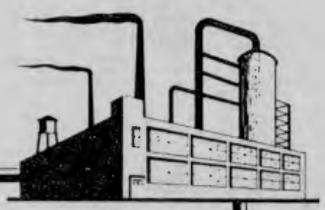
AFETY REGULATION NO. 11



Providing for

SAFETY IN WELDING AND CUTTING

Effective February 9, 1959

BUREAU OF ENGINEERING & SAFETY
N.J. DEPARTMENT OF LABOR & INDUSTRY
Trenton, N.J.

This Safety Regulation No. 11 supersedes the following:

"Standards for the Protection of Workers in Gas and Electric Welding" which was filed with the Secretary of State on January 9, 1948.

This Regulation was reviewed and approved by the Occupational Health Program of the New Jersey State Department of Health.

ES-43 (1-59) (This Regulation was printed by the Department of Labor and Industry)

Contents

FOREWORD

This Regulation is promulgated to provide reasonable safeguards for workers who use, or who may come in proximity to, welding and cutting equipment in industry.

The text of this Regulation has been taken, with little change, from American Standard Z 49.1-1958, published by the American Welding Society. The A. S. A. Sectional Committee that drew this Standard comprised a wide representation of users and suppliers of welding equipment and welded products, insurance companies, governmental bodies and every other type of organization interested in welding or cutting.

This Regulation is promulgated by the Commissioner of Labor and Industry under authority vested in him by law.

> R. S. 34:1-20. The commissioner may make and publish rules and regulations not inconsistent with law as he shall deem necessary to enforce the provisions of this title.
>
> Whenever any condition is found to exist in contravention of any provision of this title, the commissioner may by written order signed by him specifying the things to be done and the time for compliance require such conditions to be corrected.

The provisions of Title 34 which refer to the subject matter regulated are:

> 34:6-1. Every factory, workshop, mill or place where the manufacture of goods of any kind is carried on shall under the supervision and direction of the commissioner ...be protected, so far as practicable against the origin and spread of fire.
>
> 34:6-48. Every employer shall, without cost to his employees, provide reasonably effective devices, means and methods to prevent the contraction by them of any illness or disease incident to the work or process in which they are engaged.

Prior to its promulgation, this regulation was reviewed and approved by the New Jersey State Industrial Safety Committee.

1. SCOPE

1.1 Purpose. The purpose of this Regulation is to provide reasonable standards for the installation, operation, and maintenance of welding and oxygen cutting equipment for the protection of workers frominjury and illness.

1.2 Scope. This Regulation is applicable to every factory, mill, workshop or place where the manufacture of goods of any kind is carried on.

1.3 Exceptions. In cases of practical difficulty or unnecessary hardship, the Commissioner may grant exceptions from this Regulation provided that a request for such exception has been made in writing. Exceptions can only be granted when it is clearly evident that a satisfactory, safe and sanitary condition is attained, but cannot be granted in any case where conflict would be created with mandatory requirements of the law.

2. DEFINITIONS

2.1 *Commissioner* – The Commissioner of Labor and Industry or his authorized representative.

2.2 *Approved* – Approved by the Commissioner

2.3 *Welder and Welding Operator* – When used herein these terms are intended to designate any operator of electric or gas welding and cutting equipment.

2.4 All other welding terms used herein are in keeping with accepted welding practice and as defined in *Standard Welding Terms and Their Definitions* of the American Welding Society (A3.0-49).

3. Installation and Operation of Gas-Welding and Cutting Euipment

3.1 GENERAL

3.1.1 Mixtures of flammable gases and air may be very explosive and shall be carefully guarded against. No device or attachment facilitating or permitting mixtures of air or oxygen with combustible gases prior to consumption, except at the burner or in a standard torch, shall be allowed unless approved for the purpose.

3.1.2 Under no condition shall acetylene be generated, piped (except in approved cylinder manifolds) or utilized at a pressure in excess of 15 psi gage pressure or 30 psi absolute pressure. (The 30 psi absolute pressure 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 according to Interstate Commerce Commission requirements, or to acetylene for chemical use. The use of liquid acetylene shall be prohibited.

3.1.3 Apparatus. Only approved apparatus (see Par. 2.3) such as torches, regulators or pressure-reducing valves, acetylene generators and manifolds shall be used.

3.1.4 Cylinders. All portable cylinders used for the storage and shipment of compressed gases shall be constructed and maintained in accordance with the regulations of the Interstate Commerce Commission.

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. The height of the lettering shall be not less than one twenty-fifth (1/25) of the diameter of the cylinder, with a minimum height of one-eighth (⅛) inch.

Compressed gas cylinders shall be equipped with valves complying with the *Compressed Gas Cylinder Valve Outlet and Inlet Connections*, American Standard B57.1–1953.

3.1.5 Instructions. Workmen in charge of the oxygen or fuel gas supply equipment, including generators, and oxygen or fuel-gas distribution piping systems should be carefully 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.

3.2 STATIONARY AUTOMATIC ACETYLENE GENERATORS

3.2.1 Approval and Marking. 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.

3.2.2 Rating. The total hourly output of a generator shall not exceed the rate for which it is approved and marked.

3.2.3 Location of Generators. Generators should preferably be placed outside of buildings in generator houses constructed and located in compliance with 3.2.4, but the installation of approved generators within buildings in accordance with 3.2.5 of this standard is permissible.

3.2.4 Outside Generator Houses.

3.2.4.1 No opening in any outside generator house shall be located within five feet of any opening in another building.

3.2.4.2 Siding and roofing of a generator house shall be of fire-resistant material. See 3.2.5.2

3.2.4.3 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 one of the types of construction listed in 3.2.5.2. 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.

3.2.4.4 A portion of the exterior walls equal to not less than 10 per cent of the combined areas of the enclosed walls shall be of light, noncombustible material, preferably single-thickness, single-strength glass. Single-thickness, single-strength window glass skylights, or lightly-fastened roof hatch covers, swinging doors in exterior walls opening outward, sheet metal siding or lightly-fastened roofs may be accepted in part or entirely in lieu of the glass area or its equivalent, provided the required percentage of explosion venting area is thus obtained.

3.2.5 Inside Generator Rooms or Compartments

3.2.5.1 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.

NOTE: Where the word *buildings* is used in this section, it means buildings having occupancy other than that directly associated with the production of acetylene, the storage of calcium carbide, or the storage and manifolding of gases used in welding and cutting.

3.2.5.2 Where generators are installed inside buildings, they shall be enclosed in a separate room or compartment of ample size. The walls or partitions, floor and ceiling of such rooms or compartments shall be one of the types of construction listed below, or other construction equivalent

in strength and fire resistance. Walls or partitions shall be continuous from floor to ceiling and shall be securely anchored. At least one wall of an inside generator room shall be an exterior wall.

Types of construction:

Gypsum or cement plaster at least ¾-inch thick on metal lath on each side of a stud partition.

Expanded metal lath encased in solid cement plaster not less than 2½-inch thick.

Reinforced concrete.

Brick.

Tile, gypsum or concrete block (cement plaster on each side to a thickness of ¼-inch).

3.2.5.3 Openings from generator rooms or compartments to other parts of the building, except rooms used exclusively for the storage of calcium carbide, shall be protected by a fire door classified and labeled as suitable for use in a Class B situation as defined in *Standards for the Protection of Openings in Walls and Partitions Against Fire,* National Fire Protection Association and National Board of Fire Underwriters No. 80, 1957. The door shall be made tight to prevent passage of flame around the edges. It shall be self-closing. Windows, if provided in partitions between generator rooms and the inside of a building, shall be protected by wired glass in approved metal frames or fixed sash. Exit doors opening outward shall be located so as to be readily accessible in case of emergency and they shall be capable of being opened from either side when anyone is inside the generator house.

3.2.5.4 A portion of the exterior walls equal to not less than 10 per cent of the combined areas of the enclosing walls shall be of light, noncombustible material, preferably single-thickness, single-strength glass. Single-thickness, single-strength window glass skylights, or lightly-fastened roof hatch covers, swinging doors in exterior walls opening outward, sheet-metal siding or lightly-fastened roofs, may be accepted in part or entirely in lieu of the glass area or its equivalent, provided the required percentage of explosion venting area is thus obtained.

3.2.6 Installation. 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.

3.2.7 Space Around Generator. The space around the generator shall be ample for free, unobstructed operation and maintenance and shall permit ready adjustment and charging.

3.2.8 Ventilation, Lighting and Heating of Generator Houses or Rooms

3.2.8.1 The space around generators shall be well ventilated to the out-of-doors. This may be done by employing vents near the floor level and near the highest practical point in the room.

3.2.8.2 The heating of generator houses or rooms shall be by steam, hot water or other indirect heating system. The furnace or other heat-providing means shall be so located that no flame, fire or electrically-heated element is in the generating house, room or any enclosure communicating with it.

3.2.8.3 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.

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.

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 Article 500, for Class I, Division 2 locations of the *National Electrical Code,* American Standard C1–1956.

3.2.9 Protection Against Freezing. 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 3.2.8.2.)

3.2.10 Water Supply Connections. 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 shut-off which will effectively prevent overfilling of the generator. Where a noncontinuous connection is used, the supply line shall terminate at a point not less than 2 in. above the regularly provided opening for filling so that the water can be observed as it enters the generator.

3.2.11 Drain Connections. 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.

NOTE: An open connection for the sludge draw-off is desirable to enable the

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

3.2.12 Generator Escape or Relief Pipes

3.2.12.1 Each generator shall be provided with an escape or relief pipe of standard full-weight galvanized iron or steel, except that outside of buildings vent pipes larger than 4 inches in diameter may be of galvanized tubing or sheet steel not less than 14-gage.

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

3.2.12.3 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 ft. 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 interconnected 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 ft. from combustible construction.

3.2.13 Maintenance and Operation

3.2.13.1 Generator rooms shall be open to authorized persons only.

3.2.13.2 When recharging generators, the order of operations specified in the instructions supplied by the manufacturer shall be strictly followed. These manufacturer's instructions shall be readily available.

3.2.13.3 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. Periodic cleanouts and maintenance shall be performed in the manner specified by the manufacturer.

Charging at other than daylight hours is allowable where the generator room is lighted as specified in 3.2.8.3.

The carbide used each time the generator is recharged should be only sufficient to refill the space provided for carbide without ramming the charge. Only a wood tool shall be used in distributing the charge.

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

3.2.13.5 Whenever repairs are to be made or the generator is to be charged or carbide is to be removed, the water chamber shall be completely filled to avoid the danger of explosive mixtures of air and acetylene within the water space and also to prevent dropping fresh carbide into insufficient water. Before making any repairs involving welding, soldering, brazing or any hot work or operation liable to produce a flame or spark, the carbide charge and feed mechanism, where necessary to avoid wetting same, shall be completely removed, and all acetylene shall be expelled by completely flooding the generator shell with water. The generator shall then be disconnected from the piping system. The generator shall be kept filled with water, as far as work permits. It shall be maintained in a position so as to hold as much water as practical.

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. Hot repairs should preferably be made out-of-doors.

3.2.13.6 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 psi. Relief valves for hydraulic back pressure valves shall be set to open at a pressure not in excess of 20 psi.

3.3 STATIONARY NONAUTOMATIC ACETYLENE GENERATORS

In addition to the foregoing rules (3.2) which also apply to nonautomatic generators, nonautomatic generators shall comply with the following requirements.

3.3.1 Limitations. Nonautomatic generators shall not be used for generating acetylene directly at pressures exceeding 1 psi., and all water overflows shall be visible.

