Author's Comment:

- Perhaps one of the most critical points to understand is that a fault or other overcurrent condition will eventually occur even in the best electrical system. Our job is to ensure the overcurrent protection equipment can handle the conditions safely with little or no damage. Proper overcurrent protection is a critical step in this process.

240.3 Other Articles (Overcurrent Protection of Equipment)

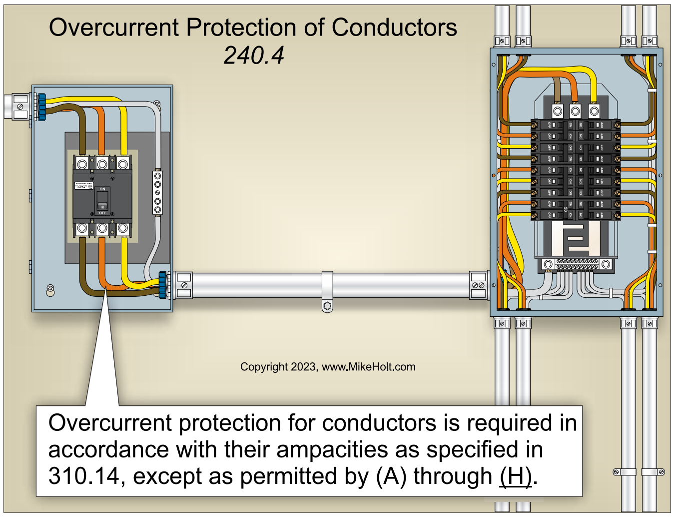
The following equipment and their conductors must be protected against overcurrent in accordance with the article for that type of equipment:

Table 240.3—Other Articles

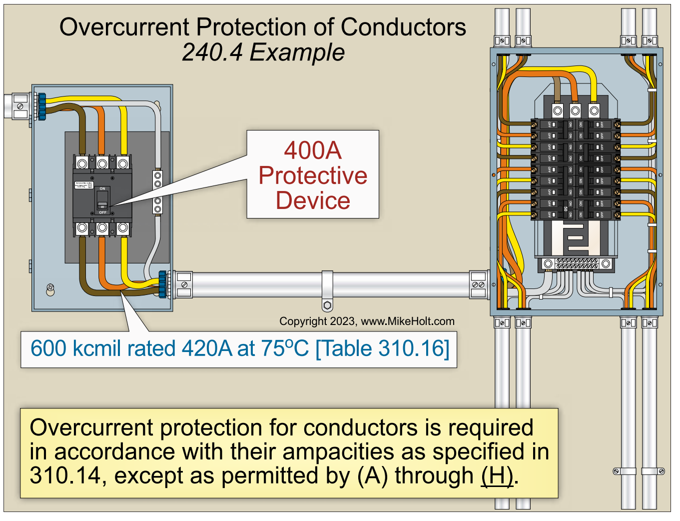
Equipment	Article	Section
Air-Conditioning Equipment	440	440.22
Appliances	422	All
Audio Circuits	640	640.9
Branch Circuits	210	210.20
Class 1 Power-Limited Circuits	724	724.43
Class 2 Power-Limited Circuits	725	All
Feeder Conductors	215	215.3
Flexible Cords	240	240.5(B)(1)
Fire Alarms	760	All
Fire Pumps	695	All
Fixed Electric Space-Heating Equipment	424	424.3(B)
Fixture Wire	240	240.5(B)(2)
Panelboards	408	408.36
Service Conductors	230	230.90(A)
Transformers	450	450.3

240.4 Overcurrent Protection of Conductors

Overcurrent protection for conductors is required in accordance with their ampacities as specified in 310.14, except as permitted by (A) through (H). ▶Figure 240–6 and ▶Figure 240–7



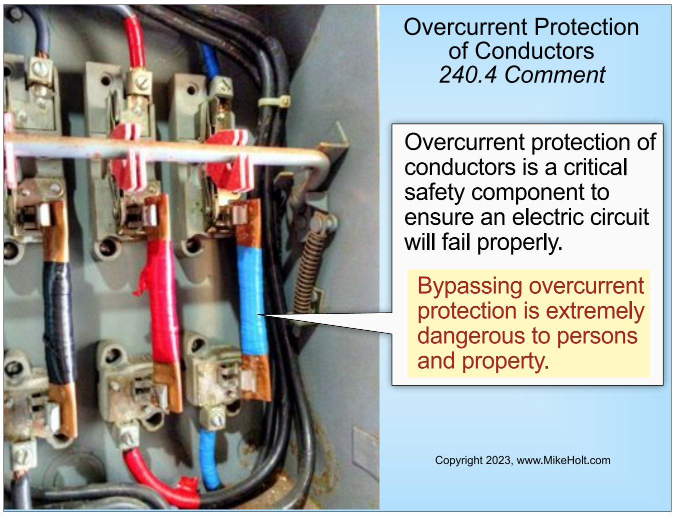
▶Figure 240–6



▶Figure 240–7

Author's Comment:

- Table 310.16 contains conductor ampacities based on up to three current-carrying conductors in a raceway with ambient temperatures of 86°F or 30°C at up to 2000V. If any other conditions apply (such as more than three current-carrying conductors, or a different ambient temperature), the ampacities found in Table 310.16 must be corrected in accordance with 310.15(B) and adjusted in accordance with 310.15(C).
- Overcurrent protection of conductors is a critical safety component to ensure an electric circuit will fail properly. Bypassing overcurrent protection is extremely dangerous to persons and property. ▶Figure 240–8



▸Figure 240–8

- Overcurrent protection of flexible cords, flexible cables, and fixture wires must be provided in accordance with 240.5.

(A) Power Loss Hazard. Conductor overload protection is not required, but short-circuit overcurrent protection is required where the interruption of the circuit will create a hazard, such as in a material-handling electromagnet circuit or fire pump circuit.

(B) Overcurrent Protective Devices Rated 800A or Less. The next higher standard overcurrent device rating (above the ampacity of the phase conductors being protected) is permitted, provided conditions (1) through (3) are met:

(1) The conductors are not part of a branch circuit supplying more than one receptacle for cord-and-plug-connected loads.

(2) The ampacity of a conductor after the application of ambient temperature correction [Table 310.15(B)(1)(1)], conductor bundling adjustment [Table 310.15(C)(1)], or both, does not correspond with the standard rating of a fuse or circuit breaker identified in 240.6(A).

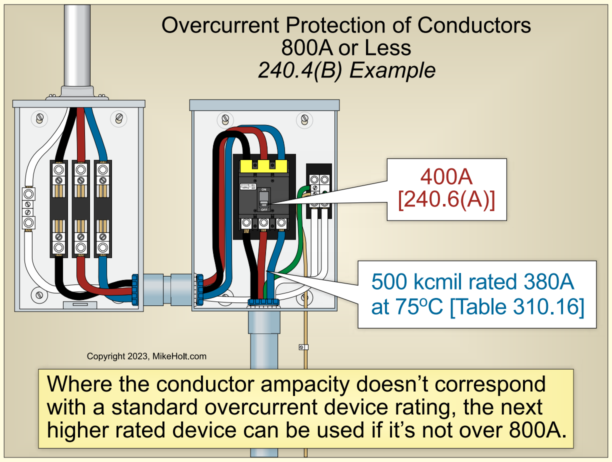
(3) The next higher standard overcurrent protective device rating from 240.6(A) does not exceed 800A.

In accordance with 240.4(B)(1), if the overcurrent protective device is an adjustable trip device, it is permitted to be set to a value that does not exceed the next higher standard value above the ampacity of the conductors being protected when in compliance with 240.6(C).

▸ Example

Question: *According to Table 310.16, what is the maximum size overcurrent protective device that can be used to protect 500 kcmil conductors where each conductor has an ampacity of 380A at 75°C?* ▸Figure 240–9

(a) 300A (b) 350A (c) 400A (d) 500A



▸Figure 240–9

Answer: *(c) 400A [240.6(A)]*

(C) Overcurrent Protective Devices Rated Over 800A. If the circuit's overcurrent protective device exceeds 800A, the conductor ampacity, after the application of ambient temperature correction [310.15(B)(1)(1)], conductor spacing adjustment [Table 310.15(C)(1)], or both, must have an ampere rating or setting of not less than the rating of the overcurrent protective device defined in 240.6.

▸ Example

Question: *What is the minimum size of conductors, paralleled in three conductors per phase, allowed to be protected by a 1,200A overcurrent protective device?* ▸Figure 240–10

(a) 400 kcmil (b) 500 kcmil (c) 600 kcmil (d) 750 kcmil

Solution:

The total ampacity of the three parallel conductor sets must be equal to or greater than 1,200A [240.4(C)]. The ampacity for each conductor within the parallel set must be equal to or greater than 400A (1,200A/3 raceways).

