Significant Changes to Chapters 3 &4 2008 & 2011 National Electric Code

1

Welcome

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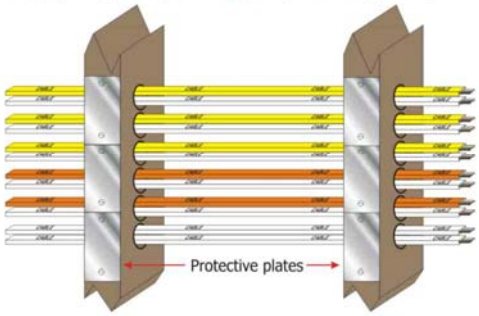
Which Edition

- Significant changes to the 2008 NEC will be represented with the 2008 NEC in the upper left corner of the slide.

- Significant changes to the 2011 NEC will be represented with the 2011 NEC in the upper left corner of the slide.

300.4(A)(1) Bored Holes

Multiple plates (stacked) or bushings are permitted to provide protection



Protective steel plates to cover the area of the wiring with appropriate length and width protection.

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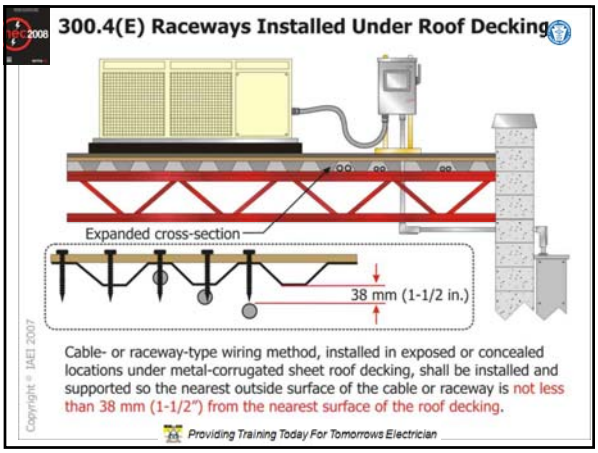

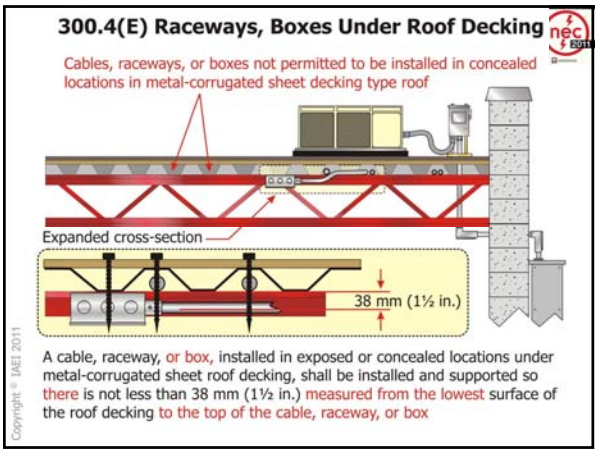

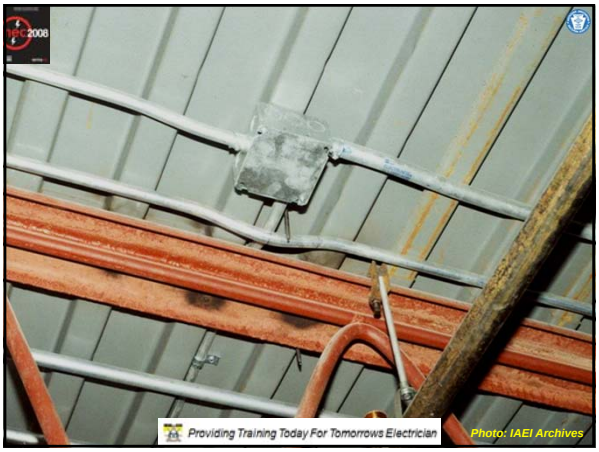

300.4(G) Insulating Fittings

- Where raceways containing <u>insulated</u> circuit conductors in sizes 4 AWG and larger enter a cabinet, box, equipment, and so forth, the conductors are required to be protected from abrasion.
- The word "insulated" has been inserted in this section for clarification.

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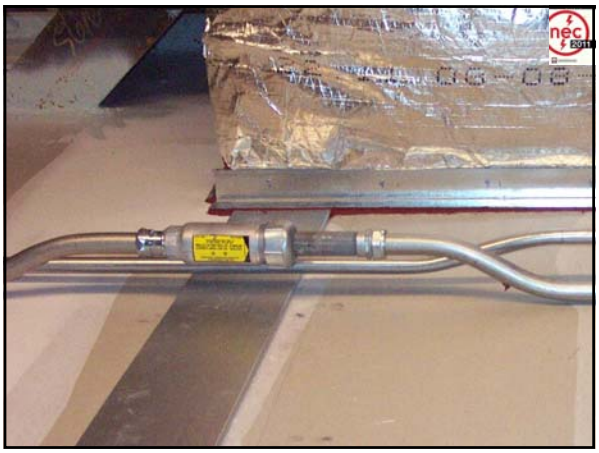


Table 300.5 Minimum Cover Requirements, 0 to 600 Volts, Nominal

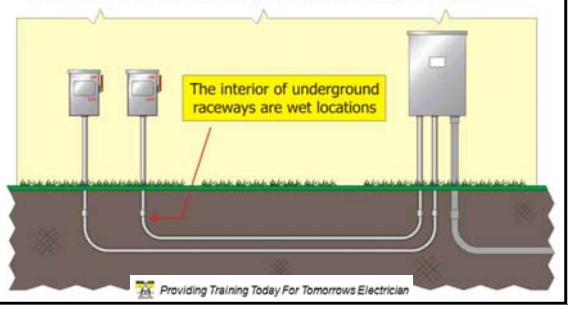
REVISION

- The text in Columns 1, 4, and 5 of Table 300.5 has been revised to include the wording "(in a raceway or Type MC or Type MI cables identified for direct burial)" and a depth of 0 inches.
- Type MC and Type MI cables can be installed in the earth under a building as allowed by the new exceptions to 300.5(C) according to specific provisions within each respective wiring method article.
- The cables used in these applications must be suitable for installation in direct burial with the earth.

300.5(B) Wet Locations

The interior of enclosures or raceways installed underground shall be considered to be a wet location.

Insulated conductors installed in wet locations are required to be listed for use in wet locations and shall comply with 310.8(C).



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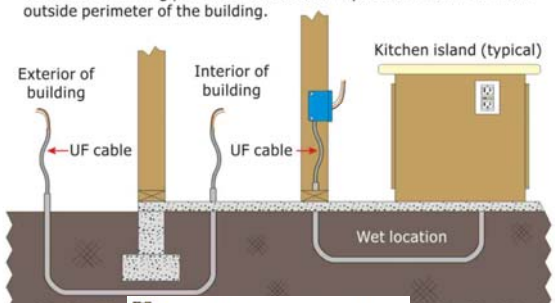
300.5(B) Wet Locations and (C) Underground Cables Under Buildings

- Renamed "Wet Locations" and clarifies that the interior of all raceways and enclosures installed underground are "wet locations."
- Requires all underground cable installed under a building to be installed in a raceway.

300.5(C) Underground Cable Under Buildings

Underground cables installed under buildings shall be in a raceway.

This requirement applies to cables routed from under the building to outside the building perimeter and to raceways that remain within the outside perimeter of the building.



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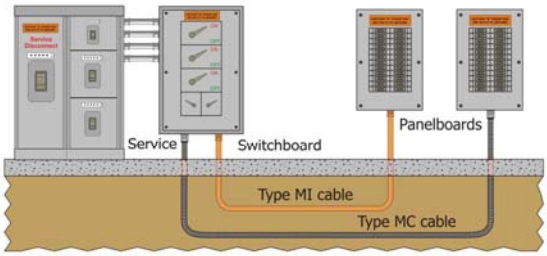
300.5(C) Underground Cables Under Buildings

Underground cable installed under a building required to be in a raceway



Ex. No. 1: Type MI cable where embedded in concrete, fill, or other masonry or in underground runs where suitably protected against physical damage and corrosive conditions

Ex. No. 2: Type MC cable listed for direct burial or concrete encasement or in wet locations with a covering impervious to moisture

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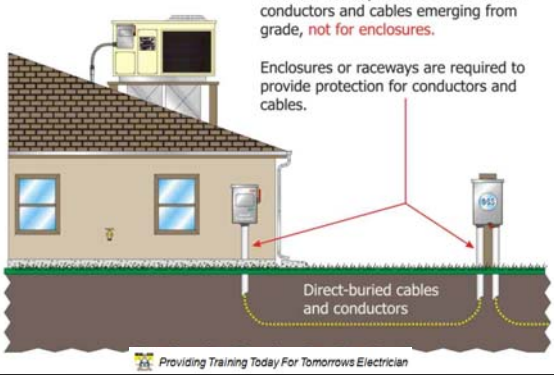
300.5(D)(1) Emerging From Grade

Protection is required for direct-buried conductors and cables emerging from grade, not for enclosures.

Enclosures or raceways are required to provide protection for conductors and cables.



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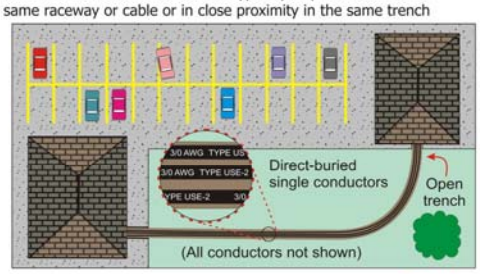
300.5(I) Ex. No. 1 Underground Installations

All conductors of the same circuit typically required to be installed in the same raceway or cable or in close proximity in the same trench



Conductors permitted to be installed in parallel in raceways, multi-conductor cables, or direct-buried single-conductor cables

Each direct-buried single-conductor cable permitted in close proximity in a trench to the other single-conductor cables in the same parallel set of conductors in the circuit

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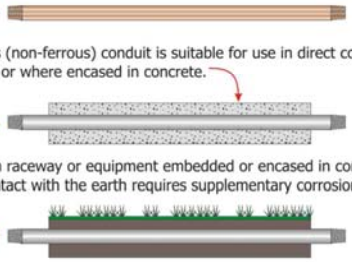
300.6(B) Aluminum Metal Equipment

Aluminum raceways, cable trays, cablebus, auxiliary gutters, cable armor, boxes, cable sheathing, cabinets, elbows, couplings, nipples, fittings, supports, and support hardware embedded or encased in concrete or in direct contact with the earth shall be provided with supplementary corrosion protection.



Red brass (non-ferrous) conduit is suitable for use in direct contact with the earth or where encased in concrete.

Aluminum raceway or equipment embedded or encased in concrete or in direct contact with the earth requires supplementary corrosion protection.

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300.6(B) Aluminum Metal Equipment

- The requirements of 300.6(B) for supplementary corrosion protection for nonferrous metals in concrete, or direct contact with earth, is now clarified and limited to aluminum. Red brass is permitted and does not require supplementary corrosion protection.

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300.7(B) Expansion Fittings

- The FPN includes a multiplier to apply when determining the expansion of aluminum raceways exposed to different temperatures. This multiplier is applied to the values in Table 352.44.
- The FPN also references Table 355.44 for expansion characteristics of Reinforced Thermosetting Resin Conduit (RTRC)

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300.9 Raceways in Wet Locations Above Grade

- All above grade installations of raceways in “wet locations” recognize the interior of the raceway as a “wet location.”

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300.11(A) Secured in Place

- Where an independent means of secure support such as a support wire, is installed in a non-fired rated assembly to support wiring methods and materials listed in 300.11(A), the support wire is permitted to be attached to the assembly.

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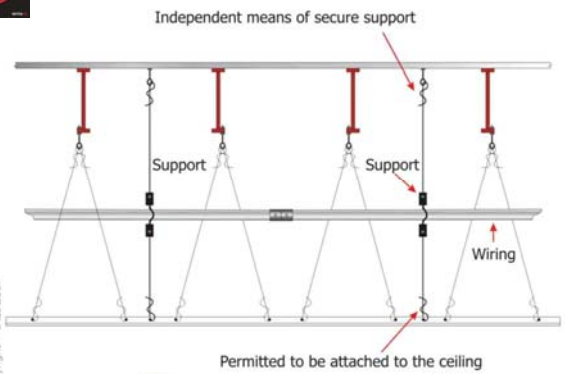
300.11(A)(2) Non-Fire-Rated Assemblies



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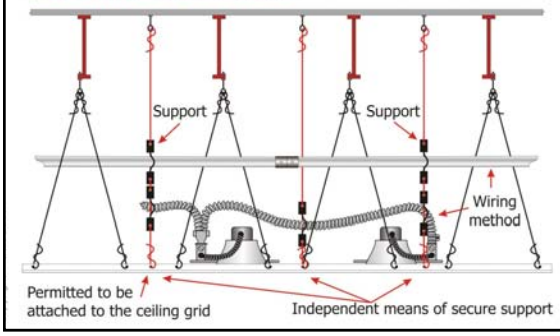
300.11(A)(2) Non-Fire-Rated Assemblies

- New language was added requiring identification of independent wiring method support ceiling wires in non-fire-rated assemblies
- Previous language only required additional wiring method support wires to be distinguishably marked for fire-rated assemblies
- Acceptable identification methods could include such things as painting, tagging or other forms of identification
- This will also assist both installers and inspectors to be able to determine which support wires are acceptable for supporting wiring methods

300.11(A)(2) Non-Fire-Rated Assemblies

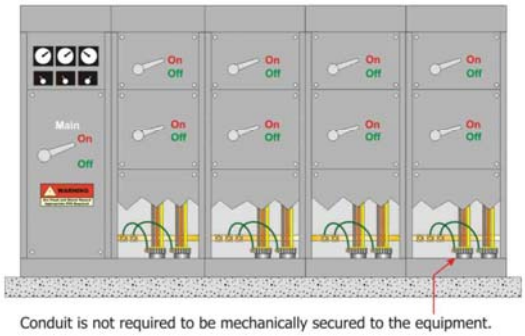
An independent means of secure support to be provided for wiring methods

Where independent support wires are used, they shall be distinguishable by color, tagging, or other effective means



300.12 Exception No. 2

Exception No. 2 applies to open bottom equipment such as switchboards, motor control centers, and transformers.



300.19(B) Fire Rated Cables and Conductors

- Addresses the installation of "fire-rated cables and conductors."
- Mandates the conductors be installed in accordance with manufacturer's instructions.

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300.20(A) Conductors Grouped Together

- Requires "ferrous" metal enclosures or "ferrous" metal raceways to group conductors.
- Avoids heating through induction.

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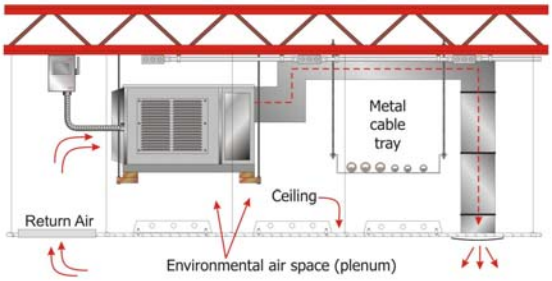
300.22 Wiring in Environmental Air Space

Section 300.22 was rewritten to simplify the requirements based on the areas of installation, and new 300.22(C)(2) was inserted to cover cable trays in other spaces for environmental air (plenums)

Metal cable trays permitted to support the wiring methods in 300.22(C)(1)



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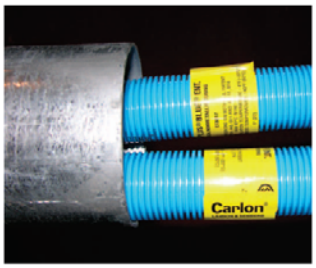
300.22(C) Other Spaces Used for Environmental Air



- Raceways such as ENT or optical fiber raceways may be installed in recognized raceways in these spaces.

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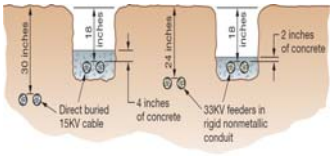
Table 300.50 Minimum Cover Requirements



- A new Note 3 to Table 300.50 allows a reduction in burial depth for wiring methods other than RMC or IMC in industrial establishments.
- Where conditions of maintenance and supervision ensure that qualified persons will service the installation, the burial depth may be reduced by 6-inches, for each 2-inches of concrete installed.

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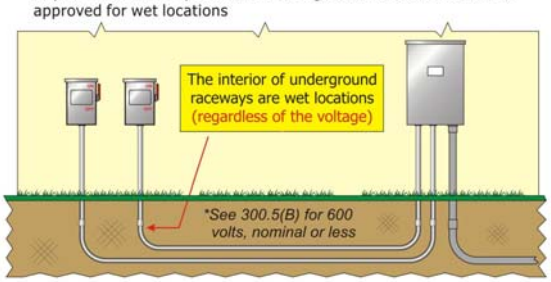
300.50(B) Wet Locations (over 600 Volts)

The interior of enclosures or raceways installed underground shall be considered to be a wet location (regardless of the voltage)

Insulated conductors installed in wet locations are required to be listed for use in wet locations and shall comply with 310.10(C)

Any connections or splices in an underground installation shall be approved for wet locations



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Article 310 - Conductors for General Wiring

Article 310 - (2011 NEC)

I. General
- 310.1 Scope
- 310.2 Definitions

II. Installation
- 310.10 Uses Permitted
- 310.15 Ampacities for Conductors Rated 0–2000 Volts
- 310.60 Conductors Rated 2001 to 35,000 Volts

III. Construction Specifications
- 310.104 Conductor Constructions and Applications
- 310.106 Conductors
- 310.110 Conductor Identification
- 310.120 Marking

Article 310 received and extensive reorganization for the 2011 *NEC* in an effort to comply with the *NEC* Style Manual and provide consistency with other *NEC* Chapter 3 articles

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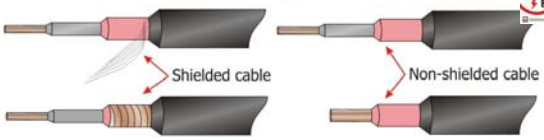
310.4 Conductors in Parallel

- 310.4 Conductors in Parallel – Reorganization
- (A) General. [The existing first paragraph of the rule located here.]
- Existing Exception Nos. 1, 2 and 3 to (A) General
- (B) Conductor Characteristics. [The existing text in the second paragraph and items (1) through (5) located here in new subdivision (B).]
- (C) Separate Cables or Raceways.
- (D) Ampacity Adjustment. Conductors installed in parallel shall comply with the provisions of 310.15(B)(2)(a).
- (E) Equipment Grounding Conductors.

310.6 Shielding

- Medium-voltage shielding is required to be connected to a grounding electrode conductor, grounding busbar in equipment, or to a grounding electrode.

310.10(E) Shielding of Conductors



Shielded cable generally required for voltages greater than 2000 volts

Non-shielded, ozone-resistant insulated conductors permitted in Type MC cables
- Maximum phase-to-phase voltage of 5000 volts
- Industrial establishments only where the conditions of maintenance and supervision ensure that only qualified persons service the installation

Non-shielded cable permitted for use with the following:
- Maximum 2400 volts listed by qualified testing laboratory (Ex. No. 1)
- Replacement of existing nonshielded conductors (up to 5000 volts with existing equipment in industrial establishments only) (Ex. No. 2)
- Airfield lighting cable (series circuits up to 5000 volts powered by regulators) (Ex. No. 3)

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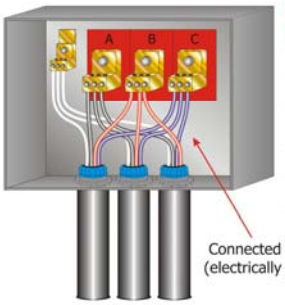
310.10(H)(1) Conductors in Parallel

Only conductors in sizes 1/0 AWG and larger, comprising each phase, polarity, neutral, or grounded circuit conductor shall be connected in parallel



Where conductors of size 1/0 and larger are installed in parallel, must be installed as follows:

(1) Same length

(2) Consist of same conductor material

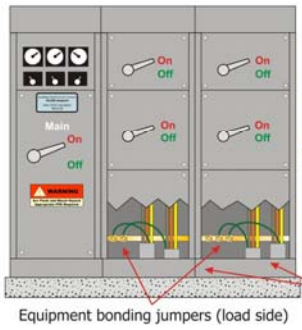
(3) Same circular mil area

(4) Same insulation type

(5) Terminated in same manner

310.10(H)(6) EBJs Installed in Parallel

Where parallel equipment bonding jumpers are installed in raceways, they are required to be sized and installed in accordance with 250.102



Size supply-side bonding jumper for each raceway or cable from Table 250.66 based on size of ungrounded supply conductors in each raceway or cable [250.102(C)(1) and (C)(2)]

Size equipment bonding jumpers (load side) in accordance with 250.122 (overcurrent device ahead of equipment) [250.122(D)]

Feeders (installed in parallel)

Equipment bonding jumpers (load side)

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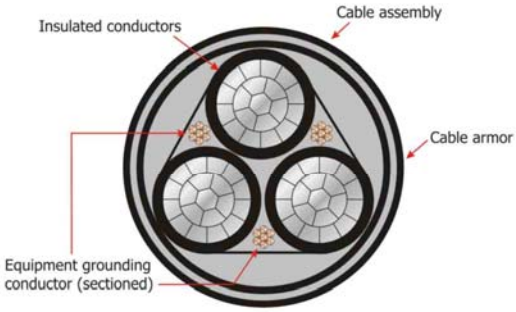
310.13 Conductor Constructions and Applications



Equipment grounding conductors shall be permitted to be sectioned within a listed multiconductor cable assembly.

