# 6.0 ELECTRICAL EQUIPMENT

## 6.1 SECTION CONTENTS

This section provides guidance for the design, and use of electrical equipment.



NOTE: An asterisk (*) after a section of text indicates that the information in that section is new or revised as of September 1996.

## Fed-OSHA 1910.303

1. Electrical equipment shall be free from recognized hazards that are likely to cause death or serious physical harm to employees. Safety of equipment shall be determined using the following considerations:
   - Suitability of equipment for an identified purpose may be evidenced by listing or labeling for that identified purpose.
   - Mechanical strength and durability, including, for parts designed to enclose and, protect other equipment, the adequacy of the protection thus provided.
   - Electrical insulation.
   - Heating effects under conditions of use.
   - Arcing effects.
   - Classification by type, size, voltage current capacity, and specific use.
   - Other factors which contribute to the practical safeguarding of employees using or likely to come in contact with the equipment.
2. Listed or labeled equipment shall be used or installed in accordance with any instructions included in the listing or labeling.
3. Conductors shall be spliced or joined with splicing devices suitable for the use or by brazing, welding, or soldering with a fusible metal or alloy. All splices and joints and the free ends of conductors shall be covered with an insulation equivalent to that of the conductors or with an insulating device suitable for the purpose.
4. Parts of electric equipment which in ordinary operation produce arcs, sparks, flames, or molten metal shall be enclosed or separated and isolated from all combustible material.
5. Electrical equipment may not be used unless the manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product may be identified is placed on the equipment. Other markings shall be provided giving voltage, current, wattage, or other ratings as necessary. The marking shall be of sufficient durability to withstand the environment involved.
6. Each disconnecting means for motors and appliances shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident. Each service, feeder, and branch circuit, at its disconnecting means or overcurrent device, shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident. These markings shall be of sufficient durability to withstand the environment involved.

# 6.2 GENERAL REQUIREMENTS FOR ELECTRICAL EQUIPMENT*

### Chevron Guidelines

**1.** Electrical equipment shall be free from recognized hazards that are likely to cause death or serious physical harm to employees.

**2.** Parts of electric equipment that produce arcs in ordinary operation shall be enclosed or separated and isolated from all combustible material.

**3.** Each disconnecting means for motors and appliances shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident. These markings shall be of sufficient durability to withstand the environment involved.

## 6.3 WORKING SPACES ABOUT ELECTRICAL EQUIPMENT - GENERAL

### Chevron Guidelines

**1.** The working space in front of electrical equipment shall be at least 30 inches wide and shall not be used for storage.

**2.** Refer to *Figure 6.1* for minimum depth of clearance in front of electrical equipment.

**3.** Working space is not required in back of assemblies such as dead front switchboards or control assemblies when there are no renewable or adjustable parts (such as fuses or switches) on the back of the assemblies *and* when all connections are accessible from locations other than the back.

**4.** Adequate lighting shall be provided for all working spaces containing electrical equipment. **(A minimum of 15 foot candles is recommended for aisle ways.)***

**5.** Permanent ladders or stairways shall be provided to give safe access to the working space around electric equipment installed at elevated locations **when the electrical equipment is routinely** operated or frequently repaired, serviced or adjusted. (See Section 3.2 to determine when fixed stairways are required.)*

6. Vertical and horizontal clearances of power conductors are shown in *Figure 6.2.*

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1. Sufficient access and working space shall be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of such equipment.
2. The dimension of the working space 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 may not be less than indicated in Table S-1 of 1910.303 (g)(1)(i).
3. In addition to the dimensions shown in Table S-1, work space may not be less than 30" wide in front of the electric equipment. Distances shall be measured from the live parts if they are exposed, or from the enclosure front or opening if the live parts are enclosed.
4. 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.
5. The working space may 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 suitably guarded.

*(continued on next page)*

**MINIMUM DEPTH OF CLEAR WORKING SPACE IN FRONT OF ELECTRIC EQUIPMENT**

| | NOMINAL VOLTAGE TO GROUND | FEET |
|---|---|---|
| **CONDITION 1** 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 suitable wood or other insulating materials. Insulated wire or insulated busbars operating at not over 300 volts shall not be considered live parts. | 0-2,500 | 3 |
| | 2,501-9000 | 4 |
| | 9,001-25,000 | 5 |
| | 25,001-75 kV | 6 |
| | Above 75 kV | 8 |
| **CONDITION 2** Exposed live parts on one side and grounded parts on the other side. Concrete, brick, or tile walls will be considered as grounded surfaces. | 0-150 | 3 |
| | 151-600 | 3-1/2 |
| | 601-2,500 | 4 |
| | 2,501-9000 | 5 |
| | 9,001-25,000 | 6 |
| | 25,001-75 kV | 8 |
| | Above 75 kV | 10 |
| **CONDITION 3** Exposed live parts on both sides of the working space (not guarded as provided in Condition 1) with the operator between. | 0-150 | 3 |
| | 151-600 | 4 |
| | 601-2,500 | 5 |
| | 2,501-9000 | 6 |
| | 9,001-25,000 | 9 |
| | 25,001-75 kV | 10 |
| | Above 75 kV | 12 |