3.3.2 Gas Holders.

3.3.2.1 All 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 from the shell.

3.3.2.2 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 due to a vacuum caused by the compressor or booster pump or cooling of the gas, a compressor or booster cut-off shall be provided at a point 12 inches or more above the landing point of the bell. When the gas holder is located indoors, the room shall be ventilated in accordance with 3.2.8.1.

3.3.2.3 When the gas holder is not located within a heated building, gas-holder seals shall be protected against freezing.

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

3.3.2.5 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.

3.3.2.6 Where acetylene is used directly from the gas holder, without increase in pressure at some points, and with increase in pressure by a compressor or booster pump for other points, separate hydraulic back-pressure valves shall be used in the supply lines. The main low-pressure hydraulic back-pressure valve shall be between the gas holder and the

shop line, and the medium-pressure hydraulic back-pressure valve shall be between the compressor or booster pump and the shop line.

3.4 PORTABLE AUTOMATIC ACETYLENE GENERATORS

NOTE: In addition to the foregoing rules contained in 3.2 that may apply, portable automatic acetylene generators shall comply with the following requirements:

3.4.1 General

3.4.1.1 All portable generators shall be of a type specifically approved for portable use.

3.4.1.2 Portable generators shall not be used within 10 feet of combustible material other than the floor.

3.4.1.3 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.

3.4.1.4 Portable generators shall be protected against the freezing of water in the generator and in its appurtenances. The use of common salt (sodium chloride) or other corrosive chemicals for protection against freezing is not permitted. (For heating systems see 3.2.8.2.)

3.4.2 Operation and Maintenance

3.4.2.1 Portable generators shall be cleaned and recharged and the air mixture blown off outside buildings. In large, well-ventilated, one-story buildings, special exceptions to this rule may be granted.

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

3.4.2.3 When not in use, portable generators shall not be stored in any room in which open lights or fires are used unless such generators are free of carbide and thoroughly purged of gas. Storage rooms shall be ventilated to avoid the accumulation of acetylene.

3.4.2.4 When portable acetylene generators are to be transported and operated on vehicles, they shall be securely anchored to the vehicles. If transported by truck, the motor shall be turned off during charging, cleaning and generating periods.

3.5 COMPRESSOR OR BOOSTER SYSTEMS

3.5.1 The compressor or booster system shall be of an approved type.

3.5.2 The electric motor for driving the compressor or booster pump shall be located outside the room in which the compressor or booster is located, and the drive shaft shall pass through a gas-tight stuffing box or equivalent. A belt drive shall not be used inside the compressor room.

3.5.3 The compressor or booster pump shall be provided with a suitable device which will relieve any pressure exceeding 15 psi. to the open air, or by returning the gas to the inlet side or to the gas supply source.

3.5.4 The booster pump should be water-cooled with visible water supply or arranged with an interlocking device to shut down the booster pump in case of failure of the cooling-water supply.

3.5.5 The booster-pump discharge outlet shall be equipped with a suitable flash arrester or hydraulic back-pressure valve.

*To obtain the gas-generating capacity in cubic feet per charge, multiply the pounds of carbide per charge by 4.5.

3.6 CALCIUM CARBIDE

3.6.1 Storage—General. Local, state and municipal regulations relative to the storage of calcium carbide shall be closely observed.

3.6.2 Containers and Packages. Calcium carbide shall be contained in metal packages of sufficient strength to permit handling without rupture and provided with a screw top or its equivalent. They shall be constructed water- and air-tight without the use of solder, except at such points as it may be necessary to use solder in order to close small crevices which cannot otherwise be sealed. Solder shall not be used in joints in such a manner that fire would disrupt the package.

3.6.3 Marking. Packages containing calcium carbide shall be conspicuously marked *Calcium Carbide—Dangerous if not kept dry.*

3.6.4 Opening Containers. Metal tools, even so-called *sparkless tools* for opening carbide containers shall be used with caution to avoid striking a spark; such a spark may cause ignition of an acetylene and air mixture.

3.6.5 Handling. Drums should be handled so that they will not be punctured or ruptured. Full drums of calcium carbide should be used in rotation as received from the supplier.

3.6.6 Storage Indoors

3.6.6.1 Storage—Under 600 Lb. Calcium carbide in quantities not to exceed 600 lb. may be stored inside of buildings when contained in metal packages, complying with 3.6.2 provided that the place of storage be dry, waterproof and well ventilated, and also provided that all but one of the packages of each size of carbide is sealed. The seals shall not be broken so long as there is carbide in excess of one pound in any other unsealed package of that size of carbide in the building. The above quantities of carbide permitted may be stored in the generator room and not elsewhere, unless a more suitable place can be provided.

3.6.6.2 Storage—Over 600 Lb. Calcium carbide in excess of 600 lb., but not in excess of 5000 lb., may be stored in a separate room or compartment inside a one-story building containing other occupancy, provided such room or compartment is constructed in accordance with the provisions of 3.2.5.2 and 3.2.5.3 and without cellar or basement underneath such carbide storage section. This room or compartment shall not

be used for any other purpose. Storage rooms shall be ventilated to prevent the accumulation of acetylene. Calcium carbide, not in excess of 5000 lb. may also be stored within an inside generator room or compartment of construction as prescribed by 3.2.5.2. and 3.2.5.3 when such generator room or compartment is located in a one-story building without cellar or basement underneath the generator section.

3.6.6.3 Storage—Over 5000 Lb. Calcium carbide in excess of 5000 lb. may be stored above ground in a one-story building without cellar or basement, and used for no other purpose. Calcium carbide in excess of 5000 lb. may be stored in outside generator houses. Such storage buildings shall be located outside congested mercantile or manufacturing districts. The type of construction used shall be such as to insure a dry, waterproof building. Storage rooms shall be ventilated to prevent the accumulation of acetylene. If storage buildings are of noncombustible construction, they may adjoin other one-story buildings if separated therefrom by unpierced fire walls. If detached and located less than 10 feet from such other building or buildings, there shall be no opening in any of the mutually exposed sides of such buildings. If the storage building is of combustible-construction, it shall not be located within 20 feet of any other one- or two-story building, nor within 30 feet of any other building exceeding two stories.

3.6.6.4 Danger Sign. A conspicuous sign should be posted on all calcium carbide storage rooms or buildings reading *"Danger—No smoking, matches or open lights. In case of fire do not use water,"* or other equivalent wording.

3.6.6.5 Sprinkler Systems. Sprinkler systems shall not be installed in carbide storage rooms.

3.6.7 Storage Out-of-Doors. Calcium carbide in full unopened metal containers complying with the requirements of Section 3.6.2 may be stored out-of-doors in industrial areas provided reasonable precautions are observed. Each container to be so stored should be carefully examined to make sure that it is in good condition. Frequent, periodic re-examinations should be made for excessive rusting or other damage to a container that might affect its water- and air-tightness. Containers preferably should be stored horizontally in single or double rows. Ample space should be provided between rows or pairs of rows to facilitate periodic re-examination and the removal of containers found defective. The bottom tier of each row should be placed on wooden planking or an equivalent so that containers will not come in contact with the ground or ground water. The contents of drums longest in storage should be used first. Such storage shall be located not less than 10 feet from the line of adjoining property that may be built upon.

3.7 SERVICE PIPING SYSTEMS FOR ALL GASES*

*See 3.9 for manifolding of cylinders to headers.

3.7.1 Materials

3.7.1.1 General

Except as provided in 3.7.1.2 and 3.7.1.3, all piping shall be of wrought iron, steel, brass, copper or other suitable material. All piping and fittings used for conveying gas or liquids at pressures up to 150 psi. shall be suitable for a safe working pressure of not less than 150 psi. Except as provided in 3.7.1.2 piping in systems intended for a working pressure in excess of 150 psi. shall have a wall thickness and fittings in accordance with the requirements of Section 2, Industrial Gas and Air Piping Systems of the *Code For Pressure Piping*, American Standard B31.1—1955, except that such pipe and fittings shall be at least extra heavy.

3.7.1.2 Oxygen Piping. Black steel, wrought iron, brass or copper shall be used for oxygen piping. Extra-heavy pipe shall be used where the pressure is over 150 psi. For lower pressures, standard weight pipe or approved seamless nonferrous gas tubing may be used. For pressures in excess of 700 psi., nonferrous pipe and fittings are recommended.

All fittings and lengths of pipe for service lines shall be examined internally before assembly and, if necessary, hammered to free them from scale or dirt. They shall be washed out with a suitable nonflammable solution which will effectively remove grease and dirt. Hot solutions of caustic soda and tri-sodium phosphate solutions have been found effective cleaning agents for this purpose.

3.7.1.3 Acetylene Piping. Steel or wrought-iron pipe only shall be used for acetylene piping. Under no circumstances shall acetylene gas be brought in contact with unalloyed copper except in a torch.

3.7.2 Jointings

3.7.2.1 Joints in steel or wrought-iron pipe shall be welded or made up with threaded or flanged fittings. Rolled, forged or cast steel or malleable iron fittings may be employed.

3.7.2.2 Joints in brass or copper pipe may be welded or made up with theaded or flanged fittings; or if of the socket type, they may be brazed. Joints shall not be soldered.

3.7.2.3 Joints in seamless copper, brass or other nonferrous gas tubing shall be made by means of suitable fittings; or if of the socket type, they may be brazed. Joints shall not be soldered.

3.7.2.4 Threaded connections in oxygen piping should be tinned or made up with litharge and glycerin (litharge and water are sometimes used for service pressures over 300 psi.) or other joint compound approved for oxygen service, applied to the male threads only.

3.7.3 Installation

3.7.3.1 Piping located inside or outside of buildings may be placed above or below ground. All piping shall be run as directly as practicable, carefully 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 or nitrogen to remove foreign materials. For oxygen piping only oil-free air or oil-free nitrogen shall be used.

3.7.3.2 The surface temperature of acetylene pipe lines should not be allowed to exceed 130°F.

3.7.3.3 Only piping which has been welded or brazed shall be installed in tunnels, trenches or ducts. Shut-off valves shall be located outside such conduits. Oxygen piping may be placed in the same tunnel, trench or duct with fuel-gas pipe lines, provided there is good natural or forced ventilation, but under no circumstances shall an oxygen pipe line be placed in a tunnel, trench or duct where it may be exposed to contact with oil or grease.

3.7.3.4 Where of necessity low points occur in any piping carrying a moist gas, they shall be drained into drip pots constructed so as to permit pumping or draining out the condensate at necessary intervals, and provided with drain valves 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.

3.7.3.5 Gas cocks or valves shall be provided for all buildings at points where they will be readily accessible for shutting off the gas supply to these buildings in any emergency. Underground valve boxes or manholes should be avoided wherever possible. When used they should be constructed so as to provide good natural ventilation. There shall also be provided a shut-off valve in the discharge line from the generator, gas holder, manifold or other source of supply.

3.7.3.6 When combustible 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.

3.7.3.7 No welding or cutting shall be performed on an acetylene or oxygen pipe line, 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.

3.7.4 Testing. All piping and valves shall be tested and proved gas-tight at one and one-half times the maximum working pressure and shall be thoroughly purged of air before being placed in service. Any medium used for testing oxygen lines must be oil-free. Flames shall not be used to detect leaks.

3.7.5 Painting and Signs

3.7.5.1 All buried pipe and tubing and all outdoor ferrous pipe and tubing shall be covered or painted to protect against corrosion.

3.7.5.2 All exposed oxygen pipe lines should be identified by one color of paint, and all exposed fuel-gas pipes by a different color. Where more than one fuel gas is employed, the pipe lines supplying the different fuel gases shall be identified by distinctive means.

