(5) Bare Conductors. Bare conductors shall not be taped.

(6) Terminals. Where metal raceway or other metallic covering is used in the battery room, at least 12 inches of the conductor at the end connected to a cell terminal shall be free from the raceway or metallic covering and shall be bushed by a substantial glazed insulating bushing. The end of the raceway shall be sealed tightly to resist the entrance of electrolyte by spray or by creepage Sealing compound, rubber insulating tape or other suitable material shall be used for this purpose.

SPECIAL OCCUPANCIES

CHAPTER E-500

HAZARDOUS LOCATIONS

E-500.01. Scope.

(1) The provisions of Chapters E-500 - E-503 apply to locations in which the administrative authority judges the apparatus and wiring to be subject to the conditions indicated by the following classifications. It is intended that each room, section or area (including motor and generator rooms, and rooms for the enclosure of control equipment) shall be considered individually in determining its classification. Except as modified in Chapters E-500 - E-503, all other applicable rules contained in this Code shall apply to electrical apparatus and wiring installed in hazardous locations. For definitions of "approved" and "explosion-proof" as used in these Chapters, refer to Chapter E-100; "dust-ignition-proof" is defined in E-502.01.

(2) Equipment and associated wiring approved as intrinsically safe may be installed in any hazardous location for which it is approved, and the provisions of Chapters E-500 - E-517 need not apply to such installation. Intrinsically safe equipment and wiring is incapable of releasing sufficient electrical energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture. Abnormal conditions will include accidental damage to any part of the equipment or wiring,insulation or other failure of electrical components, application

of over-voltage, adjustment and maintenance operations, and other similar conditions.

Note 1. Through the exercise of ingenuity in the layout of electrical installations for hazardous locations, it is frequently possible to locate much of the equipment in less hazardous or in non-hazardous areas and thus to reduce the amount of special equipment required. In some cases, hazards may be reduced or hazardous areas limited or eliminated by adequate positive-pressure ventilation from a source of clean air in conjunction with effective safeguards against ventilation failure. It is recommended that the administrative authority be consulted before such layouts are prepared. It is recommended also that the administrative authority be familiar with such recorded industrial experience as well as with such standards of the National Fire Protection Association as may be of use in the classification of various areas with respect to hazard.

Note 2. For recommendations for protection against static electricity hazards, refer to the standards of the National Fire Protection Association on this subject.

E-500.02. Special Precaution.

(1) The intent of Chapters E-500 - E-503 is to require a form of construction of equipment, and of installation that will insure safe performance under conditions of proper use and maintenance. It, therefore, is assumed that inspection authorities and users will exercise more than ordinary care with regard to installation and maintenance.

(2) The characteristics of various atmospheric mixtures of hazardous gases, vapors and dusts depend on the specific hazardous material involved. It is necessary therefore that equipment be approved not only for the class of location but also for the specific gas, vapor or dust that will be present.

Note: For purposes of testing and approval, various atmospheric mixtures have been grouped on the basis of their hazardous characteristics, and facilities have been made available for testing and approval of equipment for use in the following atmospheric groups:

Group A, Atmospheres containing acetylene;

Group B, Atmospheres containing hydrogen, or gases or vapors of equivalent hazard such as manufactured gas;

Group C, Atmospheres containing ethyl-ether vapors, ethylene, or cyclo-propane;

Group D, Atmospheres containing gasoline, hexane, Naphtha, benzine, butane, propane, alcohol, acetone, benzol, lacquer solvent vapors or natural gas;

Group E, Atmospheres containing metal dust, including aluminum, magnesium, and their commercial alloys, and other metals of similarly hazardous characteristics;

Group F, Atmospheres containing carbon black, coal or coke dust;

Group G, Atmospheres containing flour, starch, or grain dusts.

E-500.03. Specific Occupancies.

See Chapters E-510 to E-517 inclusive for rules applying to garages, aircraft hangars, gasoline dispensing and service stations, bulk storage plants, finishing processes, and flammable anesthetics.

E-500.04. Class I Locations.

Class I locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitible mixtures. Class I locations shall include the following:

(1) Class I, Division 1. Locations (a) in which hazardous concentrations of flammable gases or vapors exist continuously, intermittently, or periodically under normal operating conditions, (b) in which hazardous concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage, or (c) in which breakdown or faulty operation of equipment or processes which might release hazardous concentrations of flammable gases or vapors, might also cause simultaneous failure of electrical equipment.

Note: This classification would usually include locations where flammable volatile liquids or liquefied flammable gases are transferred from one container to another; interiors of spray booths and areas in the vicinity of spraying and painting operations where volatile flammable solvents are used; locations containing open

tanks or vats of volatile flammable liquids; drying rooms or compartments for the evaporation of flammable solvents; locations containing fat and oil extraction apparatus using volatile flammable solvents; portions of cleaning and dyeing plants where hazardous liquids are used; gas generator rooms and other portions of gas manufacturing plants where flammable gas may escape; inadequately ventilated pump rooms for flammable gas or for volatile flammable liquids; and all other locations where hazardous concentrations of flammable vapors or gases are likely to occur in the course of normal operations.

(2) Class I, Division 2. Locations (a) in which flammable volatile liquids or flammable gases are handled, processed or used, but in which the hazardous liquids, vapors or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation of equipment, (b) in which hazardous concentrations of gases or vapors are normally prevented by positive mechanical ventilation, but which might become hazardous through failure or abnormal operation of the ventilating equipment, or (c) which are adjacent to Class I, Division 1 locations, and to which hazardous concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

Note 1. This classification would usually include locations where flammable volatile liquids or flammable gases or vapors are used, but which, in the judgment of the administrative authority, would become hazardous only in case of an accident or of some unusual operating condition. The quantity of hazardous material that might escape in case of accident, the adequacy of ventilating equipment, the total area involved, and the record of the industry or business with respect to explosions or fires are all factors that should receive consideration in determining the classification and extent of each hazardous area.

Note 2. Piping without valves, checks, meters and similar devices would not ordinarily be deemed to introduce a hazardous condition even though used for hazardous liquids or gases. Locations used for the storage of hazardous liquids or of liquefied or compressed gases in sealed containers would not normally be considered hazardous unless subject to other hazardous conditions also.

E-500.05. Class II Locations.

Class II locations are those which are hazardous because of the presence of combustible dust. Class II locations shall include the following:

(1) Class II, Division 1. Locations (a) in which combustible dust is or may be in suspension in the air continuously, intermittently, or periodically under normal operating conditions, in quantities sufficient to produce explosive or ignitible mixtures, (b) where mechanical failure or abnormal operation of machinery or equipment might cause such mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electrical equipment, operation of protection devices, or from other causes, or (c) in which dusts of an electrically conducting nature may be present.

Note 1. This classification would usually include the working areas of grain handling and storage plants; rooms containing grinders or pulverizers, cleaners, graders, scalpers, open conveyors or spouts, open bins or hoppers, mixers or blenders, automatic or hopper scales, packing machinery, elevator heads and boots, stock distributors, dust and stock collectors (except all-metal collectors vented to the outside), and all similar dust producing machinery and equipment in grain processing plants, starch plants, sugar pulverizing plants, malting plants, hay grinding plants, and other occupancies of similar nature; coal pulverizing plants (except where the pulverizing equipment is essentially dust-tight); all working areas where metal dusts and powders are produced, processed, handled, packed or stored (except in tight containers); and all other similar locations where combustible dust may, under normal operating conditions, be present in the air in quantities sufficient

to produce explosive or ignitible mixtures.

Note 2. Combustible dusts which are electrically non-conducting will include dusts produced in the handling and processing of grain and grain products, pulverized sugar and cocoa, dried egg and milk powders, pulverized spices, starch and pastes, potato and woodflour, oil meal from beans and seed, dried hay, and other organic materials which may produce combustible dusts when processed or handled. Electrically conducting non-metallic dusts will include dusts from pulverized coal, coke and charcoal. Metallic dusts from magnesium, aluminum and aluminum bronze are particularly hazardous and every precaution must be taken to avoid ignition and explosion.

(2) Class II, Division 2. Locations in which combustible dust will not normally be in suspension in the air, or will not be likely to be thrown into suspension by the normal operation of equipment or apparatus, in quantities sufficient to produce explosive or ignitible mixtures, but (a) where deposits or accumulations of such dust may be sufficient to interfere with the safe dissipation of heat from electrical equipment or apparatus, or (b) where such deposits or accumulations of dust on, in, or in the vicinity of electrical equipment might be ignited by arcs, sparks or burning material from such equipment.

Note: Locations where dangerous concentrations of suspended dust would not be likely, but where dust accumulations might form on, or in the vicinity of electrical equipment, would include rooms and areas containing only closed spouting and conveyors, closed bins or hoppers, or machines and equipment from which appreciable quantities of dust would escape only under abnormal operating conditions; rooms or areas adjacent to locations described in E-500.05(1), and into which explosive or ignitible concentrations of suspended dust might be communicated only under abnormal operating conditions; rooms or areas where the formation of explosive or ignitible concentrations of suspended dust is prevented by the operation of effective dust control equipment; warehouses and shipping rooms where dust producing materials are stored or handled only in bags or containers; and other similar locations.

E-500.06. Class III Locations.

Class III locations are those which are hazardous because of the presence of easily ignitible fibers or flyings, but in which such fibers or flyings are not likely to be in suspension in air in quantities sufficient to produce ignitible mixtures. Class III locations shall include the following:

(1) Class III, Division 1. Locations in which easily ignitible fibers or materials producing combustible flyings are handled, manufactured or used.

Note 1. Such locations would include some parts of rayon, cotton and other textile mills; combustible fiber manufacturing and processing plants; cotton gins and cotton-seed mills; flax processing plants; clothing manufacturing plants; wood-working plants; and establishments and industries involving similar hazardous processes or conditions.

Note 2. Easily ignitible fibers and flyings will include rayon, cotton (including cotton linters and cotton waste), sisal or henequen, istle, jute, hemp, tow, cocoa fiber, oakum, baled waste kapok, Spanish moss, excelsior and other materials of similar nature.

(2) Class III, Division 2. Locations in which easily ignitible fibers are stored or handled (except in process of manufacture).

CHAPTER E-501

CLASS I INSTALLATIONS _ HAZARDOUS LOCATIONS

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 E-500.04 except as modified by this Chapter.

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 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 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 E-450.21 to E-450.25 inclusive.

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.

Note: It is recommended that such equipment be located outside of the hazardous area where practicable.

(2) Class I, Division 2. In Class I, Division 2 locations, meters, instruments and relays shall conform to the following:

(a) With Make or Break Contacts. Meters, instruments, and relays in which are incorporated contacts for making or breaking current shall conform to E-501.02(1) unless general purpose enclosures are provided and such contacts are 1. immersed in oil, or 2. enclosed within a chamber hermetically sealed against the entrance of gases or vapors.

(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 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 slide-wire contacts in potentiometers used in conjunction with thermocouples) and when the maximum operating temperature of any exposed surface will not exceed eighty per cent (80%) of the ignition temperature in degrees Centigrade of the gas or vapor involved as determined by A.S.T.M. test procedure (Designation D286-30).

(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 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 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-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 five 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 I, Division 2 locations, threaded rigid metal conduit or Type MI cable with termination fittings approved for Class I locations shall be the wiring method employed. Type MI cable shall be installed in a manner to avoid tensile stress at the termination fittings. 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.

