



Don H. Mahaffey Drilling Co.

ELECTRICAL SAFETY



YOUR OSHA COMPLIANCE SOLUTION

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1 OBJECTIVE

It is with full intent of Don H. Mahaffey Drilling Co. to provide employees with comprehensive knowledge and training on the prevention of serious injuries from electrical hazards at work sites. This Electrical Safety Program is developed and designed in accordance with the California Code of Regulations, Title 8, Sections 2320.1 through 2420.7.

2 ADMINISTRATOR

Don H. Mahaffey Drilling Co. has designated Ashley Mahaffey Tullius for the implementation of the Electrical Safety Program. Ashley Mahaffey Tullius is responsible for:

- Identifying work areas, processes, or tasks that could potentially expose employees to electrical hazards.
- Enforcing methods of exposure control.
- Maintaining records pertaining to the program.
- Maintaining, reviewing, and updating the Electrical Safety Program at least annually.

3 WORK PROCEDURES

3.1 General

3.1.1 Only qualified persons will work on electrical equipment or systems.

3.1.2 Only qualified persons will be permitted to perform any function in proximity to energized overhead conductors unless means to prevent accidental contact have been provided in accordance with California Code of Regulations, Title 8, Subchapter 5, Articles 3 and 4.

3.2 Energized Equipment or Systems

- 3.2.1 Work will not be performed on exposed energized parts of equipment or systems until the following conditions are met:
- a. Responsible supervision has determined that the work is to be performed while the equipment or systems are energized.
 - b. Involved personnel have received instructions on the work techniques and hazards involved in working on energized equipment.
 - c. Suitable personal protective equipment and safeguards are provided and used.
- EXCEPTION: The use of approved insulating gloves, insulated tools, or other protective measures are not required when working on exposed parts of equipment or systems energized at less than 50 volts, provided a conclusive determination has been made prior to the start of work by a qualified person that there will be no employee exposure to electrical shock, electrical burns, explosion or hazards due to electric arcs.*

1. Rubber insulating gloves will meet the provisions of the American Society for Testing Materials (ASTM) D 120-02a, Standard Specification for Rubber Insulating Gloves and will be maintained in accordance with ASTM F 496-02a, Standard Specification for In-Service Care of Insulating Gloves and Sleeves.
 2. Insulated tools will meet the provisions of the American Society of Testing Materials (ASTM) F 1505-01, Standard Specification for Insulated and Insulating Hand Tools.
 - d. Approved insulated gloves will be worn for voltages in excess of 250 volts to ground.
 - e. Suitable barriers or approved insulating material will be provided and used to prevent accidental contact with energized parts.
 - f. Suitable eye protection has been provided and is used.
 - g. Where required for personnel protection, suitable barricades, tags or signs are in place.
 - h. Each employee who is exposed to the hazards of flames or electric arcs wears apparel that, when exposed to flames or electric arcs, does not increase the extent of injury that would be sustained by the employee. This subsection prohibits clothing made from the following types of fabrics, either alone or in blends, unless the employee can demonstrate that the fabric has been treated with flame retardant: acetate, nylon, polyester and rayon.
- 3.2.2 After the required work on an energized system or equipment has been completed, an authorized person will be responsible for:
- a. Removing from the work area any temporary personnel protective equipment.
 - b. Reinstalling all permanent barriers or covers.

3.3 Tests

All electrical equipment and systems will be treated as energized as required by Section 3.2 until tested or otherwise proven to be de-energized.

3.4 De-Energized Equipment or Systems

An authorized person will be responsible for the following before working on de-energized electrical equipment or systems, unless the equipment is physically removed from the wiring system:

- a. Notifying all involved personnel.
- b. Locking the disconnecting means in the “open” position with the use of lockable devices, such as padlocks, combination locks, the disconnecting of conductor(s) or other positive methods or procedures which will effectively prevent unexpected or inadvertent energizing of a designated circuit, equipment or appliance.

EXCEPTION: Locking is not required under the following conditions:

1. *Where tagging procedures are used as specified in Section 3.4(c).*
2. *Where the disconnecting means is accessible only to personnel instructed in these tagging procedures.*

- c. Tagging the disconnecting means with suitable accident prevention tags conforming to the provisions of Section 3.6 and California Code of Regulations, Title 8, Section 3314(e); and
- d. Effectively blocking the operation or dissipating the energy of all stored energy devices which present a hazard, such as capacitors or pneumatic, spring-loaded and similar mechanisms.

3.5 Energizing (or Re-Energizing) Equipment or Systems

An authorized person will be responsible for the following before energizing equipment or systems which have been de-energized:

- a. Determining that all persons are clear from hazards which might result from the equipment or systems being energized.
- b. Removing locking devices and tags.
 - Locking devices and tags may be removed only by the employee who placed them. Locking devices and tags will be removed upon completion of the work, and after the installation of the protective guards, and/or safety interlock systems.

EXCEPTION: When the employee has left the premises or is otherwise unavailable, other persons may be authorized to remove the locking devices and tags in accordance with a pre-determined procedure.

3.6 Accident Prevention Tags

Suitable accident prevention tags will be used to control a specific hazard. Such tags will provide at minimum, the following information:

- a. Reason for placing the tag.
- b. Name of person placing the tag and how that person may be contacted.
- c. Date the tag was placed.

3.7 Safety Precautions

- 3.7.1 Suitable temporary barriers or barricades will be installed when access to opened enclosures, containing exposed energized electrical equipment, is not under the control of an authorized person.
- 3.7.2 Conductive measuring tapes, ropes, or similar measuring devices will not be used when working on or near exposed energized conductors or parts of equipment.
- 3.7.3 Conductive fish tapes will not be used in raceways entering enclosures containing exposed energized parts, unless such parts are isolated by suitable barriers.
- 3.7.4 Prior to climbing poles or other elevated structures supporting overhead electrical lines or equipment, an inspection will be made to ensure that such poles or structures are in safe condition for the work to be performed. Where poles or structures are determined to be unsafe for climbing, they will not be climbed until made safe by guying, bracing, or other adequate means.

3.8 Fall Protection

When work is performed at elevated locations more than 4 feet above the ground on poles, towers, or similar structures, employees are required to use either fall arrest equipment, work positioning equipment, or travel-restricting equipment if other fall protection methods have not been provided (e.g., guardrails, safety nets, etc.). The use of body belts for fall arrest systems is prohibited.

EXCEPTION: Point-to-point travel by a qualified person, unless conditions such as ice, high winds, design of the structure or other condition (e.g., chemical contaminants) prevents the employee from gaining a firm hand or foothold while traveling.

3.9 Backfeeding or Interconnection

No electrical power source, permanent or temporary, will be connected to a premise's wiring system, or parts of such a system, unless positive means are used to prevent the transmission of electricity beyond the premises wiring system or beyond any intentionally segregated parts of such system.

EXCEPTION: When an interconnection has been authorized by the servicing utility.

4 REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

4.1 Maintenance

Electrical equipment will be maintained free from recognized hazards that are likely to cause death or serious physical harm to employees.

4.2 Examination, Installation and Use of Equipment

4.2.1 Examination

Electric equipment will be free from recognized hazards that are likely to cause death or serious harm to employees. Safety of equipment will be determined using the following considerations:

- a. Suitability for installation and use in conformity with the provisions of this program.
NOTE: Suitability of equipment for an identified purpose may be evidenced by listing or labeling for that purpose.
- b. Mechanical strength and durability, including for parts designed to enclose and protect other equipment, the adequacy of the protection thus provided.
- c. Wire-bending and connection space
- d. Electrical insulation
- e. Heating effects under all conditions of use
- f. Arcing effects
- g. Classification by type, size, voltage, current capacity and specific use.
- h. Other factors that contribute to the practical safeguarding of persons using, or likely to contact the equipment.

- 4.2.2 Installation and Use:
Listed or labeled equipment will be installed and used in accordance with any instructions included with the listing or labeling.

4.3 Conductors

- 4.3.1 Insulation:
All conductors used for general wiring will be insulated unless otherwise permitted in this program.
- 4.3.2 Type:
The conductor insulation will be of a type that is approved for the voltage, operating temperature, and location of use.
- 4.3.3 Distinguishable:
Insulated conductors will be distinguishable by color or other suitable means as being grounded conductors, ungrounded conductors, or equipment grounding conductors.