***Figure 6.1 Working Space Requirements***

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6. At least one entrance of sufficient area shall be provided to give access to the working space about electric equipment.
7. Where there are live parts normally exposed on the front of switchboards or motor control centers, the working space in front of such equipment may not be less than 3 feet.
8. Illumination shall be provided for all working spaces about service equipment, switchboards, panelboards, and motor control centers installed indoors.
9. The minimum headroom of working spaces about service equipment, switchboards, panelboards, or motor control centers shall be 6 feet 3 inches.

   **Note:** A motor control center is an assembly of one or more enclosed sections having a common power bus and principally containing motor control units.
10. Live parts of electric equipment operating at 50 volts or more shall be guarded against accidental contact by approved cabinets or other forms of approved enclosures.

    **Note:** See other means provided by 1910.303 (g)(2).

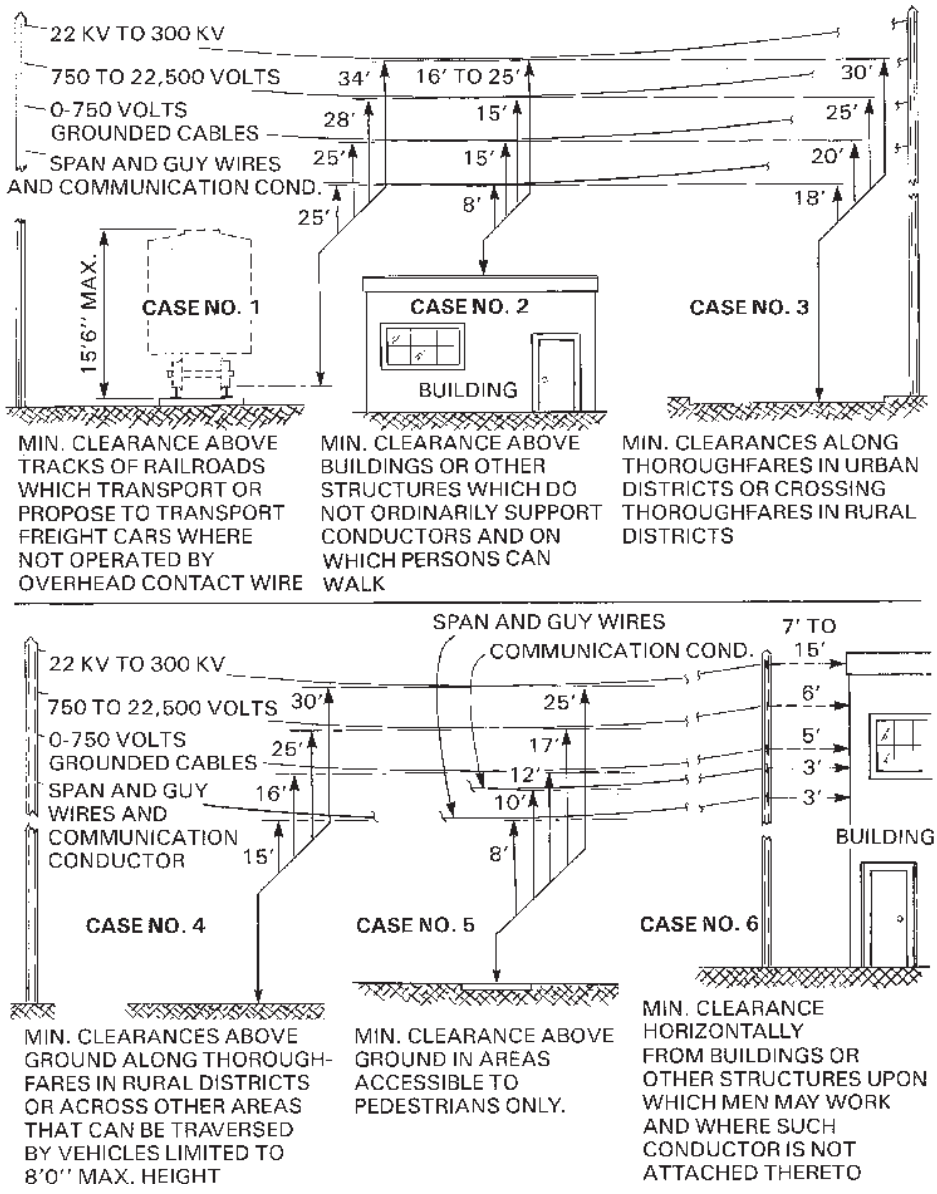


*Figure 6.2 Vertical and Horizontal Clearances of Power Conductors*

Refer to applicable codes for allowable expansion, sag, and tension design conditions. Clearances required by local code may differ.