E-501.05. Sealing.

Seals are provided in conduit 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 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 two or more enclosures for which seals are required under 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 ClassI, 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 E-501.05 (1) (a) (b). All portions of the conduit run or nipple between the seal and such

enclosure shall conform to 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.

(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) Drainage. 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.

(f) Motors and Generators. Where

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.

(g) 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 E-501.05(1)(b).

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 will include 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 E-501.06(2)(d), 1. standard plug or cartridge fuses 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 shall be 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 three-phase circuit, and a

single fuse protecting the ungrounded conductor of an identified two-wire single-phase circuit, would each be considered as a set of fuses. Fuses conforming to E-501.06(2)(c) need not be included in counting the 10 sets of fuses permitted in general purpose enclosures.

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 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 eighty per cent (80%) of the ignition temperature of the gas or vapor involved as determined by A.S.T.M. test procedure (Designation D 286-30).

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 approved for Class I locations

(explosion-proof).

(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.

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 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 eighty per cent (80%) of the ignition temperature in degrees Centigrade of the gas or vapor involved, as determined by A.S.T.M. test procedure (Designation D 286-30), fixtures shall conform to E-501.09(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 E-501.06(2)(a).

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

E-501.10. Appliances, Fixed and Portable.

Appliances, fixed and portable, shall conform to the following:

(1) Class I, Division 1. In Class I, Division 1 locations, appliances, including electrically-heated and motor-driven appliances, shall be approved for Class I locations.

(2) Class I, Division 2. In Class I, Division 2 locations, appliances, fixed and portable, shall conform to the following:

(a) Heaters. Electrically-heated appliances shall be approved for Class I locations.

(b) Motors. Motors of motor-driven appliances shall conform to E-501.08 (2).

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

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 a portable appliance 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 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: Where flexible cords may be exposed to liquids having a deleterious effect on the conductor insulation, they should conform also to E-501.13.

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.

E-501.13. Conductor Insulation Class I, Division 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.

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 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.

(b) Resistors and Similar Equipment. Resistors, resistance devices, thermionic tubes and rectifiers shall conform to 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.

E-501.15. Live Parts, Class I, Divisions 1 and 2.

There shall be no exposed live parts.

E-501.16. Grounding, Class 1, 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 equip-

ment such as the frames or metal exteriors of motors, fixed or portable lamps or appliances, lighting fixtures, cabinets, cases, and conduit, shall be grounded as specified in Chapter E-250 of this Code.

(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. Where flexible conduit is used as permitted in 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 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) Grounded 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 a current carrying capacity 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 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 E-501.16 (4) and (5) shall not be abandoned while any other grounding connection remains connected to the supply system.

CHAPTER E-502

CLASS II INSTALLATIONS - HAZARDOUS LOCATIONS

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 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 ignitible amounts of dusts 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.

Note 1. Equipment installed in Class II locations should 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 should 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 2. 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.

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 E-450.41 to E-450.48 inclusive, and in addition 1. door 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 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 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.

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 supply systems, be suitably protected against high-voltage surges. This protection shall include suitable lightning protective devices, interconnection of all grounds, and surge-protective capacitors.

Note 1. Suitable lightning protective devices should include primary devices, and also secondary devices where overhead secondary lines exceed 300 feet in length or where secondary is ungrounded.

Note 2. Interconnection of all grounds should 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.

Note 3. Surge protective capacitors should be of a type especially designed for the duty, should be connected to each ungrounded service conductor, and should

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

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, 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 metal conduit shall not be used, and 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 or Type MI cable with approved termination fittings 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 E-502.04(1) (b) shall apply.

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.

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 will include 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 E-502.06(1)(b).

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:

(1) Class II, Division 1. In Class II, Division 1 locations, control transformers, solenoids, impedance coils and resistors, and any overcurrent 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 overcurrent devices) associated with control transformers, solenoids, impedance coils and resistors, shall be provided with enclosures conforming to 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 E-502.07(2)(b).

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.

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.

E-502.10. Appliances, Fixed and Portable.

Appliances, fixed and portable, shall conform to the following:

(1) Class II, Division 1. In Class II, Division 1 locations, appliances, including electrically-heated and motor-driven appliances, 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 appliances shall be specifically approved for such locations.

(2) Class II, Division 2. In Class II, Division 2 locations, appliances, fixed and portable, shall conform to the following:

(a) Heaters. Electrically-heated appliances shall be dust-ignition-proof approved for Class II locations.

(b) Motors. Motors of motor-driven appliances shall conform to E-502.08 (2).

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

(d) Transformers, Impedance Coils and Resistors. Transformers, solenoids, impedance coils and resistors shall conform to E-502.07(2).

Note: Where there is a possibility that a portable appliance may be used in both Division 1 or Division 2 locations of this class, such appliance should conform to the requirements for Division 1 locations.

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 E-502.07(2).

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 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.

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.

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 per cent 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 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 E-502.14(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 E-502.14(1)(c) except that en-

closures 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 E-502.08(b).

E-502.15. Live Parts, Class II, Divisions 1 and 2.

There shall be no exposed live parts.

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 appliances, lighting fixtures, cabinets, cases, and conduit, shall be grounded as specified in Chapter E-250 of this Code.

(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. Where flexible conduit is used as permitted in 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) Grounded 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 a current-carrying capacity 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 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 E-502.16(4) or (5) shall not be abandoned while any other grounding connection remains connected to the supply system.

CHAPTER E-503

CLASS III INSTALLATIONS - HAZARDOUS LOCATIONS

E-503.01. General.

The general rules of this Code shall apply to the installation of electrical wiring and apparatus in locations classified as Class III under E-500.06 except as modified by this Chapter.

Note: Equipment installed in Class III locations should be able to function at full rating without developing surface temperatures high enough to cause excessive dehydration or gradual carbonization of accumulated fibers or flyings. Organic material which is carbonized or is excessively dry is highly susceptible to spontaneous ignition. In general, maximum surface temperatures under actual operating conditions should 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.

E-503.02. Transformers and Capacitors, Class III, Divisions 1 and 2.

Transformers and capacitors shall conform to E-502.02(2).

E-503.03. Wiring Methods.

Wiring methods shall conform to the following:

(1) Class III, Division 1. In Class III, Division 1 locations, rigid metal conduit or Type MI cable shall be the wiring method employed.

(a) Boxes and Fittings. Fittings and boxes in which taps, joints or terminal connections are made shall 1. 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 E-502.04(1)(b) shall apply.

(2) Class III, Division 2. In Class III, Division 2 locations, the wiring method shall conform to E-503.03(1), except that in sections, compartments or areas used solely for storage and containing no machinery, open wiring on insulators may be employed when installed to conform to Chapter E-320, but only on condition that protection as required by E-320.12 be provided where conductors are not run in roof spaces, and well out of reach of sources of physical damage.

E-503.04. Switches, Circuit-Breakers, Motor Controllers and Fuses, Class III, Divisions 1 and 2.

Switches, circuit-breakers, motor controllers and fuses, including push-buttons, relays and similar devices, shall be provided with tight metal enclosures designed to minimize entrance of fibers and flyings, and which shall (1) be equipped with telescoping or close fitting covers, or with other effective means to prevent 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 fibers or flyings or adjacent combustible material might be ignited.

E-503.05. Control Transformers and Resistors, Class III, Divisions 1 and 2.

Transformers, impedance coils and resistors used as or in conjunction with control equipment for motors, generators and appliances, shall conform to E-502.07 (2), with the exception that, in Class III, Division 1 locations, when these devices are in the same enclosure with switching devices of such control equipment, and are used only for starting or short time duty, the enclosure shall conform to the requirements of E-503.04.

E-503.06. Motors and Generators.

Motors and generators shall conform to the following:

(1) Class III, Division 1. In Class III, 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, except that in locations where, in the judgment of the administrative authority,

only moderate accumulations of lint and flyings will be likely to collect on, in, or in the vicinity of a rotating electrical machine, and where such machine 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 overload 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.

(2) Class III, Division 2. In Class III, 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.

(3) Partially Enclosed Type, Class III, Divisions 1 and 2. Motors, generators or other rotating electrical machinery of the partially enclosed or splash-proof type shall not be installed in Class III locations.

E-503.07. Ventilating Piping, Class III, Divisions 1 and 2.

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 (1) lead directly to a source of clean air outside of buildings, (2) be screened at the outer ends to prevent the entrance of small animals or birds, (3) be protected against physical damage and against rusting or other corrosive influences, and (4) vent pipes and their connections shall be sufficiently tight to prevent the entrance of appreciable quantities of fibers or flyings into the ventilated equipment or enclosure, and to prevent the escape of sparks, flame or burning material which might ignite accumulations of fibers or flyings 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.

E-503.08. Appliances, Fixed and Portable, Class III, Divisions 1 and 2.

Appliances shall conform to the following:

(1) Heaters. Electrically heated appliances shall be approved for Class III locations.

(2) Motors. Motors of motor-driven appliances shall conform to E-503.06(2). Appliances which may be readily moved from one location to another should conform to requirements for the most hazardous location.

(3) Switches, Circuit-Breakers, Motor Controllers and Fuses. Switches, circuit-breakers, motor controllers and fuses shall conform to E-503.04.

E-503.09. Lighting Fixtures, Class III, Divisions 1 and 2.

Lamps shall be installed in fixtures which shall conform to the following:

(1) Fixed Lighting. Lighting fixtures for fixed lighting shall provide enclosures for lamps and lampholders which shall be designed to minimize entrance of fibers and flyings, 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 tem perature of 165°C. (329°F.) under normal conditions of use.

(2) Physical Damage. A fixture which may be exposed to physical damage shall be protected by a suitable guard.

(3) Pendent Fixtures. Pendent fixtures shall be suspended by stems of threaded rigid conduit or threaded metal tubing of equivalent thickness. 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 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.

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

(5) Portable Lamps. Portable lamps shall be equipped with handles and protected with substantial guards, and lampholders shall be of unswitched type with no exposed metal parts and without provision for receiving attachment plugs. In all other respects, portable lamps shall conform to E-503.09(1).

E-503.10. Flexible Cords, Class III, Divisions 1 and 2.

Flexible cords shall conform to E-502.12.

E-503.11. Receptacles and Attachment Plugs, Class III, Divisions 1 and 2.

Receptacles and attachment plugs shall conform to E-502.13(2).

E-503.12. Signal, Alarm, Remote-Control and Local Loud-Speaker Intercommunication Systems, Class III, Divisions 1 and 2.

Signal, alarm, remote-control and local loudspeaker intercommunication systems shall conform to E-502.14(1).

E-503.13. Electric Cranes and Hoists, and Similar Equipment, Class III, Divisions 1 and 2.

Where installed for operation over combustible fibers or accumulations of flyings, traveling cranes and hoists for material handling, traveling cleaners for textile machinery, and similar equipment shall conform to the following:

(1) Power supply to contact conductors shall be isolated from all other systems and shall be ungrounded, and shall be equipped with an acceptable recording ground detector which will give an alarm and will automatically de-energize the contact conductors in case of a fault to ground, or with an acceptable ground fault indicator which will give a visual and audible alarm, and maintain the alarm as long as power is supplied to the system and the ground fault remains.

(2) Contact conductors shall be so located or guarded as to be inaccessible to other than authorized persons, and shall be protected against accidental contact with foreign objects.

