of liquid or gas or vapor fails or the pressure is reduced to atmospheric

Totally enclosed motors of the types specified in 501.125(A)(2) or (A)(3) shall have no external surface with an operating temperature in degrees Celsius in excess of 80 percent of the autoignition temperature of the gas or vapor involved. Appropriate devices shall be provided to detect and automatically de-energize the motor or provide an adequate alarm if there is any increase in temperature of the motor beyond designed limits. Auxiliary equipment shall be of a type identified for the location in which it is installed.

Δ **(B) Class I, Division 2.** In Class I, Division 2 locations, motors, generators, and other rotating electrical machinery shall comply with (1), (2), or (3). They shall also comply with (4) and (5), if applicable.

Motors with arcing devices, such as commutators, are required to be provided with an enclosure identified for the location, such as an explosionproof enclosure. Other motor types without arcing devices, such as a squirrel-cage induction motor, are permitted without special enclosures. Additionally, indication of the maximum temperature present in a motor is critical to proper installation. Many motor heaters are de-energized automatically when the motor is running. However, the heater ratings usually are low compared with the normal heat generated during motor operation. Unless otherwise indicated on the motor wiring diagram or in instructions provided with the motor, there is no need to de-energize the heater except to save energy. The heater temperature must be marked on the motor, or the heater must be identified for the location.

(1) Be identified for Class I, Division 2 locations, or
(2) Be identified for Class I, Division 1 locations where sliding contacts, centrifugal or other types of switching mechanism (including motor overcurrent, overloading, and overtemperature devices), or integral resistance devices, either while starting or while running, are employed, or
(3) Be open or nonexplosionproof enclosed motors, such as squirrel-cage induction motors without brushes, switching mechanisms, or similar arc-producing devices that are not identified for use in a Class I, Division 2 location.
(4) The exposed surface of space heaters used to prevent condensation of moisture during shutdown periods shall not exceed 80 percent of the autoignition temperature in degrees Celsius of the gas or vapor involved when operated at rated voltage, and the maximum space heater surface temperature [based on a 40°C or higher marked ambient] shall be permanently marked on a visible nameplate mounted on the motor. Otherwise, space heaters shall be identified for Class I, Division 2 locations.
(5) A sliding contact shaft bonding device used for the purpose of maintaining the rotor at ground potential, shall be permitted where the potential discharge energy is determined to be nonincendive for the application. The shaft bonding device shall be permitted to be installed on the inside or the outside of the motor.

Informational Note No. 1: It is important to consider the temperature of internal and external surfaces that might be exposed to the flammable atmosphere.

Informational Note No. 2: It is important to consider the risk of ignition due to currents arcing across discontinuities and overheating of parts in multisection enclosures of large motors and generators. Such motors and generators might need equipotential bonding jumpers across joints in the enclosure and from enclosure to ground. Where the presence of ignitible gases or vapors is suspected, clean-air purging might be needed immediately prior to and during start-up periods.

Informational Note No. 3: See IEEE 1349, *IEEE Guide for the Application of Electric Machines in Zone 2 and Class I, Division 2 Hazardous (Classified) Locations*, for information on the application of rotating electric machines including shaft bonding devices and potential discharge energy calculations.

Informational Note No. 4: See ANSI/UL 122001, *General Requirements for Electrical Ignition Systems for Internal Combustion Engines in Class I, Division 2 or Zone 2, Hazardous (Classified) Locations*, for reciprocating engine–driven generators, compressors, and other equipment installed in Class I, Division 2 locations. Reciprocating engine–driven generators, compressors, and other equipment installed in Class I, Division 2 locations might present a risk of ignition of flammable materials associated with fuel, starting, and compression due to inadvertent release or equipment malfunction by the engine ignition system and controls.

Motor types used where flammable gases or vapors with very low ignition temperatures might be present should be carefully selected. Modern motors with high-temperature insulation systems, such as Class H [180°C (356°F)], could operate close to or above the ignition temperature of the flammable mixture.

