breakers and the panelboards are listed for information technology equipment applications.

647.4(A): Technical power systems that provide 120 volts to sensitive electronic equipment with two ungrounded conductors and no grounded neutral conductor. Each ungrounded conductor is 60 volts to ground. A standard receptacle is used with an ungrounded conductor to each terminal. There is a new rule that both ungrounded conductors for a circuit or feeder are required to be disconnected simultaneously. This means that individual single-pole circuit breakers for a circuit are not permitted. Either a 2-pole circuit breaker or two single-pole circuit breakers with handle ties are required. It is recommended that 2-pole circuit breakers be used so there will be a common trip on an overcurrent condition. Handle ties do not necessarily result in common trip on an overcurrent condition.

670.1 FPN: A new sentence was added to the fine print note that now makes reference to *110.26* for workspace clearances at industrial machinery. This reference was added because *670.5* was deleted that provided working clearance requirements in front of openings that provided access to live parts and terminals. The clearance requirement was 2½ ft unless a tool was required to open the equipment for only testing and diagnostics and then the clearance was permitted to be less than 2½ ft. The deletion of *670.5* and the addition of the reference in the fine print note means the minimum workspace clearance is found in *110.26* which is 3 ft in most cases.

670.3(A)(4): Instead of just providing the short-circuit current rating of the industrial machine overcurrent device on the nameplate, now it is required to provide the short-circuit current rating of the machine industrial control panel. The machine control enclosure or assembly is also required to be listed and labeled.

680.21(A)(1): Wiring supplying motors associated with a permanent swimming pool is required to contain an equipment grounding conductor not smaller than size 12 AWG insulated copper. The change is that the equipment grounding wire is now required to be insulated.

680.23(B)(6): This is a new requirement that wet-niche luminaires are required to be installed such that the luminaire is removable for relamping and maintenance by a person located on the deck or dry area adjacent to the pool. This section was modified in the 2008 *NEC*. It is permitted to enter the pool to remove the luminaire, but it must be capable of being placed on a dry surface out of the pool for maintenance.

680.25(B)(2): This subsection deals with the case where permanent swimming pool equipment is supplied from a panelboard in a separate building or structure that receives power by means of a feeder from another building. The previous edition of the Code permitted the grounded conductor (neutral) to serve as the equipment grounding conductor if installed in accordance with *250.32*. This practice is no longer permitted. There must be an equipment grounding conductor in the feeder separate from the grounded conductor and installed to meet the requirements of *250.32(B)(1).*

A feeder installed to a separate building that supplies permanent swimming pool equipment is now

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required to have the neutral and equipment ground separated as described in *250.32(B)(1).* All of the conductors in the feeder, including the equipment grounding conductor, are required to be insulated.

Equipotential Bonding of a permanent swimming pool: There was a TIA issued by NFPA with respect to when an equipotential bonding grid was required around the envelope of a permanent swimming pool. The rules on equipotential bonding are much clearer in *680.26* of the 2008 *NEC*.

680.26: The title of this section was changed from bonding to equipotential bonding. The term equipotential plane is defined in *547.2* which is the same concept of attempting to keep step and touch potentials blow the level of human perception.

680.26(B)(1): This subsection specifies which pool equipment and material is required to be bonded together. The last sentence requires an alternate means to be installed if reinforcing steel is coated with a nonconductive material and is not bonded to the pool equipotentoal grid. The change is that the deck area around the pool is now included. If the reinforcing steel in the deck is coated with a noncondutive material and is not bonded, an alternate means is now required to be installed in the deck to create an equipotential grid.

680.26(C): The equipotential bonding grid required to be installed at a permanent swimming pool is now required to extend under walkways around the pool extending out from the inside edge of the pool a distance of not less than 3 ft.

680.26(C)(3): There are now three methods permitted for establishing an equipotential bonding grid for a permanent swimming pool. The two methods permitted in the past and still permitted is the reinforcing steel in the pool floor, walls, and surrounding deck, and a bolted or welded metal pool. A new method of establishing an equipotential bonding grid consists of size 8 AWG bare solid copper wire forming 1 ft squares on the bottom, sides, and deck extending out under the walkway a distance not less than 3 ft from the inside edge of the pool. The copper wires are required to be connected at every crossing point by a method described in *250.8*. This method of establishing an equipotential grid is not necessary if the method of *680.26(C)(1)* is used to establish the gird.

680.32: All 125 volt, 15- and 20-ampere receptacles located within 20 ft of the inside wall of a storable swimming pool is now required to be ground-fault circuit-interrupter protected.

680.34: This is a new section that does not permit any receptacle to be installed less than 10 ft from the inside edge of a storable swimming pool.

