ARTICLE
300

GENERAL REQUIREMENTS FOR WIRING METHODS AND MATERIALS

Introduction to Article 300—General Requirements for Wiring Methods and Materials

Article 300 contains the general requirements for all installed wiring methods included in the *NEC*. Because the Code is an installation standard this article does not apply where these wiring methods are integral parts of electrical equipment.

Because Article 300 contains the general requirements for wiring methods and materials, you must have a solid understanding of these rules to correctly and safely install the wiring methods included in Chapter 3. Some topics covered in this material include:

- Conductors
- Terminations
- Burial Depth
- Electrical and mechanical continuity of raceways and cables
- Securing and supporting
- Length of free conductors
- Induced currents in steel enclosures
- Spread of fire

Part I. General Requirements

300.1 Scope

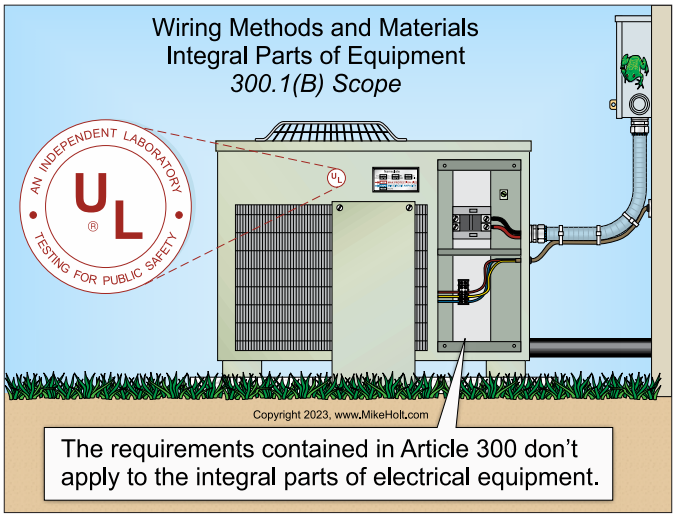
(A) All Wiring Installations. Article 300 contains the general requirements for wiring methods and materials for power and lighting. ▸Figure 300–1

Author's Comment:

- The requirements contained in Article 300 do not apply to Class 2 power-limited circuits, fire alarm circuits, optical fiber cables, or coaxial cable, unless they are specifically reference in the appropriate article.

▸Figure 300–1

(B) Integral Parts of Equipment. The requirements contained in Article 300 do not apply to the integral parts of electrical equipment. ▸Figure 300–2



▸Figure 300–2

Author's Comment:

- Integral wiring of equipment is covered by various product standards and not the *NEC*. It is the intent of this *Code* that the factory-installed internal wiring of equipment processed by a qualified testing laboratory does not need to be inspected [90.7].

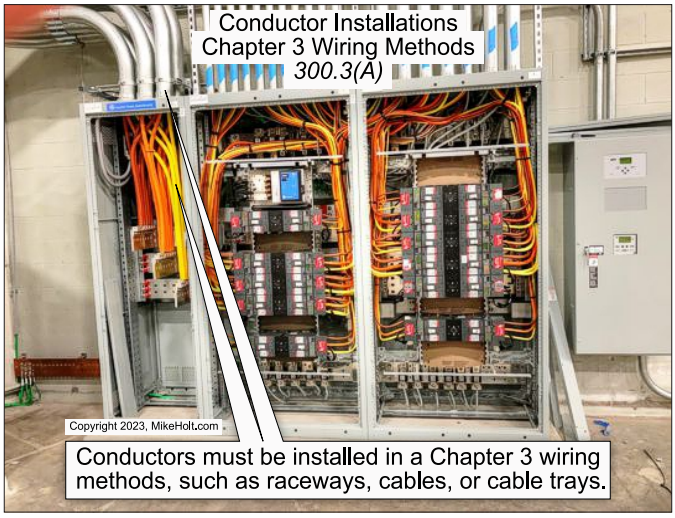
300.3 Conductors

(A) Conductors. Conductors must be installed in a Chapter 3 wiring method, such as raceways, cables, or cable trays. ▸Figure 300–3

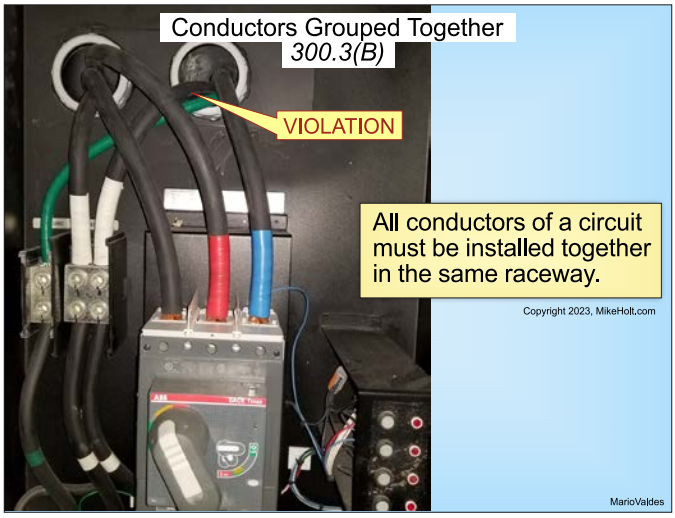
(B) Conductors Grouped Together. All conductors of a circuit, including the neutral and equipment grounding conductors, must be installed together in the same raceway, conduit body, cable, trench, or cable tray except as permitted by 330.3(B)(1) through (4). ▸Figure 300–4

Author's Comment:

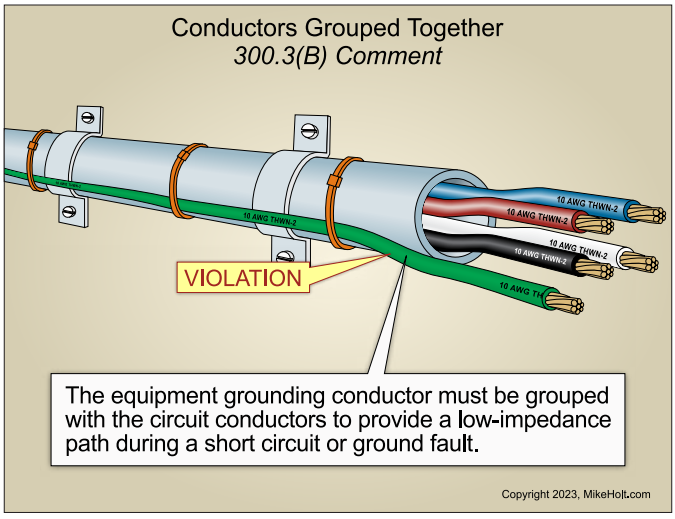
- The equipment grounding conductor must be grouped together with the circuit conductors to provide a low impedance path during a short-circuit or ground-fault event. ▸Figure 300–5



▸Figure 300–3

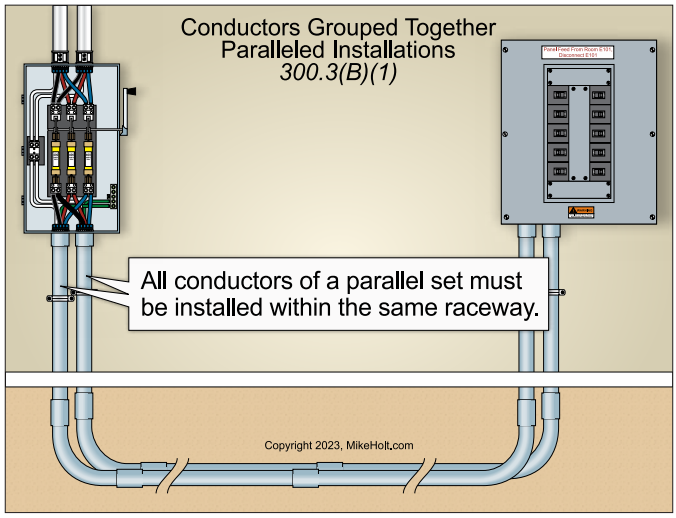


▸Figure 300–4



▸Figure 300–5

(1) Paralleled Installations. All conductors of a parallel set must be installed within the same raceway, cable, or cable tray in accordance with 310.10(G). ▸Figure 300–6

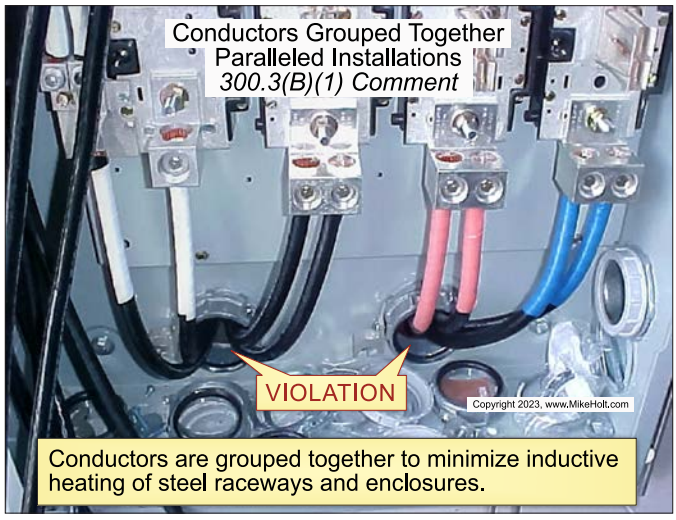


▸Figure 300–6

Connections, taps, or extensions made from paralleled conductors must connect to all conductors of the paralleled set.

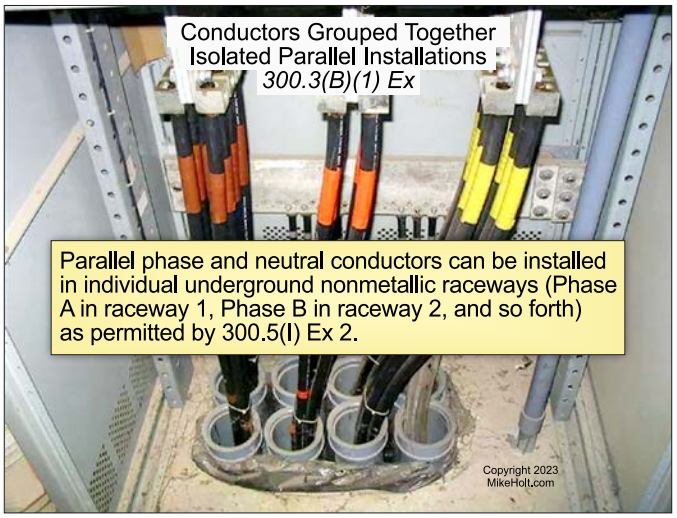
Author's Comment:

- Grouping all phase, neutral, and equipment grounding and bonding conductors of the circuit helps minimize the inductive heating of the surrounding steel raceways and enclosures for alternating-current circuits. See 300.20(A). ▸Figure 300–7



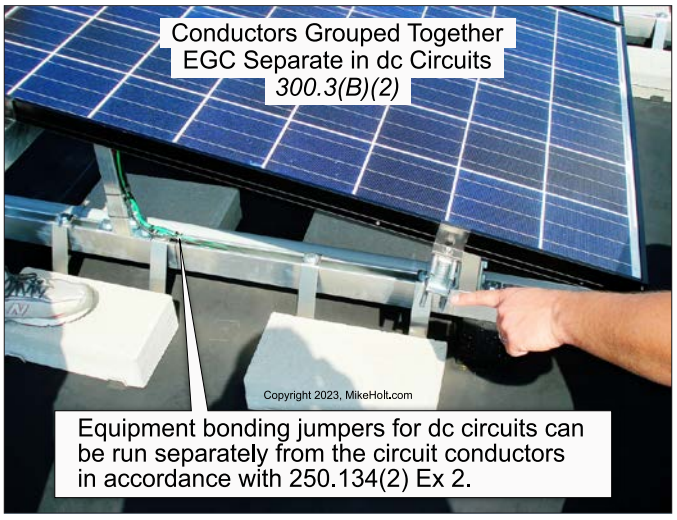
▸Figure 300–7

Ex: Isolated parallel phase and neutral conductors can be installed in individual underground nonmetallic raceways (Phase A in raceway 1, Phase B in raceway 2, and so forth) as permitted by 300.5(I) Ex 2, if the installation complies with 300.20(B). ▸Figure 300–8



▸Figure 300–8

(2) Bonding Jumpers Outside the Raceway. Equipment bonding jumpers for dc circuits can be run separately from the circuit conductors in accordance with 250.134(2) Ex 2. ▸Figure 300–9



▸Figure 300–9

Equipment bonding jumpers can be run outside the circuit raceway in accordance with 250.102(E)(2). ▸Figure 300–10

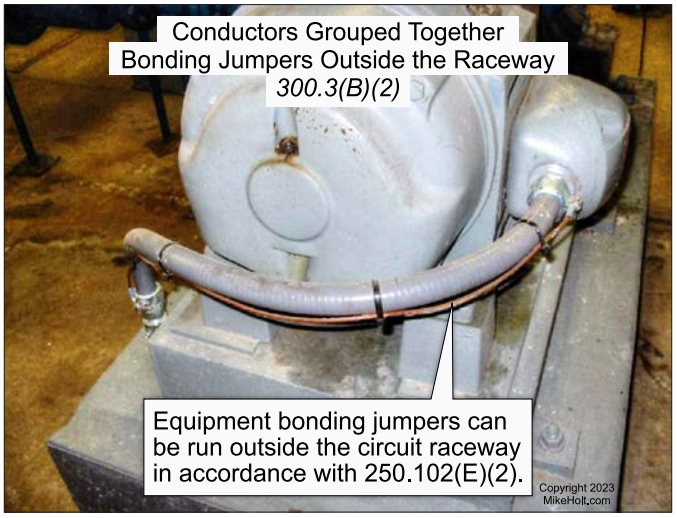


Figure 300–10

(C) Mixing Conductors of Different Voltage Systems.

(1) Voltage Insulation Rating. Power conductors can occupy the same raceway, cable, or enclosure if all conductors have an insulation voltage rating not less than the maximum circuit voltage. Figure 300–11

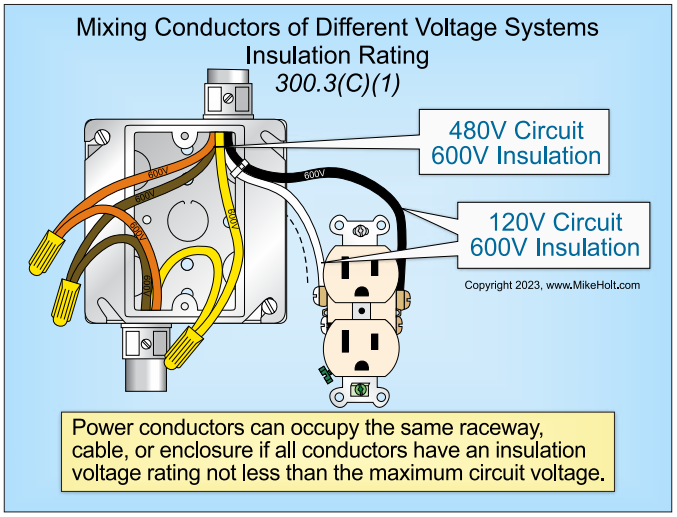


Figure 300–11

Author's Comment:

- The maximum circuit voltage in the raceway is what determines the minimum voltage rating for the insulation of the conductors–not the maximum insulation voltage of the conductors in the raceway. For example, a 120/240V circuit installed in a raceway with 600V insulated conductors must have all conductors with a minimum insulation voltage rating of 240V not 600V.

Note 1: Class 2 power-limited circuits must be separated from power circuits in raceways, so the higher-voltage conductors do not accidentally energize the Class 2 power-limited circuits [725.136(A)]. Figure 300–12

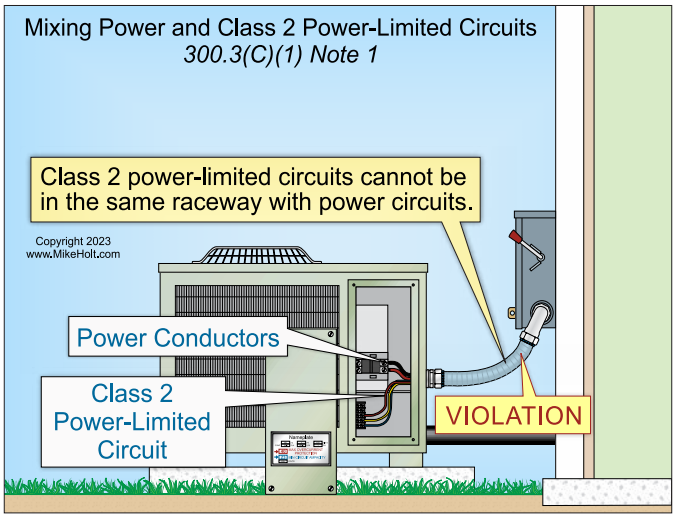


Figure 300–12

300.4 Protection Against Physical Damage

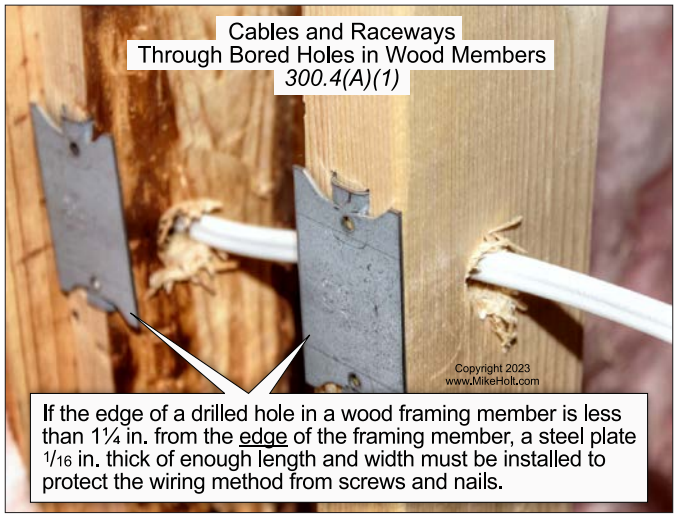
Where subject to physical damage, conductors, raceways, and cables must be protected in accordance with 300.4(A) through (H).