4.4 Insulation Integrity

Completed wiring installations will be free from short circuits and from grounds other than those required or permitted by this program.

4.5 Interrupting Rating

- 4.5.1 Equipment intended to interrupt current at fault levels will have an interrupting rating sufficient for the nominal circuit voltage and the current which is available at the line terminals of the equipment.
- 4.5.2 Equipment intended to interrupt currents at other than fault levels will have an interrupting rating at nominal circuit voltage sufficient for the current that must be interrupted.

4.6 Circuit Impedance and Other Characteristics

The overcurrent protective devices, the total impedance, the component short-circuit current ratings, and other characteristics of the circuit to be protected will be selected and coordinated to permit the circuit protective devices used to clear a fault, to do so without the occurrence of extensive damage to the electrical components of the circuit. This fault will be assumed to be either between two or more of the circuit conductors, or between any circuit conductor and the grounding conductor or enclosing metal raceway.

4.7 Deteriorating Agents

- Unless approved for the purpose, no conductors or equipment will be located:
- In damp or wet locations.
 - Where exposed to gases, fumes, vapors, liquids, or other agents that have a deteriorating effect on the conductors or equipment.
 - Where exposed to excessive temperatures.

4.8 Mechanical Execution of Work

Electric equipment will be installed in a neat and workmanlike manner.

- 4.8.1 Unused openings in boxes, raceways, auxiliary gutters, cabinets, equipment cases, or housings will be effectively closed to afford protection substantially equivalent to the wall of the equipment.
- 4.8.2 Conductors will be racked to provide ready and safe access in underground and subsurface enclosures that persons enter for installation and maintenance.
- 4.8.3 Internal parts of electrical equipment, including busbars, wiring terminals, insulators and other surfaces, will not be damaged or contaminated by foreign materials such as paint, plaster, cleaners, abrasives or corrosive residues.
- 4.8.4 There will be no damaged parts that may adversely affect safe operation or mechanical strength of the equipment, such as parts that are broken, bent, cut, or deteriorated by corrosion, chemical action, or overheating.

4.9 Mounting and Cooling of Equipment

- 4.9.1 Mounting:
Electric equipment will be firmly secured to the surface on which it is mounted.

NOTE: Wooden plugs driven into holes in masonry, concrete, plaster or similar materials are not considered secure means of fastening electric equipment.

- 4.9.2 Electric equipment that depends on the natural circulation of air and convection principles for cooling of exposed surfaces will be installed so that room airflow over such surfaces is not prevented by walls or by adjacent installed equipment. For equipment designed to be floor mounted, clearance between top surfaces and adjacent surfaces will be provided to dissipate rising warm air.
- 4.9.3 Cooling:
Electrical equipment provided with ventilating openings will be installed and maintained so that free circulation of air through the equipment is not obstructed.

4.10 Electrical Connections

- 4.10.1 General:
Because of different characteristics of dissimilar metals:
 - a. Devices such as pressure terminals, pressure splicing connectors, and soldering lugs will be identified for the material of the conductor and will be properly installed and used.

- b. Conductors of dissimilar metals may not be intermixed in a terminal or splicing connector where physical contact occurs between dissimilar conductors (such as copper and aluminum, copper and copper-clad aluminum, or aluminum and copper-clad aluminum), unless the device is identified for the purpose and conditions of use.
- c. Materials such as solder, fluxes, inhibitors, and compounds, will be suitable for the use and will be of a type that will not adversely affect the conductors, installation, or equipment, where employed.

4.10.2 Terminals

- a. Connection of conductors to terminal parts will ensure a good connection without damaging the conductors and will be made by means of pressure connectors (including set-screw type), solder lugs, or splices to flexible leads. However, No. 10 or smaller conductors may be connected by means of wire-binding screws, or studs and nuts having upturned lugs or equivalent.
- b. Terminals for more than one conductor and terminals used to connect aluminum will be appropriately identified.

4.10.3 Splices

- a. Conductors will be spliced or joined with splicing devices, brazing, welding, or soldering with a fusible metal or alloy. Soldered splices will first be spliced or joined to be mechanically and electrically secure without solder, then soldered. All splices, joints, and the free ends of conductors will be covered with an insulation equivalent to that of the conductors or with an insulating device identified for the purpose.
- b. Wire connectors or splicing means installed on conductors for burial will be listed for such use.

4.11 Workspace About Electric Equipment

4.11.1 Space About Electric Equipment:

Sufficient access and working space will be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of such equipment.

4.11.2 Workspace:

Working space for equipment likely to require examination, adjustment, servicing, or maintenance while energized will comply with the following dimensions, except as required or permitted elsewhere in this program:

a. Depth:

The depth of the working space in the direction of access to live parts will not be less than indicated in Table 2340.16 unless permitted elsewhere in this program. Distances will be measured from the live parts if they are exposed, from the enclosure front, or opening if they are enclosed.

b. Width:

In addition to the dimensions of depth shown in Table 2340.16, the width of the workspace in front of the electric equipment will not be less than the width of the equipment or 30 inches, whichever is

greater. In all cases, the workspace will be adequate to permit at least a 90-degree opening of equipment doors or hinged panels.

c. Height:

The workspace will be clear and extend from the grade, floor, or platform to the height required by Section 4.11.6. However, other equipment associated with the electrical installation and located above or below the electric equipment may extend not more than 6 inches beyond the front of the electric equipment.

Table 2340.16 Minimum Depth of Clear Working Space at Electrical Equipment 600 V or Less						
Nominal Voltage to Ground	Minimum Clear Distance (Feet)					
	Condition 1		Condition 2		Condition 3	
	Feet	Meters	Feet	Meters	Feet	Meters
0 – 150	3*	0.9	3*	0.9	3	0.9
151 – 600	3*	0.9	3.5	1.0	4	1.2

NOTES TO TABLE 2340.16

Where the “Conditions” are as follows:

Condition 1 – Exposed live parts on one side, no live or grounded parts on the other side of the working space or exposed live parts on both sides effectively guarded by suitable wood or other insulating materials. Insulated wire or insulated busbars operating at 300 volts or less will not be considered live parts.

Condition 2 – Exposed live parts on one side and grounded parts on the other side. Concrete, brick, or tile surfaces will be considered as grounded surfaces.

Condition 3 – Exposed live parts on both sides of the workspace (not guarded as provided in Condition 1) with the operator in-between.

EXCEPTIONS:

- *1. Minimum clear distances may be up to 2.5 feet for installations built before April 16, 1981.
2. Working space is not required behind 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 conditions are accessible from locations other than the back.
3. Where rear access is required to work on de-energized parts on the back of enclosed equipment, a minimum working space of 30 inches horizontally will be provided.

4.11.3 Clear Spaces:

Working space required by this section will 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, will be suitably guarded.

4.11.4 Entrance and Access to Workspace:

At least one entrance of sufficient area will be provided to give access to the working space about electric equipment.

- a. For equipment rated 1,200 amperes or more and over 6 feet wide, containing overcurrent devices, switching devices, or control devices, there will be one entrance not less than 24 inches wide and 6-feet 6-inches high at each end of the workspace, except that:
 - 1. Where the location permits a continuous and unobstructed way of exit travel, one means of exit is permitted.
 - 2. Where the working space required by Section 4.11.2 is doubled, only one entrance to the working space is required. However, the entrance will be located so that the edge of the entrance nearest the equipment is the minimum clear distance given in Table 2340.16 away from such equipment.
- b. Attics, furred ceilings, and underfloor spaces will have minimum unobstructed access openings of 22 inches by 30 inches.

4.11.5 Illumination:

Portable or fixed illumination, suitable for the nature of the work being performed, will be provided when working on electrical equipment. The light fixtures and their control points will be arranged so that persons operating light switches, replacing lamps, or making repairs on the lighting system will not be endangered by energized parts of other equipment.

EXCEPTION: Additional lighting fixtures are not required where the working space is illuminated by an adjacent light source. In electric equipment rooms, the illumination may not be controlled by automatic means only.

4.11.6 Headroom:

The minimum headroom of working space about service equipment, switchboards, panelboards, and motor control centers, which require manual operation or where there are energized parts exposed at any time, will be as follows:

- a. For installations built before May 5, 2008 – 6 feet 3 inches.
- b. For installations built on or after May 5, 2008, 6 feet 6 inches, except that where the electrical equipment exceeds 6'5" feet in height, the minimum headroom may not be less than the height of the equipment.