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Article 310 Ampacity Tables

- All tables located within Article 310 were renumbered in the 2011 *NEC*
- Article 310 *(Conductors for General Wiring)* went through extensive reorganization for the 2011 *NEC*
- This reorganization had an extreme impact on the tables within the article as well
- This was an effort to bring the table numbering in line with the *NEC* Style Manual
- *NEC Style Manual* Section 2.3.1 - "Tables and figures shall be referenced in the text and shall be designated by the number of the *NEC* rule in which they are referenced"

Article 310 Tables Comparison Chart

2008 NEC	Table Title	2011 NEC
310.15(B)(2)(a)	Adjustment Factors for More Than Three Current-Conductor in a Raceway or Cable	310.15(B)(3)(a)
310.15(B)(2)(c)	Ambient Temperature Adjustment for Conduits Exposed to Sunlight On or Above Rooftops	310.15(B)(3)(c)
310.15(B)(6)	Conductor Types and Sizes for 120/240-Volt, ~~3-Wire~~, Single-Phase Dwelling Services and Feeders	310.15(B)(7)
310.16	Allowable Ampacities of Insulated Conductors Rated Up to and Including 2000 Volts, 60°C Through 90°C (140°F Through 194°F), Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)	310.15(B)(16)
310.16 *(bottom of Table)*	Ambient Temperature Correction Factors Based on 30°C (86°F)	310.15(B)(2)(a)
(Not in '08 NEC)	Ambient Temperature Correction Factors	310.60(C)(4)
310.68	Ampacities of Insulated Single Aluminum Conductor Cables Triplexed in Air Based on Conductor Temperatures of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)	310.60(C)(68)

Article 310 Table Comparison Chart (in part)

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310.15(B)(2) (a) Adjustment Factors, More Than Three Current-Carrying Conductors in a Raceway or Cable

- Single conductors and multiconductor cables installed without maintaining spacing for a "continuous" length of 24 inches must be derated.
- Terms "stacked or bundled" are deleted and replaced with "the words "installed without maintaining spacing".

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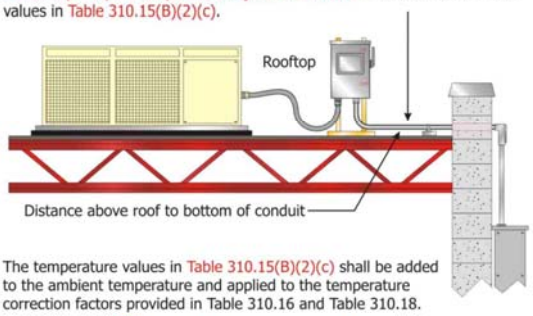
310.15(B)(2)(c) Conduits Exposed to Sunlight on Rooftops

Conductors or cables installed in conduit or tubing exposed to direct sunlight on rooftops require temperature adjustment factors in accordance with the values in Table 310.15(B)(2)(c).



The temperature values in Table 310.15(B)(2)(c) shall be added to the ambient temperature and applied to the temperature correction factors provided in Table 310.16 and Table 310.18.

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Table 310.15(B)(2)(c)

Table 310.15(B)(2)(c) Ambient Temperature Adjustment for Conduits Exposed to Sunlight On of Above Rooftops

Distance Above Roof to Bottom of Conduit	Temperature Added	
	°C	°F
0 - 13 mm (½ in.)	33	60
Above 13 mm (½ in.) - 90 mm (3½ in.)	22	40
Above 90 mm (3½ in.) - 300 mm (12 in.)	17	30
Above 300 mm (12 in.) - 900 mm (36 in.)	14	25

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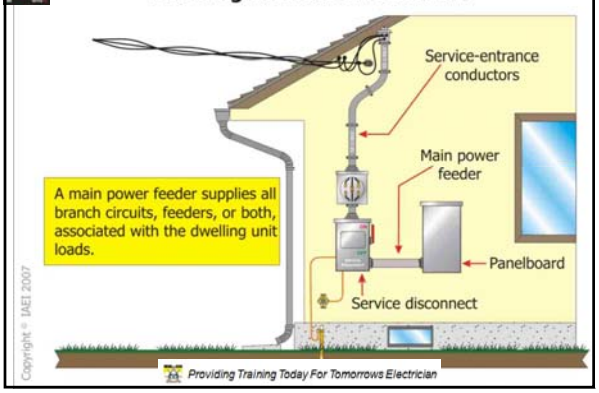
Providing Training Today For Tomorrows Electrician of NEC Table 310.15(B)(2)(c)

310.15(B)(6) 120/240-Volt, 3-Wire, Single-Phase Dwelling Services and Feeders



310.15(B) Tables

REVISION

- The first sentence of 310.15(B) has been revised to reflect the changes to table numbers resulting from the acceptance of Proposal 6-52 and Comment 6-21.
- A new second sentence has been added to refer users to Section 110.14(C).
- The added correlation with 110.14(C) reinforces that the termination is an important factor in determining conductor amacities.

Table 310.15(B)(2)(a) Ambient Temperature Correction Factors Based on 30°C (86°F)

- The ambient temperature correction factor table has been relocated from the bottom of previous Table 310.16 to a new Table 310.15(B)(2)(a)
- Temperature correction factors NECded and will now have there own table
- All temperature applications now at one location as the other temperature correction factor tables previously located at the bottom of the other allowable ampacity tables were relocated to new Table 310.15(B)(2)(b)
- Ambient temperature correction factor tables were also expanded to include temperatures and correction factors below the ambient temperature of allowable ampacity tables

Table 310.15(B)(2)(a) Temperature Correction Factors

Ambient Temperature Correction Factors Based on 30°C (86°F)

For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities specified in the ampacity tables by the appropriate factor shown below

Ambient Temperature (°C)	Temperature Rating of Conductor			Ambient Temperature (°F)
	60°C	75°C	90°C	
10 or less	1.29	1.20	1.15	50 or less
11-15	1.22	1.15	1.12	51-59
16-20	1.15	1.11	1.08	60-68
21-25	1.08	1.05	1.04	69-77
26-30	1.00	1.00	1.00	78-86
31-35	0.91	0.94	0.96	87-95
36-40	0.82	0.88	0.91	96-104
41-45	0.71	0.82	0.87	105-113
46-50	0.58	0.75	0.82	114-122
51-55	0.41	0.67	0.76	123-131
56-60	—	0.58	0.71	132-140
61-65	—	0.47	0.65	141-149
66-70	—	0.33	0.58	150-158
71-75	—	—	0.50	159-167
76-80	—	—	0.41	168-176
81-85	—	—	0.29	177-185

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Table 310.15(B)(3)(a) Adjustment Factors for More Than Three Current-Carrying Conductors in a Raceway or Cable

- Table 310.15(B)(3)(a) [formally Table 310.15(B)(2)(a)] contains requirements for adjustment or derating of conductors where the number of current-carrying conductors in a raceway or cable exceeds three
- The first column heading has been changed from "Number of Current-Carrying Conductors" to "Number of Conductors"
- This will take into account "spare" conductors that might be installed in raceways for future expansion or use but are not yet "current-carrying" conductors

Table 310.15(B)(3)(a) Adjustment Factors for More Than Three Current-Carrying Conductors in a Raceway or Cable

Number of Conductors[1]	Percent of Values in Tables 310.15(B)(16) through 310.15(B)(19) as Adjusted for Ambient Temperature if Necessary
4-6	80
7-9	70
10-20	50
21-30	45
31-40	40
41 and above	35

[1]Number of Conductors is the total number of conductors in the raceway or cable adjusted in accordance with 310.15(B)(5) and (6).

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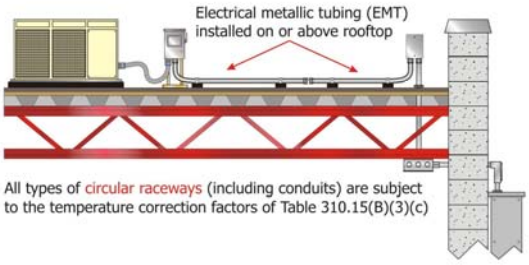
310.15(B)(3)(c) Circular Raceways on Rooftops

Conductors or cables installed in circular raceways exposed to direct sunlight on or above rooftops require adjustments shown in Table 310.15(B)(3)(c)



All types of circular raceways (including conduits) are subject to the temperature correction factors of Table 310.15(B)(3)(c)

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Table 310.15(B)(16) (in part)

Table 310.15(B)(16) Allowable Ampacities of Insulated Conductors Rated Up to and Including 2000 Volts Through 90° C (140°F), Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (D Buried), Based on Ambient Temperature of 30°C (86°F)*

Size AWG or kcmil	Temperature Rating of Conductor [See Table 310.13(A)]						Size AWG or kcmil
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
	Types TW, UF	Types RHW, THHW, THW, THWN,XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN,XHHW, USE	Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
18**	—	—	14	—	—	—	—
16**	—	—	18	—	—	—	—
14**	15	20	25	—	—	—	—
12**	20	25	30	15	20	25	12**
10**	30	35	40	25	30	35	10**
8	40	50	55	35	40	45	8
6	55	65	75	40	50	55	6
4	70	85	95	55	65	75	4
3	85	100	115	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	145	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0

*Refer to 310.15(B)(2) for the ampacity correction factors where the ambient temperature is other than 30°C (86°F).
**Refer to 240.4(D) for conductor overcurrent protection limitations.

Reproduction of NEC Table 310.16 (in part)

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Table 310.60(C)(4) Ambient Temperature Correction Fact

For ambient temperatures other than 40°C (104°F), multiply the allowable ampacities specified in the ampacity tables by the appropriate factor shown below

Ambient Temperature (°C)	Temperature Rating of Conductor		Ambient Temperature (°F)
	90°C (194°F)	105°C (221°F)	
10 or less	1.26	1.21	50 or less
11-15	1.22	1.18	51-59
16-20	1.18	1.14	60-68
21-25	1.14	1.11	69-77
26-30	1.10	1.07	78-86
31-35	1.05	1.04	87-95
36-40	1.00	1.00	96-104
41-45	0.95	0.96	105-113
46-50	0.89	0.92	114-122

Reproduction of NEC Table 310.60(C)(4) (in part)

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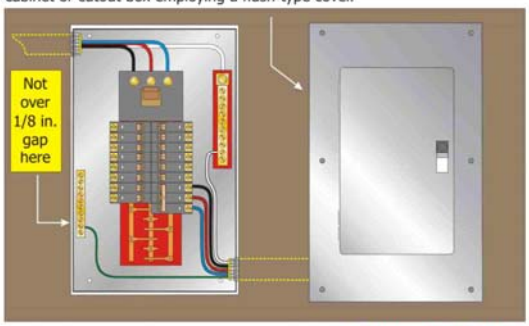
312.4 Repairing Noncombustible Surfaces

No gaps or open spaces greater than 3 mm (1/8 in.) at the edge of the cabinet or cutout box employing a flush-type cover.



Surface repairs at cabinet or cutout boxes apply to all noncombustible surfaces including, but not limited to, plaster, drywall, and plasterboard surfaces.

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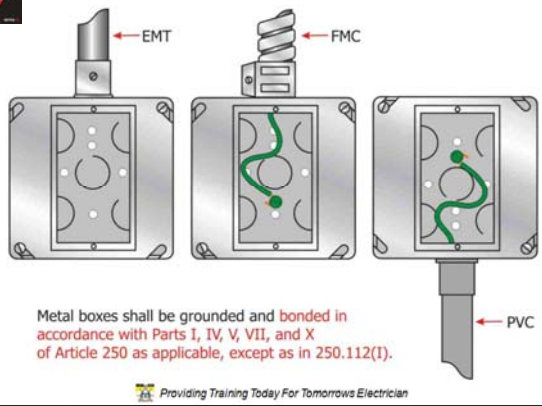
312.8 Switch and Overcurrent Device Enclosures

REVISION

- The title of 312.8 was revised as follows: Switch and Overcurrent Device Enclosures with Splices, Taps, and Feed-Through Conductors.
- A new list item (3) requires a warning label the closest disconnecting means for conductors that pass through an enclosure.
- The warning label provides workers with direction to the disconnecting means for the conductors feeding through the equipment, thereby improving safety.

314.4 Metal Boxes



Metal boxes shall be grounded and bonded in accordance with Parts I, IV, V, VII, and X of Article 250 as applicable, except as in 250.112(I).

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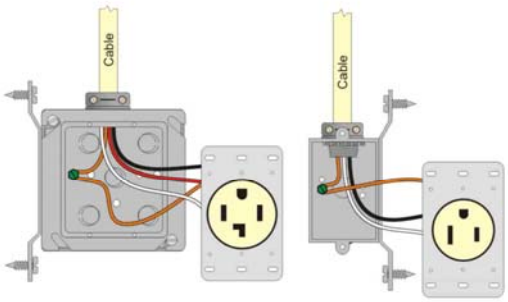
314.16(B)(4) Device or Equipment Fill



A device or utilization equipment wider than a single 50 mm (2 in.) device box as described in Table 314.16(A) shall have double volume allowances provided for each gang required for mounting.

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314.16(C)(3) Short Radius Conduit Bodies

DETOUR AHEAD

Relocate

- A new list item (3) titled Short- Radius Conduit Bodies has been added to 314.16(C).
- The new (3) includes the requirements relocated from former Section 314.5.
- No technical revisions have been made to this section.

314.24 Minimum Depth of Boxes for Outlets, Devices and Utilization Equipment

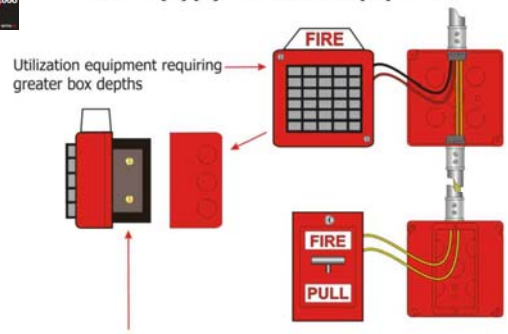
- (A) Outlet and Device Boxes Without Enclosed Devices or Utilization Equipment. No box shall have an internal depth of less than 12. 7 mm (1/2 in.).
- (B) Outlet and Device Boxes With Enclosed Devices. Boxes intended to enclose flush devices shall have an internal depth of not less than 23. 8 mm (15/16 in.).
- (C) Utilization Equipment.

314.24 Minimum Depth of Boxes for Outlets, Devices and Utilization Equipment

(C) Utilization Equipment.

(1) Large Equipment
(2) Conductors Larger than 4 AWG
(3) Conductors 8, 6, or 4 AWG
(4) Conductors 12 or 10 AWG
(5) Conductors 14 AWG and Smaller

314.24(C)(1) Utilization Equipment



Boxes that enclose utilization equipment that projects more than 48 mm (1-7/8 in.) rearward from the mounting plane of the box shall have a depth that is not less than the depth of the equipment plus 6 mm (1/4 in.).

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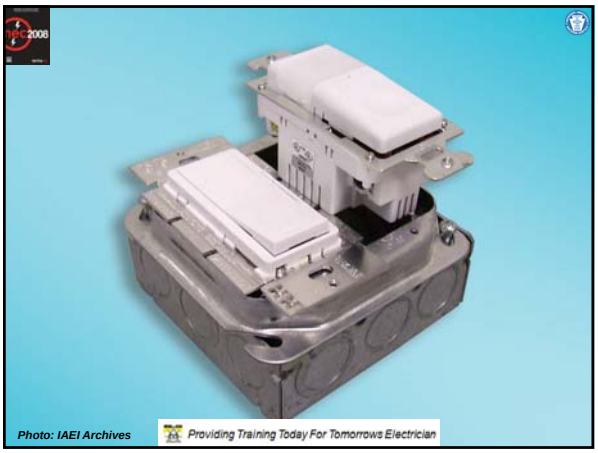

Photo: IAEI Archives

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314.27 Outlet Boxes

- Boxes used for ceiling and wall mounted lighting outlets must be designed for the purpose and support a minimum of 50 pounds.
- Luminaires weighing more than 50 pounds must be independently supported or the box must be listed and marked with the maximum weight.

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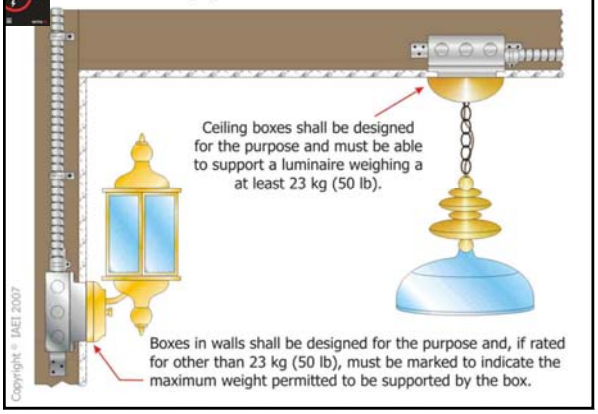
314.27(A) Boxes at Luminaire Outlets



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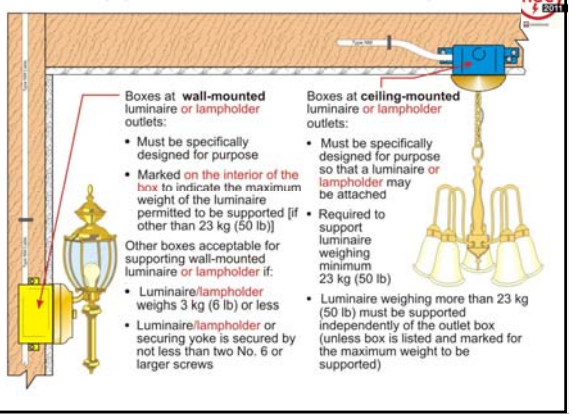
314.27(A) Boxes at Luminaires or Lampholders



Boxes at **wall-mounted** luminaire or lampholder outlets:

- Must be specifically designed for purpose
- Marked on the interior of the box to indicate the maximum weight of the luminaire permitted to be supported [if other than 23 kg (50 lb)]

Other boxes acceptable for supporting wall-mounted luminaire or lampholder if:

- Luminaire/lampholder weighs 3 kg (6 lb) or less
- Luminaire/lampholder or securing yoke is secured by not less than two No. 6 or larger screws

Boxes at **ceiling-mounted** luminaire or lampholder outlets:

- Must be specifically designed for purpose so that a luminaire or lampholder may be attached
- Required to support luminaire weighing minimum 23 kg (50 lb)
- Luminaire weighing more than 23 kg (50 lb) must be supported independently of the outlet box (unless box is listed and marked for the maximum weight to be supported)

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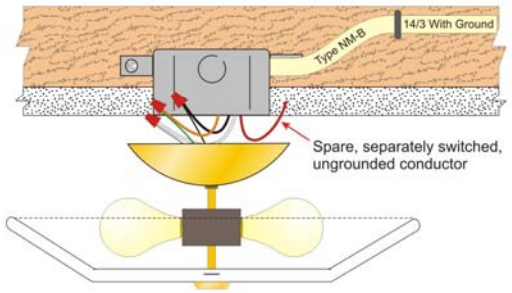
314.27(C) Boxes at Ceiling Fan Outlets

At single or multi-family dwellings, spare, separately switched, ungrounded conductors at ceiling-mounted outlet boxes (in a location acceptable for a ceiling fan) require outlet box or system listed for sole support of a ceiling-suspended (paddle) fan



