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State of Iowa

EMPLOYMENT SAFETY COMMISSION

East Seventh and Court

Des Moines, Iowa 50319

SAFETY RULE FOR ELECTRICAL INSTALLATIONS IN HAZARDOUS LOCATIONS

CARL G. DAHL
Chairman

J. Peter Olesen
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FOREWARD

This rule establishes minimum Safety Standards for the protection of workers and others in places of employment from accidents so that places of employment shall be rendered safe and accidents shall be prevented.

This rule is promulgated by the Employment Safety Commission of the State of Iowa under the authority of Section 88A.11 of the 1966 Code of Iowa.

It became effective with the force and effect of law on

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BUREAU OF LABOR

Pursuant to authority of Section 88A.11 of the Code, the following rules are adopted.

EMPLOYMENT SAFETY RULES

Utilities and Services Division
Title III
Chapter 1

**ELECTRICAL INSTALLATIONS IN HAZARDOUS
LOCATIONS**
Introduction

PURPOSE.

(a) The purpose of these Rules is the practical safeguarding of persons and of buildings and their contents from hazards arising from the use of electricity for light, heat, power, radio, signalling and for other purposes.

(b) These Rules contain basic minimum provisions considered necessary for safety. Compliance therewith and proper maintenance will result in an installation essentially free from hazard, but not necessarily efficient, convenient, or adequate for good service or future expansion of electrical use.

Hazards often occur because of overloading of wiring systems by methods or usage not in conformity with these Rules. This occurs because initial wiring did not provide for increases in use of electricity. For this reason it is recommended that the initial installation be adequate and that reasonable provisions for system changes be made as may be required for future increase in the use of electricity.

(c) These Rules are not intended as a design specification nor an instruction manual for untrained persons.

SCOPE.

(a) COVERED. It covers the electric conductors and equipment installed within or on public and private buildings and other premises, including yards, carnival and

parking lots, and industrial substations; also the conductors that connect the installations to a supply of electricity, and other outside conductors adjacent to the premises.

(b) NOT COVERED. It does not cover installations in mines, ships, railway cars, aircraft, automotive equipment or the installations or equipment employed by a railway, electric or communication utility in the exercise of its function as a utility, and located outdoors or in buildings used exclusively for that purpose.

1.1(88A) DEFINITIONS.

1.1(1) Accessible.

a. (As applied to wiring methods.) Not permanently closed in by the structure or finish of the building; capable of being removed without disturbing the building structure or finish. (See "Concealed" and "Exposed.")

b. (As applied to equipment.) Admitting close approach because not guarded by locked doors, elevation or other effective means. (See "Readily Accessible.")

1.1(2) Ampacity. Current-carrying capacity expressed in amperes.

1.1(3) Anesthetizing Location. Areas in hospitals, clinics and doctor's offices 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 classified as anesthetizing locations unless used for administering flammable anesthetics.

1.1(4) Appliance. An appliance is utilization equipment, generally other than industrial, normally built in

standardized sizes, or types, which is installed or connected as a unit to perform one or more functions such as clothes washing, air conditioning, food mixing, and deep frying.

a. Fixed: An appliance which is fastened or otherwise secured at a specific location.

b. Portable: An appliance which is actually moved or can easily be moved from one place to another in normal use.

c. Stationary: An appliance which is not easily moved from one place to another in normal use.

1.1(5) Approved. Acceptable to the authority enforcing these Rules.

1.1(6) Askarel. A synthetic nonflammable insulating liquid which, when decomposed by the electric arc, evolves only nonflammable gaseous mixtures.

1.1(7) Attachment Plug (Plug Cap) (Cap). An attachment plug is a device which, by insertion in a receptacle, establishes connection between the conductors of the attached flexible cord and the conductors connected permanently to the receptacle.

1.1(8) Automatic. Automatic means self-acting, operating by its own mechanism when actuated by some impersonal influence, as for example, a change in current strength, pressure, temperature, or mechanical configuration.

1.1(9) Branch Circuit. A branch circuit is that portion of a wiring system extending beyond the final overcurrent device protecting the circuit.

A device not approved for branch circuit protection such as a thermal cutout or motor overload protective device is not considered as the overcurrent device pro-

tecting the circuit.

a. Appliance. An appliance branch circuit is a circuit supplying energy to one or more outlets to which appliances are to be connected; such circuits to have no permanently connected lighting fixtures not a part of an appliance.

b. General Purpose. A branch circuit that supplies a number of outlets for lighting and appliances.

c. Individual. A branch circuit that supplies only one utilization equipment.

d. Multiwire. A multiwire branch circuit is a circuit consisting of two or more ungrounded conductors having a potential difference between them and an identified grounded conductor having equal potential difference between it and each ungrounded conductor of the circuit and which is connected to the neutral conductor of the system.

1.1(10) Building. A structure which stands alone or which is cut off from adjoining structures by fire walls with all openings therein protected by approved fire doors.

1.1(11) Cabinet. An enclosure designed either for surface of flush mounting, and provided with a frame, mat or trim in which swinging doors are hung.

1.1(12) Cable:

a. MI Cable; Mineral-insulated metal-sheathed cable is completely non-combustible and consists of a copper tubing enclosing copper conductors insulated with a compressed magnesium oxide. Special moisture-tight terminal fittings are employed, and the completed system must be tested for insulation resistance. The cable is relatively small but somewhat more expensive than other types of wiring.

b. ALS Cable: Aluminum sheathed cable.

c. MC Cable: Metal clad cable.

1.1(13) Cell (As applied to raceway.). A cell shall be defined as a single enclosed tubular space in a cellular metal floor member, or an enclosed tubular space in a floor made of precast cellular concrete slabs, the axis of the cell being parallel to the axis of the floor member.

1.1(14) Circuit Breaker. A device designed to open and close a circuit by non-automatic means, and to open the circuit automatically on a predetermined overload of current, without injury to itself when properly applied within its rating.

1.1(15) Communication Circuit. Applies to telephone, telegraph (except radio), district messenger, fire and burglar alarms and similar central station systems and to telephone systems not connected to a central station system but using similar type of equipment, methods of installation and maintenance.

1.1(16) Concealed. Rendered inaccessible by the structure or finish of the building. Wires in concealed raceways are considered concealed, even though they may become accessible by withdrawing them.

1.1(17) Conductor.

a. Bare: A bare conductor is one having no covering or insulation whatsoever.

b. Covered: A covered conductor is one having one or more layers of nonconducting materials that are not recognized as insulation under these Rules.

1.1(18) Connector, Pressure (Solderless). A pressure wire connector is a device which establishes the connection between two or more conductors or between one or more conductors and a terminal by means of mechanical pressure and without the use of solder.

1.1(19) Continuous Load. A load where the maximum current is expected to continue for three hours or more.

1.1(20) Control Circuit. The circuit which carries the electrical signals directing the performance of the controller but does not carry the main power circuit.

1.1(21) Controller. A device, or group of devices, which serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected.

1.1(22) Cooking Unit, Counter-Mounted. An assembly of one or more domestic surface heating elements for cooking purposes designed for flush mounting, in or supported by, a counter, and which assembly is complete with inherent or separately mountable controls and internal wiring.

1.1(23) Cord.

a. C – Lamp Cord.

b. PD – Twisted Portable Cord.

c. PO – Parallel Cord.

1.1(24) Current Limiting Overcurrent Protective Device. Device which when interrupting a specified circuit, will consistently limit the short circuit current in that circuit to a specified magnitude substantially less than that obtainable in the same circuit if the device were replaced with a solid conductor having comparable impedance.

1.1(25) Cutout Box. An enclosure designed for surface mounting and having swinging doors or covers secured directly to and telescoping with the walls of the box proper.

1.1(26) Demand Factor. The demand factor of any system, or part of a system, is the ratio of the maximum demand of the system, or part of a system, to the total connected

load of the system, or the part of the system under consideration.

1.1(27) Device. A unit of an electrical system which is intended to carry but not utilize electric energy.

1.1(28) Disconnecting Means. A device, or group of devices, or other means whereby the conductors of a circuit can be disconnected from their source of supply.

1.1(29) Dust-Ignition-Proof. Enclosed in a manner which will exclude ignitable amounts of dust or amounts which might affect performance or rating and which when installation and protection are in conformance with these rules, 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.

1.1(30) Dustproof. So constructed or protected that dust will not interfere with its successful operation.

1.1(31) Dust-tight. So constructed that dust will not enter the enclosing case.

1.1(32) Duty.

a. Continuous: Continuous duty is a requirement of service that demands operation at a substantially constant load for an indefinitely long time.

b. Intermittent: Intermittent duty is a requirement of service that demands operation for alternate intervals of (1) load and no load; or (2) loads and rests; or (3) loads, no load and rest.

c. Periodic: Periodic duty is a type of intermittent duty in which the load conditions are regularly recurrent.

d. Short Time: Short time duty is a requirement of service that demands operation at a substantially constant

load for a short and definitely specified time.

e. Varying: Varying duty is a requirement of service that demands operations at loads, and for intervals of time, both of which may be subject to wide variation.

1.1(33) Duty Cycle (Welding). The percentage of the time during which the welder is loaded.

1.1(34) Electric Sign. A fixed or portable, self-contained electrically illuminated appliance with words or symbols designed to convey information or attract attention.

1.1(35) Enclosed. Surrounded by a case which will prevent a person from accidentally contacting live parts.

1.1(36) Equipment. A general term including material, fittings, devices, appliances, fixtures, apparatus and the like used as part of, or in connection with, an electrical installation.

1.1(37) Explosion-proof Apparatus. Apparatus enclosed in a case which is capable of withstanding an explosion of a specified gas or vapor which may occur within it and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within, and which operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby.

1.1(38) Exposed.

a. (As applied to live parts). Exposed means that a live part can be inadvertently touched or approached nearer than a safe distance by a person. It is applied to parts not suitably guarded, isolated or insulated.

b. (As applied to wiring method). Exposed means not concealed.

1.1(39) Externally Operable. Externally operable

means, capable of being operated without exposing the operator to contact with live parts.

This term is applied to equipment, such as a switch, that is enclosed in a case or cabinet.

1.1(40) Feeder. A feeder is the circuit conductors between the service equipment, or the generator switchboard of an isolated plant, and the branch circuit overcurrent device.

1.1(41) Fitting. An accessory such as a locknut, bushing or other part of a wiring system which is intended primarily to perform a mechanical rather than an electrical function.

1.1(42) Garage. A building or portion of a building in which one or more self-propelled vehicles carrying volatile, flammable liquid for fuel or power are kept for use, sale, storage, rental, repair, exhibition or demonstrating purposes, and all that portion of building which is on or below the floor or floors in which such vehicles are kept and which is not separated therefrom by suitable cutoffs.

1.1(43) Ground. A ground is a conducting connection, whether intentional or accidental, between an electrical circuit or equipment and earth, or to some conducting body which serves in place of the earth.

1.1(44) Grounded. Grounded means connected to earth or to some conducting body which serves in place of the earth.