4.11.7 For installations built on or after May 5, 2008, switchboards, panelboards and distribution boards installed for the control of light and power circuits and motor control centers will be located in dedicated spaces and protected from damage.

a. Indoor:

For indoor installation, the dedicated space will comply with the following:

- 1. The space equal to the width and depth of the equipment and extending from the floor to a height of 6.0 feet above the equipment or to the structural ceiling, whichever is lower, will be dedicated to the electrical installation. Unless isolated from equipment by height or physical enclosures or covers that will afford adequate mechanical protection from vehicular traffic or accidental contact by unauthorized personnel or that complies

with Section 4.11.7(a)(2), piping, ducts or equipment foreign to the electrical installation will not be located in this area.

2. The space equal to the width and depth of the equipment will be kept clear of foreign systems unless protection is provided to avoid damage from condensation, leaks or breaks in such foreign systems. This area will extend from the top of the electric equipment to the structural ceiling.
3. Sprinkler protection is permitted for the dedicated space where the piping complies with this section.
4. Control equipment that by its very nature, or because of other requirements in this program, must be adjacent to or within sight of its operating machinery is permitted in the dedicated space.

NOTE: A dropped, suspended, or similar ceiling that does not add strength to the building structure will not be considered a structural ceiling.

b. Outdoor:

Outdoor electric equipment will be installed in suitable enclosures and will be protected from accidental contact by unauthorized personnel, by vehicular traffic, or by accidental spillage or leakage from piping systems. No architectural appurtenance or other equipment may be located in the working space required by Section 4.11.2.

4.12 Guarding of Energized Parts

- 4.12.1 Except as elsewhere required or permitted by this program, energized parts of electric equipment operating at 50 volts or more will be guarded against accidental contact by use of approved cabinets or other forms of approved enclosures, or by any of the following means:
- a. By location in a room, vault, or similar enclosure that is accessible only to qualified persons.
 - b. By suitable permanent substantial partitions or screens so arranged that only qualified persons will have access to the space within reach of the energized parts. Any openings in such partitions or screens will be so sized and located that persons are not likely to come into accidental contact with the energized parts or to bring conducting objects into contact with them.
 - c. By location on a suitable balcony, gallery, or platform so elevated and otherwise located as to prevent access by unqualified persons.
 - d. By elevation of 8 feet or more above the floor or other working surface.
- 4.12.2 In locations where electric equipment is likely to be exposed to physical damage, enclosures or guards will be so arranged and of sufficient strength as to prevent such damage.
- 4.12.3 Entrances to rooms and other guarded locations containing exposed live parts will be marked with conspicuous warning signs forbidding unqualified persons to enter.

4.13 Arcing Parts

Parts of electric equipment which in ordinary operation produce arcs, sparks, flames, or molten metal will be enclosed or separated and isolated from all combustible material.

4.14 Marking

4.14.1 Identification of Manufacturer and Ratings:

Electric equipment will not be used unless the following markings have been placed on the equipment:

- a. The manufacturer's name, trademark or other descriptive marking by which the organization responsible for the product may be identified.
- b. Other markings giving voltage, current, wattage or other ratings.

4.14.2 Durability:

The markings will be of sufficient durability to withstand the environment that they are used in.

4.15 Identification of Equipment

4.15.1 Motors and Appliances:

Each disconnecting means required by this program for motors and appliances will be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident.

4.15.2 Services, Feeders, and Branch Circuits:

Each service, feeder, and branch circuit, at its disconnecting means or overcurrent device, will be legibly marked to indicate its purpose unless located and arranged so the purpose is evident.

4.15.3 Each service disconnecting means will plainly indicate whether it is in the open or closed position.

4.15.4 Durability of Markings:

The markings will be of sufficient durability to withstand the environment involved.

4.15.5 Capable of Accepting a Lock:

Effective with installations made after May 5, 2008, disconnecting means required by this program will be capable of being locked in the open position.

4.15.6 Marking for Series Combination Ratings:

Effective with installations made after May 5, 2008:

- a. Where circuit breakers or fuses are applied in compliance with the series combination ratings marked on the equipment by the manufacturer, the equipment enclosures will be legibly marked in the field to indicate that the equipment has been applied with a series combination rating.

- b. The marking required by Section 4.15.6(a) will be readily visible and will state:
“Caution – Series Combination System Rated --- Amperes. Identified Replacement Component Required”

5 USE AND IDENTIFICATION OF GROUNDED CONDUCTORS

5.1 Identification of Conductors

- 5.1.1 A conductor used as a grounded conductor will be identifiable and distinguishable from all other conductors.
- 5.1.2 A conductor used as an equipment grounding conductor will be identifiable and distinguishable from all other conductors.

5.2 Polarity of Connections

No grounded or grounding conductor will be attached to any terminal or lead to reverse designated polarity.

5.3 Use of Grounding Terminals and Devices

A grounding terminal or grounding-type device on a receptacle, cord connector or attachment plug will not be used for purposes other than grounding.

6 BRANCH CIRCUITS

6.1 Receptacles and Cord Connectors

- 6.1.1 Receptacles installed on 15- and 20-ampere branch circuits will be of the grounding type, except as permitted for replacement receptacles in Section 6.1.4. Grounding-type receptacles will be installed only on circuits of the voltage class and current for which they are rated, except as provided in Table 6.3(b)(2) and 6.3(b)(3).
- 6.1.2 Receptacles and cord connectors having grounding contacts will have those contacts effectively grounded except for receptacles mounted on portable and vehicle-mounted generators in accordance with Section 10.4 and replacement receptacles installed in accordance with Section 6.1.4.
- 6.1.3 The grounding contacts of receptacles and cord connectors will be grounded by connection to the equipment grounding conductor of the circuit supplying the receptacle or cord connector. The branch circuit wiring method will include or provide an equipment grounding conductor to which the grounding contacts of the receptacle or cord connector will be connected.
- 6.1.4 Replacement of receptacles will comply with the following requirements:

- a. Where a grounding means exists in the receptacle enclosure, or a grounding conductor is installed, grounding-type receptacles will be used and will be connected to the grounding means or conductor.
- b. Ground-fault circuit-interrupter protected receptacles will be provided where replacements are made at receptacle outlets that are required to be so protected elsewhere in this program.
- c. Where a grounding means does not exist in the receptacle enclosure, the installation will comply with one of the following provisions:
 - 1. A nongrounding-type receptacle may be replaced with another nongrounding-type receptacle.
 - 2. A nongrounding-type receptacle may be replaced with a ground-fault circuit-interrupter-type of receptacle that is marked "No Equipment Ground;" an equipment grounding conductor will not be connected from the ground-fault circuit-interrupter-type receptacle to any outlet supplied from the ground-fault circuit-interrupter receptacle.
 - 3. A nongrounding-type receptacle may be replaced with a grounding-type receptacle where supplied through a ground-fault circuit-interrupter; the replacement will be marked "GFCI Protected" and "No Equipment Ground." An equipment grounding conductor will not be connected to such grounding-type receptacles.

6.1.5 Receptacles connected to circuits having different voltages, frequencies or types of current (ac or dc) on the same premises will be of such design that the attachment plugs used on these circuits are not interchangeable.

6.2 Ground-Fault Circuit Interrupter Protection for Personnel

- 6.2.1 All 120-volt (nominal), single-phase, 15- and 20-ampere receptacles installed in bathrooms or on rooftops will have ground-fault circuit-interrupter protection for personnel.
- 6.2.2 The following requirements apply to temporary wiring installations that are used during maintenance, remodeling or repair of buildings, structures or equipment, or during similar activities:
 - a. All 120-volt (nominal), single-phase, 15-, 20-, and 30-ampere receptacle outlets that are not part of the permanent wiring of the building or structure, and that are in use by personnel will have ground-fault circuit-interrupter protection for personnel.
NOTE 1 to Section 6.2.2(a): A cord connector on an extension cord set is considered to be a receptacle outlet if the cord set is used for temporary electric power.
NOTE 2 to Section 6.2.2(a): Cord sets and devices incorporating the required ground-fault circuit-interrupter that are connected to the receptacle closest to the source of power are acceptable forms of protection.
 - b. Receptacles other than 120-volt (nominal), single-phase, 15-, 20- and 30-ampere receptacles that are not part of the permanent wiring of the building or structure and that are in use by personnel will have ground-fault circuit-interrupter protection for personnel.

