The Top 6 Changes to THE NEC® 2011

Extracted From
Mike Holt’s Illustrated Guide to Changes to the NEC® 2011

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**110.24 Available Fault Current**

A new section requires some equipment to be marked with the available fault current and requires updating of that marking if modifications of the electrical system occur.

### 110.24 Available Fault Current.

**(A) Field Marking.** Service equipment in other than dwelling units must be legibly field-marked with the maximum available fault current, including the date the fault current calculation was performed and be of sufficient durability to withstand the environment involved.

**Exception:** Field markings aren’t required for industrial installations where conditions of maintenance and supervision ensure that only qualified persons service the equipment.

### ANALYSIS:

All equipment must have an interrupting rating or short-circuit current rating that’s equal to or greater than the available fault current [110.9 and 110.10]. As premises wiring systems age, utilities may change transformers in an effort to become more efficient, or to increase capacity. When this occurs, the available fault current increases, many times resulting in noncompliant (and dangerous) wiring systems. This NEC change is intended to alert Code users to the fact that when utilities change transformers (or when emergency or standby systems are installed), the ratings of equipment must be reevaluated.

Opponents of this NEC change argue that oftentimes the ratings of equipment are based on a “worst case” basis. While this is suitable for designing a system, it isn’t suitable for performing the calculations required to establish the proper personal protective equipment (PPE) necessary to work on the equipment. When artificially high values of fault current are used for equipment ratings, a lower PPE rating is often the result of the calculations.
300.11(A)(2) Nonfire-Rated Ceiling Assemblies

The rule requiring identification of electrical ceiling support wires has been expanded.

300.11 Securing and Supporting.

(A) Secured in Place. Raceways, cable assemblies, boxes, cabinets, and fittings must be securely fastened in place. The ceiling-support wires or ceiling grid must not be used to support raceways and cables (power, signaling, or communications). However, independent support wires that are secured at both ends and provide secure support are permitted. Figure 300–10

Author’s Comment: Outlet boxes [314.23(D)] and luminaires can be secured to the suspended-ceiling grid if securely fastened to the ceiling-framing members by mechanical means such as bolts, screws, or rivets, or by the use of clips or other securing means identified for use with the type of ceiling-framing member(s) used [410.36(B)].

(1) Fire-Rated Ceiling Assembly. Electrical wiring within the cavity of a fire-rated floor-ceiling or roof-ceiling assembly can be supported by independent support wires attached to the ceiling assembly. The independent support wires must be distinguishable from the suspended-ceiling support wires by color, tagging, or other effective means.

(2) Nonfire-Rated Ceiling Assembly. Wiring in a nonfire-rated floor-ceiling or roof-ceiling assembly can be supported by independent support wires attached to the ceiling assembly. The independent support wires must be distinguishable from the suspended-ceiling support wires by color, tagging, or other effective means. Figure 300–11

ANALYSIS: Identification of ceiling-support wires that are used for electrical equipment was previously limited to those wires that are in fire-resistance-rated ceiling assemblies. In order to distinguish which wires are installed by the electrician and which are installed by the ceiling contractor, this change requires identification of the independent support wires for all ceiling systems, whether the ceiling assembly is fire-resistance rated or not.
310.15 Conductor Ampacity

This section, dealing with the ampacity of conductors, has been extensively revised.

310.15 Conductor Ampacity.

(A) General Requirements.

(1) Tables or Engineering Supervision. The ampacity of a conductor can be determined either by using the tables in accordance with 310.15(B), or under engineering supervision as provided in 310.15(C).

Note 1: Ampacities provided by this section don’t take voltage drop into consideration. See 210.19(A) Note 4, for branch circuits and 215.2(D) Note 2, for feeders.

(2) Conductor Ampacity—Lower Rating. Where more than one ampacity applies for a given circuit length, the lowest value must be used. Figure 310–6

Ex: When different ampacities apply to a length of conductor, the higher ampacity is permitted for the entire circuit if the reduced ampacity length doesn’t exceed 10 ft and its length doesn’t exceed 10 percent of the length of the higher ampacity. Figures 310–7 and 310–8

(3) Insulation Temperature Limitation. Conductors must not be used if the operating temperature exceeds that designated for the type of insulated conductor involved.

