breakers or sets of fuses mounted in a single enclosure, in a group of separate enclosures, or in or on a switchboard or switchgear. There shall be no more than six overcurrent devices grouped in any one location.

(3) Overcurrent relaying is connected [with a current transformer(s), if needed] to sense all of the secondary conductor current and limit the load to the conductor ampacity by opening upstream or downstream devices.

(4) Conductors shall be considered to be protected if calculations, made under engineering supervision, determine that the system overcurrent devices will protect the conductors from overload conditions.

(3) Physical Protection. The secondary conductors are protected from physical damage by being enclosed in an approved raceway or by other approved means.

(D) Outside Feeder Taps. Outside conductors shall be permitted to be tapped to a feeder or to be connected at a transformer secondary, without overcurrent protection at the tap or connection, where all the following conditions are met:

(1) The conductors are protected from physical damage in an approved manner.

(2) The sum of the overcurrent devices at the conductor termination limits the load to the conductor ampacity. The overcurrent devices shall consist of not more than six circuit breakers or sets of fuses mounted in a single enclosure, in a group of separate enclosures, or in or on a switchboard or switchgear. There shall be no more than six overcurrent devices grouped in any one location.

(3) The tap conductors are installed outdoors of a building or structure except at the point of load termination.

(4) The overcurrent device for the conductors is an integral part of a disconnecting means or is located immediately adjacent thereto.

(5) The disconnecting means for the conductors are installed at a readily accessible location complying with one of the following:

a. Outside of a building or structure
b. Inside, nearest the point of entrance of the conductors
c. Where installed in accordance with 230.6, nearest the point of entrance of the conductors

(E) Protection by Primary Overcurrent Device. Conductors supplied by the secondary side of a transformer shall be permitted to be protected by overcurrent protection provided on the primary (supply) side of the transformer, provided the primary device time–current protection characteristic, multiplied by the maximum effective primary-to-secondary transformer voltage ratio, effectively protects the secondary conductors.

ARTICLE 242

Overvoltage Protection

Part I. General

Δ **242.1 Scope.** This article provides the general requirements, installation requirements, and connection requirements for overvoltage protection and overvoltage protective devices. Part II covers surge-protective devices (SPDs) permanently installed on premises wiring systems of not more than 1000 volts, nominal, while Part III covers surge arresters permanently installed on premises wiring systems over 1000 volts, nominal.

The delineation between surge-protective devices (SPDs) covered by Part II and those covered by Part III is the voltage rating of the supply system. The designations of SPDs are varied, depending on their location in the premises wiring system. For instance, a Type 1 SPD is permitted to be connected on the supply side of the service or building disconnecting means. Type 2 and Type 3 SPDs must be installed on the load side of OCPDs and are the devices referred to in previous editions as transient voltage surge suppressors (TVSSs). Two examples of SPDs are shown in Exhibit 242.1.

N **242.2 Reconditioned Equipment.** SPDs and surge arresters shall not be reconditioned.

242.3 Other Articles. Equipment shall be protected against overvoltage in accordance with the article in this *Code* that covers the type of equipment or location specified in Table 242.3.

EXHIBIT 242.1 Two SPDs suitable for service-entrance installation — one for direct connection to panelboard busbars and one for mounting in a cabinet or enclosure knockout. (*Courtesy of Eaton*)

Δ *TABLE 242.3 Other Articles*

Equipment	Article
Class I locations	501
Class II locations	502
Community antenna television and radio distribution systems	820
Critical operations power systems	708
Elevators, dumbwaiters, escalators, moving walks, platform lifts, and stairway chairlifts	620
Emergency systems	700
Equipment over 1000 volts, nominal	495
Fire pumps	695
Industrial machinery	670
Information technology equipment	645
Modular data centers	646
Outdoor overhead conductors over 1000 volts	395
Radio and television equipment	810
Receptacles, cord connectors, and attachment plugs (caps)	406
Wind electric systems	694

EXHIBIT 242.2 An SPD as an integral component of a receptacle, providing local point-of-use protection of equipment when transient events occur within the facility. *(Courtesy of Legrand®)*

Δ Part II. Surge-Protective Devices (SPDs), 1000 Volts or Less

242.6 Listing. An SPD shall be a listed device.

UL 1449, *Standard for Surge Protective Devices*, covers Types 1, 2, 3, and 4 devices. SPDs are permitted to be installed on ungrounded systems, impedance grounded systems, and corner-grounded systems where the device is listed for the specific characteristic of the system per 242.12(2).

