

6. Electrical Safety

Chapter 296-46B WAC

1.0 Purpose

This chapter addresses the electrical safety requirements that are necessary for the practical safeguarding of employees who work with electricity.

2.0 General Procedures

2.1 Examination of Equipment

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

- Suitability for installation and use in conformity with the provisions of this subpart. 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 that contribute to the practical safeguarding of employees using or likely to come in contact with the equipment.

2.2 Installation and Use of Equipment

Listed or labeled equipment must be used or installed in accordance with any instructions included in the listing or labeling.

2.3 Splices

Conductors must be spliced or joined with splicing devices suitable for the use or by brazing, welding, or soldering with a fusible metal or alloy. Soldered splices must first be spliced or joined to be mechanically and electrically secure without solder and then soldered. All splices and joints and the free ends of conductors must be covered with an insulation equivalent to that of the conductors or with an insulating device suitable for the purpose.

2.4 Arcing parts

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

2.5 Marking

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 must be provided giving voltage, current, wattage, or other ratings as necessary. The marking must be of sufficient durability to withstand the environment involved.

2.6 Identification of Disconnecting Means and Circuits

Each disconnecting mean required by this subpart for motors and appliances must 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, must be legibly marked to indicate its

purpose, unless located and arranged so the purpose is evident. These markings must be of sufficient durability to withstand the environment involved.

2.7 Systems of 600 Volts, Nominal, or Less.

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

Except as required or permitted elsewhere in this chapter, 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 live may not be less than indicated in Table 1. In addition, workspace may not be less than 30 inches wide in front of the electric equipment. Distances must be measured from the live parts if they are exposed, or from the enclosure front or opening if the live parts are enclosed. Concrete, brick, or tile walls are considered to be grounded. Working space is not required in back of assemblies such as dead-front switchboards or motor control centers where there are no renewable or adjustable parts such as fuses or switches on the back and where all connections are accessible from locations other than the back.

Table 1

Nominal Voltage to Ground	Minimum Clear Distance for Condition** (ft)		
	(a)	(b)	(c)
0-150	3*	3*	3
151-600	3*	3 ½	4

*Minimum clear distances may be 2 feet 6 inches for installations built prior to effective date of this section.

**Conditions (a), (b), (c), are as follows:

- (a) Exposed live parts on one side and no live or grounded parts on the other side of the working space, or exposed live parts on both sides effectively guarded by suitable wood or other insulating material. Insulated wire or insulated busbars operating at not over 300 volts are not considered live parts.
- (b) Exposed live parts on one side and grounded parts on the other side
- (c) Exposed live parts on both sides of the workspace (not guarded as provided in condition (a) with the operator between).

Working space required by this subpart 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, must be suitably guarded.

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

Where there are live parts normally exposed on the front of switchboards or motor control centers, the working space may not be less than three feet.

Illumination must be provided for all working spaces around service equipment, switchboards, panel boards, and motor control center installed indoors.

The minimum headroom of working spaces around service equipment, switchboards, panel boards, or motor control centers must be 6 feet 3 inches. **Note:** As used in this section, a motor control center is an assembly of one or more enclosed sections having a common power bus and principally containing motor control units.

2.8 Guarding of Live Parts

Except as required or permitted elsewhere in this section, live parts of electric equipment operating at 50 volts or more must be guarded against accidental contact by approved cabinets or other forms of approved enclosures, or by any of the following means:

- By location in a room, vault, or similar enclosure that is accessible only to qualified persons.
- By suitable permanent, substantial partitions or screens so arranged that only qualified persons will have access to the space within reach of the live parts. Any openings in such partitions or screens must be sized and located, that persons are not likely to come into accidental contact with live parts or to bring conducting objects into contact with them.
- By location on a suitable balcony, gallery, or platform elevated and arranged so as to exclude unqualified persons.
- By elevation of 8 feet or more above the floor or other working surface.

In locations where electric equipment would be exposed to physical damage, enclosures or guards must be arranged and of such strength so as to prevent damage.

Entrances to rooms and other guarded locations containing exposed live parts must be marked with conspicuous warning signs forbidding unqualified persons to enter.

3.0 Wiring Design and Protection

3.1 Use and Identification of Grounded and Grounding Conductors

A conductor used as a grounded conductor must be identifiable and distinguishable from all other conductors. A conductor used as an equipment grounding conductor must be identifiable and distinguishable from all other conductors.

No grounded conductor may be attached to any terminal or lead so as to reverse designated polarity.

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

3.2 Outlet Devices

Outlet devices must have an ampere rating not less than the load to be served.