(3) Current collectors shall be arranged or guarded to confine normal sparking and to prevent escape of sparks or hot particles. To reduce sparking, two or

more separate surfaces of contact shall be provided for each contact conductor. Reliable means shall be provided to keep contact conductors and current collectors free of accumulations of lint or flyings.

(4) Control equipment shall conform to E-503.04 and E-503.05.

Note: It is recommended that where the distance of travel permits, current to the crane be supplied through flexible cord approved for extra hard usage and equipped with approved type of reel or takeup device.

E-503.14. Electric Trucks.

Electric trucks shall conform to NFPA Standard for the Use, Maintenance and Operation of Industrial Trucks (No. 505).

E-503.15. Storage-Battery Charging Equipment, Class III, Divisions 1 and 2.

Storage-battery charging equipment shall be located in separate rooms built or lined with substantial noncombustible materials so constructed as to adequately exclude flyings or lint, and shall be well ventilated.

E-503.16. Live Parts, Class III, Divisions 1 and 2.

There shall be no exposed live parts except as provided in E-503.13.

E-503.17. Grounding, Class III, Divisions 1 and 2.

Wiring and equipment shall be grounded in conformity with E-502.16.

CHAPTER E-510

HAZARDOUS LOCATIONS - SPECIFIC

E-510.01. Scope.

The provisions of Chapters E-511 to E-517 inclusive shall apply to occupancies or parts of occupancies which are or may be hazardous because of atmospheric concentrations of hazardous gases or vapors, or because of deposits or accumulations of materials which may be readily ignitible. It is the intent to assist the administrative authority in the classification of areas with respect to hazardous conditions which may or may not require construction and equipment conforming to

Chapters E-501 to E-503 inclusive, and to set forth such additional special requirements as are applicable to the specific occupancy.

E-510.02. General.

The general rules of this Code shall apply to the installation of electrical wiring and equipment in occupancies within the scope of Chapters E-511 to E-517 inclusive, except as such rules are modified in those chapters. Where unusual conditions exist in a specific occupancy, the administrative authority shall judge with respect to the application of specific rules.

Note: It is recommended that the administrative authority be familiar with National Fire Protection Association standards applying to occupancies included within the scope of Chapters E-511 to E-517 inclusive.

CHAPTER E-511

COMMERCIAL GARAGES, REPAIR AND STORAGE

E-511.01. Scope.

These occupancies shall include locations used for service and repair operations in connection with self-propelled vehicles (including passenger automobiles, busses, trucks, tractors, etc.) in which volatile flammable liquids or flammable gases are used for fuel or power, and locations in which more than three such vehicles are or may be stored at one time.

Note: For further information regarding classification of garages, refer to the NFPA Standard for Garages (No. 88).

E-511.02. Hazardous Areas.

Classification under Chapter E-500.

(1) For each floor at or above grade, the entire area up to a level 18 inches above the floor shall be considered to be a Class I, Division 2 location.

(2) For each floor below grade, the entire area up to a level 18 inches above the bottom of outside doors or other openings which are at or above grade level shall be considered to be Class I, Division 2 location. Where adequate

positive-pressure ventilation is provided, the administrative authority may judge that the hazardous location extends up to a level of only 18 inches above each such floor.

(3) Any pit or depression below floor level shall be considered to be a Class I, Division 2 location which shall extend up to said floor level, except that an individual unventilated pit or depression may be judged by the administrative authority to be a Class I, Division 1 location.

(4) Adjacent areas in which hazardous vapors are not likely to be released such as stock rooms, switchboard rooms and other similar locations, having floors elevated at least 18 inches above adjacent garage floor, or separated therefrom by tight curbs or partitions at least 18 inches high, shall not be classed as hazardous.

E-511.03. Wiring and Equipment in Hazardous Areas.

Within hazardous areas as defined in E-511.02, wiring and equipment shall conform to applicable provisions of Chapter E-501.

E-511.04. Sealing.

Approved seals conforming to the requirements of E-501.05 shall be provided, and E-501.05(2)(b) shall apply to horizontal as well as to vertical boundaries of the defined hazardous areas. Raceways embedded in a masonry floor or buried beneath a floor shall be considered to be within the hazardous area above the floor if any connections or extensions lead into or through such area.

E-511.05. Wiring in Spaces Above Hazardous Areas.

(1) All fixed wiring shall be in metallic raceways or shall be Type MI cable. Cellular metal floor raceways may be used only for supplying ceiling outlets or extensions to the area below the floor, but such raceways shall have no connections leading into or through any hazardous area above the floor. No electrical conductor shall be installed in any cell, header or duct which contains a pipe for steam, water, air, gas, drainage, or other service except electrical.

(2) For Pendants, flexible cord suitable for the type of service and approved for hard usage shall be used.

(3) For connection of portable lamps, motors or other appliances, flexible cord suitable for the type of service and approved for extra hard usage shall be used.

(4) Where a circuit which supplies portables or pendants includes an identified grounded conductor as provided in Chapter E-200, receptacles, attachment plugs, connectors, and similar devices shall be of polarized type, and the indentified conductor of the flexible cord shall be connected to the screw shell of any lampholder or to the identified terminal of any appliance supplied.

(5) When a pendant is used to supply a portable lamp or appliance, the female portion of a polarized pin-plug connector or equivalent shall be attached to the lower end of the pendant, and the male portion shall be attached to the cord for the portable. The connector shall be designed to break apart readily in any position, and shall be suspended at a level not less than that specified in E-511.02. Attachment plug receptacles in fixed position shall be located above the level specified in E-511.02.

E-511.06. Equipment Above Hazardous Areas.

(1) Equipment which is less than 12 feet above floor level, and which may produce arcs, sparks or particles of hot metal, such as cutouts, switches, receptacles, charging panels, generators, motors, or other equipment having make and break or sliding contacts, shall be of totally-enclosed type or shall be provided with suitable guards or screens to prevent escape of sparks or hot metal particles.

(2) Lamps and lampholders for fixed lighting which are located over lanes through which vehicles are commonly driven or which may otherwise be exposed to physical damage, shall be located not less than 12 feet above floor level unless of totally enclosed type or provided with suitable guards, screens or covers to prevent escape of sparks or hot metal particles.

(3) Portable lamps shall be equipped with handle, lampholder, hook and substantial guard attached to the lampholder or handle. All exterior surfaces which

might come in contact with battery terminals, wiring terminals or other objects shall be of non-conducting material or shall be effectively protected with insulation. Lampholders shall be of unswitched type, and shall not provide means for plug-in of attachment plugs. Outer shell shall be of moulded composition or other material approved for the purpose, and metal-shell, lined lampholders, either of switched or unswitched type, shall not be used. Unless the lamp and its cord are supported or arranged in such a manner that they cannot be used in the hazardous areas classified in E-511.02, they shall be of a type approved for such hazardous locations.

E-511.07. Battery-Charging Equipment.

Battery chargers and their control equipment, and batteries being charged shall not be located within hazardous areas classified in E-511.02. Tables, racks, trays, and wiring shall, in addition, conform to the provisions of Chapter E-480.

E-511.08. Electric Vehicle Charging.

(1) Flexible cords used for charging shall be suitable for the type of service and approved for extra hard usage. Their current carrying capacity shall be adequate for the charging current.

(2) Connectors shall have a rating not less than the current carrying capacity of the cord, and in no case less than 50 amperes.

(3) Connectors shall be so designed and installed that they will break apart readily at any position of the charging cable, and live parts shall be guarded from accidental contact. No connector shall be located within a hazardous area defined in E-511.02.

(4) Where plugs are provided for direct connection to vehicles, the point of connection shall not be within a hazardous area as defined in E-511.02, and where the cord is suspended from overhead, it shall be so arranged that the lowest point of sag is at least 6 inches above the floor. Where the vehicle is equipped with an approved plug which will readily pull apart, and where an automatic arrangement is provided to pull both cord and plug beyond the range of physical damage, no additional connector is required in the cable or at the outlet.

CHAPTER E-512

RESIDENTIAL STORAGE GARAGES

E-512.01. Definition.

A residential storage garage is a building or room in which not more than three vehicles of the types described in E-511.01 are or may be stored, but which will not normally be used for other than minor service or repair operations on such stored vehicles.

E-512.02. At or Above Grade.

Where the lowest floor is at or above adjacent ground or driveway level, and where there is at least one outside door at or below floor level, the garage area shall not be classed as a hazardous location.

E-512.03. Below Grade.

Where the lowest floor is below adjacent ground or driveway level, the following shall apply:

(1) The entire area of the garage or of any enclosed space which includes the garage shall be classified as a Class I, Division 2 location up to a level 18 inches above the garage floor. All electrical equipment and wiring within such hazardous location shall conform to applicable provisions of Chapter E-501.

(2) Wiring and equipment above the defined hazardous location shall conform to the requirements of this Code for non-hazardous locations.

(3) Adjacent areas in which hazardous vapors or gases are not likely to be released, and having floors elevated at least 18 inches above the garage floor, or separated therefrom by tight curbs or partitions at least 18 inches high, shall not be classed as hazardous.

CHAPTER E-513

AIRCRAFT HANGARS

E-513.01. Definition.

This occupancy shall include locations used for storage or servicing of aircraft in which gasoline, jet fuels, or other volatile flammable liquids, or flammable gases, are used, but shall not include such locations when used exclusively for aircraft which have never contained such liquids or gases, or which have been drained and properly purged.

E-513.02. Hazardous Areas.

Classification under Chapter E-500.

(1) Any pit or depression below the level of the hangar floor shall be considered to be a Class I, Division 1 location which shall extend up to said floor level.

(2) The entire area of the hangar including any adjacent and communicating areas not suitably cut off from the hangar shall be considered to be a Class I, Division 2 location up to a level 18 inches above the floor.

(3) The area within 5 feet horizontally from aircraft power plants, aircraft fuel tanks or aircraft structures containing fuel shall be considered to be a Class I, Division 2 hazardous location which shall extend upward from the floor to a level 5 feet above the upper surface of wings and of engine enclosures.

(4) Adjacent areas in which hazardous vapors are not likely to be released such as stock rooms, electrical control rooms, and other similar locations, shall not be classed as hazardous when adequately ventilated and when effectively cut off from the hangar itself by walls or partitions.

E-513.03. Wiring and Equipment in Hazardous Areas.

All fixed and portable wiring and equipment which is or may be installed or operated within any of the hazardous locations defined in E-513.02 shall conform to applicable provisions of Chapter E-501. All wiring installed in or under the

hangar floor shall conform to the requirements for Class I, Division 1. When such wiring is located in vaults, pits, or ducts, adequate drainage shall be provided, and the wiring shall not be placed within the same compartment with any other service except piped compressed air.

E-513.04. Wiring Not Within Hazardous Areas.

(1) All fixed wiring in a hangar, but not within a hazardous area as defined in E-513.02, shall be installed in metallic raceways or shall be Type MI cable, except that wiring in non-hazardous locations as defined in E-513.02(4) may be of any type recognized in Chapter E-300 of this Code.

(2) For pendants, flexible cord suitable for the type of service and approved for hard usage shall be used. Each such cord shall include a separate grounding conductor.

(3) For portable appliances and lamps, flexible cord suitable for the type of service and approved for extra hard usage shall be used. Each such cord shall include a separate grounding conductor.

