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located that no vapors from these operations will reach or be drawn into the atmosphere surrounding any welding operation. In addition, trichloroethylene and perchlorethylene should be kept out of atmospheres penetrated by the ultraviolet radiation of gas-shielded welding operations.

(12) *Cutting of stainless steels.* Oxygen cutting, using either a chemical flux or iron powder or gas-shielded arc cutting of stainless steel, shall be done using mechanical ventilation adequate to remove the fumes generated.

(13) *First-aid equipment.* First-aid equipment shall be available at all times. All injuries shall be reported as soon as possible for medical attention. First aid shall be rendered until medical attention can be provided.

(d) *Industrial applications—(1) Transmission pipeline—(i) General.* The requirements of paragraphs (b) and (c) of this section and §1910.254 of this part shall be observed.

(ii) *Field shop operations.* Where field shop operations are involved for fabrication of fittings, river crossings, road crossings, and pumping and compressor stations the requirements of paragraphs (a), (b), and (c) of this section and §§1910.253 and 1910.254 of this part shall be observed.

(iii) *Electric shock.* When arc welding is performed in wet conditions, or under conditions of high humidity, special protection against electric shock shall be supplied.

(iv) *Pressure testing.* In pressure testing of pipelines, the workers and the public shall be protected against injury by the blowing out of closures or other pressure restraining devices. Also, protection shall be provided against expulsion of loose dirt that may have become trapped in the pipe.

(v) *Construction standards.* The welded construction of transmission pipelines shall be conducted in accordance with the Standard for Welding Pipe Lines and Related Facilities, API Std. 1104—1968, which is incorporated by reference as specified in §1910.6.

(vi) *Flammable substance lines.* The connection, by welding, of branches to pipelines carrying flammable substances shall be performed in accordance with Welding or Hot Tapping on Equipment Containing Flammables,

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API Std. PSD No. 2201—1963, which is incorporated by reference as specified in §1910.6.

(vii) *X-ray inspection.* The use of X-rays and radioactive isotopes for the inspection of welded pipeline joints shall be carried out in conformance with the American National Standard Safety Standard for Non-Medical X-ray and Sealed Gamma-Ray Sources, ANSI Z54.1—1963, which is incorporated by reference as specified in §1910.6.

(2) *Mechanical piping systems—(i) General.* The requirements of paragraphs (a), (b), and (c) of this section and §§1910.253 and 1910.254 of this part shall be observed.

(ii) *X-ray inspection.* The use of X-rays and radioactive isotopes for the inspection of welded piping joints shall be in conformance with the American National Standard Safety Standard for Non-Medical X-ray and Sealed Gamma-Ray Sources, ANSI Z54.1—1963.

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## § 1910.253 Oxygen-fuel gas welding and cutting.

(a) *General requirements—(1) Flammable mixture.* Mixtures of fuel gases and air or oxygen may be explosive and shall be guarded against. No device or attachment facilitating or permitting mixtures of air or oxygen with flammable gases prior to consumption, except at the burner or in a standard torch, shall be allowed unless approved for the purpose.

(2) *Maximum pressure.* Under no condition shall acetylene be generated, piped (except in approved cylinder manifolds) or utilized at a pressure in excess of 15 psig (103 kPa gauge pressure) or 30 psia (206 kPa absolute). The 30 psia (206 kPa absolute) limit is intended to prevent unsafe use of acetylene in pressurized chambers such as caissons, underground excavations or tunnel construction.) This requirement is not intended to apply to storage of acetylene dissolved in a suitable solvent in cylinders manufactured and maintained according to U.S. Department of Transportation requirements, or to acetylene for chemical use. The

use of liquid acetylene shall be prohibited.

(3) *Apparatus.* Only approved apparatus such as torches, regulators or pressure-reducing valves, acetylene generators, and manifolds shall be used.

(4) *Personnel.* Workmen in charge of the oxygen or fuel-gas supply equipment, including generators, and oxygen or fuel-gas distribution piping systems shall be instructed and judged competent by their employers for this important work before being left in charge. Rules and instructions covering the operation and maintenance of oxygen or fuel-gas supply equipment including generators, and oxygen or fuel-gas distribution piping systems shall be readily available.

(b) *Cylinders and containers*—(1) *Approval and marking.* (i) All portable cylinders used for the storage and shipment of compressed gases shall be constructed and maintained in accordance with the regulations of the U.S. Department of Transportation, 49 CFR parts 171–179.

(ii) Compressed gas cylinders shall be legibly marked, for the purpose of identifying the gas content, with either the chemical or the trade name of the gas. Such marking shall be by means of stenciling, stamping, or labeling, and shall not be readily removable. Whenever practical, the marking shall be located on the shoulder of the cylinder.

(iii) Compressed gas cylinders shall be equipped with connections complying with the American National Standard Compressed Gas Cylinder Valve Outlet and Inlet Connections, ANSI B57.1—1965, which is incorporated by reference as specified in § 1910.6.

(iv) All cylinders with a water weight capacity of over 30 pounds (13.6 kg) shall be equipped with means of connecting a valve protection cap or with a collar or recess to protect the valve.

(2) *Storage of cylinders—general.* (i) Cylinders shall be kept away from radiators and other sources of heat.

(ii) Inside of buildings, cylinders shall be stored in a well-protected, well-ventilated, dry location, at least 20 feet (6.1 m) from highly combustible materials such as oil or excelsior. Cylinders should be stored in definitely assigned places away from elevators,

stairs, or gangways. Assigned storage spaces shall be located where cylinders will not be knocked over or damaged by passing or falling objects, or subject to tampering by unauthorized persons. Cylinders shall not be kept in unventilated enclosures such as lockers and cupboards.

(iii) Empty cylinders shall have their valves closed.

(iv) Valve protection caps, where cylinder is designed to accept a cap, shall always be in place, hand-tight, except when cylinders are in use or connected for use.