682.1: This is a new article that provides specifications for the installation of equipment in or on natural bodies of water such as lakes, ponds, rivers, and streams, and artificially made bodies of water such as aeration ponds, fish farm ponds, storm retention basins, treatment ponds, and irrigation channels.

682.2: An equipotential plane is defined as wire mesh or other metal elements placed under the surface of a walk and bonded to metal equipment to prevent a voltage difference from developing between the walk surface and the metal equipment. This definition states the wire mesh or conductive elements in the earth are located at a depth of not more than 3 in. below the surface.

682.2: Shoreline is defined as the perimeter of the water line when the water is at the highest point. This would be the elevation of the datum plane. This is the same datum plane that is used in *Article 555*.

682.12: Electrical equipment and enclosures that are not rated as submersible are required to be located not less than 12 in. above the datum plane.

682.14: Electrical equipment located in the water or on the surface of the water is required to have a disconnect located in sight of the shore and located not closer than 5 ft from the shoreline. It is necessary to determine the elevation of the datum plane before the shoreline can be located.

682.15: Ground-fault circuit-interrupter protection is required for equipment in or on the water that is supplied by a single-phase circuit rated not over 60 amperes, and operating at either 120 volts, 208 volts, or 240 volts.

682.31(A): Electrical equipment with exposed metal that is likely to become energized is required to be grounded with an insulated copper equipment grounding conductor sized using *Table 250.122*, and not smaller than size 12 AWG.

682.33(A): An equipotential plane is required to be installed in the earth or floor about all outdoor service equipment and disconnecting means. The equipotential plane is required to have an area the extends a minimum of 3 ft beyond the perimeter of the normal standing area of a person operating or maintaining the service or disconnect.

682.33(C): The equipotential plane is required to be bonded to the equipment grounding conductor in the disconnecting means or service equipment with a copper wire not smaller than size 8 AWG. The copper wire is to be connected to the equipotential plane by exothermic welding or by a pressure connector listed for the application.

690.35: Photovoltaic power sources are now permitted to be operated ungrounded. The direct current output conductors from the photovoltaic array are required to be provided with a disconnect, overcurrent

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protection, and a ground-fault detection system that indicates a ground-fault condition has occurred, and automatically disconnects all conductors from the source. The dc output conductors are required to be run as a sheathed cable or run in raceway. Warnings are to be placed at all points where the conductors may be accessible for servicing that a shock hazard may exist. The inverter or charge controller is required to be listed to operate with an ungrounded direct current input.

690.47(C): This section specifies the rules for grounding the ac and dc circuits of a photovoltaic power system. Subsection *(C)* is new and it deals with the usual case where there is a grounded ac system and a grounded dc system. This is a new requirement that permits the ac and dc circuits to be grounded to the same electrode. The rules for choosing a grounding electrode for a service are more restrictive. If there is a separate grounding electrode for the ac and dc system, then the two grounding electrodes are required to be bonded together using a conductor not smaller than the larger of the grounding electrode conductors from either the ac system or the dc system.

695.6(E): Listed Type MC cable with an impervious covering is now permitted as wiring to supply a fire pump motor.

700.27: The fine print note on overcurrent device coordination that was in *700.25* is not a requirement in this section. Coordination of overcurrent devices of the emergency system is now a requirement. This means that branch circuit overcurrent devices are required to open before feeder overcurrent devices open on a ground-fault or short-circuit. It will now be necessary to examine the time-current characteristics of overcurrent devices in the emergency system, to make sure the down line overcurrent devices open before the overcurrent devices near the source.

700.19: Overcurrent devices in a legally required standby system are now required to be coordinated. This means that branch circuit overcurrent devices are required to open before feeder overcurrent devices open on a ground-fault or short-circuit. It will now be necessary to examine the time-current characteristics of overcurrent devices in the emergency system to make sure the down line overcurrent devices open before the overcurrent devices near the source.

725.2: Circuit Integrity Cable (CI) is a new definition for remote control and signaling cable for critical circuits that is rated to survive fire conditions for a specified time.

725.61: Listed plenum signaling raceway is now permitted to be installed in other spaces used for environmental air, but not permitted to be installed in ducts or plenums. Cables permitted to be installed in the raceway are Types CL2P and CL3P.

The sections in this article were renumbered to create a consistency with the numbering of similar articles.

770.12(C): The term inner duct is used without a definition. Optical Fiber Raceway is manufactured with a square cross-section such as 2 in. by 2 in., 4 in. by 4 in., 4 in. by 8 in., and 4 in. by 12 in. It is also manufactured with a round cross-section corrugated for flexibility similar to Electrical Nonmetallic Tubing. This Optical Fiber Raceway with a round cross-section can be run inside other raceways and is commonly called inner duct. This section now recognizes listed flexible Optical Fiber Raceway and permits it to be installed inside any type of raceway system recognized by the Code that is suitable for the application.