(A) Cables and Raceways Through Wood Members.

Author's Comment:

- When the following wiring methods are installed through wood members, they must comply with 300.4(A)(1) or (2).
  - Armored Cable, Article 320
  - Electrical Metallic Tubing, Article 358
  - Electrical Nonmetallic Tubing, Article 362
  - Flexible Metal Conduit, Article 348
  - Liquidtight Flexible Metal Conduit, Article 350
  - Liquidtight Flexible Nonmetallic Conduit, Article 356
  - Metal-Clad Cable, Article 330
  - PVC Conduit, Article 352
  - Nonmetallic-Sheathed Cable, Article 334
  - Service-Entrance Cable, Article 338
  - Underground Feeder and Branch-Circuit Cable, Article 340

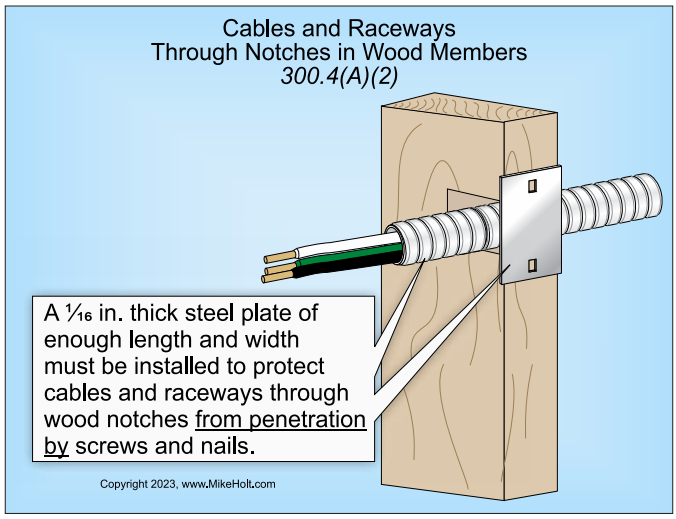
(1) Bored Holes in Wood Members. Holes through wood framing members for cables or raceways must be not less than 1¼ in. from the edge of the wood member. If the edge of a drilled hole in a wood framing member is less than 1¼ in. from the edge of the framing member, a steel plate 1/16 in. thick of sufficient length and width must be installed to protect the wiring method from screws and nails. ▸Figure 300–13



▸Figure 300–13

Ex 1: A steel plate is not required to protect rigid metal conduit, intermediate metal conduit, PVC conduit, reinforced thermosetting resin conduit (RTRC), or electrical metallic tubing.

(2) Notches in Wood Members. If notching of wood framing members for cables and raceways is permitted by the building code, a 1/16 in. thick steel plate of sufficient length and width must be installed to protect the wiring method laid in those wood notches from penetration by screws and nails. ▸Figure 300–14



▸Figure 300–14

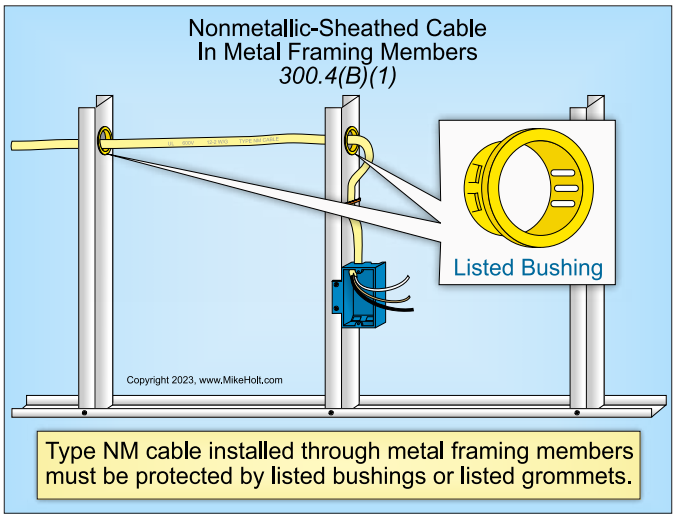
Ex 1: A steel plate is not required to protect rigid metal conduit, intermediate metal conduit, PVC conduit, or electrical metallic tubing.

Caution

CAUTION: Many wood and metal framing members (especially joists and beams) have specific drilling and/or notching instructions meant to maintain structural integrity. Building code requirements limit the diameter of the hole to ⅓ the depth of the joist framing member. Notching is limited to ¼ the depth of joist framing members in accordance with the IBC 2308, *International Building Code* and IRC 5208, *International Residential Code*.

(B) Nonmetallic-Sheathed Cable and Electrical Nonmetallic Tubing Through Metal Framing Members.

(1) Type NM Cable, Metal Framing Members. If Type NM cable passes through factory or field-made openings in metal framing members, the cable must be protected by listed bushings or grommets that cover all metal edges. The protection fitting must be securely fastened in the opening before the installation of the cable. ▸Figure 300–15

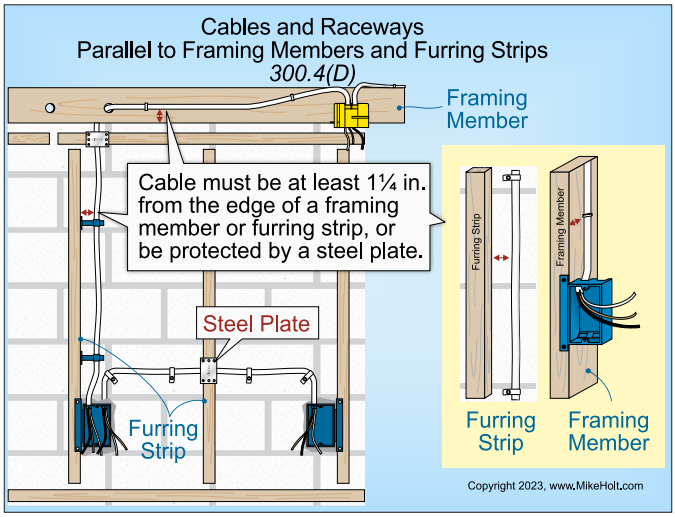


▸Figure 300–15

(2) Type NM Cable and Electrical Nonmetallic Tubing. If nails or screws are likely to penetrate Type NM cable or electrical nonmetallic tubing, a steel sleeve, steel plate, or steel clip not less than 1/16 in. thick must be installed to protect the cable or tubing.

Ex: A listed and marked steel plate less than 1/16 in. thick that provides equal or better protection against nail or screw penetration is permitted.

(D) Cables and Raceways Parallel to Framing Members and Furring Strips. Cables or raceways run parallel to framing members or furring strips must be protected by installing the wiring method not less than 1¼ in. from the nearest edge of the framing member or furring strip. If the edge of the framing member or furring strip is less than 1¼ in. away, a 1/16 in. thick steel plate of sufficient length and width must be installed to protect the wiring method from screws and nails. ▸Figure 300–16



▸Figure 300–16

Ex 1: Protection is not required for rigid metal conduit, intermediate metal conduit, PVC conduit, or electrical metallic tubing.

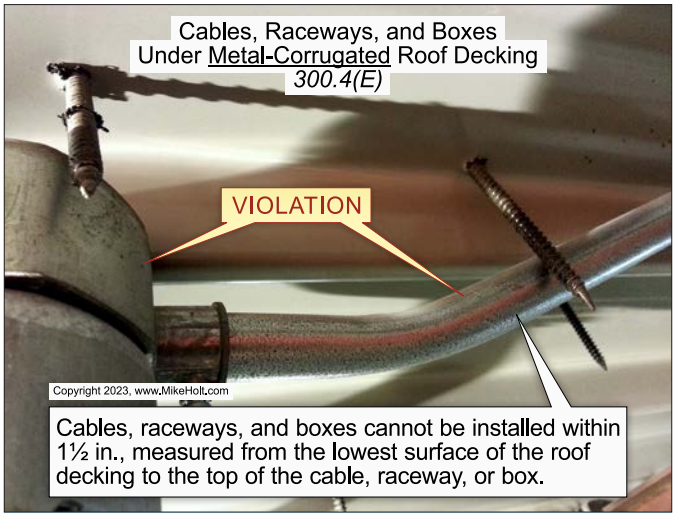
(E) Wiring Under Metal-Corrugated Roof Decking. Cables, raceways, and boxes under metal-corrugated sheet roof decking are not permitted to be within 1½ in. of the roof decking, measured from the lowest surface of the roof decking to the top of the cable, raceway, or box. ▸Figure 300–17

Author's Comment:

- A similar requirement applies to luminaires installed in or under roof decking [410.10(F)].

Note: Raceways or cables installed under metal roof decking might be penetrated by screws or other mechanical devices designed to "hold down" the waterproof membrane or roof insulating material.

Ex 1: Spacing from roof decking does not apply to rigid metal conduit and intermediate metal conduit with listed steel or malleable iron fittings and boxes.

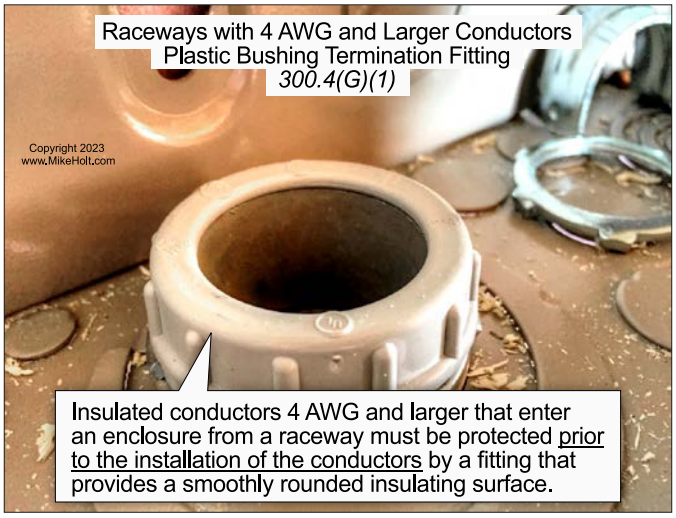


▸Figure 300–17

Ex 2: The 1½ in. spacing is not required where metal-corrugated sheet roof decking is covered with a minimum of 2 in. of concrete, measured from the top of the corrugated roofing.

(G) Raceway Termination Fittings. Raceways containing insulated circuit conductors 4 AWG and larger that enter a cabinet, box, enclosure, or raceway must be protected prior to the installation of the conductors as follows:

(1) An identified raceway fitting providing a smoothly rounded insulating surface ▸Figure 300–18



▸Figure 300–18

(2) A listed metal raceway fitting with smoothly rounded edges ▸Figure 300–19

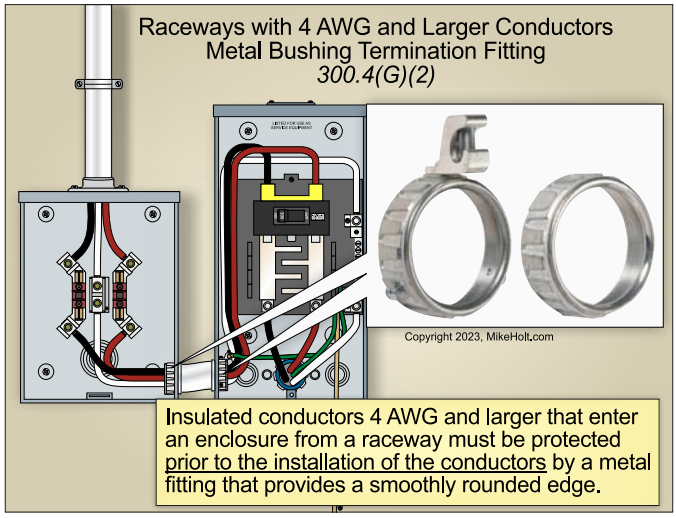


Figure 300–19

Conduit bushings constructed of metal can be used to secure a fitting or raceway.

(H) Structural Joints. A listed expansion/deflection fitting, or other means approved by the authority having jurisdiction, must be used where a raceway crosses a structural joint intended for expansion, contraction, or deflection.

300.5 Underground Installations

(A) Minimum Burial Cover Requirements. When cables or raceways are installed underground, they must have a minimum burial cover in accordance with Table 300.5(A). Figure 300–20

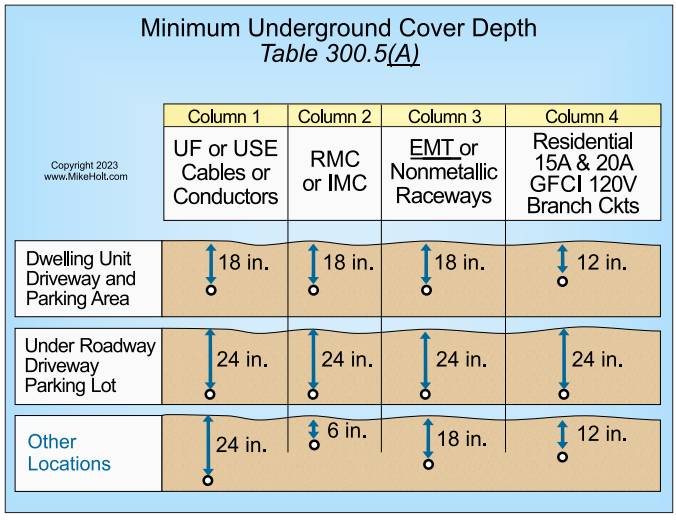


Figure 300–20

Author's Comment:

- There are no burial cover requirements for raceways underneath a building. Figure 300–21

Figure 300–21

Table 300.5(A) Minimum Cover Requirements in Inches

Location	Column 1 Buried Cables	Column 2 RMC or IMC	Column 3 EMT or Nonmetallic Raceways
Under Building	0	0	0
Dwelling Unit	24/12*	6	18
Dwelling Unit Driveway	18/12*	6	18/12*
Under Roadway	24	24	24
Other Locations	24	6	18

**Residential branch circuits rated 120V or less with GFCI protection and maximum protection of 20A.*

See the table in the NEC *for full details.*

Note 1 to Table 300.5: *"Cover" is measured as the shortest distance from the top of the underground cable or raceway to the top surface of finished grade.* Figure 300–22

Note 6 to Table 300.5: *Directly buried electrical metallic tubing (EMT) must comply with 358.10.*

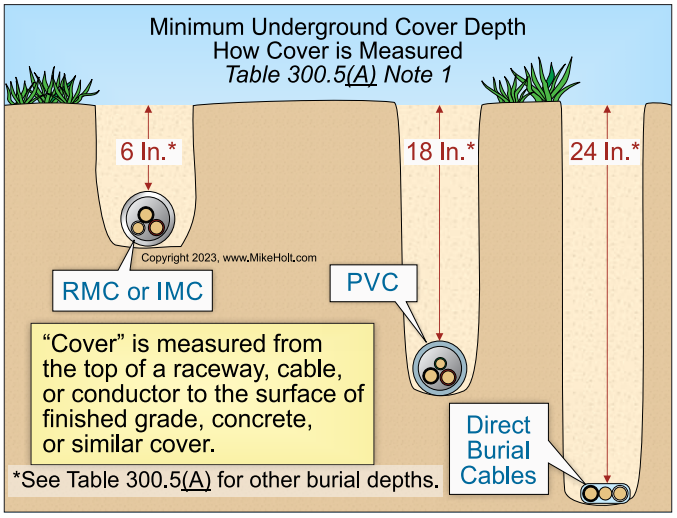


Figure 300–22

(B) Wet Locations. Cables and insulated conductors installed in raceways and enclosures underground must be listed as suitable for a wet location in accordance with 310.10(C). Figure 300–23

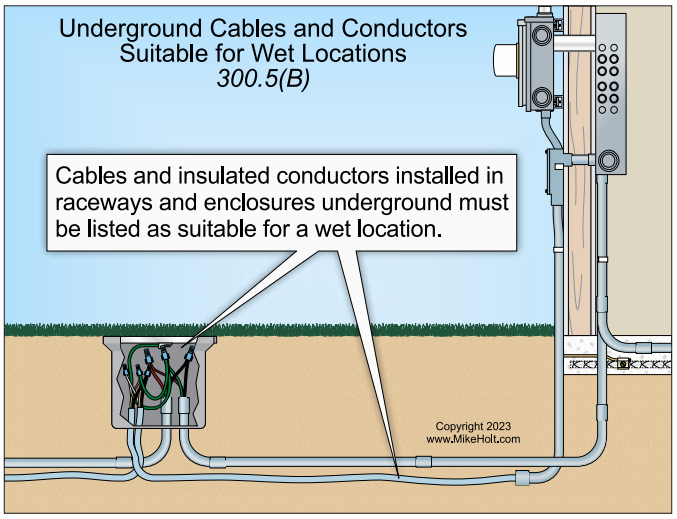


Figure 300–23

According to Article 100, "Wet Location" includes installations underground, in concrete slabs in direct contact with the Earth, locations subject to saturation with water, and unprotected locations exposed to weather. See 300.9 for raceways in wet locations above ground.

