

# **ELECTRICAL SAFETY**



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**INTRODUCTION**

**REGULATORY AUTHORITY FOR IMPLEMENTATION OF**

**ELECTRICAL SAFETY**

The Occupational Safety and Health Act under 29 CFR 1926.400 through 29 CFR 1926.449 establishes the requirements relative to safety and health procedures when working with electricity and/or electrical powered tools in the construction industry. In response to the regulatory mandate, Steingass Mechanical Contracting, Inc. has developed and will maintain an Electrical Safety Program to provide proper safety and health procedures for all applicable employees.

All employees must use ground fault circuit interrupters at all times. Violation of this policy will be considered a work rule violation and disciplinary action up to and including suspension or discharge from employment will be taken.

## **ELECTRICAL SAFETY**

### ***PURPOSE***

This document is primarily intended to outline methods of protecting and/or informing all Steingass Mechanical Contracting, Inc. employees whose job requires them to work with electricity and/or electrical powered equipment. In addition, it is the intent that Steingass Mechanical Contracting, Inc. be in full compliance with the OSHA Construction Standards 29 CFR 1926.400 through 29 CFR 1926.449.

### **RESPONSIBILITY**

#### ***(Management Commitment)***

Steingass Mechanical Contracting, Inc. shall instruct all appropriate employees in the safety significance of the Electrical Safety Program. Steingass Mechanical Contracting, Inc. considers these requirements to be of critical importance in helping to insure that the applicable provisions of the Electrical Safety Program are known, understood, and adhered to by all employees. It shall be the responsibility of the general superintendent and all construction site superintendents to ensure that all requirements of this program are being followed and any deviations or inadequacies are corrected.

## **PROGRAM ELEMENTS**

Steingass Mechanical Contracting, Inc. has developed and will maintain a written Electrical Safety Program with the intention of being in full compliance with OSHA's Construction Safety Standards 29 CFR 1926.400 through 29 CFR 1926.449. The elements shall be addressed and in addition, it is intended to serve as guidelines for employee training relative to the Standards.

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## I. GLOSSARY OF TERMS

**Acceptable:** An installation or equipment is acceptable to the Assistant Secretary of Labor, and approved within the meaning of this Subpart K of 29 CFR 1926.

- (a) If it is accepted, or certified, or listed, or labeled, or otherwise determined to be safe by a qualified testing laboratory capable of determining the suitability of materials and equipment for installation and use in accordance with this Standard; or
- (b) With respect to an installation or equipment of a kind which no qualified testing laboratory accepts, certifies, lists, labels, or determines to be safe, if it is inspected or tested by another Federal agency, or by a State, municipal, or other local authority responsible for enforcing occupational safety provisions of the National Electrical Code, and found in compliance with those provisions; or
- (c) With respect to custom-made equipment or related installations which are designed, fabricated for, and intended for use by a particular customer, if it is determined to be safe for its intended use by its manufacturer on the basis of test data that the employer keeps and makes available for inspection to the Assistant Secretary and his authorized representatives.

**Accepted:** An installation is "accepted" if it has been inspected and found to be safe by a qualified testing laboratory.

**Accessible:** (As applied to wiring methods.) Capable of being removed or exposed without damaging the building structure or finish, or not permanently closed in by the structure or finish of the building. **(See "concealed" and "exposed.")**

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

**Ampacity:** The current in amperes a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

**Appliances:** 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.

**Approved:** Acceptable to the authority enforcing this Subpart. The authority enforcing this Subpart is the Assistant Secretary of Labor for Occupational Safety and Health. The definition of "acceptable" indicates what is acceptable to the Assistant Secretary of Labor, and therefore approved within the meaning of this Subpart K of 29 CFR 1926.

**Askarel:** A generic term for a group of nonflammable synthetic chlorinated hydrocarbons used as electrical insulating media. Askarels of various compositional types are used. Under arcing conditions the gases produced, while consisting predominantly of noncombustible hydrogen chloride, can include varying amounts of combustible gases depending upon the askarel type.

**Attachment plug (Plug cap) (Cap):** A device, which, by insertion in a receptacle, established connection between the conductors of the attached flexible cord and the conductors, connected permanently to the receptacle.

**Automatic:** 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.

**Bare conductor. See "Conductor."**

**Bonding:** The permanent joining of metallic parts to form an electrically conductive path which will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.

**Bonding jumper:** A reliable conductor to assure the required electrical conductivity between metal parts required to be electrically connected.

**Branch circuit:** The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s).

**Building:** A structure which stands alone or which is cut off from adjoining structures by firewalls with all openings therein protected by approved fire doors.

**Cabinet:** An enclosure designed either for surface or flush mounting, and provided with a frame, mat, or trim in which a swinging door or doors are or may be hung.

**Certified:** Equipment is "*certified*" if it:

- (a) Has been tested and found by a qualified testing laboratory to meet applicable test standards or to be safe for use in a specified manner, and
- (b) Is of a kind whose production is periodically inspected by a qualified testing laboratory. Certified equipment must bear a label, tag, or other record of certification.

**Circuit breaker:**

- (a) (600 volts nominal, or less.) A device designed to open and close a circuit by nonautomatic means and to open the circuit automatically on a predetermined overcurrent without injury to itself when properly applied within its rating.
- (b) (Over 600 volts, nominal.) A switching device capable of making, carrying, and breaking currents under normal circuit conditions, and also making, carrying for a specified time, and breaking currents under specified abnormal circuit conditions, such as those of short circuit.

**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 include the following:

- (a) Class I, Division 1. A Class I, Division 1 location is a location:
  - (1) In which ignitable concentrations of flammable gases or vapors may exist under normal operating conditions; or
  - (2) In which ignitable 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 might release ignitable concentrations of flammable gases or vapors, and might also cause simultaneous failure of electric equipment.

*Note: 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; inadequately ventilated pump rooms for flammable gas or for volatile flammable liquids; and all other locations where ignitable concentrations of flammable vapors or gases are likely to occur in the course of normal operations.*

- (b) Class I, Division 2. A Class I, Division 2 location is a location:
- (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; or
  - (2) In which ignitable concentrations of gases or vapors are normally prevented by positive mechanical ventilation's, and which might become hazardous through failure or abnormal operations of the ventilating equipment; or
  - (3) That is adjacent to a Class I, Division 1 location, and to which ignitable concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

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

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

*Electrical conduits and their associated enclosures separated from process fluids by a single seal or barrier are classed as a Division 2 location if the outside of the conduit and enclosures is a non-hazardous location.*

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

- (a) Class II, Division 1. A Class II, Division 1 location is a location:
- (1) In which combustible dust is or may be in suspension in the air under normal operating conditions, in quantities sufficient to produce explosive or ignitable mixtures; or



- (2) Where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitable mixtures to be produced, an might also provide a source of ignition through simultaneous failure of electric equipment, operation of protection devices, or from other causes, or
- (3) In which combustible dusts of an electrically conductive nature may be present.

*Note: Combustible dusts which are electrically nonconductive 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 wood-flour, oil meal from beans and seed, dried hay, and other organic materials which may produce combustible dusts when processed or handled. Dusts containing magnesium or aluminum are particularly hazardous and the use of extreme caution is necessary to avoid ignition and explosion.*

- (b) Class II, Division 2. A Class II, Division 2 location is a location in which:
  - (1) Combustible dust will not normally be in suspension in the air in quantities sufficient to produce explosive or ignitable mixtures, and dust accumulations are normal operation of electrical equipment or other apparatus; or
  - (2) Dust may be suspension in the air as a result of infrequent malfunctioning of handling or processing equipment ,and dust accumulations resulting there from may be ignitable by abnormal operation of failure or electrical equipment or other apparatus.

*Note: This classification includes locations where dangerous concentrations of suspended dust would not be likely but where dust accumulations might form on or in the vicinity of electric equipment. These areas may contain equipment from which appreciable quantities of dust would escape under abnormal operating conditions or be adjacent to a Class II Division 1 location, as described above, into which an explosive or ignitable concentration of dust may be put into suspension under abnormal operating conditions.*

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

- (a) Class III, Division 1. A Class III, Division 1 location is a location in which easily ignitable fibers or materials producing combustible flyings are handled, manufactured, or used.

*Note: Easily ignitable fibers and flyings include rayon, cotton (including cotton linters and cotton waste), sisal or henequen, istle, jute, hemp, tow, cocoa fiber, oakum, baled waste kapok, Spanish moss, excelsior, sawdust, woodchips, and other material of similar nature.*

- (b) Class III, Division 2. A Class III, Division 2 location is a location in which easily ignitable fibers are stored or handled, except in process or manufacture.

**Collector ring:** A collector ring is an assembly of slip rings for transferring electrical energy from a stationary to a rotating member.

**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. **(See "Accessible as applied to wiring methods.")**

**Conductor:**

- (a) **Bare.** A conductor having no covering or electrical insulation whatsoever.
- (b) **Covered.** A conductor encased within material of composition or thickness that is not recognized as electrical insulation.
- (c) **Insulated.** A conductor encased within material of composition and thickness that is recognized as electrical insulation.

**Controller:** A device or group of devices that serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected.

**Covered conductor:** **See "Conductor."**

**Cutout:** (Over 600 volts, nominal.) Assemblies of a fuse support with either a fuseholder, fuse carrier, or disconnecting blade. The fuseholder, or fuse carrier may include a conducting element (fuse link), or may act as the disconnecting blade by the inclusion of a nonfusible member.

**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. (See "Cabinet.")

**Damp location:** **See "Location."**

**Dead front:** Without live parts exposed to a person on the operating side of the equipment.

**Device:** A unit of an electrical system, which is intended to carry but not utilize electric energy.

**Disconnecting means:** A device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply.

**Disconnecting (or Isolating) switch:** (Over 600 volts, nominal.) A mechanical switching device used for isolating a circuit or equipment from a source of power.

**Dry location. See "Location.":**

**Enclosed:** Surrounded by a case, housing, fence or walls, which will prevent persons from accidentally contacting, energized parts.

**Enclosure:** A case or housing of apparatus, or the fence or walls surrounding an installation to prevent personnel from accidentally contacting energized parts, or to protect the equipment from physical damage.

**Equipment:** A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like, used as a part of, or in connection with, an electrical installation.

**Equipment grounding conductor. See "Grounding conductor, equipment.":**

**Explosion-proof apparatus:** Apparatus enclosed in a case that 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 it will not ignite a surrounding flammable atmosphere.

**Exposed: (As applied to live parts.)** Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to parts not suitably guarded, isolated, or insulated. (See "Accessible and "Concealed.")