242.8 Short-Circuit Current Rating. The SPD shall be marked with a short-circuit current rating and shall not be installed at a point on the system where the available fault current is in excess of that rating. This marking requirement shall not apply to receptacles.

In residential and small commercial electrical systems, the first SPD is commonly installed either as an integral component of or near to the service-entrance equipment.

Depending on the system voltage, surge protection in larger commercial and industrial electrical systems can be provided by installing a Type 1 SPD (a surge arrester for systems 1000 volts and less) or surge arrester (the devices covered in Part III for systems over 1000 volts) on the line side of the service equipment. Subsequent levels of SPDs are then provided at intermediate points in the distribution system (such as at panelboards that serve loads susceptible to transients) and at the point where utilization equipment connects to the electrical system.

Point-of-use SPDs such as receptacles and relocatable power taps (power strips) can be installed at the equipment (such as computers or equipment with electronic controls). The function of a point-of-use SPD is to remove small transients that pass through the more robust surge devices located at the service. Point-of-use SPDs are also useful in removing small transients that have been generated within the building. See Exhibit 242.2 for a point-of-use, or Type 3 SPD.

N **242.9 Indicating.** An SPD shall provide indication that it is functioning properly.

242.12 Uses Not Permitted. An SPD device shall not be installed in the following:

(1) Circuits over 1000 volts
(2) On ungrounded systems, impedance grounded systems, or corner grounded delta systems unless listed specifically for use on these systems
(3) Where the rating of the SPD is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application

242.13 Type 1 SPDs. Type 1 SPDs shall be installed in accordance with 242.13(A) and (B).

(A) Installation. Type 1 SPDs shall be permitted to be connected in accordance with one of the following:

(1) To the supply side of the service disconnect as permitted in 230.82(4)
(2) As specified in 242.14

(B) At the Service. When installed at services, Type 1 SPDs shall be connected to one of the following:

(1) Grounded service conductor
(2) Grounding electrode conductor
(3) Grounding electrode for the service
(4) Equipment grounding terminal in the service equipment

Although four locations for connecting the SPD grounding lead are acceptable, the requirement in 242.24 covering the length and physical routing of the conductor must be followed.

242.14 Type 2 SPDs. Type 2 SPDs shall be installed in accordance with 242.14(A) through (C).

(A) Service-Supplied Building or Structure. Type 2 SPDs shall be connected anywhere on the load side of a service disconnect overcurrent device required in 230.91 unless installed in accordance with 230.82(8).

(B) Feeder-Supplied Building or Structure. Type 2 SPDs shall be connected at the building or structure anywhere on the load side of the first overcurrent device at the building or structure.

(C) Separately Derived System. The SPD shall be connected on the load side of the first overcurrent device in a separately derived system.

242.16 Type 3 SPDs. Type 3 SPDs shall be permitted to be installed on the load side of branch-circuit overcurrent protection up to the equipment served. If included in the manufacturer's instructions, the Type 3 SPD connection shall be a minimum 10 m (30 ft) of conductor distance from the service or separately derived system disconnect.

The point in the electrical system where SPDs are connected is dependent on the type of SPD. UL 1449, *Standard for Surge Protection Devices*, is the product standard used to evaluate safe performance of SPDs. A Type 2 SPD must be installed on the load side of the service-disconnect overcurrent protection unless installed in accordance with 230.82(8), and a Type 3 SPD must be installed on the load side of a branch-circuit OCPD. The requirement for Type 2 SPDs to be connected on the load side of the first OCPD in a feeder-supplied structure is necessary due to the exposure of external feeder conductors to a more hostile surge environment, such as lightning.

