

Chapter E 501

CLASS I INSTALLATIONS; HAZARDOUS LOCATIONS

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Note: Where conduit is threaded in the field, it is assumed that a standard conduit cutting die providing $\frac{3}{4}$ inch taper per foot will be employed.

E 501.01 General. The general rules of this code shall apply to the installation of electrical wiring and equipment in locations classified as class I under section E 500.04 except as modified by this chapter.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.02 Transformers and capacitors. The installation of transformers and capacitors shall conform to the following:

(1) **CLASS I, DIVISION 1.** In class I, division 1 locations, transformers and capacitors shall conform to the following:

(a) *Containing a liquid that will burn.* Transformers and capacitors containing a liquid that will burn shall be installed only in approved vaults, which shall conform to sections E 450.41 to E 450.48 inclusive, and in addition, 1. there shall be no door or other communicating opening between the vault and the hazardous area, 2. ample ventilation shall be provided for the continuous removal of hazardous gases or vapor, 3. vent openings or ducts shall lead to a safe location outside of buildings, and 4. vent ducts and openings shall be of sufficient area to relieve explosion pressures within the vault, and all portions of vent ducts within the buildings shall be of reinforced concrete construction.

(b) *Not containing a liquid that will burn.* Transformers and capacitors which do not contain a liquid that will burn shall 1. be installed in vaults conforming to the requirements of subsection E 501.02 (1) (a), or 2. be approved for class I locations (explosion-proof).

(2) **CLASS I, DIVISION 2.** In class I, division 2 locations, transformers and capacitors shall conform to sections E 450.21 to E 450.25 inclusive.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.03 Meters, instruments and relays. The installation of meters, instruments and relays shall conform to the following:

(1) **CLASS I, DIVISION 1.** In class I, division 1 locations, meters, instruments and relays, including kilowatt-hour meters, instrument transformers and resistors, rectifiers and thermionic tubes, shall be provided with enclosures approved for class I locations.

(2) **CLASS I, DIVISION 2.** In class I, division 2 locations, meters, instruments and relays shall conform to the following:

(a) *Contacts.* Switches and circuit-breakers, and make and break contacts of push buttons, relays, and alarm bells or horns, shall have enclosures approved for class I locations, unless general purpose enclosures are provided, and current interrupting contacts are 1. immersed in oil, 2. enclosed within a chamber hermetically sealed against the entrance of gases or vapors, or 3. in circuits which under normal conditions do not release sufficient energy to ignite a specific hazardous atmospheric mixture.

(b) *Resistors and similar equipment.* Resistors, resistance devices, thermionic tubes, and rectifiers, which are used in or in connection with meters, instruments and relays, shall conform to section E 501.03 (1), except that enclosures may be of general purpose type when such equipment is without make and break or sliding contacts other than as provided in subsection (2) (a) above) and when the maximum operating temperature of any exposed surface will not exceed 80% of the ignition temperature in degrees Centigrade of the gas or vapor involved as determined by approved test procedures.

(c) *Without make or break contacts.* Transformer windings, impedance coils, solenoids, and other windings which do not incorporate sliding or make or break contacts shall be provided with enclosures which may be of general purpose type where vents adequate to permit prompt escape of any gases or vapors are provided.

(d) *General purpose assemblies.* Where an assembly is made up of components for which general purpose enclosures are acceptable under sections E 501.03 (2) (a) (b) (c), a single general purpose enclosure is acceptable for the assembly. Where such an assembly includes any of the equipment described in section E 501.03 (2) (b) the maximum obtainable surface temperature of any component of the assembly shall be clearly and permanently indicated on the outside of the enclosure.

