NEC® 2005 HANDBOOK

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unless the branch circuits over 600 volts are located at facilities that qualify as supervised installations.

210.20 Overcurrent Protection

Branch-circuit conductors and equipment shall be protected by overcurrent protective devices that have a rating or setting that complies with 210.20(A) through (D).

(A) Continuous and Noncontinuous Loads Where a branch circuit supplies continuous loads or any combination of continuous and noncontinuous loads, the rating of the overcurrent device shall not be less than the noncontinuous load plus 125 percent of the continuous load.

An example calculation for a continuous load only is illustrated in Exhibit 210.22.

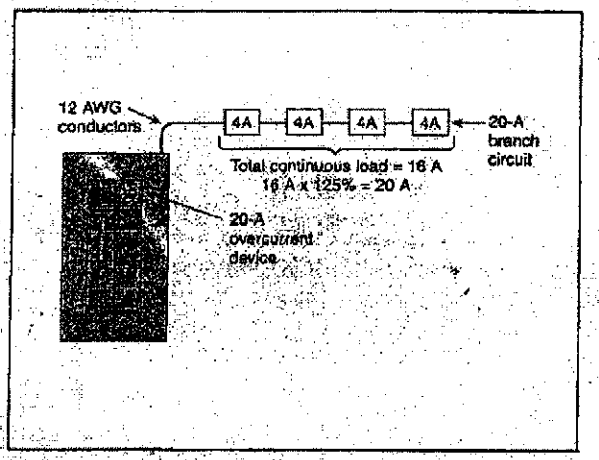

Exhibit 210.22 A continuous load (store lighting) calculated at 125 percent to determine the ampacity of the conductor and the branch-circuit size.

Exception: Where the assembly, including the overcurrent devices protecting the branch circuit(s), is listed for operation at 100 percent of its rating, the ampere rating of the overcurrent device shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load.

According to 210.20, an overcurrent device that supplies continuous and noncontinuous loads must have a rating that is not less than the sum of 100 percent of the noncontinuous load plus 125 percent of the continuous load, calculated in accordance with Article 210.

In addition, 210.19(A)(1) requires that the circuit conductors, chosen from the ampacity tables, must have an initial ampacity of not less than the sum of 100 percent of the noncontinuous load plus 125 percent of the continuous load, the same as calculated for the overcurrent device.

The rating of the overcurrent device cannot exceed the final ampacity of the circuit conductors after all the derating or correction factors have been applied, such as for temperature or number of conductors.

Example

Determine the minimum-size overcurrent protective device and the minimum conductor size for the following circuit:

- 25 amperes of continuous load
- 60°C overcurrent device terminal rating
- Type THWN conductors
- Four current-carrying copper conductors in a raceway

Solution

STEP 1. Determine the size of the overcurrent protective device (OCPD). Referring to 210.20(A), 125 percent of 25 amperes is 31.25 amperes. Thus, the minimum standard-size overcurrent device, according to 240.6(A), is 35 amperes.

STEP 2. Determine the minimum conductor size. The ampacity of the conductor must not be less than 125 percent of the 25-ampere continuous load, which results in 31.25 amperes. The conductor must have an allowable ampacity of not less than 31.25 amperes before any adjustment or correction factors are applied. Because there are four current-carrying conductors in the raceway, Table 310.15(B)(2)(a) applies. First, calculate the ampacity of the conductor using the ampacity value calculated above:

$$\text{Conductor ampacity} = \frac{\text{Computed load}}{\text{Percent adjustment factor from Table 310/15(B)(2)(a)}}$$

$$\frac{31.25 \text{ amperes}}{0.80} = 39.06 \text{ amperes}$$

Because of the 60°C rating of the overcurrent device terminal, it is necessary to choose a conductor based on the ampacities in the 60°C column of Table 310.16. The calculated load must not exceed the conductor ampacity. Therefore, an 8 AWG conductor with a 60°C allowable ampacity of 40 amperes is the minimum size permitted. Conductors with a higher allowable ampacity based on their insulation temperature rating may be used, but only at a 60°C allowable ampacity.

