

## Chapter E 502

## CLASS II INSTALLATIONS; HAZARDOUS LOCATIONS

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**E 502.01 General.** (1) The general rules of this code shall apply to the installation of electrical wiring and apparatus in locations classified as class II under section E 500.05 except as modified by this chapter.

(2) "Dust-ignition-proof", as used in this chapter, shall mean enclosed in a manner which will exclude ignitable amounts of dust or amounts which might affect performance or rating and which, when installation and protection are in conformance with this code, will not permit arcs, sparks or heat otherwise generated or liberated inside of the enclosure, to cause ignition of exterior accumulations or atmospheric suspensions of a specified dust on or in the vicinity of the enclosure.

(3) Equipment installed in class II locations shall be able to function at full rating without developing surface temperatures high enough to cause excessive dehydration or gradual carbonization of any organic dust deposits that may occur. Dust which is carbonized or is excessively dry is highly susceptible to spontaneous ignition. In general, maximum surface temperatures under actual operating conditions shall not exceed 165° C. (329° F.) for equipment which is not subject to overloading, and 120° C (248° F.) for equipment such as motors, power transformers, etc., which may be overloaded.

*Note:* Equipment and wiring of the type defined in chapter E 100 as explosion-proof is not required in class II locations, and may not be acceptable unless approved for such locations.

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

**E 502.02 Transformers and capacitors.** The installation of transformers and capacitors shall conform to the following:

(1) **CLASS II, DIVISION 1.** In class II, 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 conforming to sections E 450.41 to E 450.48 inclusive, and in addition 1. doors or other openings communicating with the hazardous area shall have self-closing fire doors on both sides of the wall, and

the doors shall be carefully fitted and provided with suitable seals (such as weather stripping) to minimize the entrance of dust into the vault, 2. vent openings and ducts shall communicate only with the outside air, and 3. suitable pressure-relief openings communicating with the outside air shall be provided.

(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 sections E 450.41 to E 450.48 inclusive, or 2. be approved as a complete assembly including terminal connections for class II locations.

(c) *Metal dusts.* No transformer or capacitor shall be installed in a location where dust from magnesium, aluminum, aluminum bronze powders, or other metals of similarly hazardous characteristics may be present.

(2) **CLASS II, DIVISION 2.** In class II, division 2 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 in vaults conforming to sections E 450.41 to E 450.48 inclusive.

(b) *Containing askarel.* Transformers containing askarel and rated in excess of 25 kva shall 1. be provided with pressure-relief vents, 2. be provided with means for absorbing any gases generated by arcing inside the case, or the pressure-relief vents shall be connected to a chimney or flue which will carry such gases outside the building and 3. have an air space of not less than 6 inches between the transformer cases and any adjacent combustible material.

(c) *Dry-type transformers.* Dry-type transformers shall be installed in vaults or shall 1. have their windings and terminal connections enclosed in tight metal housings without ventilating or other openings, and 2. operate at voltages not exceeding 600 volts.

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

**E 502.03 Surge protection, class II, divisions 1 and 2.** In geographical locations where lightning disturbances are prevalent, wiring systems in class II locations shall, when supplied from overhead lines, be suitably protected against high-voltage surges. This protection shall include suitable lightning protective devices, interconnection of all grounds, and surge-protective capacitors.

(1) Interconnection of all grounds shall include grounds for primary and secondary lightning protective devices, secondary system grounds if any, and grounds of conduit and equipment of the interior wiring system. For ungrounded secondary systems, secondary lightning protective devices may be provided both at the service and at the point where the secondary system receives its supply, and the intervening secondary conductors may be accepted as the metallic connection between the secondary protective devices, provided grounds for the primary and secondary devices are metallically interconnected at the supply end of the secondary system and the secondary devices are grounded to the raceway system at the load end of the secondary system.

(2) Surge protective capacitors shall be of a type especially designed for the duty, shall be connected to each ungrounded service

conductor, and shall be grounded to the interior conduit system. Capacitors shall be protected by 30-ampere fuses of suitable type and voltage rating, or by automatic circuit-breakers of suitable type and rating and shall be connected to the supply conductors on the supply side of the service disconnecting means.