3.3 Outside conductors, 600 volts, nominal, or less.

Sections (a), (b), (c), and (d) of this subsection apply to branch circuit, feeder, and service conductors rated 600 volts, nominal, or less and run outdoors as open conductors. Subdivision (e) of this subsection applies to lamps installed under such conductors.

(a) Conductors supported on poles must provide a horizontal climbing space not less than the following:

- Power conductors below communication conductors: 30 inches.
- Power conductors alone or above communication conductors, 300 volts or less: 24 inches; more than 300 volts: 30 inches.
- Communication conductors below power conductors with power conductors 300 volts or less: 24 inches; more than 300 volts: 30 inches.

(b) Open conductors must conform to the following minimum clearances:

- 10 feet: above finished grade, sidewalks, or from any platform or projection from which they might be reached.
- 12 feet: over areas subject to vehicular traffic other than truck traffic.
- 15 feet: over areas other than those specified in this subsection that are subject to truck traffic.
- 18 feet: over public streets, alleys, roads, and driveways.

(c) Conductors must have a clearance of at least 3 feet from windows, doors, porches, fire escapes, or similar locations. Conductors run above the top level of a window are considered to be out of reach from that window and, therefore, do not have to be 3 feet away.

(d) Conductors must have a clearance of not less than 8 feet from the highest point of roofs over which they pass, except that:

- Where the voltage between conductors is 300 volts or less and the roof has a slope of not less than 4 inches in 12, the clearance from the roofs must be at least 3 feet; or
- Where the voltage between conductors is 300 volts or less and the conductors do not pass over more than 4 feet of the overhang portion of the roof and they are terminated at a through-the-roof raceway or approved support, the clearance from the roofs must be at least 18 inches.

(e) Lamps for outdoor lighting must be located below all live 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 re-lamping operations.

3.4 Services

Means must be provided to disconnect all conductors in a building or other structure from the service-entrance conductors. The disconnecting means must plainly indicate whether it is in the open or closed position and must be installed at a readily accessible location nearest the point of entrance of the service-entrance conductors.

Each service-disconnecting means must simultaneously disconnect all ungrounded conductors.

The following additional requirements apply to services over 600 volts, nominal.

- Service-entrance conductors installed as open wires must be guarded to make them accessible only to qualified persons.
- Signs warning of high voltage must be posted where people other than qualified employees might come in contact with live parts.

3.5 Overcurrent Protection

The following requirements apply to overcurrent protection of circuits rated 600 volts, nominal, or less.

- Conductors and equipment must be protected from overcurrent in accordance with their ability to safely conduct current.
- Except for motor-running overload protection, overcurrent devices may not interrupt the **continuity** of the grounded conductor unless all conductors of the circuit are opened simultaneously.
- Except for service fuses, all cartridge fuses that are accessible to people who are not qualified and all fuses and thermal cutouts on circuits over 150 volts to ground must be provided with disconnecting **means**. This disconnecting means must be installed so that the fuse or thermal cutout can be disconnected from its supply without disrupting service to equipment and circuits unrelated to those protected by the overcurrent device.
- Overcurrent devices must be readily accessible to each employee or authorized building management personnel. These overcurrent devices may not be located where they will be exposed to physical damage or in the vicinity of easily ignitable material.
- **Fuses** and circuit breakers must be located or shielded so that employees will not be burned or otherwise injured by their operation.
- **Circuit breakers.**
 1. Circuit breakers must clearly indicate whether they are in the open (off) or closed (on) position.
 2. Where circuit breaker **handles** on switchboards are operated vertically rather than horizontally or rotationally, the up position of the handle must be in the closed (on) position. (See WAC 296-46B)
 3. If used as switches in 120-volt, fluorescent lighting circuits, circuit breakers must be approved for the purpose and marked "SWD." (See WAC 296-46B)

Feeders and branch circuits over 600 volts, nominal, must have short-circuit protection.

3.6 Grounding

The following systems that supply premises wiring must be grounded:

- All three-wire DC systems must have their neutral conductor grounded.
- Two-wire DC systems operating at over 50 volts but under 300 volts between conductors must be grounded unless one of the following applies:
 1. They supply only industrial equipment in limited areas and are equipped with a ground detector;
 2. They are rectifier-derived from an AC system complying with sections 3, 4, and 5 below; or
 3. They are fire-protective signaling circuits having a maximum current of 0.030 amperes.
- AC circuits of less than 50 volts must be grounded if they are installed as overhead conductors outside of buildings or if they are supplied by transformers and the transformer primary supply system is ungrounded or exceeds 150 volts to ground.
- AC systems of 50 volts to 1000 volts must be grounded under any of the following conditions, unless exempted by item 4 below:
 1. If the system can be grounded so that the maximum voltage to ground on the ungrounded conductors does not exceed 150 volts;
 2. If the system is nominally rated 480Y/277 volt, 3-phase, 4-wire in which the neutral is used as a circuit conductor;
 3. If the system is nominally rated 240/120 volt, 3-phase, 4-wire in which the midpoint of one phase is used as a circuit conductor; or
 4. If a service conductor is un-insulated.
- AC systems of 50 volts to 1000 volts are not required to be grounded when the system is separately derived and is supplied by a transformer that has a primary voltage rating of less than 1000 volts, provided all of the following conditions are met:
 1. • The system is used exclusively for control circuits
 2. • The conditions of maintenance and supervision assure that only qualified persons will service the installation
 3. • Continuity of control power is required
 4. • Ground detectors are installed on the control system.

Conductors to be Grounded

For AC premises wiring systems the identified conductor must be grounded.

Grounding Connections

For a grounded system, a grounding electrode conductor must 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 must be connected to the grounded circuit conductor on the supply side of the service disconnecting means, or on the supply side of the system disconnecting means or overcurrent devices if the system is separately derived.

For an ungrounded service-supplied system, the equipment grounding conductor must be connected to the grounding electrode conductor at the service equipment. For an ungrounded, separately derived system, the equipment grounding conductor must be connected to the grounding electrode conductor at, or ahead of, the system disconnecting means or overcurrent devices.

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.

Grounding Path

The path to ground from circuits, equipment, and enclosures must be permanent and continuous.

Supports, Enclosures, and Equipment to be Grounded

Metal cable trays, metal raceways, and metal enclosures for conductors must be grounded, except that:

- Metal enclosures such as sleeves that are used to protect cable assemblies from physical damage need not be grounded.
- 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 of the following conditions are met:
 1. Runs are less than 25 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.

Metal enclosures for service equipment must be grounded.

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

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

- If within 8 feet vertically or 5 feet horizontally of ground or grounded metal objects and subject to employee contact.
- If in a wet or damp location and not isolated.
- If in electrical contact with metal.
- If in a hazardous (classified) location.
- If supplied by a metal-clad, metal-sheathed, or grounded metal raceway wiring method.
- If equipment operates with any terminal at over 150 volts to the ground; however, the following need not be grounded:
 1. Enclosures for switches or circuit breakers used for other than service equipment and accessible to qualified persons only
 2. Metal frames of electrically heated appliances which are permanently and effectively insulated from ground
 3. The cases of distribution apparatus such as transformers and capacitors mounted on wooden poles at a height exceeding 8 feet above ground or grade level.

Exposed noncurrent-carrying metal parts of cord-connected and plug-connected equipment that may become energized must be grounded in the following circumstances:

- If in hazardous (classified) locations (see WAC 296-46B).
- If operated at over 150 volts to ground, except for guarded motors and metal frames of electrically heated appliances if the appliance frames are permanently and effectively insulated from ground.
- 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
 4. Motor-operated appliances of the following types: Hedge clippers, lawn mowers, snow blowers, and wet scrubbers
 5. Cord-connected and plug-connected appliances used in damp or wet locations or by employees standing on the ground or on metal floors or working inside of metal tanks or boilers
 6. Portable and mobile x-ray and associated equipment
 7. Tools likely to be used in wet and conductive locations
 8. Portable hand lamps. Tools likely to be used in wet and conductive locations need not be grounded if supplied through an isolating transformer with an ungrounded secondary of not over 50 volts. Listed or labeled portable tools and appliances

protected by an approved system of double insulation, or its equivalent, need not be grounded. If such a system is employed, the equipment must be distinctively marked to indicate that the tool or appliance utilizes an approved system of double insulation.

The metal parts of the following non-electrical equipment must be grounded: Frames and tracks of electrically operated cranes; frames of non-electrically driven elevator cars to which electric conductors are attached; hand operated metal shifting ropes or cables of electric elevators; and metal partitions, grill work, and similar metal enclosures around equipment of over 750 volts between conductors.

Methods of grounding fixed equipment

Non-current-carrying metal parts of fixed equipment, if required to be grounded by this section, must be grounded by an equipment-grounding conductor that is contained within the same raceway, cable, or cord, or that runs with or encloses the circuit conductors. For DC circuits only, the equipment grounding conductor may be run separately from the circuit conductors.

Electric equipment is considered to be effectively grounded if it is secured to, and in electrical contact with, a metal rack or structure that is provided for its support and the metal rack or structure is grounded by the method specified for the non-current-carrying metal parts of fixed equipment. For installations made before May 30, 1982 only, 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. Metal car frames supported by metal hoisting cables attached to or running over metal sheaves or drums of grounded elevator machines are also considered to be effectively grounded.