Informational Note No. 5: See UL 1836, *Outline of Investigation for Electric Motors and Generators for Use in Class I, Division 2, Class I, Zone 2, Class II, Division 2 and Zone 22 Hazardous (Classified) Locations*, for details of the evaluation process to determine incendivity. Refer to Annex A and Figure A1.

501.130 Luminaires. Luminaires shall comply with 501.130(A) or (B).

(A) Class I, Division 1. In Class I, Division 1 locations, luminaires shall comply with 501.130(A)(1) through (A)(4).

(1) Luminaires. Each luminaire shall be identified as a complete assembly for the Class I, Division 1 location and shall be clearly marked to indicate the maximum wattage of lamps for which it is identified. Luminaires intended for portable use shall be specifically listed as a complete assembly for that use.

(2) Physical Damage. Each luminaire shall be protected against physical damage by a suitable guard or by location.

(3) Pendant Luminaires. Pendant luminaires shall be suspended by and supplied through threaded rigid metal conduit stems or threaded steel intermediate conduit stems, and threaded joints shall be provided with set-screws or other effective means

to prevent loosening. For stems longer than 300 mm (12 in.), permanent and effective bracing against lateral displacement shall be provided at a level not more than 300 mm (12 in.) above the lower end of the stem, or flexibility in the form of a fitting or flexible connector identified for the Class I, Division 1 location shall be provided not more than 300 mm (12 in.) from the point of attachment to the supporting box or fitting.

(4) Supports. Boxes, box assemblies, or fittings used for the support of luminaires shall be identified for Class I locations.

(B) Class I, Division 2. In Class I, Division 2 locations, luminaires shall comply with 501.130(B)(1) through (B)(6).

(1) Luminaires. Where lamps are of a size or type that may, under normal operating conditions, reach surface temperatures exceeding 80 percent of the autoignition temperature in degrees Celsius of the gas or vapor involved, luminaires shall comply with 501.130(A)(1) or shall be of a type that has been tested in order to determine the marked operating temperature or temperature class (T code).

(2) Physical Damage. Luminaires shall be protected from physical damage by suitable guards or by location. Where there is danger that falling sparks or hot metal from lamps or luminaires might ignite localized concentrations of flammable vapors or gases, suitable enclosures or other effective protective means shall be provided.

(3) Pendant Luminaires. Pendant luminaires shall be suspended by threaded rigid metal conduit stems, threaded steel intermediate metal conduit stems, or other approved means. For rigid stems longer than 300 mm (12 in.), permanent and effective bracing against lateral displacement shall be provided at a level not more than 300 mm (12 in.) above the lower end of the stem, or flexibility in the form of an identified fitting or flexible connector shall be provided not more than 300 mm (12 in.) from the point of attachment to the supporting box or fitting.

Δ **(4) Portable Lighting Equipment.** Portable lighting equipment shall comply with 501.130(B)(4)(a) or (B)(4)(b).

(a) Portable lighting equipment shall comply with 501.130(B)(1).

(b) Portable lighting equipment mounted on movable stands and connected by flexible cords in accordance with 501.140 shall be permitted to comply with 501.130(B)(1), where mounted in any position, if it is protected from physical damage in accordance with 501.130(B)(2).

(5) Switches. Switches that are a part of a luminaire or of an individual lampholder shall comply with 501.115(B)(1).

(6) Starting Equipment. Starting and control equipment for electric-discharge lamps shall comply with 501.120(B).

Exception: A thermal protector potted into a thermally protected fluorescent lamp ballast if the luminaire is identified for the location.