(C) Cables and Conductors Under Buildings. Cables and conductors installed under a building must be installed within a raceway that extends past the outside walls of the building.

Ex 2: Type MC cable listed for direct burial or concrete encasement is permitted under a building without installation within a raceway [330.10(A)(5) and 330.10(A)(11)].

(D) Protecting Underground Cables and Conductors. Conductors and cables such as Types MC, UF, and USE installed underground must be protected from damage in accordance with 300.5(1) through (4).

(1) Emerging from Grade. Type UF and USE cables and conductors that emerge from grade must be protected against physical damage. Protection below grade is required to extend no less than the cover requirements of Table 300.5 and not more than 18 in. The protection above grade must extend to a height of not less than 8 ft. Figure 300–24

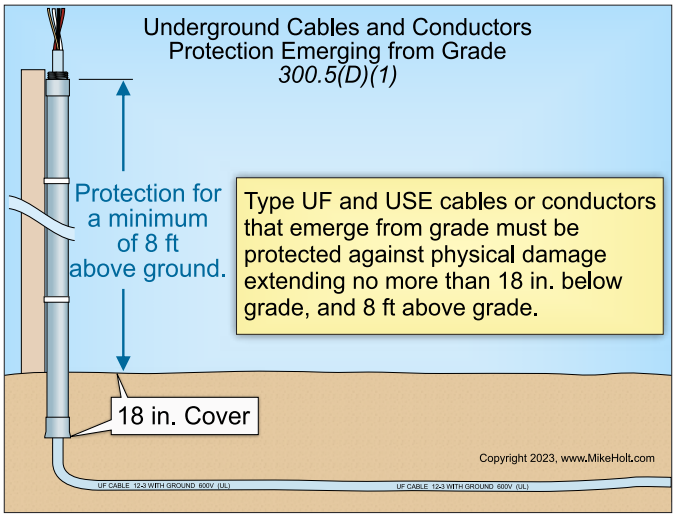


Figure 300–24

Author's Comment:

- Where a raceway is subject to physical damage, the conductors must be installed in EMT, RMC, IMC, RTRC-XW, or Schedule 80 PVC conduit [300.5(D)(4)].

(2) Conductors Entering Buildings. Underground conductors and cables that enter a building must be protected to the point of entrance.

(3) Underground Service Conductors. Underground service-entrance conductors (USE) must have their location identified by a warning ribbon placed in the trench at least 12 in. above the underground conductors. Figure 300–25

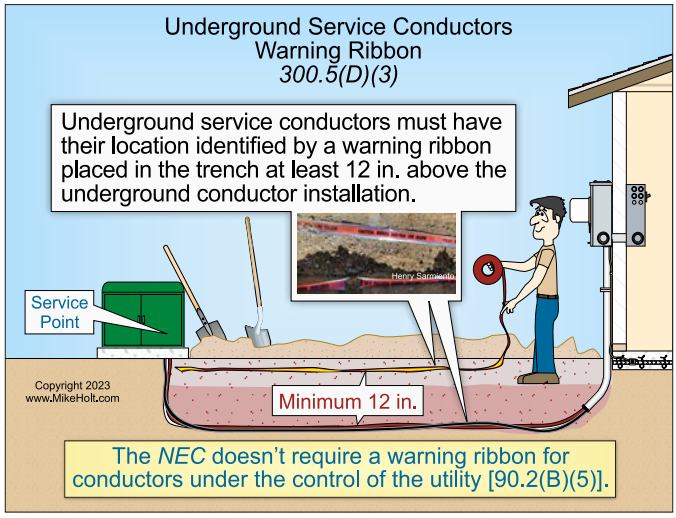


Figure 300–25

Author's Comment:

- The *NEC* does not require a warning ribbon for conductors under the exclusive control of the utility [90.2(D)(5)].
- The requirements for a warning ribbon do not apply to underground service conductors that are installed in a raceway or encased in concrete.

(4) Raceway Damage. Where an underground raceway emerging from grade is subject to physical damage, the conductors must be installed in EMT, RMC, IMC, RTRC-XW, or Schedule 80 PVC conduit. Figure 300–26

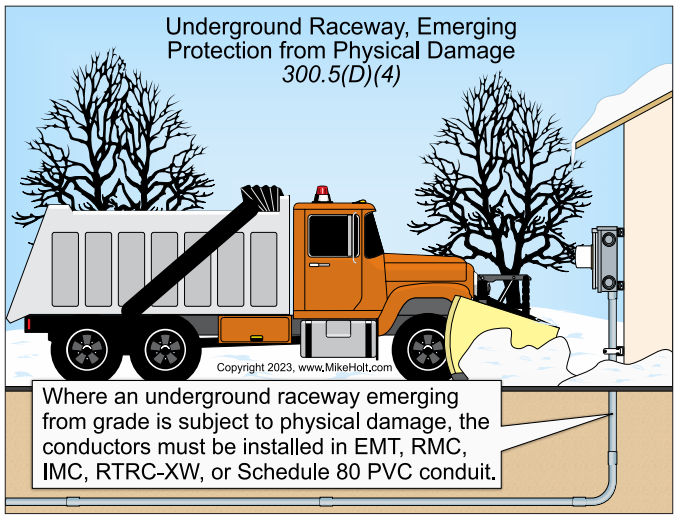


Figure 300–26

(E) Underground Splices and Taps. Direct-buried UF or USE conductors or cables can be spliced or tapped underground without a splice box [300.15(G)], if the splice or tap is made in accordance with 110.14(B). Figure 300–27

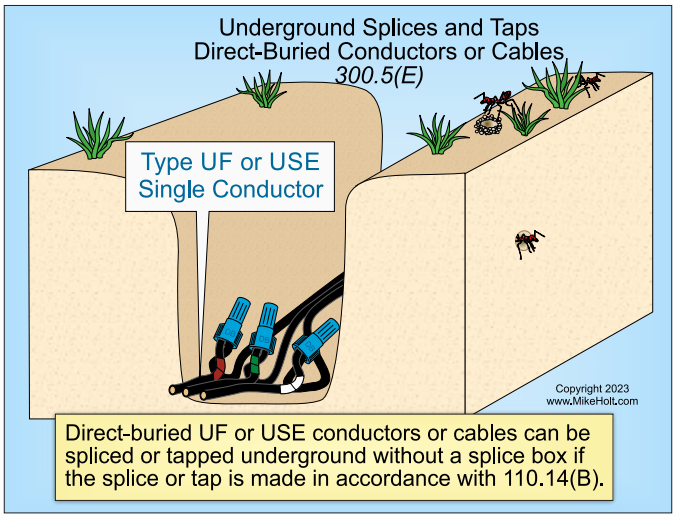


Figure 300–27

(F) Backfill. Backfill material for underground wiring must not damage underground raceways, cables, or conductors. Figure 300–28

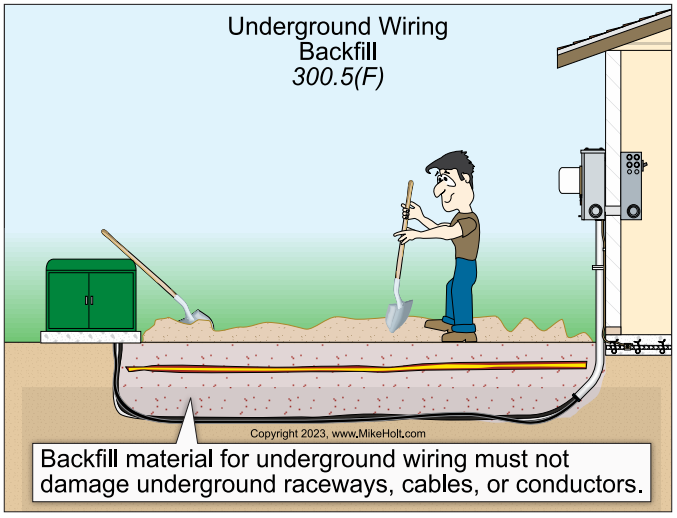
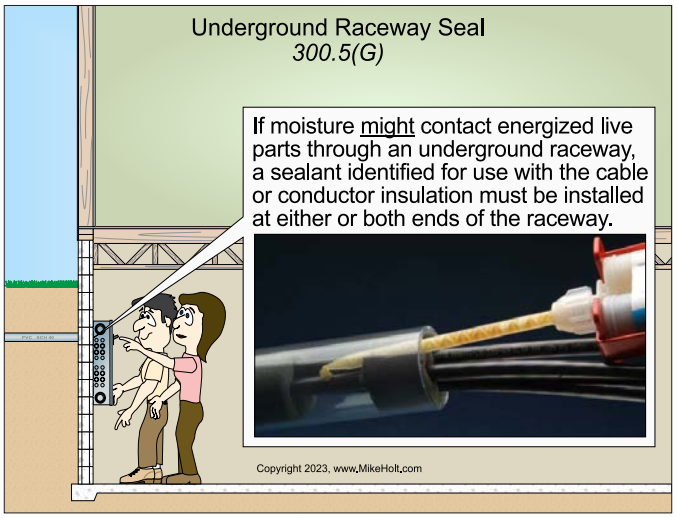


Figure 300–28

Author's Comment:

- Large rocks, chunks of concrete, steel rods, mesh, and other sharp-edged objects are not permitted to be used for backfilling material because they can damage the underground conductors, cables, or raceways.

(G) Raceway Seals. If moisture might contact energized live parts through an underground raceway, a seal identified for use with the cable or conductor insulation must be installed at either or both ends of the raceway [225.27 and 230.8]. ▸Figure 300–29



▸Figure 300–29

Author's Comment:

- Moisture is a common problem for equipment downhill from the supply or in underground equipment rooms.

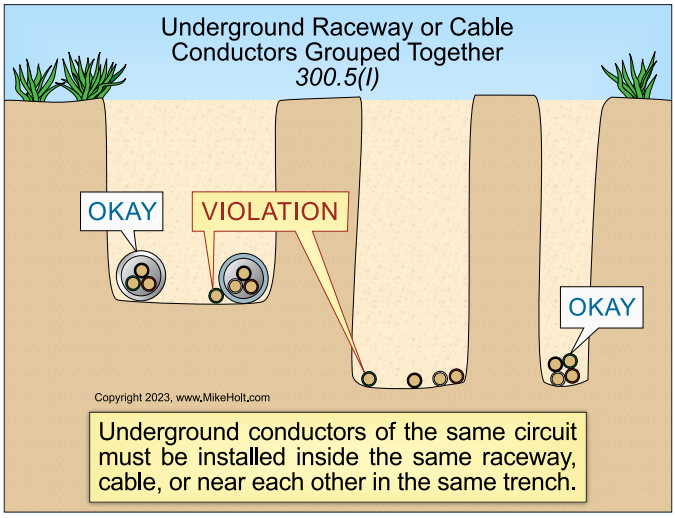
(H) Bushing. Raceways that terminate underground must have a bushing or fitting at the end of the raceway to protect emerging cables or conductors.

(I) Conductors Grouped Together. Underground conductors of the same circuit (including the neutral and equipment grounding conductor) must be installed inside the same raceway, multiconductor cable, or near each other in the same trench. See 300.3(B). ▸Figure 300–30

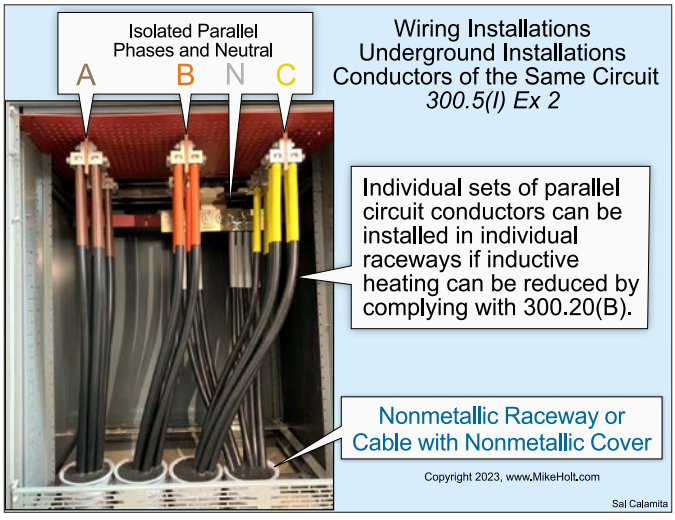
Ex 2: Underground parallel conductors can have the conductors of each phase or neutral installed in separate nonmetallic raceways where inductive heating at raceway terminations is reduced by using aluminum locknuts and cutting a slot between the individual holes through which the conductors pass as required by 300.20(B). ▸Figure 300–31

Author's Comment:

- Separating phase and neutral conductors in individual PVC conduits makes it easier to terminate larger parallel installations, but it also results in elevated electromagnetic fields (EMF). Keeping the phase and neutral conductors close to each other helps reduce circuit impedance.



▸Figure 300–30



▸Figure 300–31

(J) Earth Movement. Direct-buried conductors, cables, or raceways that are subject to movement by settlement or frost must be arranged to prevent damage to conductors or equipment connected to the wiring.

300.6 Protection Against Corrosion

Raceways, cable trays, cable armor, boxes, cable sheathing, cabinets, enclosures, elbows, couplings, fittings, supports, and support hardware must be suitable for the environment.

(A) Steel Equipment. Steel raceways, cables, cable trays, cabinets, enclosures, fittings, and support hardware must be protected against corrosion by a coating of approved corrosion-resistant material. ▸Figure 300–32

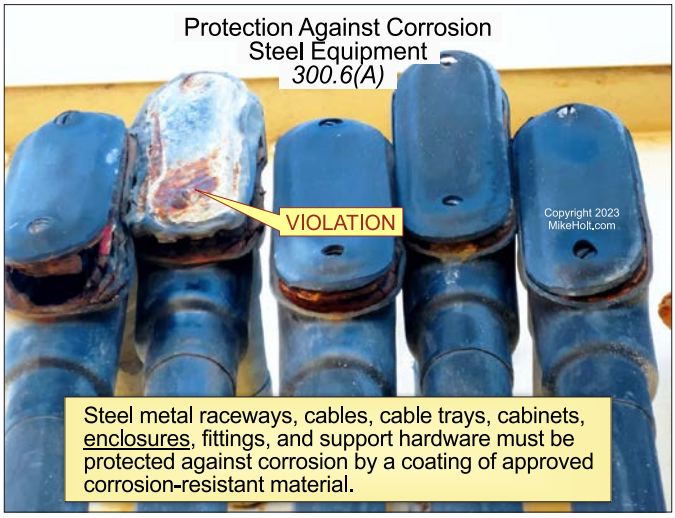


Figure 300–32

Author's Comment:

- In accordance with "*UL Guide Information DYIX,*" supplementary corrosion protection is required when a steel raceway transitions from concrete encasement to the soil. Figure 300–33

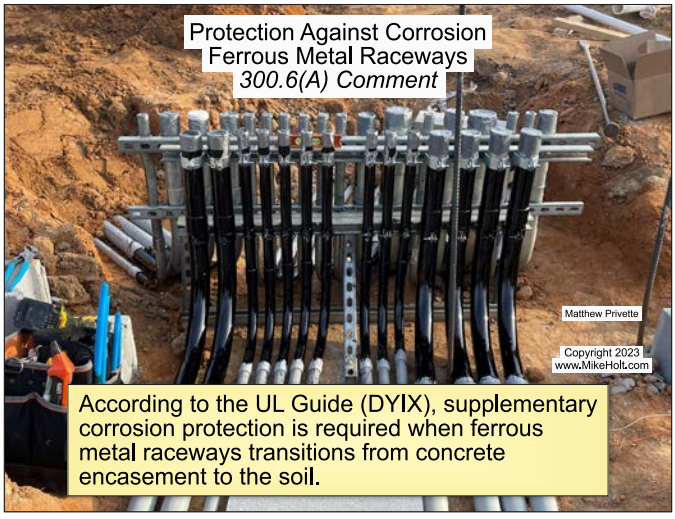


Figure 300–33

Where corrosion protection is required and IMC or RMC is threaded in the field, the threads must be coated with an approved electrically conductive, corrosion-resistant compound.