Note 1: The insulation temperature rating of a conductor is the maximum temperature a conductor can withstand over a prolonged time period without serious degradation. The main factors to consider for conductor operating temperature include:

(1) Ambient temperature may vary along the conductor length as well as from time to time [Table 310.15(B)(2)(a)].

(2) Heat generated internally in the conductor—load current flow.

(3) The rate at which generated heat dissipates into the ambient medium.
(4) Adjacent load-carrying conductors have the effect of raising the ambient temperature and impeding heat dissipation (Table 310.15(B)(3)(a)).

**Note 2:** See 110.14(C) for the temperature limitation of terminations.

**(B) Ampacity Table.** The allowable conductor ampacities listed in Table 310.15(B)(16) are based on conditions where the ambient temperature isn’t over 86°F, and no more than three current-carrying conductors are bundled together. **Figure 310–9**

The temperature correction and adjustment factors apply to the ampacity for the temperature rating of the conductor, provided the corrected and adjusted ampacity doesn’t exceed the ampacity for the temperature rating of the termination in accordance with the provisions of 110.14(C).

**(2) Ambient Temperature Correction Factors.** When conductors are installed in an ambient temperature other than 78°F to 86°F, the ampacities listed in Table 310.15(B)(16) must be corrected in accordance with the multipliers listed in Table 310.15(B)(2)(a). **Figure 310–10**

<table>
<thead>
<tr>
<th>Ambient Temperature °F</th>
<th>Ambient Temperature °C</th>
<th>Correction Factor 75°C Conductors</th>
<th>Correction Factor 90°C Conductors</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 or less</td>
<td>10 or less</td>
<td>1.20</td>
<td>1.15</td>
</tr>
<tr>
<td>51–59°F</td>
<td>11–15°C</td>
<td>1.15</td>
<td>1.12</td>
</tr>
<tr>
<td>60–68°F</td>
<td>16–20°C</td>
<td>1.11</td>
<td>1.08</td>
</tr>
<tr>
<td>69–77°F</td>
<td>21–25°C</td>
<td>1.05</td>
<td>1.04</td>
</tr>
<tr>
<td>78–86°F</td>
<td>26–30°C</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>87–95°F</td>
<td>31–35°C</td>
<td>0.94</td>
<td>0.96</td>
</tr>
<tr>
<td>96–104°F</td>
<td>36–40°C</td>
<td>0.88</td>
<td>0.91</td>
</tr>
<tr>
<td>105–113°F</td>
<td>41–45°C</td>
<td>0.82</td>
<td>0.87</td>
</tr>
<tr>
<td>114–122°F</td>
<td>46–50°C</td>
<td>0.75</td>
<td>0.82</td>
</tr>
<tr>
<td>123–131°F</td>
<td>51–55°C</td>
<td>0.67</td>
<td>0.76</td>
</tr>
<tr>
<td>132–140°F</td>
<td>56–60°C</td>
<td>0.58</td>
<td>0.71</td>
</tr>
<tr>
<td>141–149°F</td>
<td>61–65°C</td>
<td>0.47</td>
<td>0.65</td>
</tr>
<tr>
<td>150–158°F</td>
<td>66–70°C</td>
<td>0.33</td>
<td>0.58</td>
</tr>
<tr>
<td>159–167°F</td>
<td>71–75°C</td>
<td>0.00</td>
<td>0.50</td>
</tr>
<tr>
<td>168–176°F</td>
<td>76–80°C</td>
<td>0.00</td>
<td>0.41</td>
</tr>
<tr>
<td>177–185°F</td>
<td>81–85°C</td>
<td>0.00</td>
<td>0.29</td>
</tr>
</tbody>
</table>
Author's Comment: When adjusting conductor ampacity, the ampacity is based on the temperature insulation rating of the conductor as listed in Table 310.15(B)(16), not the temperature rating of the terminal [110.14(C)].

Question: What's the corrected ampacity of 3/0 THHN/THWN conductors in a dry location if the ambient temperature is 108°F?

(a) 173A  (b) 196A  (c) 213A  (d) 241A

Answer: (b) 196A
Conductor Ampacity [90°C] = 225A
Correction Factor [Table 310.15(B)(2)(a)] = 0.87
Corrected Ampacity = 225A x 0.87
Corrected Ampacity = 196A

Question: What's the corrected ampacity of 3/0 THHN/THWN conductors in a wet location if the ambient temperature is 108°F?