4.0 Wiring Methods, Components, and Equipment for General Use

4.1 Wiring methods

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

General Requirements

Metal raceways, cable armor, and other metal enclosures for conductors must be metallically joined together into a continuous electric conductor and must be so connected to all boxes, fittings, and cabinets as to provide effective electrical continuity.

No wiring systems of any type be installed in ducts used to transport dust, loose stock or flammable vapors. No wiring system of any type may 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.

Temporary Wiring

Temporary electrical power and lighting wiring methods may be of a class less than would be required for a permanent installation. Except as specifically modified in this paragraph, all other requirements of this subpart for permanent wiring must apply to temporary wiring installations.

Temporary electrical power and lighting installations 600 volts, nominal, or less may be used only:

- During and for **remodeling**, maintenance, repair, or demolition of buildings, structures, or equipment, and similar activities
- For experimental or **development** work
- For a period not to **exceed** 90 days for Christmas decorative lighting, carnivals, and similar purposes.

Temporary wiring over 600 volts, nominal, may be used only during periods of tests, experiments, or emergencies.

General requirements for temporary wiring are:

- Feeders must originate in an approved distribution center. The conductors must be run as multiconductor cord or cable assemblies, or, where not subject to physical damage, as open conductors on insulators not more than 10 feet apart.
- Branch circuits must originate in an approved power outlet or panelboard. Conductors must be multiconductor cord or cable assemblies or open conductors. If run as open conductors they must be fastened at ceiling height every 10 feet. No branch-circuit conductor may be laid on the floor. Each branch circuit that supplies receptacles or fixed equipment must contain a separate equipment grounding conductor if run as open conductors.
- Receptacles must be of the grounding type. Unless installed in a complete metallic raceway, each branch circuit must contain a separate equipment grounding conductor and all receptacles must be electrically connected to the grounding conductor.
- No bare conductors or earth returns may be used for the wiring of any temporary circuit.
- Suitable disconnecting switches or plug connectors must be installed to permit disconnection of all ungrounded conductors of each temporary circuit.
- Lamps for general illumination must be protected from accidental contact or breakage. Protection must be provided by elevation of at least 7 feet from normal working surface or by a suitable fixture or lampholder with a guard.
- Flexible cords and cables must be protected from accidental damage. Sharp corners and projections must be avoided. Where passing through doorways or other pinch points, flexible cords and cables must be provided with protection to avoid damage.

Cable trays

Only the following may be installed in cable tray systems:

- Mineral-insulated metal-sheathed cable (Type MI)
- Armored cable (Type AC)
- Metal-clad cable (Type MC)
- Power-limited tray cable (Type PLTC)
- Nonmetallic-sheathed cable (Type NM or NMC)
- Shielded nonmetallic-sheathed cable (Type SNM)
- Multiconductor service-entrance cable (Type SE or USE)
- Multiconductor underground feeder and branch-circuit cable (Type UF)
- Power and control tray cable (Type TC)
- Other factory-assembled, multiconductor control, signal, or power cables which are specifically approved for installation in cable trays or
- Any approved conduit or raceway with its contained conductors.

In industrial establishments only, 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 4-inch ventilated channel-type cable trays:

- -Single conductor cables that are 250 MCM or larger and are Types RHH, RHW, MV, USE, or THW, and other 250 MCM or larger single conductor cables if specifically approved for installation in cable trays. Where exposed to direct rays of the sun, cables must be sunlight-resistant.

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

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

Open Wiring on Insulators

Open wiring on insulators is only permitted on systems of 600 volts, nominal, or less for industrial or agricultural establishments and for services.

Conductors must be rigidly supported on noncombustible, nonabsorbent insulating materials and may not contact any other objects.

In dry locations where not exposed to severe physical damage, conductors may be separately enclosed in flexible nonmetallic tubing. The tubing must be in continuous lengths not exceeding 15 feet and secured to the surface by straps at intervals not exceeding 4 feet 6 inches.

Open conductors must be separated from contact with walls, floors, and 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 must 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 absolutely out of contact with the sleeve. Each conductor must be carried through a separate tube or sleeve.

Conductors within 7 feet from the floor are considered exposed to physical damage. Where open conductors cross ceiling joints and wall studs and are exposed to physical damage, they must be protected.

4.2 Cabinets, Boxes, and Fittings

Conductors entering boxes, cabinets, or fittings must be protected from abrasion, and openings through which conductors enter must be effectively closed. Unused openings in cabinets, boxes, and fittings must also be effectively closed.