300.7 Raceways Exposed to Different Temperatures

(A) Sealing. If a raceway is subjected to different temperatures and where condensation is known to be a problem, the raceway must be filled with a material approved by the authority having jurisdiction that will prevent the circulation of warm air to a colder section of the raceway. Sealants must be identified for use with cable insulation, conductor insulation, a bare conductor, a shield, or other components. Figure 300–34 and Figure 300–35

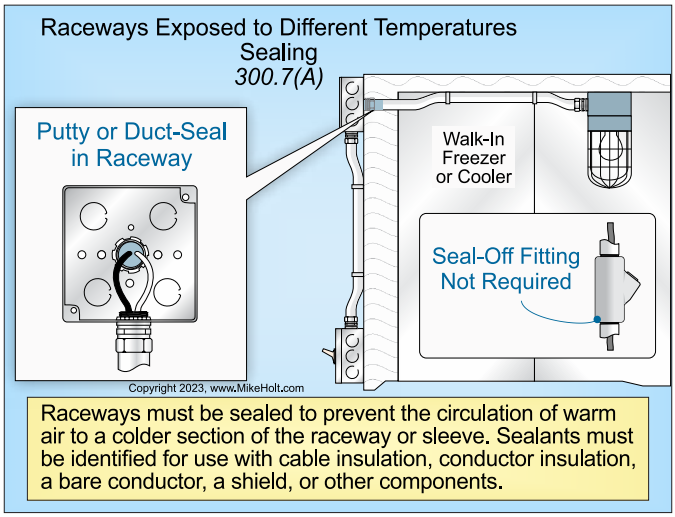


Figure 300–34

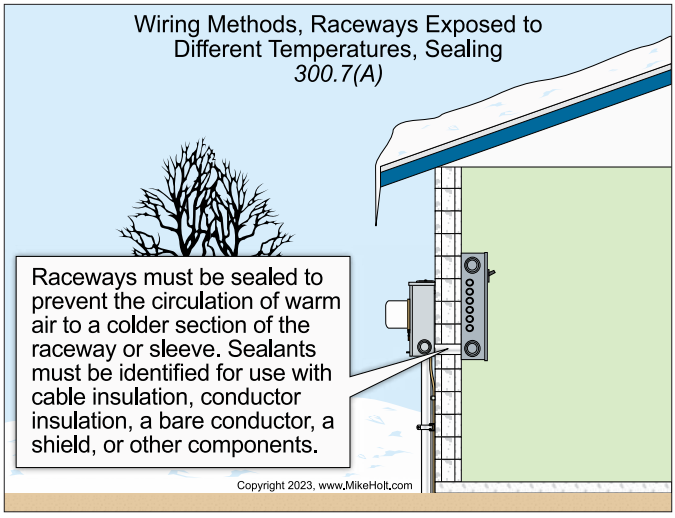


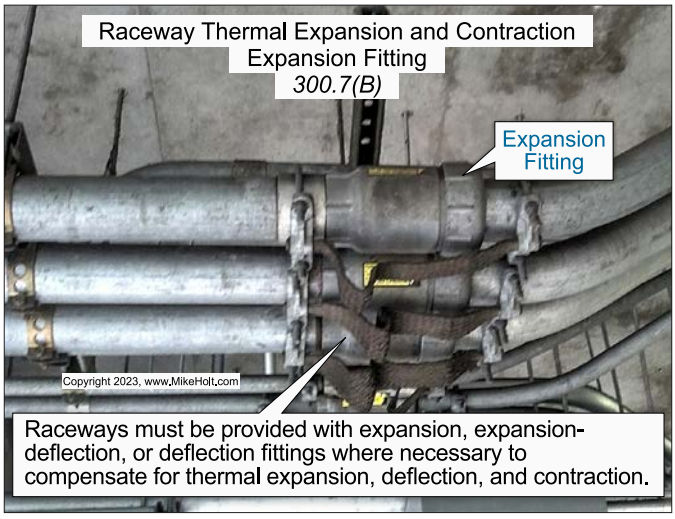
Figure 300–35

Author's Comment:

- One common product used for this is electrical duct seal and it is so identified. There are other identified products such as Polywater's FST Duct Sealant. Typical expanding foams used to seal buildings are not identified for this application.

According to Article 100, "Identified" means marked suitable for the purpose by the manufacturer, and recognized as suitable for a specific purpose, function, use, environment, or application.

(B) Expansion, Expansion-Deflection, and Deflection Fittings. Raceways must be provided with expansion, expansion-deflection, or deflection fittings where necessary to compensate for thermal expansion, deflection, and contraction. ▸Figure 300–36



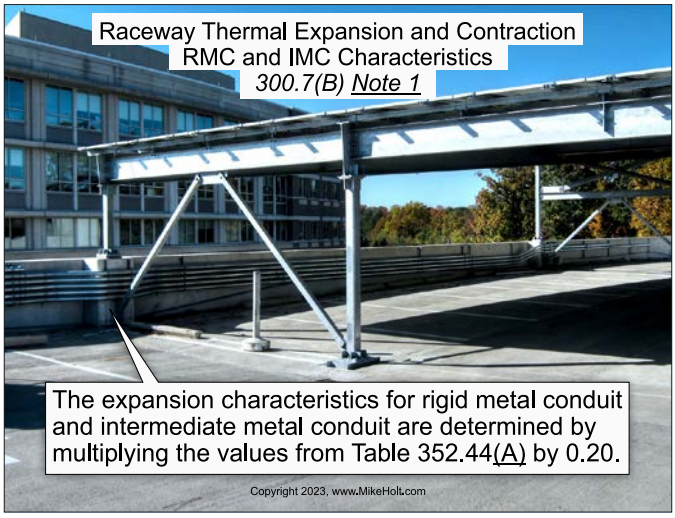
▸Figure 300–36

Note 1: Table 352.44(A) provides the expansion characteristics for PVC conduit. The expansion characteristics for rigid metal conduit and intermediate metal is determined by multiplying the values from Table 352.44(A) by 0.20. ▸Figure 300–37

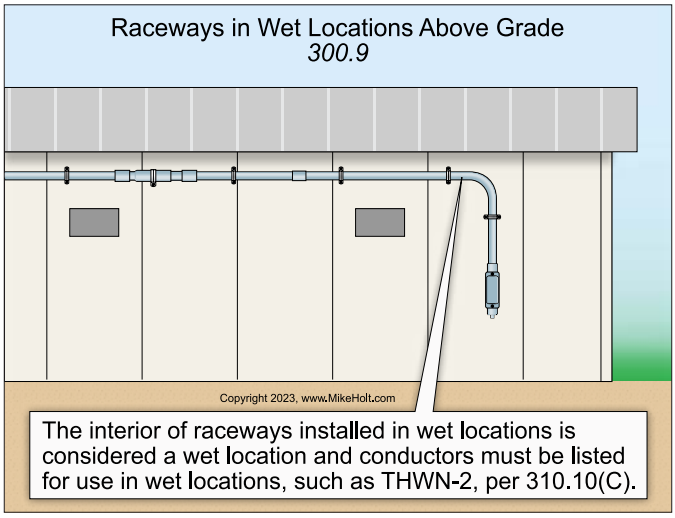
Note 2: For information on expansion and expansion-deflection fittings, see NEMA FB 2.40, *Installation Guidelines for Expansion and Expansion/Deflection Fittings.*

300.9 Raceways in Wet Locations Above Grade

The interior of raceways installed in wet locations above ground is considered a wet location. Insulated conductors and cables installed in raceways in above ground wet locations must be listed for use in wet locations in accordance with 310.10(C). ▸Figure 300–38



▸Figure 300–37



▸Figure 300–38

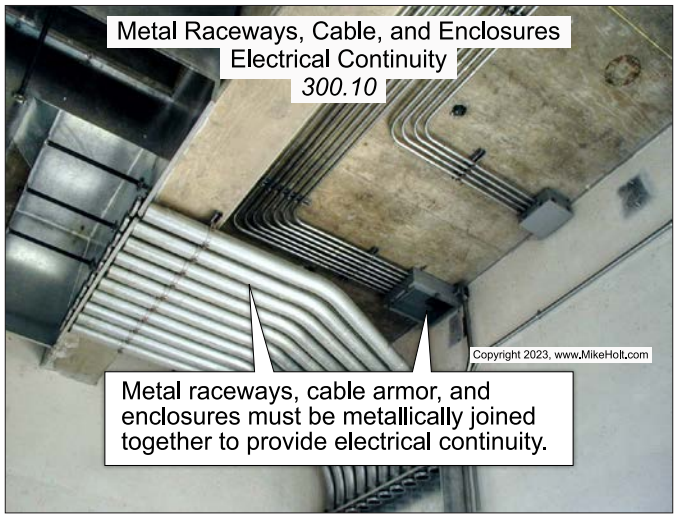
Author's Comment:

- In addition to 310.10(C), Table 310.4(A)(1) can be used to find other insulation types permitted in wet locations.

According to Article 100, "Wet Location" means installations underground or in concrete slabs in contact with the Earth, and locations subject to water spray or exposed to weather.

300.10 Electrical Continuity

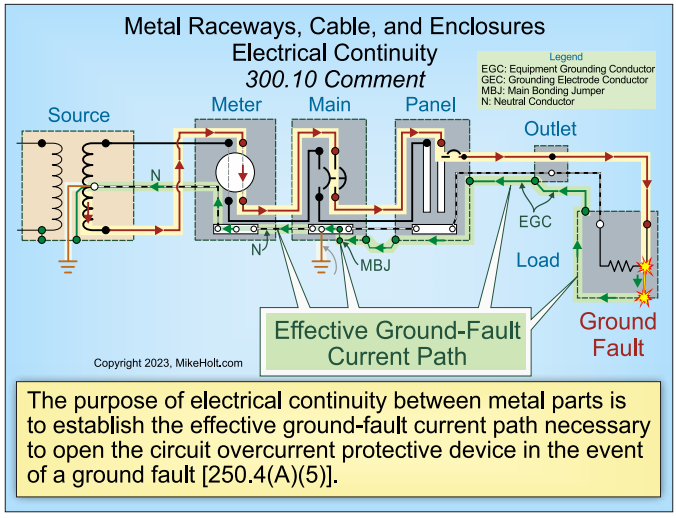
Metal raceways, cable armor, and metal enclosures must be metallically joined together to provide electrical continuity [250.4(A)(3)]. ▸Figure 300–39



▸Figure 300–39

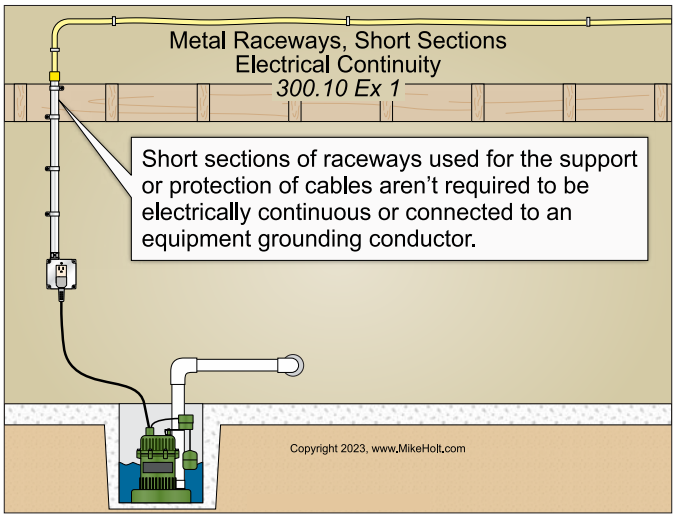
Author's Comment:

- The purpose of electrical continuity between metal parts is to establish the effective ground-fault current path necessary to open the circuit overcurrent protective device in the event of a ground fault [250.4(A)(5)]. ▸Figure 300–40



▸Figure 300–40

Ex 1: Short lengths of metal raceways used for the support or protection of cables are not required to be electrically continuous or connected to the circuit equipment grounding conductor [250.86 Ex 2 and 300.12 Ex 1]. ▸Figure 300–41

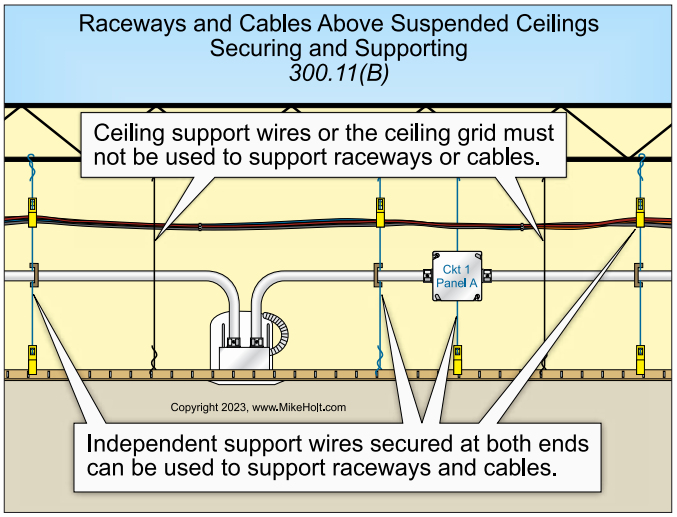


▸Figure 300–41

300.11 Securing and Supporting

(A) Secured in Place. Raceways, cable assemblies, and enclosures must be securely fastened in place.

(B) Wiring Systems Installed Above Suspended Ceilings. Ceiling-support wires or the ceiling grid are not permitted to support raceways or cables. Independent support wires secured at both ends can be used to support raceways or cables. ▸Figure 300–42



▸Figure 300–42

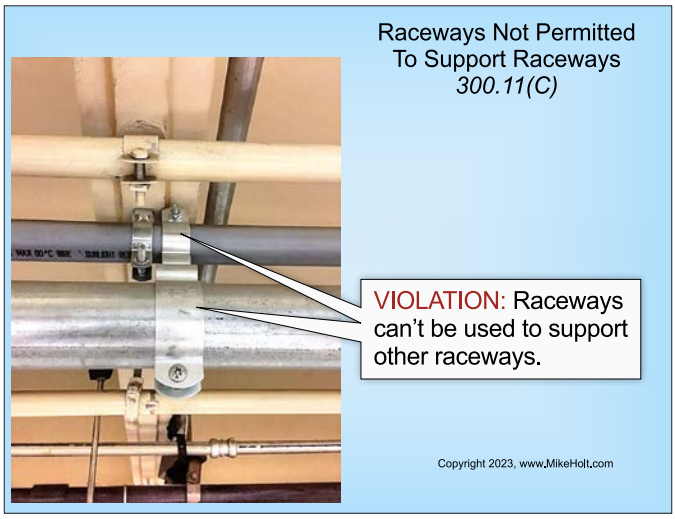
(1) Fire-Rated Assemblies. Electrical wiring within the cavity of a fire-rated ceiling assembly must be supported by independent support wires attached to the ceiling assembly. The independent support wires must be distinguishable from the suspended-ceiling support wires by color, tagging, or other effective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

Ex: Electrical wiring can be supported by ceiling-support wires if installed in accordance with the ceiling system manufacturer's instructions.

Author's Comment:

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

(C) Raceways Used for Support. Raceways are not permitted to support raceways or cables, except as follows: ▸Figure 300–43 and ▸Figure 300–44

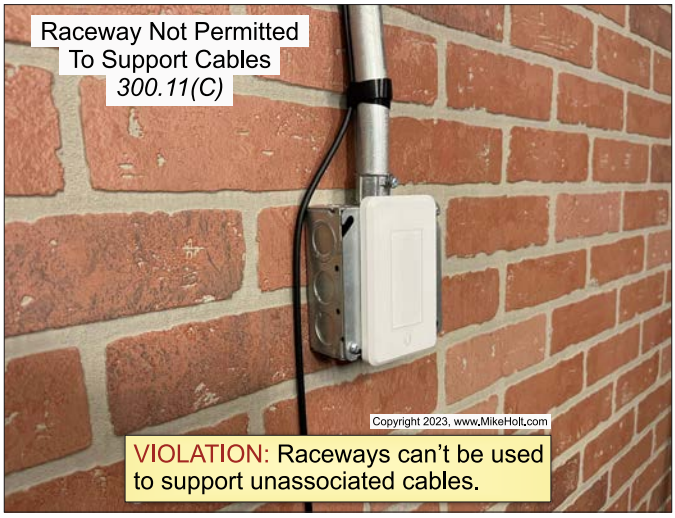


▸Figure 300–43

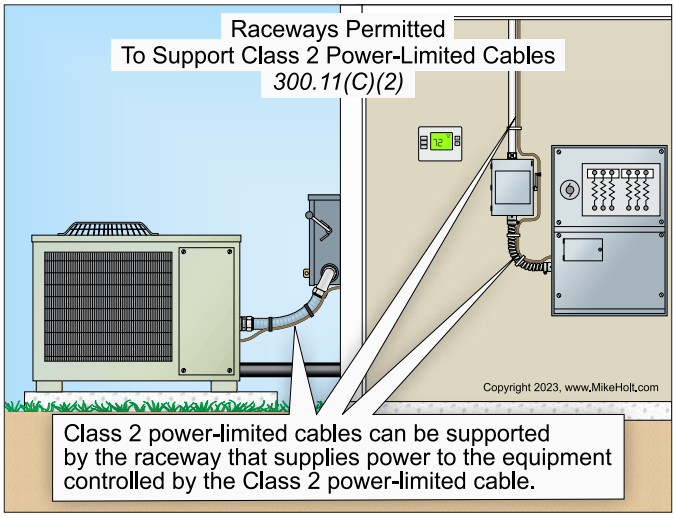
(2) Class 2 Power-Limited Cables. Class 2 power-limited cables can be supported by the raceway that supplies power to the equipment controlled by the Class 2 power-limited cable. ▸Figure 300–45

(3) Boxes. Raceways are permitted to support boxes in accordance with 314.23.