1.1(45) Grounded (Effectively Grounded Communication System). Effectively grounded means permanently connected to earth through a ground connection of sufficiently low impedance and having sufficient ampacity to prevent the building up of voltages which may result in undue hazard to connected equipment or to persons.

1.1(46) Grounded Conductor. A conductor which is intentionally grounded, either solidly or through a current

limiting device.

1.1(47) Grounding Conductor. A conductor used to connect an equipment, device, or wiring system with a grounding electrode or electrodes.

1.1(48) Guarded. Covered, shielded, fenced, enclosed, or otherwise protected, by means of suitable covers or casings, barriers, rails or screens, mats or platforms, to remove the liability of dangerous contact or approach by persons or objects to a point of danger.

1.1(49) Hazardous Locations. Locations in which flammable gases, vapors or dusts are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.

1.1(50) Header Ducts. Transverse metal raceways for electrical conductors, furnishing access to predetermined cells of a precast cellular concrete floor, thus providing for the installation of electrical conductors from a distribution center to the floor cells.

1.1(51) Hoistway. Any shaftway, hatchway, wall hole, or other vertical opening or space in which an elevator or dumbwaiter is designed to operate.

1.1(52) Identified. Identified, as used in these rules in reference to a conductor or its terminal, means that such conductor or terminal is to be recognized as grounded.

1.1(53) Isolated. Isolated means that an object is not readily accessible to persons unless special means for access are used.

1.1(54) Lighting Outlet. An outlet intended for the direct connection of a lampholder, a lighting fixture or a pendant cord terminating in a lampholder.

1.1(55) Location.

a. Damp Location. A location subject to a moderate

degree of moisture, such as some basements, some barns, some cold storage warehouses and some tunnels.

b. Dry Location. A location not normally subject to dampness or wetness.

A location classified as dry may be temporarily subject to dampness or wetness, as in the case of a building under construction.

c. Wet Location. A location subject to saturation with water or other liquids, such as locations exposed to weather, washrooms in garages, and like locations. Installations underground or in concrete slabs or masonry in direct contact with the earth shall be considered as wet locations.

1.1(56) Low-Energy Power Circuit. A circuit which is not a remote-control or signal circuit but which has the power supply limited in accordance with the requirements of Class II remote-control circuits.

Such circuits include electric door openers and circuits used in the operation of coin operated phonographs.

1.1(57) Multioutlet Assembly. A type of surface or flush raceway designed to hold conductors and attachment plug receptacles, assembled in the field or at the factory.

1.1(58) Nonautomatic. Nonautomatic means that the implied action requires personal intervention for its control.

As applied to an electric controller, nonautomatic control does not necessarily imply a manual controller, but only that personal intervention is necessary.

1.1(59) Outlet. A point on the wiring system at which current is taken to supply utilization equipment.

1.1(60) Outline Lighting. An arrangement of incan-

descent lamps or gaseous tubes to outline and call attention to certain features such as the shape of a building or the decoration of a window.

1.1(61) Oven, Wall-Mounted. A domestic oven for cooking purposes designed for mounting in or on a wall or other surface.

1.1(62) Panelboard. A single panel or group of panel units designed for assembly in the form of a single panel; including buses, and with or without switches or automatic overcurrent protective devices for the control of light, heat or power circuits of small individual as well as aggregate capacity; designed to be placed in a cabinet or cutout box placed in or against a wall or partition and accessible only from the front.

1.1(63) Qualified Person. One familiar with the construction and operation of the apparatus and the hazards involved.

1.1(64) Raceway. Any channel for holding wires, cables or busbars, which is designed expressly for, and used solely for, this purpose.

Raceways may be of metal or insulating material and the term includes rigid metal conduit, rigid nonmetallic conduit, flexible metal conduit, electrical metallic tubing, underfloor raceways, cellular concrete floor raceways, cellular metal floor raceways, surface metal raceways, structural raceways, wireways and busways.

1.1(65) Raintight. So constructed or protected that exposure to a beating rain will not result in the entrance of water.

1.1(66) Readily Accessible. Capable of being reached quickly, for operation, renewal, or inspections, without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders or chairs.

1.1(67) Receptacle (Convenience Outlet). A receptacle is a contact device installed at an outlet for the connection of an attachment plug and flexible cord.

1.1(68) Receptacle Outlet. An outlet where one or more receptacles are installed.

1.1(69) Refrigeration Compressor, Sealed (Hermetic Type). A mechanical compressor consisting of a compressor and a motor, both of which are enclosed in the same sealed housing, with no external shaft nor shaft seals, the motor operating in the refrigerant atmosphere.

1.1(70) Remote-Control Circuit. Any electrical circuit which controls any other circuit through a relay or an equivalent device.

1.1(71) Sealable Equipment. Equipment enclosed in a case or cabinet that is provided with means of sealing or locking so that live parts cannot be made accessible without opening the enclosure. The equipment may or may not be operable without opening the enclosure.

1.1(72) Service. The conductors and equipment for delivering energy from the electricity supply system to the wiring system of the premises served.

1.1(73) Service Cable. The service cable is the service conductors made up in the form of a cable.

1.1(74) Service Conductors. The supply conductors which extend from the street main, or from transformers to the service equipment of the premises supplied.

1.1(75) Service Drop. The overhead service conductors between the last pole or other aerial support and the first point of attachment to the building or other structure.

1.1(76) Service-Entrance Conductors, Overhead System. The service conductors between the terminals of the service equipment and a point usually outside the build-

ing, clear of building walls, where joined by tap or splice to the service drop.

1.1(77) Service-Entrance Conductors, Underground System. The service conductors between the terminals of the service equipment and the point of connection to the service lateral.

Where service equipment is located outside the building walls, there may be no service-entrance conductors, or they may be entirely outside the building.

1.1(78) Service Equipment. The necessary equipment, usually consisting of circuit breaker or switch and fuses, and their accessories, located near point of entrance of supply conductors to a building and intended to constitute the main control and means of cutoff for the supply to that building.

1.1(79) Service Lateral. The underground service conductors between the street main, including any risers at a pole or other structure or from transformers, and the first point of connection to the service entrance conductors in a terminal box inside or outside the building wall. Where there is no terminal box, the point of connection shall be considered to be the point of entrance of the service conductors into the building.

1.1(80) Service Raceway. The rigid metal conduit, electrical metallic tubing, or other raceway, that encloses the service entrance conductors.

1.1(81) Setting (Of Circuit-Breaker). The value of the current at which it is set to trip.

1.1(82) Show-Window. A show-window is any window used or designed to be used for the display of goods or advertising material, whether it is fully or partly enclosed or entirely open at the rear, and whether or not it has a platform raised higher than the street floor level.

1.1(83) Signal Circuit. Any electrical circuit which supplies energy to an appliance which gives a recognizable signal.

Such circuits include circuits for door bells, buzzers, code-calling systems and signal lights.

1.1(84) Special Permission. The written consent of the authority enforcing these Rules.

1.1(85) Switches.

a. General Use Switch. A general use switch is a switch intended for use in general distribution and branch circuits. It is rated in amperes, and it is capable of interrupting its rated current at its rated voltage.

b. General Use Snap Switch. A form of general use switch so constructed that it can be installed in flush device boxes, or on outlet box covers, or otherwise used in conjunction with wiring systems recognized by these Rules.

c. AC General Use Snap Switch. A form of general use snap switch suitable only for use on alternating current circuits for controlling the following:

(1) Resistive and inductive loads (including electric discharge lamps) not exceeding the ampere rating at the voltage involved.

(2) Tungsten filament lamp loads not exceeding the ampere rating at 120 volts.

(3) Motor loads not exceeding 80 per cent of the ampere rating of the switches at the rated voltage.

All AC general use snap switches are marked "AC" in addition to their electrical rating.

d. AC-DC General Use Snap Switch. A form of general

use snap switch suitable for use on either direct or alternating current circuits for controlling the following:

(1) Resistive loads not exceeding the ampere rating at the voltage involved.

(2) Inductive loads not exceeding one-half the ampere rating at the voltage involved, except that switches having a marked horsepower rating are suitable for controlling motors not exceeding the horsepower rating of the switch at the voltage involved.

(3) Tungsten filament lamp loads not exceeding the ampere rating at 125 volts, when marked with the letter "T".

AC-DC general use snap switches are not generally marked AC-DC, but are always marked with their electrical rating.

e. Isolating Switch. An isolating switch is a switch intended for isolating an electric circuit from the source of power. It has no interrupting rating, and it is intended to be operated only after the circuit has been opened by some other means.

f. Motor Circuit Switch. A switch, rated in horsepower, capable of interrupting the maximum operating overload current of a motor of the same horsepower rating as the switch at the rated voltage.

1.1(86) Switchboard. A large single panel, frame, or assembly of panels, on which are mounted, on the face or back or both, switches, overcurrent and other protective devices, buses and usually instruments. Switchboards are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets.

1.1(87) Thermal Cutout. An overcurrent protective device which contains a heater element in addition to and affecting a renewable fusible member which opens the

circuit. It is not designed to interrupt short circuit currents.

1.1(88) Thermal Protection. (As applied to motors). The words, "Thermal Protection", appearing on the nameplate of a motor indicate that the motor is provided with a thermal protector.

1.1(89) Thermal Protector. (As applied to motors). An inherent overheating protective device which is responsive to motor current and temperature and which, when properly applied to a motor, protects the motor against dangerous overheating due to overload or failure to start.

1.1(90) Threaded Bosses or Hubs. A raised portion which is thicker than the box or conduit which can be drilled, tapped or threaded to allow conduit to be attached so the box is explosion proof.

1.1(91) Utilization Equipment. Equipment which utilizes electric energy for mechanical, chemical, heating, lighting or similar useful purposes.

1.1(92) Ventilated. Provided with a means to permit circulation of air sufficient to remove an excess, of heat, fumes, or vapors.

1.1(93) Volatile Flammable Liquid. A flammable liquid having a flash point below 100 degrees F. or whose temperature is above its flash point.

1.1(94) Voltage (of a circuit). Voltage is the greatest root-mean-square (effective) difference of potential between any two conductors of the circuit concerned.

On various systems such as 3-phase 4 wire, single phase 3 wire and 3 wire direct current, there may be various circuits of various voltages.

1.1(95) Voltage to Ground. In grounded circuits the

voltage between the given conductor and that point or conductor of the circuit which is grounded; in ungrounded circuits, the greatest voltage between the given conductor and any other conductor of the circuit.

1.1(96) Watertight. So constructed that moisture will not enter the enclosing case.

1.1(97) Weatherproof. Weatherproof means so constructed or protected that exposure to the weather will not interfere with successful operation.

Raintight or watertight equipment may fulfill the requirements for "weatherproof".

However, weather conditions vary and consideration should be given to conditions resulting from snow, ice, dust, or temperature extremes.

1.2(88A) Special Occupancies.

1.2(1) Scope. The provisions of 1.2(5) apply to locations in which the authority enforcing these Rules 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 1.2(5) all other applicable rules contained in these Rules shall apply to electrical apparatus and wiring installed in hazardous locations.

