

**WAC 296-155-447 Wiring design and protection. (1) Use and identification of grounded and grounding conductors.**

(a) **Identification of 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.

(b) **Polarity of connections.** You must not attach any grounded conductor to any terminal or lead so as to reverse designated polarity.

(c) **Use of grounding terminals and devices.** You must not use a grounding terminal or grounding-type device on a receptacle, cord connector, or attachment plug for purposes other than grounding.

**(2) Branch circuits.**

**(a) Ground-fault protection.**

(i) **General.** You must use either ground-fault circuit interrupters as specified in (a)(ii) of this subsection or an assured equipment grounding conductor program as specified in (a)(iii) of this subsection to protect employees on construction sites. These requirements are in addition to any other requirements for equipment grounding conductors.

(ii) **Ground-fault circuit interrupters.** All 120-volt, single-phase, 15-ampere and 20-ampere receptacle outlets on construction sites, which are not a part of the permanent wiring of the building or structure and which are in use by employees, must have approved ground-fault circuit interrupters for personnel protection. Receptacles on a two-wire, single-phase portable or vehicle-mounted generator rated not more than 5kW, where the circuit conductors of the generator are insulated from the generator frame and all other grounded surfaces, need not be protected with ground-fault circuit interrupters.

(iii) **Assured equipment grounding conductor program.** You must establish and implement an assured equipment grounding conductor program on construction sites covering all cord sets, receptacles which are not a part of the building or structure, and equipment connected by cord and plug which are available for use or used by employees. This program must comply with the following minimum requirements:

(A) A written description of the program, including the specific procedures adopted by you, must be available at the job site for inspection and copying by the director and any affected employee.

(B) You must designate one or more competent persons (as defined in WAC 296-155-012(4)) to implement the program, and to perform continuing tests and inspections as required.

(C) You must visually inspect each cord set, attachment cap, plug and receptacle of cord sets, and any equipment connected by cord and plug, except cord sets and receptacles which are fixed and not exposed to damage, before each day's use for external defects, such as deformed or missing pins or insulation damage, and for indications of possible internal damage. You must not use equipment found damaged or defective until repaired.

(D) You must perform the following tests on all cord sets, receptacles which are not a part of the permanent wiring of the building or structure, and cord-connected and plug-connected equipment required to be grounded:

(I) You must test all equipment grounding conductors for continuity and found to be electrically continuous.

(II) You must test each receptacle and attachment cap or plug for correct attachment of the equipment grounding conductor. The equipment grounding conductor must be connected to its proper terminal.

(III) You must test each outlet receptacle, or power source to ensure proper polarity.

(E) You must perform all required tests:

(I) Before first use;

(II) Before equipment is returned to service following any repairs;

(III) Before equipment is used after any incident which can be reasonably suspected to have caused damage (for example, when a cord set is run over); and

(IV) At intervals not to exceed 3 months, except that you must test cord sets and receptacles which are fixed and not exposed to damage at intervals not exceeding 6 months.

(F) You must not make available or permit the use by employees of any equipment which has not met the requirements of (a)(iii) of this subsection.

(G) You must record tests performed as required in this subsection. This test record must identify each receptacle, cord set, and cord-connected and plug-connected equipment that passed the test and must indicate the last date it was tested or the interval for which it was tested. You must keep this record by means of logs, color coding, or other effective means and you must maintain it until replaced by a more current record. You must make the record available on the job site for inspection by the director and any affected employee.

(b) **Outlet devices.** Outlet devices must have an ampere rating not less than the load to be served and must comply with the following:

(i) **Single receptacles.** A single receptacle installed on an individual branch circuit must have an ampere rating of not less than that of the branch circuit.

(ii) **Two or more receptacles.** Where connected to a branch circuit supplying two or more receptacles or outlets, receptacle ratings must conform to the values listed in Table I-4.

(iii) **Receptacles used for the connection of motors.** The rating of an attachment plug or receptacle used for cord-connection and plug-connection of a motor to a branch circuit must not exceed 15 amperes at 125 volts or 10 amperes at 250 volts if individual overload protection is omitted.

Table I-4  
Receptacle Ratings for Various Size  
Circuits

Circuit Rating Amperes	Receptacle Rating Amperes
15.....	Not Over 15
20.....	15 or 20
30.....	30
40.....	40 or 50
50.....	50

(3) **Outside conductors and lamps.**

(a) **600 volts, nominal, or less.** (a)(i) through (iv)(D) of this subsection apply to branch circuit, feeder, and service conductors rated 600 volts, nominal, or less and run outdoors as open conductors.