(3) *Fuel-gas cylinder storage.* Inside a building, cylinders, except those in actual use or attached ready for use, shall be limited to a total gas capacity of 2,000 cubic feet (56 m<sup>3</sup>) or 300 pounds (135.9 kg) of liquefied petroleum gas.

(i) For storage in excess of 2,000 cubic feet (56 m<sup>3</sup>) total gas capacity of cylinders or 300 (135.9 kg) pounds of liquefied petroleum gas, a separate room or compartment conforming to the requirements specified in paragraphs (f)(6)(i)(H) and (f)(6)(i)(I) of this section shall be provided, or cylinders shall be kept outside or in a special building. Special buildings, rooms or compartments shall have no open flame for heating or lighting and shall be well ventilated. They may also be used for storage of calcium carbide in quantities not to exceed 600 (271.8 kg) pounds, when contained in metal containers complying with paragraphs (g)(1)(i) and (g)(1)(ii) of this section.

(ii) Acetylene cylinders shall be stored valve end up.

(4) *Oxygen storage.* (i) Oxygen cylinders shall not be stored near highly combustible material, especially oil and grease; or near reserve stocks of carbide and acetylene or other fuel-gas cylinders, or near any other substance likely to cause or accelerate fire; or in an acetylene generator compartment.

(ii) Oxygen cylinders stored in outside generator houses shall be separated from the generator or carbide storage rooms by a noncombustible partition having a fire-resistance rating of at least 1 hour. This partition shall be without openings and shall be gastight.

(iii) Oxygen cylinders in storage shall be separated from fuel-gas cylinders or

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combustible materials (especially oil or grease), a minimum distance of 20 feet (6.1 m) or by a noncombustible barrier at least 5 feet (1.5 m) high having a fire-resistance rating of at least one-half hour.

(iv) Where a liquid oxygen system is to be used to supply gaseous oxygen for welding or cutting and the system has a storage capacity of more than 13,000 cubic feet (364 m<sup>3</sup>) of oxygen (measured at 14.7 psia (101 kPa) and 70 °F (21.1 °C)), connected in service or ready for service, or more than 25,000 cubic feet (700 m<sup>3</sup>) of oxygen (measured at 14.7 psia (101 kPa) and 70 °F (21.1 °C)), including unconnected reserves on hand at the site, it shall comply with the provisions of the Standard for Bulk Oxygen Systems at Consumer Sites, NFPA No. 566—1965, which is incorporated by reference as specified in §1910.6.

(5) *Operating procedures.* (i) Cylinders, cylinder valves, couplings, regulators, hose, and apparatus shall be kept free from oily or greasy substances. Oxygen cylinders or apparatus shall not be handled with oily hands or gloves. A jet of oxygen must never be permitted to strike an oily surface, greasy clothes, or enter a fuel oil or other storage tank.

(ii)(A) When transporting cylinders by a crane or derrick, a cradle, boat, or suitable platform shall be used. Slings or electric magnets shall not be used for this purpose. Valve-protection caps, where cylinder is designed to accept a cap, shall always be in place.

(B) Cylinders shall not be dropped or struck or permitted to strike each other violently.

(C) Valve-protection caps shall not be used for lifting cylinders from one vertical position to another. Bars shall not be used under valves or valve-protection caps to pry cylinders loose when frozen to the ground or otherwise fixed; the use of warm (not boiling) water is recommended. Valve-protection caps are designed to protect cylinder valves from damage.

(D) Unless cylinders are secured on a special truck, regulators shall be removed and valve-protection caps, when provided for, shall be put in place before cylinders are moved.

(E) Cylinders not having fixed hand wheels shall have keys, handles, or nonadjustable wrenches on valve stems while these cylinders are in service. In multiple cylinder installations only one key or handle is required for each manifold.

(F) Cylinder valves shall be closed before moving cylinders.

(G) Cylinder valves shall be closed when work is finished.

(H) Valves of empty cylinders shall be closed.

(I) Cylinders shall be kept far enough away from the actual welding or cutting operation so that sparks, hot slag, or flame will not reach them, or fire-resistant shields shall be provided.

(J) Cylinders shall not be placed where they might become part of an electric circuit. Contacts with third rails, trolley wires, etc., shall be avoided. Cylinders shall be kept away from radiators, piping systems, layout tables, etc., that may be used for grounding electric circuits such as for arc welding machines. Any practice such as the tapping of an electrode against a cylinder to strike an arc shall be prohibited.

(K) Cylinders shall never be used as rollers or supports, whether full or empty.

(L) The numbers and markings stamped into cylinders shall not be tampered with.

(M) No person, other than the gas supplier, shall attempt to mix gases in a cylinder. No one, except the owner of the cylinder or person authorized by him, shall refill a cylinder.

(N) No one shall tamper with safety devices in cylinders or valves.

(O) Cylinders shall not be dropped or otherwise roughly handled.

(P) Unless connected to a manifold, oxygen from a cylinder shall not be used without first attaching an oxygen regulator to the cylinder valve. Before connecting the regulator to the cylinder valve, the valve shall be opened slightly for an instant and then closed. Always stand to one side of the outlet when opening the cylinder valve.

(Q) A hammer or wrench shall not be used to open cylinder valves. If valves cannot be opened by hand, the supplier shall be notified.

(R)(I) Cylinder valves shall not be tampered with nor should any attempt be made to repair them. If trouble is experienced, the supplier should be sent a report promptly indicating the character of the trouble and the cylinder's serial number. Supplier's instructions as to its disposition shall be followed.

(2) Complete removal of the stem from a diaphragm-type cylinder valve shall be avoided.

(iii)(A) Fuel-gas cylinders shall be placed with valve end up whenever they are in use. Liquefied gases shall be stored and shipped with the valve end up.

(B) Cylinders shall be handled carefully. Rough handling, knocks, or falls are liable to damage the cylinder, valve or safety devices and cause leakage.

(C) Before connecting a regulator to a cylinder valve, the valve shall be opened slightly and closed immediately. The valve shall be opened while standing to one side of the outlet; never in front of it. Never crack a fuel-gas cylinder valve near other welding work or near sparks, flame, or other possible sources of ignition.