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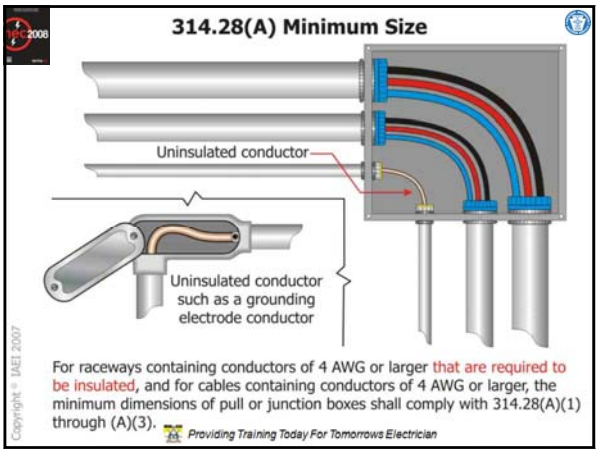
314.28(A) Minimum Size
Uninsulated conductor
Uninsulated conductor such as a grounding electrode conductor
For raceways containing conductors of 4 AWG or larger that are required to be insulated, and for cables containing conductors of 4 AWG or larger, the minimum dimensions of pull or junction boxes shall comply with 314.28(A)(1) through (A)(3).
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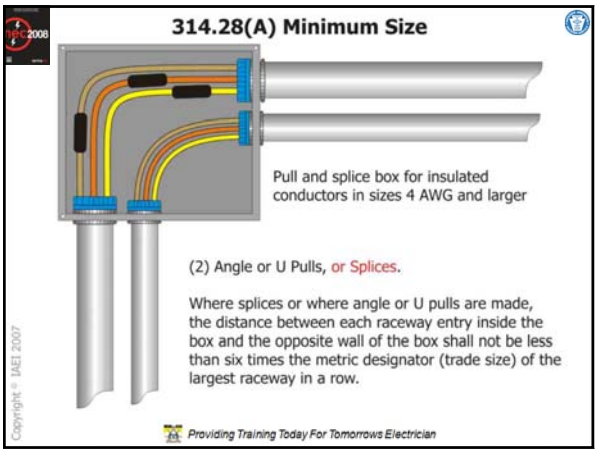
314.28(A) Minimum Size
Pull and splice box for insulated conductors in sizes 4 AWG and larger
(2) Angle or U Pulls, or Splices.
Where splices or where angle or U pulls are made, the distance between each raceway entry inside the box and the opposite wall of the box shall not be less than six times the metric designator (trade size) of the largest raceway in a row.
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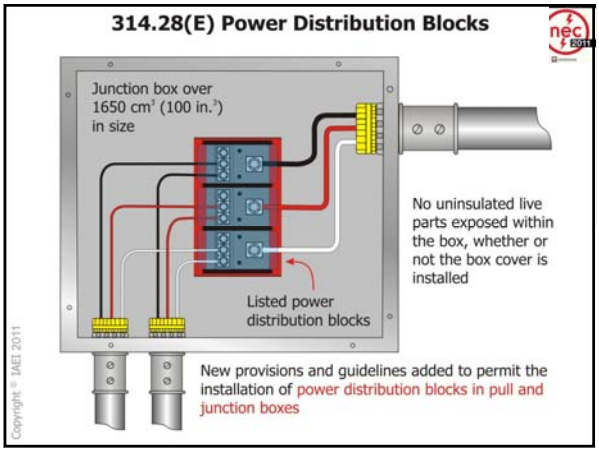
314.28(E) Power Distribution Blocks
Junction box over 1650 cm³ (100 in.³) in size
No uninsulated live parts exposed within the box, whether or not the box cover is installed
Listed power distribution blocks
New provisions and guidelines added to permit the installation of power distribution blocks in pull and junction boxes
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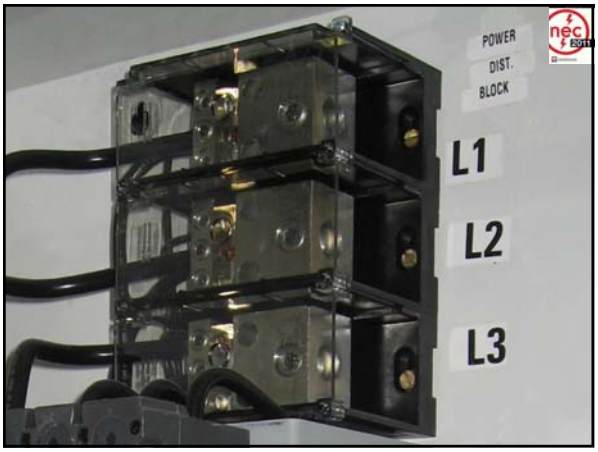
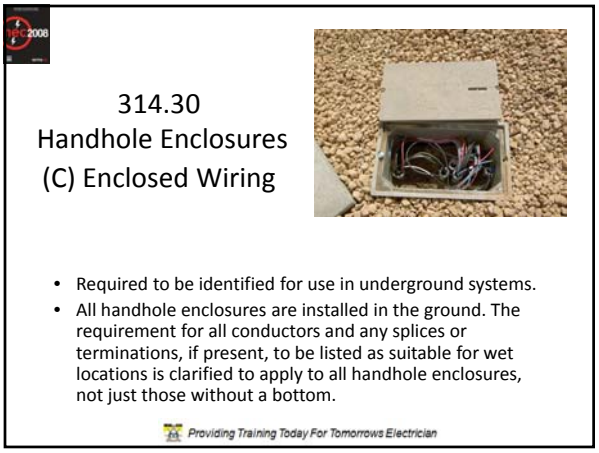

POWER DIST. BLOCK
L1
L2
L3


314.30
Handhole Enclosures
(C) Enclosed Wiring
• Required to be identified for use in underground systems.
• All handhole enclosures are installed in the ground. The requirement for all conductors and any splices or terminations, if present, to be listed as suitable for wet locations is clarified to apply to all handhole enclosures, not just those without a bottom.
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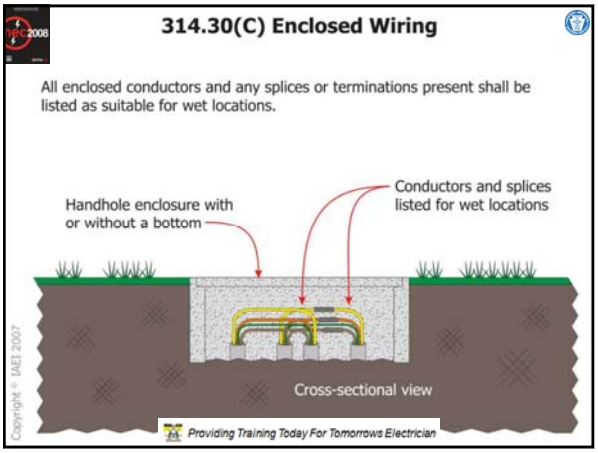
314.30(C) Enclosed Wiring
All enclosed conductors and any splices or terminations present shall be listed as suitable for wet locations.
Handhole enclosure with or without a bottom
Conductors and splices listed for wet locations
Cross-sectional view
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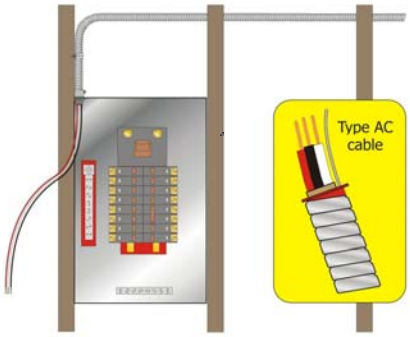
314.71 Pull and Junction Boxes, Conduit Bodies, and Handhole Enclosures

- Section 314.71 has been revised to include conduit bodies in the sizing requirements.
- Where conduit bodies are used in installations over 600 volts, they are required to meet the applicable requirements contained in Part IV of Article 314.

320.2 Definition: Type AC Cable

Armored Cable, Type AC - A fabricated assembly of insulated conductors in a flexible interlocked metallic armor (See 320.100)



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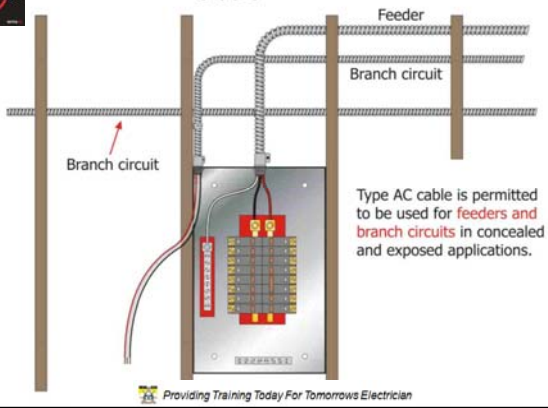
320.10(A)(1) Uses Permitted



Type AC cable is permitted to be used for feeders and branch circuits in concealed and exposed applications.

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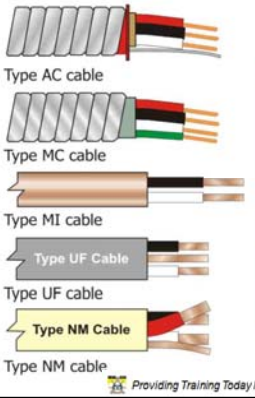
320.108, 330.108, 332.108, 334.108, 340.108



The titles to these sections have been revised to refer to equipment grounding conductors.

The .108 sections in these cable articles provide requirements for equipment grounding conductors in these cable assemblies, rather than general requirements for equipment grounding.

Note: Cable fittings not shown

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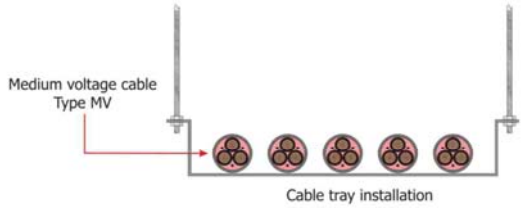
328.10 Uses Permitted



Medium voltage cable shall be permitted to be installed in cable trays where identified for the use and where the applicable requirements in Part II of Article 392 are met.

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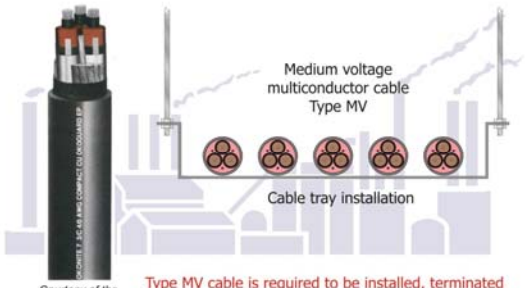
328.14 Medium Voltage Cable: Type MV



Courtesy of the Okonite Co.

Type MV cable is required to be installed, terminated and tested by qualified persons

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330.10 MC Cable Uses Permitted

- The installation of type MC cable in wet locations now clearly requires:
  - A metallic covering is impervious to moisture or
  - A lead sheath or moisture-impervious jacket or
  - Conductors listed for wet location with a corrosion-resistant jacket provided over the metallic sheath

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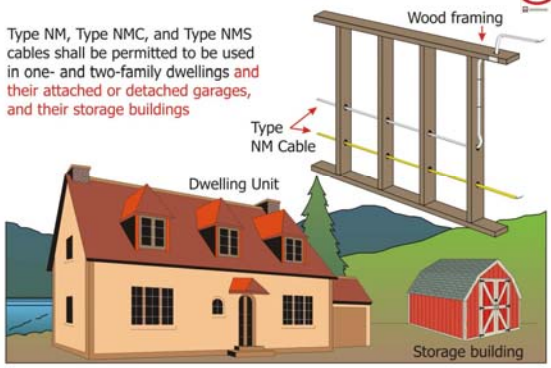
334.10(1) Uses Permitted - Type NM Cable

Type NM, Type NMC, and Type NMS cables shall be permitted to be used in one- and two-family dwellings and their attached or detached garages, and their storage buildings



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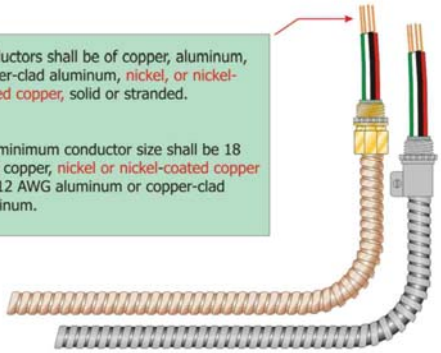
330.104 Conductors

Conductors shall be of copper, aluminum, copper-clad aluminum, nickel, or nickel-coated copper, solid or stranded.

The minimum conductor size shall be 18 AWG copper, nickel or nickel-coated copper and 12 AWG aluminum or copper-clad aluminum.



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334.12(A)(1) Type NMC Uses Not Permitted

- Exception will permit the installation of types NM, NMC, and NMS cables in Type I and II construction when installed in raceway.

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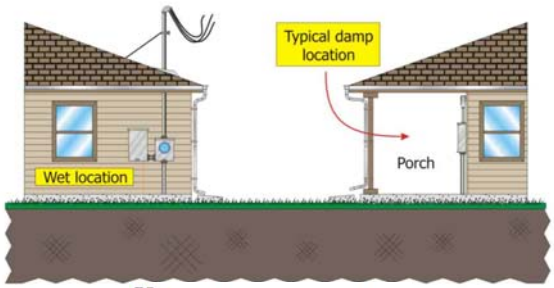
334.12(B)(4) Uses Not Permitted

Type NM and NMS shall not be permitted in wet or damp locations.

Article 100 defines damp, dry, and wet locations.



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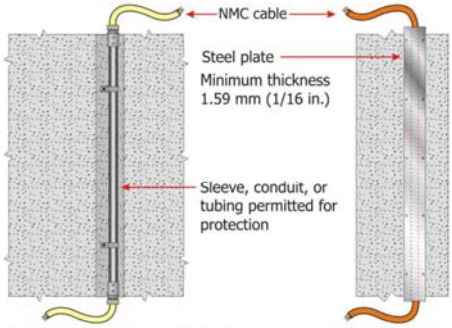
334.15(B) Protection From Physical Damage



Type NMC cable installed in shallow chases or grooves in masonry, concrete, or adobe, shall be protected in accordance with the requirements in 300.4(F) and covered with plaster, adobe, or similar finish.

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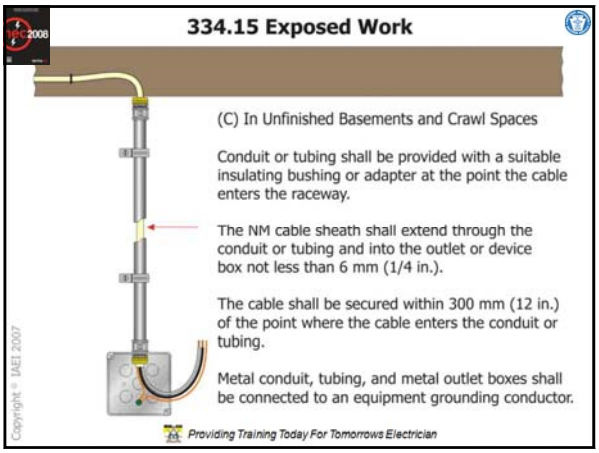
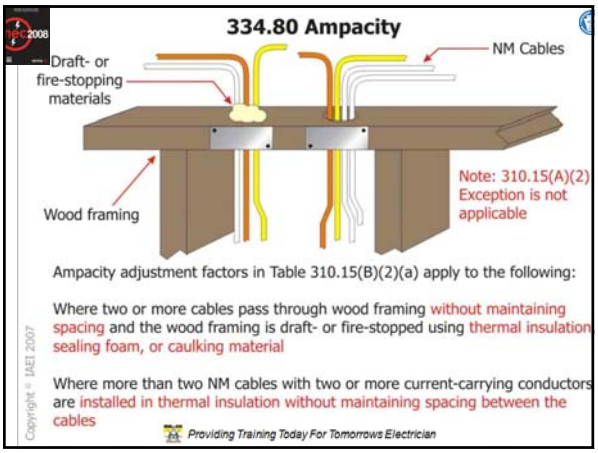
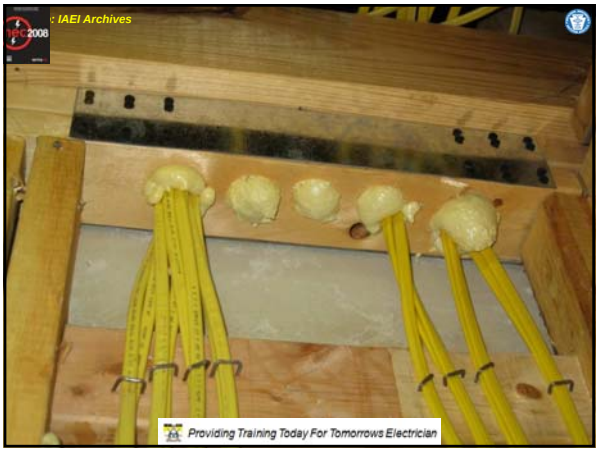
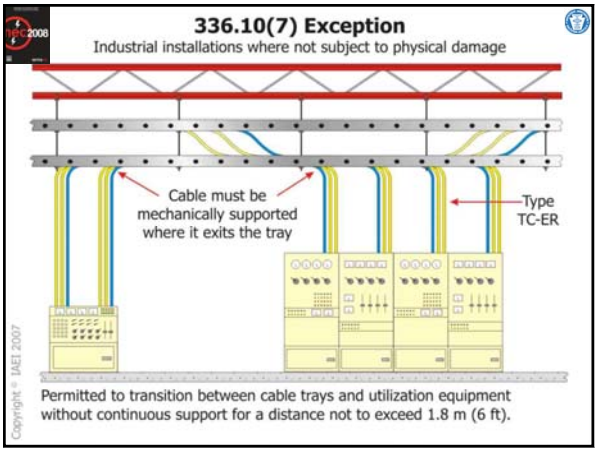








338.10(B)(2) Use of Uninsulated Conductor

- The term uninsulated conductor is now used to describe the permitted use of the concentric conductors in Type SE cable where it is used as a branch circuit or feeder.
- The uninsulated conductor of these cable assemblies is permitted to be used for the equipment grounding conductor.
- The exception has been revised to clearly inform the Code user that the uninsulated concentric conductor in an SE cable may be used for the grounded conductor in EXISTING installations only. [See Section 250.140]

338.10(B)(4) Installation Methods for Branch Circuits and Feeders

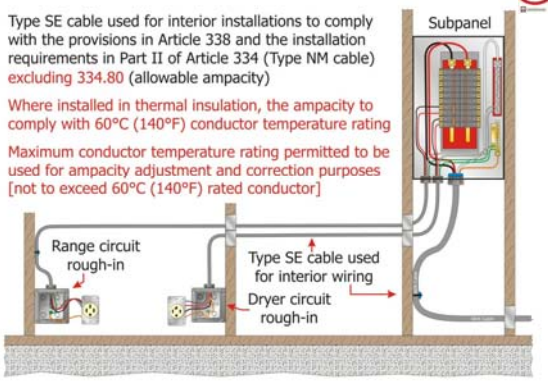
- Section 338.10(B)(4) provides installation methods for the use of Type SE in both interior and exterior installations.
- Section 338.10(B)(4)(a) for interior installations has been revised to exclude the requirements of 334.80.
- The use of Type SE cable is no longer subject to the ampacity requirements of 334.80.
- The use of Type SE cable in thermal insulation requires a ampacity correction of 60°C.

338.10(B)(4)(a) Uses Permitted - Type SE Cable

Type SE cable used for interior installations to comply with the provisions in Article 338 and the installation requirements in Part II of Article 334 (Type NM cable) excluding 334.80 (allowable ampacity)

Where installed in thermal insulation, the ampacity to comply with 60°C (140°F) conductor temperature rating

Maximum conductor temperature rating permitted to be used for ampacity adjustment and correction purposes [not to exceed 60°C (140°F) rated conductor]



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338.12 Uses Not Permitted

Includes prescriptive text:

- Type SE cable in 338.12(A)
- Type USE cable in 338.12(B)

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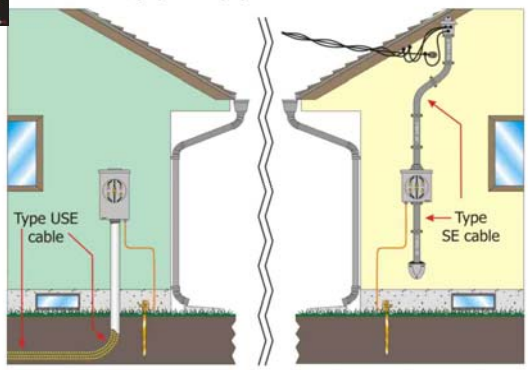
338.12(A) and (B) Uses Not Permitted



Uses not permitted clearly differentiated between USE cable and SE cable

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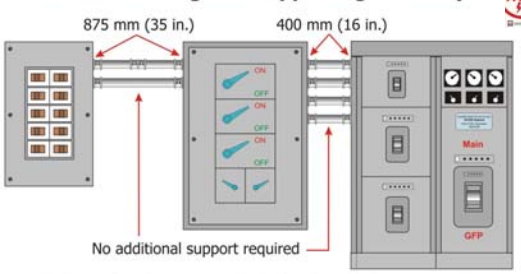
342.30 Securing and Supporting Raceways



Securely fastened within 900 mm (3 ft) of each outlet box, junction box, device box, cabinet, conduit body, or other conduit termination

Provisions for unbroken conduit (without couplings) unsupported in lengths up to 450 mm (18 in.) has been deleted

Applies to IMC, RMC, PVC, RTRC, and EMT

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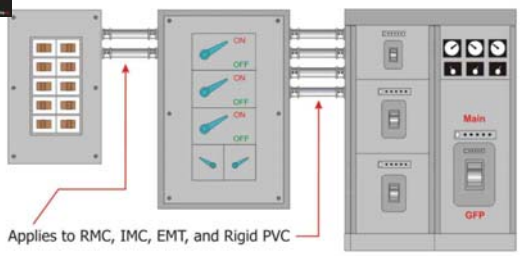
342.30(C) Unsupported Raceways



Where oversized, concentric or eccentric knockouts are not encountered, Type IMC shall be permitted to be unsupported in lengths up to 450 mm (18 in.).

The conduit must be unbroken (without couplings) and be terminated in a box or enclosure at the end of the raceway.

