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(v) Previous to making repairs involving welding, soldering, or other hot work or other operations which produce a source of ignition, the carbide charge and feed mechanism shall be completely removed. All acetylene shall be expelled by completely flooding the generator shell with water and the generator shall be disconnected from the piping system. The generator shall be kept filled with water, if possible, or positioned to hold as much water as possible.

(vi) Hot repairs shall not be made in a room where there are other generators unless all the generators and piping have been purged of acetylene.

(g) *Calcium carbide storage*—(1) *Packaging.* (i) Calcium carbide shall be contained in metal packages of sufficient strength to prevent rupture. The packages shall be provided with a screw top or equivalent. These packages shall be constructed water- and air-tight. Solder shall not be used in such a manner that the package would fail if exposed to fire.

(ii) Packages containing calcium carbide shall be conspicuously marked “Calcium Carbide—Dangerous If Not Kept Dry” or with equivalent warning.

(iii) Caution: Metal tools, even the so-called spark resistant type may cause ignition of an acetylene and air mixture when opening carbide containers.

(iv) Sprinkler systems shall not be installed in carbide storage rooms.

(2) *Storage indoors.* (i) Calcium carbide in quantities not to exceed 600 pounds (272.2 kg) may be stored indoors in dry, waterproof, and well-ventilated locations.

(A) Calcium carbide not exceeding 600 pounds (272.2 kg) may be stored indoors in the same room with fuel-gas cylinders.

(B) Packages of calcium carbide, except for one of each size, shall be kept sealed. The seals shall not be broken when there is carbide in excess of 1 pound (0.5 kg) in any other unsealed package of the same size of carbide in the room.

(ii) Calcium carbide exceeding 600 pounds (272.2 kg) but not exceeding 5,000 pounds (2,268 kg) shall be stored:

(A) In accordance with paragraph (g)(2)(iii) of this section;

(B) In an inside generator room or outside generator house; or

(C) In a separate room in a one-story building which may contain other occupancies, but without cellar or basement beneath the carbide storage section. Such rooms shall be constructed in accordance with paragraphs (f)(6)(i)(H) and (f)(6)(i)(I) of this section and ventilated in accordance with paragraph (f)(6)(ii) of this section. These rooms shall be used for no other purpose.

(iii) Calcium carbide in excess of 5,000 pounds (2,268 kg) shall be stored in one-story buildings without cellar or basement and used for no other purpose, or in outside generator houses. If the storage building is of noncombustible construction, it may adjoin other one-story buildings if separated therefrom by unpierced firewalls; if it is detached less than 10 feet (3 m) from such building or buildings, there shall be no opening in any of the mutually exposing sides of such buildings within 10 feet (3 m). If the storage building is of combustible construction, it shall be at least 20 feet (6.1 m) from any other one- or two-story building, and at least 30 feet (9.1 m) from any other building exceeding two stories.

(3) *Storage outdoors.* (i) Calcium carbide in unopened metal containers may be stored outdoors.

(ii) Carbide containers to be stored outdoors shall be examined to make sure that they are in good condition. Periodic reexaminations shall be made for rusting or other damage to a container that might affect its water or air tightness.

(iii) The bottom tier of each row shall be placed on wooden planking or equivalent, so that the containers will not come in contact with the ground or ground water.

(iv) Containers of carbide which have been in storage the longest shall be used first.

[55 FR 13696, Apr. 11, 1990, as amended at 55 FR 32015, Aug 6, 1990; 55 FR 46053, Nov. 1, 1990; 61 FR 9241, Mar. 7, 1996]

§ 1910.254 Arc welding and cutting.

(a) *General*—(1) *Equipment selection.* Welding equipment shall be chosen for safe application to the work to be done

as specified in paragraph (b) of this section.

(2) *Installation.* Welding equipment shall be installed safely as specified by paragraph (c) of this section.

(3) *Instruction.* Workmen designated to operate arc welding equipment shall have been properly instructed and qualified to operate such equipment as specified in paragraph (d) of this section.

(b) *Application of arc welding equipment—(1) General.* Assurance of consideration of safety in design is obtainable by choosing apparatus complying with the Requirements for Electric Arc-Welding Apparatus, NEMA EW-1-1962, National Electrical Manufacturers Association or the Safety Standard for Transformer-Type Arc-Welding Machines, ANSI C33.2-1956, Underwriters' Laboratories, both of which are incorporated by reference as specified in § 1910.6.

(2) *Environmental conditions.* (i) Standard machines for arc welding service shall be designed and constructed to carry their rated load with rated temperature rises where the temperature of the cooling air does not exceed 40 °C (104 °F) and where the altitude does not exceed 3,300 feet (1,005.8 m), and shall be suitable for operation in atmospheres containing gases, dust, and light rays produced by the welding arc.