(4) Where a circuit which supplies portables or pendants includes an identified grounded conductor as provided in Chapter E-200, receptacles, attachment plugs, connectors, and similar devices shall be of polarized type, and the identified conductor of the flexible cord shall be connected to the screw shell of any lampholder or to the identified terminal of any appliance supplied. Acceptable means shall be provided for maintaining continuity of the grounding conductor between the fixed raceway system and the non-current-carrying metallic portions of pendent fixtures, portable lamps, and portable appliances.

E-513.05. Equipment not Within Hazardous Areas.

(1) In locations other than those described in E-513.02, equipment which is less than 10 feet above wings and engine enclosures of aircraft and which may produce arcs, sparks or particles of hot metal, such as lamps and lampholders for fixed lighting, cutouts, switches, receptacles, charging panels, generators, motors,

or other equipment having make and break or sliding contacts, shall be of totally-enclosed type or shall be provided with suitable guards or screens to prevent escape of sparks or hot metal particles, except that equipment in areas described in E-513.02(4) may be of general purpose type.

(2) Lampholders of metal shell, fiber-lined types shall not be used for fixed incandescent lighting.

(3) Portable lamps which are or may be used within a hangar shall be approved for Class I locations.

(4) Portable appliances which are or may be used within a hangar shall be of a type suitable for use in Class I, Division 2 locations.

E-513.06. Stanchions, Rostrums and Docks.

(1) Electric wiring, outlets and equipment (including lamps) on or attached to stanchions, rostrums or docks which are located or likely to be located in a hazardous area as defined in E-513.02(3) shall conform to the requirements for Class I, Division 2 locations.

(2) Where stanchions, rostrums, or docks are not located or likely to be located in a hazardous area as defined in E-513.02(3), wiring and equipment shall conform to E-513.04 and E-513.05, except that such wiring and equipment not more than 18 inches above the floor in any position shall conform to E-513.06(1). Receptacles and attachment plugs shall be of locking type which will not break apart readily.

(3) Mobile stanchions with electrical equipment conforming to E-513.06(2) shall carry at least one permanently affixed warning sign to read: "WARNING - KEEP 5 FEET CLEAR OF AIRCRAFT ENGINES AND FUEL TANK AREAS."

E-513.07. Sealing.

Approved seals shall be provided in conformance with E-501.05 and E-501.05(1)(c) and E-501.05(2)(b) and shall apply to horizontal as well as to vertical boundaries of the defined hazardous areas. Raceways embedded in a masonry floor or

buried beneath a floor shall be considered to be within the hazardous area above the floor when any connections or extensions lead into or through such area.

E-513.08. Aircraft Electrical Systems.

Aircraft electrical systems should be de-energized when the aircraft is stored in a hangar, and, whenever possible, while the aircraft is undergoing maintenance.

E-513.09. Aircraft Battery - Charging and Equipment.

(1) Aircraft batteries should not be charged when installed in an aircraft located inside or partially inside a hangar.

(2) Battery chargers and their control equipment shall not be located or operated within any of the hazardous areas defined in E-513.02, and should preferably be located in a separate building or in an area such as described in E-513.02 (4). Mobile chargers shall carry at least one permanently affixed warning sign to read: "WARNING - KEEP 5 FEET CLEAR OF AIRCRAFT ENGINES AND FUEL TANK AREAS." Tables, racks, trays, and wiring shall not be located within a hazardous area, and shall, in addition, conform to the provisions of Chapter E-480.

E-513.10. Energizing Aircraft from External Power Sources.

(1) Aircraft energizers shall be so designed and mounted that all electrical equipment and fixed wiring will be at least 18 inches above floor level and shall not be operated in a hazardous area as defined in E-513.02(3).

(2) Mobile energizers shall carry at least one permanently affixed warning sign to read: "WARNING - KEEP 5 FEET CLEAR OF AIRCRAFT ENGINES AND FUEL TANK AREAS."

(3) Aircraft energizers shall be equipped with polarized external power plugs and shall have automatic controls to isolate the ground power unit electrically from the aircraft in case excessive voltage is generated by the ground power unit.

E-513.11. Mobile Servicing Equipment with Electrical Components.

(1) Mobile servicing equipment (such as vacuum cleaners, air compressors, air movers, etc.) having electrical wiring and equipment not suitable for Class I, Division 2 locations shall be so designed and mounted that all such fixed wiring and equipment will be at least 18 inches above the floor. Such mobile equipment

shall not be operated within the hazardous areas defined in E-513.02(3) and shall carry at least one permanently affixed warning sign to read: "WARNING - KEEP 5 FEET CLEAR OF AIRCRAFT ENGINES AND FUEL TANK AREAS."

(2) Flexible cords for mobile equipment shall be suitable for the type of service and approved for extra hard usage, and shall include a grounding conductor. Attachment plugs and receptacles shall be approved for the location in which they are installed, and shall provide for connection of the grounding conductor to the raceway system.

(3) Equipment not of a type suitable for Class I, Division 2 locations shall not be operated in areas where maintenance operations likely to release hazardous vapors are in progress.

E-513.12. Grounding.

All metallic raceways, and all non-current-carrying metallic portions of fixed or portable equipment, regardless of voltage, shall be grounded as provided in Chapter E-250.

CHAPTER E-514

GASOLINE DISPENSING AND SERVICE STATIONS

E-514.01. Definitions.

(1) This classification shall include locations where gasoline or other volatile flammable liquids or liquefied flammable gases are transferred to the fuel tanks (including auxiliary fuel tanks) of self-propelled vehicles. Dispensing islands are areas elevated above surrounding surfaces and on which are mounted dispensing pumps or other dispensing devices. Where an individual pump or dispensing device is not mounted on an elevated island, an area extending 18 inches in all directions from the base of the pump or device shall be considered to be a dispensing island.

(2) Other areas used as lubritoriums, service rooms and repair rooms, and offices, salesrooms, compressor rooms and similar locations shall conform to

Chapter E-511 with respect to electrical wiring and equipment.

E-514.02. Hazardous Areas.

(1) The area of a dispensing island shall be considered to be a Class I, Division 1 location which shall extend upward to a level 4 feet above adjacent driveway level, and which shall include any space within or under the island which may contain electrical wiring or equipment.

(2) In an outside location, any area (including buildings not suitably cut off) within 20 feet horizontally from any dispensing island or pump, or from any tank fill-pipe or tank vent-pipe, shall be considered to be a Class I, Division 2 location which shall extend upward to a level 18 inches above driveway or ground level. Electrical wiring and equipment, any portion of which is below the surface of such areas, shall be considered to be within a Class I, Division 1 location which shall extend at least to the point of emergence.

E-514.03. Wiring and Equipment Within Hazardous Areas.

All electrical equipment and wiring within the hazardous areas defined in E-514.02 shall conform to applicable provisions of Chapter E-501.

Note: For special requirements for conductor insulation, see E-501.13.

E-514.04. Wiring and Equipment not Within Hazardous Areas.

Wiring and equipment not within hazardous areas defined in E-514.02 shall conform to E-511.05 and E-511.06.

E-514.05. Circuit Disconnects.

Each circuit leading to or through a dispensing pump or island shall be provided with a switch or other acceptable means to disconnect simultaneously from the source of supply all conductors of the circuit including the grounded neutral, if any.

E-514.06. Sealing.

(1) An approved seal shall be provided in each conduit run entering or leaving a dispensing pump or other enclosure on a dispensing island. There shall be no

union, coupling, box or fitting in the conduit between the sealing fitting and the point at which the conduit emerges into the pump or other equipment, or into any cavities or enclosures in direct communication therewith.

Note: This paragraph states that the first fitting after the conduit emerges from the slab or from the concrete of the island must be the sealing fitting. Above the fitting, the remainder of the wiring and equipment up to the four foot level is required to conform to the rules for Class I, Division 1 locations.

(2) Additional seals shall be provided in conformance with E-501.05 and E-501.05(1)(c) and E-501.05(2)(b) shall apply to horizontal as well as to vertical boundaries of the defined hazardous areas.

E-514.07. Grounding.

Metallic portions of dispensing pumps, metallic raceways, and all non-current-carrying portions of electrical equipment, regardless of voltage, shall be grounded as provided in Chapter E-250.

CHAPTER E-515

BULK-STORAGE PLANTS

E-515.01. Definition.

This designation shall include locations where gasoline or other volatile flammable liquids are stored in tanks having an aggregate capacity of one carload or more, and from which such products are distributed (usually by tank truck).

E-515.02. Hazardous Areas.

(1) Loading racks or platforms and rooms containing pumps for volatile flammable liquids or in which are located valves in pipe lines handling such liquids under pressure shall be considered to be Class I, Division 1 locations.

(2) Rooms in which volatile flammable liquids are transferred to individual containers shall be considered to be Class I, Division 1 locations.

(3) In outdoor locations, areas adjacent to loading racks or platforms, or to aboveground tanks shall be considered to be Class I, Division 2 locations. Such areas shall be considered to extend 25 feet horizontally from such racks or tanks, and upward from adjacent ground level to a height of 15 feet.

Note: Open conductors shall not pass over flammable liquids storage tanks. Such conductors operating at more than 300 volts to ground shall be kept at least 15 feet horizontally from such tanks. When the voltage is 300 or below, *

(4) Basements, pits or depressions which are within 25 feet of aboveground tanks, within 25 feet and below the level of the top of underground tanks, or within 25 feet of any loading rack or platform shall be considered to be Class I, Division 2 locations.

(5) Storage and repair garages for tank trucks shall be considered to be Class I, Division 2 locations without limitation with respect to height above floor level.

(6) Office buildings, boiler rooms and other similar locations which are outside the limits of hazardous areas as defined herein, and which are not used for handling or storage of volatile flammable liquids or containers for such liquids, shall not be considered to be hazardous locations.

* a horizontal clearance of not less than 8 feet shall be maintained.

E-515.03. Wiring and Equipment Within Hazardous Areas.

All electrical wiring and equipment within the hazardous areas defined in E-515.02 shall conform to applicable provisions of Chapter E-501.

E-515.04. Wiring and Equipment Above Hazardous Areas.

All fixed wiring above hazardous areas shall be in metallic raceways. Fixed equipment which may produce arcs, sparks or particles of hot metal, such as lamps and lampholders for fixed lighting, cutouts, switches, receptacles, motors, or other equipment having make and break or sliding contacts, shall be of totally-enclosed type or shall be provided with suitable guards or screens to prevent escape of sparks or hot metal particles. Portable lamps or appliances, and their flexible cords shall conform to the provisions of Chapter E-501 for the class of location above which they are connected or used.

E-515.05. Underground Wiring.

(1) Underground wiring shall be installed in rigid metal conduit, or, where buried under not less than 2 feet of earth, may be installed in non-metallic conduit or duct or in the form of cable approved for the purpose. Where cable is used, it shall be enclosed in rigid metal conduit from the point of lowest buried cable level to the point of connection to the aboveground raceway.

(2) Conductor insulation shall conform to E-501.13 of Chapter E-501.

(3) Where cable with non-metallic sheath or non-metallic conduit is used, an additional grounding conductor shall be included to provide for metallic continuity of the raceway system and for grounding of non-current-carrying metallic parts of equipment.

E-515.06. Sealing.

Approved seals shall be provided in conformance with E-501.05 and E-501.05 (1)(c) and E-501.05(2)(b) shall apply to horizontal as well as to vertical boundaries of the defined hazardous areas. Buried raceways under defined hazardous areas shall be considered to be within such areas.