Equipment and associated wiring approved as intrinsically safe may be installed in any hazardous location for which is approved, and the provisions of 1.2(88A) through 1.12(88A) need not apply to such installation. Intrinsically safe equipment and wiring are 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.

All conduit referred to herein shall be threaded with standard conduit cutting die which provides 3/4" taper per foot. Such conduit shall be made up wrench tight to minimize sparking when fault current flows through the conduit system. Where it is impractical to make a threaded joint tight, a bonding jumper shall be utilized.

1.2(2) The intent of 1.2(88A) through 1.4(88A) 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.

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.

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:

a. Group A. Atmospheres containing acetylene;

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

c. Group C. Atmospheres containing ethyl ether vapors, ethylene, or cyclopropane;

d. Group D. Atmospheres containing gasoline, hexane, naphtha, benzene, butane, propane, alcohol, acetone, benzol, lacquer solvent vapors, or natural gas;

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

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

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

1.2(3) 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 ignitable mixtures. Class I locations shall include the following:

a. Class I, Division 1. Locations (1) in which hazardous concentrations of flammable gases or vapors exist continuously, intermittently, or periodically under normal operating conditions, (2) in which hazardous concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage, or (3) 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.

This classification usually includes locations where volatile flammable 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; the interiors of refrigerators and freezers in which volatile, flammable materials are stored in open, lightly stoppered, or easily ruptured containers, and all other locations where hazardous concentrations of flammable vapors or gases are likely to occur in the course of normal operations.

b. Class I, Division 2. Locations (1) in which volatile flammable 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, (2) 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 (3) 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.

This classification usually includes locations where volatile flammable liquids or flammable gases or vapors are used, but which, in the judgment of the Rule enforcing 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 busi-

ness with respect to explosions or fires are all factors that should receive consideration in determining the classification and extent of each hazardous area.

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.

Electrical conduits and their associated enclosures separated from process fluids by a single seal or barrier shall be classed as Division 2 locations if the outside of the conduit and enclosures is a nonhazardous area.

1.2(4) 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:

a. Class II, Division 1. Location (1) 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 ignitable mixtures, (2) 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 or protection devices, or from other causes, or (3) in which dusts of an electrically conducting nature may be present.

This classification usually includes the working areas of grain handling and storage plants; rooms containing grinders or pulverizers, cleaners, graders, scalpels, 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 ignitable mixtures.

Combustible dusts which are electrically nonconducting 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 nonmetallic dusts containing magnesium or aluminum are particularly hazardous and every precaution must be taken to avoid ignition and explosion.

b. 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 normal operation of equipment or apparatus, in quantities sufficient to produce explosive or ignitable mixtures, but (1) where deposits or accumulations of such dust may be sufficient to interfere with the safe dissipation of heat from electrical equipment or apparatus, or (2) 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.

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 ma-

chines and equipment from which appreciable quantities of dust would escape only under abnormal operating conditions; rooms or areas adjacent to locations described in 1.2(4)a and into which explosive or ignitable concentrations of suspended dust might be communicated only under abnormal operating conditions; rooms or areas where the formation of explosive or ignitable 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.

1.2(5) Class III Locations. Class III locations are those which are hazardous because of the presence of easily ignitable fibers or flyings, but in which such fibers or flyings are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures. Class III locations shall include the following:

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

Such locations usually include some parts of rayon, cotton and other textile mills; combustible fiber manufacturing and processing plants; cotton gins and cottonseed mills; flax processing plants; clothing manufacturing plants; woodworking plants; and establishments and industries involving similar hazardous processes or conditions.

Easily ignitable fibers and flyings include rayon (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.

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

1.3(88A) Class I Installations.

1.3(1) General. This Rule shall apply to the installation of electrical wiring and equipment in locations classified as Class I under 1.2(3) except as modified by this section.

1.3(2) Transformers and Capacitors. The installation of transformers and capacitors shall conform to the following:

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 the following:

(1) Location. Vaults shall be located where they can be ventilated to the outside air without using flues or ducts wherever such an arrangement is practicable.

(2) Walls, Roof, and Floor. The walls and roofs of vaults shall be constructed of reinforced concrete, brick, load bearing tile, concrete block, or other fire resistive constructions which have adequate structural strength for the conditions, and a minimum fire resistance of 2½ hours. The floors of vaults in contact with the earth shall be of concrete not less than 4 inches thick but when the vault is constructed with a vacant space or other stories below it, the floor shall have adequate structural strength for the load imposed thereon and a minimum fire resistance of 2½ hours.

(3) Doorways. Vault doorways shall be protected as follows:

Type of Door. Each doorway leading into a building shall be provided with a tight-fitting door of a type approved for openings in Class A situations. The authority

enforcing these Rules may require such a door for an exterior wall opening or on each side of an interior wall opening where conditions warrant.

Sills. A door sill or curb of sufficient height to confine within the vault the oil from the largest transformer shall be provided and in no case shall the height be less than 4 inches.

Locks. Entrance doors shall be equipped with locks, and doors shall be kept locked, access being allowed only to qualified persons. Locks and latches shall be so arranged that the door may be readily and quickly opened from the inside.

(4) Ventilation. The ventilation shall be adequate to prevent a transformer temperature in excess of the manufacturer's recommendations.

(5) Ventilation Openings. When required by Section 1.3(2) 4, openings for ventilation shall be provided in accordance with the following:

Location. Ventilation openings shall be located as far away as possible from doors, windows, fire escapes, and combustible material.

Arrangement. Vaults ventilated by natural circulation of air may have roughly half of the total area of openings required for ventilation in one or more openings near the floor and the remainder in one or more openings in the roof or in the sidewalls near the roof; or all of the area required for ventilation may be provided in one or more openings near the roof.

Size. In the case of vaults ventilated to an outdoor area without using ducts or flues the combined net area of all ventilating openings after deducting the area occupied by screens, gratings, or louvers, shall be not less than 3 square inches per kva of transformer capacity in service, except that the net area shall be not less than 1 square foot for any capacity under 50 kva.

Covering. Ventilation openings shall be covered with durable gratings, screens, or louvers, according to the treatment required in order to avoid unsafe conditions.

Dampers. Where automatic dampers are used in the ventilation openings of vaults containing oil-insulated transformers, the actuating device should be made to function at a temperature resulting from fire and not at a temperature which might prevail as a result of an overheated transformer or bank of transformers. Automatic dampers should be so designed and constructed to minimize the possibility of accidental closing.

Ducts. Ventilating ducts shall be constructed of fire-resistant material.

Drainage. Where practicable, vaults containing more than 100 kva transformer capacity shall be provided with a drain or other means which will carry off any accumulation of oil or water in the vault unless local conditions make this impracticable. The floor shall be pitched to the drain when provided.

Water Pipes and Accessories. Any pipe or duct systems foreign to the electrical installation should not enter or pass through a transformer vault. Where the presence of such foreign systems cannot be avoided, appurtenances thereto which require maintenance at regular intervals shall not be located inside the vault. Arrangements shall be made where necessary to avoid possible trouble from condensation, leaks and breaks in such foreign systems. Piping or other facilities provided for fire protection or for water-cooled transformers are not deemed to be foreign to the electrical installation.

Storage in Vaults. Materials shall not be stored in transformer vaults. 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 Section 1.3(2) a or b, or (2) be approved for Class I locations (explosion-proof).

Class I, Division 2. In Class I, Division 2 locations, transformers and capacitors shall conform to the following:

a. Dry-Type Transformers Installed Indoors. Transformers rated 112½ kva or less shall have a separation of at least 12 inches from combustible material unless separated therefrom by a fire-resistant heat-insulating barrier, or unless of a rating not exceeding 600 volts and completely enclosed except for ventilating openings.

Transformers of more than 112½ kva rating shall be installed in a transformer room of fire-resistant construction unless they are constructed with 80°C rise (Class B) or 150°C rise (Class H) insulation, and are separated from combustible material not less than 6 feet horizontally and 12 feet vertically or are separated therefrom by a fire-resistant heat-insulating barrier.

Transformers rated more than 35,000 volts shall be installed in a vault. See 1.3(2)a.

b. Askarel-Insulated Transformers Installed Indoors. Askarel-insulated transformers rated in excess of 25 kva shall be furnished with a pressure-relief vent. Where installed in a poorly ventilated place they shall be furnished with a means for absorbing any gases generated by arcing inside the case, or the pressure relief vent shall be connected to a chimney or flue which will carry

such gases outside the building. Askarel-insulated transformers rated more than 35,000 volts shall be installed in a vault.

c. Oil-Insulated Transformers Installed Indoors. Oil-insulated transformers shall be installed in a vault constructed as specified in this section except as follows:

(1) Not Over 112½ kva Total Capacity. The provisions for transformer vaults specified in 1.3(2) apply except that the vault may be constructed of reinforced concrete not less than 4 inches thick.

(2) Not Over 600 Volts. A vault is not required provided suitable arrangements are made where necessary to prevent a transformer oil fire igniting other materials, and the total transformer capacity in one location does not exceed 10 kva in a section of the building classified as combustible, or 75 kva where the surrounding structure is classified as fire-resistant construction.

(3) Furnace Transformers. Electric furnace transformers of a total rating not exceeding 75 kva may be installed without a vault in a building or room of fire-resistant construction provided suitable arrangements are made to prevent a transformer oil fire spreading to other combustible material.

(4) Detached Buildings. Transformers may be installed in a building which does not conform with the provisions specified in these Rules for transformer vaults provided neither the building nor its contents present a fire hazard to any other building or property, and provided the building is used only in supplying electric service and the interior is accessible only to qualified persons.

d. Oil-Insulated Transformers Installed Outdoors. Combustible material, combustible buildings and parts of buildings, fire escapes, door and window openings shall be safeguarded from fires originating in oil-insulated transformers installed on, attached to, or adjacent to a

building or combustible material. Space separations, fire-resistant barriers, automatic water spray systems and enclosures which confine the oil of a ruptured transformer tank are recognized safeguards. One or more of these safeguards shall be applied according to the degree of hazard involved in cases where the transformer installation presents a fire hazard. Oil enclosures may consist of fire-resistant dikes, curbed areas or basins, or trenches filled with coarse crushed stone. Oil enclosures shall be provided with trapped drains in cases where the exposure and the quantity of oil involved are such that removal of oil is important.

1.3(3) Meters, Instruments and Relays. The installation of meters, instruments and relays shall conform to the following:

Class I, Division 1. In Class I, Division 1 location, 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.