## 6.4 WORKING SPACES ABOUT ELECTRICAL EQUIPMENT - 600 VOLTS OR MORE*

### Chevron Guidelines

**1.** Refer to Section 6.3 for general guidelines.

**2.** Entrances to buildings, rooms, or enclosures containing exposed live parts operating in excess of 600 volts shall be kept locked in such a way that it can be opened from inside without a key and shall be permanently and conspicuously posted with warning signs reading "DANGER - High Voltage Area - Authorized Personnel Only" or equivalent.

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**Note:** Conductors and equipment used on circuits exceeding 600 volts, nominal, shall comply with all applicable provisions for 1910.303 (g), "Electrical Equipment 600 Volts or Less," in addition to the following requirements.

1. Electrical installations in a vault, room, closet or in an area surrounded by a wall, screen, or fence, access to which is controlled by lock and key or other approved means, are considered to be accessible to qualified persons only.
2. A wall, screen, or fence less than 8 feet in height is not considered to prevent access unless it has other features that provide a degree of isolation equivalent to an 8 foot fence.
3. The entrances to all buildings, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 volts, nominal, shall be kept locked or shall be under the observation of a qualified person at all times.
4. Electrical installations having exposed live parts shall be accessible to qualified persons only and shall comply with the applicable provisions of paragraph 1910.303 (h)(3).
5. Electrical installations that are open to unqualified persons shall be made with metal-enclosed equipment or shall be enclosed in a vault or in an area access to which is controlled by a lock. If metal-enclosed equipment is installed so that the bottom of the enclosure is less than 8 feet above the floor, the door or cover shall be kept locked.
6. Metal-enclosed switchgear, unit substations, transformers, pull boxes, connection boxes, and other similar associated equipment shall be marked with appropriate caution signs. If equipment is exposed to physical damage from vehicular traffic, suitable guards shall be provided to prevent such damage. Ventilating or similar openings in metal-enclosed equipment shall be designed so that foreign objects inserted through these openings will be deflected from energized parts.
7. Sufficient space shall be provided and maintained about electric equipment to permit ready and safe operation and maintenance of such equipment. Where energized parts are exposed, the minimum clear workspace may not be less than 6 feet 6 inches high (measured vertically from the floor or platform), or less than 3 feet wide (measured parallel to the equipment). The depth shall be as required in Table S-2 of 1910.303 (h)(3)(i). The workspace shall be adequate to permit at least a 90-degree opening of doors or hinged panels.
8. The minimum clear working space in front of electric equipment such as switchboards, control panels, switches, circuit breakers, motor controllers, relays, and similar equipment may not be less than specified in Table S-2 of 1910.303 (h)(3)(i).

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9. Adequate illumination shall be provided for all working spaces about electric equipment. The lighting outlets shall be so arranged that persons changing lamps or making repairs on the lighting system will not be endangered by live parts or other equipment. The points of control shall be so located that persons are not likely to come in contact with any live part or moving part of the equipment while turning on the lights.
10. Unguarded live parts above working space shall be maintained at elevations not less than specified in Table S-3 of 1910.303 (h)(3)(ii).
11. At least one entrance not less than 24 inches wide and 6 feet 6 inches high shall be provided to give access to the working space about electric equipment. On switchboard and control panels exceeding 48 inches in width, there shall be one entrance at each end of such board 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 suitably guarded.
12. Permanent ladders or stairways shall be provided to give safe access to the working space around electric equipment installed on platforms, balconies, mezzanine floors, or in attic or roof rooms or spaces.

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1. The requirements for electric equipment and wiring in locations which are classified depend on the properties of the flammable vapors, liquids or gases, or combustible dusts or fibers which may be present therein and the likelihood that a flammable or combustible concentration or quantity is present.
2. Hazardous (classified) locations may be found in occupancies such as, but not limited to, the following: aircraft hangars, gasoline dispensing and service stations, bulk storage plants for gasoline or other volatile flammable liquids, paint-finishing process plants, health care facilities, agricultural or other facilities where excessive combustible dusts may be present, marinas, boat yards, and petroleum and chemical processing plants.