(a) 164A  (b) 196A  (c) 213A  (d) 241A

Answer: (a) 164A
Conductor Ampacity [75°C] = 200A
Correction Factor [Table 310.15(B)(2)(a)] = 0.82
Corrected Ampacity = 200A x 0.82
Corrected Ampacity = 164A

Author's Comment: When correcting conductor ampacity for elevated ambient temperature, the correction factor [310.15(B)(2)(a)] used for THHN/THWN conductors is based on the 90°C rating of the conductor in a dry location and 75°C rating of the conductor in a wet location, based on the conductor ampacity listed in Table 310.15(B)(16) [110.14(C)].

Question: What's the corrected ampacity of 3/0 THHN/THWN conductors in a dry location if the ambient temperature is 108°F?

(a) 173A  (b) 196A  (c) 213A  (d) 241A

Answer: (b) 196A
Conductor Ampacity [90°C] = 225A
Correction Factor [Table 310.15(B)(2)(a)] = 0.87
Corrected Ampacity = 225A x 0.87
Corrected Ampacity = 196A

Conductor Ampacity - Table 310.15(B)(16)
Adjustment Factor - AC and MC Cables
310.15(B)(3)(a)(4)

Ampacity adjustment doesn't apply to Type AC or MC cable when:
(a) Cable has no outer jacket.
(b) Each cable has no more than three current-carrying conductors.
(c) The conductors are 12 AWG copper.
(d) No more than 20 current-carrying conductors are installed without maintaining spacing.

If more than 20 current-carrying conductors are bundled, a 60% ampacity adjustment factor applies.

(B) Ampacity Table.

(3) Adjustment Factors.

(a) Conductor Bundle.

(4) Ampacity adjustment factors don’t apply to conductors within Type AC or Type MC cable under the following conditions: Figure 310–11

(a) The cables don't have an outer jacket.

(b) Each cable has no more than three current-carrying conductors.

(c) The conductors are 12 AWG copper, and

Figure 310–11

(d) No more than 20 current-carrying conductors (ten 2-wire cables or six 3-wire cables) are installed without maintaining spacing for a continuous length longer than 24 in.

(5) Ampacity adjustment of 60 percent applies to conductors within Type AC or Type MC cable without an overall outer jacket under the following conditions:

(b) The number of current-carrying conductors exceeds 20.

(c) The cables are stacked or bundled longer that measure 24 in. without spacing being maintained.

(c) Circular Raceways Exposed to Sunlight on Rooftops. When applying ampacity adjustment correction factors, the ambient temperature adjustment contained in Table 310.15(B)(3)(c) is added to the outdoor ambient temperature for conductors installed in circular raceways exposed to direct sunlight on or above rooftops to determine the applicable ambient temperature for ampacity correction factors in Table 310.15(B)(2)(a) or Table 310.15(B)(2)(b).

Note 1: See the ASHRAE Handbook—Fundamentals (www.ashrae.org) as a source for the average ambient temperatures in various locations.

Note 2: The temperature adders in Table 310.15(B)(3)(c) are based on the results of averaging the ambient temperatures.
When adjusting conductor ampacity, use the conductor ampacity as listed in Table 310.15(B)(16) based on the conductors’ insulation rating; in this case, it’s 75A at 90°F. Conductor ampacity adjustment isn’t based on the temperature terminal rating in accordance with 110.14(C).

Table 310.15(B)(3)(c) Ambient Temperature Adder for Raceways On or Above Rooftops

<table>
<thead>
<tr>
<th>Distance of Raceway Above Roof</th>
<th>°C</th>
<th>°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to ½ in.</td>
<td>33</td>
<td>60</td>
</tr>
<tr>
<td>Above ½ in. to 3½ in.</td>
<td>22</td>
<td>40</td>
</tr>
<tr>
<td>Above 3½ in. to 12 in.</td>
<td>17</td>
<td>30</td>
</tr>
<tr>
<td>Above 12 in. to 36 in.</td>
<td>14</td>
<td>25</td>
</tr>
</tbody>
</table>

Author's Comment: This rule requires the ambient temperature used for ampacity correction to be adjusted where conductors or cables are installed in a circular raceway on or above a rooftop and the raceway is exposed to direct sunlight. The reasoning is that the air inside circular raceways in direct sunlight is significantly hotter than the surrounding air, and appropriate ampacity corrections must be made in order to comply with 310.10.