(e) *Fuses.* Where general purpose enclosures are permitted under subsections (2) (a), (b), (c), (d), fuses for overcurrent protection of the instrument circuits may be mounted in general purpose enclosures provided such fuses do not exceed 3 ampere rating in 120 volts and provided each such fuse is preceded by a switch conforming to subsection (2) (a).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.04 Wiring methods. Wiring methods shall conform to the following:

(1) **CLASS I, DIVISION 1.** In class I, division 1 locations, threaded rigid metal conduit or type MI cable with termination fittings approved for the location shall be the wiring method employed. All boxes, fittings, and joints shall be threaded for connection to conduit

or cable terminations, and shall be explosion-proof. Threaded joints shall be made up with at least 5 threads fully engaged. Type MI cable shall be installed and supported in a manner to avoid tensile stress at the termination fittings. Where necessary to employ flexible connections, as at motor terminals, flexible fittings approved for class I locations (explosion-proof) shall be used.

(2) CLASS I, DIVISION 2. In class 1 division 2 locations, threaded rigid metal conduit or type MI cable with termination fittings approved for class I locations, or approved type MC or ALS cable with termination fittings approved for class I locations shall be the wiring method employed. Type MI, MC or ALS cable shall be installed in a manner to avoid tensile stress at the termination fittings. Boxes, fittings and joints need not be explosion proof except as required by sections E 501.05 (2) (a) and (b). Where provision must be made for limited flexibility, as at motor terminals, flexible metal fittings, flexible metal conduit with approved fittings, or flexible cord approved for extra hard usage and provided with approved bushed fittings shall be used. An additional conductor for grounding shall be included in the flexible cord unless other acceptable means of grounding are provided.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.05 Sealing and drainage. Seals are provided in conduit and cable systems to prevent the passage of gases, vapors or flames from one portion of the electrical installation to another through the conduit. Such communication through type MI cable is inherently prevented by construction of the cable, but sealing compound is used in cable termination fittings to exclude moisture and other fluids from the cable insulation, and shall be of a type approved for the conditions of use. Seals in conduit and cable systems shall conform to the following:

(1) CLASS I, DIVISION 1. In class I, division 1 locations, seals shall be located as follows:

(a) In each conduit run entering an enclosure for switches, circuit-breakers, fuses, relays, resistors or other apparatus which may produce arcs, sparks or high temperatures. Seals shall be placed as close as practicable and in no case more than 18 inches from such enclosures.

(b) In each conduit run of 2-inch size or larger entering the enclosure or fitting housing terminals, splices or taps, and within 18 inches of such enclosure or fitting.

Note: Where 2 or more enclosures for which seals are required under sections E 501.05 (1) (a) (b) are connected by nipples or by runs of conduit not more than 36 inches long, a single seal in each such nipple connection or run of conduit would be sufficient if located not more than 18 inches from either enclosure. Ordinary conduit fittings of the "L", "T" or "Cross" type would not usually be classed as enclosures when not larger than the trade size of the conduit.

(c) In each conduit run leaving the class I, division 1 hazardous area. The sealing fitting may be located on either side of the boundary of such hazardous area, but shall be so designed and installed that any gases or vapors which may enter the conduit system, within the division 1 hazardous area, will not enter or be communicated to the conduit beyond the seal. There shall be no union, coupling, box or fitting

in the conduit between the sealing fitting and the point at which the conduit leaves the division 1 hazardous area.

(2) **CLASS I, DIVISION 2.** In class I, division 2 locations, seals shall be located as follows:

(a) For conduit connections to enclosures which are required to be approved for class I locations, seals shall be provided in conformance to subsections (1) (a) (b). All portions of the conduit run or nipple between the seal and such enclosure shall conform to section E 501.04 (1).

(b) In each conduit run passing from the class I, division 2 hazardous area into a non-hazardous area. The sealing fitting may be located on either side of the boundary of such hazardous area, but shall be so designed and installed that any gases or vapors which may enter the conduit system, within the division 2 hazardous area, will not enter or be communicated to the conduit beyond the seal. Rigid conduit shall be used between the sealing fitting and the point at which the conduit leaves the hazardous area, and a threaded connection shall be used at the sealing fitting. There shall be no union, coupling, box or fitting in the conduit between the sealing fitting and the point at which the conduit leaves the hazardous area.