**Exposed: (As applied to wiring methods.)** On or attached to the surface or behind panels designed to allow access. (See "Accessible. (As applied to wiring methods.)"

**Exposed:** (For the purposes of Communications systems.) Where the circuit is in such a position that in case of failure of supports or insulation, contact with another circuit may result.

**Externally operable:** Capable of being operated without exposing the operator to contact with live parts.

**Feeder:** All circuit conductors between the service equipment, or the generator switchboard of an isolated plant, and the final branch-circuit overcurrent device.

**Festoon lighting:** A string of outdoor lights suspended between two points more than 15 feet (4.57 m) apart.

**Fitting:** An accessory such as a locknut, bushing, or other part of a wiring system that is intended primarily to perform a mechanical rather than an electrical function.

**Fuse:** (Over 600 volts, nominal.) An overcurrent protective device with a circuit opening fusible part that is heated and severed by the passage of overcurrent through it. A fuse comprises all the parts that form a unit capable of performing the prescribed functions. It may or may not be the complete device necessary to connect it into a electrical circuit.

**Ground:** A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

**Grounded:** Connected to earth or to some conducting body that serves in place of the earth.

**Grounded, effectively:** (Over 600 volts, nominal.) Permanently connected to earth through a ground connection of sufficiently low impedance and having sufficient ampacity that ground fault current which may occur cannot build up to voltages dangerous to personnel.

**Grounded conductor:** A system or circuit conductor that is intentionally grounded.

**Grounding conductor:** A conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes.

**Grounding conductor, equipment:** The conductor used to connect the noncurrent-carrying metal parts of equipment, raceways, and other enclosures to the system grounded conductor and/or the grounding electrode conductor at the service equipment or at the source of a separately derived system.

**Grounding electrode conductor:** The conductor used to connect the grounding electrode to the equipment-grounding conductor and/or to the grounded conductor of the circuit at the service equipment or at the source of a separately derived system.

**Ground-fault circuit interrupter:** A device for the protection of personnel that functions to deenergize a circuit or portion thereof within an established period of time when a current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit.

**Guarded:** Covered, shielded, fenced, enclosed, or otherwise protected by means of suitable cover, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach to a point of danger or contact by persons or objects.

**Hoistway:** Any shaftway, hatchway, well hole, or other vertical opening or space in which an elevator or dumbwaiter is designed to operate.

**Identified (conductors or terminals):** Identified, as used in reference to a conductor or its terminal, means that such conductor or terminal can be recognized as grounded.

**Identified (for the use):** Recognized as suitable for the specific purpose, function, use, environment, application, etc. where describes as a requirement in this standard. Suitability of equipment for a specific purpose, environment, or application is determined by a qualified testing laboratory where such identification includes labeling or listing.

**Insulated conductor: See "Conductor":**

**Interrupter switch:** (Over 600 volts, nominal.) A switch capable of making, carrying, and interrupting specified currents.

**Intrinsically safe equipment and associated wiring:** Equipment and associated wiring in which any spark or thermal effect, produced either normally or in specified fault conditions, is incapable, under certain prescribed test conditions, of causing ignition of a mixture of flammable or combustible material in air in its most easily ignitable concentration.

**Isolated:** Not readily accessible to persons unless special means for access are used.

**Isolated power system:** A system comprising an isolating transformer or its equivalent, a line isolation monitor, and its ungrounded circuit conductors.

**Labeled:** Equipment or materials to which has been attached a label, symbol or other identifying mark of a qualified testing laboratory which indicates compliance with appropriate standards or performance in a specified manner.

**Lighting outlet:** An outlet intended for the direct connection of a lampholder, a lighting fixture, or a pendant cord terminating in a lampholder.

**Listed:** Equipment or materials included in a list published by a qualified testing laboratory whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

**Location:**

(a) **Damp location.** Partially protected locations under canopies, marquees, roofed open porches, and like locations, and interior locations subject to moderate degrees of moisture, such as some basements.

(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.** Installations underground or in concrete slabs or masonry in direct contact with the earth, and locations subject to saturation with water or other liquids, such as locations exposed to weather and unprotected.

**Mobile X-ray:** X-ray equipment mounted on a permanent base with wheels and/or casters for moving while completely assembled.

**Motor control center:** An assembly of one or more enclosed sections having a common power bus and principally containing motor control units.

**Outlet:** A point on the wiring system at which current is taken to supply utilization equipment.

**Overcurrent:** Any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload (**see definition**), short circuit, or ground fault. A current in excess of rating may be accommodated by certain equipment and conductors for a given set of conditions. Hence the rules for overcurrent protection are specific for particular situations.

**Overload:** Operation of equipment in excess of normal, full load rating, or of a conductor in excess of rated ampacity which, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload. (**See "Overcurrent."**)

**Panelboard:** A single panel or group of panel units designed for assembly in the form of a single panel; including buses, automatic overcurrent devices, and with or without switches for the control of light, heat, or power circuits; designed to be placed in or against a wall or partition and accessible only from the front. (**See "Switchboard."**)

**Portable X-ray:** X-ray equipment designed to be hand-carried.

**Power fuse:** (Over 600 volts, nominal.) **See "Fuse."**

**Power outlet:** An enclosed assembly which may include receptacles, circuit breakers, fuse holders, fused switches, buses and watt-hour meter mounting means; intended to serve as a means for distributing power required to operate mobile or temporarily installed equipment.

**Premises wiring system:** That interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all of its associated hardware, fittings, and wiring devices, both permanently and temporarily installed, which extends from the load end of the service drop, or load end of the service drop, or load end of the service lateral conductors to the outlet(s). Such wiring does not include wiring internal to appliances, fixtures, motors, controllers, motor control centers, and similar equipment.

**Qualified person:** One familiar with the construction and operation of the equipment and the hazards involved.

**Qualified testing laboratory:** A properly equipped and staffed testing laboratory which as capabilities for and which provides the following services:

- (a) Experimental testing for safety of specified items of equipment and materials referred to in a standard to determine compliance with appropriate test standards or performance in a specified manner;
- (b) Inspecting the run of such items of equipment and materials at factories for product evaluation to assure compliance with the test standards;
- (c) Service-value determinations through field inspections to monitor the proper use of labels on products and with authority for recall of the label in the event a hazardous product is installed;
- (d) Employing a controlled procedure for identifying the listed and/or labeled equipment or materials tested; and
- (e) Rendering creditable reports or findings that are objective and without bias  
of the tests and test methods employed.

**Raceway:** A channel designed expressly for holding wires, cables, or busbars, with additional functions as permitted in 29 CFR 1926, SUBPART K and the National Electrical Code. Raceways may be of metal or insulating material, and the term includes rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, flexible metallic tubing, flexible metal conduit, electrical metallic tubing, underfloor raceways, cellular concrete floor raceways, surface raceways, wireways, and busways.

**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, chairs, etc. (See "Accessible.")

**Receptacle:** A receptacle is a contact device installed at the outlet for the connection of a single attachment plug. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is a single device containing two or more receptacles.

**Receptacle outlet:** An outlet where one or more receptacles are installed.

**Remote-control circuit:** Any electric circuit that controls any other circuit through a relay or an equivalent device.

**Sealable equipment:** Equipment enclosed in a case or cabinet that is provided with a 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.

**Separately derived system:** A premises wiring system whose power is derived from generator, transformer, or converter windings and has no direct electrical connection, including a solidly connected grounded circuit conductor, to supply conductors originating in another system.

**Service:** The conductors and equipment for delivering energy from the electricity supply system to the wiring system of the premises served.

**Service conductors:** The supply conductors that extend from the street main or from transformers to the service equipment of the premises supplied.

**Service drop:** The overhead service conductors from the last pole or other aerial support to and including the splices, if any, connecting to the service-entrance conductors at the building or other structure.

**Service-entrance conductors, overhead system:** The service conductors between the terminals of the service equipment and a point usually outside the building, clear of building walls, where joined by tap or splice to the service drop.

**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.



**Service equipment:** The necessary equipment, usually consisting of a circuit breaker or switch and fuses, and their accessories, located near the point of entrance of supply conductors to a building or other structure, or an otherwise defined area, and intended to constitute the main control and means of cutoff of the supply.

**Service raceway:** The raceway that encloses the service-entrance conductors.

**Signaling circuit:** Any electric circuit that energizes signaling equipment.

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

**Switches:**

- (a) **General-use switch.** 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 this subpart.
- (c) **Isolating switch.** 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.
- (d) **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.

**Switching devices:** (Over 600 volts, nominal.) Devices designed to close and/or open one or more electric circuits. Included in this category are circuit breakers, cutouts, disconnecting (or isolating) switches, disconnecting means, and interrupter switches.

**Transportable X-ray:** X-ray equipment installed in a vehicle or that may readily be disassembled for transport in a vehicle.

**Utilization equipment:** Utilization equipment means equipment, which utilizes electric energy for mechanical, chemical, heating, lighting, or similar useful purpose.

**Utilization system:** A utilization systems is a system which provides electric power and light for employees workplaces, and includes the premises wiring system and utilization equipment.

**Ventilated:** Provided with a means to permit circulation of air sufficient to remove an excess of heat, fumes, or vapors.

**Volatile flammable liquid:** A flammable liquid having a flash point below 38 degrees C (100<sup>o</sup> F) or whose temperature is above its flash point, or a Class II combustible liquid having a vapor pressure not exceeding 40 psia (276 kPa) at 38<sup>o</sup> C (100<sup>o</sup> F) whose temperature is above its flash point.

**Voltage:** (Of a circuit.) The greatest root-mean-square (effective) difference of potential between any two conductors of the circuit concerned.

**Voltage, nominal:** A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (as 120/240, 480Y/277, 600, etc.). The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment.

**Voltage to ground:** For grounded circuits, the voltage between the given conductor and that point or conductor of the circuit that is grounded; for ungrounded circuits, the greatest voltage between the given conductor and any other conductor of the circuit.

**Watertight:** So constructed that moisture will not enter the enclosure.

**Weatherproof:** So constructed or protected that exposure to the weather will not interfere with successful operation. Rainproof, raintight, or watertight equipment can fulfill the requirements for weatherproof where varying weather conditions other than wetness, such as snow, ice, dust, or temperature extremes, are not a factor.

**Wet location:** See "*Location.*"

## II. INSTALLATION SAFETY REQUIREMENTS

### A. Covered

This section contains installation safety requirements for electrical equipment and installations used to provide electric power and light at the job site and used on the job site. These requirements do not apply to existing permanent installations in place before construction is started.

\* Also included are portable and vehicular-mounted generators used to provide power for equipment used at the job site.