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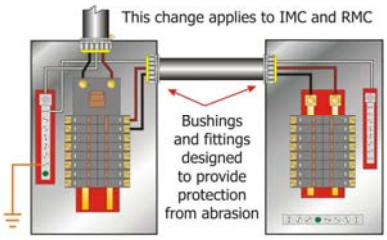
342.46 Bushings

Where a conduit enters a box, fitting, or other enclosure, a bushing is required to protect the wires from abrasion unless the box, fitting, or enclosure is designed to provide this protection

This change applies to IMC and RMC



Previous language indicated a bushing was required "unless the design of the box, fitting, or enclosure is such as to afford equivalent protection"

The term "equivalent" is a subjective term

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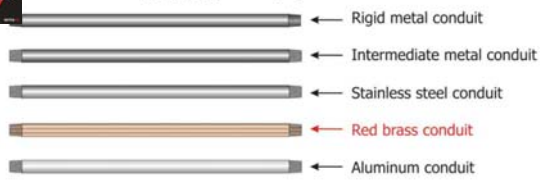
344.10(A),(B), and (C) Uses Permitted



(A) All Atmospheric Conditions and Occupancies
(1) Galvanized Steel and Stainless Steel RMC
(2) Red brass RMC
(3) Aluminum RMC
(4) Ferrous Raceways and Fittings
(B) Corrosive Environments
(1) Galvanized Steel, Stainless Steel and Red Brass RMC, Elbows, Couplings, and Fittings
(2) Supplementary Protection of Aluminum RMC
(C) Cinder Fill. Galvanized steel, stainless steel and red brass RMC...

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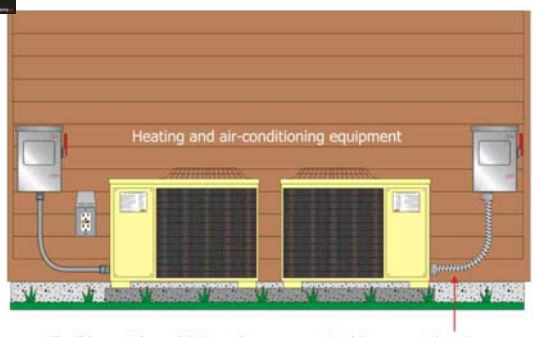
348.12(1) Uses Not Permitted



Flexible metal conduit is no longer permitted in any wet locations.

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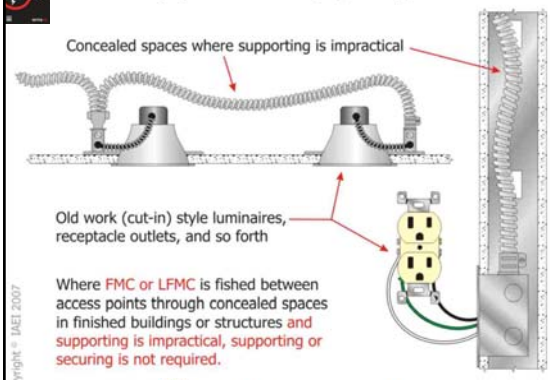
348.30(A) and 350.30(A) Exception No. 1

Concealed spaces where supporting is impractical



Old work (cut-in) style luminaires, receptacle outlets, and so forth

Where FMC or LFMC is fished between access points through concealed spaces in finished buildings or structures and supporting is impractical, supporting or securing is not required.

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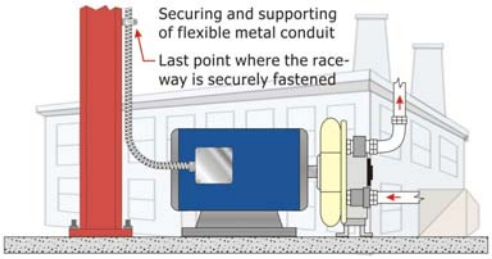
348.30(A) and 350.30(A) Securely Fastened

REVISION

- New text has been added to the exception that permits support in excess of 12 inches of conduit termination where flexibility is required after installation.
- This new text requires that the distance permitted be measured from the last point of support conduit support.

348.30(A) Ex. No. 2 Flexible Metal Conduit



At terminations where flexibility is necessary after installation, lengths from the last point where the raceway is securely fastened shall not exceed the following:

(1) 900 mm (3 ft) for trade sizes ½ through 1¼
(2) 1200 mm (4 ft) for trade sizes 1½ through 2
(3) 1500 mm (5 ft) for trade size 2½ and larger

*Note: Same change occurred for liquid-tight flexible metal conduit (350.30)

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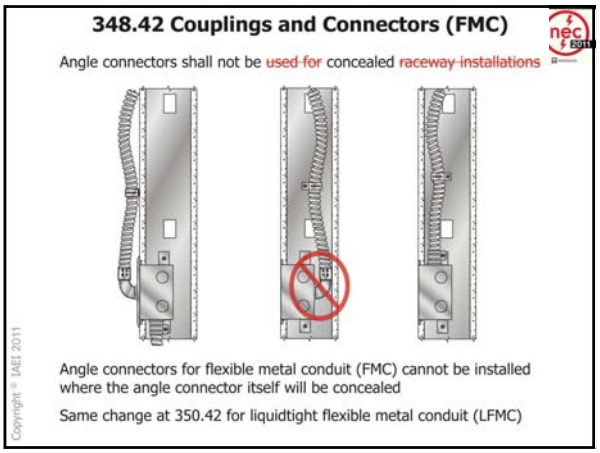
348.42 Couplings and Connectors (FMC)
Angle connectors shall not be used for concealed raceway installations
Angle connectors for flexible metal conduit (FMC) cannot be installed where the angle connector itself will be concealed
Same change at 350.42 for liquidtight flexible metal conduit (LFMC)
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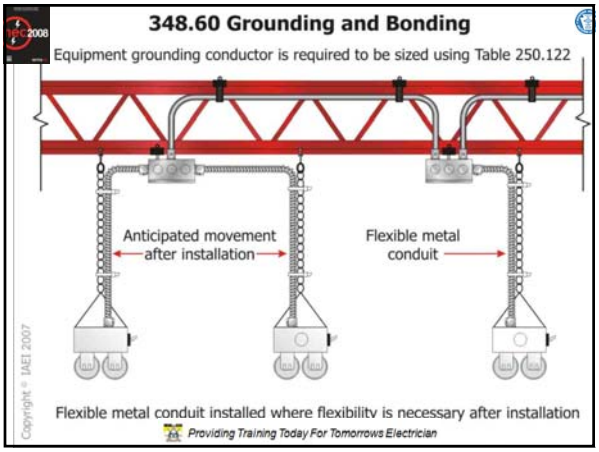
348.60 Grounding and Bonding
Equipment grounding conductor is required to be sized using Table 250.122
Anticipated movement after installation
Flexible metal conduit
Flexible metal conduit installed where flexibility is necessary after installation
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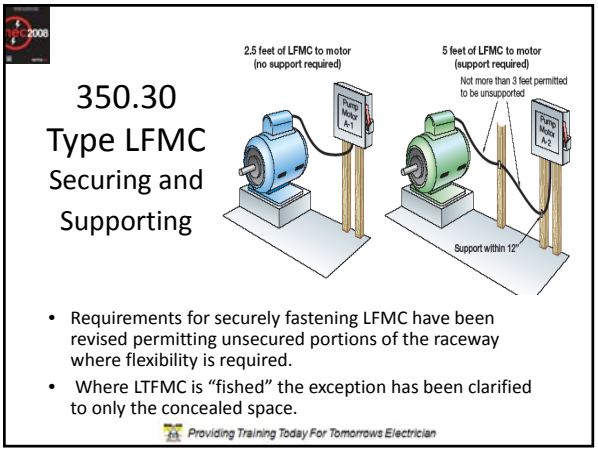
350.30
Type LFMC
Securing and Supporting
2.5 feet of LFMC to motor (no support required)
5 feet of LFMC to motor (support required)
Not more than 3 feet permitted to be unsupported
Support within 12"
• Requirements for securely fastening LFMC have been revised permitting unsecured portions of the raceway where flexibility is required.
• Where LTFMC is "fished" the exception has been clarified to only the concealed space.
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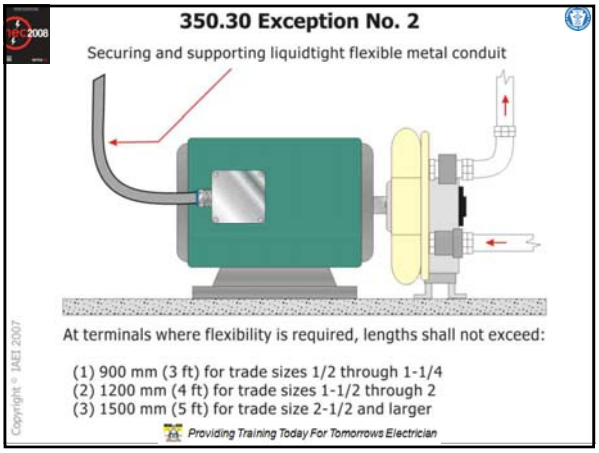
350.30 Exception No. 2
Securing and supporting liquidtight flexible metal conduit
At terminals where flexibility is required, lengths shall not exceed:
(1) 900 mm (3 ft) for trade sizes 1/2 through 1-1/4
(2) 1200 mm (4 ft) for trade sizes 1-1/2 through 2
(3) 1500 mm (5 ft) for trade size 2-1/2 and larger
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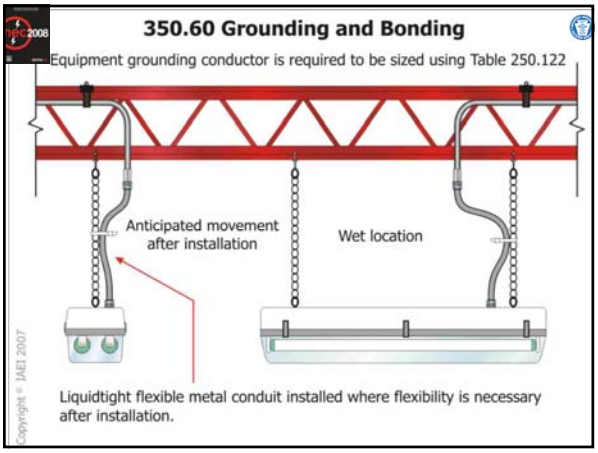

350.60 Grounding and Bonding
Equipment grounding conductor is required to be sized using Table 250.122
Anticipated movement after installation
Wet location
Liquidtight flexible metal conduit installed where flexibility is necessary after installation.
Copyright © IAEI 2007

Article 352 Rigid Polyvinyl Chloride Conduit: Type PVC

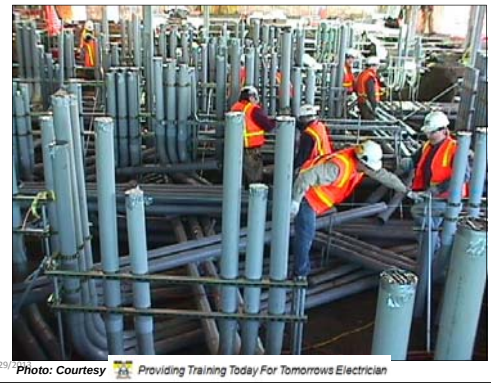


Photo: Courtesy

Article 352 Rigid Polyvinyl Chloride Conduit: Type PVC

	Rigid PVC	HDPE	RTRC
NEC article[a]	352	353	355
U.S. listing standards	UL 651	UL 651A and UL 651B[b]	UL 1684 and UL 1684A
Listed trade sizes	½ – 6	1 – 6	½ – 6
Types listed for aboveground use	Schedule 40 or 80	See 353.10(5)	Type AG or XW
Types listed for direct burial	Schedule 40 or 80	Yes	Type BG, AG, or XW
Types listed for physical damage	Schedule 80	No	Type XW
Can be used where concealed	Yes	No	Yes
Can be used for directional boring	If approved	Yes	If approved
Maximum support span[c]	See NEC table 352.30	N/A	See NEC table 355.30
Temperature rating	Maximum 50°C ambient	N/A	–40°C – 110°C continuous operating
Can be used inside buildings	Schedule 40 or 80	No	Type AG or XW
Expansion characteristics	3.38×10^{-5} in/in/°F 6.084×10^{-5} mm/mm/°C	N/A	1.5×10^{-5} in/in/°F 2.7×10^{-5} mm/mm/°C
Weather resistant	Yes	No	Yes
Approximate weight (4-inch trade size per 100')	Schedule 40 –232 lbs Schedule 80 – 308 lbs	Schedule 40 _ 143 lbs Schedule 80 – 196 lbs	Type AG or BG – 82 lbs Type XW – 282 lbs
Low halogen	No	No	Yes

a NEC Article references pertain to the 2008 National Electric Code.
b UL 651A applies to discrete length HDPE and UL 651B to continuous length HDPE.
c Unless otherwise listed, the maximum support span distances for both Rigid PVC and RTRC are identical.

Three separate articles for RNC now exist:

- PVC in Article 352
- HDPE in Article 353
- RTRC in Article 355

352.10(F) PVC Exposed

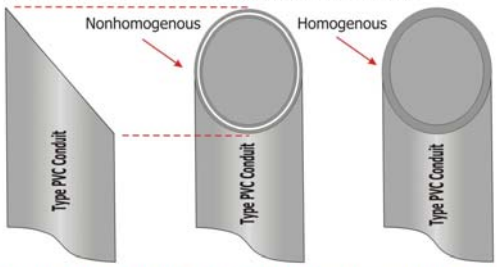
- FPN identifies schedule 80 PVC as being identified for use in areas of physical damage.

352.10(G) PVC Underground Installations

- Permits both homogenous (solid wall) and non-homogenous (foam core wall) PVC for direct burial applications and for underground applications where encased in concrete.

352.10(G) Underground Installations (PVC)

For underground installations, ~~homogenous and nonhomogenous~~ PVC shall permitted for direct burial and underground encased in concrete



The terms "homogenous and nonhomogenous" were removed from 352.10(G)

Both types listed to UL Standard 651 and both are permitted to be used for direct burial and underground encased in concrete

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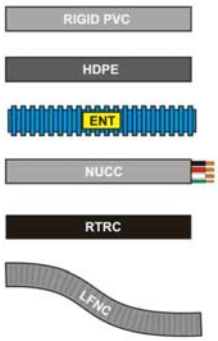
352.10(I) Insulation Temperature Limitations

REVISION

- The conductor operating temperature requirements for PVC, HDPE, RTRC, and ENT have been clarified and placed in the 3XX.10 (Uses Permitted) sections of each article.
- Conductors rated at temperatures higher than the conduit rating are permitted, provided they are not operated higher than the temperature rating of the conduit.

352.12(A) Uses Not Permitted



(A) Hazardous (Classified) Locations

Nonmetallic wiring methods are not permitted in any hazardous (classified) location unless specifically permitted in other articles of the *NEC*.

Applies to:

Rigid PVC conduit
High density polyethylene conduit
Electrical nonmetallic tubing
Nonmetallic underground conduit with conductors
Reinforced thermosetting resin conduit
Liquititght flexible nonmetallic conduit

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Article 353
High Density Polyethylene Conduit: Type HDPE

- New FPN with scope of Article 353
- Revised uses permitted, above ground encased in 2-inches of concrete
- New FPN describes methods of joining type HDPE

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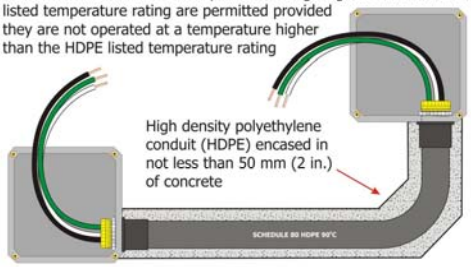
353.10(6) Uses Permitted (HDPE)

Conductors or cables with temperature ratings higher than the HDPE listed temperature rating are permitted provided they are not operated at a temperature higher than the HDPE listed temperature rating



Moved from "Uses Not Permitted" - same change at the following:

352.10(I)	Rigid Polyvinyl Chloride Conduit (PVC)
353.10(6)	High Density Polyethylene Conduit (HDPE)
355.10(I)	Reinforced Thermosetting Resin Conduit (RTRC)
362.10(9)	Electrical Nonmetallic Tubing (ENT)

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353.20(B) Maximum Size

High density polyethylene conduit larger than metric designator 155 (trade size 6) shall not be used.

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353.48 FPN

HDPE conduit can be joined using either heat fusion, electrofusion, or mechanical fittings.

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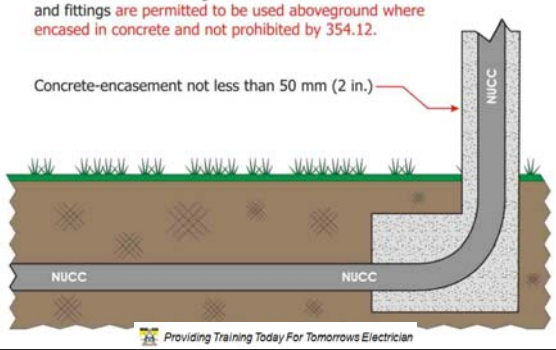
354.10(5) Uses Permitted

Listed nonmetallic underground conduit with conductors and fittings are permitted to be used aboveground where encased in concrete and not prohibited by 354.12.



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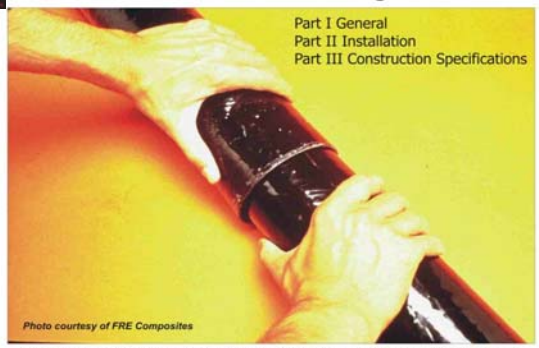
Article 355 Reinforced Thermosetting Resin Conduit



A new Article 355 Reinforced Thermosetting Resin Conduit: Type RTRC has been added to Chapter 3. The article includes three parts.

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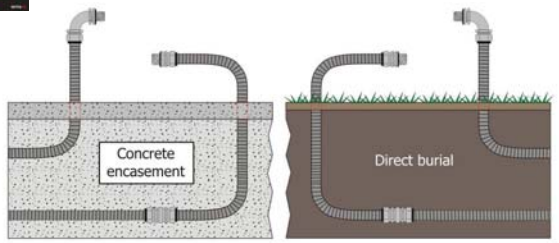
356.10(7) Uses Permitted



LFNC is permitted to be used where encased in concrete provided it is listed for direct burial use and meets the requirements in 356.42.

Straight fittings are permitted to be used in direct-burial or concrete-encased applications of LFNC.

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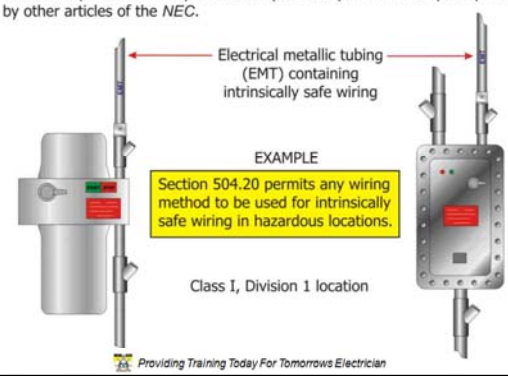
358.12(4) Uses Not Permitted

EMT is not permitted in any hazardous (classified) location except as permitted by other articles of the *NEC*.



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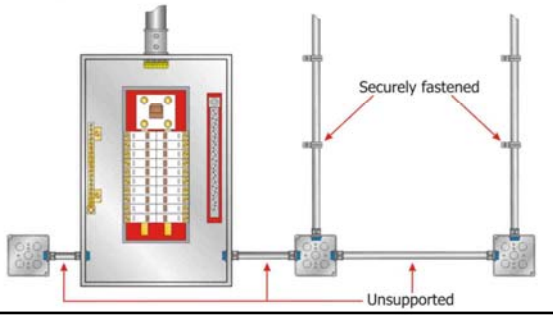
358.30(C) Unsupported Raceways

EMT, IMC, RMC, RTRC, and rigid PVC conduit permitted to be unsupported in lengths up to 450 mm (18 in.) between enclosures, boxes, equipment, and so forth only where oversized, concentric or eccentric knockouts not encountered.



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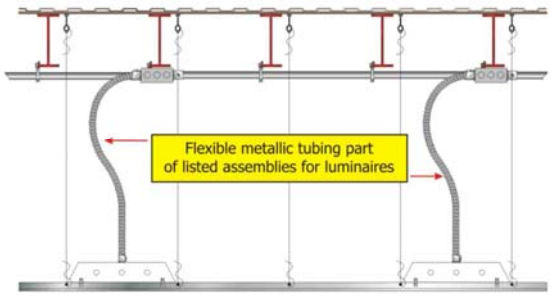
360.20(A) Exception No. 2

The word *listed* replaces the word *approved* in the exception.



FMT in metric designator 12 (trade size 3/8) is permitted to be used where part of a listed assembly for luminaires.