3.7.5.3 Where colors are used as a means of identification a color chart indicating the colors employed for this purpose shall be prominently displayed or the piping shall be otherwise identified.

3.7.5.4 All outlet stations shall be suitably identified.

3.7.5.5 Signs clearly establishing the location and identity of section shut-off valves should be provided.

3.7.6 Hydraulic Back-Pressure Valves. The terms *hydraulic back-pressure valves, hydraulic valves* and *hydraulic seals* are used interchangeably.

3.7.6.1 In low-pressure fuel-gas systems where the gas is piped at a pressure not in excess of 1 psi., an approved hydraulic back-pressure valve shall be employed at every point where gas is withdrawn from the piping system to supply a torch* or machine†. A shut-off valve shall be installed at the inlet of each hydraulic back-pressure valve.

3.7.6.2 In fuel-gas systems where the gas is piped at a pressure in excess of 1 psi., an approved pressure-reducing regulator, an approved back-flow check valve or an approved hydraulic back-pressure valve shall be employed at every point where the gas is withdrawn from the piping system to supply a torch or machine. A shut-off valve shall be installed at the inlet of each hydraulic back-pressure valve, regulator or back flow-check valve.

3.7.6.3 The escape or relief pipe from hydraulic back-pressure valves should be at least as large as the vent connection on the hydraulic back-pressure valve. The escape or relief pipe should be installed without low points where moisture may collect. If shop conditions make low points unavoidable, these points should be provided with drip pots normally closed with screw caps or plugs. No petcocks shall be used.

3.7.6.4 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 above the ground, preferably above the roof, and as far

*As many as four torches may be suppled from one hydraulic back-pressure valve through rigid piping connected to the hydraulic outlet provided each outlet from such piping is equipped with a shut-off valve, and provided the fuel-gas capacity of any one torch does not exceed 15 cu. ft. per hour.

†The term *machine* is used here to mean a machine in which one or more torches are incorporated.

as practicable from windows or other openings into buildings, and as far as practicable from sources of ignition such as flues or chimneys, and tracks used by locomotives. 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 from combustible construction. No valves shall be installed between the vessel and the safety valve nor in the safety valve discharge line.

3.7.6.5 Correct liquid levels in hydraulic back-pressure valves shall be maintained. Such liquid levels shall be checked at intervals frequent enough to insure correctness of same. Permanent type antifreeze may be used in hydraulic back-pressure valves for manifold branch lines and station outlet service, but not hydraulic back-pressure valves on acetylene generators.

3.7.7 Portable Outlet Headers. The term *portable outlet header* is used to mean any assembly of valves and connections used for service outlet purposes, which is connected to the service piping system by means of hose or other nonrigid conductors. Devices of this nature are commonly used at piers and drydocks in shipyards where the service piping cannot be located close enough to the work to provide a direct supply.

3.7.7.1 Use of portable outlet headers shall be restricted to locations out-of-doors, and to temporary service where the conditions preclude a direct supply from outlets located on the service piping system.

3.7.7.2 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 shut-off valve located in a readily accessible position. Where conditions at the location permit, the installation of a hydraulic back-pressure valve on the supply outlet of the fuel-gas service piping is sometimes desirable.

3.7.7.3 Hose and hose connections used for connecting the portable outlet header to the service piping outlet shall comply with the Standards specified in 3.11.

3.7.7.4 Connection fittings for the supply hose shall comply with the requirements specified in 3.11.5. These requirements provide that connections for oxygen hose shall be of sufficiently different dimension or pattern from that for fuel-gas hose to prevent intermixing in making a connection.

3.7.7.5 Master shut-off valves for both oxygen and fuel gas shall be provided at the entry end of the portable outlet header.

3.7.7.6 Outlet headers for fuel-gas service shall be provided with approved hydraulic back-pressure valves installed at the inlet ends preceding the service outlets unless an approved pressure-reducing regulator, approved back-flow check valve or approved hydraulic back-pressure valve is employed at each outlet. Outlets provided on headers for oxygen service may be fitted for the use of pressure-reducing regulators or for direct hose connections.

3.7.7.7 Each service outlet on the portable header unit shall be provided with a valve assembly that includes a detachable outlet seal cap, chained or otherwise attached to the body of the valve.

3.7.7.8 Materials and fabrication procedures employed in the construction of portable outlet headers shall comply with the requirements stated in 3.7.1.1, 3.7.1.2 and 3.7.1.3; 3.7.2, 3.7.4 and 3.7.5.2 and 3.7.5.4.

3.7.7.9 Portable outlet headers shall be provided with frames which will support the equipment securely in its correct operating position, and protect it from physical damage during handling and operation.

3.8 STORAGE, HANDLING AND USE OF OXYGEN AND FUEL-GAS CYLINDERS

3.8.1 General. Department Regulations relative to the storage of cylinders shall be observed.

3.8.2 Storage—General

3.8.2.1 Cylinders should be kept away from radiators and other sources of heat.

3.8.2.2 Inside of buildings, cylinders shall be stored in a well-protected, well-ventilated, dry location, well away 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. Cylinders shall not be kept in unventilated enclosures such as lockers and cupboards.

3.8.2.3 Inside of buildings, cylinders of oxygen should not be stored in close proximity to cylinders of fuel gas; unless well separated, there should be a fire-resisting partition between the oxygen cylinders and fuel gas cylinders.

3.8.2.4 All cylinders shall be protected against excessive rise in temperature. Cylinders may be stored in the open, but in such case they should be protected against extremes of weather. During winter, cylinders stored in the open should be protected against accumulation of ice or snow. Warm (not boiling) water shall be used to thaw ice in cylinder valve outlets. Cylinders stored in the open should be screened against the continuous direct rays of the sun in localities where extreme temperatures prevail. Cylinders containing oxygen should be stored separate from cylinders containing fuel gases.

3.8.2.5 Full cylinders of oxygen should be used in rotation as received from the supplier.

3.8.2.6 Empty cylinders shall have their valves closed.

3.8.2.7 Valve protection caps, when provided for, shall always be in place, hand-tight, except when cylinders are in use or connected for use.

3.8.3 Handling—General

3.8.3.1 When transporting cylinders by a crane or derrick, a cradle, boat or suitable platform should be used. Slings or electric magnets shall not be used for this purpose. Valve-protection caps, when provided for, shall always be in place.

3.8.3.2 Cylinders should be moved by tilting and rolling them on their bottom edges dragging and sliding should be avoided. When cylinders are transported by vehicle they should be secured in position. Cylinder shall not be dropped or struck or permitted to strike each other violently.

3.8.3.3 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. Before raising cylinders provided with valve-protection caps from a horizontal to a vertical position, the cap should be properly in place, the cap should be turned clockwise to see that it is hand-tight, then the cylinder should be raised by grasping the cap.

3.8.3.4 A suitable cylinder truck, chain or steadying device should be used to keep cylinders from being knocked over while in use.

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

3.8.3.6 Cylinder valves shall be closed before moving cylinders.

3.8.3.7 Cylinder valves shall be closed when work is finished.

3.8.3.8 Valves of empty cylinders shall be closed.

3.8.3.9 Cylinders should preferably be kept far enough away from the actual welding or cutting operation so that sparks, hot slag or flame will not reach them. Where this is impractical, nonflammable, fire-resistant shields should be provided.

3.8.3.10 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.

3.8.3.11 Cylinders shall never be used as rollers or supports, whether full or empty.

3.8.3.12 The numbers and markings stamped into cylinders shall not be tampered with.

3.8.3.13 Empty cylinders should be marked *empty* or *MT*, segregated from full cylinders and promptly returned to the supplier with valve-protection caps in place. All valves shall be closed.

3.8.3.14 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. No one shall use a cylinder's contents for purposes other than those intended by the supplier.

3.8.3.15 No one shall tamper with safety devices in cylinders or valves.

3.8.4 Fuel-Gas Cylinders

3.8.4.1 Fuel gases shall be called by their proper names and not by the word *gas*.

3.8.4.2 Storage—Fuel-Gas Cylinders

3.8.4.2a Inside a building, cylinders, except those in actual use or attached ready for use, shall be limited to a total gas capacity of 2000 cubic feet. In large, well-ventilated one-story buildings, special exceptions to this rule may be granted.

3.8.4.2b For storage in excess of 2000 cubic feet total gas capacity of cylinders, a separate room or compartment conforming to the requirements specified in 3.2.5.2 and 3.2.5.3 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 pounds, when contained in metal packages complying with 3.6.2 and 3.6.3. Signs should be conspicuously posted in such rooms reading, **"Danger—No Smoking, Matches or Open Lights,"** or other equivalalent wording. (See *Specifications for Industrial Accident Prevention Signs*, American Standard Z35.1–1941.)

3.8.4.2c Fuel gas cylinders shall be placed with valve end up whenever they are in use. Acetylene cylinders shall be stored valve end up.

3.8.4.2d Storage of liquefied petroleum gas shall be in compliance with the requirements of Departmental regulations on the use, storage and handling of liquefied petroleum gas.

3.8.4.3 Use—Fuel-Gas Cylinders

3.8.4.3a Fuel-gas cylinders shall be handled carefully. (Rough handling, knocks, or falls are liable to damage the cylinder, valve or safety devices and cause leakage.)

Before connecting a regulator to a cylinder valve, the valve shall be opened slightly and closed immediately. (This action is generally termed *cracking*.) This action is intended to clear the valve of dust or dirt that otherwise might enter the regulator. 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.

3.8.4.3b Before a regulator is removed from a cylinder valve, the cylinder valve shall always be closed and the gas released from the regulator.

3.8.4.3c 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.

3.8.4.3d If when the valve on a fuel-gas cylinder is opened there is found to be a leak around the valve stem, the valve should be closed and the gland nut tightened. If this does not stop the leak, the use of the cylinder should be discontinued, it should be removed to the out-of-doors, properly tagged and the supplier advised. In case the fuel gas should leak from the cylinder valve, and cannot be shut off with the valve stem, the cylinder should be removed to the outdoors, properly tagged and the supplier advised. A regulator may be attached to a cylinder valve to stop temporarily a leak through the valve seat.

3.8.4.3e If a leak should develop at a fuse plug or other safety device, the cylinder should be removed to the out-of-doors well away from any source of ignition, the cylinder valve should be opened slightly and the fuel gas allowed to escape slowly.

3.8.4.3f 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.

3.8.4.3g Safety devices shall not be tampered with.

3.8.4.3h Fuel gas shall never be used from cylinders through torches or other devices equipped with shut-off valves without reducing the pressure through a suitable regulator attached to the cylinder valve or manifold.

3.8.4.3i The cylinder valve shall always be opened slowly.

3.8.4.3j An acetylene cylinder valve shall not be opened more than 1½ turns of the spindle.

3.8.4.3k 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.

3.8.4.3l Use of liquefied petroleum gas shall be in compliance with Departmental regulations on the use, storage and handling of liquefied petroleum gas.

3.8.5 Oxygen Cylinders

3.8.5.1 The following important precautions shall be observed:

3.8.5.1a Always refer to oxygen by its proper name *oxygen* and not, for example, by the word *air*. Oxygen will not burn, but supports and accelerates combustion, and will cause oil and other similar materials to burn with great intensity. Oil or grease in the presence of oxygen under pressure may ignite violently.

WARNING

A serious accident may easily result if oxygen is used as a substitute for compressed air. Never use oxygen in pneumatic tools, in oil preheating burners, to start internal-combustion engines, to blow out pipe lines, to dust clothing or work, to create pressure or for ventilation.

3.8.5.1b 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. Oxygen cylinders should never be handled on the same platform with oil or placed in a position where oil or grease from overhead cranes or belts is likely to fall upon them. A jet of oxygen should never be permitted to strike an oily surface, greasy clothes, or enter a fuel oil or other storage tank.