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

(A) **Power conductors below communication conductors:** 30 inches (762 mm).

(B) **Power conductors alone or above communication conductors:** 300 volts or less—24 inches (610 mm); more than 300 volts—30 inches (762 mm).

(C) **Communication conductors below power conductors:** With power conductors 300 volts or less—24 inches (610 mm); more than 300 volts—30 inches (762 mm).

(ii) **Clearance from ground.** Open conductors must conform to the following minimum clearances:

(A) 10 feet (3.05 m)—above finished grade, sidewalks, or from any platform or projection from which they might be reached.

(B) 12 feet (3.66 m)—over areas subject to vehicular traffic other than truck traffic.

(C) 15 feet (4.57 m)—over areas other than those specified in (a)(ii)(D) of this subsection that are subject to truck traffic.

(D) 18 feet (5.49 m)—over public streets, alleys, roads, and driveways.

(iii) **Clearance from building openings.** Conductors must have a clearance of at least 3 feet (914 mm) from windows, doors, 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 (914 mm) away.

(iv) **Clearance over roofs.** Conductors above roof space accessible to employees on foot must have a clearance from the highest point of the roof surface of not less than 8 feet (2.44 m) vertical clearance for insulated conductors, not less than 10 feet (3.05 m) vertical or diagonal clearance for covered conductors, and not less than 15 feet (4.57 m) for bare conductors, except that:

(A) Where the roof space is also accessible to vehicular traffic, the vertical clearance must not be less than 18 feet (5.49 m); or

(B) Where the roof space is not normally accessible to employees on foot, fully insulated conductors must have a vertical or diagonal clearance of not less than 3 feet (914 mm); or

(C) Where the voltage between conductors is 300 volts or less and the roof has a slope of not less than 4 inches (102 mm) in 12 inches (305 mm), the clearance from roofs must be at least 3 feet (914 mm); or

(D) Where the voltage between conductors is 300 volts or less and the conductors do not pass over more than 4 feet (1.22 m) of the overhang portion of the roof and they are terminated at a through-the-roof raceway or support, the clearance from roofs must be at least 18 inches (457 mm).

(b) **Location of outdoor lamps.** 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 relamping operations.

(4) **Services.**

(a) **Disconnecting means.**

(i) **General.** You must provide means 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.

(ii) **Simultaneous opening of poles.** Each service disconnecting means must simultaneously disconnect all ungrounded conductors.

(b) **Services over 600 volts, nominal.** The following additional requirements apply to services over 600 volts, nominal.

(i) **Guarding.** You must guard service-entrance conductors installed as open wires to make them accessible only to qualified persons.

(ii) **Warning signs.** You must post signs warning of high voltage where unauthorized employees might come in contact with live parts.

(5) **Overcurrent protection.**

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

(i) **Protection of conductors and equipment.** Conductors and equipment must be protected from overcurrent in accordance with their ability to safely conduct current. Conductors must have sufficient ampacity to carry the load.

(ii) **Grounded conductors.** Except for motor-running overload protection, overcurrent devices must not interrupt the continuity of the grounded conductor unless all conductors of the circuit are opened simultaneously.

(iii) **Disconnection of fuses and thermal cutouts.** Except for devices provided for current-limiting on the supply side of the service disconnecting means, all cartridge fuses which are accessible to other than qualified persons and all fuses and thermal cutouts on circuits over 150 volts to ground must be provided with disconnecting means. You must install this disconnecting means 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.

(iv) **Location in or on premises.** Overcurrent devices must be readily accessible. You must not locate overcurrent devices where they could create an employee safety hazard by being exposed to physical damage or located in the vicinity of easily ignitable material.

(v) **Arcing or suddenly moving parts.** You must locate or shield fuses and circuit breakers so that employees will not be burned or otherwise injured by their operation.

(vi) **Circuit breakers.**

(A) Circuit breakers must clearly indicate whether they are in the open (off) or closed (on) position.

(B) Where circuit breaker handles on switchboards are operated vertically rather than horizontally or rotationally, the up position of the handle must be the closed (on) position.

(C) If used as switches in 120-volt, fluorescent lighting circuits, circuit breakers must be marked "SWD."

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

(6) **Effective grounding.** The path from circuits, equipment, structures, and conduit or enclosures to ground must be permanent and continuous; have ample carrying capacity to conduct safely the currents liable to be imposed on it; and have the impedance sufficiently low to limit the potential above ground and to result in the operation of the overcurrent devices in the circuit. (a) through (k) of this subsection contain grounding requirements for systems, circuits, and equipment.