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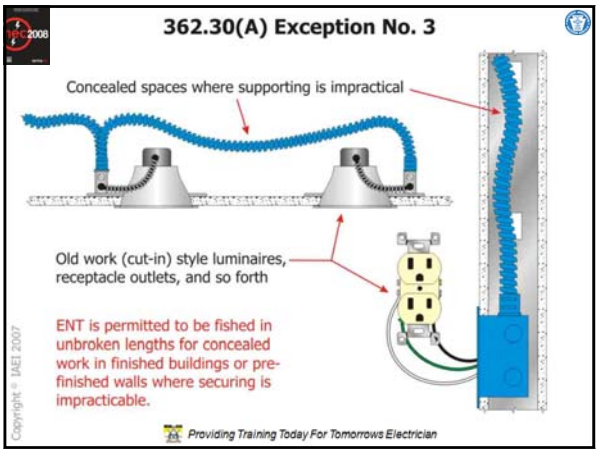
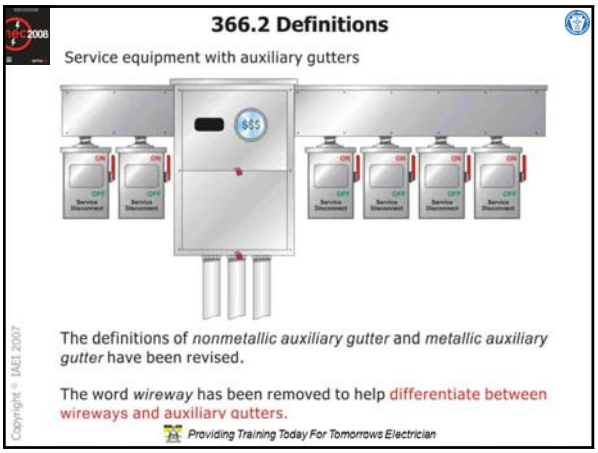
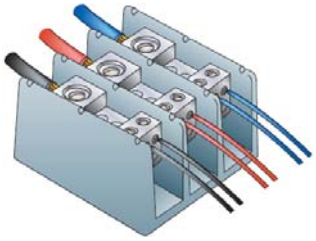




368.10(B) Busways Behind Access Panels

- Busways are permitted to be installed behind access panels
- Previous title of "Concealed" was changed to "Behind Access Panels"
- Busways were previously permitted to be installed behind an access panel, but meeting the definition of "concealed" was difficult at best

Article 376 Metal Wireways



- Clarifies where conductor ampacity requirements exist
- Prohibits the use of power distribution blocks which have exposed live parts
- New construction requirements

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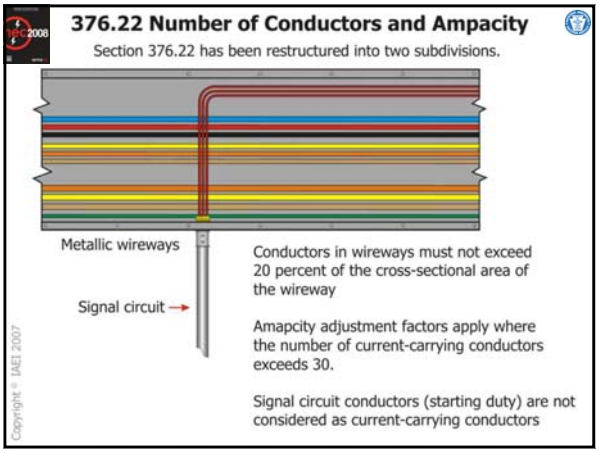

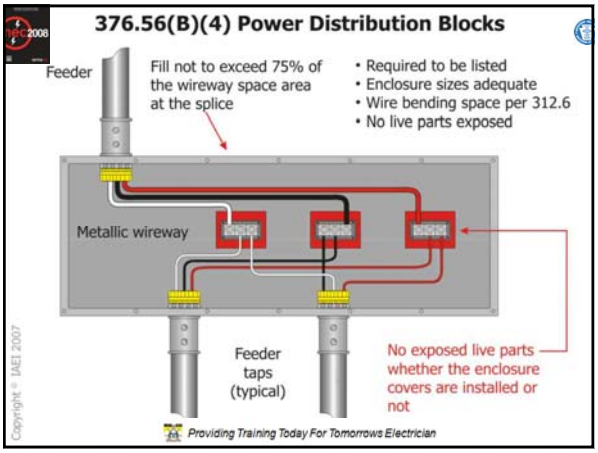

376.100 Construction

- An new section has been included covering construction specifications for metal wireways.

- (A) Electrical and Mechanical Continuity
- (B) Substantial Construction
- (C) Smooth Rounded Edges
- (D) Covers

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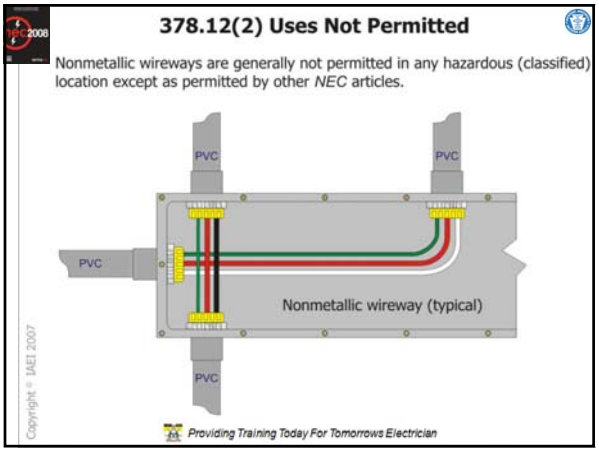

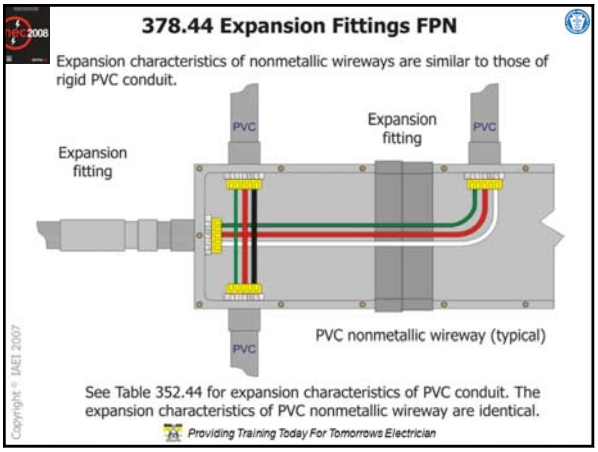

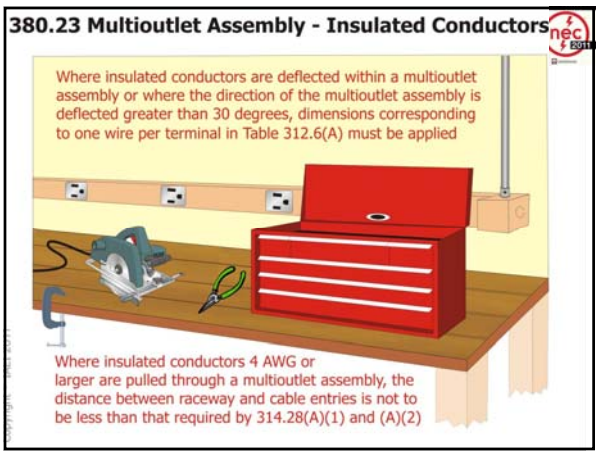

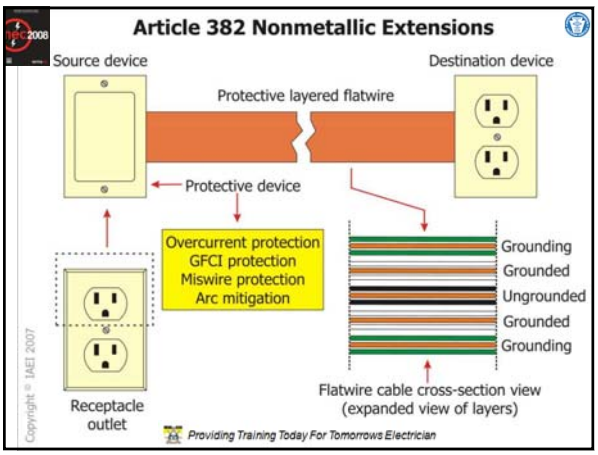

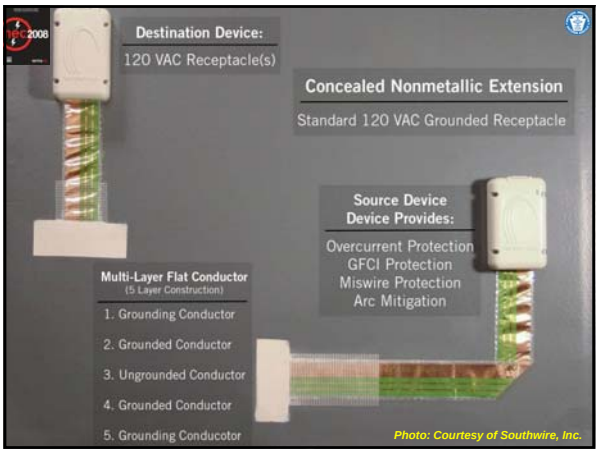

388.30 Securing and Supporting
388.56 Splices and Taps
Surface Nonmetallic Raceways

- Supported in accordance with the manufacturers instructions.
- Splices and taps are permitted within a surface nonmetallic raceway, provided there is a cover which is capable of being opened in place after installation.

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Article 392 – Cable Trays

I. General
- 392.1 Scope
- 392.2 Definitions

II. Installation
- 392.10 Uses Permitted
- 392.12 Uses Not Permitted
- 392.18 Cable Tray Installation
- 392.19 Cable Installation
- 392.22 Number of Conductors or Cables
- 392.30 Securing and Supporting of Cables
- 392.46 Bushed Conduit and Tubing
- 392.56 Cable Splices
- 392.60 Grounding and Bonding
- 392.80 Ampacity of Conductors

III. Construction Specifications
- 392.100 Construction

Article 392 (Cable Trays) was reorganized to a similar style to other Chapter 3 articles

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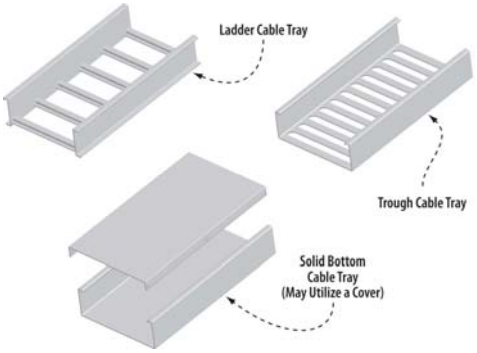

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392.3(A) Wiring Methods Cable Trays

- Table 392.3(A) is revised to recognize additional wiring methods which are permitted to be installed in cable trays.

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392.8(A) Cable Splices

- Cable splices made and insulated by approved methods shall be permitted in cable trays, provided they are accessible.
- <u>Cable splices shall be permitted to project above the side rails of the cable tray where not subject to physical damage.</u>

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392.9 Number of Multiconductor Cables, Rated 2000 Volts or Less, in Cable Trays

- New text has been added in 392.9(A) to help the code user correlate requirements for cable tray fill with conductor ampacity.

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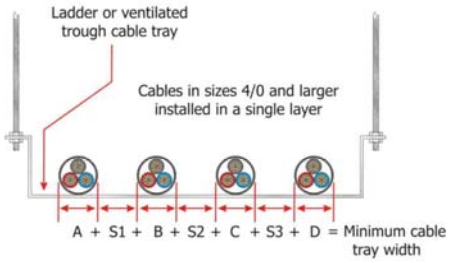
392.9(A)(1) Any Mixture of Cables



Where cable ampacity is determined according to 392.11(A)(3), the cable tray width shall not be less than the sum of the diameters of the cables and the sum of the required spacing widths between the cables.

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392.11(C) Combinations of Multiconductor and Single-Conductor Cables

- Provides guidance for cable tray fill and conductor ampacity where a combination of multiconductor and single-conductor cables exist in the same tray.

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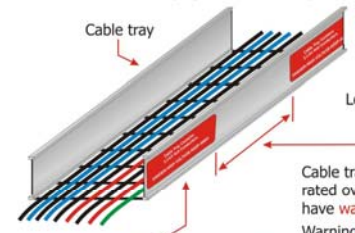
392.18(H) Cable Trays - Marking



Cable trays containing conductors rated over 600 volts required to have warning notice (label)

Warning notice must be:

- permanent
- legible
- placed in a readily visible position
- spaced not to exceed 3 m (10 ft)

Cable Tray Contains 2.3 kV Volt Conductors
DANGER-HIGH VOLTAGE-KEEP AWAY

Must contain the wording "DANGER-HIGH VOLTAGE-KEEP AWAY"

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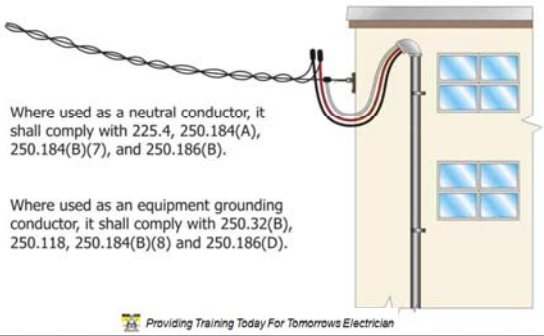
396.30 Messenger

This section has been arranged into three subdivisions providing rules for messengers used as support, neutral conductors, or equipment grounding conductors.



Where used as a neutral conductor, it shall comply with 225.4, 250.184(A), 250.184(B)(7), and 250.186(B).

Where used as an equipment grounding conductor, it shall comply with 250.32(B), 250.118, 250.184(B)(8) and 250.186(D).

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Article 399 - Outdoor, Overhead Conductors, Over 600 Volts

Article 399 Outdoor, Overhead Conductors, Over 600 Volts

- 399.1 Scope
- 399.2 Definitions
- 399.10 Uses Permitted
- 399.12 Uses Not Permitted
- 399.30 Support

A new article has been added to cover installations of outdoor, overhead conductors rated over 600 volts

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Chapter Four

Equipment for General Use

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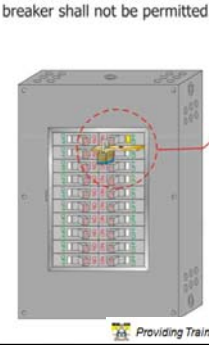
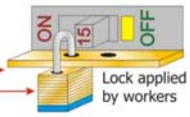
Disconnects Capable of Being Locked Open

The provisions for locking or adding a lock to the disconnecting means shall remain in place at the switch or circuit breaker whether the lock is installed or not. Portable means for adding a lock to the switch or circuit breaker shall not be permitted.





Lock applied by workers

Applies in multiple sections such as:

410.141(B)
422.31(B)
424.19
440.14 Exception No. 1
600.6(A)(2)(3)
620.51(A) Exception No. 1
620.53
620.55

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Table 400.4 Superscript Note 8 (in part)

Trade Name	Type Letter	Voltage	AWG or kcmil	Number of Conductors
Parallel heater cord	HPN See Note 8.	300	18-12	2 or 3

Reproduction of Table 400.4 (in part)

Table 400.4

Superscript Note 8. The third conductor in Type HPN shall be used as an equipment grounding conductor only.

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Table 400.5(A) (in part)

Table 400.5(A) Allowable Ampacity for Flexible Cords and Cables [Based on Ambient Temperature of 30°C (86°F). See 400.13 and Table 400.4.]

Size (AWG)	Thermoplastic Types TPT, TST	Thermoset Types C, E, EO, PD, S, SJ, SJO, SJOW, SJOO, SJOOW, SO, SOW, SOO, SOOW, SP-1, SP-2, SP-3, SRD, SV, SVO, SVOO		Types HDP, HPN, HSJ, HSJOO
		Thermoset Types ET, ETLB, ETP, ETT, SE, SEW, SEO, SEOW, SEOOW, SJE, SJEW, SJEO, SJEOW, SJEOOW, SJT, SJTW, SJTO, SJTOW, SJTOO, SJTOOW, SPE-1, SPE-2, SPE-3, SPT-1, SPT-1W, SPT-2, SPT-2W, SPT-3, ST, SRDE, SVEO, SVT, SVTO, SVTOO		
		Column A*	Column B*	
27*	0.5	—	—	—
20	—	5**	***	—
18	—	7	10	10
17	—	9	12	13
16	—	10	13	15
15	—	12	15	17
14	—	15	18	20
12	—	20	25	30
10	—	25	30	35
8	—	35	40	—
6	—	45	55	—
4	—	60	70	—
2	—	80	95	—

No changes to table notes

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Providing Training Today For Tomorrows Electrician IEC Table 400.5(A) less notes

400.5(A) Ampacity Tables for Cords and Cables

Temperature correction factors from Table 310.15(B)(2)(a) corresponding to the temperature rating of the cord to be applied to the ampacity from Table 400.5(A)(2)

Ambient temperature below 30°C (86°F)

Flexible cord used in ambient temperature other than 30°C (86°F)

ON

OFF

Flexible Cords and cables used in ambient temperatures above (or below) 30°C (86°F) require ambient temperature adjustment correction factors

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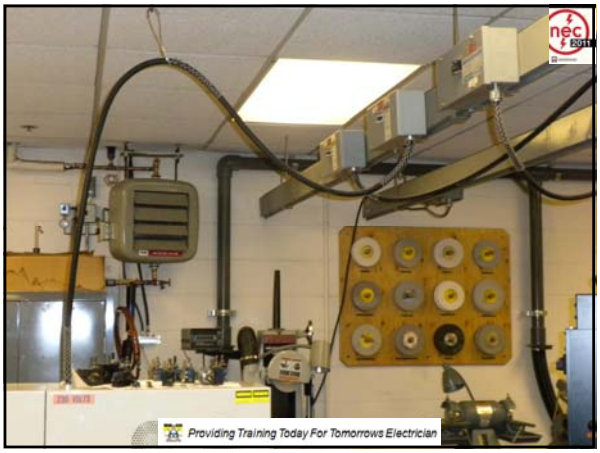


400.31 Construction of Flexible Cords and Cables

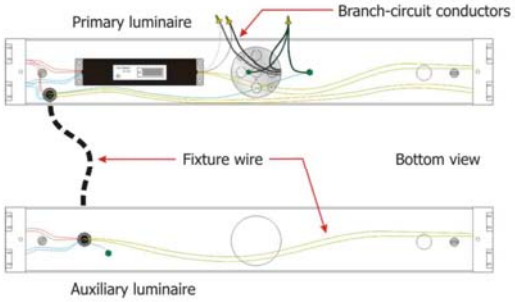
Table 400.4 Flexible Cords and Cables (in part)

Trade Name	Type Letter	Voltage	AWG or kcmil	Number of Conductors	Insulation
Lamp cord	C	300 600	18-16 14-10	2 or more	Thermoset or thermoplastic
Elevator cable	E	300 600	20-2	2 or more	Thermoset
Portable power cord	G	2000	12-500	2-6 plus EGC(s)	Thermoset
Hard service cord	SO	600	18-2	2 or more	Thermoset

Reproduction of Table 400.4 (in part)

Previous 400.31(B) for shielded cables has been deleted as there are no cords or cables in Article 400 that are rated for use above 2000 volts

402.11 Uses Not Permitted



Fixture wire shall not be used as branch-circuit conductors except as permitted elsewhere in the *Code*.

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404.2(C) Switches Controlling Lighting Loads

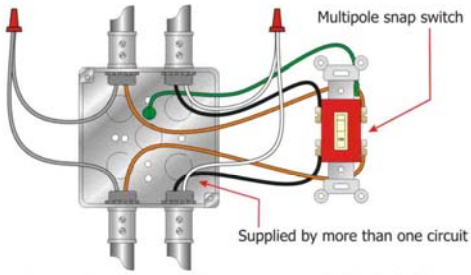
NEW!

- The grounded (neutral) conductor is required at switches controlling lighting loads.
- Exceptions are provided for wiring installed in a raceway system or for cable assembly wiring if the cable is accessible.
- Many devices require a neutral connection for the 120-volt circuitry within the device that must operate whether the switch is on or off.
- Occupancy sensors, motion detectors, and so forth.

404.4 Damp or Wet Locations

- All surface mounted switches or circuit breakers in damp or wet locations are now required to be in a weatherproof enclosure.
- All flush mounted switches or circuit breakers in damp or wet locations are now required to be equipped with a weatherproof cover.

404.8(C) Multipole Snap Switches



General-use multipole snap switches are not permitted to be fed from more than a single circuit unless listed and marked as a two-circuit or a three-circuit switch.

Switches are permitted in these applications where the rating is not less than the nominal line-to-line voltage of the system supplying the circuits.

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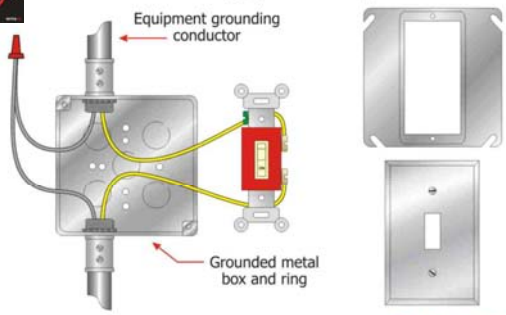
404.9(B) Grounding



Snap switches, dimmers, and similar control switches shall be connected to an equipment grounding conductor and shall provide a means to connect metal faceplates to the equipment grounding conductor, whether or not a metal faceplate is installed.