For example, a conduit with three 6 THWN-2 conductors with direct sunlight exposure that’s ¾ in. above the roof will require 40°F to be added to the correction factors on Table 310.15(B)(2)(a). Assuming an ambient temperature of 90°F, the temperature to use for conductor ampacity correction will be 130°F (90°F + 40°F), the 6 THWN-2 conductor ampacity after correction will be 57A (75A x 0.76). Figure 310–12
Table 310.15(B)(16) Allowable Ampacities of Insulated Conductors Based on Not More Than Three Current-Carrying Conductors and Ambient Temperature of 30°C (86°F)*

<table>
<thead>
<tr>
<th>Size</th>
<th>Temperature Rating of Conductor, See Table 310.13</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWG</td>
<td>60°C (140°F)</td>
<td>AWG kcmil</td>
</tr>
<tr>
<td>kcmil</td>
<td>75°C (167°F)</td>
<td>kcmil</td>
</tr>
<tr>
<td>TW</td>
<td>90°C (194°F)</td>
<td>TW</td>
</tr>
<tr>
<td>THHW</td>
<td>60°C (140°F)</td>
<td>THHW</td>
</tr>
<tr>
<td>THW</td>
<td>75°C (167°F)</td>
<td>THW</td>
</tr>
<tr>
<td>THWN</td>
<td>90°C (194°F)</td>
<td>THWN</td>
</tr>
<tr>
<td>XHHW</td>
<td>TW</td>
<td>XHHW</td>
</tr>
<tr>
<td>THHN</td>
<td>75°C (167°F)</td>
<td>THHN</td>
</tr>
<tr>
<td>THW-2</td>
<td>90°C (194°F)</td>
<td>THW-2</td>
</tr>
<tr>
<td>THWN-2</td>
<td>60°C (140°F)</td>
<td>THWN-2</td>
</tr>
<tr>
<td>XHHW-2</td>
<td>75°C (167°F)</td>
<td>XHHW-2</td>
</tr>
<tr>
<td>THW</td>
<td>90°C (194°F)</td>
<td>THW</td>
</tr>
<tr>
<td>THWN</td>
<td>60°C (140°F)</td>
<td>THWN</td>
</tr>
<tr>
<td>XHHW</td>
<td>75°C (167°F)</td>
<td>XHHW</td>
</tr>
<tr>
<td>THHN</td>
<td>90°C (194°F)</td>
<td>THHN</td>
</tr>
<tr>
<td>THW-2</td>
<td>60°C (140°F)</td>
<td>THW-2</td>
</tr>
<tr>
<td>THWN-2</td>
<td>75°C (167°F)</td>
<td>THWN-2</td>
</tr>
<tr>
<td>XHHW-2</td>
<td>90°C (194°F)</td>
<td>XHHW-2</td>
</tr>
<tr>
<td>Copper</td>
<td>Wet Location</td>
<td>Wet Location</td>
</tr>
<tr>
<td>Aluminum/Copper-Clad Aluminum</td>
<td>Dry Location</td>
<td></td>
</tr>
<tr>
<td>14*</td>
<td>15</td>
<td>14*</td>
</tr>
<tr>
<td>12*</td>
<td>20</td>
<td>12*</td>
</tr>
<tr>
<td>10*</td>
<td>30</td>
<td>10*</td>
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<td>2</td>
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<td>1</td>
<td>110</td>
<td>1</td>
</tr>
<tr>
<td>1/0</td>
<td>125</td>
<td>1/0</td>
</tr>
<tr>
<td>2/0</td>
<td>145</td>
<td>2/0</td>
</tr>
<tr>
<td>3/0</td>
<td>165</td>
<td>3/0</td>
</tr>
<tr>
<td>4/0</td>
<td>195</td>
<td>4/0</td>
</tr>
<tr>
<td>250</td>
<td>215</td>
<td>250</td>
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<td>240</td>
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<td>400</td>
<td>280</td>
<td>400</td>
</tr>
<tr>
<td>500</td>
<td>320</td>
<td>500</td>
</tr>
</tbody>
</table>

*See 240.4(D)
colder environments, it allowed only for an increase to 104 percent of the conductor’s ampacity, a value that never really made the math worthwhile.