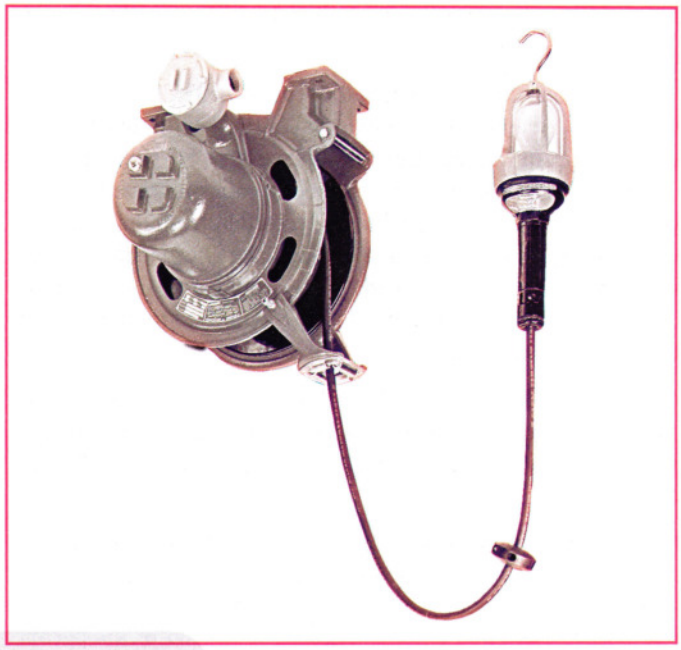

EXHIBIT 501.12 An explosionproof hand lamp for use in Class I locations. *(Courtesy of Appleton™, Emerson Electric Co.)*

Operating temperatures must be considered if the area is a Class I location. Luminaires must be identified for this location and properly marked. Generally, enclosed and gasketed luminaires — without guards, if breakage is unlikely — or luminaires identified for Class I, Division 2 locations are required in Division 2 locations.

Portable luminaires are required to be specifically listed as a complete assembly for use in Class 1, Division 1 or 2 locations. Exhibit 501.12 shows an explosionproof hand lamp. Lamp compartments must be sealed from the terminal compartment. Provisions must be made for the connection of 3-conductor (one must be a grounding conductor) flexible, extra-hard-usage cord in accordance with 501.140(A)(1).

501.135 Utilization Equipment.

(A) Class I, Division 1. In Class I, Division 1 locations, all utilization equipment shall be identified for Class I, Division 1 locations.

(B) Class I, Division 2. In Class I, Division 2 locations, all utilization equipment shall comply with 501.135(B)(1) through (B)(4).

Δ **(1) Heaters.** Electrically heated utilization equipment shall meet one of the following requirements:

(1) The heater shall not exceed 80 percent of the autoignition temperature in degrees Celsius of the gas or vapor involved on any surface that is exposed to the gas or vapor when continuously energized at the maximum rated ambient temperature. If a temperature controller is not provided, these conditions shall apply when the heater is operated at 120 percent of rated voltage.

Exception No. 1 to (1): For motor-mounted anticondensation space heaters, see 501.125.

Exception No. 2 to (1): Where a current-limiting device is applied to the circuit serving the heater to limit the current in the heater to a value less than that required to raise the heater surface temperature to 80 percent of the autoignition temperature.

(2) The heater shall be identified for Class I, Division 1 locations.

Exception to (2): Electrical resistance and skin effect heat tracing identified for Class I, Division 2 locations shall be permitted.

Informational Note No. 1: See ANSI/UL 60079-30-1, *Explosive Atmospheres — Part 30-1: Electrical Resistance Trace Heating — General and Testing Requirements*, for information on electric resistance heat tracing.

Informational Note No. 2: See IEEE 844.1/CSA C22.2 No. 293.1, *IEEE/CSA Standard for Skin Effect Trace Heating of Pipelines, Vessels, Equipment, and Structures — General, Testing, Marking, and Documentation Requirements*, for information on electric skin effect heat tracing.

Informational Note No. 3: See IEEE 844.3/CSA C22.2 No. 293.3, IEEE/CSA *Standard for Impedance Heating of Pipelines and Equipment — General, Testing, Marking, and Documentation Requirements*, for information on electric impedance heating.

(2) Motors. Motors of motor-driven utilization equipment shall comply with 501.125(B).

(3) Switches, Circuit Breakers, and Fuses. Switches, circuit breakers, and fuses shall comply with 501.115(B).

N **(4) Luminaires.** Luminaires shall comply with 501.130(B).