All pull boxes, junction boxes, and fittings must be provided with covers approved for the purpose. If metal covers are used they must be grounded. In completed installations each outlet box must have a cover, faceplate, or fixture canopy. Covers of outlet boxes having holes through which flexible cord pendants pass must be provided with bushings designed for the purpose or must have smooth, well-rounded surfaces on which the cords may bear.

4.3 Switches

Single-throw knife switches must be connected so that the blades are dead when the switch is in the open position. They must be placed so that gravity will not tend to close them. Those approved for use in the inverted position must be provided with a locking device that will ensure that the blades remain in the open position when so set. Double-throw knife switches may be mounted so that the throw will be either vertical or horizontal. However, if the throw is vertical a locking device must be provided to ensure that the blades remain in the open position when so set.

Flush snap switches that are mounted in ungrounded metal boxes and located within reach of conducting floors or other conducting surfaces must be provided with faceplates of nonconducting, noncombustible material.

4.4 Switchboards and Panelboards

Switchboards that have any exposed live parts must be located in permanently dry locations and accessible only to qualified persons. Panelboards must be mounted in cabinets, cutout boxes, or enclosures approved for the purpose and must be dead front. However, panelboards other than the dead front externally-operable type are permitted where accessible only to qualified persons. Exposed blades of knife switches must be dead when open.

4.5 Enclosures for Damp or Wet Locations

Cabinets, cutout boxes, fittings, boxes, and panelboard enclosures in damp or wet locations must be installed so as to prevent moisture or water from entering and accumulating within them. In wet locations the enclosures must be weatherproof.

Switches, circuit breakers, and switchboards installed in wet locations must be enclosed in weatherproof enclosures.

4.6 Conductors for General Wiring

All conductors used for general wiring must be insulated unless otherwise permitted in this section. The conductor insulation must be of a type that is approved for the voltage, operating temperature, and location of use. Insulated conductors must be distinguishable by appropriate color or other suitable means as being grounded conductors, ungrounded conductors, or equipment grounding conductors.

4.7 Flexible Cords and Cables

Flexible cords and cables must be approved and suitable for conditions of use and location. Flexible cords and cables must be used only for:

1. Pendants
2. Wiring of fixtures
3. Connection of portable lamps or appliances
4. Elevator cables
5. Wiring of cranes and hoists
6. Connection of stationary equipment to facilitate their frequent interchange
7. Preventing the transmission of noise or vibration
8. Appliances where the fastening means and mechanical connections are designed to permit removal for maintenance and repair
9. Data processing cables approved as a part of the data processing system.

If used as permitted in #3, #6, or #8 above, the flexible cord must be equipped with an attachment plug and must be energized from an approved receptacle outlet.

Unless specifically permitted in items 1-9 above, flexible cords and cables may not be used:

- As a substitute for the fixed wiring of a structure
- Where run through holes in walls, ceilings, or floors
- Where run through doorways, windows, or similar openings
- Where attached to building surfaces
- Where concealed behind building walls, ceilings, or floors.

Flexible cords used in show windows and showcases must be Type S, SO, SJ, SJO, ST, STO, SJT, SJTO, or AFS except for the wiring of chain-supported lighting fixtures and supply cords for portable lamps and other merchandise being displayed or exhibited.

A conductor of a flexible cord or cable that is used as a grounded conductor or an equipment grounding conductor must be distinguishable from other conductors. Types SJ, SJO, SJT, SJTO, S, SO, ST, and STO must be durably marked on the surface with the type designation, size, and number of conductors.

Flexible cords must be used only in continuous lengths without splice or tap. Hard service flexible cords No. 12 or larger may be repaired if spliced so that the splice retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced.

Flexible cords must be connected to devices and fittings so that strain relief is provided that will prevent pull from being directly transmitted to joints or terminal screws.

4.8 Fixture Wires

Fixture wires must be approved for the voltage, temperature, and location of use. A fixture wire used as a grounded conductor must be identified.

Fixture wires may be used:

- For installation in lighting fixtures and in similar equipment where enclosed or protected and not subject to bending or twisting in use

- For connecting lighting fixtures to the branch-circuit conductors supplying the fixtures.

Fixture wires may not be used as branch-circuit conductors except as permitted for Class 1 power-limited circuits.

4.9 Equipment for General Use

Lighting Fixtures, Lampholders, Lamps, Rosettes and Receptacles

Fixtures, lampholders, lamps, rosettes, and receptacles may have no live parts normally exposed to employee contact. However, rosettes and cleat-type lampholders and receptacles located at least 8 feet above the floor may have exposed parts.

Handlamps of the portable type supplied through flexible cords must be equipped with a handle of molded composition or other material approved for the purpose, and a substantial guard must be attached to the lampholder or the handle.