(B) Conductor Protection Conductors shall be protected in accordance with 240.4. Flexible cords and fixture wires shall be protected in accordance with 240.5.

(C) Equipment The rating or setting of the overcurrent protective device shall not exceed that specified in the applicable articles referenced in Table 240.3 for equipment.

voltage drop exceeds 5 percent, or 12 volts, larger-size conductors should be used, the circuit length should be shortened, or the circuit load should be reduced.

See the commentary following Chapter 9, Table 9, for an example of voltage-drop calculation using ac reactance and resistance. Voltage-drop tables and calculations are also available from various manufacturers.

(B) Feeders Over 600 Volts The ampacity of conductors shall be in accordance with 310.15 and 310.60 as applicable. Where installed, the size of the feeder circuit grounded conductor shall not be smaller than that required by 250.122, except that 250.122(F) shall not apply where grounded conductors are run in parallel. Feeder conductors over 600 volts shall be sized in accordance with 215.2(B)(1), (B)(2), or (B)(3).

(1) Feeders Supplying Transformers The ampacity of feeder conductors shall not be less than the sum of the nameplate ratings of the transformers supplied when only transformers are supplied.

(2) Feeders Supplying Transformers and Utilization Equipment The ampacity of feeders supplying a combination of transformers and utilization equipment shall not be less than the sum of the nameplate ratings of the transformers and 125 percent of the designed potential load of the utilization equipment that will be operated simultaneously.

(3) Supervised Installations For supervised installations, feeder conductor sizing shall be permitted to be determined by qualified persons under engineering supervision. Supervised installations are defined as those portions of a facility where all of the following conditions are met:

(1) Conditions of design and installation are provided under engineering supervision.
(2) Qualified persons with documented training and experience in over 600-volt systems provide maintenance, monitoring, and servicing of the system.

Section 215.2(B) sets the minimum requirements for feeders over 600 volts. Unless the circuit is part of a supervised installation [defined in 215.2(B)(3)], the minimum ampacity for feeder circuit conductors over 600 volts can be no less than 100 percent of the transformer nameplate load plus 125 percent of any additional utilization equipment. The overcurrent protection requirements for feeders over 600 volts must be in accordance with Article 240, Part IX.

215.3 Overcurrent Protection

Feeders shall be protected against overcurrent in accordance with the provisions of Part I of Article 240. Where a feeder supplies continuous loads or any combination of continuous and noncontinuous loads, the rating of the overcurrent device shall not be less than the noncontinuous load plus 125 percent of the continuous load.

Exception: Where the assembly, including the overcurrent devices protecting the feeder(s), is listed for operation at 100 percent of its rating, the ampere rating of the overcurrent device shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load.

The feeder overcurrent protection requirements in 215.3 are somewhat similar to the branch-circuit overcurrent protection requirements in 210.20(A).

Exception: Overcurrent protection for feeders over 600 volts, nominal, shall comply with Part XI of Article 240.

215.4 Feeders with Common Neutral

(A) Feeders with Common Neutral Two or three sets of 3-wire feeders or two sets of 4-wire or 5-wire feeders shall be permitted to utilize a common neutral.

(B) In Metal Raceway or Enclosure Where installed in a metal raceway or other metal enclosure, all conductors of all feeders using a common neutral shall be enclosed within the same raceway or other enclosure as required in 300.20.

If feeder conductors carrying ac current, including the neutral, are installed in metal raceways, the conductors are required to be grouped together to avoid induction heating of the surrounding metal. If it is necessary to run parallel conductors through multiple metal raceways, conductors from each phase plus the neutral must be run in each raceway. See 250.102(E), 250.134(B), 300.3, 300.5(I), and 300.20 for requirements associated with conductor grouping of feeder circuits.

A 3-phase, 4-wire (208Y/120-volt, 480Y/277-volt) system is often used to supply both lighting and motor loads. The 3-phase motor loads are typically not connected to the neutral and thus will not cause current in the neutral conductor. The maximum current on the neutral, therefore, is due to lighting loads or circuits where the neutral is used. On this type of system (3-phase, 4-wire), a demand factor of 70 percent is permitted by 220.61 for that portion of the neutral load in excess of 200 amperes.