770.12(D): Plastic inner duct of the unlisted underground type or the outside plant construction type is required to be terminated at the point of entrance to a building. Now firestopping is required to be installed at the point of entrance for these materials. These materials are considered to be highly combustible.

770.24: This is the section that specifies how Optical Fiber Cable is to be installed and supported. This section supplied few specific requirements in the past. Now Optical Fiber Cable is required to be installed according to the rules in *300.11*. There is no specific spacing requirement for supports, but there is now a rule that the cable must be supported by the structure of the building. If run above suspended ceilings, it is not permitted to be placed on the ceiling or supported by the ceiling support wires. It is permitted to add support wires specifically for the support of wiring such as Optical Fiber Cable. An installation above a suspended ceiling.

770.113 Exception 2: The previous edition of the Code permitted unlisted Optical Fiber Cable to be run through a building if installed in any acceptable raceway. Now only specific raceways are permitted to be used with unlisted Optical Fiber Cable, which are Rigid Metal Conduit, Intermediate Metal Conduit, Rigid Nonmetallic Conduit, and Electrical Metallic Tubing. Other types of raceways are not recognized for this application.

The most of the sections in this article were renumbered to be consistent with a new numbering system being applied to *Article 770, Article 800, Article 810, Article 820*, and *Article 830*.

800.2: Circuit Integrity Cable is now defined for communications cables as one that will continue operation for a specified period of time such as 2-hours. This cable is marked with the designation (CI).

800.24: This section specifies the installation of communications cable in buildings. There was an added

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reference to *300.11* which specifies how communications cable is to be installed above suspended ceilings. It is no longer permitted to be placed on the ceiling grid. It is permitted to be attached to support wires that are added to support wiring.

800.100(A)(4) FPN: This section specifies that for one- and two-family dwellings the length of the grounding electrode conductor for the primary protector is not permitted to exceed 20 ft. A new fine print note was added that suggests the primary protector grounding electrode conductor length be as short as possible to limit possible differences in voltage from developing between the communications ground and the electrical system ground during a lightning event for other types of buildings.

Table 2: This is a new table that gives radius of bends for conduit and tubing. It was *Table 344.24* in the previous edition of the Code. This table was moved to *Chapter 9* since other conduit and tubing articles use this table for determining the minimum radius of bends.

Table 4: The columns in this table give the cross-sectional area for the various percentages of fill as listed at the top of the column. The columns were rearranged, but there were no changes made in the numbers withing the column.

Table 8: The metric cross-sectional area of conductors was added to the table for sizes 250 kcmil through 2000 kcmil. This is the actual cross-sectional area of the metal conductor which is used for determination of conductor ampacity. The overall cross-sectional area of the conductors was given in the previous edition of the Code, and that value is used for conductor fill in raceways and conductor spacing in cable trays. An example of where this new data is used in when adjusting the size of an equipment grounding conductor because the ungrounded conductor size is increased to compensate for voltage drop.

Annex C, Note 2: The tables in *Annex C* are used to determine the minimum trade size conduit and tubing for conductors all of which are of the same size and have the same insulation . There is a two-hour fire-rated Type RHH insulation available for conductors, but it is thicker than other RHH insulation. Two-hour fire-rated RHH insulated conductors have a larger cross-sectional area than standard RHH insulated conductors. This means the tables in *Annex C* cannot be used to determine minimum conduit and tubing size for these conductors.

Example D2(c): The change has to do with the method of determining the heating load. This is due to a change in *220.82(D)(4)*. The heat pump is included in the calculation at 100% but now the supplemental electric heat load in included in the calculation at 65% rather than 100% which may result in a smaller size service required when a heat pump in installed in a single-family dwelling.

Example D3(a): This is an example of an industrial feeder calculation where two outbuildings are supplied 3-phase, 480/277 volt, 4-wire power from a main building. It is necessary to determine the continuous load and non-continuous load in the outbuildings and determine the minimum permitted overcurrent device rating for the feeders. The two feeders are run in the same conduit for a portion of the run, therefore, it is necessary to adjust the conductor ampacity for more than 3 current-carrying conductors in the raceway. The conduit is run such that the ambient temperature is 35°C which requires an ampacity adjustment for high ambient temperature. This is an excellent example that demonstrates how to determine whether the neutral conductors are to be counted as current-carrying conductors, and how to determine the minimum permitted wire size when ampacity adjustments are required.

2008 NEC Changes

For a complete analysis of the major changes to the 2008 *NEC* obtain a copy of *Interpreting the National Electrical Code*, 8th edition, Delmar - Cengage Learning, Clifton Park, NY available January 1, 2008. To order a copy contact Delmar - Cengage Learning at 1-800-648-7450 or on line at www.delmarelectric.com.

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