Lampholders of the screw-shell type must be installed for use as lampholders only. Lampholders installed in wet or damp locations must be of the weatherproof type.

Fixtures installed in wet or damp locations must be approved for the purpose and must be constructed or installed so that water cannot enter or accumulate in wireways, lampholders, or other electrical parts.

Receptacles, Cord Connectors, and Attachment Plugs (Caps)

Receptacles, cord connectors, and attachment plugs must be constructed so that no receptacle or cord connector will accept an attachment plug with a different voltage or current rating than that for which the device is intended. However, a 20-ampere T-slot receptacle or cord connector may accept a 15-ampere attachment plug of the same voltage rating.

A receptacle installed in a wet or damp location must be suitable for the location.

Appliances

Appliances, other than those in which the current-carrying parts at high temperatures are necessarily exposed, may have no live parts normally exposed to employee contact.

A means must be provided to disconnect each appliance.

Each appliance must be marked with its rating in volts and amperes or volts and watts.

Motors, Motor Circuits, and Controllers

If specified that one piece of equipment must be “in sight from” another piece of equipment, one must be visible and not more than 50 feet from the other.

A disconnecting means must be located in sight from the controller location. However, a single disconnecting means may be located adjacent to a group of coordinated controllers mounted adjacent to each other or a multimotor continuous process machine. The controller disconnecting means for motor branch circuits over 600 volts, nominal, may be out of sight of the controller, if the controller is marked with a warning label giving the location and identification of the disconnecting means that is to be locked in the open position.

The disconnecting means must disconnect the motor and the controller from all ungrounded supply conductors and must be designed so that no pole can be operated independently.

If a motor and the driven machinery are not in sight from the controller location, the installation must comply with one of the following conditions:

- a. The controller disconnecting means must be capable of being locked in the open position.

- b. A manually operable switch that will disconnect the motor from its source of supply must be placed in sight from the motor location.

The disconnecting means must plainly indicate whether it is in the open (off) or closed (on) position.

The disconnecting means must be readily accessible. If more than one disconnect is provided for the same equipment, only one need be readily accessible.

An individual disconnecting means must be provided for each motor, but a single disconnecting means may be used for a group of motors under any one of the following conditions:

- If a number of motors drive special parts of a single machine or piece of apparatus, such as a metal or woodworking machine, crane, or hoist
- If a group of motors is under the protection of one set of branch-circuit protective devices
- If a group of motors is in a single room in sight from the location of the disconnecting means.

Motors, motor-control apparatus, and motor branch-circuit conductors must be protected against overheating due to motor overloads or failure to start, and against short-circuits or ground faults. These provisions must not require overload protection that will stop a motor where a shutdown is likely to introduce additional or increased hazards, as in the case of fire pumps, or where continued operation of a motor is necessary for a safe shutdown of equipment or process and motor overload sensing devices are connected to a supervised alarm.

Stationary motors having commutators, collectors, and brush rigging located inside of motor end brackets and not conductively connected to supply circuits operating at more than 150 volts to ground need not have such parts guarded. Exposed live parts of motors and controllers operating at 50 volts or more between terminals must be guarded against accidental contact by any of the following:

- By installation in a room or enclosure that is accessible only to qualified persons
- By installation on a suitable balcony, gallery, or platform, so elevated and arranged as to exclude unqualified persons
- By elevation 8 feet or more above the floor.

Where live parts of motors or controllers operating at over 150 volts to ground are guarded against accidental contact only by location, and where adjustment or other attendance may be necessary during the operation of the apparatus, suitable insulating mats or platforms must be provided so that the attendant cannot readily touch live parts unless standing on the mats or platforms.

Transformers

The following paragraphs cover the installation of all transformers except the following:

- Current transformers
- Dry-type transformers installed as a component part of other apparatus
- Transformers that are an integral part of an x-ray, high frequency, or electrostatic-coating apparatus
- Transformers used with Class 2 and Class 3 circuits, sign and outline lighting, electric discharge lighting, and power-limited fire-protective signaling circuits
- Liquid-filled or dry-type transformers used for research, development, or testing, where effective safeguard arrangements are provided.

Warning signs or visible markings on the equipment or structure must indicate the operating voltage of exposed live parts of transformer installations.

Dry-type, high-fire-point-liquid-insulated, and askarel-insulated transformers installed indoors and rated over 35kV must be in a vault.

If they present a fire hazard to employees, oil-insulated transformers installed indoors must be in a vault.

Combustible material, combustible buildings and parts of buildings, fire escapes, and door and window openings must be safeguarded from fires that may originate in oil-insulated transformers attached to or adjacent to a building or combustible material.