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## 6.5 DEFINITIONS OF HAZARDOUS LOCATIONS*

**NOTE:** The CRTC *Electrical Manual* is the primary reference for area classification.

Article 505 in the National Electrical Code permits use of the "zone" classification system if area classification, wiring, and equipment election are under the supervision of a qualified Registered Professional Engineer.

### A. AREA CLASSIFICATION

#### Chevron Guidelines

1. The following definitions are paraphrased from the 1996 National Electrical Code.

**Class I, Division 1 Location**

A Class I, Division 1 location is a location: (1) in which ignitible concentrations of flammable gases or vapors can

exist under normal operation conditions, even if intermittently; (2) in which ignitible 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 ignitible concentrations of flammable gases or vapors, and might also cause simultaneous failure of electric equipment in a manner that the electrical equipment could become a source of ignition.

Some examples of Class I, Division 1 locations are locations where volatile flammable liquids are transferred from one container to another (unless the transfer is made through a closed piping system) and in inadequately ventilated buildings containing pumps and compressors handling flammable gas or volatile flammable liquids. Also, below grade such as pits and sumps, when the pits or sumps are within classified locations, usually are considered Class I, Division 1 locations.

### Class I, Division 2 Location

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 liquids, vapors, or gases normally are confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of the containers or systems, or in case of abnormal equipment operation; (2) in which ignitible concentrations of gases or vapors are normally prevented by positive mechanical ventilation, but which might become hazardous through failure or abnormal operation of the ventilating equipment; or (3) that is adjacent to Class I, Division 1 location, and to which ignitible 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.

Some examples of Class I, Division 2 locations include the adequately ventilated areas around non-enclosed pumps and compressors handling flammable fluids and hydrocarbon pressure vessels.

### Unclassified

Locations where there is little or no likelihood that flammable concentrations of gases or vapors, combustible dust, or easily ignitible fibers (under normal or abnormal operating conditions) will be present usually are considered unclassified. Also, locations containing only piping without valves, checks, meters, and similar devices normally are considered unclassified, even though the piping may contain flammable fluids. In a similar manner, appro-priate sealed containers (usually should be approved by the US Department of Transportation or other approval

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3. Each room, section or area shall be considered individually in determining its classification. These hazardous (classified) locations are assigned six designations as follows:

   Class I, Division I

   Class I, Division 2

   Class II, Division I

   Class II, Division 2

   Class III, Division I

   Class III, Division 2

   **Note:** For definitions of these locations see 1910.399(a).

## Fed-OSHA 1910.106(e)(7) Industrial Plants

**Note:** All electrical wiring and equipment shall be installed according to the requirements of Subpart S of 1910.301-.399.

1. Locations where flammable vapor-air mixtures may exist under normal operating conditions shall be classified Class I, Division 1. The Division 1 area shall extend 5 feet in all directions from all points of vapor liberation. All areas within pits shall be classified Division 1 if any part of the pit is within a Division 1 or 2 classified area, unless the pit is provided with mechanical ventilation.
2. Locations where flammable vapor-air mixtures may exist under abnormal conditions and for a distance beyond Division I locations shall be classified Division 2. These locations include an area within 20 feet horizontally, 3 feet vertically beyond a Division 1 area, and up to 3 feet above floor or grade level within 25 feet, if indoors, or 10 feet if outdoors, from any pump, bleeder, withdrawal fitting, meter, or similar device handling Class I liquids. Pits provided with adequate mechanical ventilation within a Division I or 2 area shall be classified Division 2. If Class II or Class III liquids only are handled, then ordinary electrical equipment is satisfactory though care shall be used in locating electrical apparatus to prevent hot metal from falling into open equipment.

   **Note:** Chevron follows the recommendations of API 500.
3. Where the above provisions are required, the installation of electrical equipment suitable for Class I, Division I or Division 2 locations, ordinary electrical equipment including switchgear may be used if installed in a room or enclosure which is maintained under positive pressure with respect to the hazardous area. Ventilation makeup air shall be uncontaminated by flammable vapors.

authority), even though they may contain volatile flammable fluids, normally are not considered a sole basis for classification.

2. Refer to API RP500 for the classification of specific areas in petroleum facilities. Section A addresses Petroleum Refineries; Section B applies to the classification of areas adjacent to specific items of equipment normally associated with oil and gas drilling and producing equipment; and Section C is applicable to transportation (pipeline) facilities. See 500-2(b), Reference Standards, of the 1996 National Electrical Code for references related to the classification of other locations.