For example, if the maximum possible unbalanced load is 500 amperes, the neutral would have to be large enough to carry 410 amperes (200 amperes plus 70 percent of 300 amperes, or 410 amperes). No reduction of the neutral capacity for that portion of the load consisting of electric-discharge lighting is permitted.

Section 310.15(B)(4)(c) points out that a neutral conductor must be counted as a current-carrying conductor if the

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Schedule VHB-5

ampacity as specified in Tables 400.5(A) and 400.5(B). Fixture wire shall be protected against overcurrent in accordance with its ampacity as specified in Table 402.5. Supplementary overcurrent protection, as in 240.10, shall be permitted to be an acceptable means for providing this protection.

(B) Branch Circuit Overcurrent Device Flexible cord shall be protected where supplied by a branch circuit in accordance with one of the methods described in 240.5(B)(1), (B)(2), (B)(3), or (B)(4).

(1) Supply Cord of Listed Appliance or Portable Lamps Where flexible cord or tinsel cord is approved for and used with a specific listed appliance or portable lamp, it shall be considered to be protected when applied within the appliance or portable lamp listing requirements.

(2) Fixture Wire Fixture wire shall be permitted to be tapped to the branch circuit conductor of a branch circuit in accordance with the following:

(1) 20-ampere circuits — 18 AWG, up to 15 m (50 ft) of run length
(2) 20-ampere circuits — 16 AWG, up to 30 m (100 ft) of run length
(3) 20-ampere circuits — 14 AWG and larger
(4) 30-ampere circuits — 14 AWG and larger

Section 240.5(A) references Tables 400.5(A) and 400.5(B) for flexible cords and flexible cables and Table 402.5 for fixture wire ampacity. Supplementary protection, as described in 240.10, is also acceptable as an alternative for protection of either flexible cord or fixture wire.

Sections 240.5(B)(1) through 240.5(B)(4) permit smaller conductors to be connected to branch circuits of a greater rating. For flexible cords, 240.5(B)(1) and 240.5(B)(3) now specify that flexible cord connected to a listed appliance or portable lamp or used in a listed extension cord set is considered to be protected as long as the appliance, lamp, or extension cord is used in accordance with its listing requirements. These listing requirements are developed by the third-party testing and listing organizations with technical input from cord, appliance, and lamp manufacturers. For other than field-assembled extension cords, the *Code* no longer contains specific provisions for the overcurrent protection of flexible cord based on cord conductor size. For fixture wire, 240.5(B)(2) establishes a maximum protective device rating based on a minimum conductor size and a maximum conductor length.

(5) 40-ampere circuits — 12 AWG and larger
(6) 50-ampere circuits — 12 AWG and larger

(3) Extension Cord Sets Flexible cord used in listed extension cord sets shall be considered to be protected when applied within the extension cord listing requirements.

(4) Field Assembled Extension Cord Sets Flexible cord used in extension cords made with separately listed and installed components shall be permitted to be supplied by a branch circuit in accordance with the following:

20-ampere circuits — 16 AWG and larger

Field-assembled extension cords are permitted provided the conductors are 16 AWG or larger and the overcurrent protection for the branch circuit to which the cord is connected does not exceed 20 amperes. The cord and the cord caps and connectors used for this type of assembly are required to be listed.

240.6 Standard Ampere Ratings

(A) Fuses and Fixed-Trip Circuit Breakers The standard ampere ratings for fuses and inverse time circuit breakers shall be considered 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 110, 125, 150, 175, 200, 225, 250, 300, 350, 400, 450, 500, 600, 700, 800, 1000, 1200, 1600, 2000, 2500, 3000, 4000, 5000, and 6000 amperes. Additional standard ampere ratings for fuses shall be 1, 3, 6, 10, and 601. The use of fuses and inverse time circuit breakers with nonstandard ampere ratings shall be permitted.