501.140 Flexible Cords, Class I, Divisions 1 and 2.

(A) Permitted Uses. Flexible cord shall be permitted as follows:

(1) For connection between portable lighting equipment or other portable utilization equipment and the fixed portion of their supply circuit. The flexible cord shall be attached to the utilization equipment with a cord connector listed for the protection technique of the equipment wiring compartment. An attachment plug in accordance with 501.140(B)(4) shall be employed.

(2) For that portion of the circuit where the fixed wiring methods of 501.10(A) cannot provide the necessary degree of movement for fixed and mobile electrical utilization equipment, and the flexible cord is protected by location or by a suitable guard from damage and only in a restricted industrial establishment.

(3) For electric submersible pumps with means for removal without entering the wet-pit. The extension of the flexible cord within a suitable raceway between the wet-pit and the power source shall be permitted.

EXHIBIT 501.13 A temporary portable assembly. *(Courtesy of Killark, a division of Hubbell Incorporated)*

(4) For electric mixers intended for travel into and out of open-type mixing tanks or vats.

(5) For temporary portable assemblies consisting of receptacles, switches, and other devices that are not considered portable utilization equipment but are individually listed for the location.

An example of a portable assembly that is not considered utilization equipment is a power cart (see Exhibit 501.13) that provides power during servicing or maintenance. The flexible cord is required to be continuous from the power source to the assembly and from the assembly to the utilization equipment.

(B) Installation. Where flexible cords are used, the cords shall comply with all of the following:

(1) Be of a type listed for extra-hard usage

(2) Contain, in addition to the conductors of the circuit, an equipment grounding conductor complying with 400.23

(3) Be supported by clamps or by other suitable means in such a manner that there is no tension on the terminal connections

(4) In Division 1 locations or in Division 2 locations where the boxes, fittings, or enclosures are required to be explosionproof, the cord shall be terminated with a cord connector or attachment plug listed for the location or a listed cord connector installed with a seal listed for the location. In Division 2 locations where explosionproof equipment is not required, the cord shall be terminated with a listed cord connector or listed attachment plug.

(5) Be of continuous length. Where 501.140(A)(5) is applied, cords shall be of continuous length from the power source to the temporary portable assembly and from the temporary portable assembly to the utilization equipment.

Informational Note: See 501.20 for flexible cords exposed to liquids having a deleterious effect on the conductor insulation.

N **501.141 Flexible Cables, Class I, Division 2.** Flexible cables installed in Class I, Division 2 locations shall comply with 501.141(A) and (B).

N **(A) Permitted Uses.** Flexible cables shall be permitted to be installed in accordance with 501.141(A)(1) and (A)(2).

N **(1) Other Than Nonincendive Field Wiring Applications.** Flexible cables in other than nonincendive field wiring applications shall be permitted in accordance with the following:

(1) Flexible cables shall be permitted to connect two pieces of electrical equipment by means of a cable assembly installed in accordance with 501.141(B)(2)(a) or (B)(2)(b).
(2) Flexible cables shall be permitted to connect a piece of electrical equipment to the premises wiring by means of a cable assembly installed in accordance with 501.141(B)(2)(c).

N **(2) Nonincendive Field Wiring Applications.** Flexible cables in nonincendive field wiring applications shall be permitted to be used in accordance with 501.10(B)(3).

N **(B) Installation.** If flexible cables are used as permitted in 501.141(A), the associated cable assemblies shall comply with 501.141(B)(1) through (B)(3).

N **(1) Cable Types.** Listed Type P cables shall comply with 501.141(A)(1) and shall be installed as required in Part II of Article 337. The associated cable assemblies shall comply with the requirements of 501.141(B)(2).

N **(2) Termination Means.** Terminations shall comply with 501.141(B)(2)(a), (B)(2)(b), or (B)(2)(c).

(a) *Connecting Two Devices or Pieces of Electrical Utilization Equipment Together.* The cable connectors on each end of the cable shall be listed for use in Class I, Division 2 locations and listed for the type of cable being used.