### B. Not Covered

This section does not cover installations used for the generation, transmission, and distribution of electric energy, including related communication, metering, control, and transformation installations.

### C. General Requirements

1. All electrical equipment and conductors shall be of an approved type and bear such a label.
2. The Steingass Mechanical Contracting, Inc. shall ensure that electrical equipment is free from recognized hazards that are likely to cause death or serious injury to employees. Only qualified persons may work on energized parts. Safety of equipment shall be determined on the basis of the following:
  - (a) Suitability of equipment for an identified purpose may be determined by listing, labeling, or certification for that purpose.
  - (b) Mechanical strength and durability
  - (c) Electrical insulation

- (d) Heating effects under conditions of use
  - (e) Arcing effects
  - (f) Classification by type, size, voltage, current capacity, and specific use.
  - (g) Practical safeguarding of employees using the equipment.
3. Listed, labeled, or certified equipment shall be used in accordance with instructions for the equipment.
  4. Equipment intended to break current shall have an interrupting rating at system voltage sufficient for the current that must be interrupted.
  5. Electrical equipment shall be firmly secured to the surface on which it is mounted. Wooden plugs driven into holes for mounting shall not be used.
  6. Electrical equipment depending upon natural circulation of air and convection principles for cooling shall be so installed to promote appropriate cooling to avoid over-heating.
  7. Splices shall be joined with splicing devices designed to such use or by brazing, welding, or soldering. Soldered splices shall be made secure before soldering. All splices, joints, and free ends of conductors shall be covered with insulation designed for the purpose.
  8. Arcing, sparks, flames, or molten metal shall be enclosed from all combustible material.
  9. Marking plates or the equivalent bearing manufacturer's name, listing, voltage, current wattage shall be on all electrical equipment and be of sufficient durability relative to withstand the environment involved.
  10. Disconnecting means required by the NEC for motors and appliances shall be legibly marked to indicate its purpose unless it is self-evident.
  11. Equipment operating at 600 volts, nominal, or less

- (a) **Working space** about electrical equipment shall be sufficient to permit ready and safe operation and maintenance of such equipment. Working clearances in the direction of access to live parts operating at 600 volts or less and likely to require examination, adjustment, servicing, or maintenance while alive shall not be less than indicated in **Table 1**. In addition, workspace shall not be less than 30 inches wide in front of the electrical equipment. Distances shall be measured from the live parts if they are exposed, or from the enclosed front or opening if the live parts are enclosed. Working space is not required in back of assemblies such as dead-front switchboards or motor control centers where there are no renewable or adjustable parts such as fuses or switches on the back and where all connections are accessible from locations other than the back.

**Table 1 -- Working Clearances**

Normal voltage to ground	Minimum clear distance for conditions <sup>1</sup>		
	(a)	(b)	(c)
	Feet <sup>2</sup>	Feet <sup>2</sup>	Feet <sup>2</sup>
0-150 .....	3	3	3
151-600 .....	3	3 1/2	4

<sup>1</sup> Conditions (a), (b), and (c) are as follows: (a) Exposed live parts on one side and no live or grounded parts on the other side of the working space, or exposed live parts on both sides effectively guarded by insulating material. Insulated wire or insulated busbars operating at not over 300 volts are not considered live parts. (b) Exposed live parts on one side and grounded parts on the other side. (c) Exposed live parts on both sides of the workspace (not guarded as provided in Condition (a) with the operator between.)

<sup>2</sup> Note: For International System of Units (SI): one foot = 0.3048m.

- (b) **Clear spaces** required by this policy shall not be used for storage. When normally enclosed live parts are exposed for inspection or servicing, the working space, if in a passageway or general open space, shall be guarded.
- (c) **Access and entrance** to working space shall be provided to give access to the working space about electrical equipment.
- (d) **Front working space** of equipment shall not be less than 3 feet (9.4 mm) where there are live parts normally exposed on the front of switchboards, or motor control centers.
- (e) **Headroom.** The minimum about service equipment, switchboards, panelboards or motor control centers shall be 6 feet 3 inches (1.91 m).
- (f) **Guarding of live parts** operating at 50 volts or more shall be guarded against accidental contact by cabinets, or other enclosures, or by any of the following:
  - (i) By location in a room, vault, etc, that is accessible only to qualified persons.
  - (ii) By partitions or screens so arranged that only qualified persons will have access.
  - (iii) By location on a balcony, gallery, or platform so that only qualified persons will have access.
  - (iv) By elevation of 8 feet or more above the floor or other working surface and so installed that only qualified persons have access.
  - (v) In locations where electrical equipment would be exposed to physical damage, enclosures or guards shall be arranged and of such strength as to prevent such anticipated damage.
  - (vi) Entrances to rooms and other guarded locations containing exposed live parts shall be marked with conspicuous warning signs forbidding unqualified persons to enter.

12. Equipment operating over 600 volts, nominal, shall comply 1 through 11 above and the following through:
- (a) Vaults, rooms, closets, or areas surrounded by a wall, screen, or fence and entrance is controlled by lock and key are considered to be accessible to qualified persons only.
  - (b) A wall, screen or fence less than 8 feet in height is not considered adequately guarded unless it has other features that provide a degree of isolation equal to an 8 foot fence.
  - (c) The entrances to all buildings, rooms, or enclosures containing exposed live parts or exposed conductors (over 600 volts nominal) shall be kept locked or be under observation of a qualified person at all times.
  - (d) Electrical installation having exposed live parts over 600 volts nominal shall be accessible to qualified persons only.  
*(See paragraph (f) below)*
  - (e) Installations accessible to unqualified persons shall be made with metal-enclosed equipment or shall be enclosed in a vault, or in an area that is controlled by lock and key.

**The following shall be marked with appropriate caution signs:**

- (i) Metal enclosed switchgear  
Unit substations  
Transformers  
Pull boxes  
Connection boxes, etc.
- (ii) If equipment is exposed to physical damage from vehicles, guards shall be provided.
- (iii) Ventilation or similar openings in metal enclosed equipment shall be made to prevent foreign objects inserted through the openings.

- (f) Workspace about equipment shall be sufficiently maintained about electrical equipment to permit ready and safe operation and maintenance. Where energized parts are exposed a minimum of clear work space shall be 6' 6" high by 3' wide as measured parallel to the equipment and workspace shall be adequate to permit at least a 90 - degree opening of doors or hinged panels.

**See Table 2 on next page.**

- (i) Clear working space in front of electrical equipment, e.g. switchboards, control panels, switches, circuit breakers, etc. **shall not be less** than specified in **Table 2 next page.** Distances shall be measured from live parts if exposed, or from enclosure front or opening if live parts are enclosed. Working space is not required in back of equipment where there are no renewable or adjustable parts on the back **and** where all connections are accessible from locations other than the back. Where rear access is required to work on de-energized parts on the back of enclosed equipment minimum work space shall be 30 inches horizontally.
- (g) Qualified employee must adhere to the approach distance outlined below:

<u>Voltage range (phase to phase)</u>	<u>Minimum approach distance</u>
300V or less	Avoid Contact
Over 300V not over 750V	1 ft. 0 in. (30.5 cm)
Over 750V not over 2kV	1 ft. 6 in. (46 cm)
Over 2kV not over 15kV	2 ft. 0 in. (61 cm)
Over 15kV not over 37kV	3 ft. 0 in. (91 cm)
Over 37kV not over 87.5kV	3 ft. 6 in. (107 cm)
Over 87.5kV not over 121kV	4 ft. 0 in. (122 cm)
Over 121kV not over 140kV	4ft. 6i in. (137 cm)



**TABLE 2 - MINIMUM DEPTH OF CLEAR WORKING SPACE IN FRONT OF ELECTRICAL EQUIPMENT**

Nominal voltage to ground	Conditions <sup>1</sup>		
	(a)	(b)	(c)
	Feet <sup>2</sup>	Feet <sup>2</sup>	Feet <sup>2</sup>
601 to 2,500 .....	3	4	5
2,501 to 9,000 .....	4	5	6
9,001 to 25,000 .....	5	6	9
25,001 to 75 kV .....	6	8	10
Above 75kV .....	8	10	12

<sup>1</sup> Conditions (a), (b), and (c) are as follows: (a) Exposed live parts on one side and no live or grounded parts on the other side of the working space, or exposed live parts on both sides effectively guarded by insulating materials, insulated wire or insulated busbars operating at not over 300 volts are not considered live parts. (b) Exposed live parts on one side and grounded parts on the other side. Walls constructed of concrete, brick, or tile are considered to be grounded surfaces. (c) Exposed live parts on both sides of the workspace (Not guarded as provided in Condition (a) with the operator between.

<sup>2</sup> NOTE: For SI units: one foot = 0.3048 m.

- (ii) Lighting outlets shall be so arranged that persons changing lamps or making repairs will not be endangered by live parts or other equipment.
- (iii) Points of control shall be so located that persons are not likely to come in contact with any live part or moving part while turning on lights.
- (iv) Elevation of unguarded live parts above the working space shall be as specified in **Table 3 below**.

**TABLE 3 - ELEVATION OF UNGUARDED ENERGIZED PARTS  
ABOVE WORKING SPACE**

Nominal voltage between phases	Minimum elevation
601 - 7,500 .....	8 feet 6 inches. <sup>1</sup>
7,501 - 35,000 .....	9 feet.
Over 35kV .....	9 feet + 0.37 inches per kV above 35kV.

<sup>1</sup>NOTE: For SI units: one inch = 25.4 mm; one foot = 0.3048m.

- (g) Entrance and access to workplace shall be not less than 24" wide and 6'6" high about electrical equipment. On switchboards and control panels exceeding 48" wide there shall be one entrance at each end of the board or panel where practicable. Where bare energized parts at any voltage or insulated energized parts above 600 volts are located adjacent to such entrance, they shall be guarded.

**D. Wiring Design & Protection**

1. **Use and identification of grounded and grounding conductors.**
  - (a) Identification of conductors. Those for equipment grounding shall be identifiable and distinguishable from all other conductors.
  - (b) Polarity of connections. No grounded conductor shall be attached to any terminal or lead as to reverse designated polarity.
  - (c) Grounding terminal or grounding type devices on receptacles, cord connector, or attachment plug shall not be used for any purpose other than grounding.