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

**E 502.04 Wiring methods.** Wiring methods shall conform to the following:

(1) **CLASS II, DIVISION 1.** In class II, division 1 locations, threaded rigid metal conduit or type MI cable with termination fittings approved for the location shall be the wiring method employed. Type MI cable shall be installed and supported in a manner to avoid tensile stress at the termination fittings.

(a) *Fittings and boxes.* Fittings and boxes shall be provided with threaded bosses for connection to conduit or cable terminations, shall have close fitting covers, and shall have no openings (such as holes for attachment screws) through which dust might enter, or through which sparks or burning material might escape. Fittings and boxes in which taps, joints or terminal connections are made, or which are used in locations where dusts are of an electrically-conducting nature shall be dust-ignition-proof and approved for class II locations.

(b) *Flexible connections.* Where necessary to employ flexible connections, dust-tight flexible connectors, liquid-tight flexible metal conduit with approved fittings, or flexible cord approved for extra hard usage and provided with bushed fittings shall be used, except that where dusts are of an electrically-conducting nature, flexible cords shall be provided with dust-tight seals at both ends. An additional conductor for grounding shall be provided in the flexible cord unless other acceptable means of grounding is provided. Where flexible connections are subject to oil or other corrosive conditions, the insulation of the conductors shall be of a type approved for the condition or shall be protected by means of a suitable sheath.

(2) **CLASS II, DIVISION 2.** In class II, division 2 locations, rigid metal conduit, electrical metallic tubing, type MI cable with approved termination fittings, or approved type MC or ALS cable with approved termination fittings for class II locations shall be the wiring method employed.

(a) *Fittings and boxes.* Fittings and boxes in which taps, joints or terminal connections are made shall be designed to minimize the entrance of dust, and 1. shall be provided with telescoping or close fitting covers, or other effective means to prevent the escape of sparks or burning material, and 2. shall have no openings (such as holes for attachment screws) through which, after installation, sparks or burning material might escape, or through which adjacent combustible material might be ignited.

(b) *Flexible connections.* Where flexible connections are necessary the provisions of subsection (1) (b) shall apply.

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

**E 502.05 Sealing, class II, divisions 1 and 2.** Where a raceway provides communication between an enclosure which is required to be

dust-ignition-proof and one which is not, suitable means shall be provided to prevent the entrance of dust into the dust-ignition-proof enclosure through the raceway. This means may be (1) a permanent and effective seal, (2) a horizontal section not less than 10 feet long in the raceway, or (3) a vertical section of raceway not less than 5 feet long and extending downward from the dust-ignition-proof enclosure. Sealing fittings shall be accessible.

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

**E 502.06 Switches, circuit-breakers, motor controllers, and fuses.** Switches, circuit-breakers, motor controllers and fuses shall conform to the following:

(1) **CLASS II, DIVISION 1.** In class II, division 1 locations, switches, circuit-breakers, motor controllers and fuses shall conform to the following:

(a) *Type required.* Switches, circuit-breakers, motor controllers and fuses, including push buttons, relays and similar devices, which are intended to interrupt current in the normal performance of the function for which they are installed, or which are installed where dusts of an electrically-conducting nature may be present, shall be provided with dust-ignition-proof enclosures which, together with the enclosed apparatus in each case, shall be approved as a complete assembly for class II locations.

*Note:* This includes service and branch circuit fuses, switches and circuit-breakers, motor controllers (including push buttons, pilot switches, relays, and motor overload protective devices), and switches, fuses and circuit-breakers for the control and protection of lighting and appliance circuits.

(b) *Isolating switches.* Disconnecting and isolating switches containing no fuses and not intended to interrupt current, and which are not installed where dusts may be of an electrically-conducting nature, shall be provided with tight metal enclosures which shall be designed to minimize the entrance of dust, and which shall 1. be equipped with telescoping or close fitting covers, or with other effective means to prevent the escape of sparks or burning material, and 2. have no openings (such as holes for attachment screws) through which, after installation, sparks or burning material might escape, or through which exterior accumulations of dust or adjacent combustible material might be ignited.