(3) **CLASS I, DIVISIONS 1 AND 2.** Where seals are required, they shall conform to the following:

(a) *Fittings.* Enclosures for connections or for equipment shall be provided with approved integral means for sealing, or sealing fittings approved for class I locations shall be used. Sealing fittings shall be accessible.

(b) *Compound.* Sealing compound shall be approved for the purpose, shall not be affected by the surrounding atmosphere or liquids, and shall not have a melting point of less than 93°C. (200°F.).

(c) *Thickness of compound.* In the completed seal, the minimum thickness of the sealing compound shall be not less than the trade size of the conduit, and in no case less than 5/8 inch.

(d) *Splices and taps.* Splices and taps shall not be made in fittings intended only for sealing with compound, nor shall other fittings in which splices or taps are made be filled with compound.

(e) *Assemblies.* In an assembly where equipment which may produce arcs, sparks or high temperatures is located in a compartment separate from the compartment containing splices or taps, and an integral seal is provided where conductors pass from one compartment to the other, the entire assembly shall be approved for class I locations. Seals in conduit connections to the compartment containing splices or taps shall be provided in class I, division 1, locations where required by subsection (1) (b).

(4) **DRAINAGE.** (a) *Control equipment.* Where there is probability that liquid or other condensed vapor may be trapped within enclosures for control equipment or at any point in the raceway system, approved means shall be provided to prevent accumulation or to permit periodic draining of such liquid or condensed vapor.

(b) *Motors and generators.* Where the authority enforcing this code judges that there is probability that liquid or condensed vapor may accumulate within motors or generators, joints and conduit

systems shall be arranged to minimize entrance of liquid. If means to prevent accumulation or to permit periodic draining are judged necessary, such means shall be provided at the time of manufacture, and shall be deemed an integral part of the machine.

(c) *Canned pumps, etc.* Canned pumps, process connections for flow, pressure or analysis measurement, etc., frequently depend upon a single seal diaphragm or tube to prevent process fluids from entering the electrical conduit system. An additional approved seal or barrier shall be provided with an adequate drain between the seals in such a manner that leaks would be obvious.

Note: See section E 500.04 (3).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.06 Switches, circuit-breakers, motor controllers and fuses. Switches, circuit-breakers, motor controllers and fuses shall conform to the following:

(1) **CLASS I, DIVISION 1.** In class I, division 1 locations, switches, circuit-breakers, motor controllers and fuses, including push buttons, relays and similar devices, shall be provided with enclosures, and the enclosure in each case together with the enclosed apparatus shall be approved as a complete assembly for use in class I locations.

(2) **CLASS I, DIVISION 2.** Switches, circuit-breakers, motor controllers and fuses in class I, division 2 locations shall conform to the following:

(a) *Type required.* Circuit-breakers, motor controllers and switches intended to interrupt current in the normal performance of the function for which they are installed shall be provided with enclosures approved for class I locations, unless general purpose enclosures are provided and 1. the interruption of current occurs within a chamber hermetically sealed against the entrance of gases and vapors, or 2. the current interrupting contacts are oil-immersed and the device is approved for locations of this class and division.

Note: This includes service and branch circuit switches and circuit-breakers; motor controllers, including push-buttons, pilot switches, relays and motor-overload protective devices; and switches and circuit-breakers for the control of lighting and appliance circuits. Oil-immersed circuit-breakers and controllers of ordinary general use type may not confine completely the arc produced in the interruption of heavy overloads, and specific approval for locations of this class and division is therefore necessary.

(b) *Isolating switches.* Enclosures for disconnecting and isolating switches without fuses and which are not intended to interrupt current may be of general purpose type.

(c) *Fuses.* For the protection of motors, appliances and lamps, except as provided in subsection (2) (d), 1. standard plug or cartridge fuse may be used provided they are placed within enclosures approved for the purpose and for the location, or 2. fuses of a type in which the operating element is immersed in oil or other approved liquid, or is enclosed within a chamber hermetically sealed against the entrance of gases and vapors may be used provided they are approved for the purpose and are placed within general purpose enclosures.