Conductor Size = 600 kcmil conductors per phase rated 420A at 75°C [110.14(C)(1)(b)(2) and Table 310.16]

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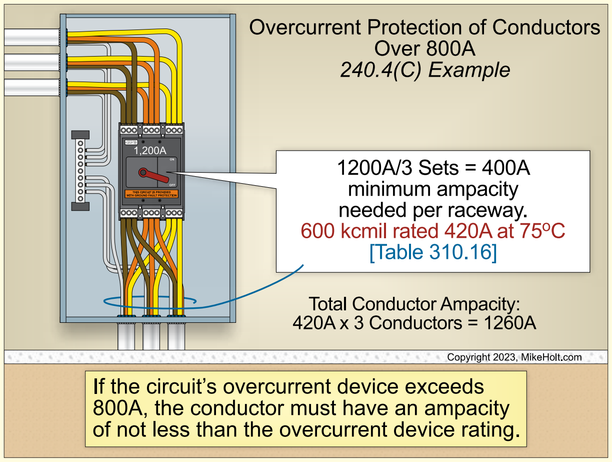


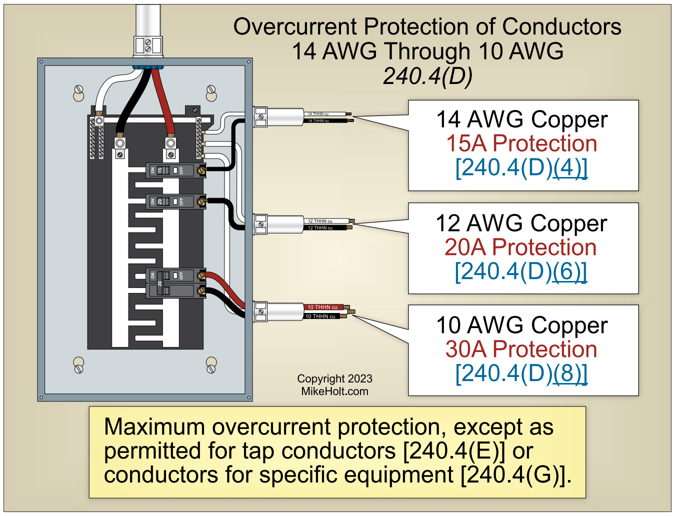
▸Figure 240–10

Total Conductor Ampacity = 420A × 3 conductors

Total Conductor Ampacity = 1,260A, okay for a 1,200A overcurrent protective device

Answer: *(c) 600 kcmil*

(D) Small Conductors. Overcurrent protection for conductors is not permitted to exceed the following values, except as permitted in 240.4(E) or (G): ▸Figure 240–11



▸Figure 240–11

(1) 18 AWG copper—7A

(2) 16 AWG copper—10A

(4) 14 AWG copper—15A

(5) 12 AWG aluminum and copper-clad aluminum—15A

(6) 12 AWG copper—20A

(7) 10 AWG aluminum and copper-clad aluminum—25A

(8) 10 AWG copper—30A

(E) Tap Conductors. Tap conductors must have overcurrent protection in accordance with the following:

(1) Household ranges, cooking appliances, and other loads [210.19(D)]

(2) Fixture wire [240.5(B)(2)]

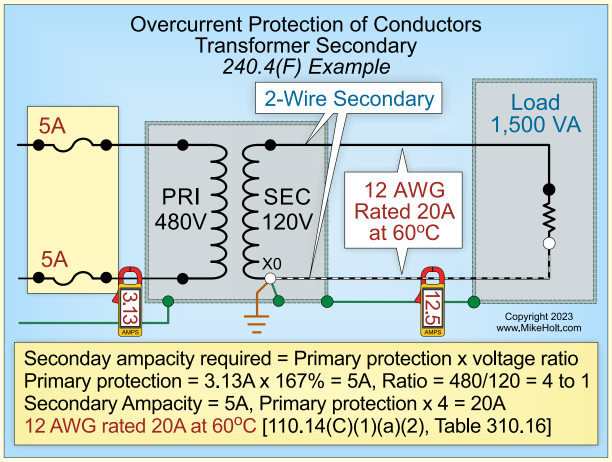
(3) Location in circuit [240.21]

(F) Transformer Secondary Conductors. For a 2-wire, single-voltage system and delta/delta, 3-wire systems, the primary overcurrent protective device sized in accordance with 450.3(B) is considered suitable to protect the secondary conductors, provided it does not exceed the value determined by multiplying the secondary conductor ampacity by the secondary-to-primary transformer voltage ratio.