(D) Before a regulator is removed from a cylinder valve, the cylinder valve shall be closed and the gas released from the regulator.

(E) Nothing shall be placed on top of an acetylene cylinder when in use which may damage the safety device or interfere with the quick closing of the valve.

(F) If cylinders are found to have leaky valves or fittings which cannot be stopped by closing of the valve, the cylinders shall be taken outdoors away from sources of ignition and slowly emptied.

(G) A warning should be placed near cylinders having leaking fuse plugs or other leaking safety devices not to approach them with a lighted cigarette or other source of ignition. Such cylinders should be plainly tagged; the supplier should be promptly notified and his instructions followed as to their return.

(H) Safety devices shall not be tampered with.

(I) Fuel-gas shall never be used from cylinders through torches or other devices equipped with shutoff valves

without reducing the pressure through a suitable regulator attached to the cylinder valve or manifold.

(J) The cylinder valve shall always be opened slowly.

(K) An acetylene cylinder valve shall not be opened more than one and one-half turns of the spindle, and preferably no more than three-fourths of a turn.

(L) Where a special wrench is required it shall be left in position on the stem of the valve while the cylinder is in use so that the fuel-gas flow can be quickly turned off in case of emergency. In the case of manifolded or coupled cylinders at least one such wrench shall always be available for immediate use.

(c) *Manifolding of cylinders*—(1) *Fuel-gas manifolds*. (i) Manifolds shall be approved either separately for each component part or as an assembled unit.

(ii) Except as provided in paragraph (c)(1)(iii) of this section fuel-gas cylinders connected to one manifold inside a building shall be limited to a total capacity not exceeding 300 pounds (135.9 kg) of liquefied petroleum gas or 3,000 cubic feet (84 m<sup>3</sup>) of other fuel-gas. More than one such manifold with connected cylinders may be located in the same room provided the manifolds are at least 50 feet (15 m) apart or separated by a noncombustible barrier at least 5 feet (1.5 m) high having a fire-resistance rating of at least one-half hour.

(iii) Fuel-gas cylinders connected to one manifold having an aggregate capacity exceeding 300 pounds (135.9 kg) of liquefied petroleum gas or 3,000 cubic feet (84 m<sup>3</sup>) of other fuel-gas shall be located outdoors, or in a separate building or room constructed in accordance with paragraphs (f)(6)(i)(H) and (f)(6)(i)(I) of this section.

(iv) Separate manifold buildings or rooms may also be used for the storage of drums of calcium carbide and cylinders containing fuel gases as provided in paragraph (b)(3) of this section. Such buildings or rooms shall have no open flames for heating or lighting and shall be well-ventilated.

(v) High-pressure fuel-gas manifolds shall be provided with approved pressure regulating devices.

(2) *High-pressure oxygen manifolds (for use with cylinders having a Department of Transportation service pressure above 200 psig (1.36 MPa)).* (i) Manifolds shall be approved either separately for each component part or as an assembled unit.

(ii) Oxygen manifolds shall not be located in an acetylene generator room. Oxygen manifolds shall be separated from fuel-gas cylinders or combustible materials (especially oil or grease), a minimum distance of 20 feet (6.1 m) or by a noncombustible barrier at least 5 feet (1.5 m) high having a fire-resistance rating of at least one-half hour.

(iii) Except as provided in paragraph (c)(2)(iv) of this section, oxygen cylinders connected to one manifold shall be limited to a total gas capacity of 6,000 cubic feet (168 m<sup>3</sup>). More than one such manifold with connected cylinders may be located in the same room provided the manifolds are at least 50 feet (15 m) apart or separated by a noncombustible barrier at least 5 feet (1.5 m) high having a fire-resistance rating of at least one-half hour.

(iv) An oxygen manifold, to which cylinders having an aggregate capacity of more than 6,000 cubic feet (168 m<sup>3</sup>) of oxygen are connected, should be located outdoors or in a separate noncombustible building. Such a manifold, if located inside a building having other occupancy, shall be located in a separate room of noncombustible construction having a fire-resistance rating of at least one-half hour or in an area with no combustible material within 20 feet (6.1 m) of the manifold.

(v) An oxygen manifold or oxygen bulk supply system which has storage capacity of more than 13,000 cubic feet (364 m<sup>3</sup>) of oxygen (measured at 14.7 psia (101 kPa) and 70 °F (21.1 °C)), connected in service or ready for service, or more than 25,000 cubic feet (700 m<sup>3</sup>) of oxygen (measured at 14.7 psia (101 kPa) and 70 °F (21.1 °C)), including unconnected reserves on hand at the site, shall comply with the provisions of the Standard for Bulk Oxygen Systems at Consumer Sites, NFPA No. 566–1965.

(vi) High-pressure oxygen manifolds shall be provided with approved pressure-regulating devices.

(3) *Low-pressure oxygen manifolds (for use with cylinders having a Department of Transportation service pressure not exceeding 200 psig (1.36 MPa)).* (i) Manifolds shall be of substantial construction suitable for use with oxygen at a pressure of 250 psig (1.7 MPa). They shall have a minimum bursting pressure of 1,000 psig (6.8 MPa) and shall be protected by a safety relief device which will relieve at a maximum pressure of 500 psig (3.4 MPa). DOT-4L200 cylinders have safety devices which relieve at a maximum pressure of 250 psig (1.7 MPa) (or 235 psig (1.6 MPa) if vacuum insulation is used).

(ii) Hose and hose connections subject to cylinder pressure shall comply with paragraph (e)(5) of this section. Hose shall have a minimum bursting pressure of 1,000 psig (6.8 MPa).

(iii) The assembled manifold including leads shall be tested and proven gas-tight at a pressure of 300 psig (2.04 MPa). The fluid used for testing oxygen manifolds shall be oil-free and not combustible.

(iv) The location of manifolds shall comply with paragraphs (c)(2)(ii), (c)(2)(iii), (c)(2)(iv), and (c)(2)(v) of this section.