(d) *Fuses or circuit-breakers for overcurrent protection.* When not more than 10 sets of approved enclosed fuses, or not more than 10 circuit-breakers which are not intended to be used as switches for the

interruption of current, are installed for branch or feeder circuit protection in any one room, area or section of this class and division, the enclosures for such fuses or circuit-breakers may be of general purpose type, provided the fuses or circuit-breakers are for the protection of circuits or feeders supplying lamps in fixed positions only.

Note: A set of fuses is construed to mean a group containing as many fuses as are required to perform a single protective function in a circuit. For example, a group of 3 fuses protecting an ungrounded 3-phase circuit, and a single fuse protecting the ungrounded conductor of an identified 2-wire single-phase circuit, would each be considered as a set of fuses. Fuses conforming to section E 501.06 (2) (c) need not be included in counting the 10 sets of fuses permitted in general purpose enclosures.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.07 Control transformers and resistors. Transformers, impedance coils and resistors used as or in conjunction with control equipment for motors, generators and appliances shall conform to the following:

(1) **CLASS I, DIVISION 1.** In class I, division 1 locations, transformers, impedance coils and resistors, together with any switching mechanism associated with them, shall be provided with enclosures approved for class I locations (explosion-proof).

(2) **CLASS I, DIVISION 2.** In class I, division 2 locations control transformers and resistors shall conform to the following:

(a) *Switching mechanisms.* Switching mechanisms used in conjunction with transformers, impedance coils and resistors shall conform to section E 501.06 (2).

(b) *Coils and windings.* Enclosures for windings of transformers, solenoids or impedance coils may be of general purpose type, but shall be provided with vents adequate to permit prompt escape of gases or vapors that may enter the enclosure.

(c) *Resistors.* Resistors shall be provided with enclosures and the assembly shall be approved for class I locations, unless resistance is non-variable and maximum operating temperature, in degrees Centigrade, will not exceed 80% of the ignition temperature of the gas or vapor involved as determined by approved test procedures.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.08 Motors and generators. Motors and generators shall conform to the following:

(1) **CLASS I, DIVISION 1.** In class I, division 1 locations, motors, generators and other rotating electrical machinery shall be (a) approved for class I locations (explosion-proof), or (b) of the totally-enclosed type supplied with positive-pressure ventilation from a source of clean air with discharge to a safe area, so arranged to prevent energizing of the machine until ventilation has been established and the enclosure has been purged with at least 10 volumes of air, and also arranged to automatically de-energize the equipment when the air supply fails, or (c) of the totally-enclosed inert-gas-filled type supplied with a suitable reliable source of inert gas for pressuring the enclosure, with devices provided to insure a positive pressure in the enclosure, and arranged to automatically de-energize the equipment when the gas supply fails. Totally-enclosed motors of types (b) or (c) shall have no external surface with an operating tem-

perature in degrees centigrade in excess of eighty per cent (80%) of the ignition temperature of the gas or vapor involved, as determined by ASTM test procedure (Designation: D-286-30). Appropriate devices shall also be provided to detect any increase in temperature of the motor beyond design limits and automatically de-energize the equipment. Auxiliary equipment shall be of a type approved for the location in which it is installed.

(2) **CLASS I, DIVISION 2.** In class I, division 2 locations, motors, generators and other rotating electrical machinery in which are employed sliding contacts, centrifugal or other types of switching mechanism (including motor overcurrent devices), or integral resistance devices, either while starting or while running, shall be approved for class I locations (explosion-proof), unless such sliding contacts, switching mechanisms and resistance devices are provided with enclosures approved for such locations.

Note: This rule does not prohibit installation of open or non-explosion-proof enclosed motors, such as squirrel-cage induction motors, without brushes, switching mechanism, etc., in class I, division 2 locations.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.09 Lighting fixtures. Lamps shall be installed in fixtures which shall conform to the following:

(1) **CLASS I, DIVISION 1.** In class I, division 1 locations, lighting fixtures shall conform to the following:

(a) *Approved fixtures.* Each fixture shall be approved as a complete assembly for locations of this class, and shall be clearly marked to indicate the maximum wattage of lamps for which it is approved. Fixtures intended for portable use shall be specifically approved as a complete assembly for that use.