**2. Branch circuits**

- (a) Ground fault protection for employees shall be by either ground fault circuit interrupters (G F C I), or assured equipment grounding conductor program. These are in addition to any other requirements for equipment grounding conductors.
- (b) G F C I. All 120 volts, single-phase 15 - and 20 - ampere receptacle outlets on construction sites, which are not a part of the permanent wiring of the building or structure and which are used by employees, shall be **approved** G F I C 's for personal protection. Receptacles in a two-wire, single phase portable or vehicular-mounted generator rated not more than 5kW, where the circuit conductors of the generator are insulated from the generator frame and all other grounded, surfaces, need not be protected with G F I C 's.
- (c) Assured equipment grounding conductor programs. (Due to the complexity and repetitive work required by this method of protection it is not used by many construction general or subcontractors. Therefore it is omitted from here.) If the reader, wants more information concerning Assured Equipment Grounding Conductor Program please consult with Safety Systems, Inc.
- (d) Outlet devices shall have an ampere rating not less than the load to be served and shall have:
  - (i) Single receptacles installed on an individual branch circuit shall have ampere rating of not less than the branch circuit.
  - (ii) Two or more receptacles or outlets, the receptacle ratings shall conform to the values listed in **Table 4.**

**Table K - 4 - Receptacle Ratings For Various Size Circuits**

Circuit rating amperes	Receptacle rating amperes
15 .....	Not over 15.
20 .....	15 or 20.
30 .....	30.
40 .....	40 or 50.
50 .....	50.

- (iii) Receptacles or attachment plugs used for cord- and- plug connection of motors of a branch circuit shall not exceed 15 amperes 125 volts or 10 amperes at 250 volts if overload protection is omitted.

**3. Outside conductors and lamps at 600 volts, nominal, or less and run outdoors as open conductors:**

- (a) Conductors on poles shall provide a horizontal climbing space not less than the following:
  - (i) Power conductors below communication conductors - 30 inches.
  - (ii) Power conductors alone or above communication conductors of 300 volts or less - 24 inches; if more than 300 volts - 30 inches.
  - (iii) Communication conductors below power conductors of 300 volts or less - 24 inches, more than 300 volts - 30 inches.
- (b) Clearance from ground for open conductors shall conform to the following clearances:
  - (i) 10 feet above finish grade, sidewalks, or from any platform or projection from which they might be reached.
  - (ii) 12 feet over areas subject to vehicular traffic other than truck traffic.
  - (iii) 15 feet over areas other than those specified in paragraph 3.(b)(iv) below of this section that are subject to truck traffic.
  - (iv) 18 feet over public streets, alleys, roads, and driveways.
- (c) Clearance from building openings. Conductors shall have a clearance of at least 3 feet from windows, doors, fire escapes, etc. Conductors run above the top level of a window are considered to be out of reach.

- (d)** Clearance over roofs. Conductors above roof space accessible to employees on foot shall have a clearance from the highest point of the roof surface of not less than 8 feet vertical clearance for clearance for covered conductors, and not less than 15 feet for bare conductors except that:

  - (i)** Where roof space is also accessible to vehicular traffic, the vertical clearance shall not be less than 18 feet.
  - (ii)** Where roof space is not normally accessible to employees on foot, fully insulated conductors shall have a vertical or diagonal clearance of not less than 3 feet.
  - (iii)** Where the voltage between conductors is 300 volts or less and the roof has a slope of not less than 4 inches in inches, the clearance from roofs shall be at least 3 feet.
  - (iv)** Where voltage between conductors is 300 volts or less and the conductors do not pass over more than 4 feet of the overhang portion of the roof and they are terminated at a through-the-roof raceway or support, the clearance from roof shall be at least 18 inches.

#### **4. Services**

- (a)** Disconnecting means shall be provided to disconnect all conductors in a building or other structure from the service-entrance conductors. The disconnecting means shall plainly indicate if it is in the open or closed position and shall be installed at a readily accessible location nearest the point of entrance of the service-entrance conductors.
- (b)** Each service disconnecting means shall simultaneously disconnect all ungrounded conductors.
- (c)** Service over 600 volts, nominal have the following requirements:

  - (i)** Guarding Service-entrance conductors installed or open wires shall be guarded to make them accessible only to qualified persons.
  - (ii)** Warning signs of high voltage shall be posted where unauthorized employees might come in contact with live parts.

**5. Over current protection**

- (a) 600 volts, nominal or less
  - (i) Protection of conductors and equipment. These shall be protected from overcurrent in accordance with their ability to safely carry the load.
  - (ii) Grounded conductors. Except for motor running overload protection, overcurrent devices shall not interrupt the continuity of the grounded conductor unless all conductors of the circuit are open simultaneously.
  - (iii) Disconnection of fuses and thermal cutouts. Except for devices provided for current limiting on the supply side of the device disconnecting means, all cartridge fuses which are accessible to other than qualified persons and all fuses and thermal cutouts on circuits over 150 volts to ground shall be provided with disconnecting means so installed that the fuses or thermal cutouts can be disconnected from its supply without disrupting service to equipment and circuits **UNRELATED** to those protected by the overcurrent device.
  - (iv) Location in or on premises. Overcurrent devices shall be readily accessible, and shall not be located where they could create an employee safety hazard by being exposed to physical damage or located in the vicinity of easily ignitable material.
  - (v) Arcing or suddenly moving parts. Fuses and circuit breakers shall be so located or shielded that employees will not be burned or injured by their operation.
  - (vi) Circuit breakers.
    - (A) Shall clearly indicate if they are **OPEN** or **CLOSED**.
    - (B) Where circuit breaker handles on switch-boards are operated vertically, the **UP** position of the handle shall be the **CLOSED (ON)** position.
    - (C) If used as switches on 120-volt fluorescent lighting circuits, circuit breakers shall be marked **"SWD"**.

- (b) Over 600 volts, nominal. Feeders and branch circuits over 600 volts, nominal, shall have short circuit protection.

**6. Grounding requirements:**

(a) Systems to be grounded:

- (i) 3-wire D C Systems shall have their neutral conductor grounded.
- (ii) 2-wire D C Systems at over 50 through 300 volts between conductors shall be grounded unless they are rectifier-derived from an A C Systems complying to the following paragraphs 6.(a)(iii),(iv), and (v) below.
- (iii) A C circuits of less than 50 volts shall be grounded if installed as overhead conductors outside of buildings or if they are supplied by transformers and transformer primary supply system is grounded or exceeds 150 volts to ground.
- (iv) A C Systems of 50 volts to 1800 volts shall be grounded under any of the following conditions, (unless exempted by paragraph (6), (a), (v) below, Exceptions).
  - (A) If the system can be so grounded that the maximum voltage to ground on the ungrounded conductors does not exceed 150 volts;
  - (B) If the system is nominally rated 480Y/277 volt, 3 phase, 4-wire in which the neutral is used as a circuit conductor;
  - (C) If the system is nominally rated 240/120 volt, 3-phase, 4-wire in which the midpoint of one phase is used as a circuit conductor; or
  - (D) If a service conductor is un-insulated.

- (v) Exceptions. AC Systems of 50 volts to 1000 volts are ***not*** required to be grounded if the system is separately derived and is supplied by a transformer that has a primary voltage rating less than 1000 volts provided all the following conditions are met.
  - (A) The system is used exclusively for control circuits.
  - (B) The conditions of maintenance and supervision assure that only qualified persons will service the installation;
  - (C) Continuity of control power is required, and
  - (D) Ground detectors are installed on the control system
- (b) Separately derived systems. Where the above paragraph, all of (6)(a) Grounding Requirements, requires grounding of wiring systems whose power is derived from generator, transformer, or converter windings ***and*** has no direct electrical connection, including a solidly connected circuit conductor, to supply conductors originating in another system, above paragraph (6)(e), Grounding Connection, below shall also apply.
- (c) Portable and vehicle-mounted generators
  - (i) Portable generators. Under the following conditions, the frame of a portable generator need not be grounded and may serve as the grounding electrode for a system supplied by the generator:
    - (A) If the generator supplies only equipment mounted on the generator and/or cord-and-plug connected equipment through receptacles mounted on the generator, ***and***
    - (B) The noncurrent-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are



**bonded** to the generator frame.

- (ii) Vehicle-mounted generators. Under the following conditions the frame of a vehicle may serve as the grounding electrode for a system supplied by a generator located on the vehicle.
  - (A) The frame of the generator is bonded to the vehicle, **and**,
  - (B) The generator supplies only equipment located on the vehicle and/or cord-and-plug connected equipment through receptacles mounted on the vehicle or on the generator, **and**
  - (C) The noncurrent-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame, **and**
  - (D) The system complies with all other provisions of this standard.
- (iii) A neutral conductor shall be bonded to the generator frame if the generator is a component of a separately derived system. No other conductor need be bonded to the generator frame.
- (d) Conductors to be grounded. For A C premises wiring systems the identified conductor shall be grounded.

(e) **Grounding connections**

(i) For a grounded system, a grounding electrode conductor shall be used to connect both the equipment grounding conductor and the grounded circuit conductor to the grounding circuit conductor to the grounding electrode. Both the equipment grounding conductor and the grounding electrode conductor shall be connected to the grounded circuit conductor on the supply side of the service disconnecting means, or on the supply side of the system disconnecting means or overcurrent devices if the system is separately derived.

(ii) **Ungrounded systems**

(A) For ungrounded service-supplied systems, the equipment grounding conductor shall be connected to the grounding electrode conductor at the service equipment.

(B) For ungrounded separately derived system, the equipment grounding electrode conductor, at or ahead of, the system disconnecting means or overcurrent devices.

(f) Grounding path. The path to ground from circuits, equipment, and enclosures shall be permanent, and continuous.

(g) Supports, enclosures, and equipment to be grounded:

(i) Supports and enclosures for conductors. Metal cable trays, metal raceways, and metal enclosures for conductors shall be grounded, ***except that:***

(A) Metal enclosures such as sleeves used to protect cable assemblies from physical damage need not be grounded; ***and***

(B) Metal enclosures for conductors added to existing installation of open wire, knob-and-tube- wiring, and nonmetallic-sheathed cable need not be grounded if all the following conditions are met:

- (1) Runs are less than 25 feet (7.62 m)
  - (2) Enclosures are free from probable contact with ground, grounded metal, metal lathes or other conductive materials; **and**
  - (3) Enclosures are guarded against employee contact.
- (ii) Service equipment enclosure for service equipment shall be grounded.
- (iii) Fixed equipment. Exposed non-current-carrying metal parts of fixed equipment which may become energized shall be grounded under any of the following conditions:
- (A) If within 8 feet (2.44 m) vertically or 5 feet (1.52m) horizontally of ground or grounded metal objects and subject to employee contact.
  - (B) If located in a wet or damp location and subject to employee contact.
  - (C) If in electrical contact with metal
  - (D) If in a hazardous (classified) location
  - (E) If supplied by a metal-clad, metal-sheathed, or grounded metal raceway wiring method.
  - (F) If equipment operates with any terminal at over 150 volts to ground. **However, the following need not be grounded:**
    - (1) Enclosures for switches or circuit breakers used for other than service equipment and accessible to qualified persons only;
    - (2) Metal frames of electrically heated appliances which are permanently insulated from ground; and

- (3) The cases of distribution apparatus such as transformers and capacitors mounted on wooden poles at a height ***exceeding*** 8 feet (2,44 m) above ground or grade level.
  