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

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

b. Resistors and Similar Equipment. Resistors, resistance devices, thermionic tubes, and rectifiers, which are used in or in connection with meters, instruments and relays, shall conform to 1.3(3) Class I, Division 1, except

that enclosures may be of general purpose type when such equipment is without make and break or sliding contacts (other than as provided in 1.3(3)a above) 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.

c. Without Make and Break Contacts. Transformer windings, impedance coils, solenoids, and other windings which do not incorporate sliding or make and 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 1.3(3) a, b, and c, a single general purpose enclosure is acceptable for the assembly. Where such an assembly includes any of the equipment described in 1.3(3)b, the maximum obtainable surface temperature of any component of the assembly shall be clearly and permanently indicated on the outside of the enclosure.

e. Fuses. Where general purpose enclosures are permitted under 1.3(3) a, b, c, and d, fuses for overcurrent protection of the instrument circuits may be mounted in general purpose enclosures provided such fuses do not exceed 3 ampere rating at 120 volts and provided each such fuse is preceded by a switch conforming to 1.3(3)a.

1.3(4) Wiring Methods. Wiring methods shall conform to the following:

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.

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, or approved Type MC or ALS cable with termination fittings approved for Class I locations shall be the wiring method employed. Type MI, MC or ALS cable shall be installed in a manner to avoid tensile stress at the termination fittings. Boxes, fittings and joints need not be explosion-proof except as required by 1.3(5) a and b. Where provision must be made for limited flexibility, as at motor terminals, flexible metal fittings, flexible metal conduit with approved fittings, or flexible cord approved for extra hard usage and provided with approved bushed fittings shall be used. An additional conductor for grounding shall be included in the flexible cord unless other acceptable means of grounding are provided.

1.3(5) Sealing and Drainage. Seals are provided in conduit and cable systems to prevent the passage of gases, vapors or flames from one portion of the electrical installation to another through the conduit. Such communications 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 insulations, and shall be of a type approved for the conditions of use. Seals in conduit and cable systems shall conform to the following:

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 temper-

atures. 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.

Where two or more enclosures for which seals are required under 1.3(5) a and b, are connected by nipples or by runs of conduit not more than 36 inches long, a single seal in each such nipple connection or run of conduit would be sufficient if located not more than 18 inches from either enclosure. Ordinary conduit fittings of the "L", "T" or "Cross" type would not usually be classed as enclosures when not larger than the trade size of the conduit.

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

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 1.3(5) a and b. All portions of the conduit run or nipple between the seal and such enclosure shall conform to 1.3(4) Class I, Division 1.

b. In each conduit run passing from the Class I, Division 2 hazardous area into a nonhazardous 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.

Class I, Divisions 1 and 2. Where seals are required, they shall conform to the following:

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

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

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

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

e. Assemblies. In an assembly where equipment which may produce arcs, sparks or high temperatures is located in a compartment separate from the compartment containing splices or taps, and an integral seal is provided where conductors pass from one compartment to the other, the entire assembly shall be approved for Class I locations. Seals in conduit connections to the compartment contain-

ing splices or taps shall be provided in Class I, Division 1 locations where required by 1.3(5) b.

f. Drainage.

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

(2) Motor and Generators. Where the authority enforcing these Rules judges that there is probability that liquid or condensed vapor may accumulate within motors or generators, joints and conduit systems shall be arranged to minimize entrance of liquid. If means to prevent accumulation or to permit periodic draining are judged necessary, such means shall be provided at the time of manufacture, and shall be deemed an integral part of the machine.

(3) Canned Pumps, Process Connections for Flow, Pressure or Analysis Measurement, frequently depend upon a single seal diaphragm or tube to prevent process fluids from entering the electrical conduit system. An additional approved seal or barrier shall be provided with an adequate drain between the seals in such a manner that leaks would be obvious.

See also the third paragraph in 1.2(3) b.

1.3(6) Switches, Circuit Breakers, Motor Controllers and Fuses. Switches, circuit breakers, motor controllers and fuses shall conform to the following:

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 loca-

tions.

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.

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

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

c. Fuses. For the protection of motors, appliances and lamps, except as provided in 1.3(6) 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.

A set of fuses is construed to mean a group containing as many fuses as are required to perform a single protective function in a circuit. For example, a group of 3 fuses protecting an ungrounded 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 1.3(6) c need not be included in counting the 10 sets of fuses permitted in general purpose enclosures.

1.3(7) 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:

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)

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 1.3(6) Class I, Division 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 nonvariable and maximum operating temperature, in degrees Centigrade, will not exceed eighty per cent (80%) of the ignition temperature of the gas or vapor involved.

1.3(8) Motors and Generators. Motors and generators shall conform to the following:

Class I, Division 1. In Class I, Division 1 locations, motors, generators and other rotating electrical machinery shall be (1) approved for Class I locations (explosion-proof), or (2) of the totally enclosed type supplied with positive-pressure ventilation from a source of clean air with discharge to a safe area, so arranged to prevent energizing of the machine until ventilation has been established and the enclosure has been purged with at least ten (10) volumes of air, and also arranged to automatically de-energize the equipment when the air supply fails, or (3) of the totally enclosed inert-gas-filled type supplied with a suitable reliable source of inert gas for pressuring the enclosure and arranged to automatically de-energize the equipment when the gas supply fails. Totally enclosed motors of types (2) or (3) shall have no external surface with an operating temperature in degrees Centigrade in excess of eighty per cent (80%) of the ignition temperature of the gas or vapor involved. Appropriate devices shall also be provided to detect any increase in temperature of the motor beyond design limits and automatically de-energize the equipment. Auxiliary equipment shall be of a type approved for the location in which it is installed.

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 over-current 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.

This rule does not prohibit installation of open or non-explosion-proof enclosed motors, such as squirrel cage induction motors, without brushes, and switching mechanisms, in Class I, Division 2 locations.

1.3(9) Lighting Fixtures. Lamps shall be installed in fixtures which shall conform to the following:

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. Pendant Fixtures. Pendant 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 of 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.

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 1.3(9) 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, fixtures shall conform to 1.3(9) a.

c. Pendant Fixtures. Pendant 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 1.3(6) a.

f. Starting Equipment. Starting and control equipment for mercury-vapor and fluorescent lamps shall conform to the requirements of 1.3(7) Class I, Division 2.

1.3(10) Utilization Equipment, Fixed and Portable. Utilization equipment, fixed and portable, shall conform to the following:

Class I, Division 1. In Class I, Division 1 locations, utilization equipment including electrically-heated and motor-driven equipment shall be approved for Class I locations.

Class I, Division 2. In Class I, Division 2 locations, utilization equipment, fixed and portable, shall conform to the following:

a. Heaters. Electrically-heated utilization equipment shall be approved for Class I locations.

b. Motors. Motors of motor-driven utilization equipment shall conform to 1.3(8) Class I, Division 2.

c. Switches, Circuit-Breakers, and Fuses. Switches, circuit-breakers and fuses shall conform to 1.3(6) Class I, Division 2.

1.3(11) Flexible Cords, Class I, Divisions 1 and 2. A flexible cord may be used only for connection between a portable lamp or other portable utilization equipment and the fixed portion of its supply circuit and where used shall (a) be of a type approved for extra hard usage, (b) contain, in addition to the conductors of the circuit, a grounding conductor conforming to the following:

Grounded Conductor Identification. One conductor of flexible cords shall have a continuous marker readily distinguishing it from the other conductor or conductors. The identification shall consist of one of the following:

Colored Braid. A braid finished to show a white or

natural gray color and the braid on the other conductor or conductors finished to show a readily distinguishable solid color or colors.

Tracer in Braid. A tracer in a braid of any color contrasting with that of the braid and no tracer in the braid of the other conductor or conductors. No tracer shall be used in the braid of any conductor of a flexible cord which contains a conductor having a braid finished to show white or natural gray, except in the case of Types C, PD, and PO cords having the braids on the individual conductors finished to show white or natural gray. In such C, PD, and PO cords the identifying marker may consist of the solid white or natural gray finish on one conductor provided there is a colored tracer in the braid of each other conductor.

Colored Insulation. A white or natural gray insulation on one conductor and insulation of a readily distinguishable color or colors on the other conductor or conductors for cords having no braids on the individual conductors (except cords which have insulation on the individual conductors integral with the jacket.) The insulation may be covered with an outer finish to provide the desired color.

Colored Separator. A white or natural gray separator on one conductor and a separator of a readily distinguishable solid color on the other conductor or conductors of cords having insulation on the individual conductors integral with the jacket.

Tinned Conductors. One conductor having the individual strands tinned and the other conductor or conductors having the individual strands untinned for cords having insulation on the individual conductors integral with the jacket.

Surface Marking. A stripe, ridge or groove so located on the exterior of the cord as to identify one conductor for cords having insulation on the individual conductors integral with the jacket.

(c) be connected to terminals or to supply conductors in an approved manner, (d) be supported by clamps or by other suitable means in such a manner that there will be no tension on the terminal connections, and, (e) suitable seals shall be provided where the flexible cord enters boxes, fittings or enclosures of explosion-proof type.

Refer to Section 1.3(13) when flexible cords are exposed to liquids having a deleterious effect on the conductor insulation.

1.3(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.

1.3(13) Conductor Insulation Class I, Divisions 1 and 2. Where condensed vapors or liquids may collect on or come in contact with the insulation on conductors, such insulation shall be of a type approved for use under such conditions or the insulation shall be protected by a sheath of lead or by other approved means.

1.3(14) Signal, Alarm, Remote-Control and Communication Systems. Signal, alarm, remote-control, and communication systems shall conform to the following:

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 1.3(4) Class I, Division 1 and 1.3(5) Class I, Division 1, and Class I, Divisions 1 and 2.

Class I, Division 2. In Class I, Division 2 locations, signal, alarm, remote-control and communication systems shall conform to the following:

a. Contacts. Switches and circuit breakers, and make and break contacts of push buttons, relays, and alarm

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

b. Resistors and Similar Equipment. Resistors, resistance devices, thermionic tubes and rectifiers shall conform to 1.3(3) b.

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

d. All wiring shall conform to 1.3(4) Class I, Division 2, 1.3(5) Class I, Division 2 and Class I, Divisions 1 and 2.

1.3(15) Live Parts, Class I, Divisions 1 and 2. There shall be no exposed live parts.

1.3(16) Grounding, Class I, Divisions 1 and 2. Wiring and equipment shall be grounded in conformity with the following:

a. Exposed Parts. The exposed noncurrent-carrying metal parts of equipment such as the frames or metal exteriors of motors, fixed or portable lamps or other utilization equipment, lighting fixtures, cabinets, cases, and conduit, shall be grounded to prevent a potential above ground on the equipment.

b. Bonding. The locknut-bushing and double-locknut types of contacts shall not be depended upon for bonding purposes, but bonding jumpers with proper fittings or other approved means shall be used. Such means of bonding shall apply to all intervening raceways, fittings, boxes, and enclosures, between hazardous areas and the point of grounding for service equipment. Where flexible conduit is

used as permitted in 1.3(4) Class I, Division 2 bonding jumpers with proper fitting shall be provided around such conduit.

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

Also refer to 1.4(3).

d. 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.

e. 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 an ampacity not less than 1/5 that of the service conductors, and shall in no case be smaller than No. 10 when of soft copper, or No.12 when of medium or hard-drawn copper.

f. Multiple Grounds. Where it is necessary to abandon one or more grounding connections to avoid objectionable passage of current over the grounding conductors, the connection required in 1.3(16) d and e shall not be aban-

doned while any other grounding connection remains connected to the supply system.