(b) *Connecting Two Devices or Pieces of Electrical Utilization Equipment Together.* A cable connector listed for Class I, Division 2 and listed for the type of cable being used shall be used on one end and a fitting listed for the type of protection and the type of cable being used shall be used on the other end.

(c) *Connecting an Electrical Device or Utilization Equipment to Premises Wiring.* The cable connectors used on both ends shall be listed for Class I, Division 2 locations and for the type of cable being used. On one end of the cable, the cable connector shall also be listed for the type of protection.

N **(3) Disconnection.** Flexible cable shall be installed in accordance with 501.141(B)(3)(a) through (B)(3)(c) to protect against the disconnection of the cable connectors when energized.

(a) *Switch.* A switch complying with the requirements of 501.105(B)(2) shall be provided to disconnect power so that cable connectors are not depended on as a disconnecting means.

(b) *Cable Connectors Mechanically or Electrically Interlocked.* Switches shall not be required where the cable connectors are interlocked mechanically or electrically, or are otherwise designed to ensure the cable connectors cannot be separated when energized and cannot be energized when separated.

(c) *Warning Label.* The fixed equipment and the cable assembly shall both carry a label warning against plugging or unplugging when energized, with both labels as close to the cable connector termination as possible.

501.145 Receptacles and Attachment Plugs, Class I, Division 1 and Division 2. Receptacles and attachment plugs shall be listed for the location, except as permitted by 501.105(B)(6).

(A) Receptacles. Receptacles shall be part of the premises wiring, except as permitted by 501.140(A).

Δ **(B) Attachment Plugs.** Attachment plugs shall be of the type that provides connection to the equipment grounding conductor of a permitted flexible cord.

Exhibit 501.14 shows an explosionproof receptacle and attachment plug with an interlocking switch. The design of this device is such that when the switch is in the "on" position, the plug cannot be removed. Also, the switch cannot be placed in the "on" position when the plug has been removed. The plug is to be used with Type S or equivalent extra-hard-service flexible cord having an EGC.

Exhibit 501.15 shows a 30-ampere, 4-pole receptacle and attachment plug assembly that is suitable for use without a switch. The design is such that the mating parts of the receptacle and plug are enclosed in a chamber that seals the arc and, by delayed-action construction, prevents complete removal of the plug until the arc or hot metal has cooled.

501.150 Signaling, Alarm, Remote-Control, and Communications Systems.

(A) Class I, Division 1. In Class I, Division 1 locations, all apparatus and equipment of signaling, alarm, remote-control, and communications systems, regardless of voltage, shall be

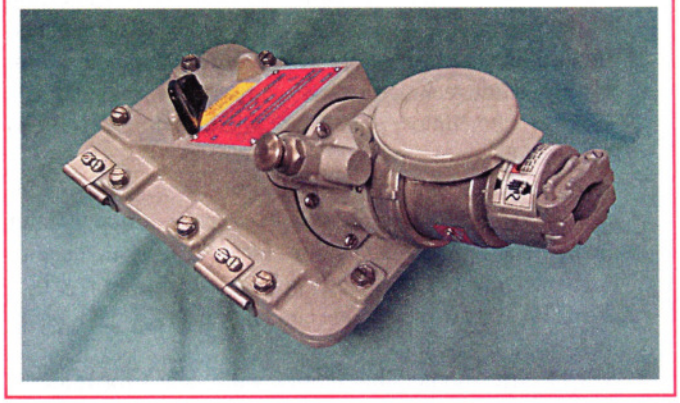

EXHIBIT 501.14 A receptacle and attachment plug of the explosionproof type with an interlocking switch. *(Courtesy of Appleton™, Emerson Electric Co.)*