- (iv) Equipment connected by cord and plug. Under ***any*** conditions described in ***paragraphs (6), (g), (iv), (A) through (6), (g), (iv), and (C) below***, exposed noncurrent carrying metal parts of cord-and-plug connected equipment which ***may*** become energized shall be grounded.
  - (A) If in a hazardous (classified) located.  
***(See Paragraph G and Glossary)***
  - (B) If operated at over 150 volts to ground except for guarded motors and metal frames of electrically heated appliances if the appliance frames are permanently and effectively insulated from ground.
  
  - (C) If the equipment is one of the following:
    - (1) Hand held motor-operated tools;
    - (2) Cord-and-plug connected equipment used in damp or wet locations or by employees standing on the ground or on metal floors or g inside of metal tanks or boilers;
  
    - (3) Portable and mobile X-ray and associated equipment;
    - (4) Tools likely to be used in wet, and/or conductive locations; and
    - (5) Portable hand lamps

**(6) Exceptions to the above: (C)(1) through (C)(5):**

Tools likely to be used in wet and/or conductive locations need not be grounded if supplied through an isolated transformer with an ungrounded secondary of not more than 50 volts; listed or labeled portable tools and appliances.

**(v) Nonelectrical equipment. The metal parts of the following nonelectrical equipment shall be grounded:**

**(A)** Frames and tracks of electrically operated cranes;

**(B)** Frames of nonelectrically driven elevator cars to which electric conductors are attached;

**(C)** Hand-operated metal shifting ropes or cables of electric elevators, and metal partitions, grill work, and similar metal enclosures around equipment of over 1kV between conductors.

**(h) Methods of grounding equipment**

**(i)** With circuit conductors. Noncurrent-carrying metal parts for fixed equipment, if required to be grounded by this paragraph shall be grounded by an equipment grounding conductor which is contained within the same raceway, cable, or cord, or runs with or encloses the circuit conductors. For D C circuits only, the equipment grounding conductor may be run separately from the circuit conductor.

- (ii) **Grounding conductor.** A conductor used for grounding fixed or movable equipment shall have capacity to conduct safely, any fault current which may be imposed upon it.
  - (iii) **Equipment considered effectively grounded.** Electrical equipment is considered to be effectively grounded if it is secured to, and in electrical contact with, a metal rack or structure that is provided for its support and the metal rack structure is grounded by the method specified for noncurrent-carrying metal parts of fixed equipment in paragraph (6)(h)(i) above. Metal car frames supported by metal hoisting cables attached to or running over metal sheaves or drums of grounded elevator machines are also considered to be effectively grounded.
- (i) **Bonding.** If bonding conductors are used to assure electrical continuity, they shall have the capacity to conduct any fault current, which may be imposed.
- (j) **Made electrodes.** If made electrodes are used, they shall be free of nonconductive coatings, and if practicable, they shall be embedded below permanent moisture level. A single electrode consisting of a rod, pipe, or plate which has a resistance to ground greater than 25 ohms shall be augmented by one additional electrode installed no closer than 6 feet ( 1.83 m ) to the first electrode.
- (k) **Grounding of systems and circuits of 1000 volts and over (high voltage)**
  - (i) **General.** If high voltage systems are grounded, they shall comply with all applicable provisions of paragraphs (6)(a) through (6)(j) above, and as modified by this paragraph (6)(k).
  - (ii) **Grounding of systems supplying portable or mobile equipment.** Systems supplying portable or mobile high voltage equipment, other than substations installed on a temporary basis, shall comply with the following:

- (A) Portable and high voltage equipment shall be supplied from a system having its neutral grounded through an impedance. If a delta-connected high voltage system is used to supply the equipment a system neutral shall be derived.
  - (B) Exposed non-current-carrying metal parts of portable and mobile equipment shall be connected by an equipment grounding conductor to the point at which the system neutral impedance is grounded.
  - (C) Ground-fault detection and relaying shall be provided to automatically de-energize and high voltage system component which has developed a ground fault. The continuity of the equipment grounding conductor shall be continuously monitored so as to de-energize automatically the high voltage feeder to the portable equipment upon loss of continuity of the equipment grounding conductor.
  - (D) The grounding electrode to which the portable or mobile equipment system neutral impedance is connected shall be isolated from and separated in the ground by at least 20 feet ( 6.1 m ) from any other system or equipment grounding electrode, and there shall be no direct connection between the grounding electrodes, such as buried pipe, fence, or like objects.
- (iii) Grounding of equipment. All noncurrent-carrying metal parts of portable equipment and fixed equipment including associated fences, housings, enclosures, and supporting structures shall be grounded. However, equipment which is guarded by location and isolated from ground need not be grounded. And, pole mounted distribution apparatus at a height exceeding 8 feet ( 2.44 m ) above the ground or grade level need not be grounded.

## **E. Wiring Methods, Components, & Equipment for General Use**

(1) **Wiring methods.** Paragraph (E) does not apply to conductor which form an integral part of equipment such as motors, controllers, motor central centers and like equipment.

### **(a) General requirements**

- (i) Electrical continuity of metal raceways and enclosures. Metal raceways, cable armor, and other metal enclosures for conductors shall be mechanically joined together into a continuous electric conductor, and shall be so connected to all boxes, fittings, and cabinets as to provide effective electrical continuity.
- (ii) **Wiring ducts.** No wiring system of any type shall be installed in ducts used to transport dust, loose stock or flammable vapors, or ducts used for vapor removal in any shaft containing only such ducts.

### **(b) Temporary Wiring**

- (i) **Scope.** This *Paragraph E.(i)(b)* applies to temporary electrical power and lighting wiring methods which may be of a class less than would be required for a permanent installation. *Except* as specifically modified by this *Paragraph E. (i)(b)*, all other requirements for permanent wiring shall apply to temporary wiring. Temporary wiring shall be removed immediately upon completion of construction or the purpose for which it was installed.
- (ii) **General requirements for temporary wiring**
  - (A) Feeders shall originate in a distribution center. Conductors shall be run as a multiconductor cord or cable assemblies or within raceways; or, where not subject to physical damage, they may run as open conductors on insulators not more than 10 feet ( 3.05 m ) apart.



**(B) Branch circuits**

- (1) Shall originate in a power outlet or panelboard;
- (2) Conductors shall be run a multiconductor cord or cable assemblies or open conductors, or shall be run in raceways;
- (3) All conductors shall be protected by overcurrent devices at their ampacity;
- (4) Runs of open conductors shall be located where the conductors will be subject to physical damage.
- (5) Conductors shall be fastened at intervals of not more than 10 feet ( 3.05 m ).
- (6) No branch circuits shall be laid on the floor.
- (7) Each branch circuit that supplies receptacles or fixed equipment shall contain a separate equipment grounding conductor if the branch circuit is run as an open conductor.

**(C) Receptacles**

- (1) Shall be of the grounded type;
- (2) Unless installed in a complete metallic raceway, each branch circuit shall contain a separate equipment grounding conductor;
- (3) All receptacles shall be electrically connected to the grounding conductor;

(4) Receptacles shall not be connected to the same ungrounded conductor of multiwire circuits which supply temporary lighting;

- (D) Disconnecting switches or plug connectors shall be installed to permit the disconnection of all ungrounded conductors of each temporary circuit.
- (E) All lamps for general illumination shall be protected from accidental contact or breakage, and all metal-case, sockets shall be grounded.
- (F) Temporary lights shall be suspended by their cords, unless they are designed for this means of suspension.
- (G) Portable electric lighting used in wet and/or other conductive locations such as drums, tanks, and vessels, shall be operated at 12 volts or less. ***However***, 120-volt protected by a G F C I.
- (H) A box shall be used whenever a change is made to a raceway system or a cable system which is metal or metal sheathed.
- (I) Flexible cords and cables shall be protected from damage to sharp corners and doorways.

(J) Extension cord sets used with portable electric tools and appliances shall be of 3-wire type, and designed for hard or extra hard usage. Flexible cords used with temporary and portable lights shall be designed for hard or extra-hard usage.

(iii) Guarding. For temporary wiring over 600 volts, nominal, fencing, barriers, or other effective means shall be provided to prevent access of other than authorized and qualified personnel.

**NOTE: See the National Electrical Code, ANS1/NFPA 70, Article 400, Table 400-4 for various acceptable flexible cords for hard and extra-hard usage.**

(2) Cabinets, boxes, and fittings (conductors entering)

- (a) Conductors entering boxes, cabinets, or fittings shall be protected from abrasion, and openings through which conductors enter shall be effectively closed. Unused openings in cabinets, boxes, and fittings shall also be effectively closed.
- (b) Covers and canopies. All pull boxes, junction boxes, and fittings shall be provided with covers.
  - (i) Metal covers shall be grounded.
  - (ii) In energized installations each outlet box shall have a cover, faceplate, or fixture canopy.
  - (iii) Covers of outlet boxes having holes through which flexible cord pendants pass shall be provided with bushings or shall have well-rounded surfaces on which the cords may bear.
- (c) Pull and junction boxes for systems over ***600 volts, nominal***. In addition to the above for pull and junction boxes, the following applies:

- (i) Complete enclosure for the contained conductors cables.
- (ii) Boxes shall be closed by covers, securely fastened in place. Ungrounded box covers that weigh over 100 pounds ( 43.6 kg ) meet this requirement. Covers for boxes shall be permanently marked "**HIGH VOLTAGE.**" The marking shall be readily visible and legible.

**(3) Knife switches**

- (a) Single-throw knife switches shall be so connected that the blades are dead when the switch is open.
- (b) Single throw knife switches shall be so placed that gravity will not tend to close them.
- (c) Single throw knife switches approved for use in the inverted position shall be provided with a locking device that will ensure the blades will remain in the open position when so set.
- (d) Double throw switches may be mounted so that the throw will be either vertical or horizontal. If mounted vertical inverted (3)(c) above applies.

**(4) Switchboards and panelboards**

- (a) Having any exposed live parts shall be located in a permanently dry locations and accessible only to qualified persons;
- (b) Shall be mounted in cabinets, cutout boxes, or enclosures designed of the purpose and shall be dead front;
- (c) However, panelboards other than dead front externally operable type are permitted where accessible only to qualified persons; and
- (d) Exposed blades of knife switches shall be dead when open.