(v) The following sign shall be conspicuously posted at each manifold:

Low-Pressure Manifold

Do Not Connect High-Pressure Cylinders

Maximum Pressure—250 psig (1.7 MPa)

(4) *Portable outlet headers.* (i) Portable outlet headers shall not be used indoors except for temporary service where the conditions preclude a direct supply from outlets located on the service piping system.

(ii) Each outlet on the service piping from which oxygen or fuel-gas is withdrawn to supply a portable outlet header shall be equipped with a readily accessible shutoff valve.

(iii) Hose and hose connections used for connecting the portable outlet header to the service piping shall comply with paragraph (e)(5) of this section.

(iv) Master shutoff valves for both oxygen and fuel-gas shall be provided at the entry end of the portable outlet header.

(v) Portable outlet headers for fuel-gas service shall be provided with an approved hydraulic back-pressure valve installed at the inlet and preceding the service outlets, unless an approved pressure-reducing regulator, an approved back-flow check valve, or an approved hydraulic back-pressure valve is installed at each outlet. Outlets provided on headers for oxygen service may be fitted for use with pressure-reducing regulators or for direct hose connection.

(vi) Each service outlet on portable outlet headers shall be provided with a valve assembly that includes a detachable outlet seal cap, chained or otherwise attached to the body of the valve.

(vii) Materials and fabrication procedures for portable outlet headers shall comply with paragraphs (d)(1), (d)(2), and (d)(5) of this section.

(viii) Portable outlet headers shall be provided with frames which will support the equipment securely in the correct operating position and protect them from damage during handling and operation.

(5) *Manifold operation procedures.* (i) Cylinder manifolds shall be installed under the supervision of someone familiar with the proper practices with reference to their construction and use.

(ii) All manifolds and parts used in methods of manifolding shall be used only for the gas or gases for which they are approved.

(iii) When acetylene cylinders are coupled, approved flash arresters shall be installed between each cylinder and the coupler block. For outdoor use only, and when the number of cylinders coupled does not exceed three, one flash arrester installed between the coupler block and regulator is acceptable.

(iv) The aggregate capacity of fuel-gas cylinders connected to a portable manifold inside a building shall not exceed 3,000 cubic feet (84 m<sup>3</sup>) of gas.

(v) Acetylene and liquefied fuel-gas cylinders shall be manifolded in a vertical position.

(vi) The pressure in the gas cylinders connected to and discharged simultaneously through a common manifold shall be approximately equal.

(d) *Service piping systems—(1) Materials and design.* (i)(A) Piping and fittings

shall comply with section 2, Industrial Gas and Air Piping Systems, of the American National Standard Code for Pressure Piping ANSI B31.1, 1967, which is incorporated by reference as specified in §1910.6, insofar as it does not conflict with paragraphs (d)(1)(i)(A)(1) and (d)(1)(i)(A)(2) of this section:

(1) Pipe shall be at least Schedule 40 and fittings shall be at least standard weight in sizes up to and including 6-inch nominal.

(2) Copper tubing shall be Types K or L in accordance with the Standard Specification for Seamless Copper Water Tube, ASTM B88-66a, which is incorporated by reference as specified in §1910.6.

(B) Piping shall be steel, wrought iron, brass or copper pipe, or seamless copper, brass or stainless steel tubing, except as provided in paragraphs (d)(1)(ii) and (d)(1)(iii) of this section.

(ii)(A) Oxygen piping and fittings at pressures in excess of 700 psi (4.8 MPa), shall be stainless steel or copper alloys.

(B) Hose connections and hose complying with paragraph (e)(5) of this section may be used to connect the outlet of a manifold pressure regulator to piping providing the working pressure of the piping is 250 psi (1.7 MPa) or less and the length of the hose does not exceed 5 feet (1.5 m). Hose shall have a minimum bursting pressure of 1,000 psig (6.8 MPa).

(C) When oxygen is supplied to a service piping system from a low-pressure oxygen manifold without an intervening pressure regulating device, the piping system shall have a minimum design pressure of 250 psig (1.7 MPa). A pressure regulating device shall be used at each station outlet when the connected equipment is for use at pressures less than 250 psig (1.7 MPa).

(iii)(A) Piping for acetylene or acetylenic compounds shall be steel or wrought iron.

(B) Unalloyed copper shall not be used for acetylene or acetylenic compounds except in listed equipment.

(2) *Piping joints.* (i) Joints in steel or wrought iron piping shall be welded, threaded or flanged. Fittings, such as ells, tees, couplings, and unions, may be rolled, forged or cast steel, malleable iron or nodular iron. Gray or white cast iron fittings are prohibited.

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(ii) Joints in brass or copper pipe shall be welded, brazed, threaded, or flanged. If of the socket type, they shall be brazed with silver-brazing alloy or similar high melting point (not less than 800 °F (427 °C)) filler metal.

(iii) Joints in seamless copper, brass, or stainless steel tubing shall be approved gas tubing fittings or the joints shall be brazed. If of the socket type, they shall be brazed with silver-brazing alloy or similar high melting point (not less than 800 °F (427 °C)) filler metal.

(3) *Installation.* (i) Distribution lines shall be installed and maintained in a safe operating condition.

(ii) All piping shall be run as directly as practicable, protected against physical damage, proper allowance being made for expansion and contraction, jarring and vibration. Pipe laid underground in earth shall be located below the frost line and protected against corrosion. After assembly, piping shall be thoroughly blown out with air, nitrogen, or carbon dioxide to remove foreign materials. For oxygen piping, only oil-free air, oil-free nitrogen, or oil-free carbon dioxide shall be used.

(iii) Only piping which has been welded or brazed shall be installed in tunnels, trenches or ducts. Shutoff valves shall be located outside such conduits. Oxygen piping may be placed in the same tunnel, trench or duct with fuel-gas pipelines, provided there is good natural or forced ventilation.