3.8.5.2 Storage—Oxygen Cylinders

3.8.5.2a 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.

3.8.5.3 Use—Oxygen Cylinders

3.8.5.3a Oxygen cylinders shall not be dropped or otherwise roughly handled.

3.8.5.3b 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. (This action is generally termed *cracking*.) This action is intended to clear the valve of dust or dirt that otherwise might enter the regulator. Always stand to one side of the outlet when opening the cylinder valve.

3.8.5.3c A hammer or wrench shall not be used to open oxygen cylinder valves. If valves cannot be opened by hand, the supplier should be notified.

3.8.5.3d Oxygen cylinder valves shall not be tampered with nor should any attempt to repair them be made. 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 return should be followed.

3.8.5.3e After a regulator is attached, an oxygen cylinder valve should be opened slightly at first so that the regulator cylinder-pressure-gage hand moves up slowly; then the valve should be opened all the way. If the high pressure is suddenly released, it is liable to damage the regulator and pressure gages. Stand to one side of the regulator and not in front of the glass-covered gage faces when opening the cylinder valve.

3.8.5.3f When the oxygen cylinder is in use, the valve should be opened fully in order to prevent leakage around the valve stem. Complete removal of the stem from a diaphragm-type cylinder valve shall be avoided.

3.9 MANIFOLDING OF CYLINDERS

3.9.1 General

3.9.1.1 Cylinder manifolds should be obtained from, and be installed under the supervision of someone familiar with the proper practices

with reference to their construction and use.

3.9.1.2 All component parts used in the methods of manifolding described in 3.9.2 shall be approved as to materials, design and construction either separately or as an assembled unit.

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

3.9.1.4 When acetylene cylinders are coupled, approved flash arresters shall be installed between each cylinder and the coupler block. For outdoor use only, and where the number of cylinders coupled does not exceed 3, one flash arrester installed between the coupler block and regulator is acceptable.

3.9.1.5 Each fuel gas cylinder lead should be provided with a backflow check valve.

3.9.1.6 The aggregate capacity of fuel gas cylinders connected to a portable manifold inside a building shall not exceed 3000 cubic feet of gas.

3.9.1.7 Acetylene and liquefied fuel gas cylinders shall be manifolded in a vertical position.

3.9.2 Manifolding Cylinders for Direct Supply to Consuming Devices

NOTE: The units described in 3.9.2.2 and 3.9.2.3 are generally called *Portable Manifolds*.

3.9.2.1 In one type of manifolding the gas passes from the cylinders through individual cylinder leads to a single, common coupler block and from there through a single common pressure-reducing regulator to the consuming device.

3.9.2.2 In a second type of manifolding the cylinders are connected together in sequence. The individual cylinders are provided with coupler tees attached to the cylinder valve. The gas content of each cylinder passes through the coupler tee and joins the main gas stream flowing through a common line composed of leads joining coupler tee to successive coupler tee. A properly supported regulator serves the entire group of connected cylinders.

3.9.2.3 The aggregate capacity of fuel gas cylinders connected as a unit inside a building as described in 3.9.2.1 or 3.9.2.2 shall not exceed 3000 cubic feet of gas or 300 lb. in the case of liquefied petroleum gas.

3.9.3 Manifolding of Cylinders for Shop Pipe Line Supply Systems

3.9.3.1 Stationary manifolds for shop supply lines shall comply with 3.9.3.2 and 3.9.4.

3.9.3.2 Fuel gas manifolds (acetylene, liquefied fuel gases and nonliquefied fuel gases other than acetylene) shall comply with the following requirements:

3.9.3.2a Only cylinders containing fuel gas at approximately equal pressure should be manifold.

3.9.3.2b Except as provided in 3.9.3.2c fuel-gas cylinders connected to one manifold inside a building shall be limited to a total gas capacity not exceeding 3000 cubic feet. More than one such manifold, each supplying one torch or one machine, may be located in the same room if separated by at least 50 feet.

3.9.3.2c Where it is necessary to manifold fuel-gas cylinders having an aggregate gas capacity in excess of 3000 cubic feet, they shall be located outside or in a special building or in a separate room constructed in accordance with the provisions of 3.2.4 or 3.2.5 respectively.

3.9.3.2d Special buildings or rooms, if provided, shall have no other occupancy except that they may be used for the storage of cylinders containing fuel gases and drums of calcium carbide as provided for in 3.6.6.1. Such buildings or rooms shall have no open flames for heating or lighting and shall be well ventilated.

3.9.4 Oxygen Manifolds

3.9.4.1 Oxygen manifolds shall not be located in an acetylene generator room, nor in close proximity to cylinders of combustible gases. Unless well separated, there should be a fire-resistant partition of one of the types of construction listed in 3.2.5.2 between the oxygen manifold and the combustible gas cylinders. Oxygen manifolds shall be located away from highly flammable material especially oil, grease or any substance likely to cause or accelerate fire.

3.9.4.2 Oxygen manifolds to which cylinders having an aggregate capacity of more than 6000 cubic feet of oxygen are connected should preferably be located outside or in a special building. If located inside a building having other occupancy, such manifolds shall be located in a separate room of fire-resistant construction or in an area of fire-resistant construction with no combustible material within 20 feet of the manifold.

3.9.5 Liquid Oxygen

3.9.5.1 Where liquid oxygen in a quantity exceeding 100 gallons is to be used for welding or cutting, the container or containers shall be located outside or in a special building having no other occupancy except that related to the handling and gasification of the oxygen.

3.10 PRESSURE-REDUCING REGULATORS

3.10.1 Pressure-reducing regulators, both adjustable and nonadjustable, shall be used only for the gas and at pressures for which they are intended. The regulator inlet connections shall comply with *Regulator Connection Standards* of the International Acetylene Association, 1953.

3.10.2 Pressure-adjusting screws on regulators should always be fully released and the regulator drained of gas before the regulator is attached to a cylinder or before the cylinder valve is opened.

3.10.3 When repairs to regulators or parts of regulators such as gages are necessary, such repairs shall be performed only by skilled mechanics properly instructed in the work. Working or low-pressure gages at-

tached to regulator should be periodically tested to insure their accuracy. Do not test oxygen gages with oil. In general it is best to return regulators to the supplier for repairs, calibrations or adjustments.

3.10.4 Union nuts and connections on regulators should be inspected before use to detect faulty seats which may cause leakage of gas when the regulators are attached to the cylinder valves. When damaged nuts or connections are found, they shall be removed from service.

3.11 HOSE AND HOSE CONNECTIONS

3.11.1 Hose for oxy-fuel gas service shall comply with the *Specification for Rubber Welding Hose* of the International Acetylene Association and Rubber Manufacturers Association, 1955.

3.11.2 The generally recognized colors are red for acetylene and other fuel-gas hose, green for oxygen hose, and black for inert-gas and air hose.

3.11.3 When parallel lengths of oxygen and acetylene hose are taped together for convenience and to prevent tangling, not more than four inches out of eight inches shall be covered by tape.

3.11.4 Metal-clad or armored hose is not recommended. However, as part of a machine or an appliance when conditions of use make metal reinforcing advantageous, hose may be used in which such metal reinforcing is exposed to neither the inside gases nor the outside atmosphere.

3.11.5 Hose connections shall comply with the *Standard Hose Connection Specifications* of the International Acetylene Association, 1953.

3.11.6 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. Oil-free air or an oil-free inert gas shall be used for the test.

3.11.7 Hose shall be inspected frequently for leaks, burns, worn places, loose connections or other defects which may render the hose unfit for service. Where hose shows excessive wear or has been subjected to flashback, it shall be inspected and tested with oil-free air or an oil-free inert gas at twice the normal pressure to which it is subjected in service, but in no case less than 200 psi., before being returned to service. Defective lengths of hose shall be discarded. Hose reels, if used, shall be of approved design.

4. Application, Installation and Operation of Arc Welding and Cutting Equipment

4.1 GENERAL

4.1.1 Welding equipment shall be carefully chosen for safe application to the work to be done as specified in 4.2.

4.1.2 Welding equipment shall be installed safely as specified by 4.3.

4.1.3 Workmen designated to operate arc welding equipment shall have been properly instructed and qualified to operate such equipment as specified in 4.4.

4.2 APPLICATION OF ARC WELDING EQUIPMENT

4.2.1 General

4.2.1.1 The safety aspects of welding should be given consideration when choosing arc welding equipment for the job to be done. Assurance of consideration of safety in design is obtainable by choosing apparatus complying with the National Electrical Manufacturers Association *Electric Arc Welding Machine Standards* or *Underwriters' Laboratories, Inc. Standard for Transformer Type Arc Welding Machines* (American Standard C33.2–1956). Special purpose machines not covered by these standards should conform in all applicable respects to these standards.

4.2.2 Environmental Conditions

4.2.2.1 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 exced 40° C (104° F) and where the altitude does not exceed 3300 feet, and shall be suitable for operation in atmospheres containing gases, dust and light rays produced by the welding arc and shall be suitable for operation in salt or moist air as in shipboard or sea coast use.

4.2.2.2 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:

1. Exposure to unusually corrosive fumes.
2. Exposure to steam or excessive humidity.
3. Exposure to excessive oil vapor.
4. Exposure to flammable gases.
5. Exposure to abnormal vibration or shock.
6. Exposure to excessive dust.
7. Exposure to weather.

4.2.3 Voltage

4.2.3.1 Open circuit (No load) voltages of arc welding machines should be as low as possible consistent with satisfactory welding of the type being done. The following limits shall not be exceeded:

(a) For manual shielded metal-arc welding.
  (1) Single operator DC welding machines–100 volts.
  (2) Constant potential multiple operator DC welding machines–80 volts.
  (3) AC welding machines–80 volts.

(b) For other manual and automatic welding and cutting processes in which the work metal is connected electrically to one side of the circuit.

(1) 150 volts providing that all equipment and circuitry are fully insulated so that the operator cannot make electrical contact other than through the arc itself while the arc is maintained and further provided that automatic disconnecting or voltage reducing means which have been demonstrated to be durable and reliable are provided as a part of the equipment and which operate within a time not exceeding one second after breaking of the arc.

(c) Welding equipment in which neither side of the circuit is connected electrically to the work.

(1) 300 volts providing control means are included preventing the operator from touching both sides of the circuit by requiring him to use at least one hand to operate control initiation devices and further providing the voltage is removed automatically by durable and reliable switch means instantly upon breaking the arc.

(d) There shall be protective means for automatically disconnecting during arc off periods power from equipment working through resistors from DC trolley voltages of 250 to 600 volts.

(e) For AC welding under wet conditions or warm surroundings where perspiration is a factor, the use of reliable automatic control means for reducing no load voltage is recommended.

4.2.4 Design

4.2.4.1 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 the National Electrical Code, American Standard C1–1956, Section 4327*.

4.2.4.2 Controllers or switches integrally mounted in AC machines or rectifier machines shall be capable of meeting the overload and endurance tests specified in *"Standards for Transformer Type Arc Welding Machines," Underwriters' Laboratories, Inc.* American Standard C33.2 –1956.

4.2.4.3 On all types of arc welding machines, control apparatus shall be enclosed except for the operating wheels, levers or handles. Control handles and wheels should be large enough to be easily grasped by a gloved hand.

*Starters with magnetic undervoltage release should be used with machines installed more than one to a circuit to prevent circuit overload caused by simultaneous starting of several motors upon return of voltage.

4.2.4.4 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.

4.2.4.5 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 the use of: dead–front receptacles for plug connections; recessed openings with non-removable 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 shall be marked to indicate that it is grounded.