## B. ZONE CLASSIFICATION

### Chevron Guidelines

1. Article 505 of the 1996 NEC has introduced the International Electrotechnical Commission (IEC) classification system in the United States. This system has been applied outside of the US for decades and offers the potential for significant savings in new and revised facilities. It is not a *replacement* for the "Division" classification system, but may be used as an *alternative* classification scheme under the supervision of a qualified Registered Professional Engineer.
2. The practical application of the Zone Classification System cannot be used until Nationally Recognized Testing Laboratories (NRTLs) have standards to approve equipment for use in Zone 0, 1 and 2 locations. These standards are currently under development by a number of ISA committees and others. Also, the American Petroleum Institute (API) is in the process of developing a recommended practice, tentatively numbered RP 505 — similar to RP 500, but for the Zone system.
3. The following definitions are applicable to the Zone system (paraphrased from Article 505 of the 1996 NEC):

**Class I, Zone 0**

A Class I, Zone 0 location is a location: (1) in which ignitible concentrations of flammable gases or vapors are present continuously; or (2) in which ignitible concentrations of flammable gases or vapors are present for long periods of time.

**Class I, Zone 1**

A Class I, Zone 1 location is a location in which: (1) ignitible concentrations of flammable gases or vapors are likely to exist under normal operating conditions; (2) ignitible concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; (3) equipment is operated or

processes are carried on, of such a nature that equipment breakdown or faulty operations could result in the release of ignitible concentrations of flammable gases or vapors and also cause simultaneous failure of electrical equipment in a mode to cause the electrical equipment to become a source of ignition; or (4) that is adjacent to a Class I, Zone 0 location from which ignitible concentrations of vapors could be communicated, unless communication is prevented by adequate positive-pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

**Class I, Zone 2**

A Class I, Zone 2 location is a location: (1) in which ignitible concentrations of flammable gases or vapors are not likely to occur in normal operation, and if they do occur, they will exist only for a short period; (2) in which volatile flammable liquids, flammable gases, or flammable vapors are handled, processed, or used, but in which the liquids, gases, or vapors normally are confined within closed containers or closed systems from which they can escape only as a result of accidental rupture or breakdown of the containers or system, or as the result of the abnormal operation of the equipment with which the liquids or gases are handled, processed, or used; (3) in which ignitible concentrations of flammable gases or vapors normally are prevented by positive mechanical ventilation, but which may become hazardous as the result of failure or abnormal operation of the ventilation equipment; or (4) that is adjacent to a Class I, Zone 1 location, from which ignitible concentrations of flammable gases or vapors could be communicated, unless communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

Zone 0 and 1, combined, are approximately equivalent to Division 1. Zone 2 is approximately equivalent to Division 2.

**4.** *Figure 6.3* gives a cross-reference between the NEC and IEC area classification systems. One IEC concept (explosion protection technique) not yet available for application with an NEC equivalent is the IEC "increased safety" (Ex "e") category. Equipment such as lighting, motors, and electrical heat tracing utilizing the EX "e" protection technique can be applied in Zone 1 locations and will offer a significant cost advantage over explosion-proof apparatus after suitable NRTL test standards are complete. Increased safety equipment essentially limits surface temperatures, provides protection against sparking within apparatus, and requires secure terminations.

**CROSS-REFERENCE OF NATIONAL ELECTRIC CODE (NEC) AND INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC) DEFINITIONS FOR CLASSIFIED LOCATIONS OF GASES AND VAPORS.**

| CLASSIFICATION TOPIC | NEC | IEC |
|---|---|---|
| Locations | Class I,<br>Group A<br>Group B<br>Group C<br>Group D | Group II<br>Group IIC<br>Group IIB plus Hydrogen<br>Group IIB<br>Group IIA |
| Divisions (Zones) | Division 1<br>Division 2 | Zone 0 & Zone 1<br>Zone 2 |
| Type of Protection | Intrinsic Safety<br>Division 1 and Division 2 | Intrinsic Safety<br>Ex Type ia, Zones 0, 1, 2<br>Ex Type ib, Zone 2 |
| | | Increased Safety<br>Ex Type e, Zone 1, 2 |
| | Explosion-proof<br>NEMA Type 7<br>Division 1, 2 | Flameproof<br>Ex Type d<br>Zone 1, 2 |
| | Purging<br>Division 1, 2 | Pressurization<br>Ex Type p, Zone 1, 2 |
| | Hermetically sealed, Division 2 | Ex Type h, Zone 1 |
| | Nonincendive, Division 2 | Ex Type n, Zone 2 |
| Identification Number (NEC) (See NEC Table 500-3(d) for the 14 sub-divisions of the Identifications Numbers as applicable in the US) | T1 450 °C<br>T2 300 °C<br>T3 200 °C<br>T4 135 °C<br>T5 100 °C | T1 450 °C<br>T2 300 °C<br>T3 200 °C<br>T4 135 °C<br>T5 100 °C |

***Figure 6.3 Table of Terms***

## 6.6 CLASSIFICATION OF EQUIPMENT*

**NOTE:** The CRTC *Electrical Manual* is the primary reference for equipment requirements and wiring methods for hazardous (classified) locations.