- c. Where the ground-fault circuit-interrupter protection required by Section 6.2.2(b) is not available for receptacles other than 120-volt (nominal), single-phase, 15-, 20-, and 30-ampere, an assured equipment grounding conductor program will be implemented covering cord sets, receptacles that are not a part of the building or structure, and equipment connected by cord and plug that are available for use or used by employees on those receptacles.

6.3 Outlet Devices

Outlet devices will have an ampere rating not less than the load to be served and will comply with the following provisions:

- a. Where connected to a branch circuit having a rating in excess of 20 amperes, lampholders will be of the heavy-duty type. A heavy-duty lampholder will have a rating of not less than 660 watts if of the admedium type, and not less than 750 watts if of any other type.
- b. Receptacle outlets will comply with the following provisions:
 1. A single receptacle installed on an individual branch circuit will have an ampere rating of not less than that of the branch circuit.
 2. Where connected to a branch circuit supplying two or more receptacles or outlets, a receptacle may not supply a total cord- and plug-connected load in excess of the maximum specified in Table 2360.4(b)(2).

Table 2360.4(b)(2)		
Maximum Cord- and Plug-Connected Load to Receptacle		
Circuit Rating (Amperes)	Receptacle Rating (Amperes)	Maximum Load (Amperes)
15 or 20	15	12
20	20	16
30	30	24

3. Where connected to a branch circuit supplying two or more receptacles or outlets, receptacle ratings will conform to the values listed in Table 2360.4(b)(3), or where larger than 50 amperes, the receptacle rating may not be less than the branch-circuit rating.

EXCEPTION: Receptacles for one or more cord- and plug-connected arc welders will have ampere ratings not less than the minimum branch-circuit conductor ampacity.

Table 2360.4(b)(3)	
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

6.4 Cord Connections

A receptacle outlet will be installed wherever flexible cords with attachment plugs are used. Where flexible cords are permitted to be permanently connected, receptacles may be omitted.

7 OUTDOOR WIRING

7.1 Scope

This section applies to branch-circuit, feeder, and service conductors rated 600 volts, nominal, or less and run outdoors as open conductors.

7.2 Conductors on Poles

Conductors on poles will have a separation of not less than 1 foot where not placed on racks or brackets. Conductors supported on poles will provide a horizontal climbing space not less than the following:

- a. Power conductors below communication conductors – 30 inches.
- b. Power conductors alone or above communication conductors:
 1. 300 volts or less – 24 inches
 2. Over 300 volts – 30 inches
- c. Communication conductors below power conductors – same as power conductors.
- d. Communications conductors alone – no requirement.

7.3 Clearance from Ground

Open conductors, open multiconductor cables and service-drop conductors of not over 600 volts, nominal, will conform to the following minimum clearances:

- a. Installations built before May 5, 2008:
 1. Above areas (other than thoroughfares) where it is possible to drive vehicles – 16 feet.
 2. Above areas accessible to pedestrians only – 12 feet.
- b. Installations built on or after May 5, 2008:

Table 2375.18 Clearances from Ground		
Distance	Voltage to Ground	Conditions
12 feet	<300V	Above finished grade or sidewalks, or from any platform or projection from which they might be reached. Over residential property and driveways. Over commercial areas subject to pedestrian traffic or to vehicular traffic other than truck traffic.
16 feet	301 to 600V	Over residential property and driveways. Over commercial areas subject to pedestrian traffic or to vehicular traffic other than truck traffic. (This category includes conditions covered under the 12-foot category where the voltage exceeds 300V.)
18 feet	<600V	

7.4 Clearances from Buildings

7.4.1 Over Roofs:

Open wiring and cables will have a clearance of not less than 8 feet from the highest point of roofs over which they pass.

EXCEPTION: No. 1 – Where the voltage between conductors does not exceed 300 and the roof has a slope of not less than 4 inches in 12 inches, a reduction in clearance to 3 feet will be permitted.

EXCEPTION: No. 2 – Where the voltage between conductors does not exceed 300, a reduction in clearance over the overhanging portion of the roof to 18 inches will be permitted if:

- a. They do not pass over more than 4 feet of the overhang portion of the roof.*
- b. They are terminated at a (through-the-roof) raceway or approved support.*

EXCEPTION: No. 3 – The area above a roof surface subject to pedestrian or vehicular traffic will have a vertical clearance from the roof surface in accordance with the clearance requirements of Section 7.3.

7.4.2 Horizontal Clearances:

Open wiring and cables not attached to a building will have a minimum horizontal clearance of 3 feet.

7.4.3 Final Spans:

- a. Open wiring and cables to a building they supply or from which they are fed will be permitted to be attached to the building, but they will be kept 3 feet from windows that are designed to be opened, doors, porches, balconies, ladders, stairs, fire escapes, or similar locations.
- b. Conductors run above the top level of a window will be permitted to be less than 3 feet above the window, if they are at the maximum practical distance, and that in no case are they less than 1 foot above the window.
- c. Vertical clearance of final spans above, or within 3.0 feet measured horizontally of, platforms, projections, or surfaces from which they might be reached will be maintained in accordance with Section 7.3.
- d. Overhead service conductors will not be installed beneath openings through which materials may be moved, such as openings in farm and commercial buildings, and may not be installed where they will obstruct entrance to these building openings.

7.5 Location of Outdoor Lamps

Lamps for outdoor lighting will be located below all energized conductors, transformers or other electric equipment unless such equipment is controlled by a disconnecting means that can be locked in the open position, or unless adequate clearances or other safeguards are provided for relamping operations.

8 SERVICES

- 8.1 Means will be provided to disconnect all conductors in a building or other structure from the service-entrance conductors. The service disconnecting means will plainly indicate whether it is in the open or closed position and will be installed at a readily accessible location nearest the point of entrance of the service-entrance conductors.
- 8.2 Each service disconnecting means will simultaneously disconnect all ungrounded conductors.
- 8.3 Each service disconnecting means will be suitable for the prevailing conditions.

9 OVERCURRENT PROTECTION

9.1 General

Conductors and equipment will be protected from overcurrent in accordance with their ability to safely conduct current.

9.2 Grounded Conductors

Except for motor running overload protection, overcurrent devices will not interrupt the continuity of the grounded conductor unless all conductors of the circuit are opened simultaneously.

9.3 Disconnecting Means for Fuses

A disconnecting means will be provided on the supply side of all fuses in circuits over 150 volts to ground and cartridge fuses in circuits of any voltage where accessible to other than qualified persons so that each individual circuit containing fuses can be independently disconnected from the source of power. However, a current-limiting device without a disconnecting means is permitted on the supply side of the service disconnecting means. In addition, a single disconnecting means is permitted on the supply side of more than one set of fuses as permitted by the exception in California Code of Regulations, Title 8, Section 2530.112 for group operation of motors, and a single disconnecting means is permitted for fixed electric space-heating equipment.

9.4 Location

Overcurrent devices will be readily accessible to each employee or authorized building management personnel. These overcurrent devices will not be located where they will be exposed to physical damage, or in the vicinity of easily ignitable material.

9.5 Arcing or Suddenly Moving Parts

Arcing or suddenly moving parts will comply with the following:

- a. Location:

Fuses and circuit breakers will be so located or shielded that persons will not be burned or otherwise injured by their operation.

b. Suddenly Moving Parts:

Handles or levers of circuit breakers and similar parts, which may move suddenly in such a way that persons in the vicinity are likely to be injured by being struck by them, will be guarded or isolated.