Transformer vaults must be constructed so as to contain fire and combustible liquids within the vault and to prevent unauthorized access. Locks and latches must be so arranged that a vault door can be readily opened from the inside.

Any pipe or duct system foreign to the vault installation may not enter or pass through a transformer vault.

Materials may not be stored in transformer vaults.

Capacitors

All capacitors, except surge capacitors or capacitors included as a component part of other apparatus, must be provided with an automatic means of draining the stored charge after the capacitor is disconnected from its source of supply.

- Capacitors rated over 600 volts, nominal, must comply with the following additional requirements:
- Isolating or disconnecting switches (with no interrupting rating) must be interlocked with the load interrupting device or must be provided with prominently displayed caution signs to prevent switching load current.
- For series capacitors (see WAC 296-46B), the proper switching must be assured by use of at least one of the following:
 1. Mechanically sequenced isolating and bypass switches
 2. Interlocks
 3. Switching procedure prominently displayed at the switching location.

Storage batteries

Provisions must be made for sufficient diffusion and ventilation of gases from storage batteries to prevent the accumulation of explosive mixtures.

5.0 Working On or Near Exposed Energized Parts

5.1 Application

This section applies to work performed on exposed live parts (involving either direct contact or contact by means of tools or materials) or near enough to them for employees to be exposed to any hazard they present.

5.2 Work on Energized Equipment.

Only qualified persons must work on electric circuit parts of equipment that have not been de-energized under the procedures of WAC 296-46B. Such persons must be capable of working safely on energized circuits and must be familiar with the proper use of special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools.

5.3 High voltage lines

No work must be performed; no material must be piled, stored or otherwise handled; no scaffolding, commercial signs, or structures must be erected or dismantled; and no tools, machinery or equipment may be operated within the specified minimum distances from any energized high voltage electrical conductor capable of energizing the material or equipment, except where the electrical distribution and

transmission lines have been de-energized and visibly grounded at point of work, or where insulating barriers not a part of or an attachment to the equipment have been erected.

To prevent physical contact with the lines, equipment must be operated proximate to, under, over, by, or near powerlines only in accordance with the following:

For lines rated 50 kV or below, minimum clearance between the lines and any part of the equipment or load must be 10 feet.

For lines rated over 50 kV minimum, clearance between the lines and any part of the equipment or load must be 10 feet plus 0.4 inch for each 1 kV over 50 kV or twice the length of the line insulator, but never less than 10 feet.

Where overhead electric conductors are encountered in proximity to a work area, the employer must be responsible for:

- Ascertaining the voltage and minimum clearance distance required,
- Maintaining the minimum clearance distance, and
- Ensuring that the other requirements of this section are complied with.

5.4 Low Voltage Lines.

When work is being carried out in proximity to energized electrical service conductors operating at 750 volts or less, such work must be performed in a manner to prevent contact by any worker with the energized conductors.

5.5 Overhead lines.

If work is to be performed near overhead lines, the lines must be de-energized and grounded, or other protective measures must be provided before work is started. If the lines are to be de-energized, arrangements must be made with the person or organization that operates or controls the electric circuits involved to de-energize and ground them. If protective measures such as guarding, isolating, or insulating are used, these precautions must prevent employees from contacting such lines directly with any part of their body or indirectly through conductive materials, tools, or equipment.

5.6 Unqualified persons.

When an unqualified person is working in an elevated position, or on the ground, near overhead lines, the location must be such that the person and the longest conductive object he or she may contact cannot come closer to any unguarded, energized overhead line than the following distances:

- For voltages to ground 50kV or below--10 ft.
- For voltages to ground over 50kV--10 ft plus 0.4 inch for every 1kV over 50kV.

5.7 Qualified persons.

When a qualified person is working in the vicinity of overhead lines, whether in an elevated position or on the ground, the person must not approach or take any conductive object without an approved insulating handle closer to exposed energized parts than listed in 5.3 and 5.4 above unless:

- The person is insulated from the energized part (gloves, with sleeves if necessary, rated for the voltage involved; or
- The energized part is insulated both from all other conductive objects at a different potential and from the person; or
- The person is insulated from all conductive objects at a potential different from that of the energized part.

5.8 Vehicular and Mechanical Equipment

Any vehicular or mechanical equipment capable of having parts of its structure elevated near energized overhead lines must be operated so that a clearance of 10 ft is maintained. If the voltage is higher than 50kV, the clearance must be increased 0.4 inches for every 1kV over that voltage. However, under any of the following conditions, the clearance may be reduced:

- If the vehicle is in transit with its structure lowered, the clearance may be reduced to 4 ft. If the voltage is higher than 50kV, the clearance must be increased 0.4 inch for every 1kV over that voltage.
- If insulating barriers are installed to prevent contact with the lines, and if the barriers are rated for the voltage of the line being guarded and are not a part of or an attachment to the vehicle or its raised structure, the clearance may be reduced to a distance within the designed working dimensions of the insulating barrier.