Two requirements — 230.82(4) for Type 1 surge-protection devices and 230.82(8) for Type 2 surge-protection devices — permit the installation of SPDs on the line side of the service disconnecting means. Section 230.71(A)(2) permits an additional disconnecting means at the service equipment for SPDs installed as part of listed equipment. The disconnecting means for the SPD does not count as one of the six permitted by 230.71(A)(2) where the SPD and its disconnecting means are provided in the listed equipment by the manufacturer. Type 2 SPDs must be installed in listed equipment where the SPD is provided with a disconnecting means and overcurrent protection.

242.18 Type 4 and Other Component Type SPDs. Type 4 component assemblies and other component type SPDs shall only be installed by the equipment manufacturer.

Type 4 and other component-type SPDs are incomplete devices that are acceptable only if installed as part of listed equipment.

242.20 Number Required. Where used at a point on a circuit, the SPD shall be connected to each ungrounded conductor.

242.22 Location. SPDs shall be permitted to be located indoors or outdoors and shall be made inaccessible to unqualified persons unless listed for installation in accessible locations.

242.24 Routing of Conductors. The conductors used to connect the SPD to the line or bus and to ground shall not be any longer than necessary and shall avoid unnecessary bends.

High-frequency currents, such as those common to lightning discharges, tend to reduce the effectiveness of a conductor that connects the device to ground. To optimize performance of SPDs, the length of the conductor that connects the device to ground is limited. Short conductors with few bends will have a lower impedance to surge current. Higher impedance drives the clamping voltage higher and reduces the protection provided by the SPD unit. Maximum protection is achieved where the SPD is located as close as practicable to the equipment being protected as shown in Exhibit 242.3.

242.28 Conductor Size. SPD line conductors and conductors to ground shall not be smaller than 14 AWG copper or 12 AWG aluminum.

242.30 Connection Between Conductors. An SPD shall be permitted to be connected between any two conductors —

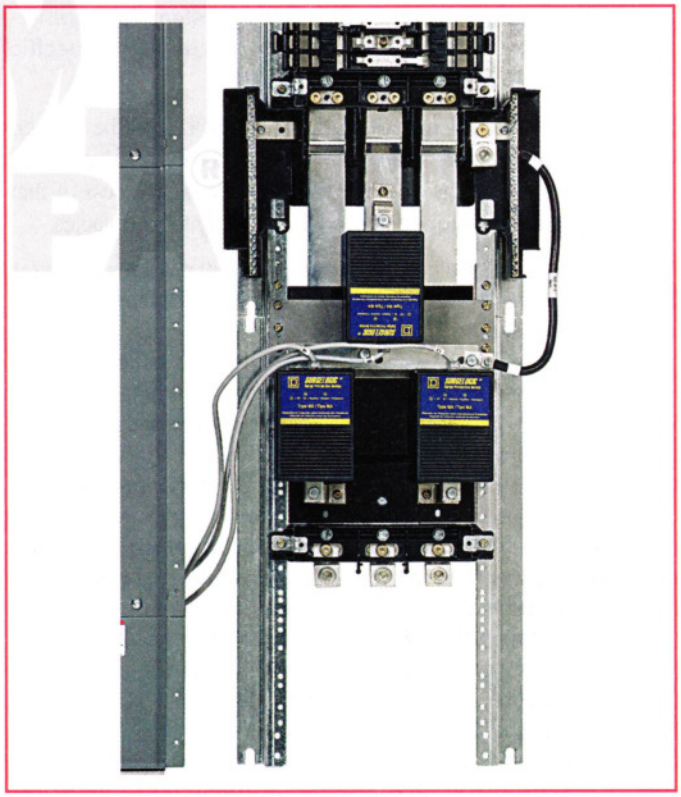

EXHIBIT 242.3 A Type 2 SPD mounted as an integral component of a panelboard, which minimizes conductor length between the electrical system and the SPD. *(Courtesy of Schneider Electric)*

ungrounded conductor(s), grounded conductor, equipment grounding conductor, or grounding electrode conductor. The grounded conductor and the equipment grounding conductor shall be interconnected only by the normal operation of the SPD during a surge.