9.6 Circuit Breakers

- 9.6.1 Circuit breakers will clearly indicate whether they are in the open “off” or closed “on” position.
- 9.6.2 Where circuit breaker handles on switchboards or in panelboards are operated vertically rather than rotationally or horizontally, the up position of the handle will be the “on” position.
- 9.6.3 Circuit Breakers Used as Switches:
Where used as switches in 120-volt and 277-volt fluorescent lighting circuits, circuit breakers will be listed and will be marked “SWD.”
- 9.6.4 Applications:
 - a. A circuit breaker with a straight voltage rating, such as 240V or 480V, will only be installed in a circuit in which the nominal voltage between any two conductors does not exceed the circuit breakers voltage rating. A two-pole circuit breaker will not be used for protecting a 3-phase, corner-grounded delta circuit unless the circuit breaker is marked 1f-3f to indicate such suitability.
 - b. A circuit breaker with a slash rating, such as 120/240V or 480Y/277V, will only be installed in a circuit where the nominal voltage of any conductor to ground does not exceed the lower of the two values of the circuit breakers voltage rating, and the nominal voltage between any two conductors does not exceed the higher value of the circuit breakers voltage rating.

10 GROUNDING

10.1 Scope

This section covers general requirements for grounding and bonding of electrical installations and specific requirements in Section 10.1(a) through 10.1(g) below:

- a. Systems, circuits and equipment required, permitted or not permitted to be grounded.
- b. Circuit conductor to be grounded on grounded systems.
- c. Location of grounding connections.
- d. Types and sizes of grounding and bonding conductors and electrodes.
- e. Methods of grounding and bonding.
- f. Conditions under which guards, isolation or insulation may be substituted for grounding.
- g. Connections for lightning rods.

NOTE: Circuits are grounded to limit excessive voltages from lightning line surges, or unintentional contact with higher voltage lines, and to limit the voltage to ground during normal operation.

NOTE: Conductive materials enclosing electric conductors or equipment, or forming part of such equipment, are grounded for the purpose of preventing a voltage above ground on these materials.

10.2 Direct-Current Systems

Systems to be Grounded:

Systems that supply premises wiring will be grounded as follows:

a. **Two-Wire Direct Current Systems**

Two-wire DC systems operating at over 50 volts through 300 volts between conductors will be grounded.

EXCEPTIONS:

1. *A system equipped with a ground detector and supplying only industrial equipment in limited areas.*
2. *A rectifier derived DC system supplied from a grounded AC system.*
3. *DC Fire Alarm Circuits having a maximum current of 0.030 amperes.*

b. **Three-Wire Direct Current Systems:**

The neutral conductor of all 3-wire DC systems will be grounded.

10.3 Alternating-Current Circuits and Systems to be Grounded

AC circuits and systems supplying premises wiring will be grounded as provided for in this section.

10.3.1 AC circuits of less than 50 volts will be grounded under any of the following conditions:

- a. Where supplied by transformers if the transformer primary supply system exceeds 150 volts to ground.
- b. Where supplied by transformers if the transformer primary supply system is ungrounded.
- c. Where installed as overhead conductors outside of buildings.

10.3.2 AC systems of 50 volts or more will be grounded under any of the following conditions:

- a. Where the system can be so grounded that the maximum voltage to ground on the ungrounded conductors does not exceed 150 volts.
- b. Where the system voltage is rated 3-phase, 4-wire wye-connected in which the neutral is used as a circuit conductor.
- c. Where the system voltage is rated 3-phase, 4-wire delta-connected in which the midpoint of one phase is used as a circuit conductor.
- d. Where a service conductor is uninsulated.

EXCEPTIONS: AC systems of 50 volts or more are not required to be grounded under any of the following conditions:

- a. *Electric systems used exclusively to supply industrial electric furnaces for melting, refining, tempering and the like.*

- b. *Separately derived systems used exclusively for rectifiers supplying only adjustable speed industrial drives.*
- c. *Separately derived systems supplied by transformers that have a primary voltage rating less than 1000 volts if all the following conditions are met:*
 - 1. *The system is used exclusively for control circuits.*
 - 2. *The conditions of maintenance and supervision ensure that only qualified persons will service the installation.*
 - 3. *Continuity of control power is required.*
 - 4. *Ground detectors are installed on the control system.*
- d. *Isolated power systems that supply circuits in health care facilities.*
- e. *The system is a high-impedance grounded neutral system in which a grounding impedance, usually a resistor, limits the ground-fault current to a low value for 3-phase ac systems of 480 volts to 1000 volts provided all the following conditions are met:*
 - 1. *The conditions of maintenance and supervision ensure that only qualified persons will service the installation.*
 - 2. *Continuity of power is required.*
 - 3. *Ground detectors are installed on the system.*
 - 4. *Line-to-neutral loads are not served.*

10.4 Portable and Vehicle Mounted Generators

- 10.4.1 The frame of a portable generator need not be grounded and may serve as the grounding electrode for a system supplied by the generator under the following conditions:
 - a. The generator supplies only equipment mounted on the generator or cord- and plug-connected equipment through receptacles mounted on the generator, or both.
 - b. The noncurrent-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame.
- 10.4.2 The frame of a vehicle need not be grounded and may serve as the grounding electrode for a system supplied by a generator located on the vehicle under the following conditions:
 - a. The frame of the generator is bonded to the vehicle frame.
 - b. The generator supplies only equipment located on the vehicle and cord- and plug-connected equipment through receptacles mounted on the vehicle.
 - c. The noncurrent-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame.
 - d. The system complies with all other provisions of this section.
- 10.4.3 A system conductor that is required to be grounded by the provisions of Section 10.6 will be bonded to the generator frame where the generator is a component of a separately derived system.

10.5 Grounding Connections

- 10.5.1 For a grounded system, a grounding electrode conductor will be used to connect both the equipment grounding conductor and the grounded circuit conductor to the grounding electrode. Both the equipment grounding conductor and the grounding electrode conductor will be connected to the grounded circuit conductor on the supply side of the service disconnecting means, on the supply side of the system disconnecting means, or overcurrent devices if the system is separately derived.
- 10.5.2 For an ungrounded service-supplied system, the equipment grounding conductor will be connected to the grounding electrode conductor at the service equipment. For an ungrounded, separately derived system, the equipment grounding conductor will be connected to the grounding electrode conductor at, or head of, the system disconnecting means or overcurrent devices.
- 10.5.3 On extensions of existing branch circuits that do not have an equipment grounding conductor, grounding-type receptacles may be grounded to a grounded cold-water pipe near the equipment if the extension was installed before May 5, 2008.

NOTE: When any element of this branch circuit is replaced, the entire branch circuit will use an equipment grounding conductor that complies with all other provisions of this section.

10.6 Conductor to be Grounded – Alternating-Current Systems

For AC premises wiring systems, the conductor required to be grounded by Section 10.3 will be as follows:

- a. One conductor of a single-phase, two-wire system will be grounded.
- b. Neutral conductors of a single-phase, three-wire system will be grounded.
- c. Common conductors of a multiphase system, having one wire common to all phases, will be grounded.
- d. One phase conductor of a multiphase system where one phase is grounded will be grounded.
- e. The neutral conductor of a multiphase system in which one phase is used as a neutral conductor will be grounded.

10.7 Supports, Enclosures, and Equipment to be Grounded

- 10.7.1 Metal cable trays, metal raceways, and metal enclosures for conductors will be grounded, except that:
- a. Metal enclosures, such as sleeves, that are used to protect cable assemblies from physical damage need not be grounded.
 - b. Metal enclosures for conductors added to existing installations 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 25.0 feet.

2. Enclosures are free from probable contact with ground, grounded metal, metal laths, or other conductive materials.
3. Enclosures are guarded against employee contact.

10.7.2 Metal enclosures for service equipment will be grounded.

10.7.3 Frames of electric ranges, wall-mounted ovens, counter-mounted cooking units, clothes dryers, metal outlets or junction boxes that are part of the circuit for these appliances, will be grounded.

10.8 Equipment Fastened in Place or Connected by Permanent Wiring Methods (Fixed)

Exposed noncurrent-carrying metal parts of fixed equipment that may become energized will be grounded under any of the following conditions:

- a. Where within 8 feet vertically or 5 feet horizontally of ground or grounded metal objects and subject to contact by persons.
- b. Where located in a wet or damp location and not isolated.
- c. Where in electrical contact with metal.
- d. Where in a hazardous (classified) location.
- e. Where supplied by a metal-clad, metal-sheathed or grounded metal-raceway wiring method.
- f. Where equipment operated with any terminal at over 150 volts to ground; or
- g. Grounding of equipment mounted on poles will comply with the Rules of Overhead Electric Line Construction of the California Public Utilities Commission, General Order No. 95.