Employees standing on the ground must not contact the vehicle or mechanical equipment or any of its attachments, unless:

- The employee is using protective equipment rated for the voltage
- The equipment is located so that no un-insulated part of its structure (that portion of the structure that provides a conductive path to employees on the ground) can come closer to the line than permitted in this section.

If any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines is intentionally grounded, employees working on the ground near the point of grounding must not stand at the grounding location whenever there is a possibility of overhead line contact. Additional precautions, such as the use of barricades or insulation, must be taken to protect employees from hazardous ground potentials, depending on earth resistivity and fault currents, that can develop within the first few feet or more outward from the grounding point.

5.9 Illumination

Employees must not enter spaces containing exposed energized parts, unless illumination is provided that enables the employees to perform the work safely.

Where lack of illumination or an obstruction precludes observation of the work to be performed, employees must not perform tasks near exposed energized parts. Employees must not reach blindly into areas that may contain energized parts.

5.10 Confined or Enclosed Work Spaces

When an employee works in a confined or enclosed space (such as a manhole or vault) that contains exposed energized parts, the employer must provide, and the employee must use, protective shields, protective barriers, or insulating materials as necessary to avoid inadvertent contact with these parts. Door hinged panels and the like must be secured to prevent their swinging into an employee and causing the employee to contact exposed energized parts.

5.11 Conductive Materials and Equipment

Conductive materials and equipment that are in contact with any part of an employee's body must be handled in a manner that will prevent them from contacting exposed energized conductors or circuit parts. If an employee must handle long dimensional conductive objects (such as ducts and pipes) in areas with exposed live parts, the employer must institute work practices (such as the use of insulation, guarding, and material handling techniques) that will minimize the hazard.

5.12 Portable Ladders

Portable ladders must have nonconductive side rails if they are used where the employee or the ladder could contact exposed energized parts.

5.13 Conductive Apparel

Conductive articles of jewelry and clothing (such as watch bands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, or metal headgear) must not be worn if they might contact exposed energized parts.

5.14 Housekeeping Duties

Where live parts present an electrical contact hazard, employees must not perform housekeeping duties at such close distances to the parts that there is a possibility of contact, unless adequate safeguards (such as insulating equipment or barriers) are provided.

Electrically conductive cleaning materials (including conductive solids such as steel wool, metalized cloth, and silicon carbide, as well as conductive liquid solutions) must not be used in proximity to energized parts unless procedures are followed that will prevent electrical contact.

5.15 Interlocks

Only a qualified person following the requirements of this section may defeat an electrical safety interlock, and then only temporarily while he or she is working on the equipment. The interlock system must be returned to its operable condition when this work is completed.

6.0 Training

Scope. The training requirements contained in this section apply to employees who face a risk of electrical shock that is not reduced to a safe level by the electrical installation requirements of WAC 296-46B. *Note: Employees in occupations listed below face such a risk and are required to be trained. Other employees who also may reasonably be expected to face a considerable risk of injury due to electric shock or electrical hazards must also be trained.*

- Blue collar supervisors¹
- Electrical and electronic engineers.¹
- Electrical and electronic equipment assemblers.¹
- Electrical and electronic technicians.¹
- Electricians.
- Industrial machine operators.¹
- Material handling equipment operators.¹
- Mechanics and repairers.¹
- Painters.¹
- Riggers and roustabouts.¹
- Stationary engineers.¹
- Welders.

¹Workers in these groups do not need to be trained if their work or the work of those supervise does not bring them or the employees they supervise close enough to exposed parts of electric circuits at 50 volts or more to ground for a hazard to exist.

6.1 Contents of Training.

Employees must be trained in and familiar with the safety-related work practices required by WAC 296-46B that pertain to their respective job assignments.

Employees who are not qualified persons must also be trained in and familiar with any electrically related safety practices not specifically addressed by WAC 296-46B but which are necessary for their safety.

Qualified persons (i.e., those permitted to work on or near exposed energized parts) must, at a minimum, be trained in and familiar with the following:

- The skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment

- The skills and techniques necessary to determine the nominal voltage of exposed live parts
- The clearance distance specified in WAC 296-24-960 and the corresponding voltages to which the qualified person will be exposed.

The training required by this section must be of the classroom or on-the-job type.
The degree of training provided must be determined by the risk to the employee.