▶ Example

Question: *What is the minimum size secondary conductor required for a single-phase, 1.50 kVA, 480V to 120V transformer that is protected with a 5A fuse on the primary?* ▸Figure 240–12

(a) 18 AWG (b) 16 AWG (c) 14 AWG (d) 12 AWG



▸Figure 240–12

Solution:

Step 1: *Determine the primary current.*

VA/E

VA = 1,500 VA

E = 480V

• • •

Primary Current = 1,500 VA/480V
Primary Current = 3.13A

Step 2: *Determine the primary overcurrent protective device rating [450.3(B)].*

Primary Overcurrent Protection = 3.13A × 167%
Primary Overcurrent Protection = 5.23A or a 5A Fuse

Step 3: *Determine the primary-to-secondary transformer ratio.*

Transformer Ratio = Primary Volts/Secondary Volts
Transformer Ratio = 480V/120V
Transformer Ratio = 4 to 1

Step 4: *Determine the secondary conductor minimum ampacity.*

Secondary Ampacity = Primary Overcurrent Protection × Transformer Ratio
Secondary Ampacity = 5A × 4
Secondary Ampacity = 20A

Use 12 AWG conductor rated 20A at 60°C [110.14(C)(1)(a)(2) and Table 310.16].

Answer: *(d) 12 AWG*

(G) Overcurrent Protection for Specific Applications. Overcurrent protection for conductors for specific equipment must comply with the requirements referenced in Table 240.4(G).

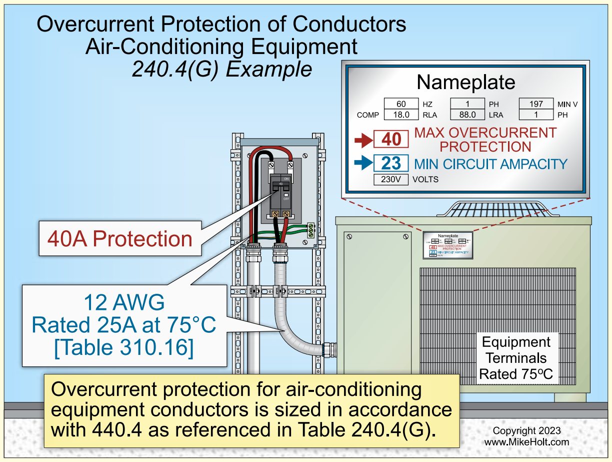
Author's Comment:

- Table 240.4(G) indicates that overcurrent protection for conductors for specific applications like air-conditioning, the requirements of Article 440 may be applied. For motors, the overcurrent protection requirements of Article 430 may be applied.
- In accordance with "*UL Guide Information LZFE,*" heating and cooling equipment terminations are based on the 75°C conductor ampacities in accordance with Table 310.16.

▶ Air Conditioner Example

Question: *What size branch-circuit conductor and overcurrent protective device are required for an air conditioner when the nameplate indicates the minimum circuit ampacity is 24A, and the maximum overcurrent protection is 40A? Terminals are rated 75°C.* ▶Figure 240–13

(a) 12 AWG, 20A OCPD
(b) 12 AWG, 30A OCPD
(c) 12 AWG, 40A OCPD
(d) 12 AWG, 50A OCPD



▶Figure 240–13

Solution:

The nameplate values for listed air-conditioning equipment are used to size the branch-circuit conductors and short-circuit overcurrent protective device [440.4(B)]. No calculation is required.

Conductor: *A 12 AWG conductor is suitable because it has an ampacity of 25A at 75°C [110.14(C)(1)(a)(3) and Table 310.16].*

Protection: *The air conditioner branch-circuit short-circuit protection is sized to the nameplate maximum overcurrent protection of 40A.*

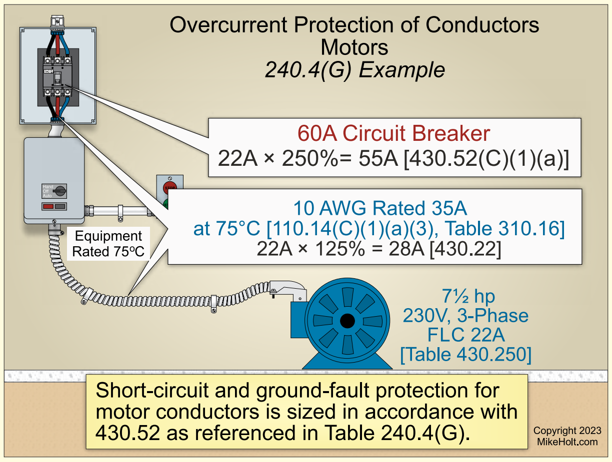
A 40A circuit breaker is permitted to protect a 12 AWG conductor rated 25A at 75°C in accordance with 110.14(C)(1)(a)(3), 240.4(G), and 440.4(B).