Previous editions of the NEC used the term “nipple” to describe a raceway that’s 24 in. or less in length. This resulted in Code users debating about the physical characteristics of the raceways, such as whether or not the raceway could contain bends. This change takes away that argument by removing the term “nipple(s)” and replacing it with “raceway(s).” One no longer needs to guess at the intent of this section, and needs now only to measure the length and determine the appropriate rules.

The term “bundled” has been used for several Code cycles to describe when ampacity adjustment is required. Because the term isn’t defined in Article 100, many people struggle in their attempts to determine when to apply the adjustment provisions of this section. While the phrase “installed without maintaining spacing” is also not defined, some NEC users may find it an easier phrase to understand and apply. This change isn’t intended to be a technical one, but rather an editorial one.

New to the 2008 Code came a rule requiring that all conductors installed in conduits on rooftops have their ampacities adjusted dramatically. The term “conduit,” while not defined in the NEC, doesn’t include raceways such as EMT, ENT, and FMT. With this change, conductors installed in these raceways will now have to have their ampacities adjusted as well.

The ampacity of some conductors in Table 310.15(B)(16) (formerly 310.16) didn’t match those found in the Canadian Electrical Code and were therefore changed. While no technical evidence was submitted showing insulation failure of the conductors, this proposal was passed. The end result was a change to the ampacities of:

Copper conductors: 14, 12, 3, and 1 AWG, and 600 kcmil, 1,500 kcmil and 2,000 kcmil.

Aluminum conductors: 12, 8, and 6 AWG, and 300 kcmil, 700 kcmil, and 800 kcmil.
404.2(C) Switches Controlling Lighting

A new rule will require a neutral conductor at nearly every switch point.

404.2 Switch Connections.

(C) Switches Controlling Lighting. Switches controlling line-to-neutral lighting loads must have a neutral provided at the switch location.

Ex: The neutral conductor isn’t required at the switch location if:

1) The conductors for switches enter the device box through a raceway that has sufficient cross-sectional area to accommodate a neutral conductor. Figure 404–1

2) Cable assemblies for switches enter the box through a framing cavity that’s open at the top or bottom on the same floor level, or through a wall, floor, or ceiling that’s unfinished on one side. Figure 404–2

Note: The purpose of the neutral conductor is to complete a circuit path for electronic lighting control devices.

ANALYSIS: Many lighting control devices (such as occupancy sensors) require that the switch be provided with standby voltage and current at the switch in order to operate. Many electricians don’t include a neutral conductor at switch locations, and the unfortunate result is the equipment grounding conductor being used as the neutral conductor. While the current on the equipment grounding conductor is typically less than 0.50 mA, the accumulation of many switches in a building can result in an unacceptable amount of current on the equipment grounding conductors. With this change, gone are the days of using dead end 3-way switches and two conductor switch loops.

The two exceptions address switch locations that use raceways, and locations that are at or near unfinished/accessible areas. The use of a raceway obviously allows the installer to pull in a neutral conductor should the need arise (provided the raceway is of adequate size), and the other exception allows for changing the wiring of the switch without resorting to removing drywall and other finish materials.

An Informational Note emphasizes the fact that this provision is for adding a dimmer switch. It is a bit surprising to see this Informational Note, due to the fact that statements of intent are typically not allowed in the Code.
406.4(D) Receptacle Replacements

A new requirement addresses the replacement of receptacles in areas requiring AFCI protection, tamper-resistant receptacles, or weather-resistant receptacles.

406.4 General Installation Requirements.

(D) Receptacle Replacement.

(4) Arc-Fault Circuit Interrupters. Effective January 1, 2014, where a receptacle outlet is supplied by a branch circuit that requires arc-fault circuit-interrupter protection [210.12(A)], a replacement receptacle at this outlet must be one of the following.

(1) A listed (receptacle) outlet branch-circuit type arc-fault circuit-interrupter receptacle.

(2) A receptacle protected by a listed (receptacle) outlet branch-circuit type arc-fault circuit-interrupter type receptacle.

(3) A receptacle protected by a listed combination type arc-fault circuit interrupter type circuit breaker.