### Chevron Guidelines

**1.** Hazardous (classified) locations require equipment approved by a Nationally Recognized Testing Laboratory (NRTL). Frequently, this equipment is "explosion-proof" — that is, equipment with all electrical parts enclosed in a housing capable of withstanding an internal explosion without igniting flammable vapors outside. However, some of the other acceptable explosion protection methods, such as intrinsic safety, often are more economical. When NRTL-approved "increased safety" equipment is available in the US, it should be considered for many locations.

**2.** SPECIAL PRECAUTION: Explosion-proof equipment requires maintaining proper conditions of use to insure safe performance and protection, especially during and after repairs.

**3.** Intrinsically safe equipment, equipment that is not capable of producing sparks capable of igniting flammable vapors under specified operating conditions (including accidental damage and over-voltage) is acceptable in all hazardous (classified) locations.

**4.** Positive pressure ventilated motors and generators are acceptable in locations for which they are approved.

**5.** Lighting fixtures, including portable lights, installed and used in Class I, Division 1 locations must be approved for the location, normally explosion-proof, but sometimes intrinsically safe or non-incendive. All fixtures must be protected against physical damage with a suitable guard or by location.

**6.** Conduit that passes from one classified location to another area classified differently (for example, from Division 1 to Division 2) requires a sealing fitting. The sealing fitting is permitted on either side of the boundary but there shall be no union, coupling, or other fitting between the seal and boundary. The 1996 NEC clarifies that reducers used in seal fittings need not be considered as such a fitting. Above ground conduits passing through an area classification with no fittings, couplings, connections, or other fitting less than 12 feet beyond the area boundary do not need sealing fittings at the boundary.

**7.** Normally, the sealing fitting should be installed on the less hazardous side, and special caution should be taken when installing drain seals in such locations. API RP 14F gives a good explanation of this subject in Section 4.8 and the accompanying figures.

### Fed-OSHA 1910.307

1. Equipment, wiring methods, and installations of equipment in hazardous (classified) locations shall be intrinsically safe, approved for the hazardous (classified) location, or safe for the hazardous (classified) location. Requirements for each of these options are as follows:

**Intrinsically safe**

2. Equipment and associated wiring approved as intrinsically safe shall be permitted in any hazardous (classified) location for which it is approved.

**Approved for the hazardous (classified) location**

3. 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 that will be present.

   **Note:** NFPA-70, the National Electrical Code, lists or defines hazardous gases, vapors, and dusts by, "Groups" characterized by their ignitable or combustible properties.

4. Equipment shall be marked to show the class, group, and operating temperature or temperature range, based on operation in a 40°C ambient, for which it is approved. The temperature marking may not exceed the ignition temperature of the specific gas or vapor to be encountered. Equipment of the non-heat-producing type, such as junction boxes, conduit, and fittings, and equipment of the heat-producing type having a maximum temperature not more than 100°C (212°F) need not have a marked operating temperature or temperature range.
   - Fixed lighting fixtures marked for use in Class I, Division 2 locations only, need not be marked to indicate the group.
   - Fixed general-purpose equipment in Class I locations, other than lighting fixtures, which is acceptable for use in Class I, Division 2 locations need not be marked with the class, group, division, or operating temperature.
   - 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.

5. Equipment which is safe for the location 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.

   **Note:** The National Electrical Code, NFPA 70, contains guidelines for determining the type and design of equipment and installations which will meet this requirement.

*(continued next page)*

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6. 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 utilized.
7. Equipment that has been approved for a Division I location may be installed in a Division 2 location of the same class and group. General-purpose equipment or equipment in general-purpose enclosures may be installed in Division 2 locations if the equipment does not constitute a source of ignition under normal operating conditions.

**8.** Conduit that enters an enclosure containing high temperature devices (devices that operate at temperature over 80% of the ignition temperature in degrees Celsius of the gas or vapor involved) or switches, breakers, and other devices that may produce sparks, requires a sealing fitting as close as possible and not more than 18 inches from the enclosure. The enclosure itself must be explosion-proof.