(ii) Unusual service conditions may exist, and in such circumstances machines shall be especially designed to safely meet the requirements of the service. Chief among these conditions are:

(A) Exposure to unusually corrosive fumes.

(B) Exposure to steam or excessive humidity.

(C) Exposure to excessive oil vapor.

(D) Exposure to flammable gases.

(E) Exposure to abnormal vibration or shock.

(F) Exposure to excessive dust.

(G) Exposure to weather.

(H) Exposure to unusual seacoast or shipboard conditions.

(3) *Voltage.* The following limits shall not be exceeded:

(i) Alternating-current machines

(A) Manual arc welding and cutting—80 volts.

(B) Automatic (machine or mechanized) arc welding and cutting—100 volts.

(ii) Direct-current machines

(A) Manual arc welding and cutting—100 volts.

(B) Automatic (machine or mechanized) arc welding and cutting—100 volts.

(iii) When special welding and cutting processes require values of open circuit voltages higher than the above, means shall be provided to prevent the operator from making accidental contact with the high voltage by adequate insulation or other means.

(iv) For a.c. welding under wet conditions or warm surroundings where perspiration is a factor, the use of reliable automatic controls for reducing no load voltage is recommended to reduce the shock hazard.

(4) *Design.* (i) A controller integrally mounted in an electric motor driven welder shall have capacity for carrying rated motor current, shall be capable of making and interrupting stalled rotor current of the motor, and may serve as the running overcurrent device if provided with the number of overcurrent units as specified by subpart S of this part.

(ii) On all types of arc welding machines, control apparatus shall be enclosed except for the operating wheels, levers, or handles.

(iii) Input power terminals, tap change devices and live metal parts connected to input circuits shall be completely enclosed and accessible only by means of tools.

(iv) Terminals for welding leads should be protected from accidental electrical contact by personnel or by metal objects, i.e., vehicles, crane hooks, etc. Protection may be obtained by use of: Dead-front receptacles for plug connections; recessed openings with nonremovable hinged covers; heavy insulating sleeving or taping or other equivalent electrical and mechanical protection. If a welding lead terminal which is intended to be used exclusively for connection to the work is connected to the grounded enclosure, it must be done by a conductor at least two AWG sizes smaller than the grounding conductor and the terminal

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shall be marked to indicate that it is grounded.

(v) No connections for portable control devices such as push buttons to be carried by the operator shall be connected to an a.c. circuit of higher than 120 volts. Exposed metal parts of portable control devices operating on circuits above 50 volts shall be grounded by a grounding conductor in the control cable.

(vi) Auto transformers or a.c. reactors shall not be used to draw welding current directly from any a.c. power source having a voltage exceeding 80 volts.

(c) *Installation of arc welding equipment*—(1) *General.* Installation including power supply shall be in accordance with the requirements of subpart S of this part.

(2) *Grounding.* (i) The frame or case of the welding machine (except engine-driven machines) shall be grounded under the conditions and according to the methods prescribed in subpart S of this part.

(ii) Conduits containing electrical conductors shall not be used for completing a work-lead circuit. Pipelines shall not be used as a permanent part of a work-lead circuit, but may be used during construction, extension or repair providing current is not carried through threaded joints, flanged bolted joints, or caulked joints and that special precautions are used to avoid sparking at connection of the work-lead cable.

(iii) Chains, wire ropes, cranes, hoists, and elevators shall not be used to carry welding current.

(iv) Where a structure, conveyor, or fixture is regularly employed as a welding current return circuit, joints shall be bonded or provided with adequate current collecting devices.

(v) All ground connections shall be checked to determine that they are mechanically strong and electrically adequate for the required current.

(3) *Supply connections and conductors.* (i) A disconnecting switch or controller shall be provided at or near each welding machine which is not equipped with such a switch or controller mounted as an integral part of the machine. The switch shall be in accordance with subpart S of this part. Overcurrent protec-

tion shall be provided as specified in subpart S of this part. A disconnect switch with overload protection or equivalent disconnect and protection means, permitted by subpart S of this part, shall be provided for each outlet intended for connection to a portable welding machine.

(ii) For individual welding machines, the rated current-carrying capacity of the supply conductors shall be not less than the rated primary current of the welding machines.

(iii) For groups of welding machines, the rated current-carrying capacity of conductors may be less than the sum of the rated primary currents of the welding machines supplied. The conductor rating shall be determined in each case according to the machine loading based on the use to be made of each welding machine and the allowance permissible in the event that all the welding machines supplied by the conductors will not be in use at the same time.