(iv) Low points in piping carrying moist gas shall be drained into drip pots constructed so as to permit pumping or draining out the condensate at necessary intervals. Drain valves shall be installed for this purpose having outlets normally closed with screw caps or plugs. No open end valves or petcocks shall be used, except that in drips located out of doors, underground, and not readily accessible, valves may be used at such points if they are equipped with means to secure them in the closed position. Pipes leading to the surface of the ground shall be cased or jacketed where necessary to prevent loosening or breaking.

(v) Gas cocks or valves shall be provided for all buildings at points where they will be readily accessible for shut-

ting off the gas supply to these buildings in any emergency. There shall also be provided a shutoff valve in the discharge line from the generator, gas holder, manifold or other source of supply.

(vi) Shutoff valves shall not be installed in safety relief lines in such a manner that the safety relief device can be rendered ineffective.

(vii) Fittings and lengths of pipe shall be examined internally before assembly and, if necessary freed from scale or dirt. Oxygen piping and fittings shall be washed out with a suitable solution which will effectively remove grease and dirt but will not react with oxygen. Hot water solutions of caustic soda or trisodium phosphate are effective cleaning agents for this purpose.

(viii) Piping shall be thoroughly blown out after assembly to remove foreign materials. For oxygen piping, oil-free air, oil-free nitrogen, or oil-free carbon dioxide shall be used. For other piping, air or inert gas may be used.

(ix) When flammable gas lines or other parts of equipment are being purged of air or gas, open lights or other sources of ignition shall not be permitted near uncapped openings.

(x) No welding or cutting shall be performed on an acetylene or oxygen pipeline, including the attachment of hangers or supports, until the line has been purged. Only oil-free air, oil-free nitrogen, or oil-free carbon dioxide shall be used to purge oxygen lines.

(4) *Painting and signs.* (i) Underground pipe and tubing and outdoor ferrous pipe and tubing shall be covered or painted with a suitable material for protection against corrosion.

(ii) Aboveground piping systems shall be marked in accordance with the American National Standard Scheme for the Identification of Piping Systems, ANSI A13.1-1956, which is incorporated by reference as specified in § 1910.6.

(iii) Station outlets shall be marked to indicate the name of the gas.

(5) *Testing.* (i) Piping systems shall be tested and proved gastight at 1½ times the maximum operating pressure, and shall be thoroughly purged of air before being placed in service. The material used for testing oxygen lines shall be

oil free and noncombustible. Flames shall not be used to detect leaks.

(ii) When flammable gas lines or other parts of equipment are being purged of air or gas, sources of ignition shall not be permitted near uncapped openings.

(e) *Protective equipment, hose, and regulators*—(1) *General*. Equipment shall be installed and used only in the service for which it is approved and as recommended by the manufacturer.

(2) *Pressure relief devices*. Service piping systems shall be protected by pres-

sure relief devices set to function at not more than the design pressure of the systems and discharging upwards to a safe location.

(3) *Piping protective equipment*. (i) The fuel-gas and oxygen piping systems, including portable outlet headers shall incorporate the protective equipment shown in Figures Q-1, Q-2, and Q-3. When only a portion of a fuel-gas system is to be used with oxygen, only that portion need comply with this paragraph (e)(3)(i).

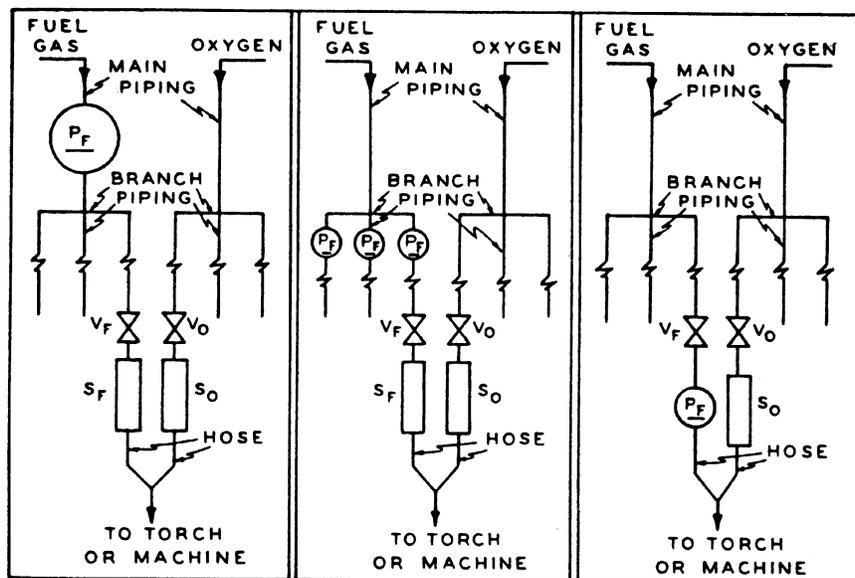


Fig. Q-1

Fig. Q-2

Fig. Q-3

## LEGEND

$P_F$ --Protective equipment in fuel gas piping  
 $V_F$ --Fuel gas station outlet valve  
 $V_O$ --Oxygen station outlet valve  
 $S_F$ --Backflow prevention device(s) at fuel gas station outlet  
 $S_O$ --Backflow prevention device(s) at oxygen station outlet

(ii) Approved protective equipment (designated  $P_F$  in Figures Q-1, Q-2, and Q-3) shall be installed in fuel-gas piping to prevent:

(A) Backflow of oxygen into the fuel-gas supply system;

(B) Passage of a flash back into the fuel-gas supply system; and

(C) Excessive back pressure of oxygen in the fuel-gas supply system. The three functions of the protective equipment may be combined in one device or may be provided by separate devices.

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(1) The protective equipment shall be located in the main supply line, as in Figure Q-1 or at the head of each branch line, as in Figure Q-2 or at each location where fuel-gas is withdrawn, as in Figure Q-3. Where branch lines are of 2-inch pipe size or larger or of substantial length, protective equipment (designated as P<sub>F</sub>) shall be located as shown in either Q-2 and Q-3.