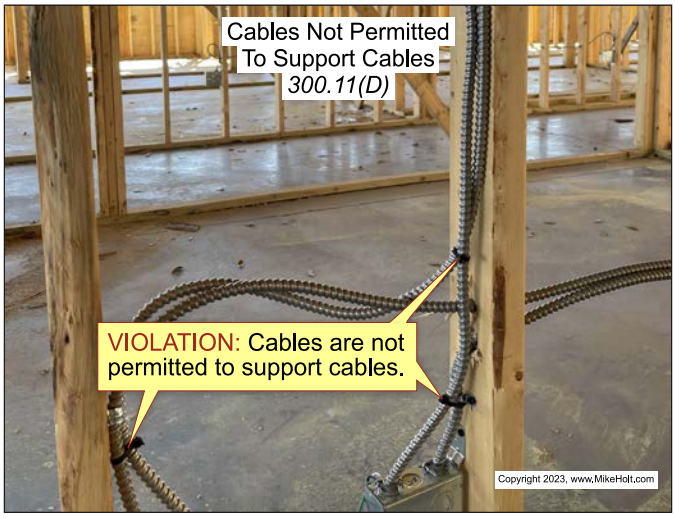
(D) Cables Not Used as Means of Support. Cables are not permitted to support raceways or cables. ▸Figure 300–46



▸Figure 300–44



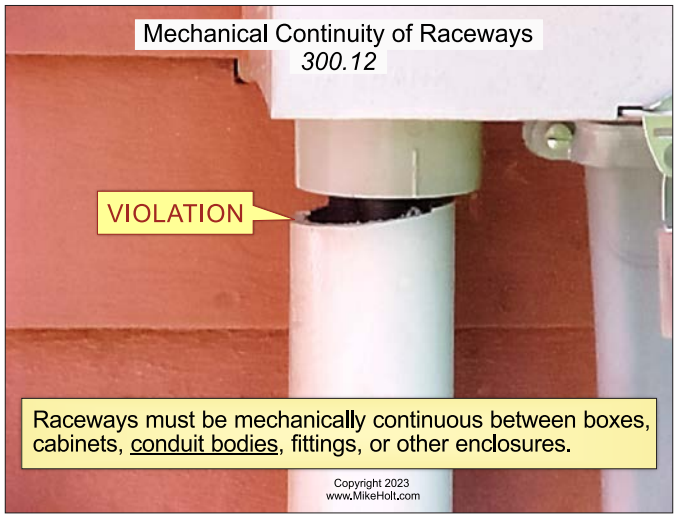
▸Figure 300–45



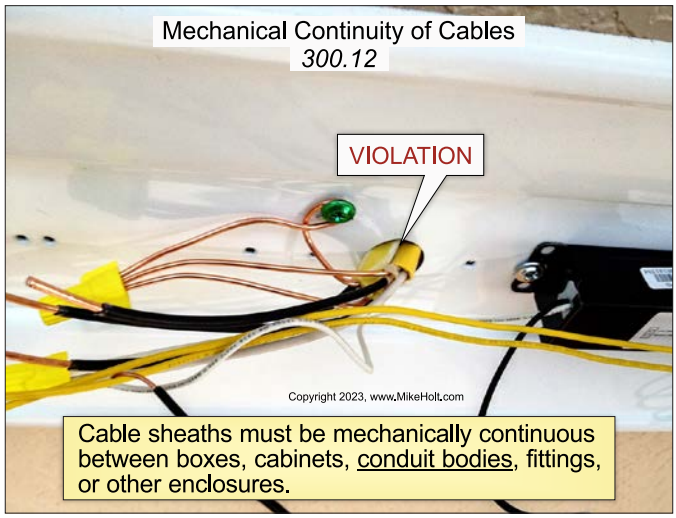
▸Figure 300–46

300.12 Mechanical Continuity

Raceways and cable sheaths must be mechanically continuous between boxes, cabinets, conduit bodies, fittings, or other enclosures. ▸Figure 300–47 and ▸Figure 300–48



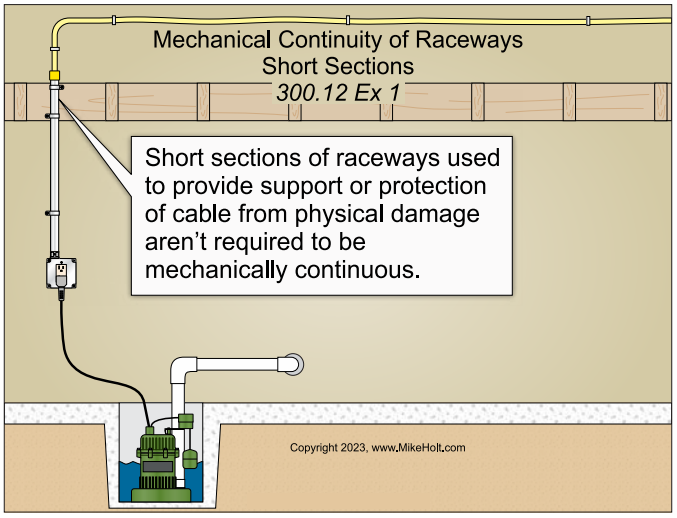
▸Figure 300–47



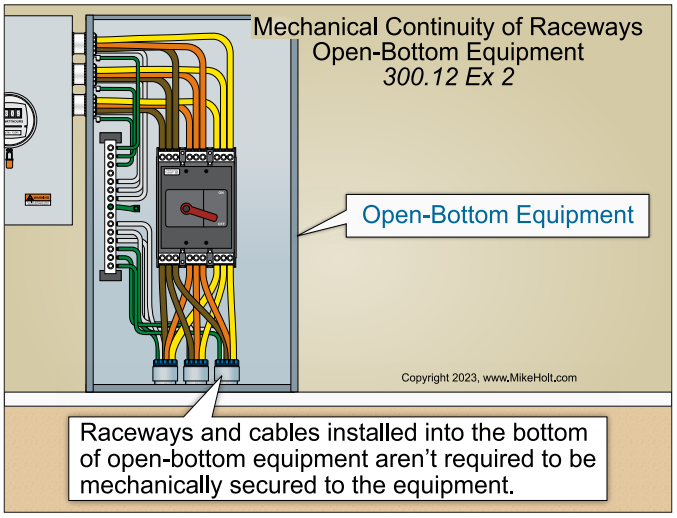
▸Figure 300–48

Ex 1: Short sections of raceways used to provide support or protection of cables from physical damage aren't required to be mechanically continuous [250.86 Ex 2 and 300.10 Ex 1]. ▸Figure 300–49

Ex 2: Raceways and cables installed into the bottom of open-bottom equipment such as switchboards, motor control centers, floor- or pad-mounted transformers aren't required to be mechanically secured to the equipment. ▸Figure 300–50



▸Figure 300–49



▸Figure 300–50

300.13 Mechanical and Electrical Continuity of Conductors—Splices and Pigtails

(A) Conductor Splices. Conductor splices and taps must be made inside enclosures in accordance with 300.15. Splices are not permitted in raceways, except as permitted for wireways in accordance with 376.56. ▸Figure 300–51

(B) Device Removal—Neutral Continuity. Continuity of the neutral conductor of a multiwire branch circuit is not permitted to be interrupted by the removal of a wiring device. ▸Figure 300–52

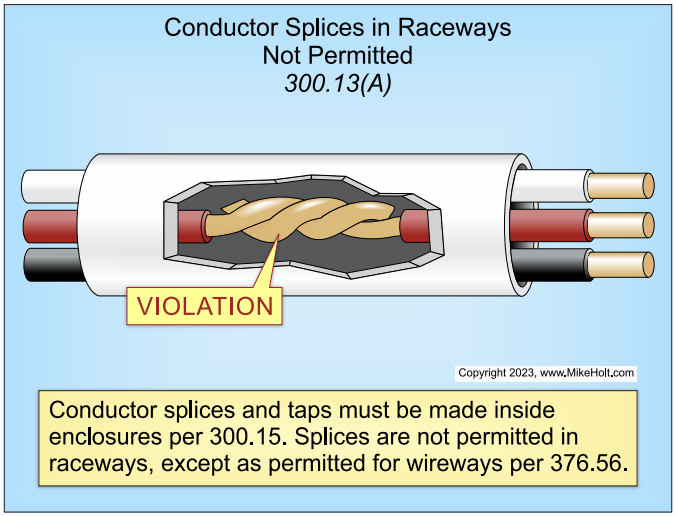


Figure 300–51

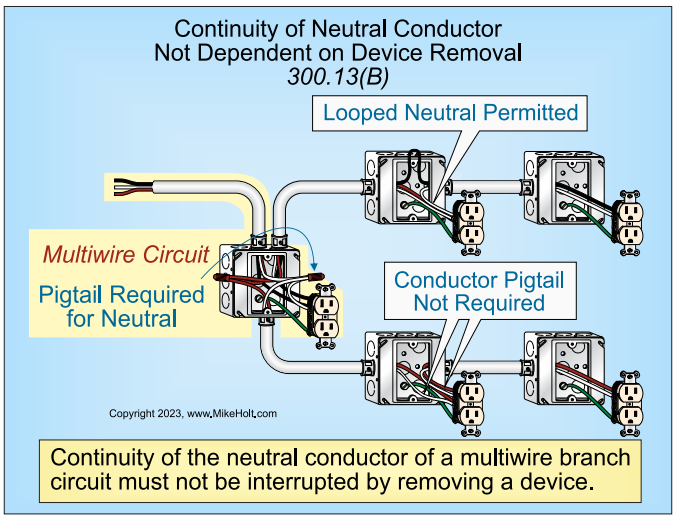


Figure 300–52

Author's Comment:

- For multiwire applications, the neutral conductors must be spliced together, and a pigtail must be provided for the wiring device.
- The opening of the phase conductors or the neutral conductor of a 2-wire circuit while a device is replaced, does not cause a safety hazard, so pigtailing those conductors is not required [110.14(B)].

Caution

CAUTION: If the continuity of the neutral conductor of a multiwire circuit is interrupted (opened), the resulting over- or undervoltage can cause a fire and/or destruction of electrical equipment.

Hazard of Open Neutral Example

Example: *If the neutral conductor is interrupted on a 3-wire, 120/240V multiwire circuit that supplies a 1,200W, 120V hair dryer and a 600W, 120V television, it will cause the 120V television to momentarily operate at 160V before it burns up. This can be determined as follows:*

Figure 300–53 *and* Figure 300–54

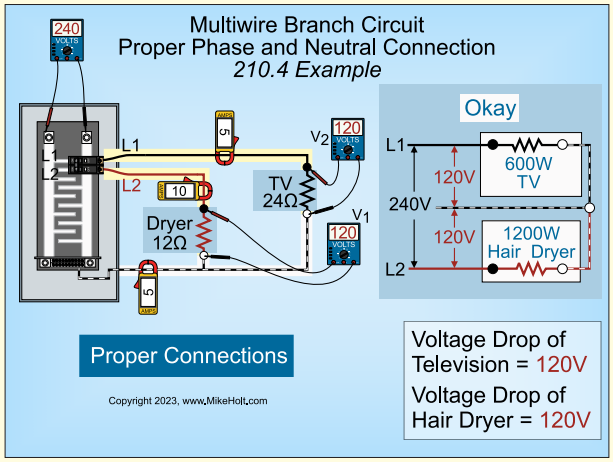


Figure 300–53

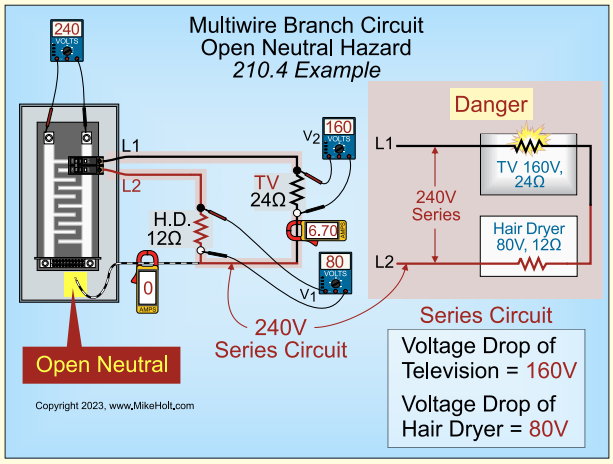


Figure 300–54

Step 1: *Determine the resistance of each appliance.*

$R = E^2/P$

R of Hair Dryer $= 120V^2/1{,}200W$

R of Hair Dryer $= 12\Omega$

R of Television $= 120V^2/600W$

R of Television $= 24\Omega$

Step 2: *Determine the current of the circuit.*

I = Volts/Resistance

Volts = 240V

R = 12Ω + 24Ω
R = 36Ω

I = 240V/36Ω
I = 6.70A

Step 3: *Determine the operating voltage for each appliance.*

Volts = I × R

I = 6.70A

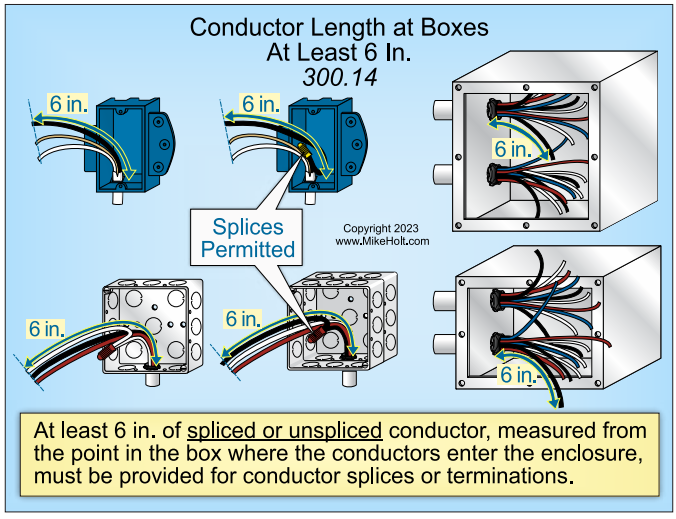
R = 12Ω for the hair dryer and 24Ω for the television.

Voltage of Hair Dryer = 6.70A × 12Ω
Voltage of Hair Dryer = 80V

Voltage of Television = 6.70A × 24Ω
Voltage of Television = 160V

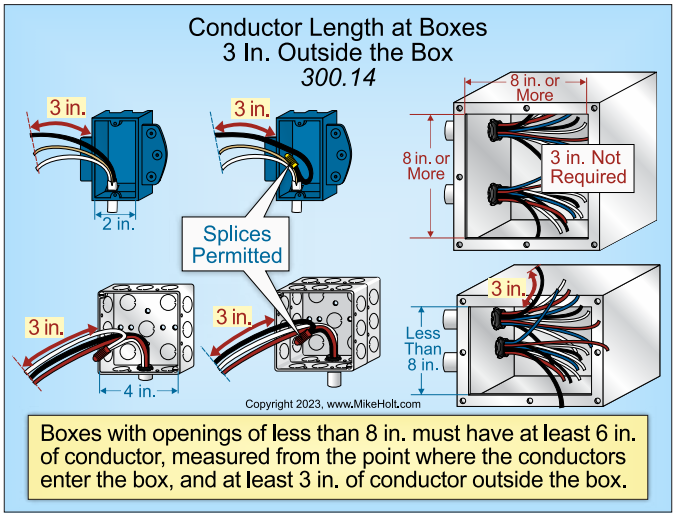
300.14 Conductor Length at Boxes

At least 6 in. of spliced or unspliced conductor, measured from the point in the box where the conductors enter the enclosure, must be provided for conductor splices or terminations. ▸Figure 300–55



▸Figure 300–55

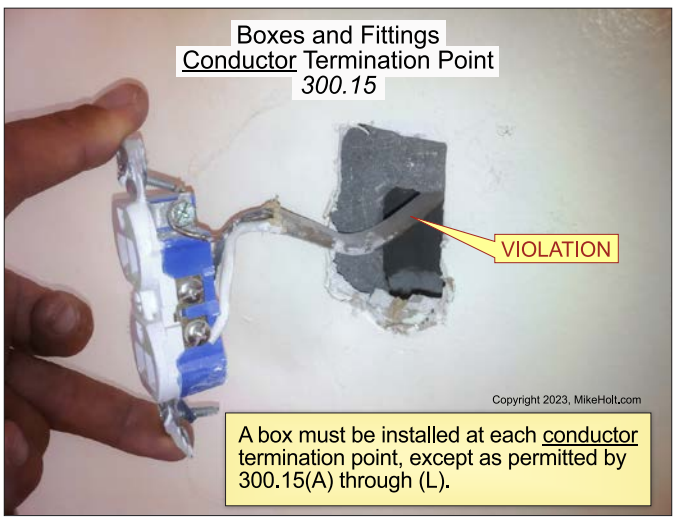
Boxes with openings less than 8 in. at any dimension must have at least 6 in. of conductor, measured from the point where the conductors enter the box, and at least 3 in. of conductor outside the box. ▸Figure 300–56



▸Figure 300–56

300.15 Boxes or Fittings, Splices and Terminations

A box must be installed at each conductor splice point or conductor termination point, except as permitted by 300.15(A) through (L): ▸Figure 300–57 and ▸Figure 300–58