Answer: *(c) 12 AWG, 40A OCPD*

▶ Motor Example

Question: *What size branch-circuit conductor and overcurrent protective device (circuit breaker) are required for a 7½ hp, 230V, three-phase motor? Terminals are rated 75°C.* ▶Figure 240–14

(a) 10 AWG, 20A OCPD *(b) 10 AWG, 30A OCPD*
(c) 10 AWG, 40A OCPD *(d) 10 AWG, 60A OCPD*



▶Figure 240–14

Solution:

Step 1: *Determine the branch-circuit conductor size at 125 percent of the motor's FLC [430.22, and Table 430.250].*

FLC = 22A [Table 430.250]

Conductor = 22A × 125%
Conductor = 28A [430.22]
Conductor = 10 AWG which is rated 35A at 75°C [110.14(C)(1)(a)(3) and Table 310.16]

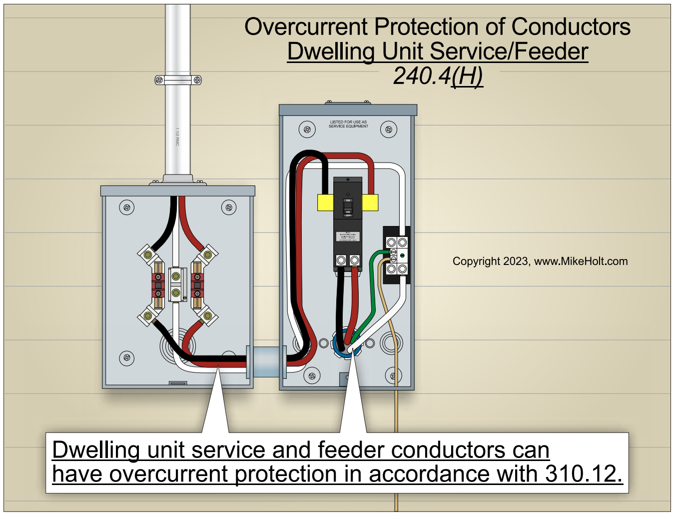
Step 2: *Determine the branch-circuit overcurrent protection size at 250 percent of the motor's FLC [Table 430.52(C)(1), 430.52(C)(1)(a), and Table 430.250].*

Inverse Time Circuit Breaker = 22A × 250%
Inverse Time Circuit Breaker = 55A

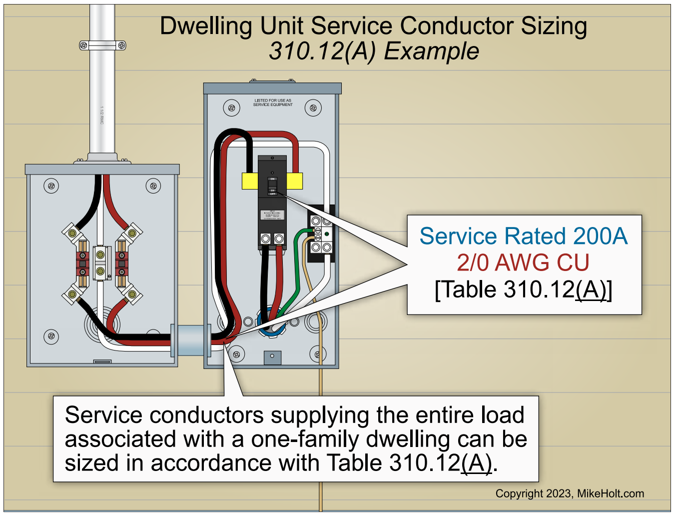
A 60A inverse time circuit breaker is permitted to protect the 10 AWG conductor in accordance with 240.4(G), Table 430.52(C)(1), and 430.52(C)(1)(a).

Answer: *(d) 10 AWG, 60A OCPD*

(H) Dwelling Unit Service and Feeder Conductors. Dwelling unit service and feeder conductors can have overcurrent protection in accordance with 310.12. ▶Figure 240–15 and ▶Figure 240–16



▶Figure 240–15



▶Figure 240–16