(2) Backflow protection shall be provided by an approved device that will prevent oxygen from flowing into the fuel-gas system or fuel from flowing into the oxygen system (see S<sub>F</sub>, Figures Q-1 and Q-2).

(3) Flash-back protection shall be provided by an approved device that will prevent flame from passing into the fuel-gas system.

(4) Back-pressure protection shall be provided by an approved pressure-relief device set at a pressure not greater than the pressure rating of the backflow or the flashback protection device, whichever is lower. The pressure-relief device shall be located on the downstream side of the backflow and flashback protection devices. The vent from the pressure-relief device shall be at least as large as the relief device inlet and shall be installed without low points that may collect moisture. If low points are unavoidable, drip pots with drains closed with screw plugs or caps shall be installed at the low points. The vent terminus shall not endanger personnel or property through gas discharge; shall be located away from ignition sources; and shall terminate in a hood or bend.

(iii) If pipeline protective equipment incorporates a liquid, the liquid level shall be maintained, and a suitable antifreeze may be used to prevent freezing.

(iv) Fuel gas for use with equipment not requiring oxygen shall be withdrawn upstream of the piping protective devices.

(4) *Station outlet protective equipment.*

(i) A check valve, pressure regulator, hydraulic seal, or combination of these devices shall be provided at each station outlet, including those on portable headers, to prevent backflow, as shown in Figures Q-1, Q-2, and Q-3 and designated as S<sub>F</sub> and S<sub>O</sub>.

(ii) When approved pipeline protective equipment (designated P<sub>F</sub>) is located at the station outlet as in Figure Q-3, no additional check valve, pressure regulator, or hydraulic seal is required.

(iii) A shutoff valve (designated V<sub>F</sub> and V<sub>O</sub>) shall be installed at each station outlet and shall be located on the upstream side of other station outlet equipment.

(iv) If the station outlet is equipped with a detachable regulator, the outlet shall terminate in a union connection that complies with the Regulator Connection Standards, 1958, Compressed Gas Association, which is incorporated by reference as specified in §1910.6.

(v) If the station outlet is connected directly to a hose, the outlet shall terminate in a union connection complying with the Standard Hose Connection Specifications, 1957, Compressed Gas Association, which is incorporated by reference as specified in §1910.6.

(vi) Station outlets may terminate in pipe threads to which permanent connections are to be made, such as to a machine.

(vii) Station outlets shall be equipped with a detachable outlet seal cap secured in place. This cap shall be used to seal the outlet except when a hose, a regulator, or piping is attached.

(viii) Where station outlets are equipped with approved backflow and flashback protective devices, as many as four torches may be supplied from one station outlet through rigid piping, provided each outlet from such piping is equipped with a shutoff valve and provided the fuel-gas capacity of any one torch does not exceed 15 cubic feet (0.42 m<sup>3</sup>) per hour. This paragraph (e)(4)(viii) does not apply to machines.

(5) *Hose and hose connections.* (i) Hose for oxy-fuel gas service shall comply with the Specification for Rubber Welding Hose, 1958, Compressed Gas Association and Rubber Manufacturers Association, which is incorporated by reference as specified in §1910.6.

(ii) When parallel lengths of oxygen and acetylene hose are taped together for convenience and to prevent tangling, not more than 4 inches (10.2 cm) out of 12 inches (30.5 cm) shall be covered by tape.

(iii) Hose connections shall comply with the Standard Hose Connection Specifications, 1957, Compressed Gas Association.

(iv) Hose connections shall be clamped or otherwise securely fastened in a manner that will withstand, without leakage, twice the pressure to which they are normally subjected in service, but in no case less than a pressure of 300 psi (2.04 MPa). Oil-free air or an oil-free inert gas shall be used for the test.

(v) Hose showing leaks, burns, worn places, or other defects rendering it unfit for service shall be repaired or replaced.

(6) *Pressure-reducing regulators.* (i) Pressure-reducing regulators shall be used only for the gas and pressures for which they are intended. The regulator inlet connections shall comply with Regulator Connection Standards, 1958, Compressed Gas Association.

(ii) When regulators or parts of regulators, including gages, need repair, the work shall be performed by skilled mechanics who have been properly instructed.

(iii) Gages on oxygen regulators shall be marked "USE NO OIL."

(iv) Union nuts and connections on regulators shall be inspected before use to detect faulty seats which may cause leakage of gas when the regulators are attached to the cylinder valves.

(f) *Acetylene generators—(1) Approval and marking.* (i) Generators shall be of approved construction and shall be plainly marked with the maximum rate of acetylene in cubic feet per hour for which they are designed; the weight and size of carbide necessary for a single charge; the manufacturer's name and address; and the name or number of the type of generator.

(ii) Carbide shall be of the size marked on the generator nameplate.

(2) *Rating and pressure limitations.* (i) The total hourly output of a generator shall not exceed the rate for which it is approved and marked. Unless specifically approved for higher ratings, carbide-feed generators shall be rated at 1 cubic foot (0.028 m<sup>3</sup>) per hour per pound of carbide required for a single complete charge.

(ii) Relief valves shall be regularly operated to insure proper functioning.

Relief valves for generating chambers shall be set to open at a pressure not in excess of 15 psig (103 kPa gauge pressure). Relief valves for hydraulic back pressure valves shall be set to open at a pressure not in excess of 20 psig (137 kPa gauge pressure).

(iii) Nonautomatic generators shall not be used for generating acetylene at pressures exceeding 1 psig (7 kPa gauge pressure), and all water overflows shall be visible.

(3) *Location.* The space around the generator shall be ample for free, unobstructed operation and maintenance and shall permit ready adjustment and charging.

(4) *Stationary acetylene generators (automatic and nonautomatic).* (1)(A) The foundation shall be so arranged that the generator will be level and so that no excessive strain will be placed on the generator or its connections. Acetylene generators shall be grounded.