4.2.4.6 No connections for portable control devices such as push buttons to be carried by the operator shall be connected to an AC 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.

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

4.2.5 Equipment Loading

4.2.5.1 Care should be taken in applying arc welding equipment to insure that the current rating chosen is adequate to handle the job. Welding machines should not be operated above their current ratings and corresponding rated duty cycles listed in the standards or above the limits specified by the manufacturer. Consideration should be given to the fact that actual welding currents may be higher than shown by indicators on the machines if welding is done with short leads or low arc voltages; particularly high over-currents are likely on general-purpose welding machines when welding with low arc voltage processes such as air-carbon arc cutting, oxygen-arc cutting or gas-tungsten arc welding.

4.2.5.2 Welding cables should be of the extra flexible type designed especially for the rigors of welding service and of size adequate for current and duty cycles reasonably to be expected. Special attention should be paid to insulation of cables used with equipment which includes high voltage high frequency oscillators. For average manual shielded metal-arc welding duty cycles, the following table may be used as a guide for current capacity; for automatic or semi-automatic installations where duty cycles approach 100%, cables should be in accordance with Chapter 10, Table 2, National Electrical Code. These ratings are for operation with cables exposed to air singly and not bundled, enclosed in conduit or coiled.

Table 1—Cable Sizes for Arc-Welding Machines Based on Safe Operating Temperatures

Welding Current, Amp.	Copper Cable Size No.	Cable Size No. Aluminum
100	4	4
150	3	2
200	2	0
300	1/0	3/0
400	2/0	4/0
500	3/0	—
600	4/0	—

4.3 INSTALLATION OF ARC WELDING EQUIPMENT

4.3.1 General

4.3.1.1 Installation including power supply shall be in accordance with the requirements of the *National Electrical Code*, American Standard C1–1956.

4.3.2 Grounding

4.3.2.1 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 the *National Electrical Code*, American Standard C1–1956, Article 250 for fixed or portable electrical equipment.

4.3.2.2 The work or metal upon which the operator welds should be grounded to a good electrical ground. This can be done by locating the work on a grounded metal floor or platen or by connection to grounded building frame or other satisfactory ground. Alternatively it may be done by grounding the work lead at or near the welding machine. Care should be taken, however, to avoid double grounding as otherwise welding current may flow through a connection intended only for safety grounding and may be of higher magnitude than the grounding conductor can safely carry. Special radio frequency grounding is advisable for equipment using high frequency arc stabilizers. Refer to *Recommended Installations and Test Procedures for High Frequency Stabilized Arc Welders*–1953 NEMA.

4.3.2.3 Welding current preferably should be returned to the welding machine by a single cable from the work to the welding machine. Connection of a cable from the welding machine to a common conductor or structure on which the work rests, or to which the work is connected, is a permissible procedure. AC machines in groups of 3 connected in delta to a 3-phase supply circuit and in "Y" on the secondary circuit may use a single work lead from the 3 units to the structure being welded of size suitable for the current rating of one machine. Refer to 4.3.3.4 for voltage and shock considerations.

4.3.2.4 Conduits containing electrical conductors shall not be used for completing a work lead circuit. Pipe lines 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. For other precautions see 4.4.1.

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

4.3.2.6 When during construction or modification, a building or any other fabricated metal structure is used for a welding current return circuit, it should be checked to ascertain whether proper electrical contact exists at all joints. Sparking or heating at any point shall cause rejection of the structure as a return circuit.

4.3.2.7 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 and appropriate periodic inspection should be conducted to ascertain that no condition of electrolysis or shock, or fire hazard exists by virtue of such use.

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

4.3.2.9 When it becomes necessary to carry cable some distance from the machines, they should be substantially supported overhead, if practicable. If this cannot be done, and cables are laid on the floor or ground, they should be protected in such a manner that they will not be damaged, entangled or interfere with safe passage. Special care should be taken to see that welding supply cables are not in proximity to power supply cables or other high-tension wires.

4.3.3 Supply Connections and Conductors

4.3.3.1 A disconnecting switch or controller shall be provided at or near each welding machine which is not equipped with such switch or controller mounted as an integral part of the machine. The switch shall be in accordance with National Electrical Code, American Standard C1–1956. Over current protection shall be provided as specified in the National Electrical Code, American Standard C1–1956, Article 630. A disconnect switch with overload protection or equivalent disconnect and protection means, permitted by the National Electrical Code, shall be provided for each outlet intended for connection to a portable welding machine.

4.3.3.2 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.

4.3.3.3 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. The load value used for each welding machine shall take into account both the magnitude and the duration of the load while the machine is in use. Conductor ratings, based on 100% of the rated primary current of the two largest welding machines, 85% for the third largest welding machine, 70% for the fourth largest welding machine, and 60% of the rated primary current for all the remaining welding machines, should provide an ample margin of safety under high production conditions with respect to the maximum permissible temperature of the conductors. Percentage values lower than those given are permisible in cases where the work is such that a high operating duty cycle for individual machines is impossible; conversely, for groups of simultaneously operating automatic welding machines higher percentage values may be required.

4.3.3.4 In operations involving several welders on one structure, DC welding process requirements may require the use of both polarities; or supply circuit limitations for AC 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 DC or 1, 1.41, 1.73 or 2 times normal on AC machines. Similar voltage differences will exist if both AC and DC welding are done on the same structure. Care should, therefore, be taken to eliminate the probability of welders touching two electrode holders simultaneously. If this cannot be done machines shall be connected as follows:

(1) All DC machines shall be connected with the same polarity*.

(2) All AC machines shall be connected to the same phase of the supply circuit and with the same instantaneous polarity*.

4.4 OPERATION AND MAINTENANCE

4.4.1 Workmen assigned to operate or maintain arc welding equipment shall be acquainted with the requirements of Section 4, especially the following parts of Section 4; also the requirements of Section 6: Fire Prevention; Section 7: Protection of Personnel; and Section 8: Health Protection and Ventilation; if doing gas-shielded arc welding also *Recommended Safe Practices for Inert-Gas Metal-Arc Welding*, American Welding Society A6.1-55.

4.4.2 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

*In either case a 120 volt incandescent lamp may be used to test; if connections are correct the lamp will not glow when connected between the electrode holders of machines at no load.

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. Jobs requiring alternately long and short cables should be equipped with insulated connectors so that idle long lengths can be disconnected when not needed.

4.4.3 Grounding of the welding machine frame shall be checked. Special attention shall be given to safety ground connections of portable machines.

4.4.4 There shall be no leaks of cooling water, shielding gas or engine fuel.

4.4.5 It shall be determined that proper switching equipment for shutting down the machine is provided.

4.4.6 Printed rules and instructions covering operation of equipment supplied by the manufacturers shall be strictly followed.

4.4.7 When the welder has occasion to leave his work or stop work for any appreciable time, or when the machine is to be moved, the power supply switch in the equipment should be open. The equipment should be disconnected from the source of power when not in use.

4.4.8 Metal and carbon electrodes should be removed from holders when not in use to eliminate danger of electrical contact with persons or conducting objects. Tungsten electrodes should be removed or retracted within holders. Electrodes in wire form in semi-automatic holders should be retracted or cut off to remove possibility of contact. 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.

4.4.9 Electric Shock

4.4.9.1 Avoidance of electric shock is largely within the control of the welding operator, therefore, it is especially important that he be thoroughly instructed in detail how to avoid shock. Voltages required for arc welding are low and normally will not cause injury or severe shock, thus parts having these voltages are likely to be handled carelessly. These voltages are nevertheless sufficiently high that under some circumstances they may be dangerous to life. Severity of shock is determined largely by the amount of current flowing through the body and this is determined by voltage and contact resistance of the area of skin involved. Clothing damp from perspiration or wet working conditions may so reduce contact resistance as to increase an imperceptible current to a value high enough to cause such violent muscular contraction as to prevent the operator from letting go of the live part. The operator should never permit the live metal parts of an electrode holder to touch his bare skin or any wet covering of his body. He should also protect himself from electrical contact with the work or ground by dry insulating material; particularly he should be protected against large area contacts by insulation when working in a sitting or prone position. He should not use

electrode holders for manual shielded metal-arc welding without well insulated jaws in good repair. Electrode holders must not be cooled by immersion in water. Water cooled holders for tungsten arc and consumable electrode welding must not be used if any water leak exists. The welding machine supplying power to the arc must always be turned off whenever changing electrodes in tungsten arc electrode holders, or whenever threading coiled electrodes into consumable electrode equipment. Special precautions should be taken to prevent shock-induced falls when the operator is working above ground level. Even mild shocks, not dangerous in themselves from normal working voltages or from high frequency stabilizers, can cause involuntary muscular contraction leading to injurious falls from high places. The welder should not coil or loop welding electrode cable around parts of his body and should not use cables with splices or repaired insulation within 10 feet of the holder.

4.4.10 Maintenance

4.4.10.1 All arc welding equipment should be maintained in safe working order at all times. Periodic inspections are strongly recommended. 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.

4.4.10.2 Welding equipment should be maintained in good mechanical and electrical condition to avoid unnecessary hazards. Commutators should be kept clean to prevent excessive flashing. Flammable liquids should not be used for cleaning commutators; fine sand paper such as No. 00 or commutator polish should be used. Rectifiers should be frequently inspected to detect accumulations of dust or lint that would interfere with ventilation. Electrical coil ventilating ducts should be similarly inspected and cleaned. It is a good practice to blow out the entire welding machine with clean dry compressed air. Fuel systems on engine driven machines should be inspected and checked for possible leaks and accumulations of water that might cause rusting. Rotating and moving components should be kept properly lubricated.

4.4.10.3 Welding equipment used in the open should be protected from inclement weather conditions. Protective cover shall not obstruct the ventilation necessary to prevent overheating of the machine. Air filters in the ventilating system of the electrical components are not recommended. The reduction of air flow caused by even a clean filter may cause overheating, and a dirty filter will reduce air flow dangerously.

4.4.10.4 When not in use the equipment should be stored in a clean dry place. Machines which have become wet shall be thoroughly dried and tested before being used.

4.4.10.5 Work and electrode lead cables should be frequently inspected for wear and damage. Cut insulation or exposed bare conductors should

be protected by good grade electrical tapes and repairs should be water tight. Splices should be made by well insulated welded joints or pressure connectors. Bolted cable lugs are not recommended because of the difficulty of insuring tightness and insulation reliability.

4.4.10.6 To insure against overheating periodic checks should be made with portable ammeters to make sure that load current has not increased beyond the capacity of the welding machine, cable or torch.

4.4.10.7 Welding cables should be kept dry where practical and free from grease and oil.

5. Installation and Operation of Resistance Welding Equipment

5.1 GENERAL

5.1.1 All equipment* shall be installed by a qualified electrician in conformance with the *National Electrical Safety Code,* American Standard C2—1956, the *National Electrical Code,* American Standard C1—1956 There shall be a safety-type disconnecting switch or its equivalent (such as a circuit breaker or circuit interrupter) opening all power circuits to the machine, 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.

5.1.2 Workmen designated to operate resistance-welding equipment shall have been properly instructed and judged competent to operate such equipment.

5.2 SPOT- AND SEAM-WELDING MACHINES

5.2.1 All external weld initiating control circuits shall operate on low voltage not over 120 volts, for the safety of the operators.

5.2.2 In case of stored energy or condenser discharge type of resistance-welding equipment, control panels involving high voltage (over 550 v.) shall be suitably insulated and protected by complete enclosures, any door of which shall be provided with suitable locks and contacts wired in the control circuit (similar to elevator interlocks). Such interlocks or contacts shall be so designed as to effectively short circuit all condensers when any door or panel is open. A manually operated switch should be installed in addition to the mechanical interlocks or contacts as an additional safety measure assuring absolute discharge of all condensers.