EXCEPTIONS: to Section 10.8 – exposed noncurrent-carrying metal parts of the following types of fixed equipment need not be grounded:

- a. Enclosures for switches or circuit breakers used for other than service equipment and accessible to qualified persons only.
- b. Electrically heated appliances that are permanently and effectively insulated from ground.
- c. Distribution apparatus, such as transformer and capacitor cases, mounted on wooden poles at a height exceeding 8 feet above ground or grade level.
- d. Listed equipment protected by a system of double insulation, or its equivalent, and distinctively marked as such.

10.9 Nonelectrical Equipment

The metal parts of nonelectrical equipment described below will be grounded:

- a. Frames and tracks of electrically operated cranes and hoists.
- b. Frames of nonelectrically driven elevator cars to which electric conductors are attached.
- c. Metal partitions, grill work and similar metal enclosures around equipment.
- d. Hand-operated metal shifting ropes or cables of electric elevators.

10.10 Equipment Connected by Cord and Plug

The exposed noncurrent-carrying metal parts of cord- and plug-connected equipment that may become energized will be grounded under any of the following conditions:

- a. Utilization equipment used in hazardous or classified locations.
- b. Any electric equipment which is operated at over 150 volts to ground; or
- c. If the equipment is of the following types:
 1. Refrigerators, freezers and air conditioners.
 2. Clothes-washing, clothes-drying and dishwashing machines, sump pumps and electrical aquarium equipment.
 3. Hand-held motor-operated tools, stationary and fixed motor-operated tools and light industrial motor-operated tools.
 4. Motor-operated tools and utilization equipment of the following types:
 - i. Drills
 - ii. Hedge clippers
 - iii. Lawn mowers
 - iv. Snow blowers
 - v. Wet scrubbers
 - vi. Sanders
 - vii. Saws
 5. Cord- and plug-connected appliances used in damp or wet locations or by persons standing on the ground or on metal or exposed concrete floors or working inside of metal tanks or boilers.
 6. Portable and mobile x-ray and associated equipment.
 7. Portable hand lamps.
 8. Tools likely to be used in wet and conductive locations.

EXCEPTIONS: The following equipment will not be required to be grounded:

- a. *Listed portable tools or utilization equipment likely to be used in wet and conductive locations if supplied through an isolating transformer with an ungrounded secondary of not over 50 volts.*
- b. *Listed or labeled portable tools and utilization equipment protected by an approved system of double insulation. Where such a system is employed, the equipment will be distinctively marked.*

10.11 Effective Grounding

The path to ground from circuits, equipment, and conductor enclosures will:

- a. Be permanent and continuous.
- b. Have ample carrying capacity to safely conduct any currents liable to be imposed on it.
- c. Have impedance sufficiently low to limit the potential above ground and to facilitate the operation of the overcurrent devices in the circuit.

10.12 Common Grounding Electrode

Where an AC system is connected to a grounding electrode in or at a building as specified in Section 10.5, the same electrode will be used to ground conductor enclosures and equipment in or on that building.

NOTE: Two or more electrodes that are effectively bonded together will be considered as a single electrode in this sense.

10.13 Equipment Fastened in Place or Connected by Permanent Wiring Methods (Fixed)

Noncurrent-carrying metal parts of fixed equipment, raceways, and other enclosures, where required to be grounded, will be grounded by an equipment grounding conductor that is contained within the same raceway, cable or cord, runs with, or encloses, the circuit conductors. For dc circuits only, the equipment grounding conductor may be run separately from the circuit conductors.

10.14 Equipment Considered Effectively Grounded

The following electric equipment, under the conditions specified in (a) and (b) below, will be considered effectively grounded:

- a. Electric equipment secured to, and in electrical contact with, a metal rack or structure that is provided for its support and the metal rack or structure is grounded by the method specified for the noncurrent-carrying metal parts of fixed equipment in Section 10.13.
 1. For installations made before April 16, 1981, electric equipment is also considered to be effectively grounded if it is secured to, and in metallic contact with, the grounded structural metal frame of a building. The structural metal frame of a building will not be used as the required AC equipment grounding conductor for installations made on, or after, April 16, 1981.
 2. Effective with installations on, or after, April 16, 1981, when any element of this branch circuit is replaced, the entire branch circuit will use an equipment grounding conductor that complies with all other provisions of this program.
- b. Metal Car Frames:
Metal car frames supported by metal hoisting cables attached to, or running over, metal sheaves or drums of grounded elevator machines.

10.15 Cord- and Plug-Connected Equipment

Noncurrent-carrying metal parts of cord- and plug-connected equipment, where required to be grounded, will be grounded by one of the methods indicated in (a), (b) or (c) below:

- a. By means of the metal enclosure of the conductors supplying such equipment if grounding-type attachment plug with one fixed grounding contact is used for grounding the metal enclosure, and if the metal enclosure of the conductors is secured to the attachment plug and to equipment by connectors approved for the purpose.
- b. By means of a grounding conductor run with the power supply conductors in a cable assembly or flexible cord properly terminated in grounding-type attachment plug with one fixed grounding contract. An uninsulated grounding conductor will be permitted but, if individually covered, the covering will have a continuous outer finish that is either green or green with one or more yellow stripes.

- c. By means of a separate flexible wire or strap, insulated or bare, protected as well as practicable against physical damage, where part of an approved portable equipment.

10.16 Use of Grounded Circuit Conductor for Grounding Equipment

10.16.1 Supply-Side Equipment:

A grounded circuit conductor will be permitted to ground noncurrent-carrying metal parts of equipment on the supply side of the service disconnecting means, such as meter enclosures, service raceways, etc., and on the supply side of the main disconnecting means of separate buildings and of separately derived systems.

10.16.2 Load-Side Equipment:

A grounded circuit conductor will not be used for grounding noncurrent-carrying metal parts of equipment on the load side of the service disconnecting means, on the load side of a separately derived system disconnecting means, or the overcurrent devices for a separately derived system not having a main disconnecting means.

EXCEPTION: It will be permissible to ground meter enclosures by connection to the grounded circuit conductor on the load-side of the service disconnect if:

- a. No service ground-fault protection is installed.*
- b. Meter enclosures are located adjacent to the service disconnecting means.*

10.17 Bonding

- 10.17.1 Bonding will be provided where necessary to assure electrical continuity and the capacity to conduct safely any fault current likely to be imposed.

10.17.2 Bonding Service Equipment:

The metal noncurrent-carrying parts of equipment indicated in (a), (b) and (c) below will be effectively bonded together:

- a. Service raceways, cable trays, or service cable armor or sheath.
- b. All service equipment enclosures containing service-entrance conductors, including meter fittings, boxes or the like, interposed in the service raceway or armor.
- c. Any metallic raceway or armor enclosing a grounding electrode conductor.

10.17.3 Bonding Other Enclosures:

Metal raceways, cable trays, cable armor, cable sheath, enclosures, frames, fittings, and other metal noncurrent-carrying parts that are to serve as grounding conductors will be effectively bonded.

10.17.4 Connecting Receptacle Grounding Terminal to Box:

An equipment bonding jumper will be used to connect the grounding terminal of a grounding-type receptacle to a grounded box.

EXCEPTION: No. 1 – Where the box is surface-mounted, direct metal-to-metal contact between the device yoke and the box will be permitted to

ground the receptacle to the box. This exception will not apply to cover-mounted receptacles unless the box and cover combination are listed as providing satisfactory ground continuity between the box and the receptacle.

EXCEPTION: No. 2 – Contact devices or yokes designed and listed for the purpose will be permitted in conjunction with the supporting screws to establish the grounding circuit between the device yoke and flush-type boxes.

EXCEPTION: No. 3 – Floor boxes designed for and listed as providing satisfactory ground continuity between the box and the device.

EXCEPTION: No. 4 – Where required for the reduction of electrical noise (electromagnetic interference) on the grounding circuit, a receptacle in which the grounding terminal is purposely insulated from the receptacle mounting means will be permitted. The receptacle grounding terminal will be grounded by an insulated equipment grounding conductor run with the circuit conductors. This grounding conductor will be permitted to pass through one or more panelboards without connection to the panelboard grounding terminal, so as to terminate directly at, and equipment grounding conductor terminal of the applicable derived system or service.