(B) Generators shall be placed where water will not freeze. The use of common salt (sodium chloride) or other corrosive chemicals for protection against freezing is not permitted. (For heating systems see paragraph (f)(6)(iii) of this section.)

(C) Except when generators are prepared in accordance with paragraph (f)(7)(v) of this section, sources of ignition shall be prohibited in outside generator houses or inside generator rooms.

(D) Water shall not be supplied through a continuous connection to the generator except when the generator is provided with an adequate open overflow or automatic water shutoff which will effectively prevent overflowing of the generator. Where a non-continuous connection is used, the supply line shall terminate at a point not less than 2 inches (5 cm) above the regularly provided opening for filling so that the water can be observed as it enters the generator.

(E) Unless otherwise specifically approved, generators shall not be fitted with continuous drain connections leading to sewers, but shall discharge through an open connection into a suitably vented outdoor receptacle or residue pit which may have such connections. An open connection for the sludge drawoff is desirable to enable

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the generator operator to observe leakage of generating water from the drain valve or sludge cock.

(ii)(A) Each generator shall be provided with a vent pipe.

(B) The escape or relief pipe shall be rigidly installed without traps and so that any condensation will drain back to the generator.

(C) The escape or relief pipe shall be carried full size to a suitable point outside the building. It shall terminate in a hood or bend located at least 12 feet (3.7 m) above the ground, preferably above the roof, and as far away as practicable from windows or other openings into buildings and as far away as practicable from sources of ignition such as flues or chimneys and tracks used by locomotives. Generating chamber relief pipes shall not be inter-connected but shall be separately led to the outside air. The hood or bend shall be so constructed that it will not be obstructed by rain, snow, ice, insects, or birds. The outlet shall be at least 3 feet (0.9 m) from combustible construction.

(iii)(A) Gas holders shall be constructed on the gasometer principle, the bell being suitably guided. The gas bell shall move freely without tendency to bind and shall have a clearance of at least 2 inches (5 cm) from the shell.

(B) The gas holder may be located in the generator room, in a separate room or out of doors. In order to prevent collapse of the gas bell or infiltration of air due to a vacuum caused by the compressor or booster pump or cooling of the gas, a compressor or booster cutoff shall be provided at a point 12 inches (0.3 m) or more above the landing point

of the bell. When the gas holder is located indoors, the room shall be ventilated in accordance with paragraph (f)(6)(ii) of this section and heated and lighted in accordance with paragraphs (f)(6)(iii) and (f)(6)(iv) of this section.

(C) When the gas holder is not located within a heated building, gas holder seals shall be protected against freezing.

(D) Means shall be provided to stop the generator-feeding mechanism before the gas holder reaches the upper limit of its travel.

(E) When the gas holder is connected to only one generator, the gas capacity of the holder shall be not less than one-third of the hourly rating of the generator.

(F) If acetylene is used from the gas holder without increase in pressure at some points but with increase in pressure by a compressor or booster pump at other points, approved piping protective devices shall be installed in each supply line. The low-pressure protective device shall be located between the gas holder and the shop piping, and the medium-pressure protective device shall be located between the compressor or booster pump and the shop piping (see Figure Q-4). Approved protective equipment (designated P<sub>F</sub>) is used to prevent: Backflow of oxygen into the fuel-gas supply system; passage of a flashback into the fuel-gas supply system; and excessive back pressure of oxygen in the fuel-gas supply system. The three functions of the protective equipment may be combined in one device or may be provided by separate devices.

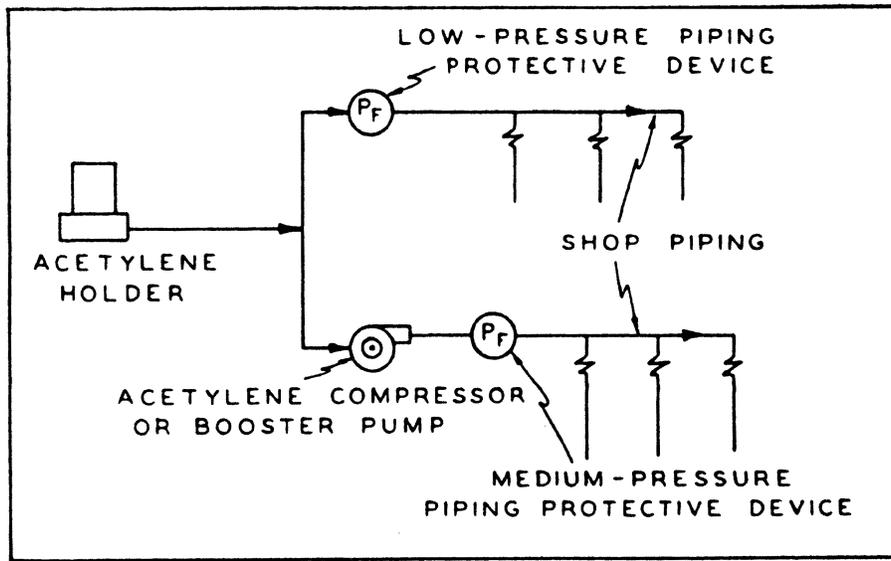


Figure Q-4

(iv)(A) The compressor or booster system shall be of an approved type.

(B) Wiring and electric equipment in compressor or booster pump rooms or enclosures shall conform to the provisions of subpart S of this part for Class I, Division 2 locations.

(C) Compressors and booster pump equipment shall be located in well-ventilated areas away from open flames, electrical or mechanical sparks, or other ignition sources.

(D) Compressor or booster pumps shall be provided with pressure relief valves which will relieve pressure exceeding 15 psig (103 kPa gauge pressure) to a safe outdoor location as provided in paragraph (f)(4)(ii) of this section, or by returning the gas to the inlet side or to the gas supply source.

(E) Compressor or booster pump discharge outlets shall be provided with approved protective equipment. (See paragraph (e) of this section.)

(5) *Portable acetylene generators.* (i)(A) All portable generators shall be of a type approved for portable use.

(B) Portable generators shall not be used within 10 feet (3 m) of combustible material other than the floor.