▸Figure 300–57

Author's Comment:

- Boxes are not required for: ▸Figure 300–59
  - Class 2 Power-Limited Circuits, 725.3
  - Coaxial Cable, 800.3
  - Optical Fiber Cable, 770.3

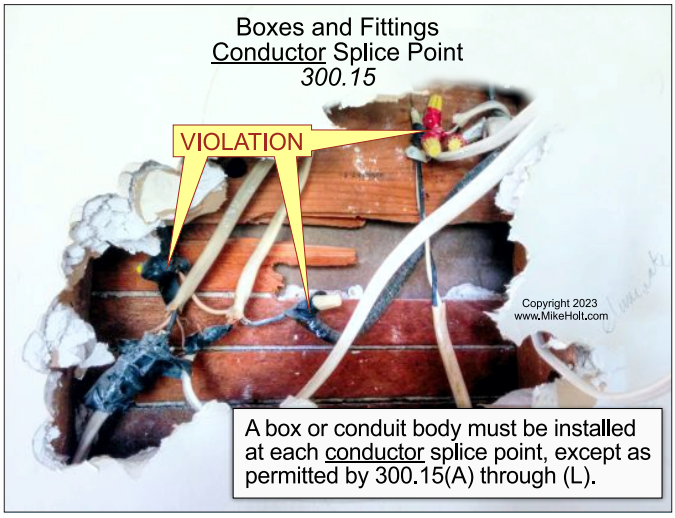


Figure 300–58

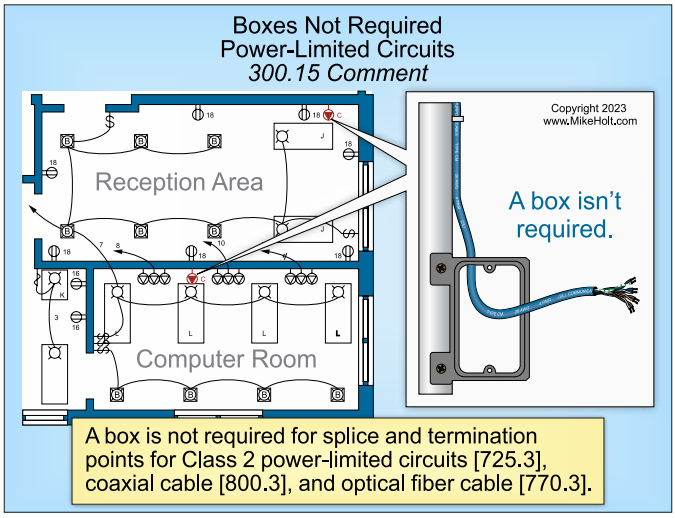


Figure 300–59

Fittings and connectors must only be used with the specific wiring methods for which they are designed and listed. Figure 300–60

Author's Comment:

- Type NM cable connectors are not permitted to be used with Type AC cable. Electrical metallic tubing fittings are not permitted to be used with rigid metal conduit or intermediate metal conduit unless listed for the purpose.
- PVC conduit couplings and connectors are permitted to be installed with electrical nonmetallic tubing if the proper glue is used in accordance with the manufacturer's instructions [110.3(B)]. See 362.48.

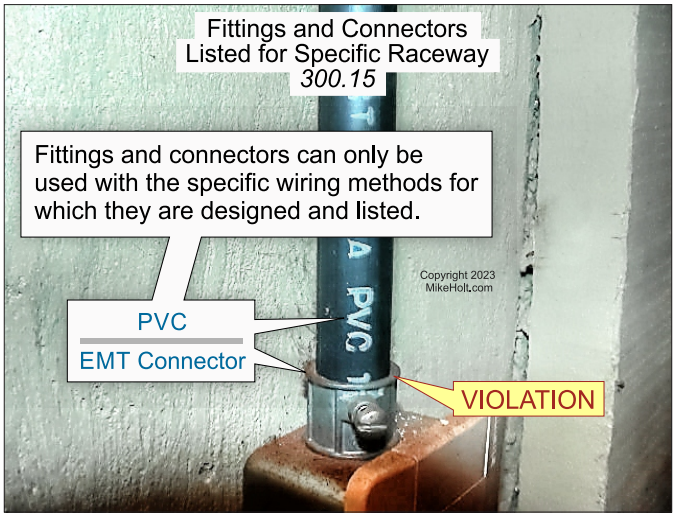


Figure 300–60

(A) Wiring Methods with Interior Access. A box is not required for wiring methods with removable covers such as wireways, multioutlet assemblies, and surface raceways.

(G) Underground Conductor and Cable Splices. A box is not required where a splice is made underground if Type UF or USE conductors are spliced with a splicing device listed for direct burial. Figure 300–61

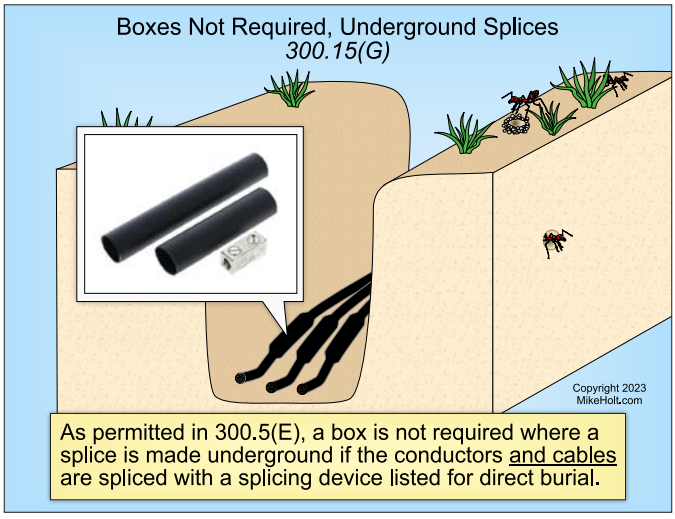


Figure 300–61

Author's Comment:

- The only conductors permitted to be direct buried are Type UF [340.10(1)] and Type USE [338.10(B)(4)(b)(2)].

300.17 Number and Size of Conductors in a Raceway

Raceways must be large enough to permit the installation and removal of conductors without damaging their insulation.

Note: See the "xxx.22" section of the specific raceway wiring method for more information about the number of conductors permitted.

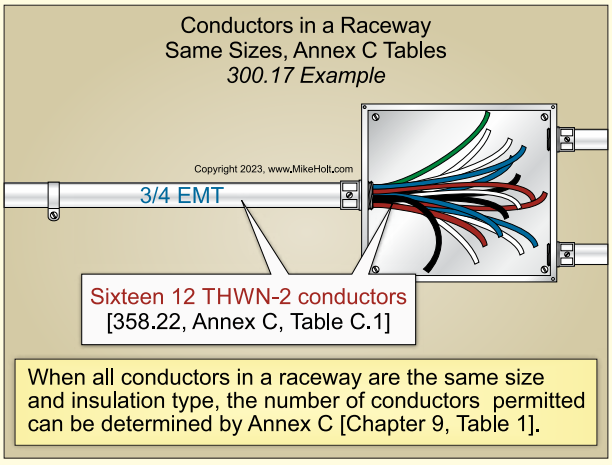
Author's Comment:

- When all conductors within a raceway are the same size, same insulation type, number of conductors permitted, or raceway size, use Annex C [Note (1) of Chapter 9].

▶ Example

Question: *How many 12 AWG, THWN-2 conductors can be installed in ¾ EMT?* ▶Figure 300–62

(a) 10 (b) 12 (c) 14 (d) 16

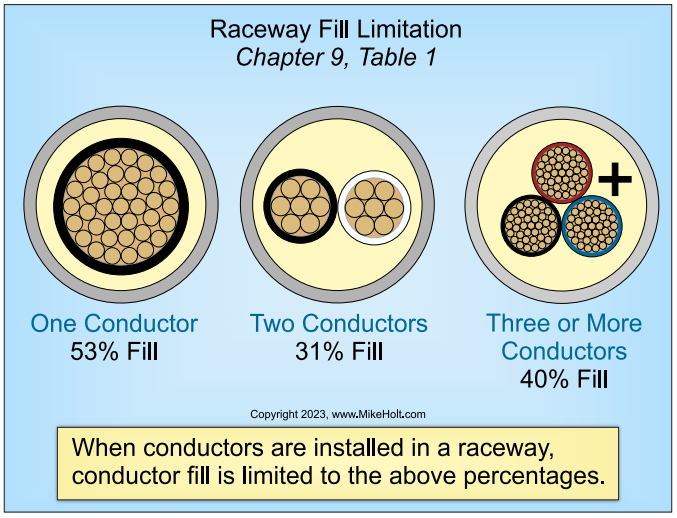


▶Figure 300–62

Answer: *(d) 16 [Annex C, Table C.1]*

Author's Comment:

- When different size conductors are installed in a raceway, conductor fill is limited to the percentages in Table 1 and Note (6) of Chapter 9. ▶Figure 300–63



▶Figure 300–63

Chapter 9, Table 1

Number	Percent Fill
1 Conductor	53%
2 Conductors	31%
3 or More	40%

The above percentages are based on conditions where the length of the conductor and number of raceway bends are within reasonable limits [Chapter 9, Table 1, Table Note 1].

Author's Comment:

- Follow these steps for sizing raceways:
  - Step 1: When sizing a raceway, first determine the total area needed for the conductors (Chapter 9, Table 5 for insulated conductors and Chapter 9, Table 8 for bare conductors). ▶Figure 300–64
  - Step 2: Select the raceway from Chapter 9, Table 4 in accordance with the percent fill listed in Chapter 9, Table 1. ▶Figure 300–65

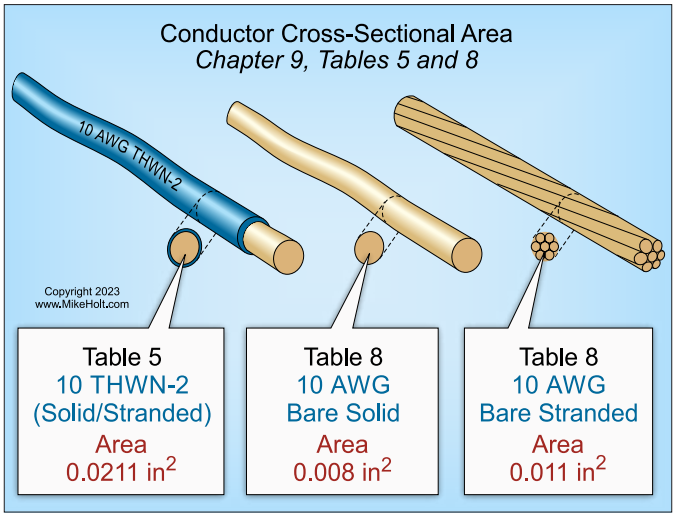


Figure 300–64

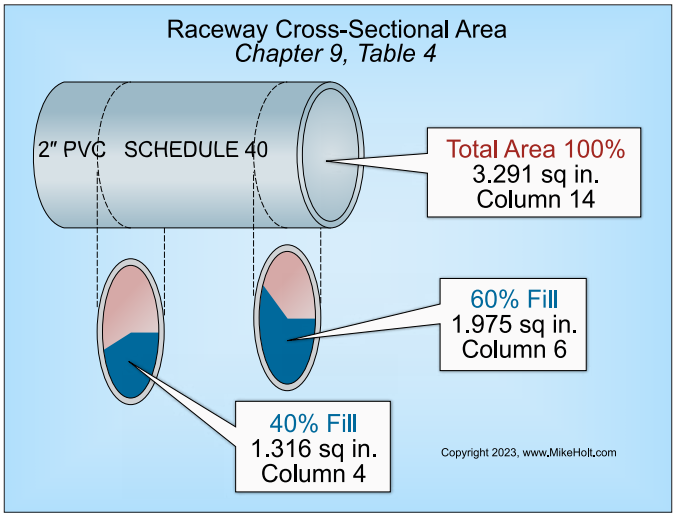


Figure 300–65

▶ Example

Question: *What size Schedule 40 PVC conduit is required for the following conductors?* Figure 300–66

- *3–500 kcmil THWN-2*
- *1–250 kcmil THWN-2*
- *1–3 AWG THWN-2*

(a) 1 in. (b) 2 in. (c) 3 in. (d) 4 in.

Solution:

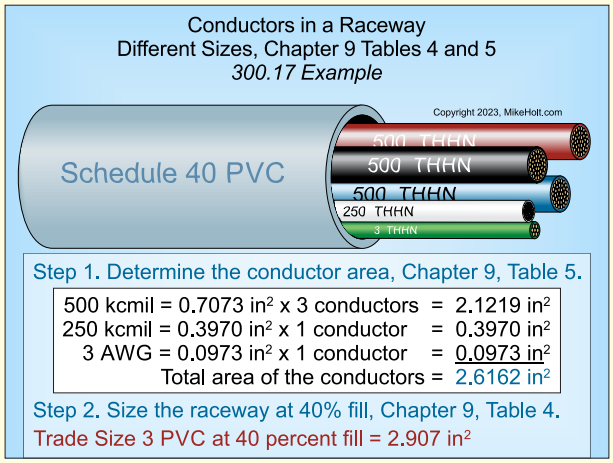


Figure 300–66

Step 1: *Determine the total area needed for the conductors [Chapter 9, Table 5].*

500 kcmil THWN-2	*0.7073 in.² × 3 =*	*2.1219 in.²*
250 kcmil THWN-2	*0.3970 in.² × 1 =*	*0.3970 in.²*
3 AWG THWN-2	*0.0973 in.² × 1 =*	*+0.0973 in.²*
Total Area of Conductors =		*2.6162 in.²*

Step 2: *Select the raceway at 40 percent fill [Chapter 9, Table 1 and Table Note (6), and Table 4].*

Use 3 in. schedule 40 PVC because there are 2.907 sq in. of conductor fill at 40 percent.

Answer: *(c) 3 in.*

300.18 Raceway Installations

(A) Complete Runs. To protect conductor insulation from abrasion during installation, raceways must be mechanically completed between the pulling points before conductors or cables are installed. See 300.10 and 300.12 for electrical and mechanical continuity of raceways. Figure 300–67

Ex: Short sections of raceways used for the protection of cables are not required to be complete between pulling points. Figure 300–68

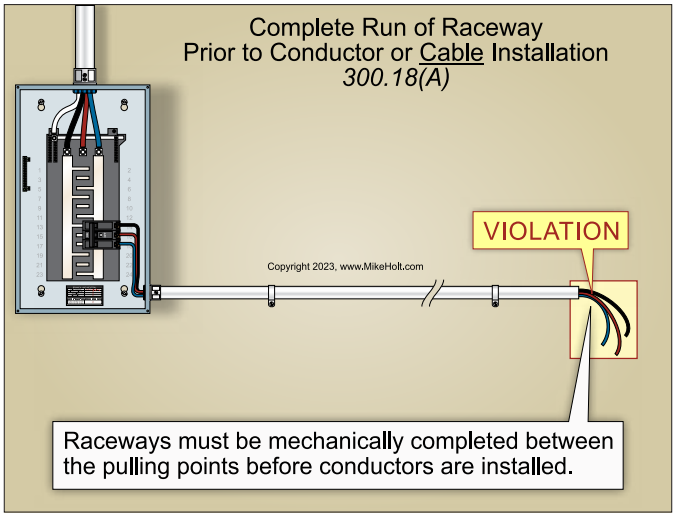


Figure 300–67

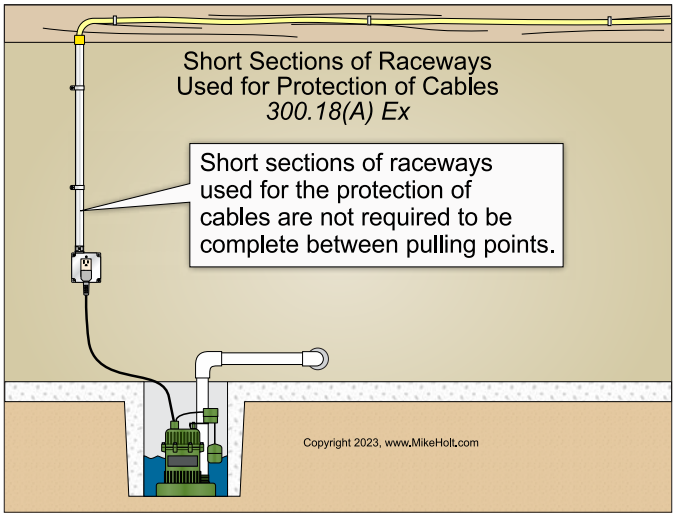


Figure 300–68

300.19 Supporting Conductors in Vertical Raceways

(A) Spacing Intervals. If the vertical rise of a raceway exceeds the values of Table 300.19(A), each conductor must be supported at the top or as close to the top as practical. Intermediate support must also be provided in increments not exceeding the values of Table 300.19(A). Figure 300–69

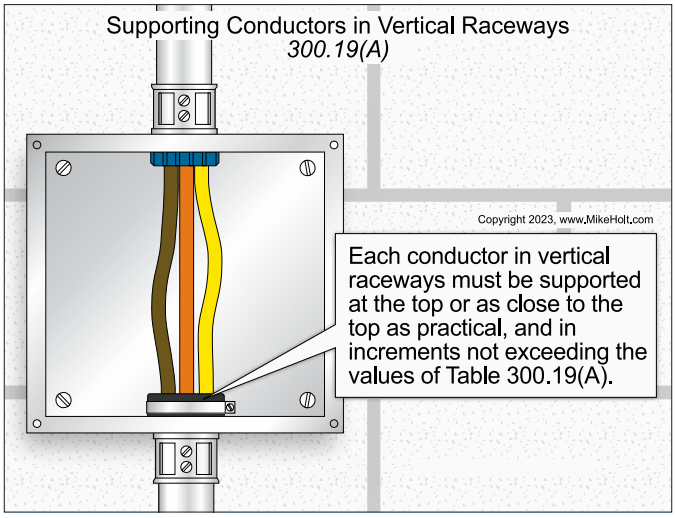


Figure 300–69

Author's Comment:

- A great deal of weight accumulates in long vertical runs of conductors and can cause them to drop out of the raceway (sometimes called a "runaway") if they are not properly secured. There have been many cases where conductors in a vertical raceway were released from the pulling "basket" or "grip" (at the top) without being secured. Sheer weight and gravity take over, accelerating the conductors down and out of the raceway and injuring those at the bottom of the installation.