**9.** 2 inches and larger conduits that enter enclosures containing terminals, splices or taps require sealing fittings within 18 inches of the enclosure.

**10.** Where any portion of an underground run passes beneath a Class I area (Division 1 or Division 2) or through soil that may contain volatile, flammable liquids, stub-ups require sealing fittings where the stub-ups penetrate grade level in the unclassified location.

**11.** Electrical equipment suitable for Class I, Division 1 is also acceptable for Division 2 locations.

**12.** General purpose enclosures may be used where equipment does not have make-and-break or sliding contacts or other arcing contacts and the maximum operating temperature of all exposed surfaces does not exceed 80 percent of the ignition temperature (in degree Celsius). General purpose enclosures may also be used in Division 2 locations if the current-interrupting contacts are immersed in oil or hermetically sealed.

**13.** TEFC and open type motors without brushes, switching mechanisms, or other arc-producing devices may be used in Division 2 locations. It is important to consider the temperature of internal and external surfaces of open type motors that may be exposed to flammable atmospheres — in particular, the temperatures of space heaters.

**14.** In Division 1 and Division 2 locations, lighting fixtures shall be protected from physical damage by suitable guards or by location. The surface temperature of lighting fixtures in Division 1 locations must be limited to 80 percent of the ignition temperature (in degrees Celsius); this temperature criteria applies not only to the surface temperature of the fixture, but also to the lamp itself, in Division 2 locations, since the fixtures are not required to be able to contain an explosion if one should result from ignition by the lamp.

**15.** Generally, when the new Zone area classification scheme allowed by Article 505 of the 1996 NEC is used, the NEC permits all wiring methods allowed in Division 1 in Zone 1 locations, and all wiring methods allowed in Division 2 in Zone 2 locations. One can install equipment listed for Division 1 in Zone 1 locations and equipment listed in Division 2 in Zone 2 locations, but not vice versa. That is, Zone 1 listed equipment *cannot* be installed in Division 1 locations; nor can Zone 2 listed equipment be installed in

Division 2 locations — unless the equipment is NRTL-listed for the specific application. Only intrinsically safe systems are allowed in Zone 0 locations. Full applicability of the Zone system awaits the publication of suitable test standards, but these test standards should be fully available prior to, and addressed in, the 1999 NEC.

16. Refer to the CRTC *Electrical Manual* for additional information. The few points listed above only cover some of the more frequently encountered situations. For offshore applications, refer to API RP 14F, "Recommended Practice for Design and Installation of Electrical Systems for Offshore Production Platforms." Federal regulations enforced by the Minerals Management Service, US Department of the Interior (the authority having jurisdiction for Outer Continental Shelf (OCS) waters) require that all areas be classified in accordance with API RP 500 and that installations be made in accordance with API RP 14F.
17. All equipment installed in unclassified locations, but interconnected to equipment in classified areas, should be carefully examined to ensure that it cannot serve as an ignition source for flammable gases or vapors that might be transmitted through interconnecting conduit.

## 6.7 MARKING OF UNDERGROUND ELECTRICAL INSTALLATIONS

**NOTE:** At some land-based locations, particularly those where buried conduits and cables are subject to damage by earth-digging operations, it may be desirable to follow the procedure below to mark underground installations. In other locations, such practice may not be necessary. Individuals associated with specific locations should decide the necessity of marking the installations.*

**Chevron Guidelines**

1. On long straight runs of cable, place posts at intervals not to exceed 100 feet with signs oriented so that arrows point along route of cable.
2. Place the post at the intersection of turns with two signs oriented so that arrows point along the route of the cable in each direction.
3. Concrete markers "D" and "E" (in *Figure 6.4*) should be used where posts cannot be used. Concrete shall be made with iron oxide pigment **or equivalent coloring material** added to tint the concrete red and the concrete to be set flush with top of pavement or ground surface with arrows and lettering impressed on concrete **to identify the routes of the cables.***

4. Signs shall be made of #20 US gauge steel or 1/8 inch thick plastic with jade green background and white letters. The signs should be mounted on white posts.
5. It is recommended that underground electrical cables first be covered by a layer of sand followed by a layer of red tinted concrete and that underground conduit be encased in concrete, the top 4 inches of which shall be red-tinted.
6. See *Figure 6.4* for additional specifications.