(C) Portable generators shall not be used in rooms of total volume less than 35 times the total gas-generating capacity per charge of all generators in the room. Generators shall not be used in rooms having a ceiling height of less than 10 feet (3 m). (To obtain the gas-generating capacity in cubic feet per charge, multiply the pounds of carbide per charge by 4.5.)

(D) Portable generators shall be protected against freezing. The use of salt or other corrosive chemical to prevent freezing is prohibited.

(ii)(A) Portable generators shall be cleaned and recharged and the air mixture blown off outside buildings.

(B) When charged with carbide, portable generators shall not be moved by crane or derrick.

(C) When not in use, portable generators shall not be stored in rooms in which open flames are used unless the generators contain no carbide and have been thoroughly purged of acetylene. Storage rooms shall be well ventilated.

(D) When portable acetylene generators are to be transported and operated on vehicles, they shall be securely anchored to the vehicles. If transported

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by truck, the motor shall be turned off during charging, cleaning, and generating periods.

(E) Portable generators shall be located at a safe distance from the welding position so that they will not be exposed to sparks, slag, or misdirection of the torch flame or overheating from hot materials or processes.

(6) *Outside generator houses and inside generator rooms for stationary acetylene generators.* (i)(A) No opening in any outside generator house shall be located within 5 feet (1.5 m) of any opening in another building.

(B) Walls, floors, and roofs of outside generator houses shall be of noncombustible construction.

(C) When a part of the generator house is to be used for the storage or manifolding of oxygen cylinders, the space to be so occupied shall be separated from the generator or carbide storage section by partition walls continuous from floor to roof or ceiling, of the type of construction stated in paragraph (f)(6)(i)(H) of this section. Such separation walls shall be without openings and shall be joined to the floor, other walls and ceiling or roof in a manner to effect a permanent gas-tight joint.

(D) Exit doors shall be located so as to be readily accessible in case of emergency.

(E) Explosion venting for outside generator houses and inside generator rooms shall be provided in exterior walls or roofs. The venting areas shall be equal to not less than 1 square foot (0.09 m<sup>2</sup>) per 50 cubic feet (1.4 m<sup>3</sup>) of room volume and may consist of any one or any combination of the following: Walls of light, noncombustible material preferably single-thickness, single-strength glass; lightly fastened hatch covers; lightly fastened swinging doors in exterior walls opening outward; lightly fastened walls or roof designed to relieve at a maximum pressure of 25 pounds per square foot (0.001 MPa).

(F) The installation of acetylene generators within buildings shall be restricted to buildings not exceeding one story in height; *provided, however*, that this will not be construed as prohibiting such installations on the roof or

top floor of a building exceeding such height.

(G) Generators installed inside buildings shall be enclosed in a separate room.

(H) The walls, partitions, floors, and ceilings of inside generator rooms shall be of noncombustible construction having a fire-resistance rating of at least 1 hour. The walls or partitions shall be continuous from floor to ceiling and shall be securely anchored. At least one wall of the room shall be an exterior wall.

(I) Openings from an inside generator room to other parts of the building shall be protected by a swinging type, self-closing fire door for a Class B opening and having a rating of at least 1 hour. Windows in partitions shall be wired glass and approved metal frames with fixed sash. Installation shall be in accordance with the Standard for the Installation of Fire Doors and Windows, NFPA 80-1970, which is incorporated by reference as specified in § 1910.6.

(ii) Inside generator rooms or outside generator houses shall be well ventilated with vents located at floor and ceiling levels.

(iii) Heating shall be by steam, hot water, enclosed electrically heated elements or other indirect means. Heating by flames or fires shall be prohibited in outside generator houses or inside generator rooms, or in any enclosure communicating with them.

(iv)(A) Generator houses or rooms shall have natural light during daylight hours. Where artificial lighting is necessary it shall be restricted to electric lamps installed in a fixed position. Unless specifically approved for use in atmospheres containing acetylene, such lamps shall be provided with enclosures of glass or other noncombustible material so designed and constructed as to prevent gas vapors from reaching the lamp or socket and to resist breakage. Rigid conduit with threaded connections shall be used.

(B) Lamps installed outside of wired-glass panels set in gas-tight frames in the exterior walls or roof of the generator house or room are acceptable.

(v) Electric switches, telephones, and all other electrical apparatus which may cause a spark, unless specifically

approved for use inside acetylene generator rooms, shall be located outside the generator house or in a room or space separated from the generator room by a gas-tight partition, except that where the generator system is designed so that no carbide fill opening or other part of the generator is open to the generator house or room during the operation of the generator, and so that residue is carried in closed piping from the residue discharge valve to a point outside the generator house or room, electrical equipment in the generator house or room shall conform to the provisions of subpart S of this part for Class I, Division 2 locations.

(7) *Maintenance and operation.* (i) Unauthorized persons shall not be permitted in outside generator houses or inside generator rooms.

(A) Operating instructions shall be posted in a conspicuous place near the generator or kept in a suitable place available for ready reference.

(B) When recharging generators the order of operations specified in the instructions supplied by the manufacturer shall be followed.

(C) In the case of batch-type generators, when the charge of carbide is exhausted and before additional carbide is added, the generating chamber shall always be flushed out with water, renewing the water supply in accordance with the instruction card furnished by the manufacturer.

(D) The water-carbide residue mixture drained from the generator shall not be discharged into sewer pipes or stored in areas near open flames. Clear water from residue settling pits may be discharged into sewer pipes.

(ii) The carbide added each time the generator is recharged shall be sufficient to refill the space provided for carbide without ramming the charge. Steel or other ferrous tools shall not be used in distributing the charge.

(iii) Generator water chambers shall be kept filled to proper level at all times except while draining during the recharging operation.

(iv) Whenever repairs are to be made or the generator is to be charged or carbide is to be removed, the water chamber shall be filled to the proper level.

(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;

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(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; 72 FR 71070, Dec. 14, 2007]

§ 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.