(B) Adjustable-Trip Circuit Breakers The rating of adjustable-trip circuit breakers having external means for adjusting the current setting (long-time pickup setting), not meeting the requirements of 240.6(C), shall be the maximum setting possible.

(C) Restricted Access Adjustable-Trip Circuit Breakers A circuit breaker(s) that has restricted access to the adjusting means shall be permitted to have an ampere rating(s) that is equal to the adjusted current setting (long-time pickup setting). Restricted access shall be defined as located behind one of the following:

(1) Removable and sealable covers over the adjusting means
(2) Bolted equipment enclosure doors
(3) Locked doors accessible only to qualified personnel

The set long-time pickup rating (as opposed to the instantaneous trip rating) of an adjustable-trip circuit breaker can be considered the circuit breaker rating where access to the adjustment means is limited. This access limitation can be provided by locating the adjustment means behind sealable covers, as shown in Exhibit 240.2, behind bolted equipment enclosures, or behind locked equipment room doors with access available only to qualified personnel. The purpose of limiting access to the adjustment prevents tampering or readjustment by unqualified personnel.

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With Complete Text of 1990 Code

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There is no restriction placed on the number of outlets connected to a general lighting or small appliance branch circuit. The number of receptacle outlets in a room is determined by Section 210-52(a). It is desirable to provide more than the minimum number of receptacle outlets required, thereby further reducing the need for use of extension cords.

Consideration must be given to balancing the loads when terminating circuits in panelboards.

B. Feeders

220-10. General.

(a) Ampacity and Computed Loads. Feeder conductors shall have sufficient ampacity to supply the load served. In no case shall the computed load of a feeder be less than the sum of the loads on the branch circuits supplied as determined by Part A of this article after any applicable demand factors permitted by Parts B, C, or D have been applied.

See Figure 220-7.

(FPN): See Examples 1 through 8, Chapter 9. See Section 210-22(b) for maximum load in amperes permitted for lighting units operating at less than 100 percent power factor.

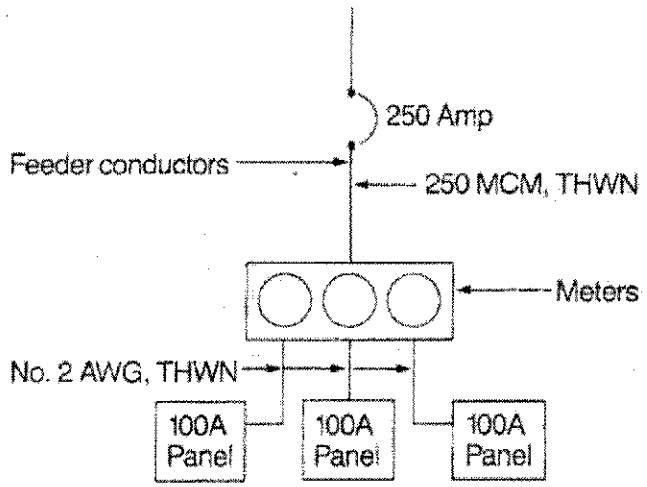

Figure 220-7. Each panel serves an 80-A load. The feeder size is based on the sum of the computed and connected loads served by each panel, not on the sum of the panel or overcurrent device rating.

(b) Continuous and Noncontinuous Loads. Where a feeder supplies continuous loads or any combination of continuous and noncontinuous loads, the rating of the overcurrent device shall not be less than the noncontinuous load plus 125 percent of the continuous load.

This section has been revised for the 1990 *Code*. It requires the overcurrent device for a feeder to be sized at not less than the sum of the combination of the noncontinuous loads plus 125 percent of the continuous loads.

The ungrounded service conductors are no longer required to be sized at this value. Service conductors are required to have sufficient ampacity to carry the loads computed in accordance with Article 220, with appropriate demand factors applied.

See Sections 230-23, 230-31, and 230-42.

Exception: Where the assembly including the overcurrent devices protecting the feeder(s) are listed for operation at 100 percent of their rating, neither the ampere rating of the overcurrent device nor the ampacity of the feeder conductors shall be less than the sum of the continuous load plus the noncontinuous load.