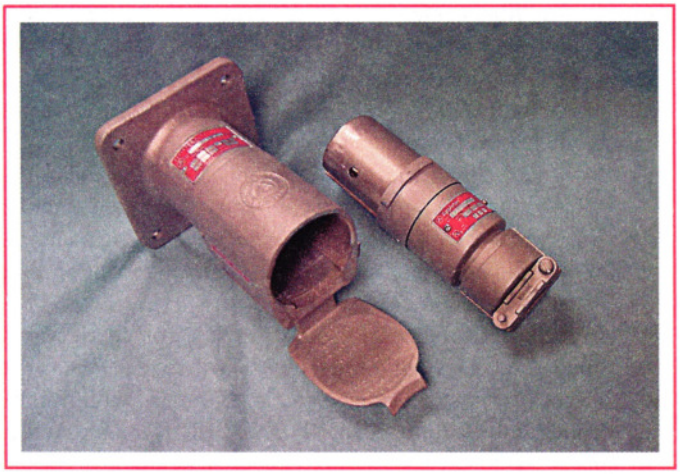

EXHIBIT 501.15 A 4-pole (delayed action) explosionproof receptacle and attachment plug suitable for use without a switch. *(Courtesy of Appleton™, Emerson Electric Co.)*

identified for Class I, Division 1 locations, and all wiring shall comply with 501.10(A), 501.15(A), and 501.15(C).

(B) Class I, Division 2. In Class I, Division 2 locations, signaling, alarm, remote-control, and communications systems shall comply with 501.150(B)(1) through (B)(4).

(1) Contacts. Switches, circuit breakers, and make-and-break contacts of pushbuttons, relays, alarm bells, and horns shall have enclosures identified for Class I, Division 1 locations in accordance with 501.105(A).

Exception: General-purpose enclosures shall be permitted if current-interrupting contacts are one of the following:

(1) Immersed in oil
(2) Enclosed within a chamber hermetically sealed against the entrance of gases or vapors
(3) In nonincendive circuits
(4) Part of a listed nonincendive component

See also

501.105(B)(2) and its commentary regarding arcing contacts and the use of general-purpose enclosures in Class I, Division 2 locations

(2) Resistors and Similar Equipment. Resistors, resistance devices, thermionic tubes, rectifiers, and similar equipment shall comply with 501.105(B)(3).

(3) Protectors. Enclosures shall be provided for lightning protective devices and for fuses. Such enclosures shall be permitted to be of the general-purpose type.

(4) Wiring and Sealing. All wiring shall comply with 501.10(B), 501.15(B), and 501.15(C).

Some audible signaling devices may contain make-and-break contacts that are capable of producing a spark of sufficient energy to cause ignition of a hazardous atmospheric mixture. If used in Class I locations, this type of equipment must be contained in explosionproof or purged and pressurized enclosures, wiring methods must comply with 501.10, and seal fittings must be provided in accordance with 501.15. (See Exhibit 501.16.) Electronic signal devices without make-and-break contacts usually do not require explosionproof enclosures in Division 2 locations.

EXHIBIT 501.16 An audible signaling device for use in hazardous locations. *(Courtesy of Eaton, Crouse-Hinds Division)*

ARTICLE 502

Class II Locations

Part I. General

502.1 Scope. This article covers the requirements for electrical and electronic equipment and wiring for all voltages in Class II, Division 1 and 2 locations where fire or explosion hazards may exist due to combustible dust.

Class II, Division 1 and 2 locations are defined in 500.5(C) as "hazardous because of the presence of combustible dust." Two different types of dust environments typically warrant a Class II, Division 1 area classification. The first is where a cloud of combustible dust is likely to be present continuously or intermittently under normal operating conditions or because of repair or maintenance operations or leakage. The other environment is one in which a dust layer is likely to accumulate to a depth greater than 1/8 inch on major horizontal surfaces over a defined period of time, usually 24 hours. A Class II, Division 2 location is typically one where these conditions exist infrequently or under abnormal conditions.

NFPA 484, *Standard for Combustible Metals*, provides methods to minimize the occurrence of, and resulting damage from, fire or explosion in areas where combustible metals or metal dusts are produced, processed, finished, handled, stored, and used.

502.5 Explosionproof Equipment. Explosionproof equipment and wiring shall not be required and shall not be acceptable in Class II locations unless also identified for such locations.