10.17.5 Bonding in Hazardous Locations:

Regardless of the voltage of the electrical system, the electrical continuity of metal noncurrent-carrying parts of equipment, raceways, and other enclosures in any hazardous location will be ensured by any of the methods specified for services that are approved for the wiring method used.

10.17.6 Equipment Bonding Jumpers:

- a. Material:
Equipment bonding jumpers will be of copper or other corrosion-resistant material.
- b. Attachment:
Equipment bonding jumpers will be attached in the manner specified by the applicable provisions of California Code of Regulations, Title 8, Section 2395.113 for circuit and equipment.
- c. Installation:
The equipment bonding jumper will be permitted to be installed inside or outside of a raceway or enclosure. When installed on the outside, the length of the equipment bonding jumper will not exceed six (6) feet and will be routed with the raceway or enclosure.

10.18 Water Pipe Electrode

Where available on the premises, a metal underground water pipe will always be used as the grounding electrode, regardless of its length and whether supplied by a community or a local underground water piping system or by a well on the premises. Where the buried portion of the water pipe (including any metal well casing effectively bonded to the pipe) is less than 10 feet long, or where the water

pipe is or is likely to be isolated by insulated sections or joints so that the effectively grounded portion is less than 10 feet long, it will be supplemented by the use of an additional electrode of a type specified by Section 10.19 or 10.20. The interior metal cold water piping system will always be bonded to the service-equipment enclosure, the grounded conductor at the service, the grounding electrode conductor where of sufficient size or to the one or more grounding electrodes used.

NOTE: Expanding use of nonmetallic piping for water systems and insulating couplings on metal water systems makes it more important that water piping within a building be adequately grounded without depending on connections to an outside piping system.

10.19 Other Available Electrodes

Where a water system as described in Section 10.18 is not available, the grounding connection will be made to any of the electrodes specified in (a) through (d) below, where available.

- a. The metal frame of the building, where effectively grounded.
- b. An electrode encased by at least 2 inches of concrete, located within and near the bottom of a concrete foundation or footing that is in direct contact with the earth, consisting of at least 20 feet of one or more steel reinforcing bars or rods of not less than 1/2-inch diameter, or consisting of at least 20 feet of bare copper conductor not smaller than No. 4 AWG.
- c. An electrically continuous metal underground gas piping system that is uninterrupted with insulating sections or joints and without an outer nonconductive coating, and then only if acceptable to, and expressly permitted by, both the serving gas supplier and the authority having jurisdiction.
- d. Other local metal underground systems or structures, such as piping systems and underground tanks.

10.20 Made Electrodes

Where none of the electrodes specified in Sections 10.18 and 10.19 is available, one or more of the electrodes specified in (a) or (b) below will be used. Where practicable, electrodes will be embedded below permanent moisture level. Where more than one electrode is used (including those used for signaling or communication circuits, radio or television installations, or lightning rods), each electrode will not be less than 6 feet from any other electrodes. All electrodes will be free from nonconductive coatings such as paint or enamel.

NOTE: Two or more electrodes that are effectively bonded together are to be treated as a single electrode in this sense.

- a. Rod and Pipe Electrodes:
Rod and pipe electrodes will not be less than 8 feet in length, will consist of the following materials, and will be installed in the following manner:
 1. Electrodes of pipe or conduit will not be smaller than 3/4-inch trade size and, where of iron or steel, will have the outer surface galvanized or otherwise metal-coated for corrosion protection.

2. Electrodes of rods of steel or iron will be at least 5/8-inch in diameter. Nonferrous rods or their equivalent will be listed and will be not less than 1/2-inch diameter.
 3. The electrode will be installed such that at least 8 feet of length is in contact with the soil. It will be driven to a depth of not less than 8 feet except that where rock bottom is encountered, the electrode will be driven at an oblique angle not to exceed 45 degrees from the vertical or will be buried in a trench that is at least 2-1/2 feet deep. The upper end of the electrode will be flush with or below ground level unless the aboveground end and the grounding electrode conductor attachment are protected against physical damage.
- b. Plate Electrodes:
Each plate electrode will expose not less than 2 square feet of surface to exterior soil. Electrodes of iron or steel plates will be at least 1/4-inch in thickness. Electrodes of nonferrous metal will be at least 0.06-inch in thickness.

10.21 Resistance of Made Electrodes

A single electrode consisting of a rod, pipe or plate which does not have a resistance to ground of 25 ohms or less will be augmented by one additional electrode of any of the types specified in Sections 10.19 or 10.20.

10.22 Use of Lightning Rods

Lightning rod conductors and driven pipes, rods, or other electrodes used for grounding lightning rods will not be used in lieu of the made grounding electrodes required by Section 10.20 for grounding wiring systems and equipment. This provision will not prohibit the bonding together of grounding electrodes of different systems.

NOTE: Bonding together of all separate electrodes will limit potential differences between them and between their associated wiring systems.

10.23 Connection Devices for Grounding Conductors

Connection devices or fittings that depend on solder will not be used.

10.24 Continuity and Attachment of Branch-Circuit Equipment Grounding Conductors to Boxes

Where more than one equipment grounding conductor of a branch circuit enters a box, all such conductors will be in good electrical contact with each other and the arrangement will be such that the disconnection or removal of a receptacle, fixture or other device fed from the box will not interfere with or interrupt the grounding continuity.

10.24.1 Metal Boxes:

A connection will be made between the one or more equipment grounding conductors and a metal box by means of a grounding screw which will be used for no other purpose or an approved grounding device.

10.24.2 Nonmetallic Boxes:

One or more equipment grounding conductors brought into a nonmetallic outlet box will be so arranged that a connection can be made to any fitting or device in that box requiring grounding.

11 ASSURED EQUIPMENT GROUNDING PROGRAM FOR CONSTRUCTION SITES

Each cord set, attachment cap, plug and receptacle of cord sets, and any equipment connected by cord and plug including these which are not required to be grounded, except cord sets and receptacles which are fixed and not exposed to damage, will be visually inspected before each day's use for external defects, such as deformed or missing pins or insulation damage, and for indication of possible internal damage. Equipment found damaged or defective will not be used until repaired or replaced.

12 ASSURED EQUIPMENT GROUNDING CONDUCTOR TESTING

12.1 Testing Requirements

The following tests will be performed on all cords sets and receptacles which are not part of the permanent building or structure, and cord- and plug-connected equipment required to be grounded:

- a. Equipment grounding conductors will be tested for continuity and will be electrically continuous.
- b. Each receptacle and attachment cap or plug will be tested for correct attachment of the equipment grounding conductor. The equipment grounding conductor will be connected to its proper terminal.

NOTE: Double-insulated tools or other similar equipment are not required to be grounded.

12.2 Performing Tests

All tests required by subsection 12.1 will be performed:

- a. Before first use for newly acquired equipment.
- b. Before equipment is returned to service following repairs.
- c. Before equipment is used after any incident which can be reasonably suspected to have caused damage (for example, when a cord is run over).
- d. At intervals not to exceed 3 months, except that cord sets and receptacles which are fixed and not exposed to damaged will not be tested at intervals not exceeding 6 months.

12.3 Equipment

Employees will not be permitted or have available to them any equipment which has not met the requirements of Sections 11 and 12.

12.4 Identification

Receptacles, cord sets, and cord- and plug- connected equipment passing the tests required by subsections 12.1 and 12.2 will be identified. Identification may be made by means of logs, color coding, or other effective means and will be maintained until replaced by a more current identification. The identification method will indicate the last test date or the interval for which the tests were performed. These dates or intervals will be readily available to the Division of Occupational Safety and Health and affected employees.

13 TEMPORARY WIRING

The provisions of this section do not apply to conductors that are an integral part of factory-assembled equipment.

13.1 General Requirements

- 13.1.1 Metal raceways, cable trays, cable armor, cable sheath, enclosures, frames, fittings, and other metal noncurrent-carrying parts that are to serve as grounding conductors, with or without the use of supplementary equipment grounding conductors, will be effectively bonded where necessary to ensure electrical continuity and the capacity to conduct safely any fault current likely to be imposed on them. Any nonconductive paint, enamel, or similar coating will be removed at threads, contact points and contact surfaces, or be connected by means of fittings designed to make such removal unnecessary.
- 13.1.2 Where necessary for the reduction of electrical noise (electromagnetic interference) of the grounding circuit, an equipment enclosure supplied by a branch circuit may be isolated from a raceway containing circuits supplying only that equipment by one or more listed nonmetallic raceway fittings located at the point of attachment of the raceway to the equipment enclosure. The metal raceway will be supplemented by an internal insulated equipment grounding conductor installed to ground the equipment enclosure.
- 13.1.3 No wiring systems of any type will be installed in ducts used to transport dust, loose stock, or flammable vapors. No wiring system of any type will be installed in any duct used for vapor removal or for ventilation of commercial-type cooking equipment or in any shaft containing only such ducts.