300.20 Reducing Inductive Heating

(A) Conductors Grouped Together. To minimize the induction heating of steel raceways, enclosures, and metal parts, all conductors of a circuit (including any neutral and equipment grounding conductors) must be installed in the same raceway or cable. See 250.102(E), 300.3(B), 300.5(I), and 392.20(C). Figure 300–70 and Figure 300–71

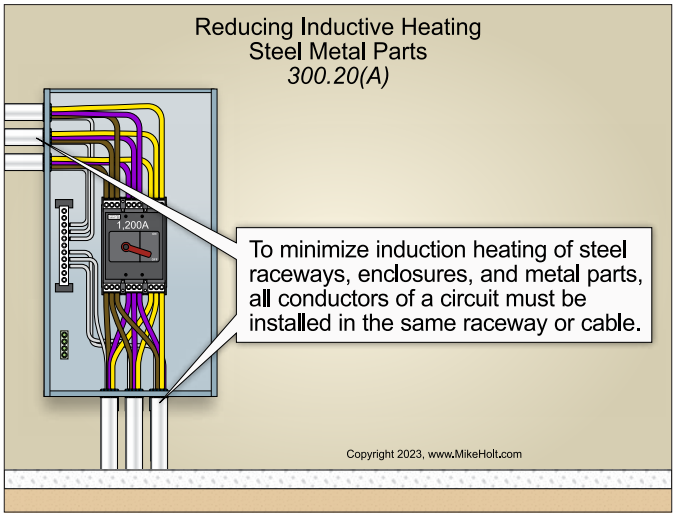


Figure 300–70

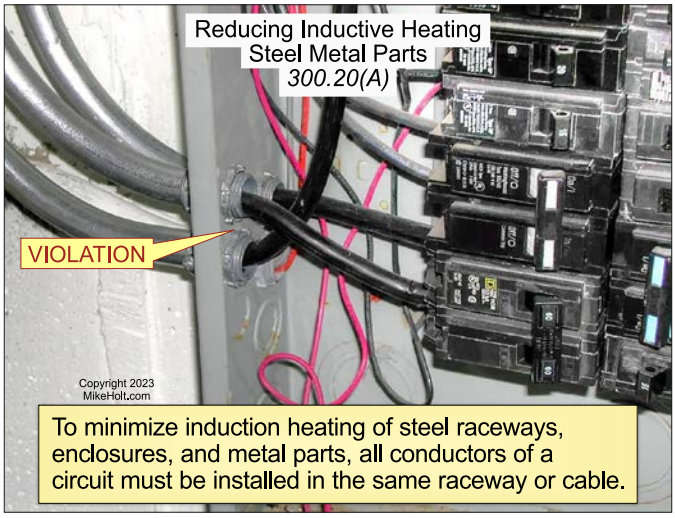


Figure 300–71

Author's Comment:

- When alternating current flows through a conductor, a pulsating or varying magnetic field is created around the conductor. This magnetic field is constantly expanding and contracting with the amplitude of the alternating current. In the United States, the frequency is 60 cycles per second (Hz). Since alternating current reverses polarity 120 times per second, the magnetic field that surrounds the conductor also reverses direction 120 times per second. This expanding and collapsing magnetic field induces eddy currents in the steel parts that surround the conductors, causing them to heat up due to hysteresis heating.
- Magnetic materials naturally resist rapidly changing magnetic fields. The resulting friction produces its own heat (hysteresis heating), in addition to eddy current heating. A metal which offers high resistance is said to have high magnetic "permeability." Permeability can vary on a scale of 100 to 500 for magnetic materials, while nonmagnetic materials have a permeability of one.
- Simply put, the molecules of steel and iron align to the polarity of the magnetic field, and when it reverses, the molecules reverse their polarity as well. This back-and-forth alignment of the molecules heats up the metal. The more the current flows, the more the heat increases in steel parts. Figure 300–72

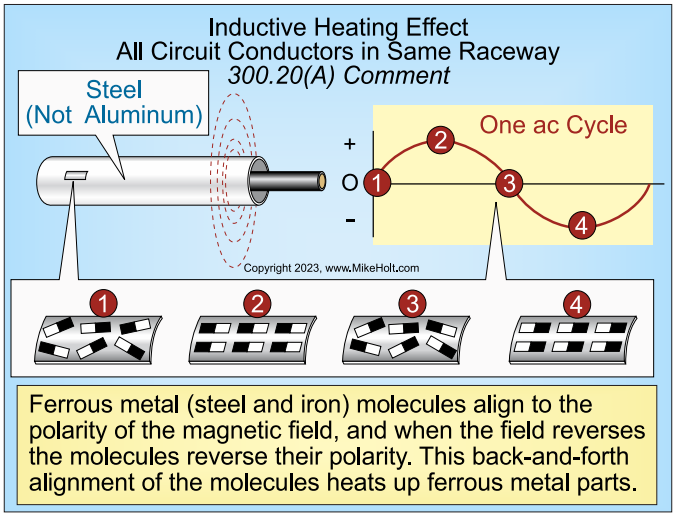


Figure 300–72

Author's Comment:

- When conductors of the same circuit are grouped together, the magnetic fields of the different conductors tend to cancel each other out, resulting in a reduced magnetic field around them. The smaller magnetic field reduces induced currents in steel raceways or enclosures, which reduces the hysteresis heating of the surrounding metal enclosure.

(B) Single Conductors. Where a single conductor or a parallel set of a conductors enter an enclosure, the inductive heating effects on the metal enclosure must be minimized by cutting slots between the individual holes through which the conductors pass, or by passing the conductors through the same wall opening. Figure 300–73 and Figure 300–74

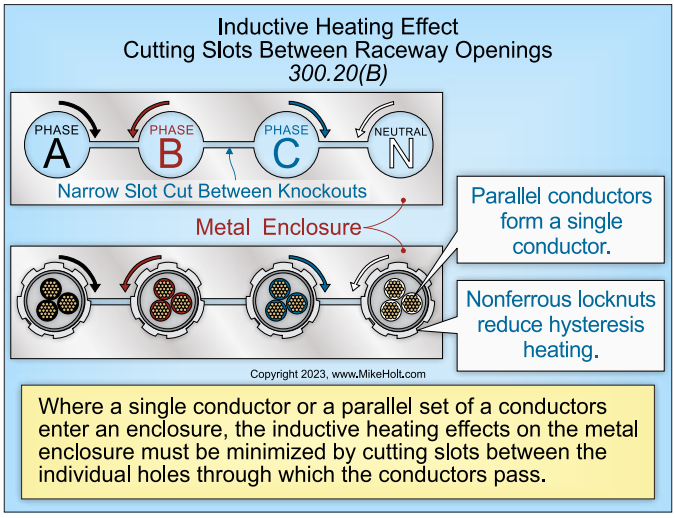


Figure 300–73

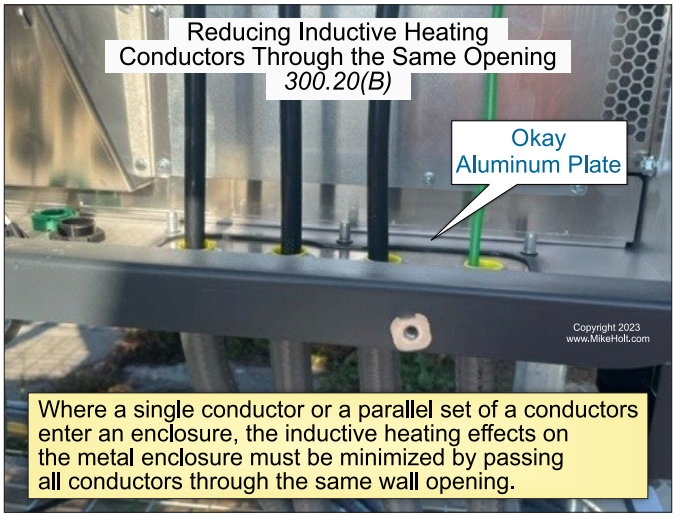


Figure 300–74

Author's Comment:

- When single conductors are installed in nonmetallic raceways as permitted in 300.5(I) Ex 2, the inductive heating of the metal enclosure can be minimized by using aluminum locknuts and by cutting a slot between the individual holes through which the conductors pass.

Note: Because aluminum is a nonmagnetic metal, aluminum parts do not heat up due to hysteresis heating.

300.21 Spread of Fire or Products of Combustion

Electrical circuits and equipment must be installed in such a way that the spread of fire or products of combustion will not be substantially increased. Openings around electrical penetrations into or through fire-resistant-rated walls, partitions, floors, or ceilings must be firestopped using approved methods to maintain the fire-resistance rating. Figure 300–75

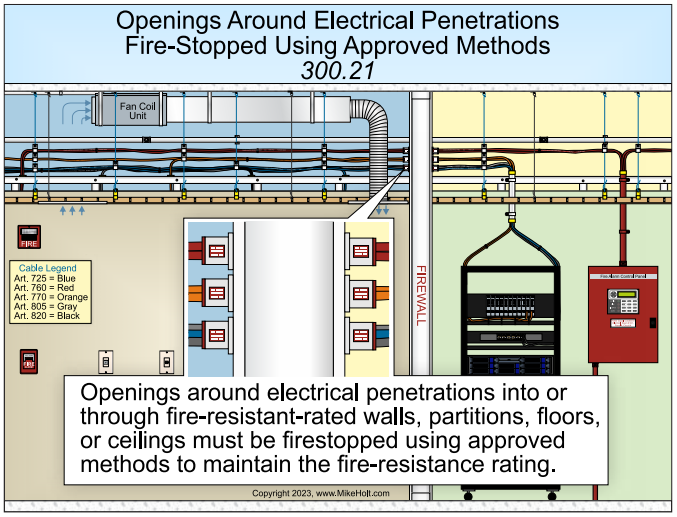
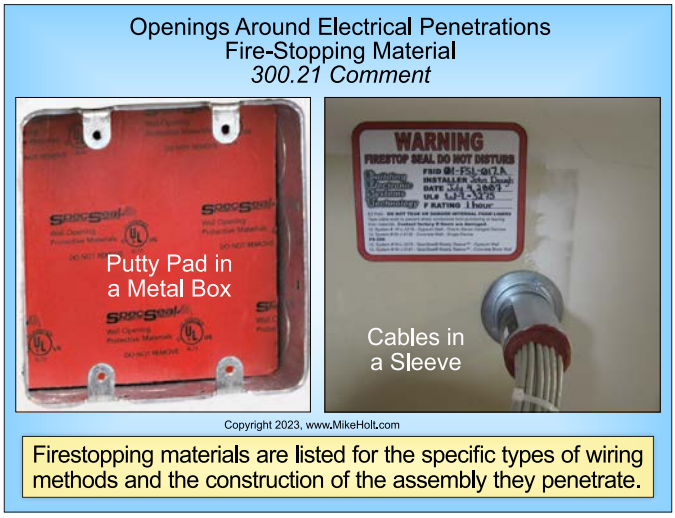


Figure 300–75

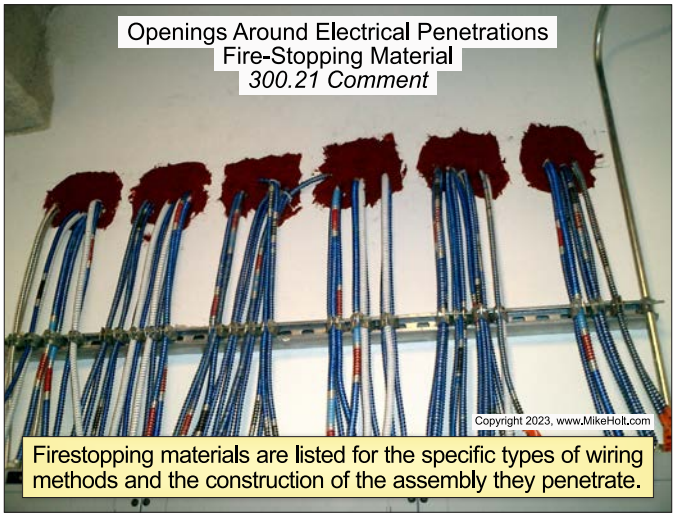
Author's Comment:

- Fire-stopping materials are listed for the specific types of wiring methods and fire-rated assembly they penetrate. For example, MC cable will have a different fire penetration detail when passing through a fire wall than will EMT. Figure 300–76 and Figure 300–77

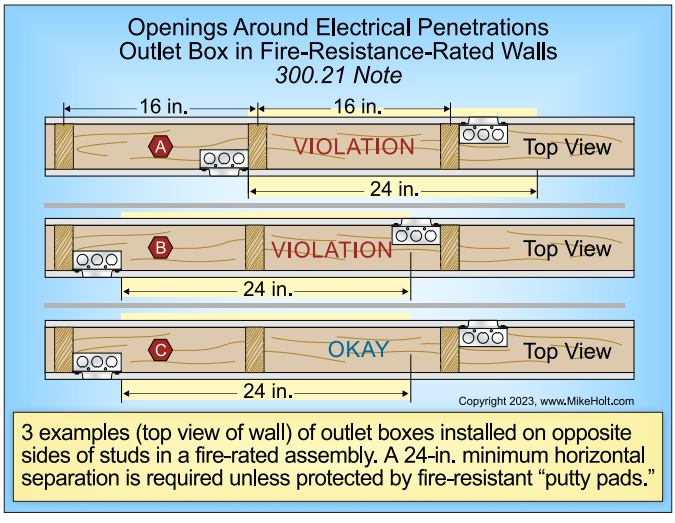
Note: Directories of electrical construction materials published by recognized testing laboratories contain listing and installation restrictions necessary to maintain the fire-resistive rating of assemblies. Building codes also have restrictions on penetrations on opposite sides of a fire-resistance-rated wall. Outlet boxes must have a horizontal separation of not less than 24 in. when installed on opposite sides in a fire-rated assembly, unless an outlet box is listed for closer spacing or protected by fire-resistant "putty pads" in accordance with the manufacturer's instructions. Figure 300–78 and Figure 300–79



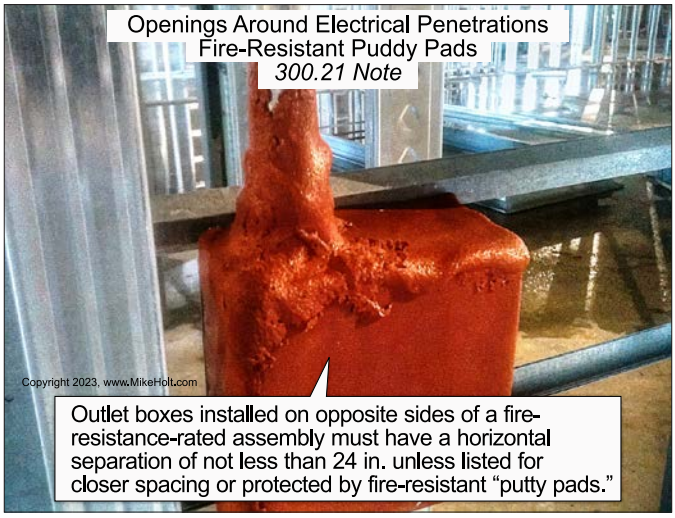
▸Figure 300–76



▸Figure 300–77



▸Figure 300–78



▸Figure 300–79

Author's Comment:

- Boxes installed in fire-resistance-rated assemblies must be listed for the purpose. If steel boxes are used, they must be secured to the framing member. Cut-in type boxes are not permitted.
- Building code requirements restrict penetrations on a fire-rated assembly section of 100 sq ft to 100 sq in. of allowable penetrations. If a 4 × 4 metal box has 16 sq in., then only six boxes (100/16 = 6.25) are allowed in that section of fire wall in accordance with IBC 714.4.2, *International Building Code*.
- This requirement also applies to:
  - Class 2 Power-Limited Circuits, 725.3(B)
  - Coaxial Cable, 800.26
  - Fire Alarms, 760.3(A)
  - Optical Fiber Cable, 770.26

300.22 Wiring in Ducts and Plenum Spaces

The requirements of this section apply to the installation and uses of electrical wiring and equipment in ducts used for dust or vapor removal, ducts specifically fabricated for environmental air, and plenum spaces used for environmental air.