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404.9(B) Grounding of Switches

Switches generally required to be connected to an equipment grounding conductor and provided a means to ground metal faceplates (whether or not a metal faceplate is installed)

Two new exceptions were added to mandatory provisions for grounding of switches:

Ex. No. 2 - Switches with nonmetallic yokes, faceplates, and accessible parts (after installation) when listed as a kit or assembly

Ex. No. 3 - Snap switch with an integral nonmetallic enclosure

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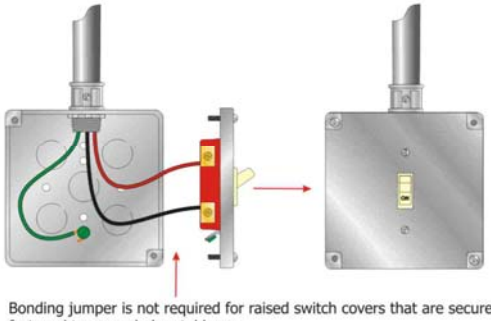
404.9(B)(1) Grounding

Applies to snap switches, dimmers, and similar control devices



Bonding jumper is not required for raised switch covers that are securely fastened to grounded metal boxes.

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406.4(D)(4) Receptacle Replacement (AFCI)

Arc-fault circuit-interrupter protection is required for replacement receptacle outlets where a receptacle outlet is supplied by a branch circuit that requires AFCI protection elsewhere in the *Code* *(effective date January 1, 2014)*

Replacement receptacle outlet can be protected by a listed outlet branch circuit type AFCI receptacle or a listed combination type AFCI circuit breaker

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210.12(B) and 406.4(D)(4) Arc-Fault Circuit-Interrupter Protection

Listed Outlet Branch-Circuit Type AFCI Device

Providing Training Today For Tomorrows Electrician *Pass & Seymour/Legrand*

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406.4(D)(5) Receptacle Replacement Tamper-Resistant Receptacles

Listed tamper-resistant receptacles are required for replacement receptacle outlets where a receptacle outlet is required to be tamper-resistant elsewhere in the *Code*

See 406.12, 406.13, and 406.14 for tamper-resistant receptacle requirements

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406.4(D)(6) Receptacle Replacement Weather-Resistant Receptacles

Listed weather-resistant receptacles are required for replacement receptacle outlets where a receptacle outlet is required to be weather-resistant elsewhere in the *Code*

See 406.9(A) and 406.9(B) for weather-resistant receptacle requirements

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406.4(G) Voltage Between Adjacent Devices

- A new subdivision (G) covering voltage between adjacent receptacles has been added to 406.4.
- Where voltages between adjacent receptacles in ganged enclosures exceed 300, identified and securely fastened barriers are required between the devices.

406.8 Receptacles in Damp or Wet Locations

- All nonlocking 15- and 20- ampere, 125- and 250-volt receptacles installed in damp or wet locations are now required to be listed as "weather-resistant type."

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406.8(A) and (B)(1) Damp and Wet Locations

- Standard nonlocking receptacles in 125- and 250-volt configurations are required to be listed weather-resistant type.
- A new second sentence has been added in 406.8(A) and 406.8(B)(1) and a new FPN follows each section.
- All nonlocking 15- and 20-ampere, 125- and 250-volt receptacles shall be listed weather-resistant type.

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406.9(B)(1) Receptacles in Wet Locations

- All 15- and 20-ampere, 125- and 250-volt receptacles installed in a wet location must have an enclosure that is weatherproof whether or not the attachment plug cap is inserted (in-use cover)
- <u>For other than one- or two-family dwellings, an outlet box hood installed for this purpose shall be listed and where installed on an enclosure supported from grade must be identified as "extra-duty"</u>
- All 15- and 20-ampere, 125- and 250-volt nonlocking <u>type</u> receptacles must be listed weather-resistant type

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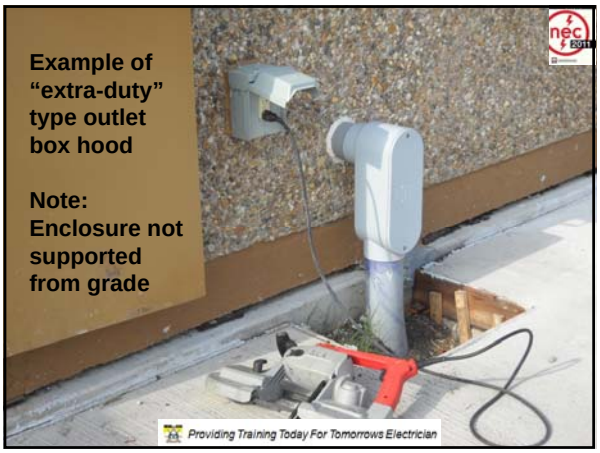
Example of "extra-duty" type outlet box hood
Note: Enclosure not supported from grade
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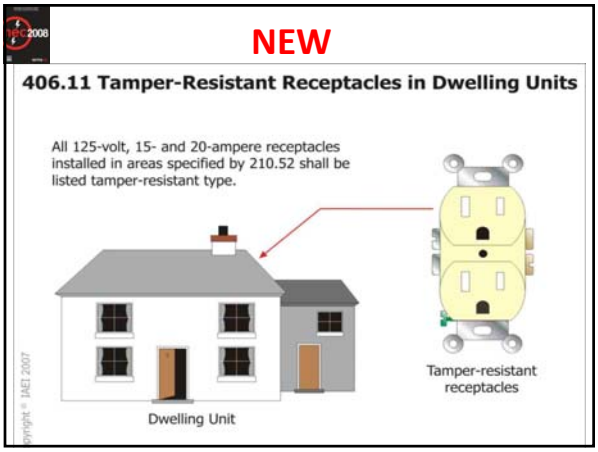
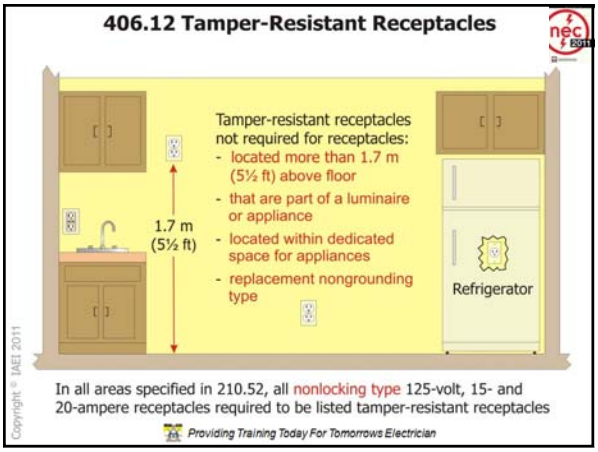

NEW
406.11 Tamper-Resistant Receptacles in Dwelling Units
All 125-volt, 15- and 20-ampere receptacles installed in areas specified by 210.52 shall be listed tamper-resistant type.
Dwelling Unit
Tamper-resistant receptacles


406.12 Tamper-Resistant Receptacles
Tamper-resistant receptacles not required for receptacles:
- located more than 1.7 m (5½ ft) above floor
- that are part of a luminaire or appliance
- located within dedicated space for appliances
- replacement nongrounding type
1.7 m (5½ ft)
Refrigerator
In all areas specified in 210.52, all nonlocking type 125-volt, 15- and 20-ampere receptacles required to be listed tamper-resistant receptacles
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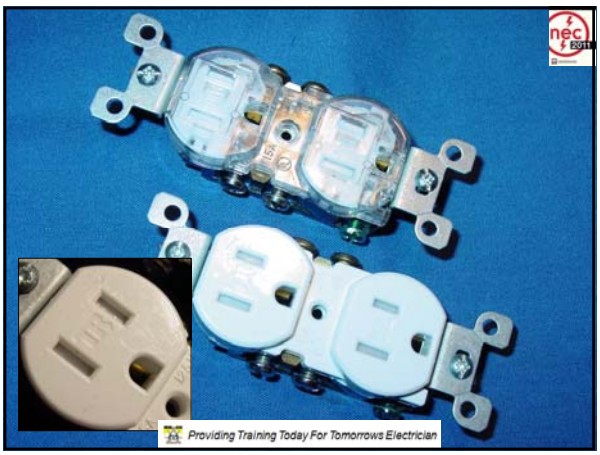
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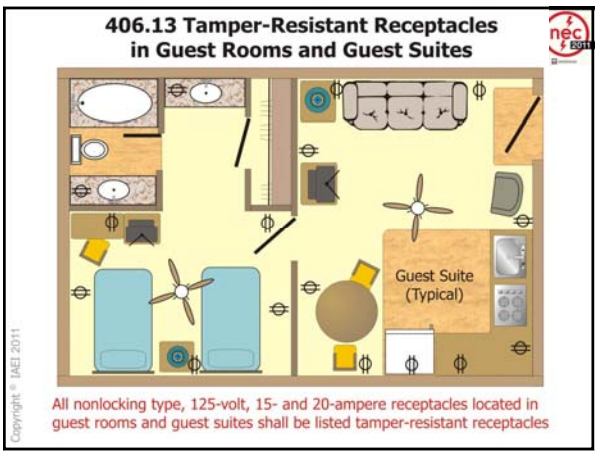
406.13 Tamper-Resistant Receptacles in Guest Rooms and Guest Suites
Guest Suite (Typical)
All nonlocking type, 125-volt, 15- and 20-ampere receptacles located in guest rooms and guest suites shall be listed tamper-resistant receptacles

406.14 Tamper-Resistant Receptacles Child Care Facilities

In all child care facilities, all nonlocking type, 125-volt, 15- and 20- ampere receptacles shall be listed tamper-resistant receptacles

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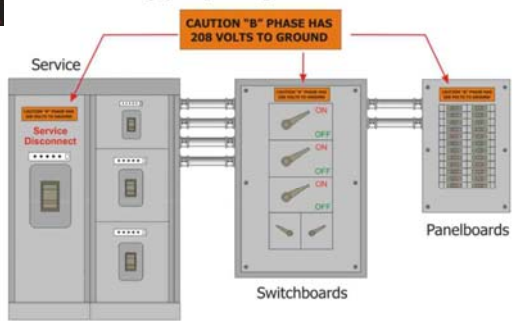
408.3(F) High-Leg Identification



Switchboard or panelboard containing a 4-wire, delta-connected system where the midpoint of one phase winding is grounded shall be marked CAUTION_____PHASE HAS_____VOLTS TO GROUND

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408.3(F) Switchboard or Panelboard Identification

NEW!

- A switchboard or panelboard containing an ungrounded system is now required to be marked in a manner similar to that for systems with a high leg.
- The specific marking requirement is as follows:
- Caution Ungrounded System
- Operating – _____ Volts Between Conductors

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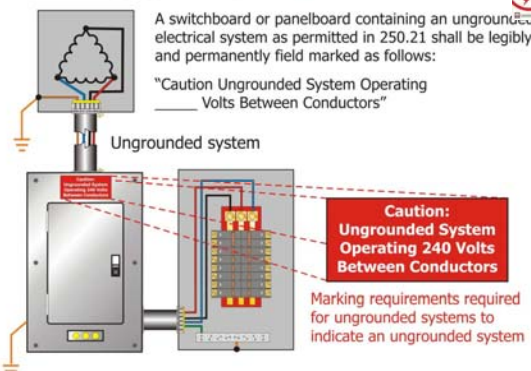
408.3(F)(2) Marking - Ungrounded Systems

A switchboard or panelboard containing an ungrounded electrical system as permitted in 250.21 shall be legibly and permanently field marked as follows:

"Caution Ungrounded System Operating _____ Volts Between Conductors"



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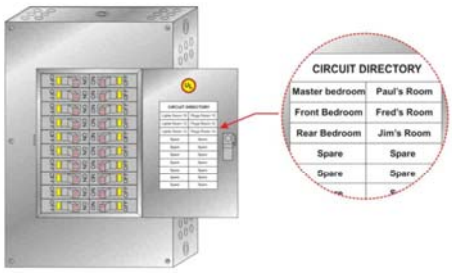
408.4 Circuit Directory or Circuit Identification



Spare positions containing unused overcurrent devices or switches shall be marked accordingly.

Circuits shall not be marked in a manner that depends on transient conditions of occupancy.

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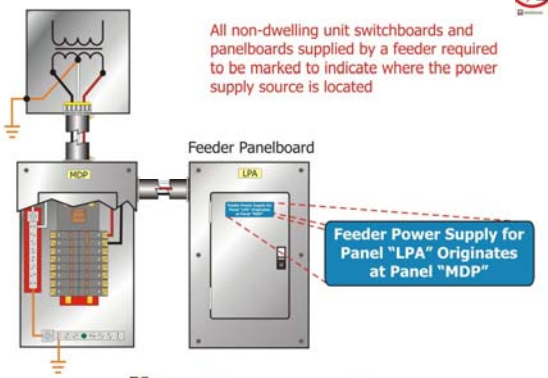
408.4(B) Identification - Source of Supply

All non-dwelling unit switchboards and panelboards supplied by a feeder required to be marked to indicate where the power supply source is located



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408.36 Overcurrent Protection

Overcurrent protection for panelboards is required within or at any point on the supply side feeder for the panelboard.

The definitions of *power panelboard* and a *lighting and appliance branch circuit panelboard* have been removed.

Section 408.35 has been deleted, removing the general limitation of not more than 42 overcurrent devices other than what is required by Exception No. 2.

Section 408.54 requires physical means to prevent the installation of more overcurrent devices than the panelboard is designed, rated, and listed for.

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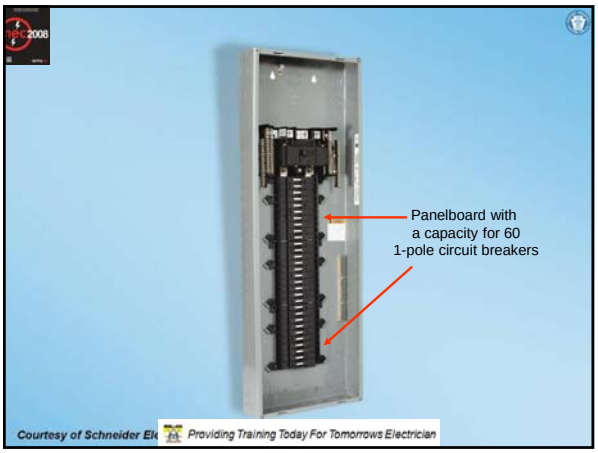
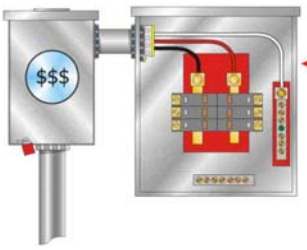


408.36 Exception No. 1



Suitable for use as service equipment

Not more than six single or multiple pole circuit breakers or sets of fuses

Individual protection shall not be required for a panelboard used as service equipment with multiple disconnecting means in accordance with 230.71.

In panelboards protected by three or more main circuit breakers or sets of fuses, the circuit breakers or sets of fuses shall not supply a second bus structure within the same panelboard assembly.

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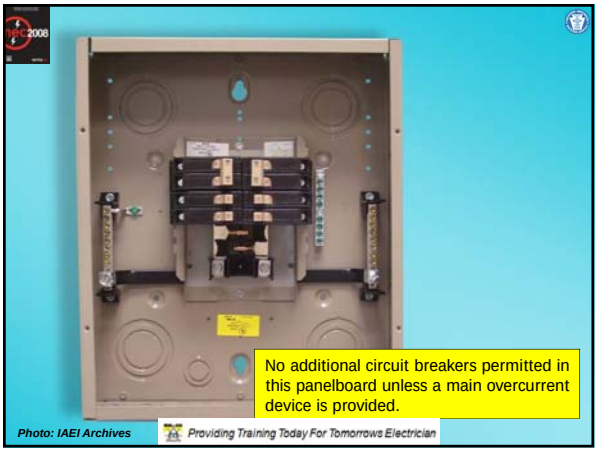

409.2 "Industrial Control Panel"

- This definition is revised to clarify that an Industrial Control Panel may consist of power circuit components only, or control circuit components only, or a combination of power and control circuit components.

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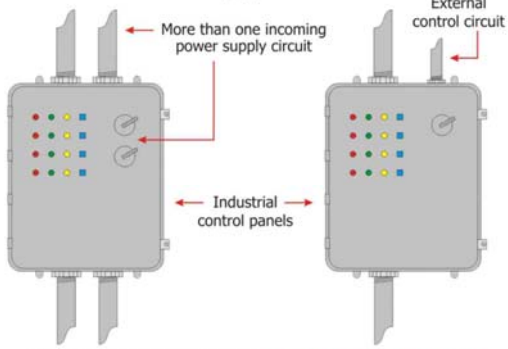
409.21(B) Location



Overcurrent protection required for each incoming supply circuit in accordance with 409.21(B)(1) or (2).

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409.22 Short-Circuit Current Rating

NEW!

- Industrial control panels are now prohibited where the available fault current exceeds the short circuit current rating of the industrial control panel.
- Industrial control panels are required by 409.110 to be marked with a short-circuit current rating.
- Sections 110.9 and 110.10 require equipment to be rated for the amount of available fault current.

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409.102(B) Phase Arrangements Industrial Control Panels

The phase arrangement on 3-phase horizontal common power and vertical buses shall be A, B, C from front to back, top to bottom, or left to right, as viewed from the front of the industrial control panel

Other busbar arrangements shall be permitted for additions to existing installations, and the phases shall be permanently marked

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409.104(A) Industrial Control Panels - Wiring Space

Other equipment (other than switches or overcurrent devices) permitted to be installed in industrial control panels with adequate wire bending space provided

Conductor fill to be less than 40 percent of the cross-sectional area of the wiring space and in addition, the conductors, splices, and taps shall not fill the wiring space at any cross section to more than 75 percent of the cross-sectional area of that space

409.104(B) Wire Bending Space

- Wire bending space for field wiring terminals shall be in accordance with the requirements in 430.10(B).
- Does not have to comply with 312.6.

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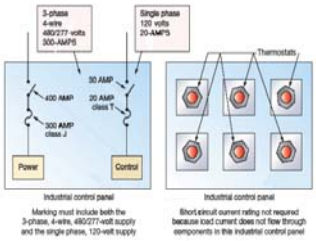
409.110 Marking Industrial Control Panels



- Clearly identify information on each incoming supply circuit, and the identification/location of wiring diagrams.
- *Exception:* short-circuit current rating markings are not required for industrial control panels containing only control circuit components.

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409.110 General

NEW!

- Where industrial control panels are supplied from more than one source and more than one disconnecting means is required to de-energize the equipment, the industrial control panel must be marked to convey that information.
- This is a safety enhancement for workers that identifies multiple sources entering the same industrial control panel.

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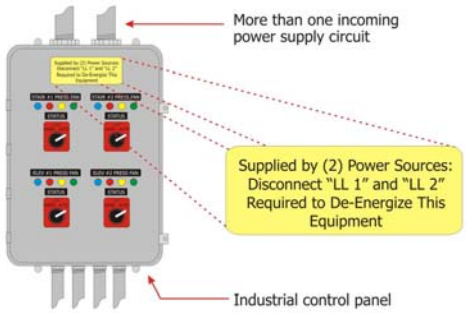
409.110(3) Industrial Control Panels - Marking



Industrial control panels required to be marked if supplied with multiple power supplies

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409.110(3) Exception to (3)

- Short-circuit current rating markings are not required for industrial control panels containing only control circuit components.

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Article 410 Luminaires

Article 410 has been reorganized and renumbered.

References for "fixtures", "light fixtures", and "lighting fixtures" removed from Article 410 and the *NEC*.

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410.6 Listing Required

Luminaires, Lampholders, and Lamps

- All luminaries and lampholders to be listed.

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410.16 Luminaires in Clothes Closets

- (A)(3) Surface-mounted fluorescent or LED luminaires identified as suitable for installation within the storage area.
- (C)(1) 300 mm (12 in.) for surface-mounted incandescent or LED luminaires…or on the ceiling.
- (C)(3) 150 mm (6 in.) for recessed incandescent or LED luminaires…or the ceiling.
- (C)(5) Surface-mounted fluorescent or LED luminaires shall be permitted to be installed in the storage space where identified for this use.

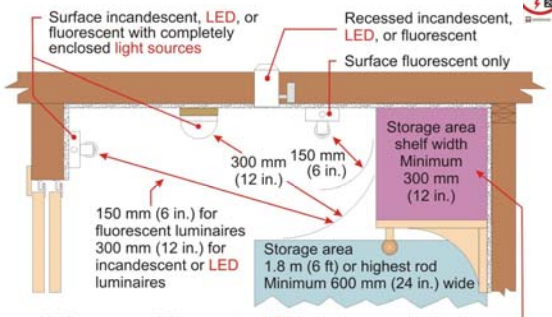
Listed LED luminaires suitable for installations in clothes closets.

Photos: Courtesy Of

410.16(A) Luminaire Types Permitted, (C) Location

- Surface-mounted LED luminaries, which are identified for the use are now permitted to be installed in a clothes closet.

410.16 Luminaires in Clothes Closets



Surface-mounted fluorescent or LED luminaires permitted to be installed within the closet storage space where identified for this use

Revisions were added to 410.16 to clearly permit surface-mounted LED luminaires in clothes closets

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410.16(A) Luminaires in Clothes Closets

LED Type Luminaires in Clothes Closets

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410.30(B)(1) Handhole

- (1) A pole shall have a handhole not less than 50 mm × 100 mm (2 in. × 4 in.) with a cover suitable for wet locations to provide access to the supply terminations within the pole or pole base.