5.2.3 Back doors of machines and panels should be kept locked or interlocked to prevent tampering by unauthorized persons.

*Appropriate standard specifications for resistance-welding equipment may be obtained from the Resistance Welder Manufacturer's Assn., 505 Arch St., Philadelphia, Pa.

5.2.4 Any press welding machine operation where there is a possibility of the operator's fingers being under the point of operation shall be effectively guarded similar to any punch press operation. All chains, gears and belts shall be protected by adequate guards in accordance with Safety Regulation No. 4 relating to the Safeguarding of Mechanical Power Transmission Apparatus.

5.2.5 The hazard of flying sparks shall be eliminated by installing a shield guard of safety glass or cellulose acetate at the point of operation. Additional shields or curtains shall be installed as necessary to protect passing persons from flying sparks. (See 7.2.1.3—Eye Protection.)

5.2.6 Foot switches, air or electrical, should be guarded to prevent accidental operation of the machine.

5.3 PORTABLE WELDING MACHINES

5.3.1 All portable welding guns shall have suitable counterbalanced devices for supporting the gun, including cables.

5.4 FLASH-WELDING EQUIPMENT

5.4.1 When flash-welding machines over 50 kva. are used, they shall be equipped with a hood to control the flying flash. In cases of high production, including the handling of oily parts, an adequate ventilating system shall be installed to carry off the metallic dust and oil fumes.

5.4.2 For the protection of operators of near-by equipment, fire-resistant curtains or suitable shields shall be set up around the machine and in such a manner that the operator's movements are not hampered.

5.4.3 Controls of all automatic or air and hydraulic clamps should be so arranged as to prevent the operator from closing the clamps with his hands on the work or on the clamps during the closing operation.

5.5 HAZARDS AND PRECAUTIONS

A careful job-analysis shall be made of the operations to be performed on each welding machine to determine the safeguards and personal protective equipment that shall be used for each job.

6. Fire Prevention and Protection

6.1 BASIC PRECAUTIONS

The basic precautions for fire prevention in welding or cutting work are:

6.1.1 Where practicable, move the object to be welded or cut to a designated safe location.

6.1.2 If the object to be welded or cut cannot readily be moved, all movable fire hazards in the vicinity shall be taken to a safe place.

6.1.3 If the object to be welded or cut cannot be moved and if all the fire hazards cannot be removed, then guards shall be used to confine the heat, sparks and slag, and to protect the immovable fire hazards.

6.1.4 If the rules stated in 6.1.1, 6.1.2 and 6.1.3 above cannot be followed then welding and cutting shall not be performed.

6.2 SPECIAL PRECAUTIONS

When the nature of the work to be performed falls within the scope of rule 6.1.3, certain additional precautions may be necessary:

6.2.1 After combustible floors have been swept clean, they should be protected by means such as thoroughly wetting with water, covering with damp sand, sheet metal, asbestos or equivalent. Provision shall be made to protect welders from the hazard of shock when floors are wet.

6.2.2 Wherever there are floor openings or cracks in the flooring that cannot be closed, precautions shall be taken so that no readily combustible materials on the floor below will be exposed to sparks which might drop through the floor. The same precautions shall be observed with regard to cracks or holes in walls, open doorways and open or broken windows.

6.2.3 Suitable fire extinguishing equipment shall be maintained in a state of readiness for instant use. Such equipment may consist of pails of water, buckets of sand, hose lines or portable extinguishers depending upon the nature and quantity of the combustible material exposed.

6.2.4 Additional personnel may be deemed necessary to be stationed as fire watchers not only while the actual welding or cutting operations are being performed but for a sufficient period of time after completion of the work to insure that no fire exists. This period may vary from 30 minutes to several hours, depending on conditions.

6.2.5 When welding or cutting must be done in a location not designed for such purposes, inspection and authorization by a designated person shall be required before such operations are begun.

6.2.6 The above precautions shall be applied in ship work to opposite sides of tank shells, decks, overheads and bulkheads where direct penetration of sparks or heat transfer in welding may introduce a fire hazard to an adjacent compartment.

6.3 WELDING OR CUTTING CONTAINERS

6.3.1 No welding, cutting or other hot work shall be performed on used drums, barrels, tanks or other containers until they have been cleaned so thoroughly as to make absolutely certain that there are no flammable materials present or any substances such as greases, tars, acids or other materials which, when subjected to heat, might produce flammable or toxic vapors. Any pipe lines or connections to the drum or vessel shall be disconnected or blanked. (See also 7.4.3.)

NOTES:

1. *See Safe Practices for Welding and Cutting Containers That Have Held Combustibles,* American Welding Society, A6.0–1952.
2. For the cleaning and gas-freeing of tanks, bunkers or compartments on board ship see *A Manual for the Safe Handling of Inflammable and Combustible Liquids,* U. S. Coast Guard, 1947 and *Standards for the Control of Gas Hazards on Vessels to be Repaired,* National Fire Protection Association, No. 306–1951.
3. For outside, aboveground petroleum storage tanks, etc., see *API Accident Prevention Manual No. 1–Cleaning Petroleum Storage Tanks*:
   Section A–Crude Oil and Unfinished Products Tanks.
   Section B–Gasoline Tanks.
4. For gasometers or gas holders for natural or manufactured gas see *Purging Principles and Practices,* American Gas Association, 1954.
5. For containers that have held nitrocellulose or pyroxylin solutions, the manufacturer or supplier should be consulted for proper methods of cleansing.
6. For tank vehicles and tank cars, see API Accident Prevention Manual No. 13, *Cleaning Mobile Tanks Used for Transportation of Flammable Liquids, Section A–Tank Vehicles,* American Petroleum Institute, 1955.
7. *Procedures for Cleaning or Safeguarding Small Tanks and Containers,* NFPA No. 327, National Fire Protection Association, 1957.

6.3.2 All hollow spaces, cavities or containers shall be vented to permit the escape of air or gases before preheating, cutting or welding. Purging with inert gas is recommended.

6.4 SPRINKLER PROTECTION

6.4.1 Where sprinkler protection exists, it should be maintained without interruption while welding or cutting work is being performed. If welding or cutting is to be done quite close to automatic sprinkler heads, sheet asbestos or damp cloth guards may be used to shield the individual heads temporarily.

6.5 CONFINED SPACES

6.5.1 When arc welding is to be suspended for any substantial period of time, such as during lunch or overnight, all electrodes shall be removed from the holders and the holders carefully located so that accidental contact cannot occur and the machine shall be disconnected from the power source.

6.5.2 In order to eliminate the possibility of gas escaping through leaks or improperly closed valves when gas welding or cutting, the torch valves shall be closed and the gas supply to the torch positively shut off at some point outside the confined area whenever the torch is not to be used for a substantial period of time, such as during lunch hour or overnight. Where practicable, the torch and hose shall also be removed from the confined space.

7. Protection of Personnel

7.1 GENERAL

7.1.1 A welder or helper working on platforms, scaffolds or runways shall be protected against falling. This may be accomplished by the use of railings, safety belts, life lines, or some other equally effective safeguard. Life belts and similar devices should be of a type that will permit quick escape of the workman.

7.1.2 Welders shall place welding cable and other equipment so that it is clear of passageways, ladders and stairways.

7.2 EYE PROTECTION*

7.2.1 Selection

7.2.1.1 Helmets or hand shields shall be used during all arc-welding or arc-cutting operations, excluding submerged arc welding. Goggles should also be worn during arc-welding or cutting operations to provide protection from injurious rays from adjacent work, and from flying objects. The goggles may have either clear glass or colored glass, depending upon the amount of exposure to adjacent welding operations.** Helpers or attendants shall be provided with proper eye protection.

7.2.1.2 Goggles or other suitable eye protection shall be used during all gas-welding or oxygen-cutting operations. Style 1 goggles (as defined in 7.2.2.6) with suitable lenses are permitted for use during gas-welding operations on light work, for torch brazing or for inspection. Styles 2 and 3 goggles may be used for all gas-welding and oxygen-cutting operations.

7.2.1.3 All operators and attendants of resistance-welding or resistance brazing equipment shall use transparent face shields or goggles, depending on the particular job, to protect their faces or eyes, as required.

7.2.1.4 Eye protection in the form of suitable goggles shall be provided where needed for brazing operations not covered in the preceding paragraphs.

7.2.2 Specifications for Protectors

7.2.2.1 Helmets and hand shields shall be made of a material which is an insulator for heat and electricity. Helmets, shields and goggles shall be not readily flammable and shall be capable of withstanding sterilization.

7.2.2.2 Helmets and hand shields shall be arranged to protect the face, neck and ears from direct radiant energy from the arc.

7.2.2.3 Helmets shall be provided with one or two windows arranged to accommodate and hold securely window lenses of the dimensions

*Most of the following material is taken from *Safety Code for the Protection of Heads, Eyes and Respiratory Organs,* American Standard Z2 (National Bureau of Standard Handbook H24–1938).

**Shade No. 2 is recommended for inert-gas metal-arc welding.

specified hereinafter, with cover glass, and designed to permit easy removal of the lenses. Absorptive lenses shall be so mounted in helmets as to be not less than 2 inches from the eyes.

7.2.2.4 If supported by headgear, the weight of the helmet, complete shall not exceed 24 oz. exclusive of other protective equipment.

7.2.2.5 Shields shall be provided with a single window of the dimensions specified hereinafter, fitted to carry suitable window lenses.

7.2.2.6 Goggles designated as Style 1 are those having a rigid nonadjustable bridge (or adjustable metallic bridge) without side shields.

Goggles designated as Style 2 are those having a rigid nonadjustable bridge (or adjustable metallic bridge) with side shields.

Goggles designated as Style 3 are those having flexibly connected lens containers shaped to conform to the configuration of the face.

7.2.2.7 All parts shall be substantially constructed of a material which will not readily corrode or discolor the skin.

7.2.2.8 Lens containers shall be suitable to hold firmly the lenses of the dimensions specified hereinafter.

7.2.2.9 Goggles of Style 2 shall be provided with side shields of metal, leather or other durable material. No quick-burning material shall be used. The material shall also be pliable to permit adjusting the shield to the contour of the face. The edges coming in contact with the face shall be finished in a manner to prevent irritating or cutting the skin. If side shields are of metal, they should be of wire mesh or of perforated sheet having openings not larger than 0.0394 inch. Ventilation shall be provided to prevent fogging of the lenses as far as practicable.

7.2.2.10 Goggles of Style 3 shall consist of eyecups of noncorrodible, opaque material, and shall be shaped to fit the configuration of the face. They shall exclude light, except through the lenses, but shall afford adequate ventilation. The eyecups shall be connected by a flexible coupling which will permit ready adjustment, or else the goggles shall be furnished of the proper size. Goggles shall have a headband or headgear which will retain them in their proper position.

7.2.2.11 Lenses for helmet and hand shield windows shall have a height of 2 inches (50.8 mm.) and a width of 4.25 inches (108 mm.) where one window is provided, or 2 inches (50.8 mm.) where helmets are provided with two windows.

7.2.2.12 Lenses for goggles shall have dimensions not less than 1.5 inches (38 mm.) in the vertical direction and 1.75 inches (44.5 mm.) in one horizontal direction. It is recommended that circular lenses not involving optical correction be a uniform diameter of 1.97 inches (50 mm.).