(5) Tamper-Resistant Receptacles. Listed tamper-resistant receptacles must be provided where replacements are made at receptacle outlets that are required to be tamper resistant elsewhere in this Code.

(6) Weather-Resistant Receptacles. Weather-resistant receptacles must be provided where replacements are made at receptacle outlets that are required to be so protected elsewhere in the Code.

Analysis: As aging wiring systems become more and more of a concern in the electrical industry, the Code is taking a proactive approach to providing protection of these systems. Many areas of a dwelling require the use of AFCI protection, in an effort to help avoid electrical fires. When AFCIs were first introduced into the NEC, the substantiation for their inclusion was based largely on electrical fires in older homes. With the inception of these devices the Code began protecting new and future wiring systems, but didn’t address the older ones that contained many of the fires discussed in the AFCI arguments. This change expands the AFCI requirements to older homes. These older homes often don’t contain an equipment grounding conductor, so installation of an AFCI circuit breaker does very, very little in the way of protecting the branch circuits. The receptacle type AFCIs also provide a significantly lower level of protection, but they will be required nonetheless.

This requirement has an effective date of Jan. 1, 2014.

The 2008 NEC introduced the concept of tamper-resistant receptacles in dwelling units. The requirements of that section (406.11, now 406.12) apply to new installations. It could have been argued that one could install tamper-resistant receptacles in the locations required by 406.11, then remove them and replace them with traditional receptacles. While most people will agree that this argument is a huge stretch of the imagination, this change eliminates it before it can come up. It also requires that on existing dwelling units, any receptacles that are replaced will need to be replaced using tamper-resistant receptacles.

A similar change was made for weather-resistant receptacles, using the same logic as tamper-resistant receptacles.
450.14 Disconnecting Means
A new section will require a disconnecting means for most transformers.

**450.14 Disconnecting Means.** For transformers, other than Class 2 and Class 3, a means is required to disconnect all transformer ungrounded primary conductors. The disconnecting means must be located within sight of the transformer unless the location of the disconnect is field-marked on the transformer and the disconnect is lockable. Figure 450–1

**Author’s Comment:** “Within Sight” is visible and not more than 50 ft from each other [Article 100].

**ANALYSIS:** Although many Code users have believed that this requirement already existed, in previous NEC editions transformers were one of the only pieces of equipment that didn’t require a disconnecting means. Although there were no documented injuries to warrant this change, it’s hard to argue that this requirement doesn’t enhance safety.

![Figure 450–1](image-url)
CHAPTER 1. GENERAL

Article 110. Requirements for Electrical Installations

1. _____ in other than dwelling units must be legibly field marked with the maximum available fault current, including the date the fault current calculation was performed and be of sufficient durability to withstand the environment involved.
   (a) Service equipment
   (b) Sub panels
   (c) Motor control centers
   (d) all of these

2. When modifications to the electrical installation affect the maximum available fault current at the service, the maximum available fault current shall be _____ to ensure the service equipment ratings are sufficient for the maximum available fault current at the line terminals of the equipment.
   (a) recalculated
   (b) increased
   (c) decreased
   (d) adjusted

3. Field markings of maximum available fault current at a service are not required for industrial installations where conditions of maintenance and supervision ensure that only qualified persons service the equipment.
   (a) True
   (b) False

CHAPTER 3. WIRING METHODS AND MATERIALS

Article 300. Wiring Methods

1. The independent support wires for supporting electrical wiring methods in a fire-rated ceiling assembly shall be distinguishable from fire-rated suspended-ceiling framing support wires by _____.
   (a) color
   (b) tagging
   (c) other effective means
   (d) any of these

2. Ceiling-support wires used for the support of electrical raceways and cables within nonfire-rated assemblies shall be distinguishable from the suspended-ceiling framing support wires.
   (a) True
   (b) False

Article 310. Conductors for General Wiring

1. The _____ rating of a conductor is the maximum temperature, at any location along its length, which the conductor can withstand over a prolonged period of time without serious degradation.
   (a) ambient
   (b) temperature
   (c) maximum withstand
   (d) short-circuit
2. There are four principal determinants of conductor operating temperature, one of which is _____ generated internally in the conductor as the result of load current flow.
   (a) friction
   (b) magnetism
   (c) heat
   (d) none of these