E-515.07. Gasoline Dispensing.

Where gasoline dispensing is carried on in conjunction with bulk station operations, applicable provisions of Chapter E-514 shall apply.

E-515.08. Grounding.

All metallic raceways, and all non-current-carrying metallic portions of electrical equipment shall be grounded as provided in Chapter E-250.

CHAPTER E-516

FINISHING PROCESSES

E-516.01. Definition.

This Chapter shall apply to locations where paints, lacquers or other flammable finishes are regularly or frequently applied by spraying, dipping, brushing or by other means, and where volatile flammable solvents or thinners are used or where readily ignitable deposits or residues from such paints, lacquers or finishes may occur.

Note: For further information regarding safeguards for finishing processes, see the NFPA Standard for Spray Finishing Using Flammable Materials (No. 33) and the NFPA Standard for Dip Tanks Containing Flammable or Combustible Liquids (No. 34).

E-516.02. Hazardous Areas.

Classification with respect to flammable vapors. For deposits and residues, see E-516.03.

(1) The following areas shall be considered to be Class I, Division 1 locations:

(a) The interiors of spray booths and their exhaust ducts.

(b) 20 feet horizontally and up to an elevation of 12 feet above the floor or 7 feet above the work, whichever is higher where open-spraying operations more extensive than touch-up spraying are permitted. The dimensions may be reduced if the space is limited by a ceiling or permanent walls.

(c) 20 feet horizontally and 12 feet above the floor or 7 feet above the top of dip tanks and their drain boards, whichever is higher. The dimensions may be reduced if the space is limited by a ceiling or permanent walls.

(d) Spaces where hazardous concentrations of flammable vapors are likely to occur.

(2) The following shall be considered to be Class I, Division 2 locations:

(a) A rectangular base area 20 feet wide having a long side extending across the open face of the booth and 20 feet beyond either side of the booth and extending to the ceiling or 5 feet above the top of the booth.

(b) Thirty feet horizontally beyond the limits of Class I, Division 1 areas (see E-516.02(1)) surrounding open spraying, dip tanks and drain boards and other hazardous operations. The vertical dimension of the Class I, Division 2 area shall be the same as the Class I, Division 1 area. The area need not extend above ceilings nor beyond permanent walls.

(3) Adjacent areas which are cut off from the defined hazardous areas by tight partitions without communicating openings, and within which hazardous vapors are not likely to be released, shall be classed as non-hazardous.

(4) Drying and baking areas provided with positive mechanical ventilation adequate to prevent formation of flammable concentrations of vapors, and provided with effective interlocks to de-energize all electrical equipment (other than equipment approved for Class I locations) in case the ventilating equipment is inoperative, may be classed as non-hazardous.

E-516.03. Wiring and Equipment in Hazardous Areas.

(1) All electrical wiring and equipment within the hazardous areas defined in E-516.02 shall conform to applicable provisions of Chapter E-501.

(2) Unless specifically approved for the location, no electrical equipment shall be installed or used where it may be subject to hazardous accumulations of readily ignitible deposits or residues, except that wiring in rigid conduit or in threaded boxes or fittings containing no taps, splices or terminal connections may be installed in such locations.

(3) Illumination of readily ignitible areas through panels of glass or other

transparent or translucent material is permissible only where: (a) fixed lighting units are used as the source of illumination, (b) the panel effectively isolates the hazardous area from the area in which the lighting unit is located, (c) the lighting unit is approved for its specific location, (d) the panel is of a material or is so protected that breakage will be unlikely and (e) the arrangement is such that normal accumulations of hazardous residue on the surface of the panel will not be raised to a dangerous temperature by radiation or conduction from the source of illumination.

(4) Portable electric lamps or appliances shall not be used within a hazardous area during operation of the finishing process. When such lamps or appliances are used during cleaning or repairing operations, they shall be of a type approved for Class I locations, and all exposed metal parts shall be effectively grounded.

(5) Electrostatic spraying or detearing equipment shall be installed and used only as provided in E-516.04.

E-516.04. Electrostatic Equipment.

Where electrostatic spraying and detearing equipment is installed, such equipment shall be of approved type, and shall conform to the following requirements.

(1) No transformers, power packs, control apparatus, or other electrical portion of the equipment (except high voltage grids and their connections) shall be installed in any of the hazardous areas defined in E-516.02 unless of a type approved for the location.

(2) High voltage grids or electrodes shall be located in suitable noncombustible booths or enclosures provided with adequate mechanical ventilation, shall be rigidly supported and of substantial construction, and shall be effectively insulated from ground by means of non-porous noncombustible insulators.

(3) High voltage leads shall be effectively and permanently supported on suitable insulators, shall be effectively guarded against accidental contact or grounding, and shall be provided with automatic means for discharging any residual

charge to ground when the supply voltage is interrupted.

(4) Goods being processed shall be supported on conveyors in such a manner that minimum clearance between goods and high voltage grids or conductors cannot be less than twice the sparking distance. A conspicuous sign indicating the sparking distance shall be permanently posted near the equipment.

(5) Approved automatic controls which will operate without time-delay shall be provided to disconnect the power supply and to signal the operator in case of 1. stoppage of ventilating fans or failure of ventilating equipment from any cause, 2. stoppage of the conveyor carrying goods through the high voltage field, 3. occurrence of a ground or of an imminent ground at any point on the high voltage system, or 4. reduction of clearance below that specified in E-516.04(4).

(6) Adequate fencing, railings or guards which are electrically conducting and effectively grounded shall be provided for safe isolation of the process, and signs shall be permanently posted designating the process zone as dangerous because of high voltage.

E-516.05. Wiring and Equipment Above Hazardous Areas.

(1) All fixed wiring above hazardous areas shall be in metallic raceways or shall be Type MI cable. Cellular metal floor raceways may be used only for supplying ceiling outlets or extensions to the area below the floor of a hazardous area, but such raceways shall have no connections leading into or through the hazardous area above the floor unless suitable seals are provided. No electrical conductor shall be installed in any cell, header or duct which contains a pipe for steam, water, air, gas, drainage, or for other service except electrical.

(2) Equipment which may produce arcs, sparks or particles of hot metal, such as lamps and lampholders for fixed lighting, cutouts, switches, receptacles, motors, or other equipment having make and break or sliding contacts, where installed above a hazardous area or above an area where freshly finished goods are handled, shall be of totally-enclosed type or shall be provided with suitable guards or screens to prevent escape of sparks or hot metal particles.

E-516.06. Grounding.

All metallic raceways, and all non-current-carrying metallic portions of fixed or portable equipment, regardless of voltage, shall be grounded as provided in Chapter E-250.

CHAPTER E-517

FLAMMABLE ANESTHETICS

E-517.01. Definitions.

(1) Flammable anesthetics are gases or vapors such as cyclopropane, divinyl ether, ethyl chloride, ethyl ether, and ethylene, which may form flammable or explosive mixtures with air, oxygen, or nitrous oxide.

(2) For the purpose of this Chapter, anesthetizing locations are areas in hospitals in which flammable anesthetics are or may be administered to patients. Such locations will include operating rooms, delivery rooms and anesthesia rooms, and will also include any corridors, utility rooms or other areas which are or may be used for administering flammable anesthetics to patients. Recovery rooms are not classed as anesthetizing locations unless used for administering flammable anesthetics.

Note: For further information regarding safeguards for hospital operating rooms, see the NFPA Code for the Use of Flammable Anesthetics (No. 56).

E-517.02. Hazardous Areas.

(1) Any room or space in which flammable anesthetics or volatile flammable disinfecting agents are stored shall be considered to be a Class I, Division 1 location throughout.

(2) In an anesthetizing location as defined in E-517.01, the entire area shall be considered to be a Class I, Division 1 location which shall extend upward to a level 5 feet above the floor.

E-517.03. Wiring and Equipment Within Hazardous Areas.

(1) In hazardous areas as defined in E-517.02, all fixed wiring and equipment,

and all portable equipment, including lamps and appliances, operating at more than 8 volts between conductors, shall conform to the requirements of E-501.01 to E-501.15 inclusive and of E-501.16(1) and (2) for Class I, Division 1 locations, and all such equipment shall be specifically approved for the hazardous atmospheres involved.

(2) Where a masonry wall or floor constitutes a boundary of a hazardous area, any portion of a raceway embedded in such masonry shall be considered to be within the boundary itself, but any portion of a raceway located in a hollow space in such wall or floor shall be considered to be within the hazardous area.

(3) Where a box fitting or enclosure is partially but not entirely within a hazardous area, the hazardous area shall be considered to be extended to include the entire box, fitting or enclosure.

(4) Flexible cords which are or may be used in hazardous areas for connection to portable equipment, appliances or lamps operating at more than 8 volts between conductors shall be of a type approved for extra hard usage, shall be of ample length, and shall include an additional insulated conductor for grounding. Receptacles and attachment plugs shall be of the type with provision for connection of the grounding conductor, and where located within a hazardous area, shall be approved for Class I locations. A storage device for the flexible cord shall be provided, and shall not subject the cord to bending at a radius of less than 3 inches.

E-517.04. Wiring and Equipment Above Hazardous Areas.

(1) Wiring above a hazardous area as defined in E-517.02(2) shall be installed in metal raceways or shall be Type MI cable.

(2) Equipment which may produce arcs, sparks or particles of hot metal, such as lamps and lampholders for fixed lighting less than 8 feet above the floor, cutouts, switches, receptacles, generators, motors, or other equipment having make and break or sliding contacts, shall be of totally-enclosed type or shall be provided with suitable guards or screens to prevent escape of sparks or hot metal

particles.

(3) Ceiling suspended surgical and other lighting fixtures shall conform to E-501.09(2), except that surface temperature limitations set forth in E-501.09(2)(b) shall not apply, and except that integral or pendent switches which are located above and cannot be lowered into the hazardous area need not be explosion-proof.

E-517.05. Sealing.

Approved seals shall be provided in conformance with E-501.05, and E-501.05 (1)(c) shall apply to horizontal as well as to vertical boundaries of the defined hazardous areas.

E-517.06. Circuits in Anesthetizing Locations.

(1) Except as provided in E-517.06(5), each circuit within or partially within an anesthetizing location as defined in E-517.01(2) shall be controlled by a switch having a disconnecting pole in each circuit conductor, and shall be supplied from an ungrounded distribution system which shall be isolated from any distribution system supplying areas other than anesthetizing locations. Such isolation may be obtained by means of one or more transformers having no electrical connection between primary and secondary windings, by means of motor generator sets, or by means of suitably isolated batteries.

(2) Circuits supplying primaries of isolating transformers shall operate at not more than 300 volts between conductors, and shall be provided with proper overcurrent protection. Secondary voltage of such transformers shall not exceed 300 volts between conductors, and all circuits supplied from such secondaries shall be ungrounded and shall have an approved overcurrent device of proper rating in each conductor. Circuits supplied from batteries or from generators, or motor-generator sets shall be ungrounded, and shall be protected against overcurrent in the same manner as transformer secondary circuits.

(3) Transformers, motor-generator sets, batteries and battery chargers, together with their overcurrent devices shall be installed in non-hazardous locations,

and shall conform to the requirements of this Code for such locations.