**(5) Enclosures for damp or wet locations**

- (a) Cabinets, fittings, and boxes and panelboards enclosures shall be installed so as to prevent moisture or water from entering and accumulating within the enclosures. In wet locations the enclosure shall be weatherproof.
- (b) Switch, circuit breakers, and switchboards installed in wet locations shall be enclosed in weatherproof enclosures.

**(6) Conductors used in general wiring shall be insulated unless otherwise permitted in this section. Conductor insulation shall be of a type that is suitable for the voltage, operating temperature, and location of use. Insulated conductors:**

- (a) Insulated conductors shall be distinguishable by appropriate color or means as being grounded conductor, ungrounded conductors, or equipment grounding conductor.

**(7) Flexible cords and cables, uses of:**

- (a) Permitted uses of flexible cords and cables are:
  - (i) Pendants;
  - (ii) Wiring fixtures;
  - (iii) Connection of portable lamps or appliances;
  - (iv) Elevator cables
  - (v) Wiring for cranes and hoists;
  - (vi) Connection of stationary equipment to facilitate frequent interchange;
  - (vii) Prevention of transmission of noise or vibration;
  - (viii) Appliances where the fastening means and mechanical connections are designed to permit removal for maintenance and repair;
- (b) Attachment plugs for cords if used as permitted in (7)(a)(iii), (7)(a)(vi), or (7)(a)(viii) above, the flexible cord shall be equipped with an attachment plug and shall be energized from a receptacle outlet.
- (c) Prohibited uses of flexible cords and cables are;

- (i) As a substitute for fixed wiring of a structure;
- (ii) Where run through holes in walls, ceilings, or floors;
- (iii) Where runs through doorways, windows, or similar openings, **except as permitted in Paragraph E(7)(a) above.**
- (iv) Where attached to building surfaces; or
- (v) Where concealed behind building walls, ceilings, or floors.

**(d) Identification, splices, and terminations**

- (i) **Identification.** A conductor of a flexible cord or cable use as a grounded conductor or an equipment grounding conductor shall be distinguished from other conductors.
- (ii) **Marking.** Type SJ, SJO, SJT, SJTO, S, SO, ST, and STO cords shall not be used unless durably marked on the surface with the type designation, size, and number of conductors.
- (iii) **Splices.** Flexible cords shall be used only in continuous lengths without splice or tap. Hard service flexible cords No. 12 or larger may be repaired if spliced, so that the splice retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced.
- (iv) **Strain relief.** Flexible cords shall be connected to plugs or appliances so that strain relief is provided which will prevent pull from being directly transmitted to joints or terminal screws.
- (v) Cords and cables shall be protected by bushings or fittings where passing through holes in covers, outlet boxes, or similar enclosures.

**(8) Portable multiconductor cables over 600 volts, nominal:**

- (a) Shall consist of No. 8 or larger conductors employing flexible stranding;
- (b) Cables operated at or over 2000 volts shall be shielded to confine the voltage stresses to the insulation;
- (c) Grounding conductors shall be provided;
- (d) Connectors for these cables shall be locking type with provisions to prevent their opening or closing while energized;
- (e) Strain relief, 7(d)(i) above, shall be provided at connections, and terminations.
- (f) Splices in portable cables shall be of the permanent molded, vulcanized, or equivalent type.
- (g) Termination enclosures shall be marked with a high voltage hazard warning, and accessible only to authorized and qualified personnel.

**(9) Fixture wires**

- (a) Shall be suitable for voltage, temperature, and location of use; and grounding conductors shall be identified.
- (b) Uses permitted;
  - (i) For installation in lighting fixtures and in similar equipment where enclosed and not subjected to bending or twisting; or
  - (ii) For connecting lighting fixtures to the branch-circuit conductors supplying the fixtures.
- (c) Uses not permitted: As branch-circuit conductors except as permitted for Class 1 power-limited circuits.

**(10) Equipment for general use**

- (a) Lighting fixtures, lampholders, lamps, and receptacles shall have no live parts normally exposed to employee contact. However, rosettes and cleat-type lampholders and receptacles located at least 8 feet above the floor may have exposed parts.
- (b) Supports. Fixtures, lampholders, rosettes, and receptacles shall be securely supported. A fixture weighing more than 6 pounds (2.72 kg) or exceeds 16 inches (406 mm) in any dimension shall not be supported by a screw shell of a lampholder.
- (c) Portable lamps shall be wired with flexible cord and an attachment plug of the polarized or grounded type. If using an Edison-based lampholder, the grounded conductor shall be identified and attached to the screw shell and the identified blade of the attachment plug. In addition, portable handlamps shall comply with the following:
  - (i) Metal shell, paperlined lampholders shall not be used;
  - (ii) Handlamps shall be equipped with a handle of insulating material;
  - (iii) Handlamps shall be equipped with a substantial guard attached to the lampholder or handle; and
  - (iv) Metallic guards shall be grounded by an equipment grounding conductor run within the power supply cord.
- (d) Lampholders of the screws shell type shall be insulated for use as lampholders only, and if installed in a wet/damp location shall be weatherproofed.



- (e) Fixtures installed in wet/damp locations shall be identified for that purpose and be installed so that water enter or accumulate in wireways, lampholders, or other electrical parts.
- (f) Receptacles, cord connectors, and attachment plug (caps)
  - (i) Shall be constructed so that no receptacle or cord connector will accept attachment plugs with a different voltage or currenting rating than that for which the device was intended.
  - (ii) However, a 20-ampere T-slot receptacle or cord connector may accept a 15-ampere attachment plug of the same rating.
  - (iii) Receptacles connected to circuits having different voltages, frequencies, or types of current (ac or dc) on the same premises shall be of such design that attachment plugs used on these circuits are not interchangeable.
  - (iv) Damp and wet locations. Receptacles installed in a wet or damp location shall be designed for the location.
- (g) **Appliances**
  - (i) Live parts, shall not be exposed, unless they are current-carrying parts at high temperatures which necessarily are exposed.
  - (ii) Disconnecting means shall be provided to each appliance.
  - (iii) Ratings for each appliance shall be marked in volts and amperes or volts and watts.
- (h) **Motors, motor circuits, and controllers**
  - (i) **" In sight from."** If specified that one piece of equipment shall be **"in sight from"** another piece of equipment, the distance shall not be more that 50 feet (15.2 m).

**(ii) Disconnecting means**

- (A)** A disconnecting means shall be located in sight from the controller location. The controller disconnecting means for motor branch circuits over 600 volts, nominal, may be out of sight of the controller, if the controller is marked with a warning label giving the location and identification of the disconnecting means which is to be locked in the open position.
- (B)** The disconnecting means shall disconnect the motor and the controller from all ungrounded supply conductors, and shall be designated that no pole can be operated independently.
- (C)** If a motor and the driven machinery are not in sight from the controller location, the installation shall comply with one of the following:

  - (1)** The controller disconnecting means shall be capable of being locked in the open position, or
  - (2)** A manually operable switch that will disconnect the motor from its source of supply shall be placed in sight from the motor location.
- (D)** The disconnecting means shall plainly indicate open (off) or closed (on) position.
- (E)** The disconnecting means shall be readily accessible.

- (F) An individual disconnecting means shall be disconnecting means may be used for a group of motors if:
- (1) If a number of motors drive special parts of a single machine such as a metal or woodworking machine, crane, or hoist, ***or***
  - (2) If a group of motors is under the protection of one set of branch-circuit protective devices; ***or***
  - (3) If a group of motors is in a single room in sight from the location of the disconnecting means.
- (iii) Motor overload, short-circuit, and ground-fault protection. Motors, motor-control apparatus, and motor branch-circuit conductors shall be protected against overheating due to motor overloads or failure to start, and against short-circuits or ground faults. These provisions do not require overload protection that will stop a motor where a shut down is likely to cause addition or increased hazards, as in the case of fire pumps, or where continued operation of a motor is necessary for a safe shutdown of equipment or process and motor overload sensing devices are connected to a supervised alarm.
- (iv) **Protection of live parts -- all voltages.**
- (A) Stationary motors having commutators, collectors, and brushes rigging located inside of motor end brackets and not conductively connected to supply its operating at more than 150 volts to ground need not have such parts guarded. Exposed live parts of motors and controllers operating at 50 volts or more between terminals shall be guarded against accidental contact by any of the following:
- (1) By installation in a room or enclosure that is accessible only to qualified persons; ***or***

- (2) By installation on a balcony, gallery, or platform, so elevated and arranged as to exclude unqualified persons; ***or***
- (3) By elevation 8 feet (2.44 m) or more above the floor.
- (B) Where live parts of motors or controllers operating at over 150 volts to ground are guarded against accidental contact only by locations, ***and*** where adjustment or other attendance may be necessary during operation of the apparatus, insulating mats or platforms shall be provided so that the attendant cannot readily touch live parts unless standing on the mats or platforms.

(i) **Transformers**

- (i) Application ***exceptions:*** Current transformers; dry-type transformers as part of other apparatus; Transformer switch are an integral part of an X-ray; high frequency, or electrostatic-coating apparatus; and transformers used with Class 2 and 3 circuits, sign and outline lighting, electrical discharge lighting, and power-limited fire protection signal circuits.
- (ii) Operating voltage of exposed live parts of transformer installations shall be indicated by warning signs or visible marking on the equipment structure.
- (iii) Transformers over 35 kV. Dry-type, high fire point liquid-insulated, and askarel-insulated transformers installed indoors and rated ***over*** 35 kV shall be in a vault.
- (iv) Oil-insulated transformers installed indoors and presenting a fire hazard to employees shall be in a vault.
- (v) **Fire protection.** Combustible materials, buildings and parts of buildings, fire escapes, and door and window openings shall be safeguarded from fires which may originate in oil-insulated transformers attached to or adjacent to a building or combustible material.

- (vi) Transformers vaults shall be constructed so as to contain fire and combustible liquids within the vault and to prevent unauthorized access. Locks and latches shall be arranged that vault doors can be readily opened from the inside.
- (vii) Pipe and duct systems foreign to vault installation shall not enter or pass through a transformer vault.
- (viii) Materials shall not be stored in transformer vault

**(j) Capacitors**

- (i) Drainage of stored charge. All capacitors, except surge capacitors or capacitors included as a component part of other apparatus, shall automatically drain the stored charge and maintain the discharged state after the capacitor disconnected from its source of supply.
- (ii) Capacitors rated over 600 volts, nominal, shall comply with the following additional requirements:
  - (A) Isolating or disconnecting switches (with no interrupting rating) shall be interlocked with the load interrupting device or shall be provided with prominently displayed caution signs to prevent switching load current.
  - (B) For series capacitors the proper switching shall be assured by use of ***at least one*** of the following:
    - (1) Mechanically sequencing isolating and bypass switches, or
    - (2) Interlocks, or
    - (3) Switching procedure prominently displayed at the switching location.