(b) *Physical damage.* Each fixture shall be protected against physical damage by a suitable guard or by location.

(c) *Pendent fixtures.* Pendent fixtures shall be suspended by and supplied through threaded rigid conduit stems and threaded joints shall be provided with set-screws or other effective means to prevent loosening. For stems longer than 12 inches, permanent and effective bracing against lateral displacement shall be provided at a level not more than 12 inches above the lower end of the stem, or flexibility in the form of a fitting or flexible connector approved for the purpose and for the location shall be provided not more than 12 inches from the point of attachment to the supporting box or fitting.

(d) *Supports.* Boxes, box assemblies or fittings used for the support of lighting fixtures shall be approved for the purpose and for class I locations.

(2) **CLASS I, DIVISION 2.** In class I, division 2 locations lighting fixtures shall conform to the following:

(a) *Portable lamps.* Portable lamps shall conform to section E 501.09 (1) (a).

(b) *Fixed lighting.* Lighting fixtures for fixed lighting 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 fixtures might ignite localized concentrations of flammable vapors

or gases, suitable enclosures or other effective protective means shall be provided. Where lamps are of a size or type which may, under normal operating conditions, reach surface temperatures exceeding 80% of the ignition temperature in degrees Centigrade of the gas or vapor involved, as determined by approved test procedures fixtures shall conform to subsection (1) (a).

(c) *Pendent fixtures.* Pendent fixtures shall be suspended by threaded rigid conduit stems or by other approved means. For rigid stems longer than 12 inches, permanent and effective bracing against lateral displacement shall be provided at a level not more than 12 inches above the lower end of the stem, or flexibility in the form of a fitting or flexible connector approved for the purpose shall be provided not more than 12 inches from the point of attachment to the supporting box or fitting.

(d) *Supports.* Boxes, box assemblies, or fittings used for the support of lighting fixtures shall be approved for the purpose.

(e) *Switches.* Switches which are a part of an assembled fixture or of an individual lampholder shall conform to the requirements of section E 501.06 (2) (a).

(f) *Starting equipment.* Starting and control equipment for mercury-vapor and fluorescent lamps shall conform to the requirements of subsection E 501.07 (2).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.10 Utilization equipment, fixed and portable. Utilization equipment, fixed and portable, shall conform to the following:

(1) **CLASS I, DIVISION 1.** In class I, division 1 locations, utilization equipment, including electrically-heated and motor-driven equipment shall be approved for class I locations.

(2) **CLASS I, DIVISION 2.** In class I, division 2 locations, utilization equipment, fixed and portable, shall conform to the following:

(a) *Heaters.* Electrically-heated utilization equipment shall be approved for class I locations.

(b) *Motors.* Motors of motor-driven utilization equipment shall conform to section E 501.08 (2).

(c) *Switches, circuit-breakers, and fuses.* Switches, circuit-breakers and fuses shall conform to section E 501.06 (2).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.11 Flexible cords, class I, divisions 1 and 2. A flexible cord may be used only for connection between a portable lamp or other portable utilization equipment and the fixed portion of its supply circuit and where used shall (1) be of a type approved for extra hard usage, (2) contain, in addition to the conductors of the circuit, a grounding conductor conforming to section E 400.13, (3) be connected to terminals or to supply conductors in an approved manner, (4) be supported by clamps or by other suitable means in such a manner that there will be no tension on the terminal connections, and (5) suitable seals shall be provided where the flexible cord enters boxes, fittings or enclosures of explosion-proof type.