3. The ampacities listed in the Tables of Article 310.15(B)(6) do not take _____ into consideration.
   (a) continuous loads
   (b) voltage drop
   (c) insulation
   (d) wet locations

4. The ampacity of a conductor can be different along the length of the conductor. The higher ampacity can be used beyond the point of transition for a distance of no more than _____ ft, or no more than _____ percent of the circuit length figured at the higher ampacity, whichever is less.
   (a) 10, 10
   (b) 10, 20
   (c) 15, 15
   (d) 20, 10

5. The ampacity adjustment factors of Table 310.15(B)(3)(a) does not apply to Type AC or Type MC cable without an overall outer jacket, if which of the following conditions are met?
   (a) Each cable has not more than three current-carrying conductors.
   (b) The conductors are 12 AWG copper.
   (c) No more than 20 current-carrying conductors are installed without maintaining spacing.
   (d) all of these

6. Where conductors or cables are installed in circular conduits exposed to direct sunlight on or above rooftops, the ambient temperature shall be increased by _____ where the conduits are less than ½ in. from the rooftop.
   (a) 30°F
   (b) 40°F
   (c) 50°F
   (d) 60°F

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**CHAPTER 4. EQUIPMENT FOR GENERAL USE**

**Article 404. Switches**

1. Switches controlling line-to-neutral lighting loads must have a neutral provided at the switch location unless _____.
   (a) the conductors for switches enter the device box through a raceway that has sufficient cross-sectional area to accommodate a neutral conductor
   (b) cable assemblies for switches enter the box through a framing cavity that's open at the top or bottom on the same floor level, or through a wall, floor, or ceiling that's unfinished on one side
   (c) the lighting consists of all fluorescent fixtures with integral disconnects for the ballasts
   (d) a or b

**Article 406. Receptacles, Cord Connectors, and Attachment Plugs (Caps)**

1. Effective January 1, 2014, where a receptacle outlet is supplied by a branch circuit that requires arc-fault circuit interrupter protection [210.12(A)], a replacement receptacle at this outlet shall be _____.
   (a) a listed (receptacle) outlet branch circuit type arc-fault circuit interrupter receptacle
   (b) a receptacle protected by a listed (receptacle) outlet branch circuit type arc-fault circuit interrupter type receptacle
   (c) a receptacle protected by a listed combination type arc-fault circuit interrupter type circuit breaker
   (d) all of these
2. Listed tamper-resistant receptacles shall be provided where replacements are made at receptacle outlets that are required to be tamper resistant elsewhere in this Code.
   
   (a) True
   (b) False

3. Weather-resistant receptacles _____ where replacements are made at receptacle outlets that are required to be so protected elsewhere in the Code.
   
   (a) shall be provided
   (b) are not required
   (c) are optional
   (d) are not allowed

Article 450. Transformers and Transformer Vaults

1. For transformers, other than Class 2 and Class 3, a means is required to disconnect all transformer ungrounded primary conductors. The disconnecting means must be located within sight of the transformer unless the _____.
   
   (a) disconnect location is field-marked on the transformer
   (b) disconnect is lockable
   (c) disconnect is non-fusible
   (d) a and b
CHAPTER 1—GENERAL
Article 110. Requirements for Electrical Installations
1. (a) 110.24(A)
2. (a) 110.24(B)
3. (a) 110.24(B) Ex

CHAPTER 3—WIRING METHODS AND MATERIALS
Article 300. Wiring Methods
1. (d) 300.11(A)(1)
2. (a) 300.11(A)(2)

Article 310. Conductors for General Wiring
1. (b) 310.15(A)(3) Note 1
2. (c) 310.15(A)(3) Note 1(2)
3. (b) 310.15(A)(1) Note 1
4. (a) 310.15(A)(2) Ex
5. (d) 310.15(B)(3)(a)(4)
6. (d) 310.15(B)(3)(c), and Table 310.15(B)(3)(c)

CHAPTER 4—EQUIPMENT FOR GENERAL USE
Article 404. Switches
1. (d) 404.2(C) Ex 1 and 2

Article 406. Receptacles, Cord Connectors, and Attachment Plugs (Caps)
1. (d) 406.4(D)(4)(1),(2), and(3)
2. (a) 406.4(D)(5)
3. (a) 406.4(D)(6)

Article 450. Transformers and Transformer Vaults
1. (d) 450.14
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