## F. Specific Purpose Equipment & Installations

### 1. Cranes and Hoists

#### (a) *Disconnecting means*

- (i) Runway conductor disconnecting means. A readily accessible disconnecting means shall be provided between the runway contact conductors and the power supply.
  - (ii) Disconnecting means for cranes and monorail hoists shall be provided and, capable of being locked in the open position, and shall be provided in the leads from the runway contact conductors or other power supplies on any crane or monorail hoist.
    - (A) If this additional disconnecting means is not readily accessible from the crane or monorail hoist operating station, means shall be provided at the operating station to open the power circuit to all motors of the crane or monorail hoist.
    - (B) The additional disconnect may be omitted if a monorail hoist or hand propelled crane bridge installation meets all of the following:
      - (1) The unit is floor controlled;
      - (2) The unit within view of the power supply disconnecting means; and
      - (3) No fixed work platform has been provided for servicing the unit.
- (b) **Control.** A limit switch or other device shall be provided to prevent the load block from passing the safe upper limit of travel of any hoisting device.
- (c) **Clearance.** Working space around live parts which may require examination, adjustment, servicing or maintenance while alive shall be 30 inches (762 mm), and any associated cabinet doors shall open at least 90 degrees or be removable.

(d) **Grounding**

- (i) All exposed metal parts of cranes, monorail hoists, hoists and accessories including pendant controls shall be metallicity joined together into a continuous electrical conductor so that the entire crane or hoist will be grounded in accordance with paragraph D.6.
- (ii) Moving parts, other than removable accessories or attachments, having metal-to-metal bearing surfaces shall be considered to be electrically connected for grounding purposes.
- (iii) The trolley frame and bridge shall be considered as electrically grounded through the bridge and trolley wheels and tracks unless paint or other insulating materials prevent reliable metal-to-metal contact. In such a case a separate bonding conductor shall be provided.

2. **Elevators, escalators, and moving walks**

- (a) Disconnecting means of these devices shall have a single means for disconnecting all ungrounded main power supply conductors for each unit.
- (b) If control panels are not located in the same space as the drive machine, they shall be located in cabinets with doors or panels capable of being locked closed.

3. **Electric welder -- disconnecting means**

- (a) Motor-generator, AC transformer, and DC rectifier arc welders. A disconnecting means shall be provided in a supply circuit for each motor-generator arc welder, and each AC transformer and DC rectifier arc welder which is not equipped with a disconnect mounted as an integral part of the welder.
- (b) Resistance welders. A switch or circuit breaker shall be provided by which each resistance welder and its control equipment can be isolated from the supply circuit. The ampere rating of this disconnect means shall not be less than the supply conductor ampacity.

#### 4. X-ray equipment

##### (a) *Disconnecting means*

- (i) **General.** A disconnecting means shall be provided in the supply circuit and shall be operable from a location readily accessible from the X-ray control. For equipment connected to a 120 volt branch circuit of 30 amperes or less, a grounding-type attachment plug cap and receptacle of proper rating may serve as a disconnecting means.
  - (ii) More than one piece of equipment operating from the same high voltage circuit, each piece or each group of equipment as a unit shall be provided with a high voltage switch or equivalent disconnecting means which shall be constructed, enclosed, or located so as to avoid contact by employees with its live parts.
- (b) **Control.** Radiographic and fluoroscopic type equipment shall be enclosed or shall have interlocks that deenergize the equipment automatically to prevent ready access to live current-carrying parts.

#### G. Hazardous (Classified) Locations

1. **Scope.** These requirements are for electric equipment and wiring locations which are classified depending upon properties of the flammable vapors, liquids, gases, or combustible dusts or fibers which may be present and the likelihood that a flammable or combustible concentration is present. Each room, section, or area shall be considered individually in determining its classification. They are as follows:

*Class I, Division 1*  
*Class I, Division 2*  
*Class II, Division 1*  
*Class II, Division 2*  
*Class III, Division 1*  
*Class III, Division 2*

***See Glossary for definitions of each of these locations. All requirements of this section (G) apply to all hazardous (classified) locations unless modified by provisions of this section.***



2. **Electrical installations**, equipment, wiring methods, of equipment in hazardous (classified) locations shall be approved as intrinsically safe, or safe for the hazardous (classified) locations.
- (a) **Intrinsically safe**. Equipment and associated wiring approved as intrinsically safe is permitted in any hazardous (classified) location included in its listing or labeling.
  - (b) Approved for the hazardous (classified) location
    - (i) Equipment shall be approved not only for the class of location but also, for the ignitable or combustible properties of the specific gas, vapor, dust, or fiber present.
    - (ii) **Marking**. Equipment shall not be used unless it is marked to show class, group, and operating temperature range, based on operation in a 40-degree C ambient for which it is approved. Temperature marking shall not exceed the ignition temperature of the specific gas, vapor, or dust to be encountered. However, the following provisions modify this marking requirement for specific equipment:
      - (A) Non-heat producing equipment and heat-producing equipment having a maximum temperature of not more than 100 degrees C (212 degrees F) need not have a marked operating temperature or temperature range.
      - (B) Fixed lighting fixtures marked for use only in Class I, Division 2 locations need not be marked to indicate the group.
      - (C) Fixed general-purpose equipment in Class I locations, other than lighting fixtures, which is acceptable for Class I, Division 2 locations need not be marked with the class, group, division, or operating temperature.

(D) Fixed dust-tight equipment, other than lighting fixtures, which is acceptable for use in Class II, Division 2, and Class III locations need not be marked with the class, group, division, or operating temperature.

(c) ***Safe for the hazardous (classified) location.*** Equipment which is safe for the locations shall be of a type and design which the employer demonstrates will provide protection from the hazards arising from the combustibility and flammability of vapors, liquids, gases, dusts, or fibers.

3. ***Conduits.*** All conduits shall be threaded and shall be made wrench tight. Where it is impractical to make a threaded joint tight a bonding jumper shall be used.

## H. Special Systems

### 1. Systems over 600 volts nominal

#### (a) *Wiring methods for fixed installations*

(i) Above ground conductors shall be installed in a rigid metal conduit in intermediate metal conduit, in cable trays, in cable bus, in other suitable raceways, or as open runs of metal-clad cable designed for the use and purpose. However, open runs of non-metallic-sheathed cable or of bare conductors or busbars may be installed in locations accessible only to qualified persons. Metallic shielding components (tapes, wires, or braids for conductors) shall be grounded. Open runs of insulated wires and cables having a bare lead sheath or a braided outer covering shall be supported in a manner designed to prevent damage to the braid or sheath.

(ii) Installation conductors emerging from the ground shall be enclosed in raceways. Raceways installed on poles, shall be of rigid metal conduit, intermediate metal conduit, PVC schedule 80 or equivalent extending from the ground line up 8 feet (2.44 m) above finished grade. Conductors entering a building shall be protected by an enclosure from the ground to a point of entrance. Metallic enclosures shall be grounded.

(b) ***Interrupting and isolating devices***

- (i) Circuit breakers located indoors shall consist of metal-enclosed or fire-resistant, cell mounted units. In locations accessible only to qualified personnel, open-mounting of circuit breakers is permitted. A means of indicating the open and closed position shall be provided.
- (ii) Fused cutouts installed in buildings or transformer vaults shall be of a type identified for the purpose, and shall be readily accessible for fuse replacement.
- (iii) Equipment isolating means shall be provided to completely isolate equipment for inspection and repairs. Isolating means which are not designed to interrupt the load current of the circuit shall be either interlocked with a circuit interrupter or provided with a sign warning against operating under load.

(c) ***Mobile and portable equipment***

- (i) Power cable connecting to mobile machines shall be provided with metallic enclosures on the mobile machines for enclosing the terminals of the power cable. These enclosures shall include provisions for a solid connection for the ground wire(s) terminal to ground effectively the machine frame. The method of cable termination used shall prevent strain or pull on the cable. The enclosure shall have provision for locking so only authorized qualified persons may open it and shall be marked with a sign warning of energized parts.
- (ii) **Guarding live parts.** All energized switching and control parts shall be enclosed in effectively grounded metal cabinets or enclosures. Circuit breakers and protective equipment shall have the operating means projecting through the metal cabinet or enclosure so these units can be reset without locked doors being opened. Enclosures on metal cabinets shall be locked and accessible only to authorized qualified persons, and shall be marked with a sign warning of energized parts. Collector ring assemblies on revolving-type machines (shovels, draglines, etc.) shall be guarded.

(d) **Tunnel installations**

- (i) **Application.** This paragraph applies to installations and use of high voltage power transmissions and utilization equipment which is associated with tunnels **and** which is portable and/or mobile such as substations, trailers, cars, mobile shovels, draglines, hoists, drills, dredges, compressors, pumps, conveyors, and underground excavators.
- (ii) Conductors in tunnels shall be installed in one or more of the following:
  - (A) Metal conduit or other metal raceway, or
  - (B) Type MC cable, or
  - (C) Other suitable multiconductor, and
  - (D) Shall be so located or guarded as to protect them from physical damage.
  - (E) Multiconductor portable cable may supply mobile equipment.
  - (F) Equipment grounding conductor shall be run with circuit conductors inside the metal raceway or inside the multiconductor cable jacket. The equipment grounding conductor may be insulated or bare.
- (iii) **Guarding live parts.** Bare terminals of transformers, switches, etc. shall be enclosed to prevent accidental contact with energized parts. Enclosures for use in tunnels shall be drip-proof, weatherproof, or submersible as required by environmental conditions.
- (iv) Disconnecting means that simultaneously opens all ungrounded conductors shall be installed at each transformer or motor location.

- (v) **Grounding and bonding.** All nonenergized metal parts of electrical equipment and metal raceways and cable sheaths shall be grounded **and** bonded to all metal pipes and rails at the portal and at intervals not exceeding 1000 feet (305 m) throughout the tunnel.

2. **Class 1, Class 2, and Class 3 remote control, signaling, and power-limited circuits.**

- (a) These circuits are characterized by their usage and electrical power limitations which differentiates them from light and power circuits as describe below:

- (i) **Class 1 circuit**

- (A) Class 1 power-limited circuit is supplied from a source having a rated output of not more than 30 volts and 1000 volt-amperes.
- (B) Class 1 remote control circuit or a Class 1 signaling circuit has a voltage which does not exceed 600 volts; however, the power output to the source need not be limited.

