(1) Low-voltage luminaires identified for the use
(2) Power supply identified for the use
(3) Low-voltage luminaire fittings identified for the use
(4) Suitably rated cord or cable, or any Chapter 3 wiring method for the secondary circuit

A lighting system may be a complete listed system or an assembly of listed parts. Lighting systems have long been field assembled from individually listed low-voltage luminaires, a power supply, and a suitably rated cord or other fixed Chapter 3 wiring method. Installers typically verify that individually listed lighting system parts (regularly from multiple manufacturers) are intended for the use and have the needed ratings to create and assemble a low-voltage lighting system.

N **411.3 Voltage Limitations.** The operating voltage of low-voltage lighting systems and their associated components shall not exceed 30 volts ac or 60 volts dc. If wet contact is likely to occur, the operating voltage of low-voltage lighting systems and their associated components shall not exceed 15 volts ac or 30 volts dc.

Informational Note: See 680.1 for swimming pools, fountains, and similar installations.

Article 411 covers low-voltage interior and exterior (landscape) lighting systems consisting of a maximum 30-volt isolating ac or 60-volt dc power supply. In wet locations where contact with the lighting system might occur, the maximum voltage limit is 15 volts ac or 30 volts dc.

411.4 Low-Voltage Lighting Systems. Low voltage lighting systems shall consist of an isolating power supply, low-voltage luminaires, and associated equipment that are all identified for the use. The output circuits of the power supply shall be rated for 25 amperes maximum under all load conditions.

Article 411 also applies to Class 2 luminaires operating above 30 volts (42.4 volts peak voltage). This permits luminaires operating up to 60 volts dc to be installed without grounding, in accordance with 411.7(A) of the *NEC*®. Grounding is not a necessary safety measure for products operating from an isolating source, especially where voltages are within Class 2 limits. What distinguishes Article 411 from Article 410 is the voltage limitation and isolation requirement, both of which allow for a different scheme for protection against electric shock injury.

411.6 Specific Location Requirements.

(A) Walls, Floors, and Ceilings. Conductors concealed or extended through a wall, floor, or ceiling shall be in accordance with one of the following:

(1) Installed using any of the wiring methods specified in Chapter 3
(2) Installed using wiring supplied by a listed Class 2 power source and installed in accordance with 725.130

(B) Pools, Spas, Fountains, and Similar Locations. Lighting systems shall be installed not less than 3 m (10 ft) horizontally from the nearest edge of the water, unless permitted elsewhere in this *Code*.

The installation requirements of 411.6 recognize that shock and fire hazards exist even with low-voltage systems.

411.7 Secondary Circuits.

(A) Grounding. Secondary circuits shall not be grounded.

Exception: Secondary circuits supplied by a Class 2 power source listed and identified as suitable for secondary grounding shall be permitted to be grounded.

(B) Isolation. The secondary circuit shall be insulated from the branch circuit by an isolating transformer.

(C) Bare Conductors. Exposed bare conductors and current-carrying parts shall be permitted for indoor installations only. Bare conductors shall not be installed less than 2.1 m (7 ft) above the finished floor, unless specifically listed for a lower installation height.

Low-voltage bare conductor systems (i.e., trapeze lights) must be listed as a system. A system listing is necessary for these products because they often rely on special detection circuitry to address the fire risk associated with a conductive material shorting across the exposed conductors.

411.8 Branch Circuit. Lighting systems covered by this article shall be supplied from a maximum 20-ampere branch circuit.

ARTICLE 422 Appliances

Part I. General

422.1 Scope. This article covers electrical appliances used in any occupancy.

Article 422 covers appliances that are fastened in place or cord-and-plug-connected, such as air-conditioning units, dishwashers, heating appliances, water heaters, and infrared heating lamps. See Article 100 for the definition of *appliance*.

422.5 GFCI Protection.

Δ **(A) General.** Appliances identified in 422.5(A)(1) through (A)(7) 150 volts or less to ground and 60 amperes or less, single- or 3-phase, shall be provided with Class A protection for personnel. Multiple Class A protective devices shall be permitted but shall not be required.

(1) Automotive vacuum machines
(2) Drinking water coolers and bottle fill stations