(iv) In operations involving several welders on one structure, d.c. welding process requirements may require the use of both polarities; or supply circuit limitations for a.c. welding may require distribution of machines among the phases of the supply circuit. In such cases no load voltages between electrode holders will be 2 times normal in d.c. or 1, 1.41, 1.73, or 2 times normal on a.c. machines. Similar voltage differences will exist if both a.c. and d.c. welding are done on the same structure.

(A) All d.c. machines shall be connected with the same polarity.

(B) All a.c. machines shall be connected to the same phase of the supply circuit and with the same instantaneous polarity.

(d) *Operation and maintenance*—(1) *General.* Workers assigned to operate or maintain arc welding equipment shall be acquainted with the requirements of this section and with 1910.252 (a), (b), and (c) of this part.

(2) *Machine hook up.* Before starting operations all connections to the machine shall be checked to make certain they are properly made. The work lead shall be firmly attached to the work; magnetic work clamps shall be freed from adherent metal particles of spatter on contact surfaces. Coiled welding

cable shall be spread out before use to avoid serious overheating and damage to insulation.

(3) *Grounding.* Grounding of the welding machine frame shall be checked. Special attention shall be given to safety ground connections of portable machines.

(4) *Leaks.* There shall be no leaks of cooling water, shielding gas or engine fuel.

(5) *Switches.* It shall be determined that proper switching equipment for shutting down the machine is provided.

(6) *Manufacturers' instructions.* Printed rules and instructions covering operation of equipment supplied by the manufacturers shall be strictly followed.

(7) *Electrode holders.* Electrode holders when not in use shall be so placed that they cannot make electrical contact with persons, conducting objects, fuel or compressed gas tanks.

(8) *Electric shock.* Cables with splices within 10 feet (3 m) of the holder shall not be used. The welder should not coil or loop welding electrode cable around parts of his body.

(9) *Maintenance.* (i) The operator should report any equipment defect or safety hazard to his supervisor and the use of the equipment shall be discontinued until its safety has been assured. Repairs shall be made only by qualified personnel.

(ii) Machines which have become wet shall be thoroughly dried and tested before being used.

(iii) Cables with damaged insulation or exposed bare conductors shall be replaced. Joining lengths of work and electrode cables shall be done by the use of connecting means specifically intended for the purpose. The connecting means shall have insulation adequate for the service conditions.

[55 FR 13696, Apr. 11, 1990, as amended at 61 FR 9241, Mar. 7, 1996; 70 FR 53929, Sept. 13, 2005]

§ 1910.255 Resistance welding.

(a) *General*—(1) *Installation.* All equipment shall be installed by a qualified electrician in conformance with subpart S of this part. There shall be a safety-type disconnecting switch or a circuit breaker or circuit interrupter to open each power circuit to the ma-

chine, conveniently located at or near the machine, so that the power can be shut off when the machine or its controls are to be serviced.

(2) *Thermal protection.* Ignitron tubes used in resistance welding equipment shall be equipped with a thermal protection switch.

(3) *Personnel.* Workmen designated to operate resistance welding equipment shall have been properly instructed and judged competent to operate such equipment.

(4) *Guarding.* Controls of all automatic or air and hydraulic clamps shall be arranged or guarded to prevent the operator from accidentally activating them.

(b) *Spot and seam welding machines (nonportable)*—(1) *Voltage.* All external weld initiating control circuits shall operate on low voltage, not over 120 volts, for the safety of the operators.

(2) *Capacitor welding.* Stored energy or capacitor discharge type of resistance welding equipment and control panels involving high voltage (over 550 volts) shall be suitably insulated and protected by complete enclosures, all doors of which shall be provided with suitable interlocks and contacts wired into the control circuit (similar to elevator interlocks). Such interlocks or contacts shall be so designed as to effectively interrupt power and short circuit all capacitors when the door or panel is open. A manually operated switch or suitable positive device shall be installed, in addition to the mechanical interlocks or contacts, as an added safety measure assuring absolute discharge of all capacitors.

(3) *Interlocks.* All doors and access panels of all resistance welding machines and control panels shall be kept locked and interlocked to prevent access, by unauthorized persons, to live portions of the equipment.

(4) *Guarding.* All press welding machine operations, where there is a possibility of the operator's fingers being under the point of operation, shall be effectively guarded by the use of a device such as an electronic eye safety circuit, two hand controls or protection similar to that prescribed for punch press operation, §1910.217 of this part. All chains, gears, operating bus linkage, and belts shall be protected by