1.4(88A) Class II Installations.

1.4(1) General. This Rule shall apply to the installation of electrical wiring and apparatus in locations classified as Class II under 1.2(88A), except as modified by this section.

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

Equipment and wiring of the type defined in 1.1(88A) as explosion-proof is not required in Class II locations, and may not be acceptable unless approved for such locations.

1.4(2) Transformers and Capacitors. The installation of transformers and capacitors shall conform to the following:

a. Class II, Division 1. In Class II, Division 1 locations, transformers and capacitors shall conform to the following:

(1) Containing a Liquid That Will Burn. Transformers and capacitors containing a liquid that will burn shall be installed only in approved vaults conforming to Sections 1.3(2), 1 to 5 inclusive, and in addition (a) 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, (b) vent openings and ducts shall communicate only with the outside air, and (c) suitable pressure-relief openings communicating with the outside air shall be provided.

(2) Not Containing a Liquid That Will Burn. Transformers and capacitors which do not contain a liquid that will burn shall (a) be installed in vaults conforming to 1.3(2), 1 to 5 inclusive, or (b) be approved as a complete assembly including terminal connections for Class II locations.

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

b. Class II, Division 2. In Class II, Division 2 locations, transformers and capacitors shall conform to the following:

(1) Containing a Liquid That Will Burn. Transformers and capacitors containing a liquid that will burn shall be installed in vaults conforming to 1.3(2), 1 to 5 inclusive.

(2) Containing Askarel. Transformers containing askarel and rated in excess of 25 kva shall (a) be provided with pressure-relief vents, (b) 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 (c) have an air space of not less than 6 inches between the transformer cases and any adjacent combustible material.

(3) Dry-type Transformers. Dry-type transformers shall be installed in vaults or shall (a) have their windings and terminal connections enclosed in tight metal

housings without ventilating or other openings, and (b) operate at voltages not exceeding 600 volts.

1.4(3) Surge Protection, Class II, Divisions 1 and 2. In geographical locations where lightning disturbances are prevalent, wiring systems in Class II locations shall, when supplied from overhead lines, be suitably protected against high-voltage surges. This protection shall include suitable lightning protective devices, interconnection of all grounds, and surge-protective capacitors.

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

Surge protective capacitors shall be of a type especially designed for the duty, shall be connected to each ungrounded service conductor, and shall be grounded to the interior conduit system. Capacitors shall be protected by 30-ampere fuses of suitable type and voltage rating, or by automatic circuit breakers of suitable type and rating and shall be connected to the supply conductors on the supply side of the service disconnecting means.

1.4(4) Wiring Methods. Wiring methods shall conform to the following:

a. 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.

(1) Fittings and Boxes. Fittings and boxes shall be provided with threaded bosses or hubs 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.

(2) 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 fitting 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.

b. Class II, Division 2. In Class II, Division 2 locations, rigid metal conduit, electrical metallic tubing, type MI cable with approved termination fittings, or approved type MC or ALS cable with approved termination fittings for Class II locations shall be the wiring method employed.

(1) 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 (a) shall be provided with telescoping or close fitting covers, or other effective means to prevent the escape of sparks or

burning material, and (b) 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.

(2) Flexible Connections. Where flexible connections are necessary the provisions of 1.4(4) a (2) shall apply.

1.4(5) 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) permanent and effective seal, (2) a horizontal section not less than 10 feet long in the raceway, or (3) a vertical section of raceway not less than 5 feet long and extending downward from the dust-ignition-proof enclosure. Sealing fittings shall be accessible.

1.4(6) Switches, Circuit Breakers, Motor Controllers, and Fuses. Switches, circuit breakers, motor controllers and fuses shall conform to the following:

a. Class II, Division 1. In Class II, Division 1 locations, switches, circuit breakers, motor controllers and fuses shall conform to the following:

(1) 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.

This includes service and branch circuit fuses, switches and circuit breakers, motor controllers (including push buttons, pilot switches, relays, and motor overload

protective devices), and switches, fuses and circuit breakers for the control and protection of lighting and appliance circuits.

(2) 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, be equipped with telescoping or close fitting covers, or with other effective means to prevent the escape of sparks or burning material, and 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.

(3) 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.

b. 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 1.4(6)(a)2.

1.4(7) 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:

a. 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.

b. Class II, Division 2. In Class II, Division 2 locations, transformers and resistors shall conform to the following:

(1) Switching Mechanisms. Switching mechanisms (including overcurrent devices) associated with control transformers, solenoids, impedance coils and resistors, shall be provided with enclosures conforming to 1.4(6)(a)2.

(2) 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.

(3) 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.) nonadjustable resistors and resistors which are part of an automatically timed starting sequence may have enclosures conforming to 1.4(b) 2.

1.4(8) Motors and Generators. Motors and generators shall conform to the following:

a. 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 specifically approved for

such locations.

b. 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 Rule enforcing authority, only moderate accumulations of non-conducting, nonabrasive 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.

1.4(9) 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 USS gage, 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. In addition, vent pipes shall conform to the following:

a. 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 (1) riveted (or bolted) and soldered, (2) welded, or (3) rendered dust-tight by some other equally effective means.

b. Class II, Division 2. In Class II, Division 2 locations, vent pipes and their connections shall be sufficient-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.

1.4(10) Utilization Equipment, Fixed and Portable. Utilization equipment, fixed and portable, shall conform to the following:

a. Class II, Division 1. In Class II, Division 1 locations, utilization equipment, including electrically heated and motor-driven equipment, shall be dust-ignition-proof approved for Class II locations. Where dust from magnesium, aluminum, aluminum bronze powders, or other metals of similarly hazardous characteristics may be present, such equipment shall be specifically approved for such locations.

b. Class II, Division 2. In Class II, Division 2 locations, utilization equipment, fixed and portable, shall conform to the following:

(1) Heaters. Electrically heated utilization equipment shall be dust-ignition-proof approved for Class II locations.

(2) Motors. Motors of motor-driven utilization equipment shall conform to 1.4(8) b.

(3) Switches, Circuit Breakers and Fuses. Enclosures for switches, circuit breakers, and fuses shall conform to 1.4(6) (a) 2.

(4) Transformers, Impedance Coils and Resistors.

Transformers, solenoids, impedance coils and resistors shall conform to 1.4(7) b.

1.4(11) Lighting Fixtures. Lamps shall be installed in fixtures which shall conform to the following:

a. Class II, Division 1. In Class II, Division 1 locations, lighting fixtures for fixed and portable lighting shall conform to the following:

(1) 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.

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

(3) Pendant Fixtures. Pendant 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 pendant 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.

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

b. Class II, Division 2. In Class II, Division 2 locations, lighting fixtures shall conform to the following:

(1) 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.

(2) 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.

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

(4) Pendant fixtures. Pendant 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 pendant 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.

(5) Supports. Boxes, box assemblies and fittings

used for the support of lighting fixtures shall be approved for that purpose.

(6) Electric Discharge Lamps. Starting and control equipment for mercury vapor and fluorescent lamps shall conform to the requirement of 1.4(7) b.

1.4(12) Flexible Cords, Class II, Divisions 1 and 2. Flexible cords used in Class II locations shall (1) be of a type approved for extra hard usage, (2) contain, in addition to the conductors of the circuit, a grounding conductor conforming to Section 1.3(11), (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.

1.4(13) Receptacles and Attachment Plugs.

a. 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.

b. Class II, Division 2. In Class II, Division 2 locations, receptacles and attachment plugs shall be of the type provided 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.

1.4(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:

a. Class II, Division 1. In Class II, Division 1 loca-

tions, signal, alarm, remote-control and local loud-speaker intercommunication systems shall conform to the following:

(1) 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.

(2) 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.

(3) 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.

(4) Rotating Machinery. Motors, generators and other rotating electrical machinery shall conform to 1.4(8) a.

(5) Electrical Conducting Dusts. Where dusts are of an electrically conducting nature, all wiring and equipment shall be approved for Class II locations.

(6) Metal Dusts.. Where dust from magnesium, alumi-

num, aluminum bronze powders, or other metals of similarly hazardous characteristics may be present, all apparatus and equipment shall be specifically approved for such conditions.

b. 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:

(1) **Contacts.** Enclosures shall conform to 1.4(14)(a)2 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.

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

(3) **Resistors and Similar Equipment.** Resistors, resistance devices, thermionic tubes, and rectifiers shall conform to 1.4(14)(a)3 except that enclosures for thermionic tubes, nonadjustable resistors or rectifiers for which maximum operating temperature will not exceed 120°C. (248°F.) may be of general purpose type.

(4) **Rotating Machinery.** Motors, generators and other rotating electrical machinery shall conform to 1.4(8)b.

1.4(15) **Live Parts, Class II, Divisions 1 and 2.** There shall be no exposed live parts.

1.4(16) **Grounding, Class II, Divisions 1 and 2.** Wiring and equipment shall be grounded in conformity with the following:

a. Exposed Parts. See 1.3(16)a.

b. Bonding. The locknut-bushing and double-locknut types of contact shall not be depended upon for bonding

purposes, but bonding jumpers with proper fittings, or other approved means shall be used. Such means of bonding shall apply to all intervening raceways, fittings, boxes, and enclosures, between hazardous areas and the point of grounding for service equipment. Where flexible conduit is used as permitted in 1.4(4), bonding jumpers with proper fittings shall be provided around such conduit.

c. 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.

d. Service Grounded Conductor Bonded to Raceway. Wiring in a Class II location, when supplied from a grounded alternating-current supply system in which a 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.

e. Transformer Ground Bonded to Raceway. Wiring in a Class II location, where supplied from a grounded alternating-current supply system in which no grounded conductor is a part of the service, shall be provided with a metallic connection between the supply system ground and the raceway system at the service entrance. The metallic connection shall have an ampacity not less than 1/5 that of the service conductors, and shall in no case be smaller than No. 10 when of soft copper, or No. 12 when of medium or hard-drawn copper.

f. Multiple Grounds. Where it is necessary to abandon one or more grounding connections to avoid objectionable passage, of current over the grounding conductors, the

connection required in 1.4(16) d or e shall not be abandoned while any other grounding connection remains connected to the supply system.

1.5(88A) Class III Installations.

1.5(1) General. This Rule shall apply to the installation of electrical wiring and apparatus in locations classified as Class III under Section 1.2(5) except as modified, by this section.

Equipment installed in Class III locations shall 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 operating conditions shall not exceed 165°C. (329°F.) for equipment which is not subject to overloading, and 120°C. (248°F.) for equipment such as motors, and power transformers, which may be overloaded.

1.5(2) Transformers and Capacitors, Class III, Divisions 1 and 2. Transformers and capacitors shall conform to 1.4(2) b.

1.5(3) Wiring Methods. Wiring methods shall conform to the following:

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

(1) Boxes and Fittings. Fittings and boxes in which taps, joints or terminal connections are made shall be provided with telescoping or close fitting covers, or other effective means to prevent the escape of sparks or burning

material, and 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.