(c) *Metal dusts.* In locations where dust from magnesium, aluminum, aluminum bronze powders, or other metals of similarly hazardous characteristics may be present, fuses, switches, motor controllers and circuit-breakers shall have enclosures specifically approved for such locations.

(2) **CLASS II, DIVISION 2.** In class II, division 2 locations, enclosures for fuses, switches, circuit-breakers and motor controllers including push buttons, relays and similar devices, shall conform to the requirements of subsection (1) (b).

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

**E 502.07 Control transformers and resistors.** Transformers, solenoids, impedance coils and resistors used as or in conjunction with control equipment for motors, generators and appliances shall conform to the following:

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(1) **CLASS II, DIVISION 1.** In class II, division 1 locations, control transformers, solenoids, impedance coils and resistors, and any over-current devices or switching mechanisms associated with them shall have dust-ignition-proof enclosures approved for class II locations. No control transformer, impedance coil or resistor shall be installed in a location where dust from magnesium, aluminum, aluminum bronze powders, or other metals of similarly hazardous characteristics may be present unless provided with an enclosure specifically approved for such locations.

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

(a) *Switching mechanisms.* Switching mechanisms (including over-current devices) associated with control transformers, solenoids, impedance coils and resistors, shall be provided with enclosures conforming to section E 502.06 (1) (b).

(b) *Coils and winding.* Where not located in the same enclosure with switching mechanisms, control transformers, solenoids and impedance coils shall be provided with tight metal housings without ventilating openings.

(c) *Resistors.* Resistors and resistance devices shall have dust-ignition-proof enclosures approved for class II locations, except that where the maximum normal operating temperature of the resistor will not exceed 120° C. (248° F.) non-adjustable resistors and resistors which are part of an automatically timed starting sequence may have enclosures conforming to section E 502.07 (2) (b).

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

**E 502.08 Motors and generators.** Motors and generators shall conform to the following:

(1) **CLASS II, DIVISION 1.** In class II, division 1 locations, motors, generators, and other rotating electrical machinery shall be totally-enclosed not ventilated, totally-enclosed pipe ventilated, or totally-enclosed fan-cooled, and shall be approved as dust-ignition-proof for class II locations. Motors, generators or other rotating electrical machinery shall not be installed in locations where dust from magnesium, aluminum, aluminum bronze powders, or other metals of similarly hazardous characteristics may be present unless such machines are totally-enclosed, or totally-enclosed fan-cooled, and specially approved for such locations.

(2) **CLASS II, DIVISION 2.** In class II, division 2 locations, motors, generators and other rotating electrical machinery shall be totally-enclosed not ventilated, totally-enclosed pipe ventilated, or totally-enclosed fan-cooled, except that in locations where, in the judgment of the administrative authority, only moderate accumulations of non-conducting, non-abrasive dust are likely to occur, and where the equipment is readily accessible for routine cleaning and maintenance self-cleaning textile motors of the squirrel-cage type, standard open type machines without sliding contacts, centrifugal or other types of switching mechanism (including motor overcurrent devices), or integral resistance devices, or standard open type machines having such contacts, switching mechanisms or resistance devices enclosed within tight metal housings without ventilating or other openings, may be

installed. Motors, generators or other rotating electrical machinery of partially-enclosed or splashproof type shall not be installed in such locations.

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

**E 502.09 Ventilating piping.** Vent pipes for motors, generators or other rotating electrical machinery, or for enclosures for electrical apparatus or equipment, shall be of metal not lighter than No. 24 MS (USS Revised) gauge, or of equally substantial noncombustible material, and shall: lead directly to a source of clean air outside of buildings, be screened at the outer ends to prevent the entrance of small animals or birds, be protected against physical damage and against rusting or other corrosive influences. In addition, vent pipes shall conform to the following:

(1) **CLASS II, DIVISION 1.** In class II, division 1 locations, vent pipes, including their connections to motors or to the dust-ignition-proof enclosures for other equipment or apparatus, shall be dust-tight throughout their length. For metal pipes, seams and joints shall be (a) riveted (or bolted) and soldered, (b) welded, or (c) rendered dust-tight by some other equally effective means.