(a) **Systems to be grounded.** You must ground the following systems which supply premises wiring:

(i) **3-wire DC systems.** All 3-wire DC systems must have their neutral conductor grounded.

(ii) **2-wire DC systems.** 2-wire DC systems operating at over 50 volts through 300 volts between conductors must be grounded unless they are rectifier-derived from an AC system complying with (a)(iii), (iv), and (v) of this subsection.

(iii) **AC circuits, less than 50 volts.** 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.

(iv) **AC systems, 50 volts to 1000 volts.** AC systems of 50 volts to 1000 volts must be grounded under any of the following conditions, unless exempted by (a)(v) of this subsection:

(A) If the system can be so grounded that the maximum voltage to ground on the ungrounded conductors does not exceed 150 volts;

(B) If the system is nominally rated 480Y/277 volt, 3-phase, 4-wire in which the neutral is used as a circuit conductor;

(C) If the system is nominally rated 240/120 volt, 3-phase, 4-wire in which the midpoint of one phase is used as a circuit conductor; or

(D) If a service conductor is uninsulated.

(v) **Exceptions.** AC systems of 50 volts to 1000 volts are not required to be grounded if the system is separately derived and is supplied by a transformer that has a primary voltage rating less than 1000 volts, provided all of the following conditions are met:

(A) The system is used exclusively for control circuits;

(B) The conditions of maintenance and supervision assure that only qualified persons will service the installation;

(C) Continuity of control power is required; and

(D) Ground detectors are installed on the control system.

(b) **Separately derived systems.** Where (a) of this subsection requires grounding of wiring systems whose power is derived from generator, transformer, or converter windings and has no direct electrical connection, including a solidly connected grounded circuit conductor, to supply conductors originating in another system, (e) of this subsection must also apply.

(c) **Portable and vehicle-mounted generators.**

(i) **Portable generators.** Under the following conditions, the frame of a portable generator need not be grounded and may serve as the grounding electrode for a system supplied by the generator:

(A) The generator supplies only equipment mounted on the generator and/or cord-connected and plug-connected equipment through receptacles mounted on the generator; and

(B) The noncurrent-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame.

(ii) **Vehicle-mounted generators.** Under the following conditions the frame of a vehicle may serve as the grounding electrode for a system supplied by a generator located on the vehicle:

(A) The frame of the generator is bonded to the vehicle frame; and

(B) The generator supplies only equipment located on the vehicle and/or cord-connected and plug-connected equipment through receptacles mounted on the vehicle or on the generator; and

(C) The noncurrent-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame; and

(D) The system complies with all other provisions of this section.

(iii) **Neutral conductor bonding.** A neutral conductor must be bonded to the generator frame if the generator is a component of a separately derived system. No other conductor need be bonded to the generator frame.

(d) **Conductors to be grounded.** For AC premises wiring systems you must ground the identified conductor.

(e) **Grounding connections.**

(i) **Grounded system.** For a grounded system, you must use a grounding electrode conductor to connect both the equipment grounding conductor and the grounded circuit conductor to the grounding electrode. You must connect both the equipment grounding conductor and the grounding electrode conductor to the grounded circuit conductor on the supply side of the service disconnecting means, or on the supply side of the system disconnecting means or overcurrent devices if the system is separately derived.

(ii) **Ungrounded systems.** For an ungrounded service-supplied system, you must connect the equipment grounding conductor to the grounding electrode conductor at the service equipment. For an ungrounded separately derived system, you must connect the equipment grounding conductor to the grounding electrode conductor at, or ahead of, the system disconnecting means or overcurrent devices.

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

(g) **Supports, enclosures, and equipment to be grounded.**

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

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

(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 of the following conditions are met:

(I) Runs are less than 25 feet (7.62 m);

(II) Enclosures are free from probable contact with ground, grounded metal, metal laths, or other conductive materials; and

(III) Enclosures are guarded against employee contact.

(ii) **Service equipment enclosures.** Metal enclosures for service equipment must be grounded.

(iii) **Fixed equipment.** Exposed noncurrent-carrying metal parts of fixed equipment which may become energized must be grounded under any of the following conditions:

(A) If within 8 feet (2.44 m) vertically or 5 feet (1.52 m) horizontally of ground or grounded metal objects and subject to employee contact.

(B) If located in a wet or damp location and subject to employee contact.

(C) If in electrical contact with metal.

(D) If in a hazardous (classified) location.

(E) If supplied by a metal-clad, metal-sheathed, or grounded metal raceway wiring method.