(2) Flexible Connections. Where flexible connections are necessary the provisions of 1.4(4)(a)2 shall apply.

b. Class III, Division 2. In Class III, Division 2 locations, the wiring method shall conform to 1.5(3)a, 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 the following:

Definition. Open wiring is a wiring method using cleats, knobs, tubes and flexible tubing for the protection and support of insulated conductors run in or on buildings, and not concealed by the building structure.

Use. Open wiring on insulators may be used for exposed work, either inside or outside building; in dry or wet locations; where subject to corrosive vapors such as covered by 1.7(7)a through g; for services provided the requirements of this section are satisfied.

Open wiring on insulators shall not be used (1) in commercial garages, (2) in theaters, (3) in motion-picture studios, (4) in hoistways, and (5) in hazardous locations, except in storage compartments of Class III locations as provided in 1.5(3)b.

Conductors. Only single conductors shall be used.

The allowable ampacities of insulated conductors (per manufacturer's specifications) shall apply to open wiring on insulators.

Supports.

Conductors shall not be in contact with any object

Separation from Metal Work. Open conductors shall be separated at least 2 inches from metallic conduit, piping, or other conducting material, and from any exposed lighting, power or signal conductor, or shall be separated therefrom by a continuous and firmly fixed nonconductor additional to the insulation of the conductor. Where any insulating tube is used, it shall be secured at the ends. Deviation from this requirement may, when necessary, be allowed by the authority enforcing these Rules.

Separation from Piping in Damp Locations. Open conductors located close to water pipes or tanks, or in other damp locations, shall be so placed that an air space will be permanently maintained between them and pipes, which they cross. Where practicable, conductors shall be installed over, rather than under, pipes upon which moisture is likely to gather or which may leak.

Protection from Physical Damage. Where open conductors cross ceiling joists and wall studs, and are exposed to physical damage, they shall be protected by one of the following methods. Conductors within 7 feet from the floor shall be considered exposed to physical damage.

By guard strips not less than 7/8 inch in thickness and at least as high as the insulating supports, placed on each side of and close to the wiring.

By a substantial running board at least 1/2 inch thick back of the conductors with side protections. Running boards shall extend at least 1 inch outside the conductors, but not more than 2 inches and the protecting sides shall be at least 2 inches high and at least 7/8 inch thick.

By boxing made as above and furnished with cover kept at least 1 inch away from the conductors within. Where protecting vertical conductors on side walls the boxing shall be closed at the top and the holes through which the conductors pass shall be bushed.

By rigid metal conduit, electrical metallic tubing, or by

metal piping, in which case the conductors shall be encased in continuous lengths of approved flexible tubing. The conductors passing through metal enclosures shall be so grouped that current in both directions is approximately equal.

In Accessible Attics. Conductors in unfinished attics or roof spaces shall be installed in accordance with the following:

Conductors in unfinished attics and roof spaces shall be run through or on the sides of joists, studs and rafters, except in attics and roof spaces having head room at all points of less than 3 feet in buildings completed before the wiring is installed.

Where conductors in accessible unfinished attics or roof spaces reached by stairway or permanent ladder are run through bored holes in floor joists or through bored holes in studs or rafters within 7 feet of the floor or floor joists, such conductors shall be protected by substantial running boards extending at least 1 inch on each side of the conductors and securely fastened in place.

Where carried along the sides of rafters, studs or floor joists, neither running boards nor guard strips will be required.

Entering Spaces Subject to Dampness, Wetness or Corrosive Vapors. Conductors entering or leaving locations subject to dampness, wetness or corrosive vapors shall have drip loops formed on them and shall then pass upward and inward from the outside of buildings, or from the damp, wet or corrosive location, through noncombustible, non-absorptive insulating tubes.

Switches.

Surface-type snap switches shall be mounted in accordance with the following:

Snap switches used with open wiring on insulators shall be mounted on sub-bases of insulating material which will separate the conductors at least ½ inch from the surface wired over. Metal boxes are not required.

Other types of switches shall be installed in accordance with the following:

Switches and circuit breakers shall be of the externally operable type enclosed in metal boxes or cabinets, except pendant and surface type snap switches and knife switches mounted on an open face switchboard or panelboard.

but only on condition that protection as required by 1.5(3)b, Protection from Physical Damage, be provided where conductors are not run in roof spaces, and well out of reach of sources of physical damage.

1.5(4) 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.

1.5(5) 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 1.4(7) b, 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 1.5(4).

1.5(6) Motors and Generators. Motors and generators shall conform to the following:

a. 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 judgement of the Rule enforcing 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.

b. 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.

c. 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.

1.5(7) 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 USS gage, 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 ap-

preciable 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.

1.5(8) Utilization Equipment, Fixed and Portable, Class III, Divisions 1 and 2. Utilization equipment shall conform to the following:

a. Heaters. Electrically heated utilization equipment shall be approved for Class III locations.

b. Motors. Motors of motor-driven utilization equipment shall conform to 1.5(6)b. Utilization equipment which may be readily moved from one location to another should conform to requirements for the most hazardous location.

c. Switches, Circuit Breakers, Motor Controllers and Fuses. Switches, circuit breakers, motor controllers and fuses shall conform to 1.5(4).

1.5(9) Lighting Fixtures, Class III, Divisions 1 and 2. Lamps shall be installed in fixtures which shall conform to the following:

a. 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 show wattage of lamp which may be used without exceeding a maximum exposed surface temperature of 165°C. (329°F.) under operating conditions of use.

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

c. Pendant Fixtures. Pendant 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.

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

e. 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 1.5(9)a.

1.5(10) Flexible Cords, Class III, Divisions 1 and 2. Flexible cords shall conform to 1.4(12).

1.5(11) Receptacles and Attachment Plugs, Class III, Divisions 1 and 2. Receptacles and attachment plugs shall conform to 1.4(13)b.

1.5(12) Signal, Alarm, Remote-Control and Local Loud-Speaker Intercommunication Systems, Class III, Divisions 1 and 2. Signal, alarm, remote-control and local loud-speaker intercommunication systems shall conform to 1.4(14)a.

1.5(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:

a. 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.

b. 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.

c. 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.

d. Control equipment shall conform to 1.5(4) and 1.5(5).

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.

1.5(14) Electric Trucks. Electric trucks shall be used, maintained and operated according to the Manufacturer's Instructions.

1.5(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.

1.5(16) Live Parts, Class III, Divisions 1 and 2. There shall be no exposed live parts except as provided in 1.5(13).

1.5(17) Grounding, Class III, Divisions 1 and 2. Wiring and equipment shall be grounded in conformity with 14(16).

1.6(88A) Hazardous Locations — Specific.

1.6(1) Scope. The provisions of 1.7(88A), 1.8(88A), 1.9(88A), 1.10(88A), 1.11(88A), and 1.12(88A), 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 ignitable. It is the intent to assist Rule enforcing authorities in the classification of areas with respect to hazardous conditions which may or may not require construction and equipment conforming to 1.3(88A) through 1.5(88A) of Hazardous Locations, and to set forth such additional special requirements as are applicable to the specific occupancy.

1.6(2) General. These Rules shall apply to the installation of electrical wiring and equipment in occupancies within the scope of 1.7(88A), 1.8(88A), 1.9(88A), 1.10(88A), 1.11(88A), and 1.12(88A), inclusive, except as such rules are modified in those Sections. Where unusual conditions exist in a specific occupancy, the authority enforcing these Rules shall judge with respect to the application of specific rules.

1.7(88A) Commercial Garages, Repair and Storage.

1.7(1) Scope. These occupancies shall include locations used for service and repair operations in connection with self-propelled vehicles (including passenger automobiles, buses, trucks, and tractors) in which volatile flammable liquids or flammable gases are used for fuel or power, and locations in which more than three such ve-

hicles are or may be stored at one time.

1.7(2) Hazardous Areas. Classification under 1.2(88A).

a. 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.

b. 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 authority enforcing these Rules may judge that the hazardous location extends up to a level of only 18 inches above each such floor.

c. 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 any unventilated pit or depression may be judged by the authority enforcing these Rules to be a Class I, Division 1 location.

d. 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.

1.7(3) Wiring and Equipment in Hazardous Areas. Within hazardous areas as defined in 1.7(2), wiring and equipment shall conform to applicable provisions of 1.3(88A), Hazardous Locations.

1.7(4) Sealing. Approved seals conforming to the requirements of 1.3(5) shall be provided, and 1.3(5) Class I, Division 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.

1.7(5) Wiring in Spaces Above Hazardous Areas.

a. All fixed wiring shall be in metallic raceways or shall be Type MI or Type ALS 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.

b. For pendants, flexible cord suitable for the type of service and approved for hard usage shall be used.

c. For connection of portable lamps, motors or other utilization equipment, flexible cord suitable for the type of service and approved for extra hard usage shall be used.

d. When a circuit which supplies portables or pendants includes an identified grounded conductor, 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 utilization equipment supplied.

e. When a pendant is used to supply a portable lamp or utilization equipment, 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 1.7(2). Attachment plug receptacles in fixed position shall be located above the level specified in 1.7(2).

1.7(6) Equipment Above Hazardous Areas.

a. 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 (excluding lamps and lampholders) 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.

b. 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.

c. 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 nonconducting 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 1.7(2), they shall be of a type approved for such hazardous locations.

1.7(7) Battery-Charging Equipment. Battery chargers and their control equipment, and batteries being charged shall not be located within hazardous areas classified in 1.7(2). Tables, racks, trays, and wiring shall, in addition, conform to the following:

a. Scope. The provisions of this Rule shall apply to all stationary installations of storage batteries using acid

or alkali as the electrolyte and consisting of a number of cells connected in series with a nominal voltage in excess of 16 volts.

b. Definition of Nominal Battery Voltage. The nominal battery voltage shall be calculated on the basis of 2.0 volts per cell for the lead-acid type, and 1.2 volts per cell for the alkali type.

c. Wiring and Apparatus Supplied from Batteries. Wiring, appliances, and apparatus supplied from storage batteries shall be subject to the requirements of these Rules applying to wiring, appliances, and apparatus operating at the same voltage.

d. Insulation of Batteries of Not Over 250 Volts. The provisions of this Section shall apply to storage batteries having the cells so connected as to operate at a nominal battery voltage not exceeding 250 volts.

(1) Lead-Acid Batteries. Cells in lead-lined wood tanks, where the number of cells in series does not exceed 25, shall be supported individually on glass or glazed porcelain insulators. Where the number of the cells in series exceeds 25, the cells shall be supported individually on oil insulators.

(2) Alkali-Type Batteries. Cells of the alkali type in jars made of conducting material shall be installed in trays of nonconducting material, with not over 20 cells in a series circuit in any one such tray, or the cells may be supported singly or in groups on porcelain or other suitable insulators.

(3) Unsealed Jars. Cells in unsealed jars made of nonconductive material shall be assembled in trays of glass or supported on glass or glazed porcelain insulators; or, where installed on a rack, shall be supported singly or in groups on glass or other suitable insulators.