410.62(C)(1)(2)c Cord-Connected Installation

- c. Is terminated in a grounding-type attachment plug cap or busway plug, or is a part of a listed assembly incorporating a manufactured wiring system connector in accordance with 604.6(C), <u>or has a luminaire assembly with strain relief and canopy having a maximum 152 mm (6 in.) long section of raceway for attachment to an outlet box above a suspended ceiling.</u>

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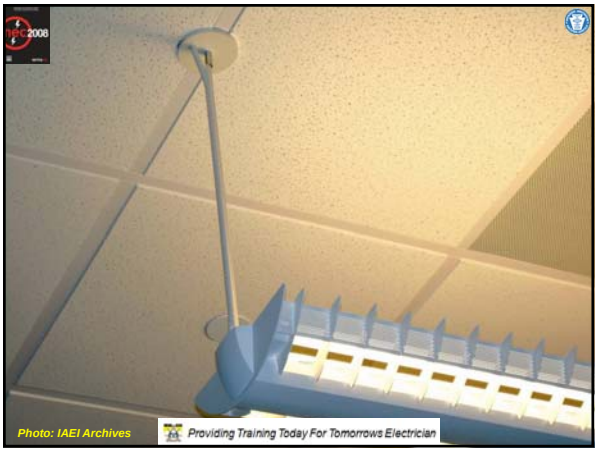
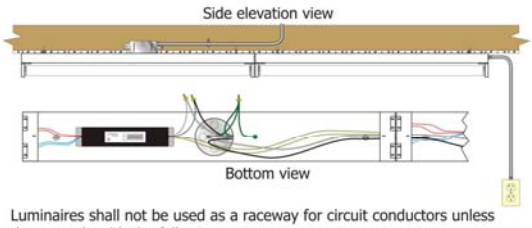


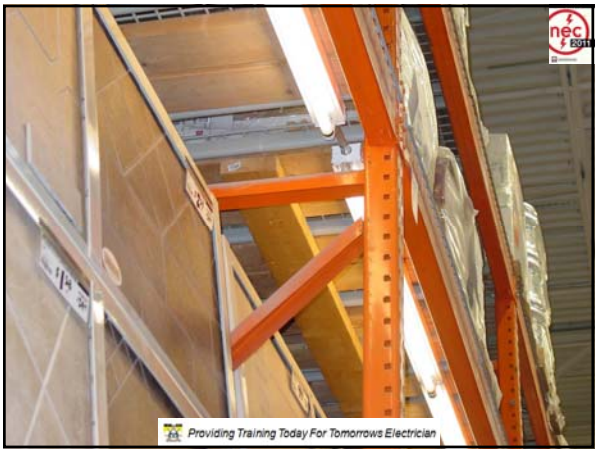
410.64 Luminaires as Raceways

References to rules for luminaires used as raceways have been incorporated into one section of the *Code*



Luminaires shall not be used as a raceway for circuit conductors unless they comply with the following:

- Listed and marked for use as a raceway
- Identified for through-wiring, as permitted by 410.21
- Designed for end-to-end connection to form a continuous assembly, or connected together by recognized wiring methods (2-wire branch circuit)



410.110 General

- Luminaires installed in suspended ceilings are now subject to the requirements of 410.115 through 410.122.
- The requirements apply to recessed luminaires in suspended ceiling installations.
- The revision recognizes the heat concerns associated with luminaires installed in accessible ceiling grid installations in addition to walls and other ceiling cavities.
- A formal interpretation has been in place since 1982 to clarify that suspended ceilings are subject to the requirements of Part XI of Article 410 and is no longer needed as a result of this revision.

410.116(B) Installation

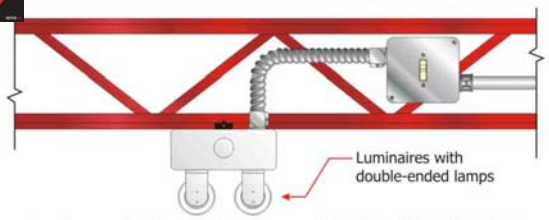
- Light-emitting diode (LED) illumination drivers and power supplies produce a significant amount of heat in normal operation.
- LED drivers and power supplies have been included in 410.116(B) to prohibit the installation of thermal insulation above or within 3 inches of the luminaire unless it is marked as Type IC.

410.130(G)

Disconnecting Means
Luminaires, Lampholders, and Lamps

- Required in ballasted fluorescent luminaries with double ended lamps
- The grounded conductor is required to be switched only where the luminaire is supplied from a multiwire branch circuit
- The location of the disconnect when it is external of the luminaire is required to be within sight of the luminaire

410.130(G) Disconnecting Means



- Requirements for disconnecting means applies only to ballasted luminaires with double-ended lamps.
- Disconnect must open all conductors, including the grounded conductor, when conneced to a multiwire branch circuit.
- The disconnect shall be a single device and where installed externally to the luminaire, it is required to located within sight from the luminaire.

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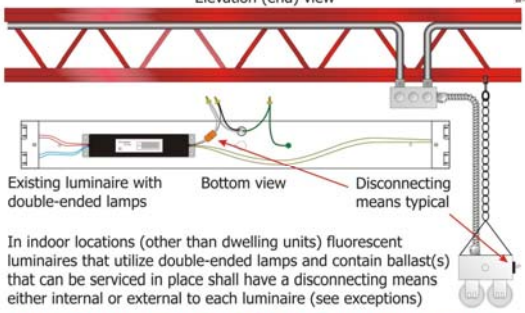
410.130(G)(1) Disconnecting Means

Elevation (end) view



In indoor locations (other than dwelling units) fluorescent luminaires that utilize double-ended lamps and contain ballast(s) that can be serviced in place shall have a disconnecting means either internal or external to each luminaire (see exceptions)

Disconnecting means required for existing installed luminaires without disconnecting means, at the time a ballast is replaced

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410.141(B) Within Sight or Locked Type

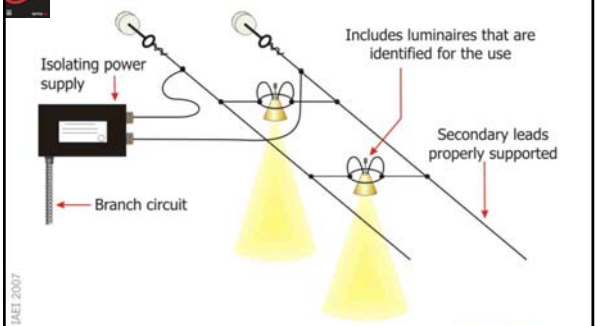
- (B) Within Sight or Locked Type. The switch or circuit breaker shall be located within sight from the luminaires (fixtures) or lamps, or it shall be permitted elsewhere if it is provided with a means for locking in the open position.
- The provisions for locking or adding a lock to the disconnecting means must remain in place at the switch or circuit breaker whether the lock is installed or not.
- Portable means for adding a lock to the switch or circuit breaker shall not be permitted to meet the installation requirements in the *NEC*.

Photo: IAEI Archives

410.151(B) FPN

- The fine print note to 410.151(B) has been revised to clarify that the length of track and number of luminaires installed on the track are not limited by the provisions in 410.151(B).
- The load calculation in 220.43(B) does not limit the length of track on a single branch circuit, and it does not limit the number of luminaires on a single track.

411.2 Definition: Low-Voltage Lighting System



A lighting system consisting of an isolating power supply, low-voltage luminaires, and associated equipment, all are identified for the use.

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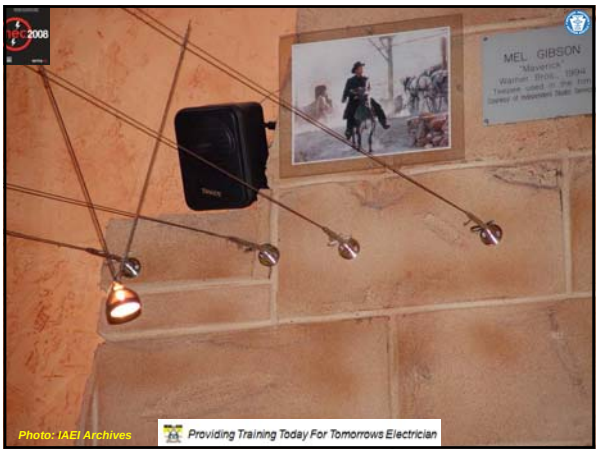
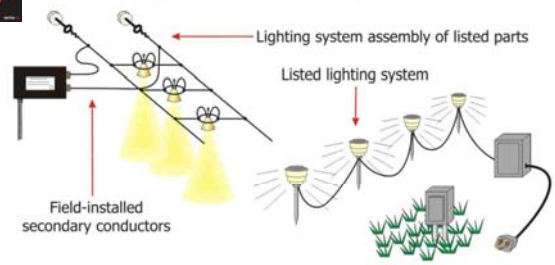
411.3 Listing Required

- This section has been revised to include a subdivision (A) covering listed systems, and a subdivision (B) covering field assemblies using listed parts.
- In (B) the luminaires, power supply, and luminaire fittings (including the exposed bare conductors) of an exposed bare conductor lighting system installation shall be listed for use as part of the same identified lighting system.

Photo: IAEI Archives



411.4 Specific Location Requirements



Installation of conductors concealed or extending through floors, walls, or ceilings shall meet the requirements in 411.4(A)(1) or (2).

Lighting systems shall be installed not less than 3 m (10 ft) from the nearest edge of the water at pools, spas, fountains, or similar locations.

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422.2 Definition Vending Machine

NEW!

- Section 422.2 includes a new definition of the term vending machine.
- Any self-service device that dispenses products or merchandise without the necessity of replenishing the device between each vending operation and is designed to require insertion of coin, paper currency, token card, key, or receipt of payment by other means.

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243

422.15(C) Central Vacuum Outlet Assemblies

Accessible non-current-carrying metal parts of the central vacuum outlet assembly likely to become energized shall be connected to an equipment grounding conductor in accordance with 250.110 *(Equipment Fastened in Place)*

Incidental metal parts such as screws or rivets installed into or on insulating material shall not be considered likely to become energized

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422.30 Disconnecting Means for Appliances

A means shall be provided to disconnect simultaneously each appliance from all ungrounded conductors

Grouped and identified as the appliance disconnect

If an appliance is supplied by more than one branch circuit or feeder, these disconnecting means shall be grouped and identified as the appliance disconnect

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422.31 Disconnecting Means for Appliances

Disconnecting means requirements (when an appliance contains a motor over 1/8 horsepower) have been revised and clarified

422.31 Disconnection of Permanently Connected Appliances

(A) Rated at Not over 300 Volt-Amperes or 1/8 Horsepower

(B) Appliances Rated over 300 Volt-Amperes ~~or 1/8 Horsepower~~

(C) Motor-Operated Appliances Rated Over 1/8 Horsepower *(was 422.32)*

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422.51 Cord-and-Plug Vending Machines

- A new last sentence and fine print note have been added to this section.
- This section has been revised to describe more clearly what qualifies as a vending machine.
- The fine print note references the UL standards for vending machines.
- Vending machines are self-service devices that dispense products or merchandise and are designed to require insertion of a coin, paper currency, token, card, key, or receipt of payment by other means.

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422.52 Electric Drinking Fountains

- Electric drinking fountains shall be protected with ground-fault circuit-interrupter protection.
- Bottled water coolers are not affected by this rule.

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424.19 Disconnecting Means Fixed Electric Space-Heating Equipment

- All disconnects are required to be sized at not less than 125 percent of the total load of the motors and the heaters.
- Provisions for locking or adding a lock to the disconnecting means for electric space heating equipment must remain in place with or without the lock installed.

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424.19(A)(2) Disconnecting Means (FESE)

Means shall be provided to simultaneously disconnect the heater, motor controller(s), and supplementary overcurrent protective device(s) of all fixed electric space-heating equipment from all ungrounded conductors

For heaters containing a motor(s) rated over 1/8 horsepower, this disconnecting means is permitted to serve as the required disconnecting means for both the motor controller(s) and heater by one of the following means:

- Where the disconnecting means is in sight from the motor controller(s) and the heater, and complies with Part IX of Article 430 *(motor disconnecting means)*
- Where the unit is provided with a single unit switch, the disconnecting means is permitted to be out of sight from the motor controller

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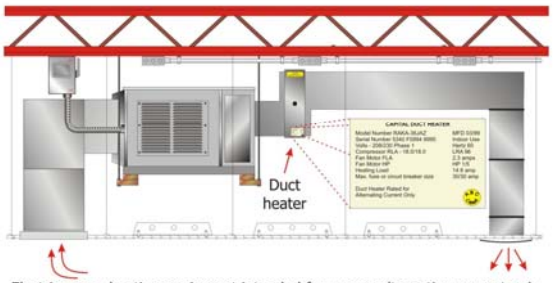
424.28(A) Nameplate Marking (FESH)

Fixed electric space-heating equipment required to be marked for both ac and dc current when the equipment is dual-rated for both ac and dc current



Electric space-heating equipment intended for use on alternating current only, direct current only, or both shall be marked to so indicate

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424.39 Clearances - Electric Space-Heating Cables

Heating cables require at least 200 mm (8 in.) separation from the edge of surface luminaire outlet boxes and junction boxes

50 mm (2 in.) clearance required from recessed luminaires and their trims, ventilating openings, and other such openings in room surfaces

Heating cables shall not be covered by any surface-mounted equipment

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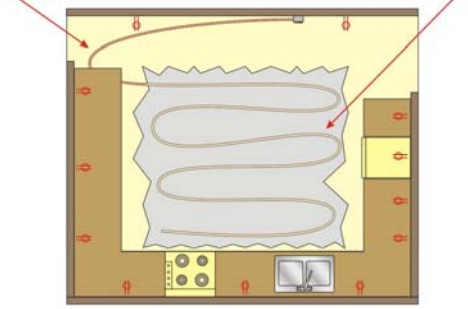
424.44(G) Heating Cables in Floors

Heating cables or panels in floors (GFCI protection required)



Electric heating cables installed in floors in bathrooms, kitchens, and in hydromassage bathtubs locations required to be GFCI protected

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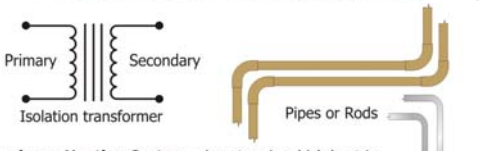
426.2 and 426.31 Fixed Outdoor Electric Deicing and Snow-Melting Equipment



Impedance Heating System - A system in which heat is generated in a pipe or rod, or combination of pipes and rods, by causing current to flow through the pipe or rod by direct connection to an ac voltage source from an isolating transformer

Isolation Transformer - An isolation transformer with a grounded shield between the primary and secondary windings shall be used to isolate the distribution system from the heating system

"Dual-winding" has been replaced with "isolation" transformers since many transformers have more than two windings

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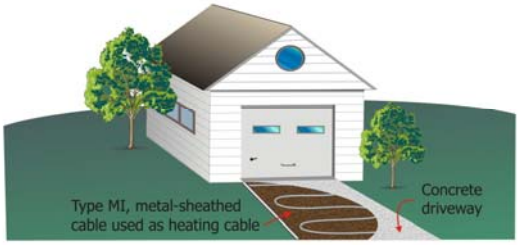
426.28 Ground-Fault Protection of Equipment
Fixed Outdoor Electric Deicing and Snow Melting Equipment

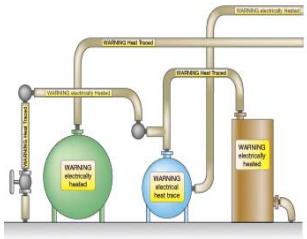
The elimination of GFP for mineral-insulated, metal-sheathed cable type fixed outdoor electric deicing and snow-melting equipment has been deleted



GFP of equipment required for fixed outdoor electric deicing and snow-melting equipment~~, except for equipment that employs mineral-insulated, metal-sheathed cable embedded in a noncombustible medium~~

427.13 Identification

Fixed Electric Heating Equipment for Pipelines and Vessels



- Required to be marked with caution signs or markings at intervals not exceeding 20-feet.
- Markings must also be placed on or adjacent to equipment in the piping system that requires periodic servicing.

430.2 Valve Actuator Motor (VAM) Assemblies

- A manufactured assembly, used to operate a valve, consisting of an actuator motor and other components such as controllers, torque switches, limit switches, and overload protection.
- Valve actuator motor assemblies typically have short-time duty and high-torque characteristics.

New

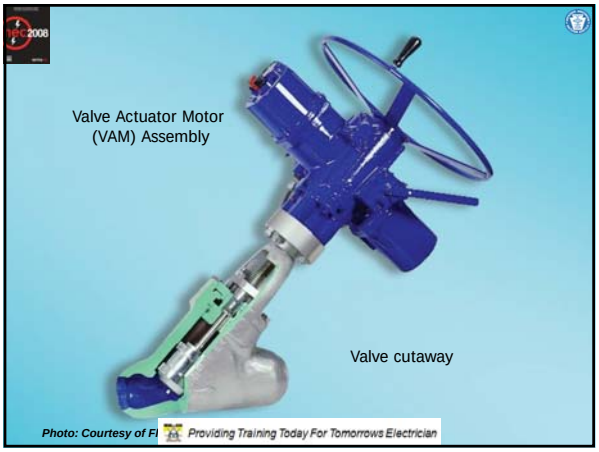


Photo: Courtesy of Fl

430.6(D) Valve Actuator Motor Assemblies

NEW!

- A new subdivision (D) has been added to Section 430.6.
- This revision clarifies which value of current must be used for a valve actuator motor assembly (VAM).
- When sizing the maximum rating or setting of the motor branch-circuit short-circuit and ground-fault protective device and the ampacity of the conductors for a VAM, the nameplate current is required to be used.

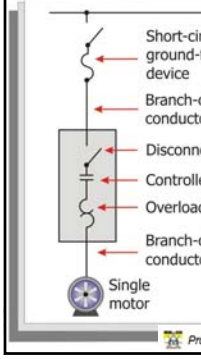
430.11 Protection Against Liquids

- The word “injurious” has been removed from this section.
- The revision clarifies requirements related to protection for motors, motor terminals and motor lead insulation from liquids and damage from liquids, rather than from injury from liquids.

Photo: IAEI Archives

430.22 Motor Circuit Conductors (Single Motor)

Revisions were incorporated to provide clarification as to the application of the 125 percent factor and when to apply it for sizing conductors for a single motor



430.22 Single Motor (Motor Circuit Conductors)

Conductors that supply a continuous duty single motor must have an ampacity of not less than 125 percent of the motor FLA taken from the applicable table, or not less than specified in 430.22(A) through (G)

(A) DC Motors-Rectifier Supplied
(B) Multispeed Motor
(C) Wye-Start, Delta-Run Motor
(D) Part-Winding Motor
(E) Other Than Continuous Duty
(F) Separate Terminal Enclosure
(G) Conductors for Small Motors
(1) 18 AWG Copper
(2) 16 AWG Copper

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430.22(G) Conductors for Small Motors

Conductors for small motors shall not be smaller than 14 AWG unless otherwise permitted in 430.22(G)(1) or 430.22(G)(2)

Where installed in a cabinet or enclosure, 18 or 16 AWG individual copper conductors, or copper conductors of either a jacketed multiconductor cable assembly or a flexible cord shall be permitted, under specific conditions

New provisions have been added at 430.22(G) to allow the use of 18 and 16 AWG conductors under specific conditions for small motors circuit conductors

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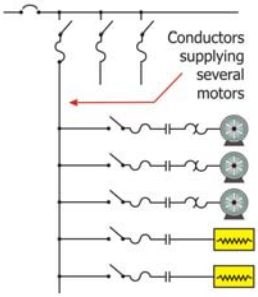
430.24 Circuit Conductors for Several Motors

Conductors supplying several motors, or a motor(s) and other load(s), shall have an ampacity not less than the sum of each of the following:



(1) 125 percent of the full-load current rating of the highest rated motor as determined by 430.6(A)

(2) the sum of the full-load current ratings of all the other motors in the group, as determined by 430.6(A)

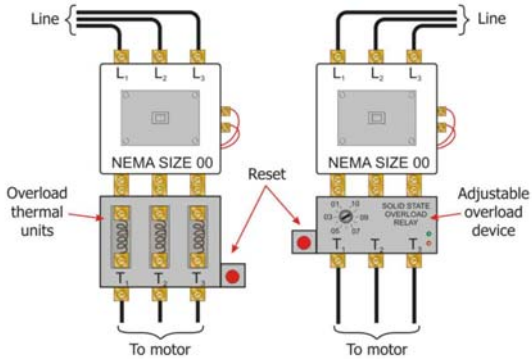
(3) 100 percent of the non-continuous non-motor load

(4) 125 percent of the continuous non-motor load

The method of calculating motor-circuit conductors for several motors or motors and other loads was revised into a list format

430.32(C) Selection of Overload Device

Section 430.32(C) covers overload devices including, but not limited to relays.