13.2 Scope

Except as specifically modified in this program, all other requirements of this section for permanent wiring will also apply to temporary wiring installations.

- 13.2.1 Temporary electrical power and lighting installations of 600 volts, nominal, or less will be used only as follows:

- a. During and for the period of construction, remodeling, maintenance, repairs or demolition of buildings, structures, equipment or similar activities.
 - b. For a period not to exceed 90 days for work associated with non-permanent work locations.
 - c. For a period of work associated with experimental or developmental work and during emergencies.
- 13.2.2 Temporary wiring will be removed immediately upon completion of the project or purpose for which the wiring was installed.
- 13.2.3 Temporary electrical installations of more than 600 volts will be in accordance with the High-Voltage Electrical Safety Orders.

13.3 General

- 13.3.1 Feeders:
The following requirements apply to feeders:
 - a. Feeders will originate in an approved distribution center.
 - b. Conductors will be run as multi-conductor cord or cable assemblies. However, if installed as permitted in Section 11.2.1(c), and if accessible only to qualified persons, feeders may be run as single insulated conductors.
- 13.3.2 Branch Circuits:
The following requirements apply to branch circuits:
 - a. Branch circuits will originate in an approved power outlet or panelboard.
 - b. Conductors will be multiconductor cord or cable assemblies, or open conductors. If run as open conductors, they will be fastened at ceiling height every 10 feet.
 - c. No branch circuit conductor will be laid on the floor.
 - d. Each branch circuit that supplies receptacles or fixed equipment will contain a separate equipment grounding conductor if run as open conductors.
- 13.3.3 Receptacles:
Receptacles will be of the grounding type. Unless installed in a continuous grounded metallic raceway or metallic covered cable, each branch circuit will contain a separate equipment grounding conductor and all receptacles will be electrically connected to the grounding conductor.
- 13.3.4 No bare conductors nor earth returns will be used for the wiring of any temporary circuit.
- 13.3.5 Disconnecting Means:
Suitable disconnecting switches or plug connectors will be installed to permit the disconnection of all ungrounded conductors of each temporary circuit. Multiwire branch circuits will be provided with a means to disconnect simultaneously all ungrounded conductors at the power outlet or panelboard where the branch circuit originated.

NOTE: Circuit breakers with their handles connected by approved handle ties are considered a single disconnecting means for the purpose of this requirement.

- 13.3.6 Lamps:
All lamps for general illumination will be protected from accidental contact or breakage by a suitable fixture or lampholder with a guard. Brass shell, paper-lined sockets, or other metal-cased sockets will not be used unless the shell is grounded.
- 13.3.7 Physical Protection:
Flexible cords and cables will be protected from accidental damage. Sharp corners and projections will be avoided. When passing through doorways or other pinch points, protection will be provided to avoid damage.
- 13.3.8 Multi-conductor cords and cables will be hard service type or equivalent with multi-conductor fittings.
- 13.3.9 Cable assemblies and flexible cords and cables will be supported in place at intervals that ensure that they will be protected from physical damage. Support will be in the form of staples, cable ties, straps or similar type fittings installed so as not to cause damage.

13.4 Temporary Poles

The minimum size of a temporary wood pole will be 6 inches by 6 inches (nominal) if square or have a top diameter of at least 5 inches if rounds and be of sufficient length to maintain all required overhead clearances specified in Section 7.3, but not less than 20 feet long. The lower end will be embedded not less than 4 feet in the ground. A pole of a material other than wood, if of equivalent strength, may be used.

EXCEPTION: For distribution poles in areas accessible to pedestrians only, a 4-inch x 4-inch (nominal) wood pole, or equivalent (embedded 4 feet in the ground), will be permitted, provided that a minimum overhead conductor clearance of 10 feet is maintained.

14 CABLE TRAYS

14.1 Wiring Methods

Only the following wiring methods will be installed in cable trays:

- a. Armored cable
- b. Electrical metallic tubing
- c. Electrical nonmetallic tubing
- d. Fire alarm cables
- e. Flexible metal conduit
- f. Flexible metallic tubing

- g. Instrumentation tray cable
- h. Intermediate metal conduit
- i. Liquidtight flexible metal conduit
- j. Liquidtight flexible nonmetallic conduit
- k. Metal-clad cable
- l. Mineral-insulated, metal-sheathed cable
- m. Multiconductor service-entrance cable
- n. Multiconductor underground feeder and branch-circuit cable
- o. Multipurpose and communications cables
- p. Nonmetallic-sheathed cable
- q. Power and control tray cable
- r. Power-limited tray cable
- s. Optical fiber cables
- t. Other factory-assembled, multiconductor control, signal or power cables that are specifically approved for installation in cable trays, rigid metal conduit and rigid nonmetallic conduit.

14.2 Industrial Establishments

In industrial establishments where conditions of maintenance and supervision assure that only qualified persons will service the installed cable tray system, the following cables may also be installed in ladder, ventilated-trough or ventilated-channel cable trays:

- a. Single conductor cable:
 - 1. Single conductor cable will be No. 1/0 or larger and will be of a type listed and marked on the surface for use in cable trays; where Nos. 1/0 through 4/0 single conductor cables are installed in ladder cable tray, the maximum allowable rung spacing for the ladder cable tray will be 9 in.; where exposed to direct rays of the sun, cables will be identified as being sunlight resistant.
 - 2. Welding cables installed in dedicated cable trays.
 - 3. Single conductors used as equipment grounding conductors; these conductors, which may be insulated, covered, or bare will be No. 4 or larger.
- b. Multiconductor cable, Type MV; where exposed to direct rays of the sun, the cable will be identified as being sunlight resistant.

14.3 Equipment Grounding Conductors

Metallic cable trays will be used as equipment grounding conductors only where continuous maintenance and supervision ensure that qualified persons will service the installed cable tray system.

14.4 Hazardous (Classified) Locations

Cable trays in hazardous (classified) locations will contain only the cable types permitted in such locations.

14.5 Uses Not Permitted

Cable tray systems will not be used in hoistways or where subjected to severe physical damage.

15 OPEN WIRING

15.1 Exposed Wiring, Uses Permitted

Open exposed wiring will not be installed in any building or portion of a building except:

- a. In substations, transformer vaults, transformer enclosures, on the supply side of electric furnace electrodes or in tunnels or similar locations where such spaces are restricted to electrical use and are accessible to qualified and authorized persons only.
- b. For insulated conductors are permitted in California Code of Regulations, Title 8, Article 13 (Temporary Wiring).

15.2 Conductor Supports

Conductors smaller than No. 8 will be rigidly supported on noncombustible, nonabsorbent insulating materials and will not contact any other objects. Supports will be installed as follows:

- a. Within 6 inches from a tap or splice.
- b. Within 12 inches of a dead-end connection to a lampholder or receptacle.
- c. At intervals not exceeding 4.5 feet and at closer intervals sufficient to provide adequate support where likely to be disturbed.

15.3 Flexible Nonmetallic Tubing

In dry locations, where not exposed to severe physical damage, conductors will be separately enclosed in flexible nonmetallic tubing. The tubing will be in continuous lengths not exceeding 15 feet and secured to the surface by straps at intervals not exceeding 4.5 feet.

15.4 Penetrations of Walls, Floors, Wood Cross Members, Etc.

Open conductors will be separated from contact with walls, floors, wood cross members, or partitions through which they pass by tubes or bushings of noncombustible, nonabsorbent insulating material. If the bushing is shorter than the hole, a waterproof sleeve of nonconductive material will be inserted in the hole and an insulating bushing slipped into the sleeve at each end in such a manner as to keep the conductors out of contact with the sleeve. Each conductor will be carried through a separate tube or sleeve.

15.5 Protection from Physical Damage

Where open conductors cross ceiling joints or wall studs and are exposed to physical damage, they will be protected.