(F) If equipment operates with any terminal at over 150 volts to ground; however, the following need not be grounded:

(I) Enclosures for switches or circuit breakers used for other than service equipment and accessible to qualified persons only;

(II) Metal frames of electrically heated appliances which are permanently and effectively insulated from ground; and

(III) The cases of distribution apparatus such as transformers and capacitors mounted on wooden poles at a height exceeding 8 feet (2.44 m) above ground or grade level.

(iv) **Equipment connected by cord and plug.** Under any of the conditions described in (g)(iv) (A) through (C) of this subsection, exposed noncurrent-carrying metal parts of cord-connected and plug-connected equipment which may become energized must be grounded:

(A) If in a hazardous (classified) location (see WAC 296-155-444).

(B) If operated at over 150 volts to ground, except for guarded motors and metal frames of electrically heated appliances if the appliance frames are permanently and effectively insulated from ground.

(C) If the equipment is one of the types listed in (g)(iv)(C)(I) through (V) of this subsection. However, even though the equipment may be one of these types, it need not be grounded if it is exempted by (g)(iv)(C)(VI) of this subsection.

(I) Hand held motor-operated tools;

(II) Cord-connected and plug-connected equipment 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;

(III) Portable and mobile X-ray and associated equipment;

(IV) Tools likely to be used in wet and/or conductive locations; and

(V) Portable hand lamps.

(VI) Tools likely to be used in wet and/or 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 a system of double insulation, or its equivalent, need not be grounded. If such a system is employed, you must distinctively mark the equipment to indicate that the tool or appliance utilizes a system of double insulation.

(v) **Nonelectrical equipment.** The metal parts of the following nonelectrical equipment must be grounded: Frames and tracks of electrically operated cranes; frames of nonelectrically 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 1 kV between conductors.

(h) **Methods of grounding equipment.**

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

(ii) **Grounding conductor.** A conductor used for grounding fixed or movable equipment must have capacity to conduct safely any fault current which may be imposed on it.

(iii) **Equipment considered effectively grounded.** 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 noncurrent-carrying metal parts of fixed equipment in (h)(i) of this subsection. Metal car frames supported by metal hoisting cables attached to or running over metal sheaves or

drums of grounded elevator machines are also considered to be effectively grounded.

(i) **Bonding.**

(i) If bonding conductors are used to assure electrical continuity, they must have the capacity to conduct any fault current which may be imposed.

(ii) When attaching bonding and grounding clamps or clips, you must make a secure and positive metal-to-metal contact. You must make such attachments before closures are opened and material movements are started and they must not be broken until after material movements are stopped and closures are made.

(j) **Made electrodes.** If made electrodes are used, they must be free from nonconductive coatings, such as paint or enamel; and, if practicable, they must be embedded below permanent moisture level. A single electrode consisting of a rod, pipe or plate which has a resistance to ground greater than 25 ohms must be augmented by one additional electrode installed no closer than 6 feet (1.83 m) to the first electrode.

(k) **Grounding of systems and circuits of 1000 volts and over (high voltage).**

(i) **General.** If high voltage systems are grounded, they must comply with all applicable provisions of (a) through (j) of this subsection as supplemented and modified by (k) of this subsection.

(ii) **Grounding of systems supplying portable or mobile equipment.** Systems supplying portable or mobile high voltage equipment, other than substations installed on a temporary basis, must comply with the following:

(A) Portable and mobile high voltage equipment must be supplied from a system having its neutral grounded through an impedance. If a delta-connected high voltage system is used to supply the equipment, a system neutral must be derived.

(B) You must connect exposed noncurrent-carrying metal parts of portable and mobile equipment by an equipment grounding conductor to the point at which the system neutral impedance is grounded.

(C) You must provide ground-fault detection and relaying to automatically deenergize any high voltage system component which has developed a ground fault. You must continuously monitor the continuity of the equipment grounding conductor so as to deenergize automatically the high voltage feeder to the portable equipment upon loss of continuity of the equipment grounding conductor.

(D) The grounding electrode to which the portable or mobile equipment system neutral impedance is connected must be isolated from and separated in the ground by at least 20 feet (6.1 m) from any other system or equipment grounding electrode, and there must be no direct connection between the grounding electrodes, such as buried pipe, fence or like objects.

(iii) **Grounding of equipment.** All noncurrent-carrying metal parts of portable equipment and fixed equipment including their associated fences, housings, enclosures, and supporting structures must be grounded. However, equipment which is guarded by location and isolated from ground need not be grounded. Additionally, pole-mounted distribution apparatus at a height exceeding 8 feet (2.44 m) above ground or grade level need not be grounded.

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