Note: Refer to section E 501.13 when flexible cords are exposed to liquids having a deleterious effect on the conductor insulation.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.12 Receptacles and attachment plugs, class I, divisions 1 and 2. Receptacles and attachment plugs shall be of the type providing for connection to the grounding conductor of the flexible cord, and shall be approved for class I locations.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.13 Conductor insulation class I, divisions 1 and 2. Where condensed vapors or liquids may collect on or come in contact with the insulation on conductors, such insulation shall be of a type approved for use under such conditions or the insulation shall be protected by a sheath of lead or by other approved means.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.14 Signal, alarm, remote-control and communication systems. Signal, alarm, remote-control and communication systems shall conform to the following:

(1) **CLASS I, DIVISION 1.** In class I, division 1 locations, all apparatus and equipment of signalling, alarm, remote-control and communication systems, irrespective of voltage, shall be approved for class I locations, and all wiring shall conform to sections E 501.04 (1) and E 501.05 (1) and (3).

(2) **CLASS I, DIVISION 2.** In class I, division 2 locations, signal, alarm, remote-control and communication systems shall conform to the following:

(a) **Contacts.** Switches and circuit breakers, and make and break contacts of push buttons, relays, and alarm bells or horns, shall have enclosures approved for class I locations, unless general purpose enclosures are provided and current interrupting contacts are 1. immersed in oil, or 2. enclosed within a chamber hermetically sealed against the entrance of gases or vapors, or 3. in circuits which under normal conditions do not release sufficient energy to ignite a specific hazardous atmospheric mixture.

(b) **Resistors and similar equipment.** Resistors, resistance devices, thermionic tubes and rectifiers shall conform to section E 501.03 (2) (b).

(c) **Protectors.** Enclosures which may be of general purpose type shall be provided for lightning protective devices and for fuses.

(d) All wiring shall conform to sections E 501.04 (2) and E 501.05 (2) and (3).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.15 Live parts, class I, divisions 1 and 2. There shall be no exposed live parts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.16 Grounding, class I, divisions 1 and 2. Wiring and equipment shall be grounded in conformity with the following:

(1) **EXPOSED PARTS.** The exposed non-current-carrying metal parts of equipment such as the frames or metal exteriors of motors, fixed or portable lamps or other utilization equipment, lighting fixtures, cabinets, cases, and conduit, shall be grounded as specified in Wis. Adm. Code chapter E 250.

(2) **BONDING.** The locknut-bushing and double-locknut types of contacts shall not be depended upon for bonding purposes, but bonding jumpers with proper fittings or other approved means shall be used. Such means of bonding shall apply to all intervening raceways, fittings, boxes, enclosures, etc. between hazardous areas and the point of grounding for service equipment. Where flexible conduit is used as permitted in section E 501.04 (2), bonding jumpers with proper fittings shall be provided around such conduit.

(3) **LIGHTNING PROTECTION.** Each ungrounded service conductor of a wiring system in a class I location, when supplied from an overhead line in an area where lightning disturbances are prevalent, shall be protected by a lightning protective device of proper type. Lightning protective devices shall be connected to the service conductors on the supply side of the service disconnecting means, and shall be bonded to the raceway system at the service entrance.

Note: Also refer to section E 502.03.

(4) **GROUNDING SERVICE CONDUCTOR BONDED TO RACEWAY.** Wiring in a class I location, when supplied from a grounded alternating current supply system in which a grounded conductor is a part of the service, shall have the grounded service conductor bonded to the raceway system and to the grounding conductor for the raceway system. The bonding connection to the grounded service conductor shall be made on the supply side of the service disconnecting means.

(5) **TRANSFORMER GROUND BONDED TO RACEWAY.** Wiring in a class I location, when supplied from a grounded alternating current supply system in which no grounded conductor is a part of the service, shall be provided with a metallic connection between the supply system ground and the raceway system at the service entrance. The metallic connection shall have ampacity not less than 1/5 that of the service conductors, and shall in no case be smaller than No. 10 when of soft copper, or No. 12 when of medium or hard-drawn copper.

(6) **MULTIPLE GROUNDS.** Where, in the application of section E 250.021, it is necessary to abandon one or more grounding connections to avoid objectionable passage of current over the grounding conductors, the connection required in subsections (4) and (5) shall not be abandoned while any other grounding connection remains connected to the supply system.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.