(2) **CLASS II, DIVISION 2.** In class II, division 2 locations, vent pipes and their connections shall be sufficiently tight to prevent the entrance of appreciable quantities of dust into the ventilated equipment or enclosure, and to prevent the escape of sparks, flame or burning material which might ignite dust accumulations or combustible material in the vicinity. For metal pipes, lock seams and riveted or welded joints may be used, and tight-fitting slip joints may be used where some flexibility is necessary as at connections to motors.

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

**E 502.10 Utilization equipment, fixed and portable.** Utilization equipment, fixed and portable, shall conform to the following:

(1) **CLASS II, DIVISION 1.** In class II, division 1 locations, utilization equipment, including electrically-heated and motor-driven equipment, shall be dust-ignition-proof approved for class II locations. Where dust from magnesium, aluminum, aluminum bronze powders, or other metals of similarly hazardous characteristics may be present, such equipment shall be specifically approved for such locations.

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

(a) *Heaters.* Electrically-heated utilization equipment shall be dust-ignition-proof approved for class II locations.

(b) *Motors.* Motors of motor-driven utilization equipment shall conform to section E 502.08 (2).

(c) *Switches, circuit-breakers and fuses.* Enclosures for switches, circuit-breakers, and fuses shall conform to section E 502.06 (1) (b).

(d) *Transformers, impedance coils and resistors.* Transformers, solenoids, impedance coils and resistors shall conform to section E 502.07 (2).

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

**E 502.11 Lighting fixtures.** Lamps shall be installed in fixtures which shall conform to the following:

(1) **CLASS II, DIVISION 1.** In class II, division 1 locations, lighting fixtures for fixed and portable lighting shall conform to the following:

(a) *Approved fixtures.* Each fixture shall be dust-ignition-proof and approved for class II locations, and shall be clearly marked to indicate the maximum wattage of the lamp for which it is approved. In locations where dust from magnesium, aluminum, aluminum bronze powders, or other metals of similarly hazardous characteristics may be present, fixtures for fixed or portable lighting, and all auxiliary equipment, shall be specifically approved for such locations.

(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 threaded rigid conduit stems or chains with approved fittings, 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 a 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. Threaded joints shall be provided with set-screws or other effective means to prevent loosening. Where wiring between an outlet box or fitting and a pendent fixture is not enclosed in conduit, flexible cord approved for hard usage shall be used, and suitable seals shall be provided where the cord enters the fixture and the outlet box or fitting. Flexible cord shall not serve as the supporting means for a fixture.

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

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

(a) *Portable lamps.* Portable lamps shall be dust-ignition-proof and approved for class II locations. They shall be clearly marked to indicate the maximum wattage of lamps for which they are approved.

(b) *Fixed lighting.* Lighting fixtures for fixed lighting, when not of a type approved for class II locations, shall provide enclosures for lamps and lampholders which shall be designed to minimize the deposit of dust on lamps and to prevent the escape of sparks, burning material or hot metal. Each fixture shall be clearly marked to indicate the maximum wattage of lamp which may be used without exceeding a maximum exposed surface temperature of 165°C. (329°F.) under normal conditions of use.

(c) *Physical damage.* Lighting fixtures for fixed lighting shall be protected from physical damage by suitable guards or by location.

(d) *Pendent fixtures.* Pendent fixtures shall be suspended by threaded rigid conduit stems or chains with approved fittings, 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 a 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. When wiring between an outlet box or fitting and a pendent fixture is not enclosed in conduit, flexible cord approved for hard usage shall be used. Flexible cord shall not serve as the supporting means for a fixture.

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

(f) *Electric discharge lamps.* Starting and control equipment for mercury vapor and fluorescent lamps shall conform to the requirements of section E 502.07 (2).

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

**E 502.12 Flexible cords, class II, divisions 1 and 2.** Flexible cords used in class II locations 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) be provided with suitable seals to prevent the entrance of dust where the flexible cord enters boxes or fittings which are required to be dust-ignition-proof.