(A) Ducts Used for Dust or Vapor. Wiring methods are not permitted to be installed in ducts that transport dust or flammable vapors. ▸Figure 300–80

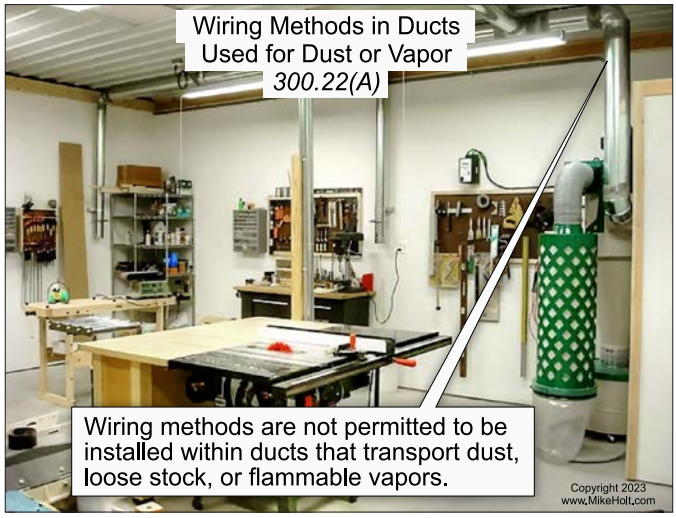


Figure 300–80

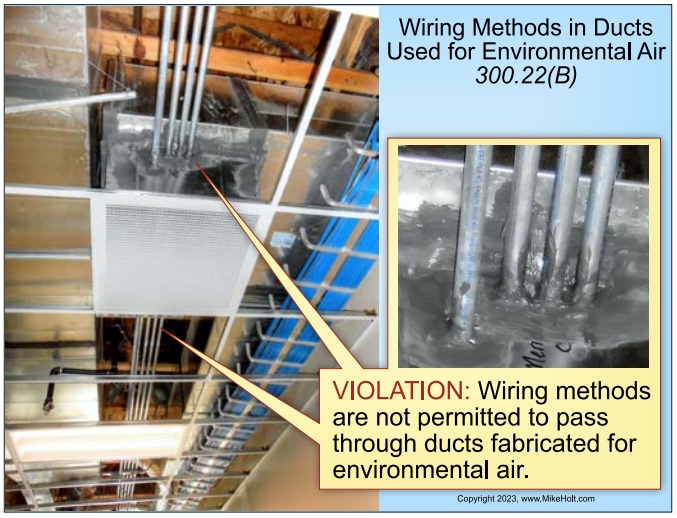


Figure 300–82

(B) Ducts Fabricated for Environmental Air. Equipment and wiring methods are only permitted within a duct fabricated to transport environmental air if the equipment is necessary for the direct action upon (or sensing of) the contained air. Figure 300–81 and Figure 300–82

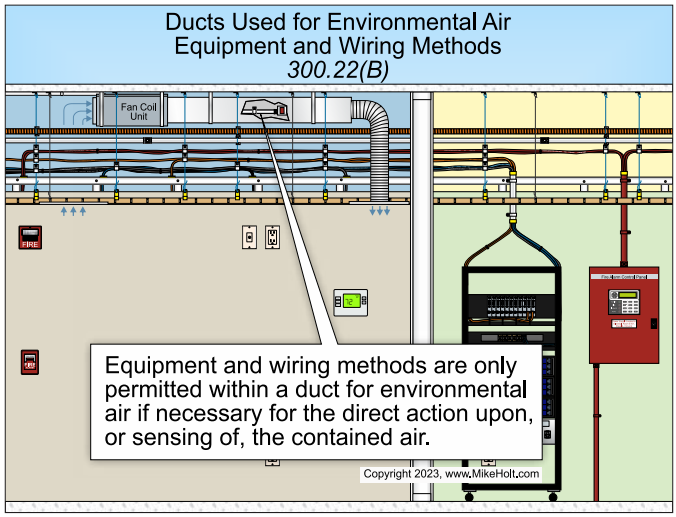


Figure 300–81

Type MC cable without an overall nonmetallic covering and metal raceways can be installed in ducts fabricated to transport environmental air. Flexible metal conduit in lengths not exceeding 4 ft can be used to connect physically adjustable equipment and devices within the fabricated duct.

Ex: Wiring methods and cabling systems, listed for use in plenum spaces, can be installed in ducts specifically fabricated for environmental air-handling purposes under both of the following conditions: Figure 300–83

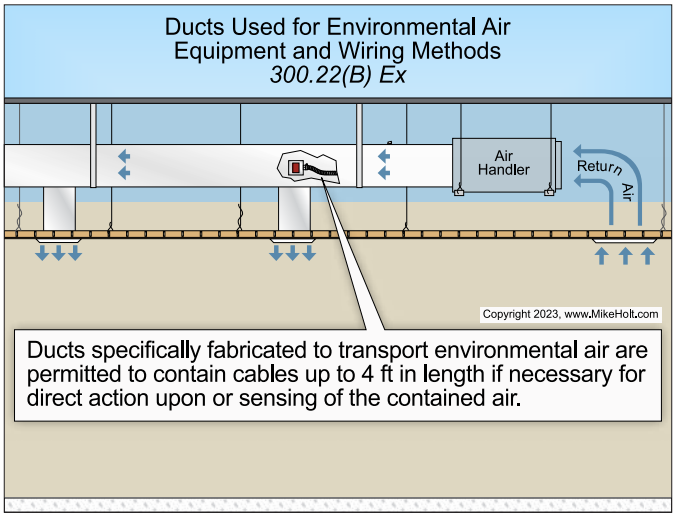


Figure 300–83

(1) The wiring methods or cabling systems are necessary to connect to equipment or devices associated with the direct action upon, or sensing of, the contained air.

(2) The total length of such wiring methods or cabling systems does not exceed 4 ft.

(C) Plenum Spaces for Environmental Air. This section applies only to the space above a suspended ceiling or below a raised floor used for environmental air. It does not apply to habitable rooms or areas of buildings, the prime purpose of which is not air handling.

Note 1: The spaces or cavities above a suspended ceiling and below a raised floor used for environmental air are examples of the type of plenum spaces to which this section applies. Figure 300–84

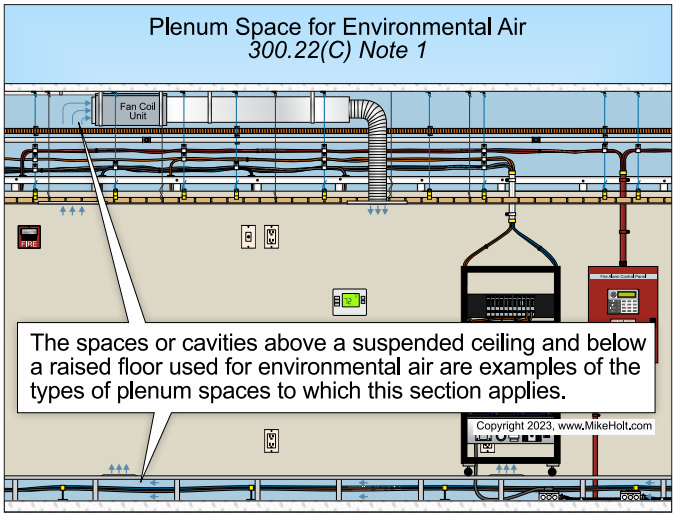


Figure 300–84

(1) Wiring Methods. Metal raceways, Type AC cable, Type MC cable without a nonmetallic cover, electrical metallic tubing, intermediate metal conduit, rigid metal conduit, flexible metal conduit, or (where accessible) surface metal raceways or metal wireways with metal covers are permitted to be installed in the plenum space. Figure 300–85

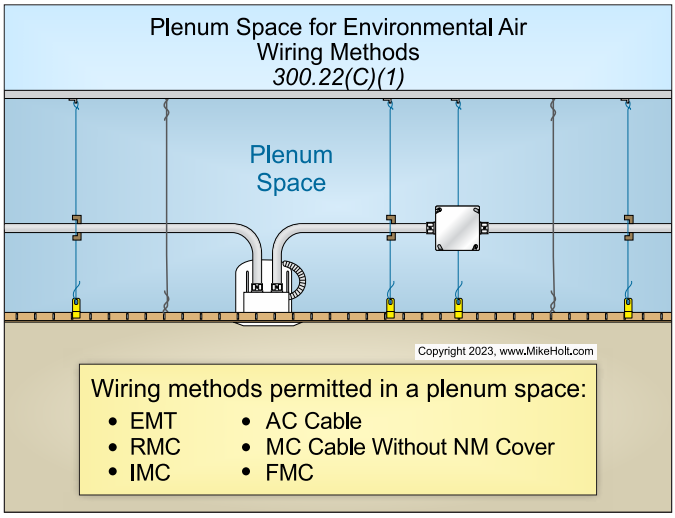


Figure 300–85

Cable ties for securing and supporting cables must be listed for use in a plenum space. Figure 300–86

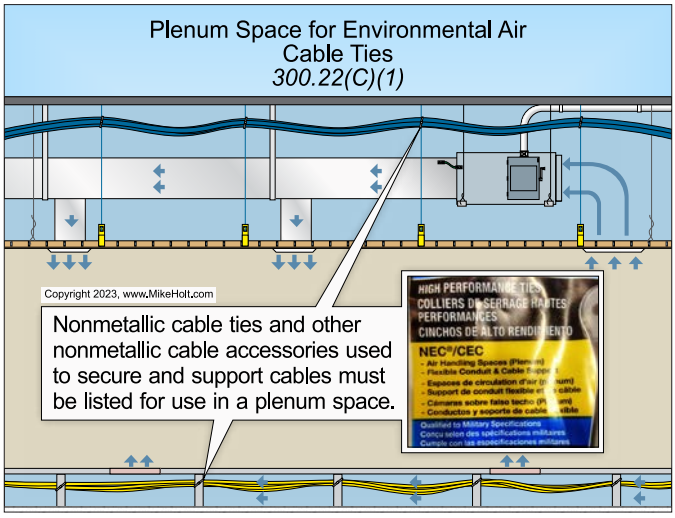


Figure 300–86

Author's Comment:

- Plenum-rated Chapter 7 and Chapter 8 wiring methods are permitted in plenum spaces according to the following: Figure 300–87
  - Class 2 Power-Limited Cables, 725.3(B)
  - Coaxial Cables, 800.3(C)
  - Fire Alarm Cables, 760.3(B) Ex 2

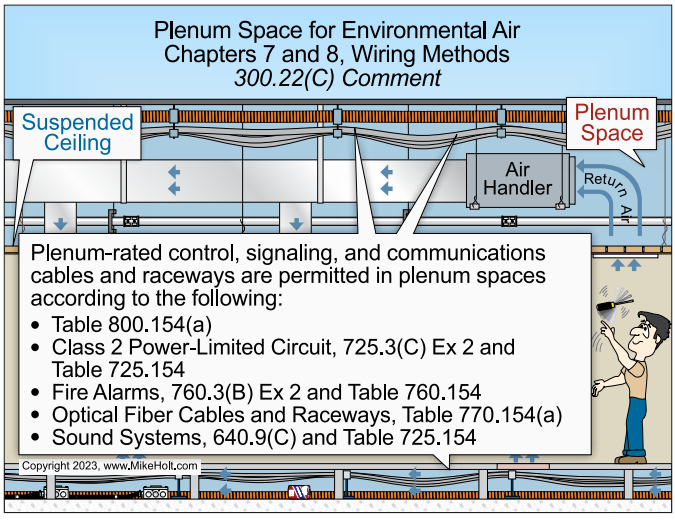


Figure 300–87

(2) Cable Tray Systems.

(a) Metal Cable Tray Systems. Metal cable tray systems can be installed to support the wiring methods permitted to be installed in a plenum space. Figure 300–88

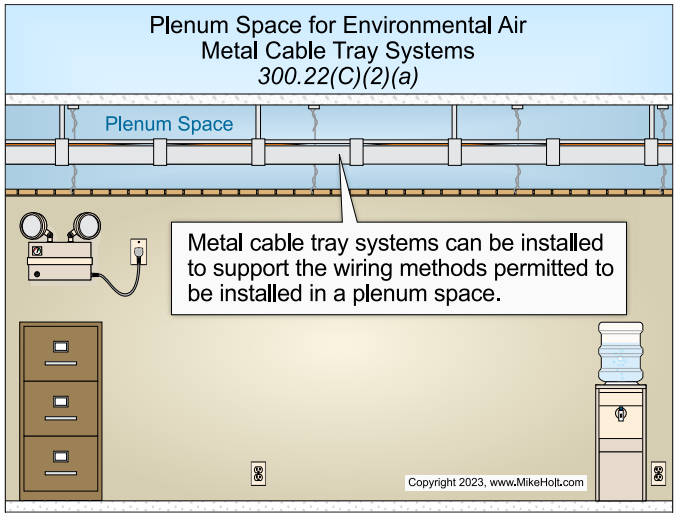


Figure 300–88

(3) Equipment. Electrical equipment with a metal enclosure, or a nonmetallic enclosure listed for use in an air-handling space, can be installed in a plenum space. Figure 300–89

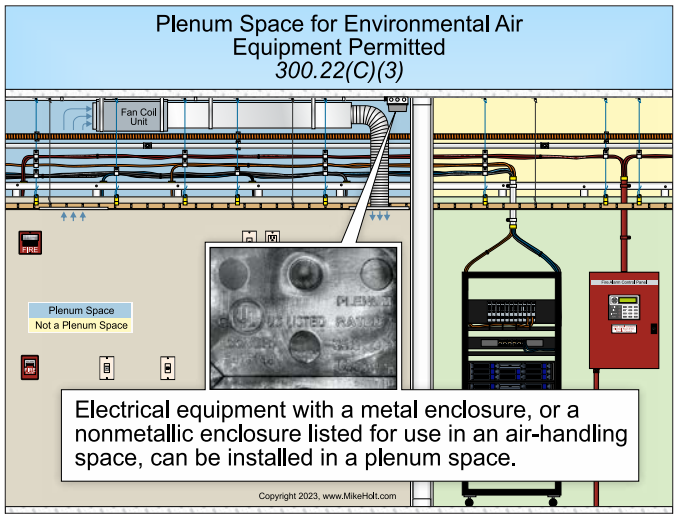


Figure 300–89

Author's Comment:

- Examples of electrical equipment permitted in plenum spaces are air handlers, junction boxes, and dry-type transformers, although transformers are not permitted to be rated over 50 kVA when in hollow spaces [450.13(B)].

300.23 Panels Designed to Allow Access

Cables, raceways, and equipment installed behind suspended-ceiling panels must be located so the panels can be removed to give access to electrical equipment. Figure 300–90

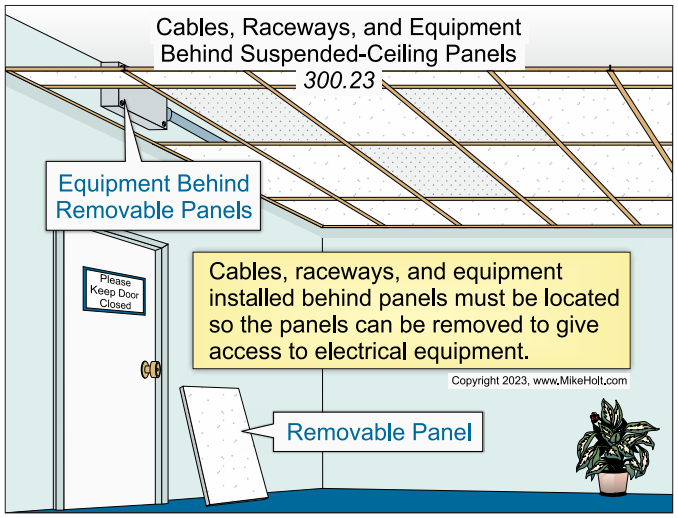


Figure 300–90

Author's Comment:

- Access to equipment is not permitted to be hindered by an accumulation of cables that prevent the removal of suspended-ceiling panels. Chapter 7 and Chapter 8 wiring methods must be located and supported so the suspended-ceiling panels can be moved to provide access to electrical equipment.
  - Class 2 Power-Limited Circuits, 725.21
  - Coaxial Cable, 800.21
  - Fire Alarm Cable, 760.21
  - Optical Fiber Cable, 770.21

300.25 Exit Stair Towers

Where an exit stair tower is required to have a fire-resistance rating, only the wiring methods serving equipment permitted by the authority having jurisdiction in the exit stair tower are permitted to be installed within the exit stair tower. Figure 300–91

Figure 300–91

Ex: Egress lighting located outside exterior doorways from the exit stair tower can be supplied from a circuit located inside the exit stair tower.

Author's Comment:

- Fire-resistance rating is a defined term in the *International Building Code*. The fire-rating rules for walls surrounding a stair tower are much more stringent and serve to "separate" it from the main building.
- Typically, only lighting and heat are necessary to serve a stair tower. For example, if a stair tower landing is the only place for a sub-panel to be installed, it will require documented special permission from the authority having jurisdiction.

Note: For more information, refer to NFPA 101, *Life Safety Code*, 7.1.3.2.1(10)(b).