7.2.2.13 Cover glasses should be provided to protect each helmet, hand shield or goggle lens.

7.2.2.14 All glass for lenses and cover glasses shall be tempered, substantially free from striae, air bubbles, waves and other flaws. Except when a lens is ground to provide proper optical correction for defective vision, the front and rear surfaces of lenses and windows shall be smooth and parallel within the following limits:

(*a*) Window and cover glasses for same, 35 min. of arc (½ prism diopter);

(*b*) Lenses and cover glasses for lenses, 9 min. of arc (⅛ prism diopter);

(*c*) The glass shall not be negative in refractive power in any meridian, shall not have a positive refractive power in any meridian greater than 0.12 diopter, and shall not have a difference in refractive power between any two meridians greater than 0.06 diopter.

7.2.2.15 Lenses shall bear some permanent distinctive marking by which the source and shade may be readily identified.

7.2.2.16 The following is a guide for the selection of the proper shade numbers. These recommendations may be varied to suit the individual's needs.

WELDING OPERATION	SHADE NUMBER
Shielded Metal-Arc Welding—1/16, 3/32, 1/8, 5/32 inch electrodes	10
Inert-Gas Metal-Arc Welding (Nonferrous)—1/16, 3/32, 1/8, 5/32 inch electrodes	11
Inert-Gas Metal-Arc Welding (Ferrous)—1/16, 3/32, 1/8, 5/32 inch electrodes	12
Shielded Metal-Arc Welding—3/16, 7/32, 1/4 inch electrodes	12
—5/16, 3/8 inch electrodes	14
Atomic hydrogen welding	10-14
Carbon arc welding	14
Soldering	2
Torch Brazing	3 or 4
Light Cutting, up to 1 inch	3 or 4
Medium Cutting, 1 inch to 6 inch	4 or 5
Heavy Cutting, 6 inch and over	5 or 6
Gas Welding (Light) up to 1/8 inch	4 or 5
Gas Welding (Medium) 1/8 inch to 1/2 inch	5 or 6
Gas Welding (Heavy) 1/2 inch and over	6 or 8

NOTE: In gas welding or oxygen cutting where the torch produces a high yellow light, it is desirable to use a filter or lens that absorbs the yellow or sodium line in the visible light of the operation.

7.2.2.17 All lenses used shall meet the test for transmission of radiant energy prescribed in Rule 154(c) of the *Safety Code for the Protection of Heads, Eyes and Respiratory Organs,* American Standard Z2—1938.

7.2.2.18 Helmets and goggles should be well maintained. They should not be transferred from one employee to another without being sterilized.

7.2.3 Protection of Fellow Workers from Arc-Welding Rays

7.2.3.1 Where arc welding is regularly carried on in a building, the walls of the welding bay should be painted a nonreflecting color to prevent flickering reflections.

7.2.3.2 Where the work permits, the welder should be enclosed in an individual booth painted with a nonreflecting color, such as zinc oxide (an important factor for absorbing ultraviolet radiations) and lamp black, or shall be enclosed with noncombustible screens similarly painted. Booths and screens shall permit circulation of air at floor level. Workers or other persons adjacent to the welding areas shall be protected from the rays by noncombustible or flameproof screens or shields or shall be required to wear appropriate goggles.

7.3 PROTECTIVE CLOTHING

7.3.1 Appropriate protective clothing required for any welding operation will vary with the size, nature and location of the work to be performed.

7.3.2 Protective means which may be employed are as follows:

7.3.2.1 Except when engaged in light work, all welders should wear flameproof gauntlet gloves.

7.3.2.2 Flameproof aprons made of leather, asbestos, or other suitable material may also be desirable as protection against radiated heat and sparks.

7.3.2.3 Woolen clothing is preferable to cotton because it is not so readily ignited and helps protect the welder from changes in temperature. Cotton clothing, if used, should be chemically treated to reduce its flammability. All outer clothing such as jumpers or overalls should be reasonably free from oil or grease.

7.3.2.4 Sparks may lodge in rolled-up sleeves or pockets of clothing, or cuffs of overalls or trousers. It is therefore recommended that sleeves and collars be kept buttoned and pockets be eliminated from the front of overalls and aprons. Trousers or overalls should not be turned up on the outside.

7.3.2.5 For very heavy work, fire-resistant leggings, high boots, or other equivalent means should be used.

7.3.2.6 Low-cut shoes with unprotected tops should not be used. (See *Specifications for Protective Occupational Footwear, Men's Safety-Toe Shoes,* American Standard Z41.1–1944.)

7.3.2.7 In production work a sheet metal screen in front of the worker's legs provides further protection against sparks and molten metal in cutting operations.

7.3.2.8 Capes or shoulder covers made of leather or other suitable material should be worn during overhead welding or cutting operations. Leather skull caps may be worn under helmets to prevent head burns.

7.3.2.9 For overhead welding, or welding in extremely confined spaces, ear protection is sometimes desirable. This may be accomplished by placing wool or rubber plugs in the ears or by covering them with wire screen protectors.

7.3.2.10 Protective clothing should conform with *Specifications for Protective Occupational Clothing,* American Standard L18.

7.3.2.11 Where there is exposure to sharp or heavy falling objects, hard hats or head protectors should be used.

7.4 WORK IN CONFINED SPACES

7.4.1 As used herein *confined space* is intended to mean a relatively small or restricted space such as a tank, boiler, pressure vessel or small compartment of a ship.

7.4.2 Ventilation is a prerequisite to work in confined spaces. For ventilation requirements see 8.1.3 and 8.4.

7.4.3 When welding or cutting is being performed in any confined spaces the gas cylinders and welding machines shall be left on the outside. Before operations are started, heavy portable equipment mounted on wheels shall be securely blocked to prevent accidental movement.

7.4.4 Where a welder must enter a confined space through a manhole or other small opening, means shall be provided for quickly removing him in case of emergency. When safety belts and lifelines are used for this purpose they shall be so attached to the welder's body that his body cannot be jammed in a small exit opening.

7.4.5 When arc welding is to be suspended for any substantial period of time, such as during lunch or overnight, all electrodes shall be removed from the holders and the holders carefully located so that accidental contact cannot occur and the machine disconnected from the power source.

7.4.6 In order to eliminate the possibility of gas escaping through leaks or improperly closed valves when gas welding or cutting, the torch valves shall be closed and the gas supply to the torch positively shut off at some point outside the confined area whenever the torch is not to be used for a substantial period of time, such as during lunch hour or overnight. Where practicable, the torch and hose shall also be removed from the confined space.

7.4.7 After welding operations are completed, the welder shall mark the hot metal or provide some other means of warning other workers.

8. Health Protection and Ventilation

8.1 GENERAL

8.1.1 The requirements in this section have been established on the basis of the following three factors in arc and gas welding which govern

the amount of contamination to which welders may be exposed:

1. Dimensions of space in which welding is to be done (with special regard to height of ceiling.).
2. Number of welders.
3. Possible evolution of hazardous fumes, gases or dust according to the metals involved.

8.1.2 It is recognized that in individual instances other factors may be involved in which case ventilation or respiratory protective devices should be provided as needed to meet the equivalent requirements of this section. Such factors would include:

1. Atmospheric conditions.
2. Heat generated.
3. Presence of volatile solvents.

8.1.3 When welding must be performed in a space entirely screened on all sides, the screens shall be so arranged that no serious restriction of ventilation exists. It is desirable to have the screens so mounted that they are about 2 feet above the floor unless the work is performed at so low a level that the screen must be extended nearer to the floor to protect nearby workers from the glare of welding. See also 7.2.3.2.

8.1.4 Local exhaust or general ventilating systems shall be provided and arranged to keep the amount of toxic fumes, gases or dusts below the threshold limit values as established by Safety Regulation No. 3, Threshold Limit Values.

8.1.5 Where welding operations are incidental to general operations, it is considered good industrial practice to apply local exhaust ventilation to prevent contamination of the general work area.

8.1.6 Individual respiratory equipment should be well maintained. It should not be transferred from one employee to another without being sterilized. (For methods of sterilization see Rule 140 of the *Safety Code for the Protection of Heads, Eyes and Respiratory Organs,* American Standard Z2–1938).

8.1.7 Manufacturers' cautions pertaining to fluxes and electrode coverings should be carefully observed. See also 8.5.3.

8.2 VENTILATION FOR GENERAL WELDING AND CUTTING

8.2.1 Mechanical ventilation shall be provided when welding or cutting is done on metals not covered in 8.5 to 8.14 inclusive.

(*a*) in a space of less than 10,000 cu. ft. per welder.

(*b*) in a room having a ceiling height of less than 16 ft.

(*c*) in confined spaces or where the welding space contains partitions, balconies or other structural barriers to the extent that they significantly obstruct cross ventilation.

8.2.2 Such ventilation shall be at the minimum rate of 2000 cu. ft. per min. per welder, except where local exhaust hoods and booths as per 8.3 or supplied-air respirators for such purposes are provided. Natural ventilation is considered sufficient for welding or cutting operations where the space restrictions listed in (a), (b) and (c) above are not present.

8.3 LOCAL EXHAUST HOODS AND BOOTHS

8.3.1 Mechanical local exhaust ventilation may be by means of either of the following:

(*a*) freely movable hoods intended to be placed by the welder as near as practicable to the work being welded and provided with a rate of air flow sufficient to maintain a velocity in the direction of the hood of 100 linear feet per minute in the zone of welding when the hood is at its most remote distance from the point of welding. The rates of ventilation required to accomplish this control velocity using a 3-inch wide flanged suction opening are shown in the following table:

Welding Zone	Minimum Air Flow, Cu. Ft./Min.	Duct Diameter, In.*
4 to 6 in. from arc or torch	150	3
6 to 8 in. from arc or torch	275	3½
8 to 10 in. from arc or torch	425	4½
10 to 12 in. from arc or torch	600	5½

*Nearest ½-in. duct diameter based on 4000 ft. per minute velocity in pipe.

NOTES: (1) Wherever possible all exhaust from operation should be discharged to the outdoors. (2) Minimum air flow should be increased by 20% for hoods not provided with flanges.

(*b*) a fixed enclosure with a top and not less than two sides which surround the welding or cutting operations and with a rate of air flow sufficient to maintain a velocity away from the welder of not less than 50 linear feet per minute.

8.4 VENTILATION IN CONFINED SPACES

8.4.1 All welding and cutting operations carried on in confined spaces shall be adequately ventilated to prevent the accumulation of toxic materials or possible oxygen deficiency. This applies not only to the welder but also to helpers and other personnel in the immediate vicinity.

8.4.2 All air replacing that withdrawn shall be clean and respirable. In such circumstances where it is impossible to provide such ventilation, air-supplied respirators or hose masks approved for this purpose may be used.

8.4.3 Where welding operations are carried on in confined spaces and welders and helpers are provided with air-supplied respirators or hose masks for the purpose intended, a workman shall be stationed

on the outside of such confined space to service the power and ventilation lines to insure the safety of those working within.

8.4.4 Oxygen from a cylinder or torch shall never be used for ventilation. (See Par. 3.8.5 1a.)

8.5 FLUORINE COMPOUNDS*

8.5.1 In confined spaces, welding or cutting involving fluxes, coverings or other materials which contain fluorine compounds shall be done in accordance with 8.4.

8.5.2 The need for local exhaust ventilation or supplied-air respirators for welding or cutting in other than confined spaces will depend upon the individual circumstances. However, experience has shown such protection to be desirable for fixed-location production welding and for all production welding on stainless steels. Where air samples taken at the welding location indicate that the fluorides liberated are below the maximum allowable concentration, such protection is not necessary. In all cases, workers in the immediate vicinity of the welding or cutting operations shall be protected as necessary by local exhaust ventilation or supplied-air respirators.