(4) In addition to the usual control and protective devices, the ungrounded system shall be provided with an approved ground contact indicator so arranged that a green signal lamp conspicuously visible to persons in the anesthetizing location remains lighted while the system is isolated from ground. An adjacent red signal lamp and an audible warning signal shall be energized when any conductor of the system becomes grounded through a resistance or a capacitive reactance of any value up to at least 60,000 ohms. The current through the ground indicator to the ground shall not exceed 2 milliamperes. The indicator and associated signals shall not be installed within a hazardous area.

Note: The proper functioning of the indicator shall be tested at intervals of not more than one week by grounding successively each conductor of the energized distribution system through a suitable meter or resistor. Such tests shall be made only while the location is not being used and when entirely free from combustible gases or vapors. A permanent record shall be kept of the results of such tests.

(5) In an anesthetizing location, lighting fixtures for fixed lighting (except ceiling suspended or ceiling mounted surgical fixtures) or permanently installed X-ray transformers and associated equipment, may be supplied from a grounded distribution system provided (a) wiring for grounded and ungrounded circuits does not occupy the same raceways, (b) the lighting fixtures and the X-ray equipment (except the enclosed X-ray tube and the metal-enclosed high voltage leads to the tube) be located at least 8 feet above the floor, and (c) switches for the grounded circuits be located outside of the anesthetizing location except that remote control stations for remote control switches may be in the anesthetizing location where the remote control circuit is energized from the ungrounded distribution system.

E-517.07. Low Voltage Equipment and Instruments.

(1) Electrical apparatus and equipment used within a hazardous area, and which has exposed current-carrying elements or which is frequently in contact with

the bodies of persons, shall be designed to operate at 8 volts or less unless it is entirely surrounded by a metallic casing or sheath. Power supply shall be ungrounded, and shall be electrically isolated from all circuits of higher voltage.

(2) Where a low voltage unit receives current from an individual transformer located within a hazardous area, the flexible cord shall conform to E-517.03(4), the core and case of the transformer shall be effectively grounded, and the transformer shall be approved for Class I locations.

(3) Where low voltage units within a hazardous area are supplied with current from a common source, such as a transformer, motor-generator set, or storage battery, such common source shall be installed in a non-hazardous location. Where located or used within a hazardous area, receptacles and attachment plugs shall be approved for Class I locations. Plugs shall be so designed that they cannot be inserted into receptacles for higher voltage. Flexible cords shall be of adequate length and current-carrying capacity, and shall be approved for extra hard usage. An extra conductor for grounding is not required.

(4) Low voltage equipment and wiring (including flexible cords) shall be protected from dangerous overcurrents by suitable overcurrent devices or by inherent current limiting characteristics of the source of supply. Overcurrent devices shall not be installed in a hazardous area.

(5) Resistance or impedance devices may be used to control low voltage units but shall not be used to limit maximum input voltage. Where a low voltage unit includes a switch or other make and break or sliding contact, or where it includes a resistor or resistance device which may under any operating condition reach a surface temperature exceeding eighty per cent (80%) of the lowest ignition temperature in degrees Centigrade (as determined by A.S.T.M. test procedure - Designation D 286-30) of the gases or vapors that may be present, the unit shall be of a type approved for Class I locations.

E-517.08. Other Equipment.

(1) Suction, pressure, or insufflation equipment involving electrical

elements, and located or used within a hazardous area shall be approved for Class I locations.

(2) X-ray equipment installed or operated in an anesthetizing location as defined in E-517.01(2) shall be provided with approved means for preventing accumulation of electrostatic charges. All control devices, switches, relays, meters, and transformers shall be totally enclosed, and where installed or operated within a hazardous area, shall be approved for Class I locations. High voltage wiring shall be effectively insulated from ground and adequately guarded against accidental contact.

(3) Equipment for generating high frequency currents or voltages used in electrocautery, diathermy, television, etc., where installed or used in an anesthetizing location, shall conform to E-517.03 and E-517.04.

E-517.09. Grounding.

In any hazardous area, all metallic raceways, and all non-current-carrying metallic portions of fixed or portable equipment (except equipment operating at not more than 8 volts between conductors) shall be grounded as provided in E-501.16(1) and (2).

CHAPTER E-520

THEATERS AND ASSEMBLY HALLS

A. General

E-520.01. Scope.

The requirements of this Chapter shall apply to all buildings, or part of a building, designed, intended, or used for dramatic, operatic, motion-picture or other shows, and night clubs, dance halls, armories, sporting arenas, bowling alleys, public auditoriums, television studios and like buildings used for public assembly.

E-520.02. Motion-Picture Projectors.

Motion-picture equipment and its installation and use shall comply with Chapter E-540.

E-520.03. Sound Reproduction.

Sound-reproducing equipment and its installation shall comply with Chapter E-640.

E-520.04. Wiring Method.

The wiring method shall be metal raceways or Type MI cable except as follows:

Exception No. 1. As provided in Chapters E-640, Sound Reproduction, and E-800, Communication Circuits.

Exception No. 2. Where the auditorium has a capacity of less than 200 persons, armored cable as provided in Chapter E-334 may be used, or for concealed work, concealed knob-and-tube work or non-metallic sheathed cable as provided in Chapters E-324 and E-336 may also be used.

Note: For recommendations for determination of population capacity, refer to NFPA Building Exits Code (No. 101).

Exception No. 3. Portable cables may be used only where fixed wiring methods are impracticable.

E-520.05. Number of Conductors in Raceway.

The number of conductors permitted in any metal conduit or electrical metallic

tubing for border or stage pocket circuits or for remote control conductors shall not exceed that shown in Table 1 of Chapter E-900. In the case of auxiliary gutters or wireways, the sum of the cross-sectional areas of all contained conductors at any cross-section shall not exceed 20 per cent of the interior cross-sectional area of the gutter or wireway.

E-520.06. Enclosing and Guarding Live Parts.

Live parts shall be enclosed or guarded to prevent accidental contact by persons and objects. All switches shall be of the externally operable type. Rheostats shall be placed in approved cases or cabinets which enclose all live parts, having only the operating handles exposed.

B. Fixed Stage Switchboard

E-520.21. Dead Front.

Stage switchboards shall be of the dead-front type.

E-520.22. Guarding Back of Switchboard.

Stage switchboards having exposed live parts on the back of such boards shall be enclosed by the building walls, wire mesh grills, or by other approved methods. The entrance to this enclosure shall be by means of a self-closing door.

E-520.23. Control and Overcurrent Protection of Receptacle Circuits.

Means shall be provided at the stage switchboard for the control and individual overcurrent protection of branch circuits to stage and gallery receptacles used for portable stage equipment.

E-520.24. Metal Hood.

A stage switchboard that is not completely enclosed dead-front and dead-rear or recessed into a wall shall be provided with a metal hood extending the full length of the board to protect all equipment on the board from falling objects.

E-520.25. Dimmers.

Dimmers shall conform to the following:

(1) Disconnection and Overcurrent Protection. Where dimmers are installed

in ungrounded conductors, each dimmer shall have overcurrent protection not greater than 125 per cent of the dimmer rating, and shall be disconnected from all ungrounded conductors when the master or individual switch or circuit-breaker supplying such dimmer is in the open position.

(2) Resistance or Reactor Type Dimmers. Resistance or series reactor type dimmers may be placed in either the grounded or the ungrounded conductor of the circuit. Where designed to open either the supply circuit to the dimmer or the circuit controlled by it, the dimmer shall then comply with E-380.01.

Note: It is recommended that resistance or reactor type dimmers be placed in the grounded neutral conductor of the circuit provided they do not open the circuit.

(3) Auto-Transformer Type Dimmers. The circuit supplying an auto-transformer type dimmer shall not exceed 150 volts between conductors. The grounded conductor shall be common to the input and output circuits. See E-200.04.

C. Stage Equipment - Fixed

E-520.41. Circuit Loads.

Footlights, border lights, and proscenium side lights shall be so arranged that no branch circuit supplying such equipment will carry a load exceeding 20 amperes; provided that where heavy-duty lampholders only are used, such circuits may conform to the provisions of Chapter E-210 for circuits supplying heavy-duty lampholders.

E-520.42. Conductor Insulation.

Foot, border, proscenium, or portable strip light fixtures shall be wired with conductors having insulation suitable for the temperatures at which the conductors will be operated and not less than 125°C. (257°F.). See Table E-310.02(1).

E-520.43. Footlights.

(1) Where metal trough construction is employed for footlights, the trough containing the circuit conductors shall be made of sheet metal not lighter than

No. 20 MS (USS Revised) gauge treated to prevent oxidation. Lampholder terminals shall be kept at least $\frac{1}{2}$ inch from the metal of the trough. The circuit conductors shall be soldered to the lampholder terminals.

(2) Where the metal trough construction specified in E-520.43(1) is not used, footlights shall consist of individual outlets with lampholders, wired with rigid or flexible metal conduit or Type MI cable. The circuit conductors shall be soldered to the lampholder terminals. Disappearing footlights shall be so arranged that the current supply shall be automatically disconnected when the footlights are replaced in the recess designed therefor.

E-520.44. Borders and Proscenium Sidelights.

(1) Borders and proscenium sidelights shall be constructed as prescribed in E-520.43, shall be suitably stayed and supported, and shall be so designed that the flanges of the reflectors or other adequate guards will protect the lamps from mechanical injury and from accidental contact with scenery or other combustible material.

(2) Cables for Border Lights. Cables for supply to border lights shall be types K, S, SO, or ST flexible cord. See Table E-400.11. The cables shall be suitably supported. Such cables shall be employed only where flexible conductors are necessary.

E-520.45. Receptacles.

Receptacles intended for the supply of arc lamps shall have not less than 35 amperes capacity and shall be supplied by conductors not smaller than No. 6. Receptacles intended for the supply of incandescent lamps shall have not less than 15 amperes capacity and shall be supplied by conductors not smaller than No. 12. Plugs for arc and incandescent receptacles shall not be interchangeable.

E-520.46. Stage Pockets.

Receptacles intended for the connection of portable stage lighting equipment shall be mounted in suitable pockets or enclosures, and shall comply with the

requirements of E-520.45.

E-520.47. Lamps in Scene Docks.

Lamps installed in scene docks shall be so located and guarded as to be free from mechanical injury and provide an air space of not less than 2 inches between such lamps and any combustible material.

E-520.48. Curtain Motors.

Curtain motors having brushes or sliding contacts shall comply with one of the following conditions:

(1) Be of the totally-enclosed, enclosed-fan-cooled, or enclosed-pipe-ventilated types.

(2) Be enclosed in separate rooms or housings built of non-combustible materials so constructed as to exclude flyings or lint, and properly ventilated from a source of clean air.

(3) Have brush or sliding-contact end of motor enclosed by solid metal covers.

(4) Have brushes or sliding contacts enclosed in substantial, tight, metal housings.

(5) Have the upper half of brush or sliding-contact end of the motor enclosed by a wire screen or perforated metal and the lower half enclosed by solid metal covers.

(6) Have wire screens or perforated metal placed at the commutator or brush ends. No dimension of any opening in the wire screen or perforated metal shall exceed .05 inch, regardless of the shape of the opening and of the material used.

E-520.49. Flue-Damper Control.

Where stage flue dampers are released by an electrical device, the circuit operating the latter shall be normally closed and shall be controlled by at least two externally-operable switches, one switch being placed at the electrician's station and the other where designated by the administrative authority. The device shall be designed for the full voltage of the circuit to which it is connected, no

resistance being inserted. The device shall be located in the loft above the scenery and shall be enclosed in a suitable iron box having a tight, self-closing door.

