The resistance or impedance of conductors can cause a substantial difference between voltage at service equipment and voltage at the point-of-utilization equipment. Excessive voltage drop impairs the starting and the operation of electrical equipment. Undervoltage can result in inefficient operation of heating, lighting, and motor loads. An applied voltage of 10 percent below rating can result in a decrease in efficiency of substantially more than 10 percent — for example, fluorescent light output would be reduced by 15 percent, and incandescent light output would be reduced by 30 percent. Induction motors would run hotter and produce less torque. With an applied voltage of 10 percent below rating, the running current would increase 11 percent, and the operating temperature would increase 12 percent. At the same time, torque would be reduced 19 percent.

In addition to resistance or impedance, the type of raceway or cable enclosure, the type of circuit [alternating current (ac), direct current (dc), single-phase, 3-phase], and the power factor should be considered to determine voltage drop.

This basic formula can be used to determine the voltage drop in a 2-wire dc circuit, a 2-wire ac circuit, or a 3-wire ac single-phase circuit, all with a balanced load at 100 percent power factor and where reactance can be neglected:

$$VD = \frac{2 \times L \times R \times I}{1000}$$

where:

VD = voltage drop (based on conductor temperature of 75°C)
L = one-way length of circuit (ft)
R = conductor resistance in ohms (Ω) per 1000 ft (from Chapter 9, Table 8)
I = load current (amperes)

For 3-phase circuits (at 100 percent power factor), the voltage drop between any two phase conductors is 0.866 times the voltage drop calculated by the formula. Voltage-drop tables and calculations are available from various manufacturers.

See also

Chapter 9, Table 9, and its commentary for an example of voltage-drop calculation using ac reactance and resistance

(B) Grounded Conductor. The size of the feeder circuit grounded conductor shall not be smaller than the equipment grounding conductor size required by 250.122, except that 250.122(F) shall not apply where grounded conductors are run in parallel.

Additional minimum sizes shall be as specified in 215.2(C) under the conditions stipulated.

Using 250.122 to establish the minimum size grounded conductor in a feeder circuit provides a relationship between the grounded conductor and the feeder circuit overcurrent protective device that is the same as that used for sizing equipment-grounding conductors. It provides an adequate fault current path in the event of a fault between a phase conductor and the grounded conductor.

See also

235.202 for sizing requirements of the grounded feeder conductor for feeder circuits over 1000 volts ac or 1500 volts dc, nominal

220.61 and **310.10(G)** for determining the minimum grounded conductor size for feeder circuits installed in parallel in separate raceways or cables

(C) Ampacity Relative to Service Conductors. The feeder conductor ampacity shall not be less than that of the service conductors where the feeder conductors carry the total load supplied by service conductors with an ampacity of 55 amperes or less.

According to Table 310.16, a 3/0 AWG, Type THW copper conductor has an ampacity of 200 amperes. However, for a 3-wire, single-phase dwelling unit service, as shown in Exhibit 215.2, 310.12 permits a service conductor (or a main power feeder conductor) with an ampacity of 83 percent of the service rating. This permits a minimum of 2/0 AWG, Type THW copper conductors or 4/0 AWG, Type THW aluminum conductors for services or a main power feeder rated at 200 amperes.

215.3 Overcurrent Protection. Feeders shall be protected against overcurrent in accordance with 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.

215.4 Feeders with Common Neutral Conductor.

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

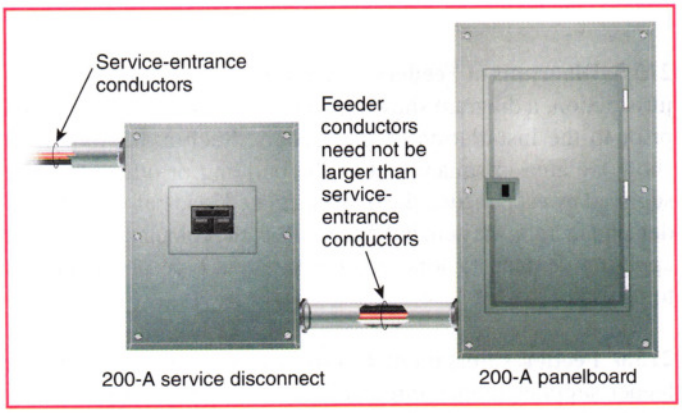

EXHIBIT 215.2 A 3-wire, single-phase dwelling service with an ampacity of 200 amperes for 2/0 AWG copper or 4/0 AWG aluminum conductors used as service-entrance conductors and feeder conductors.