(4) Sealed Rubber Jars. Cells in sealed rubber or

composition containers shall require no additional insulating support where the total nominal voltage of all cells in series does not exceed 150 volts. Where the total voltage exceeds 150 volts, batteries shall be sectionalized into groups of 150 volts or less and each group shall have the individual cells installed in trays or on racks. Where trays or racks are required for this type of cell, such trays or racks shall be supported on glass or glazed porcelain insulators or oil-type insulators.

(5) Sealed Glass or Plastic Jars. Cells in sealed glass jars or in sealed jars of approved heat-resistant plastic, with or without wood trays, require no additional insulation.

e. Insulation of Batteries of Over 250 Volts. The provisions of 1.7(7)d shall apply to storage batteries having the cells so connected as to operate at a nominal voltage exceeding 250 volts and, in addition, the provisions of this section shall also apply to such batteries. Cells shall be installed in groups having a total nominal voltage of not over 250 volts, in trays or on racks supported on oil insulators.

Exception No. 1. Where each individual cell, or subgroup in the tray or rack, is supported on oil insulators, no additional insulation for the group need be provided.

Exception No. 2. Cells of not over 10 ampere-hour capacity in sealed glass jars may be grouped in trays, the total nominal voltage of all cells in such group not to exceed 250 volts, and each such tray to be supported on glass or glazed porcelain insulators, the trays being mounted on racks supported on oil insulators with a total nominal voltage of not over 500 volts for all cells in series on each such insulated rack.

Maximum protection is secured by sectionalizing high-voltage batteries into cell groups insulated from each other.

f. Racks and Trays. Racks and trays shall conform to the following:

(1) Racks. Racks, as required in this Rule, refer to frames designed to support cells or trays. They shall be substantial, and made of:

Wood, so treated as to be resistant to deteriorating action by the electrolyte; or

Metal, so treated as to be resistant to deteriorating action by the electrolyte, and provided with nonconducting members directly supporting the cells or with suitable insulating material on conducting members; or

Other similar suitable construction.

(2) Trays. Trays refer to frames such as crates or shallow boxes usually of wood or other nonconducting material, so constructed or treated as to be resistant to deteriorating action by the electrolyte.

g. Battery Rooms. Battery rooms shall conform to the following:

(1) Use. Separate battery rooms or enclosures shall be required only for batteries in unsealed jars and tanks where the aggregate capacity at the 8-hour discharge rate exceeds 5 kilowatt hours.

(2) Ventilation. Provision shall be made for sufficient diffusion and ventilation of the gases from the battery to prevent the accumulation of an explosive mixture in the battery room.

(3) Wiring Method. In storage battery rooms, bare conductors, open wiring, Type MI cable, Type ALS cable, or conductors in rigid conduit or electrical metallic tubing shall be used as the wiring method. Rigid metal conduit, or electrical metallic tubing, where used, shall be of corrosion-resistant material or shall be suitably protected

from corrosion.

(4) Varnished-Cambric Conductors. Varnished-cambric-covered conductors, Type V, shall not be used.

(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.

1.7(8) Electric Vehicle Charging.

a. Flexible cords used for charging shall be suitable for the type of service and approved for extra hard usage. Their ampacity shall be adequate for the charging current.

b. Connectors shall have a rating not less than the ampacity of the cord, and in no case less than 50 amperes.

c. 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 1.7(2).

d. Where plugs are provided for direct connection to vehicles, the point of connection shall not be within a hazardous area as defined in 1.7(2), 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.

1.8(88A) Hazardous Locations — Aircraft Hangars.

1.8(1) 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.

1.8(2) Hazardous Areas. Classification under 1.2(88A).

a. 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.

b. 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.

c. 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.

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

1.8(3) 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 1.8(2) shall conform to applicable provisions of 1.3(88A). 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.

1.8(4) Wiring Not Within Hazardous Areas.

a. All fixed wiring in a hangar, but not within a hazardous area as defined in 1.8(2), shall be installed in metallic raceways or shall be Type MI or Type ALS cable, except that wiring in nonhazardous locations as defined in 1.8(2)d may be of general purpose type.

b. 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.

c. For portable utilization equipment 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.

d. Where a circuit which supplies portables or pendants includes an identified grounded conductor, 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 utilization supplied. Acceptable means shall be provided for maintaining continuity of the grounding conductor between the fixed raceway system and the noncurrent-carrying metallic portions of pendant fixtures, portable lamps, and portable utilization equipment.

1.8(5) Equipment Not Within Hazardous Areas.

a. In locations other than those described in 1.8(2),

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 1.8(2)d, may be of general purpose type.

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

c. Portable Lamps which are or may be used within a hangar shall be approved for Class I locations.

d. Portable utilization equipment which is or may be used within a hangar shall be of a type suitable for use in Class I, Division 2 locations.

1.8(6) Stanchions, Rostrums and Docks.

a. 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 1.8(2)c shall conform to the requirements for Class I, Division 2 locations.

b. Where stanchions, rostrums, or docks are not located or likely to be located in a hazardous area as defined in 1.8(2)c, wiring and equipment shall conform to 1.8(4) and 1.8(5), except that such wiring and equipment not more than 18 inches above the floor in any position shall conform to 1.8(6)a. Receptacles and attachment plugs shall be of locking type which will not break apart readily.

c. Mobile stanchions with electrical equipment conforming to 1.8(6) shall carry at least one permanently affixed warning sign to read: "WARNING—KEEP 5 FEET CLEAR OF AIRCRAFT ENGINES AND FUEL TANK AREAS."

1.8(7) Sealing. Approved seals shall be provided in conformance with 1.3(5) Class I, Division 1, c, and 1.3(5), Class I, Division 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.

1.8(8) 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.

1.8(9) Aircraft Battery — — Charging and Equipment.

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

b. Battery chargers and their control equipment shall not be located or operated within any of the hazardous areas defined in 1.8(2), and should preferably be located in a separate building or in an area such as described in 1.8(2)d. 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 1.7(7).

1.8(10) External Power Sources for Energizing Aircraft.

a. 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 1.8(2)c.

b. 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."

c. 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 grounding power unit.

d. Flexible cords for aircraft energizers and ground support equipment shall be approved for the type of service and extra hard usage and shall include a ground conductor.

1.8(11) Mobile Servicing Equipment with Electrical Components.

a. Mobile servicing equipment (such as vacuum cleaners, air compressors, and air movers) 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 1.8(2)c and shall carry at least one permanently affixed warning sign to read: "WARNING—KEEP 5 FEET CLEAR OF AIRCRAFT ENGINES AND FUEL TANK AREAS."

b. 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.

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

1.8(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 1.3(16)a.

1.9(88A) Gasoline Dispensing and Service Stations.

1.9(1) Definitions. 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.

Other areas used as lubricatoriums, service rooms and repair rooms, and offices, salesrooms, compressor rooms and similar locations shall conform to 1.6(88A) and 1.7(88A) with respect to electrical wiring and equipment.

Where the authority enforcing these Rules can satisfactorily determine that flammable liquids having a flash point below 100°F. such as gasoline will not be handled, he may classify such an area as nonhazardous.

1.9(2) Hazardous Areas.

a. The space within the dispenser up to 4 feet from its base and the space within 18 inches extending horizontally from the dispenser up to 4 feet from its base shall be considered a Class I, Division 1 location. This classification shall also apply to any space below the dispenser which may contain electrical wiring or equipment.

b. In an outside location, any area (excluding Class I, Division 1, but including buildings not suitably cut off) within 20 feet horizontally from the exterior enclosure of any dispensing pump shall be considered a Class I, Division 2 location which will extend to a level 18 inches above driveway or ground level.

c. In an outside location, any area (excluding Class I, Division 1, but including buildings not suitably cut off) within 10 feet horizontally from any tank fill-pipe shall be considered a Class I, Division 2 location which shall extend upward to a level 18 inches above driveway or ground level.

d. Electrical wiring and equipment, any portion of which is below the surface of areas defined as Class I, Division 1 or Division 2 in 1.9(2)a, b, and c above shall be considered to be within a Class I, Division 1 location which shall extend at least to the point of emergence above grade.

e. The spherical volume within a three foot radius from point of discharge of any tank vent-pipe shall be considered a Class I, Division 1 location and the volume between three foot to five foot radius from point of discharge of a vent shall be considered a Class I, Division 2 location. For any vent that does not discharge upward, the cylindrical volume below both the Division 1 and 2 locations extending to the ground shall be considered a Class I, Division 2 location. The hazardous area shall not extend beyond an unpierced wall.

1.9(3) Wiring and Equipment Within Hazardous Areas. All electrical equipment and wiring within the hazardous areas defined in 1.9(2) shall conform to applicable provisions of 1.3(88A).

For special requirements for conductor insulation, see 1.3(13).

1.9(4) Wiring and Equipment Above Hazardous Areas. Wiring and equipment above hazardous areas defined in

1.9(2) shall conform to 1.7(5) and 1.7(6).

1.9(5) Circuit Disconnects. Each circuit leading to or through a dispensing pump 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.

1.9(6) Sealing.

a. An approved seal shall be provided in each conduit run entering or leaving a dispenser or any cavities or enclosures in direct communication therewith. The sealing fitting shall be the first fitting after the conduit emerges from the earth or concrete.

b. Additional seals shall be provided in conformance with 1.3(5), 1.3(5) Class I, Division 1, c and 1.3(5) Class I, Division 2, b, shall apply to horizontal as well as to vertical boundaries of the defined hazardous areas.

1.9(7) Grounding. Metallic portions of dispensing pumps, metallic raceways, and all noncurrent-carrying portions of electrical equipment regardless of voltage, shall be grounded as provided in 1.3(16)a.

1.9(8) 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 provided the potential is 600 volts or less. Where non-metallic conduit is used, an additional ground conductor shall be included to provide for metallic continuity of the raceway system and for grounding of noncurrent-carrying metallic parts of equipment.

1.10(88A) Bulk-Storage Plants.

1.10(1) 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).

1.10(2) Hazardous Areas.

a. Pumps, Bleeders, Withdrawal Fittings, Meters and Similar Devices.

(1) Adequately ventilated indoor areas containing pumps, bleeders, withdrawal fittings, meters and similar devices which are located in pipe lines handling flammable liquids under pressure shall be considered as Class I, Division 2 locations within a five foot distance extending in all directions from the exterior surface of such devices. The Class I, Division 2 location shall also extend 25 feet horizontally from any surface of these devices and extend upward to three feet above floor or grade level.

(2) Inadequately ventilated indoor areas containing pumps, bleeders, withdrawal fittings, meters and similar devices which are located in pipe lines handling flammable liquids under pressure shall be considered as Class I, Division 1 location within a five foot distance extending in all directions from the exterior surface of such devices. The Class I, Division 1 location shall also extend 25 feet horizontally from any surface of the devices and extend upward to three feet above floor or grade level.