242.32 Grounding Electrode Conductor Connections and Enclosures. Except as indicated in this article, SPD grounding connections shall be made as specified in Article 250, Part III. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

Part III. Surge Arresters, Over 1000 Volts

Voltage surges with peaks of several thousand volts, even on 120-volt circuits, are not uncommon. Surges occur because of induced voltages in power and transmission lines resulting from lightning strikes in the vicinity of the line. Surges also occur as a result of switching inductive circuits. The standard on surge arresters is IEEE C62.11, *Standard for Metal-Oxide Surge Arresters for Alternating-Current Power Circuits (>1 kV)*.

242.40 Uses Not Permitted. A surge arrester shall not be installed where the rating of the surge arrester is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application.

242.42 Surge Arrester Rating. The duty cycle rating of a surge arrester shall be not less than 125 percent of the maximum continuous operating voltage available at the point of application.

For solidly grounded systems, the maximum continuous operating voltage shall be the phase-to-ground voltage of the system.

For impedance or ungrounded systems, the maximum continuous operating voltage shall be the phase-to-phase voltage of the system.

Informational Note No. 1: See IEEE C62.11-2020, *Standard for Metal-Oxide Surge Arresters for Alternating-Current Power Circuits (>1 kV)*, and IEEE C62.22-2009, *Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems*, for further information on surge arresters.

Informational Note No. 2: The selection of a properly rated metal oxide arrester is based on considerations of maximum continuous operating voltage and the magnitude and duration of overvoltages at the arrester location as affected by phase-to-ground faults, system grounding techniques, switching surges, and other causes. See the manufacturer's application rules for selection of the specific arrester to be used at a particular location.

242.44 Number Required. Where used at a point on a circuit, a surge arrester shall be connected to each ungrounded conductor. A single installation of such surge arresters shall be permitted to protect a number of interconnected circuits if no circuit is exposed to surges while disconnected from the surge arresters.

242.46 Location. Surge arresters shall be permitted to be located indoors or outdoors. Surge arresters shall be made inaccessible to unqualified persons unless listed for installation in accessible locations.

Maximum protection is achieved where the SPD is located as close as practicable to the equipment being protected. When a surge passes through an arrester, a wave is reflected in both directions on the conductors connected to the surge arrester. The magnitude of the reflected wave increases as the distance from the arrester increases. If the length of the conductor between the protected equipment and the surge arrester is short, the magnitude of the wave reflected through the equipment is minimized.

242.48 Routing of Surge Arrester Equipment Grounding Conductors. The conductor used to connect the surge arrester to line, bus, or equipment and to an equipment grounding conductor or grounding electrode connection point as provided in 242.50 shall not be any longer than necessary and shall avoid unnecessary bends.

242.50 Connection. The arrester shall be connected to one of the following:

(1) Grounded service conductor
(2) Grounding electrode conductor
(3) Grounding electrode for the service
(4) Equipment grounding terminal in the service equipment

242.52 Surge-Arrester Conductors. The conductor between the surge arrester and the line, and the surge arrester and the grounding connection, shall not be smaller than 6 AWG copper or aluminum.

242.54 Interconnections. The surge arrester protecting a transformer that supplies a secondary distribution system shall be interconnected as specified in 242.54(A), (B), or (C).

(A) Metal Interconnections. A metal interconnection shall be made to the secondary grounded circuit conductor or the secondary circuit grounding electrode conductor, if, in addition to the direct grounding connection at the surge arrester, the connection complies with 242.54(A)(1) or (A)(2).

(1) Additional Grounding Connection. The grounded conductor of the secondary has a grounding connection elsewhere to a continuous metal underground water piping system. In urban water-pipe areas where there are at least four water-pipe connections on the neutral conductor and not fewer than four such connections in each mile of neutral conductor, the metal interconnection shall be permitted to be made to the secondary neutral conductor with omission of the direct grounding connection at the surge arrester.