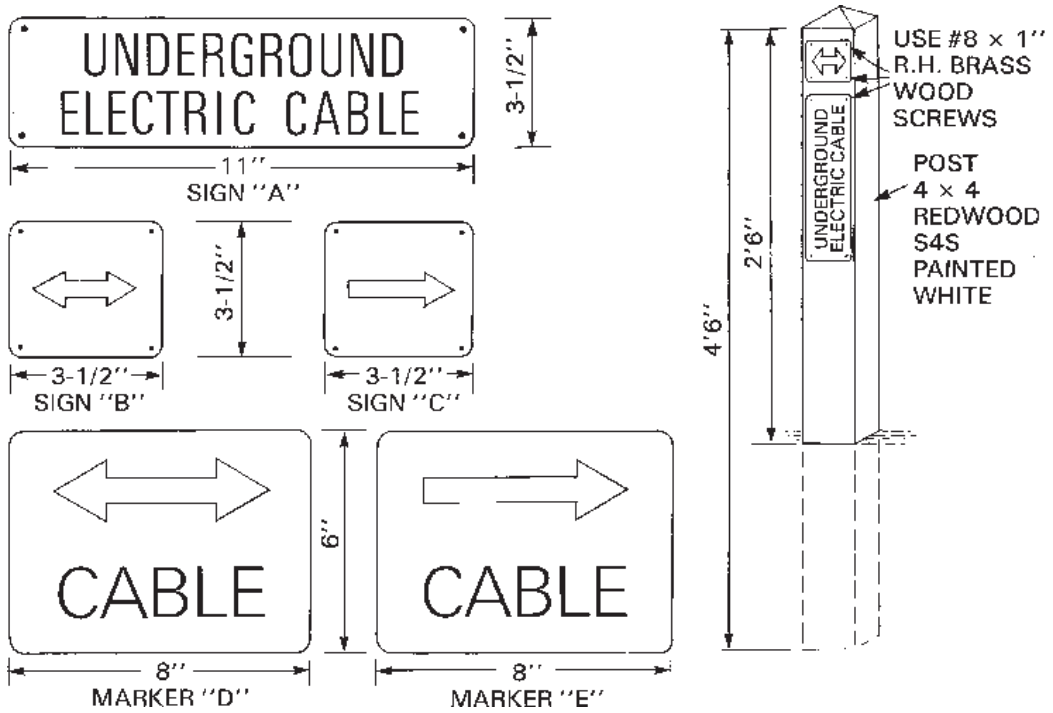


***Figure 6.4 Signs for Underground Electrical***

Ref. Std. Dwg. GD-P87601

## 6.8 GROUND FAULT CIRCUIT INTERRUPTERS

### Chevron Guidelines

1. Ground fault circuit interrupters (GFCIs) are devices that will trip and disconnect a circuit when the leakage current to ground exceeds approximately 5 milliamps, below any personnel hazard level. The speed of response generally is less than 0.05 seconds for 15 to 20 amp units.
2. GFCIs should be used for the following applications:
   - for all 120-V single phase 15- and 20- ampere receptacle outlets that are not part of the permanent wiring of a building or structure (e.g., temporary wiring during construction)
   - for lavatory washroom and change room outlets
   - for all areas with moist or wet ground where electrical equipment or portable electric tools are likely to be used
3. GFCIs may be considered for the following applications:
   - areas where portable electric tools are used regularly, such as in plant shops, or during maintenance
   - areas where 120-V electric cords are used in a plant

**NOTES:**

4. GFCIs are intended only to protect personnel and operate only on line-to-ground fault currents (such as insulation leakage currents) or currents likely to flow to ground during an accidental contact with a hot wire of a 120-V circuit. They do not protect personnel from line-to-line contact.
5. It is essential that the polarity of conductors in all cords, plugs and receptacles supplying single-pole portable GFCI units be properly maintained for the units to protect personnel from electrical shock.
6. To minimize "nuisance" tripping, it is generally desirable to locate portable GFCI units as near as possible to the equipment supplied by the unit and to use relatively short cords to each portable tool or lamp.
7. Where permanently installed GFCIs are applied on outdoor receptacles:
   - the actual GFCI element should be mounted indoors, close to the service of the branch circuit, and
   - outdoor receptacles should be of the conventional grounding type (supplied power through the GFCI).

## 6.9 NOTES AND REFERENCES

### OTHER GUIDES

**ANSI C2-1997**
"National Electrical Safety Code"

**ANSI/NFPA 70-1996**
"National Electrical Code"

**API Standard RP 500**
"Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities"

**ANSI/API RP 14F-1991**
"Design and Installation of Electrical Systems for Offshore Production Platforms"

### ADDITIONAL REFERENCES

**CRTC Standard Drawing GD-P87601**
"Signs and Markers for Underground Cables"

**CRTC *Electrical Manual***

**CRTC *Fire Protection Manual***