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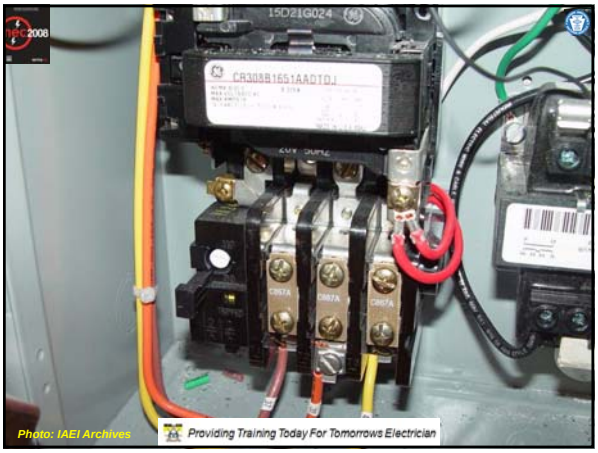

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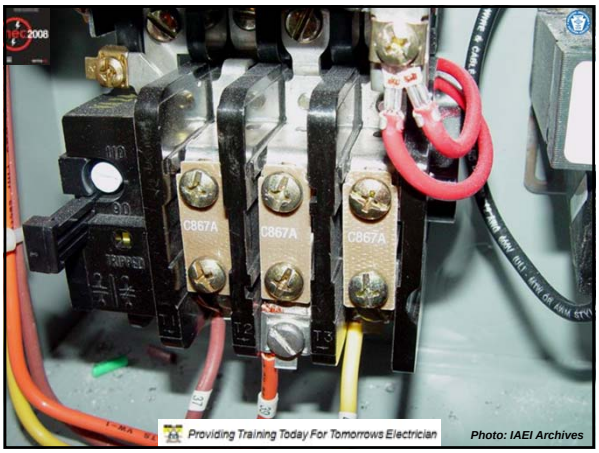
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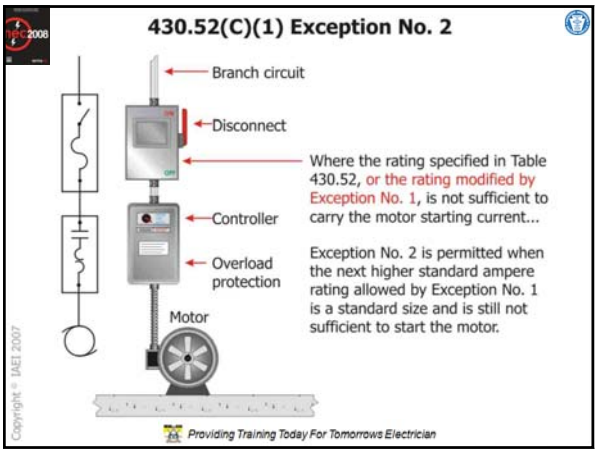
430.52(C)(1) Exception No. 2
Branch circuit
Disconnect
Where the rating specified in Table 430.52, or the rating modified by Exception No. 1, is not sufficient to carry the motor starting current...
Controller
Overload protection
Exception No. 2 is permitted when the next higher standard ampere rating allowed by Exception No. 1 is a standard size and is still not sufficient to start the motor.
Motor
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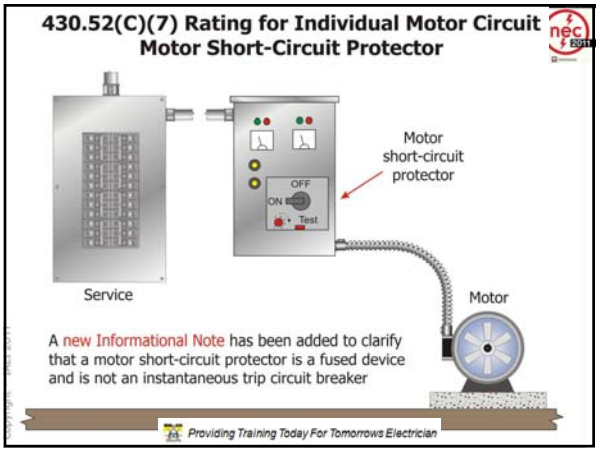
430.52(C)(7) Rating for Individual Motor Circuit
Motor Short-Circuit Protector
Motor short-circuit protector
OFF
ON
Test
Service
Motor
A new Informational Note has been added to clarify that a motor short-circuit protector is a fused device and is not an instantaneous trip circuit breaker
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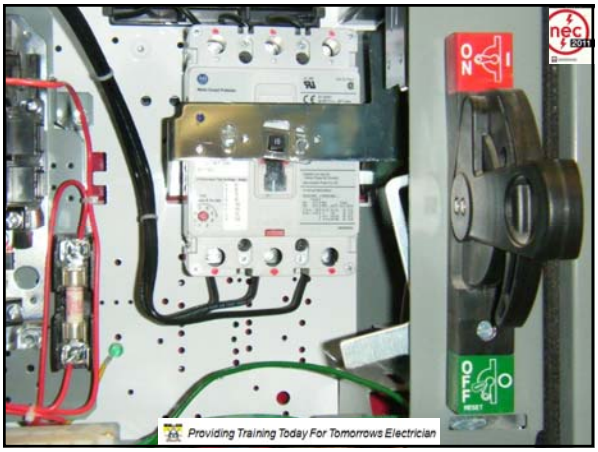
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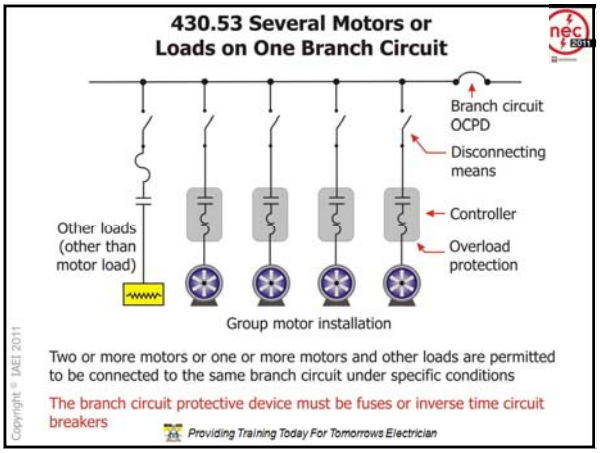
430.53 Several Motors or Loads on One Branch Circuit
Branch circuit OCPD
Disconnecting means
Controller
Overload protection
Other loads (other than motor load)
Group motor installation
Two or more motors or one or more motors and other loads are permitted to be connected to the same branch circuit under specific conditions
The branch circuit protective device must be fuses or inverse time circuit breakers
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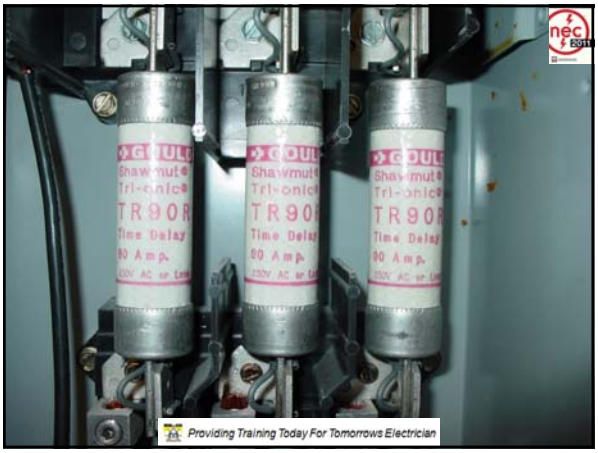
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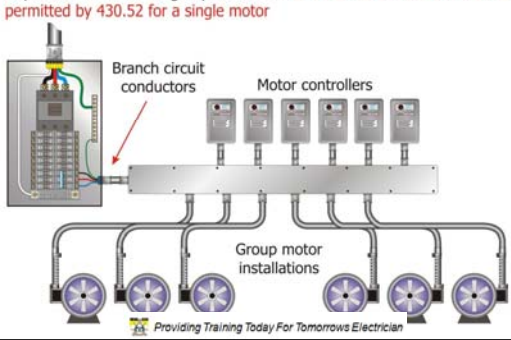
430.53(C)(1) and (C)(2) Several Motors or Loads on One Branch Circuit - Other Group Installations

Overload device and the motor controller for a group of motors are either required to be listed for group installation or sized not to exceed the value permitted by 430.52 for a single motor



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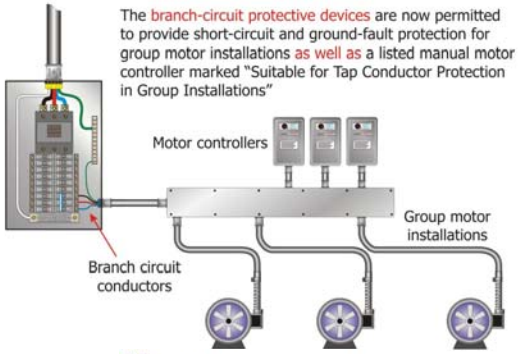
430.53(D)(3) Several Motors or Loads on One Branch Circuit - Single Motor Tap

The branch-circuit protective devices are now permitted to provide short-circuit and ground-fault protection for group motor installations as well as a listed manual motor controller marked "Suitable for Tap Conductor Protection in Group Installations"



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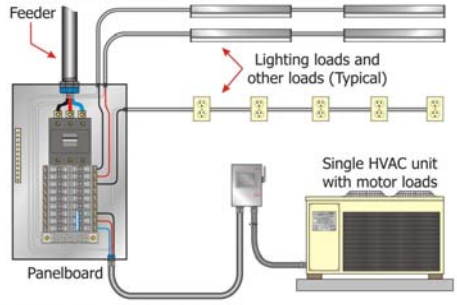
430.63 Rating or Setting - Motor and Other Loads

Motor feeder short-circuit and ground-fault protective device required to have rating to carry the other loads plus the motor load



"Other loads" replaced "lighting loads" as this section applies to more than just lighting loads

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430.74 Electrical Arrangement of Control Circuits

- Section 430.74 has been restructured to provide a more logical order, and a new 430.75 has been created.
- 430.75 includes requirements for control circuit disconnecting means previously found in 430.74.
- 430.74 as revised addresses the electrical arrangement requirements for motor control circuits where one side of the motor control circuit is grounded.
- No technical changes have been made in either section, just reorganization to improve clarity and usability.

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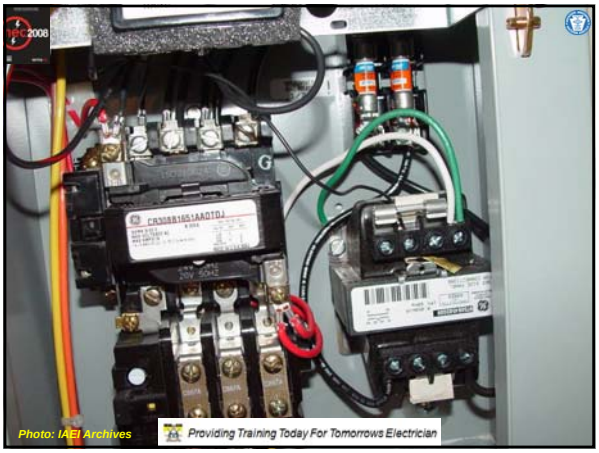

Photo: IAEI Archives

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430.102(A)

Motors, Motor Circuits, and Controllers

Disconnecting Means Location

- A new *Exception* No. 3 is added to address disconnect requirements of "valve actuated motor" controllers where the installation of a disconnect means could introduce additional or increased hazards to persons or property.

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430.102(B) Disconnecting Means Location

- Editorially revised to provide clarity in the application of requirements for motor disconnecting means.

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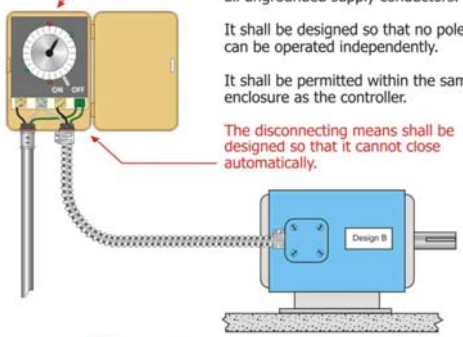
430.103 Operation



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430.110(A) General & 440.12 Rating and Interrupting Capacity

Motors, Motor Circuits, and Controllers

- Exceptions which permit a disconnecting means for a motor or compressor to be rated in horsepower and have a value less than 115% of the specified current values have been revised. The exceptions now specifically address the use of an "unfused" motor-circuit switch.

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430.126 Motor Overtemperature Protection

- The requirements of motors in an adjustable-speed drive system are clarified to be application dependent and are not required in all cases.

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430.126(A) Motor Overtemperature Protection

- (A) General. Adjustable speed drive systems shall protect against motor overtemperature conditions where the motor is not rated to operate at the nameplate rated current over the speed range required by the application. This protection shall be provided… (See remainder of subdivision for *Code* text).
- (B) Multiple Motor Applications. (See remainder of subdivision for *Code* text).
- (C) Automatic Restarting and Orderly Shutdown. (See remainder of subdivision for *Code* text).

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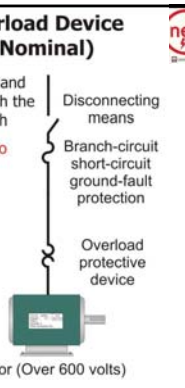
430.225(B)(1) Type of Overload Device (Motors Over 600 Volts, Nominal)

Each motor must be protected against overloads and failure to start by a thermal protector integral with the motor or external current-sensing devices, or both

Protective device settings for each motor circuit to be determined under engineering supervision



Engineering supervision is required to determine the sizing of overload and short-circuit protective devices for motors over 600 volts

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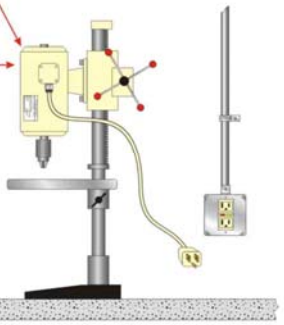
430.243 Portable Motors

Frames of portable motors operating at over 150 volts shall be guarded or grounded.

Listed motor-operated tools, appliances, and equipment are not required to be grounded where they are protected by a system of double insulation.

Double-insulated equipment must be distinctly marked.



Listed motor-operated tools, appliances, and equipment connected by cord and plug are not required to be grounded unless specified in 250.114.

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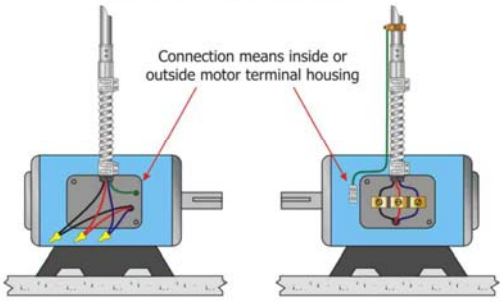
430.245 Method of Grounding

Connection to the equipment grounding conductor shall be done in the manner specified in Part VI of Article 250.



The means for connection of an equipment grounding conductor is permitted inside or outside the motor terminal housing [430.12(E)].

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440.12(A)(1) and (B)(2) Exceptions

440.12(A)(1)

- Exception: A listed unfused motor circuit switch, without fuseholders, having a horsepower rating not less than the equivalent horsepower determined in accordance with 440.12(A)(2) shall be permitted to have an ampere rating less than 115 percent of the specified current.

440.12(B)(2)

- Exception: A listed unfused motor circuit switch, without fuseholders, having a horsepower rating not less than the equivalent horsepower determined by 440.12(B)(1) shall be permitted to have an ampere rating less than 115 percent of the sum of all currents.

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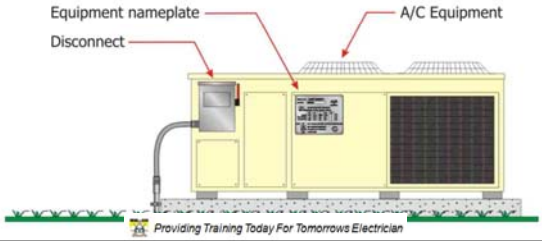
440.14 Location

Disconnect is required to be installed within sight and readily accessible from air-conditioning and refrigerating equipment

Disconnect is permitted to be installed on or within the equipment

Disconnect shall not obscure the equipment data nameplate



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440.54(A) Overload Protection

- A) Overload Protection. The motor-compressor shall be provided with overload protection selected as specified in 440.52(A).
- Both the controller and motor overload protective device shall be identified for installation with the short-circuit and ground-fault protective device for the branch circuit to which the equipment is connected.
- The word approved has been changed to identified.

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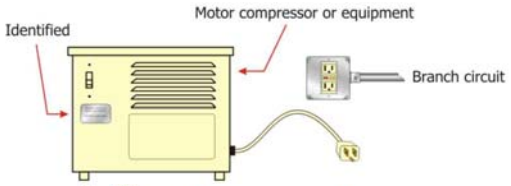
440.55(A) Overload Protection

Cord-and-plug-connected motor compressors and equipment on 15- and 20-ampere branch circuits

Motor compressor shall be provided with overload protection as specified in 440.52(A).

The controller and the overload protective device shall be identified for installation with the short-circuit and ground-fault protective device for the branch circuit to which the equipment is connected.



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445.18 Disconnecting Means Required for Generators

- Disconnecting means required for generators are required to be "lockable in the open position."

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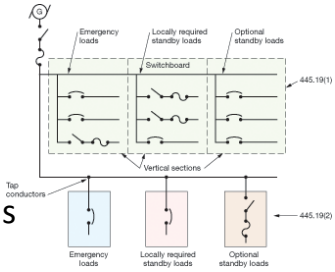
445.19 Generators Supplying Multiple Loads



- Where a single generator supplies more than one load or where multiple generators are in parallel, a switchboard or single feeder may be used to supply multiple overcurrent protective devices.

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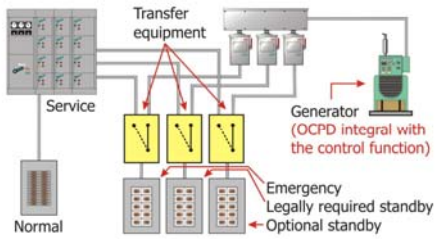
445.19 Generators Supplying Multiple Loads

A single generator supplying more than one load, or multiple generators operating in parallel, are permitted to supply either of the following:



(1) A vertical switchboard with separate sections

(2) Individual enclosures with overcurrent protection tapped from a single feeder for load separation and distribution if a generator(s) is provided with overcurrent protection meeting the requirements of 240.15(A)

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450.14 Disconnecting Means

NEW!

- This new section in Article 450 provides a requirement for installing a disconnecting means for transformers. It may be in sight of the transformer or in a remote location.
- Where the disconnecting means is out of sight from the transformer, it must be capable of being locked in the open position and the disconnect location must be marked on the transformer.
- Another safety enhancement for workers has been added to the NEC.

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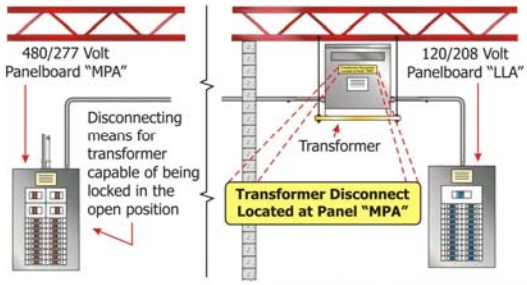
450.14 Transformers - Disconnecting Means

Transformers (other than Class 2 or Class 3) required to have a disconnecting means located either in sight of the transformer or in a remote location



Where located in a remote location, the disconnecting means must be lockable, and the location must be field marked on the transformer

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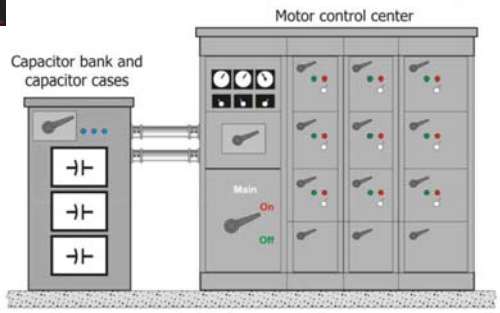
460.10 and 460.27 Capacitor Grounding



Capacitor cases are required to be connected to an equipment grounding conductor unless otherwise permitted in the exceptions.

Grounding requirements in 460.10 and 460.27 are more prescriptive.

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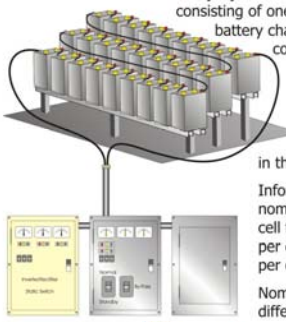
480.2 Definitions: Storage Battries

New definition for "Battery System" and revision of "Nominal Battery Voltage"



Battery System: Interconnected battery subsystems consisting of one or more storage batteries and battery chargers, and can include inverters, converters and associated electrical equipment

Nominal Battery Voltage: The voltage of a battery based on the number and type of cells in the battery

Informational Note: The most common nominal cell voltages are: 2 volts per cell for the lead-acid systems, 1.2 volts per cell for alkali systems, and 4 volts per cell for Li-ion systems

Nominal voltages might vary with different chemistries

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480.5 Disconnecting Means

- A disconnecting means shall be provided for all ungrounded conductors derived from a stationary battery system over 30 volts.
- The disconnecting means shall be readily accessible and located within sight of the battery system.

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490.44
Fused Interrupter Switches
&
490.46
Circuit Breaker Locking

- Provisions for locking the switching mechanism of a fused interrupter switch, remain in place with or without the lock installed.
- 490.46 provides requirements for locking circuit breakers over 600-volts in the open position.

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