(3) Outdoor areas containing pumps, bleeders, withdrawal fittings, meters and similar devices which are located in pipe lines handling flammable liquids under pressure shall be considered as Class I, Division 2 locations within a three foot distance extending in all directions from the exterior surface of such devices. The Class I, Division 2 location shall also extend up to 18 inches above grade level within 10 feet horizontally from any surface of the devices.

b. Transfer of Flammable Liquids to Individual Containers.

(1) In outdoor areas or where positive and reliable mechanical ventilation is provided in indoor areas in which flammable liquids are transferred to individual containers, such areas shall be considered to be a Class I, Division 1 location within three feet of the vent or fill opening extending in all directions and a Class I, Division 2 location within the area extending between a three foot and five foot radius from the vent or fill opening extending in all directions, and including the area within a horizontal radius of 10 feet from the vent or fill opening and extending to a height of 18 inches above floor or grade levels.

(2) When positive and reliable mechanical ventilation is not provided in indoor areas in which flammable liquids are transferred to individual containers, such areas shall be considered to be a Class I, Division 1 location.

c. Loading and Unloading of Tank Vehicles and Tank Cars in Outside Locations.

(1) The area extending three feet in all directions from the dome when loading through an open dome or from the vent when loading through a closed dome with atmospheric venting shall be considered a Class I, Division 1 location.

(2) The area extending between a three foot and five foot radius from the dome when loading through an open dome or from the vent when loading through a closed dome with atmospheric venting shall be considered a Class I, Division 2 location.

(3) The area extending within three feet in all directions from a fixed connection used in bottom loading or unloading, loading through a closed dome with atmospheric venting, or loading through a closed dome with a vapor recovery system, shall be considered a Class I, Division 2 location. In the case of bottom loading or unloading this classification shall also be applied to the area within a 10 foot radius from point of connection and extending 18 inches above grade.

In deciding upon extent of hazardous area, consideration should be given to the total area within which loading and unloading operation may occur such as racks, platforms, and driveways.

d. Aboveground Tanks.

(1) The area above the roof and within the shell of a floating roof type tank shall be considered a Class I, Division 1 location.

(2) For all types of aboveground tanks the area within 10 feet from the shell, ends and roof of other than a floating roof shall be considered a Class I, Division 2 location. Where dikes are provided the area inside the dike and extending upward to the top of the dike shall be considered to be a Class I, Division 2 location.

(3) The area within five feet of a vent opening and extending in all directions shall be considered a Class I, Division 1 location.

(4) The area between five and 10 feet of a vent opening and extending in all directions shall be considered a Class I, Division 2 location.

For underground tanks see 1.9(88A).

e. Pits.

(1) Any pit or depression, any part of which lies within a Division 1 or Division 2 location as defined herein, shall be considered a Class I, Division 1 location unless provided with positive and reliable mechanical ventilation.

(2) Any such areas when provided with positive and reliable mechanical ventilation shall be considered a Class I, Division 2 location.

(3) Any pit or depression not within a Division 1 or

Division 2 location as defined herein, but which contains piping, valves or fittings shall be classified as a Class I, Division 2 location.

f. Storage and Repair Garages for Tank Vehicles shall be considered to be a Class I, Division 2 location up to 18 inches above floor or grade level unless in the judgment of the authority enforcing these Rules conditions warrant more severe classification or a greater extent of the hazardous area.

g. 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.

1.10(3) Wiring and Equipment Within Hazardous Areas. All electrical wiring and equipment within the hazardous areas defined in 1.10(2) shall conform to applicable provisions of 1.3(88A).

1.10(4) Wiring and Equipment Above Hazardous Areas. All fixed wiring above hazardous areas shall be in metallic raceways or shall be Type ALS cable. 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 utilization equipment, and their flexible cords shall conform to the provisions of 1.3(88A) for the class of location above which they are connected or used.

1.10(5) Underground Wiring.

a. Underground wiring shall be installed in rigid metal conduit or, where buried under not less than 2 feet of earth,

may be installed in nonmetallic 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 above ground raceway.

b. Conductor insulation shall conform to 1.3(13).

c. Where cable with nonmetallic sheath or nonmetallic conduit is used, an additional grounding conductor shall be included to provide for metallic continuity of the raceway system and for grounding of noncurrent-carrying metallic parts of equipment.

1.10(6) Sealing. Approved seals shall be provided in conformance with 1.3(5), Class I, Division 1, a, and 1.3(5) Class I, Division 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.

1.10(7) Gasoline Dispensing. Where gasoline dispensing is carried on in conjunction with bulk station operations, applicable provisions of 1.9(88A) shall apply.

1.10(8) Grounding. All metallic raceways, and all noncurrent-carrying metallic portions of electrical equipment shall be grounded as provided in 1.3(16)a.

1.11(88A) Finishing Processes.

1.11(1) Definition. This section 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.

1.11(2) Hazardous Areas. Classification with respect to flammable vapors. For deposits and residues, see 1.11(3).

a. The interiors of spray booths and their exhaust ducts, all space within 20 feet horizontally in any direction from spraying operations more extensive than touch-up spraying and not conducted within spray booths, all space within 20 feet horizontally in any direction from dip tanks

and their drain boards, and all other spaces where hazardous concentrations of flammable vapors are likely to occur, shall be considered to be Class I, Division 1 locations.

b. All space within 20 feet horizontally in any direction from the open face of a spray booth, and all space within the room but beyond the limits for Class I, Division 1 as defined in 1.11(2)a for extensive open spraying, for dip tanks and drain boards and for other hazardous operations, shall be considered to be Class I, Division 2 locations unless the authority enforcing these Rules judge otherwise.

c. 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 nonhazardous unless the Rule enforcing authority judges otherwise.

d. 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 electric equipment (other than equipment approved for Class I locations) in case the ventilating equipment is inoperative, may be classed as nonhazardous when the Rule-enforcing authority so judges.

1.11(3) Wiring and Equipment in Hazardous Areas.

a. All electrical wiring and equipment within the hazardous areas defined in 1.11(2) shall conform to applicable provisions of 1.3(88A).

b. Unless approved for both readily ignitable deposits and the flammable vapor location, no electrical equipment shall be installed or used where it may be subject to hazardous accumulations of readily ignitable 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. Type MI cable without fittings or boxes may be used.

c. Illumination of readily ignitable 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.

d. Portable electric lamps or other utilization equipment shall not be used within a hazardous area during operation of the finishing process. When such lamps or utilization equipment 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.

e. Electrostatic spraying or detearing equipment shall be installed and used only as provided in 1.11(4).

1.11(4) Fixed Electrostatic Equipment. Where electrostatic spraying and detearing equipment is installed, such equipment shall be of approved type, and shall conform to the following requirements.

a. 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 1.11(2) unless of a type approved for location.

b. 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 nonporous noncombustible insulators.

1.11(6) Wiring and Equipment Above Hazardous Areas.

a. All fixed wiring above hazardous areas shall be in metallic raceways or shall be Type MI cable or Type ALS 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.

b. 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.

1.11(7) 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 1.3(16)a.

1.12(88A) Flammable Anesthetics.

1.12(1) Definition. 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.

1.12(2) Hazardous Areas.

a. 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.

b. In an anesthetizing location as defined in 1.12(1), 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.

1.12(3) Wiring and Equipment Within Hazardous Areas.

a. In hazardous areas as defined in 1.12(2), all fixed wiring and equipment, and all portable equipment, including lamps and other utilization equipment, operating at more than 8 volts between conductors, shall conform to the requirements of 1.3(1) to 1.3(15), inclusive and of 1.3(16)a and b, for Class I, Division 1 locations, and all such equipment shall be specifically approved for the hazardous atmospheres involved.

b. 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.

c. Flexible cords which are or may be used in hazardous areas for connection to portable utilization equipment, including 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 conductor for grounding. 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.

d. 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 location.

1.12(4) Wiring and Equipment Above Hazardous Areas.

a. Wiring above a hazardous area as defined in 1.12(2) b shall be installed in metal raceways or shall be Type MI cable or Type ALS cable.

b. 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.

c. Surgical and other lighting fixtures shall conform to 1.3(9) Class I, Division 2, except that surface temperature limitations set forth in 1.3(9) Class I, Division 2 (b) shall not apply, and except that integral or pendant switches which are located above and cannot be lowered into the hazardous area need not be explosion-proof.

1.12(5) Sealing. Approved seals shall be provided in conformance with 1.3(5) and 1.3(5) Class I, Division 1 c, and shall apply to horizontal as well as to vertical boundaries of the defined hazardous areas.

Exception. Seals may be located within 18 inches of the point at which a conduit emerges from a wall forming the boundary of an anesthetizing location if all of the following conditions are met.

The junction box switch or receptacle contains a seal-off device between the arcing contacts and the conduit.

The conduit is continuous (without coupling or fitting) between the junction box and the sealing fitting within 18 inches of the point where the conduit emerges from the wall.

1.12(6) Circuits in Anesthetizing Locations.

a. Except as provided in 1.12(6)e, each circuit within or partially within an anesthetizing location as defined in 1.12(1)b 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.

b. 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.

c. Transformers, motor-generator sets, batteries and battery chargers, together with their overcurrent devices shall be installed in nonhazardous locations, and shall conform to the requirements of 1.7(7).

d. 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.

e. Branch circuits supplying only fixed lighting fixtures above the hazardous location other than surgical lighting fixtures or supplying only approved permanently

installed X-ray equipment may be supplied by a conventional grounded 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) are located at least eight feet above the floor or outside the anesthetizing location; and (c) switches for the grounded circuits are located outside of the anesthetizing location.

Note: Remote control stations for remote control switches may be installed in the anesthetizing location if the remote control circuit is energized from the ungrounded distribution system.

1.12(7) Low Voltage Equipment and Instruments.

a. 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.

b. Where a low voltage unit receives current from an individual transformer located within a hazardous area, the flexible cord shall conform to 1.12(3)d, the core and case of the transformer shall be effectively grounded, and the transformer shall be approved for Class I locations.

c. 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 nonhazardous 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 ampacity, and shall be approved for extra hard usage. An extra con-

ductor for grounding is not required.

d. 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.

e. 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 conditions reach a surface temperature exceeding eighty per cent (80%) of the lowest ignition temperature in degrees Centigrade of the gases or vapors that may be present, the unit shall be of a type approved for Class I locations.

1.12(8) Other Equipment.

a. Suction, pressure, or insufflation equipment involving electrical elements, and located or used within a hazardous area shall be approved for Class I locations.

b. X-ray equipment installed or operated in an anesthetizing location as defined in 1.12(1)b, 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.

c. Equipment for generating high frequency currents or voltages such as used in electrocautery, diathermy, and television, where installed or used in an anesthetizing location, shall conform to 1.12(3) and 1.12(4).

1.12(9) Grounding. In any hazardous area, all metallic

raceways, and all noncurrent-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 1.3(16) a and b.

This rule is intended to implement Chapter 88A of the Code of Iowa (as provided above). These rules shall become effective immediately as provided in Chapter 17A of the Code after filing in the office of the Secretary of State after review by the Departmental Rules Review Committee.