8.5.3 Fluxes, electrode coverings and fusible granular materials containing fluorine compounds shall have a cautionary wording to indicate that they contain fluorine compounds.**

8.6 ZINC

8.6.1 In confined spaces, welding or cutting involving zinc-bearing base or filler metals or metals coated with zinc-bearing materials shall be done in accordance with 8.4.

8.6.2 Indoors, welding or cutting involving zinc-bearing base or filler metals or metals coated with zinc-bearing materials shall be done in accordance with 8.2.

8.7 LEAD

8.7.1 In confined spaces, welding involving lead base metals (erroneously called *lead-burning*) shall be done in accordance with 8.4.

8.7.2 Indoors, welding involving lead base metals (erroneously called *lead-burning*) shall be done in accordance with 8.2.

---

*A fluorine compound is one that contains fluorine, as an element in chemical combination, not as a free gas.

**One such cautionary wording recommended by the American Welding Society for brazing and gas welding fluxes reads as follows:

CAUTION
Contains Fluorides

This flux when heated gives off fumes which may irritate eyes, nose and throat.

1. Avoid fumes—use only in well-ventilated spaces.
2. Avoid contact of flux with eyes or skin.
3. Do not take internally.

8.7.3 In confined spaces or indoors, welding or cutting involving metals containing lead, other than as an impurity, or involving metals coated with lead-bearing materials, including paint, shall be done using local exhaust ventilation or supplied-air respirators. Outdoors such operations shall be done using respiratory protective equipment approved for such purposes. In all cases, workers in the immediate vicinity of the welding or cutting operation shall be protected as necessary by local exhaust ventilation or supplied-air respirators.

8.8 BERYLLIUM

8.8.1 Welding or cutting indoors or in confined spaces involving beryllium-containing base or filler metals shall be done using local exhaust ventilation and supplied-air respirators unless atmospheric tests under the most adverse conditions have established that the workers' exposure is within the acceptable concentrations defined by Safety Regulation No. 3, Threshold Limit Values. In all cases, workers in the immediate vicinity of the welding or cutting operations shall be protected as necessary by local exhaust ventilation or supplied-air respirators.

8.9 CADMIUM

8.9.1 Welding or cutting indoors or in confined spaces involving cadmium-bearing or cadmium-coated base metals shall be done using local exhaust ventilation or air-supplied respirators unless atmospheric tests under the most adverse conditions have established that the workers' exposure is within the acceptable concentrations defined by Safety Regulation No. 3, Threshold Limit Values. Outdoors such operations shall be done using respiratory protective equipment approved by the U. S. Bureau of Mines for such purposes.

8.9.2 Welding (brazing) indoors involving cadmium-bearing filler metals shall be done using ventilation as prescribed in 8.2, or 8.4 if the work is to be done in a confined space.

8.10 MERCURY

8.10.1 Welding or cutting indoors or in a confined space involving metals coated with mercury-bearing materials including paint, shall be done using local exhaust ventilation or supplied-air respirators unless atmospheric tests under the most adverse conditions have established that the workers' exposure is within the acceptable concentrations defined by Safety Regulation No. 3, Threshold Limit Values. Outdoors such operations shall be done using respiratory protective equipment approved by the U. S. Bureau of Mines for such purposes.

8.11 OTHER MATERIALS OF TOXIC SIGNIFICANCE

8.11.1 Paragraphs 8.5 through 8.10 outline precautions to be followed when using specific fluxes, coverings or base metals. Other constituents of

fluxes, coverings or materials may be of toxic significance such as antimony, arsenic, bismuth, chromium, cobalt, copper, nickel, manganese, magnesium, molybdenum, thorium, and vanadium or their compounds.

8.11.2 When welding or cutting involves any fluxes, coverings or materials containing such materials, ventilation should be provided as necessary to reduce the concentration below the maximum allowable limits.

8.12 BRAZING ATMOSPHERES

8.12.1 A furnace or retort to be used as a container of a combustible brazing atmosphere (AWS Brazing Atmosphere Nos. 1 through 7) shall be purged of all air with an inert gas (such as nitrogen) or as otherwise recommended by the furnace manufacturer before such an atmosphere is introduced into the furnace or retort when the temperature is below 1400 F. Alternatively, such an atmosphere may be introduced into a furnace or retort without purging provided the temperature in such furnace or retort is first raised above 1400 F. In either case, adequate mechanical ventilation shall be used to exhaust and discharge to the out-of-doors all toxic or explosive fumes and exhaust fumes and exhaust gases emanating from such furnace brazing operations.

8.13 CLEANING COMPOUNDS

8.13.1 Care shall be used in cleaning operations to provide the precautions necessary because of the toxicity, flammability or both of the cleaning compound used.

8.13.2 Degreasing or other cleaning operations involving chlorinated hydrocarbons shall be so located that no vapors from these operations will reach or be drawn into the atmosphere surrounding any welding operation.*

8.14 INERT GAS SHIELDED WELDING AND CUTTING

8.14.1 Inert gas shielded welding and cutting introduces special hazards with respect to increased ultra violet radiation and the production of toxic gases. These facts should be recognized by increased ventilation to remove toxic fumes and additional protection from ultra violet radiation.

8.15 MEDICAL CONTROL AND FIRST AID

8.15.1 As with many occupations, preplacement physical examinations, including chest and X-ray, is recommended, for all personnel engaged in welding operations. Periodic examinations should also be provided based on advice from the plant physician.

8.15.2 First aid equipment shall be available at all times. On every shift of welding operations there should be present employees trained to render first aid. All injuries shall be reported as soon as possible for medical attention. First aid shall be rendered until medical attention can be provided.

---

*As an additional precaution, it is suggested that personnel be made acquainted with the characteristic, objectionable irritating odor of decomposed chlorinated solvents (such as trichlorethylene, perchlorethylene, carbon tetrachloride and methyl chloroform) which include highly toxic phosgene gas and other irritating decomposition products which occur when such vapors enter into the atmosphere of an arc-welding operation. This may be done by opening a small container of trichloroethylene (or other chlorinated hydrocarbon) at a distance two or three feet from the arc.

APPENDIX

General:

Standard Welding Terms and Their Definitions, AMERICAN WELDING SOCIETY.

Gas Welding and Cutting:

Safe Practices for Installation and Operation of Oxy-Acetylene Welding and Cutting Equipment, International Acetylene Association.

Standard Hose Connection Specifications, International Acetylene Association.

Safe Handling of Compressed Gases, Compressed Gas Association.

Gas Welding and Flame Cutting, Safe Practices Pamphlet No. 23, National Safety Council.

Standards for the Installation and Operation of Gas Systems for Welding and Cutting, No. 51, National Board of Fire Underwriters.

Method for Marking Portable Compressed Gas Containers to Identify the Material Contained, American Standard Z48.1, American Standards Association.

Specifications for Industrial Accident Prevention Signs, American Standard Z35.1, American Standards Association.

Compressed Gas Cylinder Valve Outlet and Inlet Connections, American Standard B57.1, Compressed Gas Association. (Also available from American Standards Association.)

Use Gas Welding and Cutting Equipment Safely, Industrial Safety Chart No. 2, Series M, U. S. Department of Labor. (Available from U. S. Superintendent of Documents.)

Standards for the Protection of Openings in Walls and Partitions Against Fire, No. 80, National Board of Fire Underwriters and National Fire Protection Association.

Specification for Rubber Welding Hose, International Acetylene Association and Rubber Manufacturers Association.

Regulator Connection Standards, International Acetylene Association.

Standard Hose Connection Specifications, International Acetylene Association.

Code for Pressure Piping, American Society of Mechanical Engineers and American Standards Association.

Arc Welding and Cutting:

Electric Arc Welding Machine and Electrode Standards, Publication 45-105, National Electrical Manufacturers Association.

National Electrical Code, National Fire Protection Association. (Also available from National Board of Fire Underwriters and American Standards Association.)

National Electrical Safety Code, National Bureau of Standards and American Standards Association.

Electric Welding, Safe Practices Pamphlet No. 105, National Safety Council.

Use Arc Welding Equipment Safely, Industrial Safety Chart No. 2, Series J, U. S. Dept. of Labor. (Available from U. S. Superintendent of Documents.)

Recommended Safe Practices for Inert-Gas Metal-Arc Welding, American Welding Society.

Standard for Transformer–Type Arc-Welding Machines, Underwriters Laboratories, Inc., American Standard C33.2–1956, American Standards Association.

Recommended Installations and Test Procedures for High Frequency Stabilized Arc Welders, 1953, National Electrical Manufacturers Association.

Resistance Welding:

Resistance Welding Machine Standards, Resistance Welder Manufacturers Association.

Fire Prevention:

Safe Practices for Welding and Cutting Containers that Have Held Combustibles, American Welding Society.

Cleaning Petroleum Storage Tanks, Accident Prevention Manual No. 1, American Petroleum Institute.

Safe Handling of Inflammable and Combustible Liquids, U. S. Coast Guard.

Manual for Safe Handling of Inflammable and Combustible Liquids, Bureau of Marine Inspection and Navigation, U. S. Department of Commerce. (Available from U. S. Coast Guard.)

Standards for the Control of Gas Hazards on Vessels to be Repaired, National Fire Protection Association.

Purging Principles and Practices, American Gas Association.

Procedures for Cleaning or Safe-Guarding Small Tanks and Containers, NFPA No. 327, National Fire Protection Association.

Health Protection and Ventilation:

List of Respiratory Protective Devices Approved by the Bureau of Mines, Bureau of Mines, U. S. Department of the Interior.

Health Protection in Welding, Metropolitan Life Insurance Company.

Health of Arc Welders in Steel Ship Construction, Federal Security Agency, U. S. Public Health Service. (Available from U. S. Superintendent of Documents.)

Safety Code for the Protection of Heads, Eyes and Respiratory Organs, American Standard Z2, American Standards Association. (Also published by National Bureau of Standards and available from U. S. Superintendent of Documents.)

Specifications for Protective Occupational (Safety) Clothing, American War Standards L18, American Standards Association.

Specifications for Protective Occupational Footwear, American Standards Z41, American Standards Association.

Manual of Accident Prevention in Construction, American Standard A10.1, American Standards Association.

Safety Code for Building Construction, American Standard A10.2, American Standards Association.

Electric and Gas Welding and Cutting, Accident Prevention Manual No. 3, American Petroleum Institute.

Cleaning Mobile Tanks used for Transportation of Flammable Liquids, Section A—Tank Vehicles, Accident Prevention Manual No. 13, American Petroleum Institute.

LIST OF PUBLISHERS

American Gas Association, 420 Lexington Avenue, New York, N. Y.
American Petroleum Institute, 50 West 50th St., New York, N. Y.
American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.
American Standards Association, Inc., 70 East 45th St., New York 17, N. Y.
American Welding Society, 33 W. 39th St., New York 18, N. Y.
Bureau of Mines. U. S. Department of the Interior, 4800 Forbes St., Pittsburgh, Pa.
Compressed Gas Association, 11 W. 42nd St., New York 18, N. Y.
International Acetylene Association, 30 E. 42nd St., New York 17, N. Y.
Metropolitan Life Insurance Company, 1 Madison Ave., New York, N. Y.
National Board of Fire Underwriters, 85 John St., New York 38, N. Y.
National Electrical Manufacturers Association, 155 E. 44th St., New York, N. Y.
National Fire Protection Association, 60 Batterymarch St., Boston, Mass.
National Safety Council, 20 N. Wacker Dr., Chicago, Ill.
Resistance Welder Manufacturers Association, 505 Arch St., Philadelphia, Pa.
U. S. Superintendent of Documents, Washington 25, D. C.