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

**E 502.13 Receptacles and attachment plugs. (1) CLASS II, DIVISION 1.** In class II, division 1 locations, receptacles and attachment plugs shall be of the type providing for connection to the grounding conductor of the flexible cord, and shall be dust-ignition-proof approved for class II locations.

(2) **CLASS II, DIVISION 2.** In class II, division 2 locations, receptacles and attachment plugs shall be of the type providing for connection to the grounding conductor of the flexible cord and shall be so designed that connection to the supply circuit cannot be made or broken while live parts are exposed.

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

**E 502.14 Signal, alarm, remote-control, and local loud-speaker intercommunication systems.** Signal, alarm, remote-control and local loud-speaker intercommunication systems shall conform to the following:

*Note:* Refer to chapter E 800 for rules governing the installation of communication circuits as defined in chapter E 100.

(1) **CLASS II, DIVISION 1.** In class II, division 1 locations, signal, alarm, remote-control and local loud-speaker intercommunication systems shall conform to the following:

(a) *Wiring method.* Where accidental damage or breakdown of insulation might cause arcs, sparks or high temperatures, rigid metal conduit, electrical metallic tubing, or type MI cable with approved termination fittings shall be the wiring method employed. For conduit or electrical metallic tubing, the number of conductors shall be limited only by the requirement that the cross-sectional area of all conductors



shall not exceed 40% of the area of the raceway. Where limited flexibility is desirable or where exposure to physical damage is not severe, flexible cord approved for extra-hard usage may be used.

(b) *Contacts.* Switches, circuit-breakers, relays, contactors and fuses which may interrupt other than voice currents, and current-breaking contacts for bells, horns, howlers, sirens and other devices in which sparks or arcs may be produced, shall be provided with enclosures approved for the location, unless current-breaking contacts are immersed in oil, or unless the interruption of current occurs within a chamber sealed against the entrance of dust, in which case enclosures may be of general purpose type.

(c) *Resistors and similar equipment.* Resistors, transformers and choke coils which may carry other than voice currents, and rectifiers, thermionic tubes, and other heat generating equipment or apparatus shall be provided with dust-ignition-proof enclosures approved for class II locations.

(d) *Rotating machinery.* Motors, generators and other rotating electrical machinery shall conform to section E 502.08 (1).

(e) *Electrical conducting dusts.* Where dusts are of an electrically-conducting nature, all wiring and equipment shall be approved for class II locations.

(f) *Metal dusts.* Where dust from magnesium, aluminum, aluminum bronze powders, or other metals of similarly hazardous characteristics may be present, all apparatus and equipment shall be specifically approved for such conditions.

(2) CLASS II, DIVISION 2. In class II, division 2 locations, signal, alarm, remote-control and local loud-speaker intercommunication systems shall conform to the following:

(a) *Contacts.* Enclosures shall conform to subsection (1) (b) or contacts shall have tight metal enclosures designed to minimize the entrance of dust, and shall have telescoping or tight fitting covers and no openings through which, after installation, sparks or burning material might escape.

(b) *Transformers and similar equipment.* The windings and terminal connections of transformers and choke coils shall be provided with tight metal enclosures without ventilating openings.

(c) *Resistors and similar equipment.* Resistors, resistance devices, thermionic tubes and rectifiers shall conform to subsection (1) (c) except that enclosures for thermionic tubes, non-adjustable resistors or rectifiers for which maximum operating temperature will not exceed 120°C. (248°F.) may be of general purpose type.

(d) *Rotating machinery.* Motors, generators and other rotating electrical machinery shall conform to section E 502.08 (b).

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

**E 502.15 Live parts, class II, divisions 1 and 2.** There shall be no exposed live parts.

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

**E 502.16 Grounding, class II, 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 contact 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 502.04, 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 II location, when supplied from an ungrounded overhead electrical supply system 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.

(4) **GROUNDING SERVICE CONDUCTOR BONDED TO RACEWAY.** Wiring in a class II 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 II location, where 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 an 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 subsection (4) or (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.