- (ii) **Class 2 and Class 3 circuits**

- (A) Power for Class 2 and Class 3 circuits is limited either inherently (in which no overcurrent protection is required) or by a combination of a power source and overcurrent protection.
- (B) Maximum circuit voltage is 30 volts AC and 60 volts DC for a Class 2 power source limited by overcurrent protection, and 150 volts AC or DC for a Class 3 power source limited by overcurrent protection.
- (C) The maximum circuit voltage is 150 volts AC or DC for a Class 2 inherently limited power source and 100 volts AC and DC for a Class 3 inherently limited power source.

- (iii) **Application.** The maximum current voltages in paragraph 2 (a) (i), and 2 (a) (ii) of this paragraph (above) apply to sinusoidal AC or continuous DC power sources, and where wet contact occurrence is not likely.
  - (b) **Marking.** A Class 2 or Class 3 power supply unit shall not be used unless it is durably marked where plainly visible to indicate the Class of supply and its electrical rating.
- (3) **Communications systems**
  - (a) **Scope.** The provisions apply to such systems as central-station connected and non-central-station connected telephone circuits, radio receiving and transmitting equipment, and outside wiring for fire and burglar alarm, and similar central station systems. These installations need not comply with the provisions of paragraph II.C. (General Requirements) through II G.2. except II.D.3.(a)(ii) and II.G.
  - (b) **Protective devices**
    - (i) Circuits exposed to power conductors. Communication circuits exposed to accidentally contact with light or power conductors operating at over 300 volts shall have each circuit so exposed provided with an approved protector.
    - (ii) **Antenna lead-ins.** Each conductor of a lead-in from an outdoor antenna shall be provided with an antenna discharge unit or other means to drain static charged from the antenna system.
  - (c) **Conductor location**
    - (i) **Outside of buildings**
      - (A) Receiving distribution lead-in or aerial-drop cables attached to buildings and lead-in conductors to radio transmitters shall be so installed as to avoid the possibility of accidental contact with electric light or power conductors.
      - (B) The clearance lead-in conductor and any lightning protection conductors shall not be less than 6 feet (1.83 m).

- (ii) **On poles.** Where practicable, communication conductors on poles shall be located below the light or power conductors. Communications conductors shall not be attached to a crossarm that carries light or power conductors.
  - (iii) **Inside of buildings.** Indoor antennas, lead-ins, and other communication conductors attached as open conductors to the inside of buildings shall be located at least 2 inches (50.8mm) from conductors of any light or power or Class 1 circuits unless a special and equally protective method of conductor separation is used.
- (d) **Equipment location.** Outdoor metal structures supporting antennas such as vertical rods or dipole structures, shall be located as far away from overhead conductors of electric light and power circuits of over 150 volts to ground as necessary to avoid the possibility of the antenna or structure falling into or making accidental contact with such circuits.
- (e) **Grounding**
- (i) Lead-in conductors, if exposed to contact with electric light or power conductors, the metal sheath of aerial cables entering buildings shall be grounded or interrupted close to the entrance to the building by an insulating joint or equivalent device. Where protective devices are used, they shall be grounded.
  - (ii) Antenna structures and masts supporting antennas shall be permanently and effectively grounded without splice or connection in the grounding conductor.
  - (iii) **Equipment enclosures.** Transmitters shall be enclosed in a metal frame or grill or separated from the operating space by an effectively grounded barrier. All external metal handles and controls accessible to operating personnel shall be effectively grounded. Unpowered equipment and enclosures shall be considered grounded where connected to an attached coaxial cable with an effectively grounded metallic shield.

### III. SAFETY-RELATED WORK PRACTICES FOR UNQUALIFIED EMPLOYEES

#### A. GENERAL REQUIREMENTS

##### 1. *Protection of Employees*

- (a) Steingass Mechanical Contracting, Inc. shall instruct all employees who face a risk of electrical shock to be trained and familiar with electrical related safety practices. Only qualified persons may work on energized parts.
- (b) Steingass Mechanical Contracting, Inc. shall not permit employees to work in proximity to any part of electric power circuit that the employee could contact the electric power circuit in the course of work unless the employee is protected from electric shock by deenergizing the circuit and grounding it or by guarding it effectively by insulation or other means.  
\*In work areas under overhead lines, Steingass Mechanical Contracting, Inc. shall ensure lines are deenergized and grounded prior to commencing work. In the event that this is not feasible, appropriate clearance distances will be maintained as outlined by CFR 1910.333
- (c) In work areas where exact location of underground electric power lines is unknown, Steingass Mechanical Contracting, Inc. using jack-hammers, bars, or other handheld tools which may contact a line shall be provided with insulated protective gloves.
- (d) Before work is begun, the Steingass Mechanical Contracting, Inc. shall ascertain whether any part of an energized electric power circuit, exposed or concealed, is so located that the performance of the work may bring any employee, tool, or machine into physical or electrical contact with the electric power circuit. Steingass Mechanical Contracting, Inc. shall post and maintain proper warning signs where such a circuit exists. Steingass Mechanical Contracting, Inc. shall advise employees of the location of such lines, the hazards involved, and the protective measures to be taken.
- (e) Steingass Mechanical Contracting, Inc. shall ensure that additional illumination in any and all spaces is available so as employees may work safely.
- (f) Steingass Mechanical Contracting, Inc. shall ensure that protective shields, protective barriers or insulating materials are in place when employees are working in confined or enclosed work spaces.
- (g) Employees who are subject to handle long dimensional conductor objects must follow Steingass Mechanical Contracting, Inc. safe work practices.



- (h) Steingass Mechanical Contracting, Inc. shall ensure that all portable ladders shall have non-conductive side rails.
- (i) Steingass Mechanical Contracting, Inc. shall ensure that any unqualified employee, vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines shall be operated so that a *clearance of 10 ft. is maintained*. If the voltage is higher than 50 KV the clearance shall be increased 4” for every 10 KV.
- (j) Employees shall not be permitted to wear conductive apparel. (Jewelry)
- (k) Employees who are working on or near exposed de-energized parts that have not been locked or tagged out shall be treated as live parts.

**2. Passageways and open space**

- (a) Barriers or other means of guarding shall be provided to ensure that workspace for electrical equipment will not be used as a passageway during periods when energized parts of electrical equipment are exposed.
- (b) Working spaces, walkways, an similar locations, shall be kept clear of cords so as not to create a hazard to employees.

**3. Load ratings in existing installations shall not be made to increase the load in excess of the load rating of the circuit rating.**

**4. Fuses, when installed or removed with one or both terminals energized, special tools insulated for the voltage shall be used.**

**5. Electric cables and cords when worn or frayed shall not be used. Extension cords shall not be fastened with staples, hung from nails, or suspended by wires.**

**B. LOCKOUT AND TAGGING OF CIRCUITS**

- 1. Controls that are to be deactivated during the course of work on energized

or deenergized equipment or circuits shall be tagged.

2. Equipment or circuits that are deenergized shall be rendered inoperative and shall have tags attached at all points where such equipment or circuits can be energized.
3. Tags shall be placed to identify plainly the equipment or circuit being worked on.

#### **IV. SAFETY-RELATED MAINTENANCE AND ENVIRONMENTAL CONSIDERATIONS**

##### **A. Maintenance of Equipment**

The employer shall ensure that all wiring components and utilization equipment in hazardous locations are maintained in a dust-tight, dust ignition-proof, or explosion-proof condition. There shall be no loose or missing screws, gaskets, threaded connections, seals, or impairments to a tight connection.

##### **B. Environmental Deterioration of Equipment**

###### **1. Deteriorating agents**

- (a) Unless identified for use in the operating environment, no conductor or equipment shall be located:
  - (i) In damp or wet locations;
  - (ii) Where exposed to gases, fumes, vapors, liquids, or other agents having a deteriorating effect on the conductors, or equipment; or
  - (iii) Control equipment, utilization equipment, and busways approved for use in dry locations only shall be protected against damage from weather during building construction.

###### **2. Protection against corrosion. Metal raceways, cable armor, boxes,**

*cabling sheathing, cabinets, elbows, couplings, fittings, supports, and support hardware shall be of material appropriate for the environment in which they are to be installed.*

#### **IV. SAFETY - REQUIREMENTS FOR SPECIAL EQUIPMENT**

##### **A. Batteries and battery charging:**

1. Batteries of the unsealed type shall be located in enclosures with outside vents or in well ventilated rooms and shall be arranged so as to prevent the escape of fumes, gases, or electrolyte spray into other areas.
2. Ventilation shall be provided to ensure diffusion of the gases from the batteries and to prevent accumulation of an explosive mixture.
3. Racks and trays shall be substantial and shall be treated to make them resistant to electrolyte.
4. Floors shall be of acid resistant construction unless protected from acid accumulations.
5. Face shields, rubber aprons, and rubber gloves shall be provided for workers handling acids and batteries.
6. Facilities for quick drenching of eyes and body shall be provided within 25 feet (7.62 m) of battery handling areas (safety showers and safety eye wash fountains).
7. Facilities shall be provided for flushing and neutralizing spilled electrolyte and for fire protection.
8. Battery charging installations shall be located in areas designated for that purpose.
9. Charging apparatus shall be protected from damage by trucks.
10. When batteries are being charged, the vent caps shall be kept in place to avoid electrolyte spray. Vent caps shall be maintained in functioning condition.

**Steingass Mechanical Contracting, Inc.**  
**Employee Training Statement**

The purpose of this training is to gain an understanding of established Steingass Mechanical Contracting, Inc.'s Electrical Safety. **You** are accountable for ensuring that you understand by asking questions and seeking clarification during training and day-to-day practical job applications.

This Program has been developed to be as workable as possible while accomplishing our safety goals and complying with current OSHA regulations. You are welcome to suggest changes to these procedures. All suggestions will be evaluated based upon their workability, impact on safety, and compliance with current OSHA regulations.

As one of **Steingass Mechanical Contracting, Inc.'s Employees**, I have reviewed the latest copy of **Steingass Mechanical Contracting, Inc.'s Electrical Safety For Contractors**, and in addition, I have received the following training:

- |      |   |
|------|---|
| I.   | Glossary of Terms                                       |
| II.  | Installation Safety Requirements                        |
| III. | Safety-Related Work Practices                           |
| IV.  | Safety-Related Maintenance & Environment Considerations |
| V.   | Safety Requirements for Special Equipment               |

**Employee Signature:** \_\_\_\_\_

**Date:** \_\_\_\_/\_\_\_\_/\_\_\_\_

**Time:** \_\_\_\_\_