D. Portable Switchboards on Stage

E-520.51. Supply.

Portable switchboards shall be supplied only from outlets especially provided for this purpose. Such outlets shall include externally operable, enclosed fused switches or circuit-breakers mounted on the stage wall or at the switchboard in locations readily accessible from the stage floor.

E-520.52. Overcurrent Protection.

Circuits from portable switchboards directly supplying equipment containing incandescent lamps of not over 300 watts shall be protected by overcurrent devices having a rating or setting of not more than 20 amperes. Circuits for lampholders over 300 watts may be used where overcurrent protection conforms to the provisions of Chapter E-210. Other circuits shall be provided with overcurrent devices with a rating or setting not higher than the current required for the connected load.

E-520.53. Construction.

Portable switchboards for use on stages shall comply with the following:

(1) Enclosure. Portable switchboards shall be placed within an enclosure of substantial construction which may be so arranged that the enclosure is open during operation. Enclosures of wood shall be completely lined with sheet metal of not less than No. 24 MS (USS Revised) gauge, and shall be well galvanized, enamelled, or otherwise properly coated to prevent corrosion or be of a corrosion-resistant material.

(2) Live Parts. Except as provided for dimmer face plates in E-520.53(5), there shall be no exposed live parts within the enclosure.

(3) Switches and Circuit-Breakers. All switches and circuit-breakers shall be of the externally-operable, enclosed type.

(4) Circuit Protection. Overcurrent devices shall be provided in each

ungrounded conductor of every circuit supplied through the switchboard. Enclosures shall be provided for all overcurrent devices in addition to the switchboard enclosure.

(5) Dimmers. The terminals of dimmers shall be provided with enclosures, and dimmer face plates shall be so arranged that accidental contact cannot be readily made with the face-plate contacts.

(6) Interior Conductors. All conductors within the switchboard enclosure shall be stranded and, except for cables feeding to or from the switchboard, shall be asbestos-covered type AA or other types approved for a maximum operating temperature of 200°C. (392°F). Each conductor shall have a current-carrying capacity at least equal to the rating of the circuit-breaker, switch or fuse which it supplies, except for conductors for incandescent lamp circuits having overcurrent protection not exceeding 20 amperes. Conductors shall be enclosed in metal troughs or securely fastened in position and shall be bushed where they pass through metal.

(7) Pilot Light. A pilot light shall be provided within the enclosure and shall be so connected to the circuit supplying the board that the opening of the master switch will not cut off the supply to the lamp. This lamp shall be on an independent circuit having overcurrent protection of a rating or setting of not more than 15 amperes.

(8) Supply Connections. The supply to a portable switchboard shall be by means of flexible cord (types K, S, SO or ST) terminating within the switchboard enclosure or in an externally-operable fused master switch or circuit-breaker. The supply cable shall have sufficient current-carrying capacity to carry the total load on the switchboard and shall be protected by overcurrent devices.

(9) Cable Arrangement. Cables shall be protected by bushings where they pass through enclosures and shall be so arranged that tension on the cable will not be transmitted to the connections.

(10) Terminals. Terminals to which stage cables are connected shall be so

located as to permit convenient access to the terminals. At terminals not provided with approved pressure connectors the following construction shall be employed:

(a) For conductors of No. 10 or larger, solder lugs shall be used.

(b) For conductors smaller than No. 10, the strands shall be soldered together where connected to clamps or binding screws not specifically approved as pressure connectors.

E. Stage Equipment - Portable

E-520.61. Arc Lamps.

Arc lamps shall comply with the following:

(1) Installation. Arc-lamp frames and standards shall be so installed and guarded as to prevent their becoming grounded.

(2) General Construction. Portable arc lamps shall be substantially constructed entirely of metal not less than No. 20 MS (USS Revised) gauge, except where approved insulating material is necessary.

(3) Design. The design shall be such as to provide proper ventilation while retaining sparks, and to prevent carbons or other live parts of lamp from making contact with metal of hood.

(4) Hoods. Hoods for other than lens lamps shall have the front opening equipped with a self-closing hinged door frame carrying either wire gauze or glass. Hoods for lens lamps may have a stationary front, and a solid door on either back or side.

(5) Insulation. Mica shall be used for the insulation of the lamp frame.

(6) Switch. The switch on the standard shall be of such design that accidental contact with any live part will be impossible.

(7) Rheostats. Rheostats shall be enclosed in a substantial, properly ventilated metal case affording a clearance of at least 1 inch between case and resistance element. Where the rheostat is mounted on the standard, a clearance of 3 inches above the floor shall be maintained. Abestos-covered type AA conductors shall be used between the rheostat and the lamp.

(8) Terminals. Stranded conductors shall be connected to lamp, rheostat and switch terminals by means of approved lugs or connectors; but only approved pressure connectors shall be used at arc lamp terminals.

E-520.62. Portable Plugging Boxes.

Portable plugging boxes shall conform to the following:

(1) Enclosure. The construction shall be such that no current-carrying part will be exposed.

(2) Receptacles and Overcurrent Protection. Each receptacle shall have a rating of not less than 30 amperes, and shall have overcurrent protection which shall be installed in an enclosure equipped with self-closing doors.

(3) Busbars and Terminals. Busbars shall have a current-carrying capacity equal to the sum of the ampere ratings of all the receptacles. Lugs shall be provided for the connection of the master cable.

E-520.63. Lights on Scenery.

(1) Brackets on scenery shall be wired internally and the fixture stem shall be carried through to the back of the scenery where a bushing shall be placed on the end of the stem, except that externally wired brackets or other fixtures may be used when wired with Type P or other cords designed for hard usage which shall extend through scenery and without joint or splice in canopy of fixture back and terminate in an approved type stage connector located within 18 inches of the fixture.

(2) Fixtures shall be securely fastened in place.

E-520.64. Portable Strips.

Portable strips shall be constructed in accordance with the requirements for border lights and proscenium side lights in E-520.44(1). The supply cable shall be protected by bushings where it passes through metal and shall be so arranged that tension on the cable will not be transmitted to the connections. See E-520.42 for wiring of portable strips.

E-520.65. Festoons.

Joints in festoon wiring shall be staggered where practicable. Lamps enclosed in lanterns or similar devices of combustible material shall be equipped with approved guards.

E-520.66. Special Effects.

Electrical devices used for simulating lightning, waterfalls, and the like, shall be so constructed and located that flames, sparks, or hot particles cannot come in contact with combustible material.

E-520.67. Cable Connectors.

Cable connectors for flexible conductors shall be so constructed that tension on the cord or cable will not be transmitted to the connections. See E-400.10. The female half of the connector shall be attached to the line end of the cord or cable.

E-520.68. Conductors for Portables.

Flexible conductors used to supply portable stage equipment shall be Types K, S, SO or ST, except that reinforced cord may be used to supply stand lamps where the cord is not liable to severe physical damage and is protected by an overcurrent protection rated at not over 20 amperes.

F. Dressing Rooms

E-520.71. Pendent Lampholders.

Pendent lampholders shall not be installed in dressing rooms.

E-520.72. Lamp Guards.

All incandescent lamps in dressing rooms, where less than 8 feet from the floor, shall be equipped with open-end guards riveted to the outlet box cover or otherwise sealed or locked in place.

E-520.73. Switches Required.

All lights and receptacles in dressing rooms shall be controlled by wall

switches installed in the dressing rooms. Each switch controlling receptacles shall be provided with a pilot light to indicate when the receptacle or receptacles are energized.

G. Grounding

E-520.81. Grounding.

All metal raceways shall be grounded. The metal frames and enclosures of equipment including border lights shall be grounded, except the frames and enclosures of portable equipment on grounded circuits operating at not over 150 volts to ground. Grounding, when employed, shall be done in the manner specified in Chapter E-250.

CHAPTER E-530

MOTION PICTURE STUDIOS AND SIMILAR LOCATIONS

A. General

E-530.01. Scope.

The requirements of this Chapter shall apply to any motion picture studio, exchange, factory, laboratory, stage, or to any portion of the building in which motion picture films more than 7/8 inch in width are manufactured, exposed, developed, printed, cut, edited, rewound, repaired or stored.

Note: For recommendations for protection against cellulose nitrate film hazards refer to NFPA Standard for the Storage and Handling of Cellulose Nitrate Motion Picture Film (No. 40).

B. Stage or Set

E-530.11. Permanent Wiring.

The permanent wiring shall be in approved metal raceways or Type MI cable.

Exception: Communication circuits, and sound recording and reproducing equipment may be wired as permitted by the chapters covering those installations. (See Chapters E-640 and E-800.)

E-530.12. Portable Wiring.

The wiring for stage set lighting and stage effects, and other wiring which is not fixed as to location, shall be done with approved portable cables and approved flexible cords. This requirement shall not apply to portable lamps or other electrical equipment used as properties in a motion picture set, on a studio stage or lot, or on location.

E-530.13. Stage Lighting and Effects Control.

Switches used for studio stage set lighting and effects (on the stages and lots and on location) shall be of the externally-operable type. When contactors are used as the disconnecting means for fuses, an individual externally-operable type switch (such as a tumbler switch) for the control of each contactor, shall be located at a distance of not more than six feet from the contactor, in addition to remote-control switches.

Exception: A single externally-operable switch may be used to simultaneously disconnect all the contactors on any one location board, where located at a distance of not more than 6 feet from the location board.

E-530.14. Plugging Boxes.

Each receptacle of plugging boxes shall have a current-carrying capacity of not less than 30 amperes.

E-530.15. Enclosing and Guarding Live Parts.

(1) Live parts shall be enclosed or guarded to prevent accidental contact by persons and objects.

(2) All switches shall be of the externally-operable type.

(3) Rheostats shall be placed in approved cases or cabinets which enclose all live parts, having only the operating handles exposed.

(4) Current-carrying parts of "bull-switches", "location boards", "spiders", and plugging boxes shall be so enclosed, guarded, or located that persons cannot accidentally come into contact with them or bring conducting materials into contact

with them.

E-530.16. Portable Lamps.

Portable lamps and work lights shall be equipped with approved portable cords, approved composition or metal-sheathed porcelain sockets and substantial guards.

Exception: The requirements of this rule shall not apply to portable lamps used as properties in a motion picture set, on a studio stage or lot, or on location.

E-530.17. Portable Arc Lamps.

Portable arc lamps shall be substantially constructed. The arc shall be provided with an enclosure designed to retain sparks and carbons and to prevent persons or materials from coming into contact with the arc or bare live parts. The enclosures shall be ventilated. All switches shall be of the externally-operable type.

E-530.18. Overcurrent Protection - Short Time Rating.*

(1) General. Automatic overcurrent protective devices (circuit-breakers or fuses) for feeders, and subfeeders for moving-picture studio stage set lighting and the stage cables for such stage set lighting, shall be rated or set to operate at not more than 400 per cent of the values given in Table E-310.12 and Table E-400.09 (2).

*Special consideration is given to motion picture studios because filming periods are of only a few minutes duration and are rarely longer than 10 minutes.

(2) Feeders. The feeders from the substations to the stages shall be protected by means of overcurrent devices having suitable current-carrying capacity (generally located in the substation). The overcurrent devices may be double-pole, or two single-pole devices may be used. There need be no pole or overcurrent coil in the neutral conductor. The overcurrent device setting for each feeder shall not exceed 400 per cent of the carrying capacity of the feeder, as given in Table E-310.12 for the kind of insulation used.

(3) "Location Boards". Overcurrent protection (fuses or circuit-breakers) shall be provided at the "location boards". The fuses in the "location boards" shall be not larger in rating than 400 per cent of the carrying capacity of the cables between the "location boards" and the plugging boxes.

(4) Plugging Boxes. Where plugging boxes are not provided with overcurrent protective devices, each cable or cord smaller than No. 8 supplied through a plugging box shall be attached to the plugging box by means of a plug containing two cartridge fuses or a circuit-breaker. The rating of the fuses or the setting of the circuit-breaker shall be not more than 400 per cent of the safe carrying capacity of the cables or cords as given in Tables E-310.12, E-310.13 and E-400.09(2) for the kind of insulation used.

(5) Lighting. Work-lights, stand-lamps, and fixtures shall be connected to plugging boxes by means of plugs containing two cartridge fuses not larger than 20 amperes, or they may be connected to special outlets on circuits protected by fuses or circuit-breaker settings of not more than 20 amperes. Plug fuses shall not be used unless they are on the load side of the fuses or circuit-breakers on the "location boards".

E-530.19. Grounding.

Conduit, armored cable or metal raceways, and all noncurrent-carrying metal parts of appliances, devices and equipment shall be grounded as prescribed in Chapter E-250. This shall not apply to pendent and portable lamps, nor to stage lighting and stage sound equipment, nor to other portable or semiportable special stage equipment, operating at not more than 150 volts to ground.

C. Dressing Rooms

E-530.31. Dressing Rooms.

Fixed wiring in dressing rooms shall be installed in accordance with wiring methods covered in Chapter E-300. Wiring for portable dressing rooms shall be of an approved type.

D. Viewing, Cutting and Patching Tables

E-530.41. Lamps at Tables.

Only approved composition or metal-sheathed porcelain keyless lampholders, equipped with suitable means to guard lamps from physical damage and from film and film scrap, shall be used at patching, viewing and cutting tables.

E. Film Storage Vaults

E-530.51. Lamps in Film Storage Vaults.

Lamps in film storage vaults shall be rigid fixtures of the glass enclosed and gasketed type. Lamps shall be controlled by a switch having a pole in each ungrounded conductor. This switch shall be located outside of the vault and provided with a pilot light to indicate whether the switch is on or off. This switch shall disconnect from all sources of supply all ungrounded conductors terminating in any outlet in the vault.

E-530.52. Motors and Other Electrical Equipment in Film Storage Vaults.

No electric motors, heaters, portable lights, or other portable electric equipment shall be located in the film storage vaults.

F. Substations

E-530.61. Substations.

Wiring and equipment above 600 volts shall conform to Chapter E-710.

E-530.62. Low-Voltage Switchboards.

On 600 volts or less switchboards shall conform to Chapter E-384.

E-530.63. Overcurrent Protection of DC Generators.

Three-wire DC generators shall have protection consisting of overcurrent devices having current ratings or settings in accordance with the generator rating. The overcurrent protective devices may be single-pole or two-pole and need not have a pole or overcurrent coil in the neutral lead (whether it is grounded or ungrounded.)

E-530.64. Working Space and Guarding.

Working space and guarding in permanent fixed substations shall conform to E-195.15 and E-195.16. For guarding of live parts on motors and generators, see E-430.011 and E-430.014. Switchboards for voltage of not more than 250 volts DC between conductors when located in substations or switchboard rooms accessible to qualified persons only need not be dead-front.

E-530.65. Portable Substations.

Wiring and equipment in portable substations shall conform to the rules applying to installations in permanent fixed substations, but, due to the limited space available, the working spaces may be reduced, provided that the equipment shall be so arranged that the operator may do his work safely, and so that other persons in the vicinity cannot accidentally come into contact with current-carrying parts or bring conducting objects into contact with them while they are energized.

E-530.66. Grounding at Substations.

Noncurrent-carrying metal parts shall be grounded except the frames of DC circuit-breakers installed on switchboards.

CHAPTER E-540

MOTION PICTURE PROJECTORS

A. General

E-540.01. Scope.

This Chapter applies to motion picture projectors and associated equipment of the Professional and Non-Professional Types.

B. Equipment and Projectors of the Professional Type

E-540.10. Professional Projector - Definition.

The professional projector employs a 35-millimeter film which is 1-3/8 inch wide and has on each edge 5.4 perforations per inch.

E-540.11. Enclosure.

The professional type of projector, such as is commonly used in theatres and motion picture houses, shall be located in an approved enclosure. Such enclosure shall not be considered as a hazardous location as defined in Chapter E-500.

E-540.12. Motor-Driven Projectors.

Motor-driven projectors shall be approved for the purpose as an assembly or shall comply with all of the following conditions:

(1) An approved projector shall be used.

(2) An approved projector lamp shall be used.

(3) Motors shall be so designed or guarded as to prevent ignition of film by sparks or arcs.

(4) Projectors shall be in charge of a qualified operator.

E-540.13. Branch-Circuit Conductors.

Conductors supplying outlets for projectors of the professional type shall not be smaller than No. 8 and shall be of sufficient size for the projector employed.

E-540.14. Conductors on Lamps and Hot Equipment.

Asbestos covered conductors type AA or other types of insulated conductors having a maximum operating temperature of 200°C. (392°F.) shall be used on all lamps or other equipment where the ambient temperature at the conductors as installed will exceed 50°C. (122°F.).

E-540.15. Flexible Cords.

Cords approved for hard service in Table E-400.11 shall be used on portable equipment.

E-540.16. Lamp Guards.

Incandescent lamps in projection rooms or booths shall be provided with an approved lamp guard unless otherwise protected by noncombustible shades or other enclosures.

E-540.17. Location of Equipment.

Motor-generator sets, transformers, rectifiers, rheostats, and similar equipment, for the supply or control of current to arc lamps on projectors shall, if practicable, be located in separate rooms. Where placed in the projector room, they shall be so located or guarded that arcs or sparks cannot come in contact with film, and motor-generator sets shall have the commutator end or ends protected as provided in E-520.48.

E-540.18. Construction and Ventilation.

It is recommended that the administrative authority having jurisdiction over the construction and ventilation of rooms for professional type projectors refer to the NFPA Standard for the Storage and Handling of Cellulose Nitrate Motion Picture Film (NFPA No. 40).

E-540.19. Equipment Prohibited.

Switches, overcurrent devices, or other equipment not normally required or used for projectors, sound reproduction, flood, or other special effect lamps or other equipment shall not be installed in such booths or rooms.

Exception: Remote-control switches for the control of auditorium lights or a switch for the motor operating the curtain at the motion-picture screen.

E-540.20. Approval.

Projectors and enclosures for arc or incandescent lamps, rectifiers, transformers, rheostats, and similar equipment, shall be of an approved type.

E-540.21. Marking.

Projectors and other equipment as set forth in E-540.20 shall be marked with the name or trademark of the maker and with the voltage and current for which they are designed.

E-540.22. Rewinding, Examination and Storage of Extra Films.

It is recommended that the administrative authority having jurisdiction refer to the NFPA Standard for the Storage and Handling of Cellulose Nitrate Motion Picture

Film (NFPA No. 40).

Note: See E-530.51 and E-530.52. Also See E-530.41 for viewing tables.

C. Non-Professional Type Projectors

E-540.30. Definition.

The non-professional projector employs film other than that used on professional type projectors.

E-540.31. Booth Not Required.

Projectors of the non-professional or miniature type, when employing only approved slow-burning (cellulose acetate or equivalent) film, may be operated without a booth.

E-540.32. Approval.

Projectors, lamp enclosures, and current-controlling devices and similar devices shall be approved as component parts of the projector equipment.

E-540.33. Source of Illumination.

The source of illumination shall be a lamp of a type approved for stereopticon use or for motion-picture projection.

E-540.34. Marking.

Projectors shall be marked with name or trademark of the maker, with the current and voltage for which they are designed, and for projectors of this type using the standard 35-millimeter film, with the wording "For use with slow-burning films only".

E-540.35. Non-Professional Film Marking.

The slow-burning (cellulose acetate or equivalent) film shall have a permanent distinctive marker for its entire length identifying the manufacturer and the slow-burning character of the film stock.

D. Sound Recording and Reproduction

E-540.50. Sound Recording and Reproduction

Sound recording and reproduction equipment shall comply with Chapter E-640.

CHAPTER E-560

FARM WIRING

E-560.01. General.

Farms contain a variety of different locations from dry to corrosive and are generally located in areas where it is difficult to obtain low resistance grounds. In addition farm animals are often in a position where they form a path to ground for any electric charge which may appear on stanchions. This chapter covers only those features of farm wiring which are to be handled differently from other occupancies.*

E-560.02. Service.

(1) The electric service may be brought to one point or one building and complete service equipment placed at that point or the service equipment may be omitted. If the service entrance equipment is placed at one point, disconnect means shall be placed at each building but service cable and entrance is not necessary. If service disconnect means are not located at one point each building shall have a complete service entrance.

(2) The water pump may be connected in such a way that the opening of other than its own circuit protection will not interrupt service to the pump.

(3) Service equipment and any other outdoor electrical equipment should be placed at least 6 feet above the ground.

E-560.03. Grounding.

(1) The neutral conductor and service raceway shall be grounded at the entrance to each building served. If the buried portion of the water system on the farm is less than 50 feet, exaluding well casings, or has a resistance to ground of more than 3 ohms, the water system shall be augmented by at least 2 grounding electrodes recognized in E-250.083.

Note: Any metal stanchions or other metal objects in contact with animals should be insulated from the metal in contact with the ground electrode if this is possible. It may be necessary to install a gravity feed to water cups or use hoses arranged to drain when shut off. The metal in contact with animals may be grounded separately. Additional protection for animals in stanchions could be provided by

*Other rules in this code are applicable to farm wiring when not in conflict with this chapter.

bonding all parts of the stanchions together and placing metal reinforcing rods bonded to the stanchions in the floor.

(2) The neutral conductor shall be grounded at each building even though there may be no service entrance equipment. In addition a ground shall be carried back from from metal enclosures of electrical equipment to the point where the neutral is grounded. The ground for non-current carrying parts and the neutral shall be tied together at the grounding point.

E-560.04. Wiring.

The following types of wiring may be used for different farm locations:

(1) Spaces where livestock is housed, milk house, utility rooms, pump houses, cooling rooms, root cellars, silos, chicken coops, and basements, knob-and-tube wiring or nonabsorbent (Neoprene jacket) non-metallic sheathed cable shall be used. In addition, insulated boxes, lampholders, ducts, and bushings should be used. The type of insulation recommended is porcelain. If some metal enclosures must be used they shall be mounted on insulating material out of contact with masonry. Entrance switches and distribution cabinets may be placed outside and this is recommended where corrosive, temperature and moisture conditions within the building warrant.

(2) Dry portions of living quarters, any type of wiring system authorized by this code may be used.

(3) Workshops, storage sheds, shelters, tobacco sheds, any type of wiring system authorized by this code may be used.

(4) Hay mows and granaries. Any type of wiring authorized by this code may be used, provided all lamps are installed in a vertical position and protected with a dust-tight fixture, all wiring is arranged or enclosed to keep hay and grain away, and ducts if used arranged to reduce condensation and to drain.

(5) Outside wiring. For outside wiring requirements see Chapter E-730.