230. WELDING, CUTTING, AND BRAZING

01. Scope

Welding, cutting, and brazing shall conform to all other applicable requirements of this standard, as well as the following provisions. Nothing in this standard shall be construed to prohibit better or otherwise safer conditions than specified herein. (7-1-97)
02. Definitions: For definitions of other terms used in this section, see sub-section 010 of this standard. (7-1-97)

a. Welder and welding operator is any operator of electric or gas welding and cutting equipment. (7-1-97)

b. All other welding terms are used in accordance with American Welding Society terms and definitions - A3.0. (7-1-97)

03. General Requirements: (7-1-97)

a. First-aid equipment shall be available at all times. All injuries shall be reported as soon as possible for medical attention. First aid shall be rendered until medical attention can be provided. (7-1-97)

b. A job hazard analysis shall be made, by qualified personnel, of the operations to be performed to determine the safeguards and personal protective equipment that shall be used for each job. (7-1-97)

c. Periodic inspection shall be made by qualified maintenance personnel and records of the same maintained. The welder/operator shall be instructed to report any equipment defects to his supervisor and the use of the welding/cutting equipment shall be discontinued until safety repairs have been completed. (7-1-97)

04. Protection of Employees: (7-1-97)

a. A welder or helper working on a platform, scaffold or runways shall be protected against falling. This may be accomplished by the use of guard railings, safety belts, life lines, or some other equally effective safeguards. (7-1-97)

b. Welders shall place welding cable, hoses, and other equipment so that it is clear of passageways, ladders, and stairways. (7-1-97)

c. 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 against injurious rays from adjacent work, and from flying objects. The goggles may have either clear or colored glass, depending upon the amount of exposure to adjacent welding operations. Helpers or attendants shall be provided with proper eye protection. (7-1-97)

d. Goggles or other suitable eye protection shall be used during all gas welding or oxygen cutting operations. Spectacles without side shields, with suitable filter lenses are permitted for use during gas welding operation on light work, for torch brazing or for inspection. (7-1-97)
e. 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 and eyes, as required. (7-1-97)

f. Eye protection in the form of suitable goggles shall be provided where needed for brazing operations not covered in sub-section 230.04.c., 230.04.d., and 230.04.e. of this section. (7-1-97)

g. 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 undergoing sterilization. (7-1-97)

h. Helmets and hand shields shall be arranged to protect the face, neck and ears from direct radiant energy from the arc. (7-1-97)

i. Helmets shall be provided with filter plates and cover plates designed for easy removal. (7-1-97)

j. All parts of eye and face protectors shall be constructed of a material which will not readily corrode or discolor the skin. (7-1-97)

k. Goggles shall be ventilated to prevent fogging of the lenses as much as possible. (7-1-97)

l. Cover lenses or plates shall be provided to protect each helmet, hand shield or goggle filter lens or plate. (7-1-97)

m. All glass for lenses shall be tempered, substantially free from striae, air bubbles, waves and other flaws. Except when a lens is ground to provide proper vision, the front and rear surfaces of lenses and windows shall be smooth and parallel. (7-1-97)

n. Lenses shall bear some permanent distinctive marking by which the source and shade may be readily identified. (7-1-97)

o. Table 230.04-A is a guide for the selection of the proper shade numbers. These recommendations may be varied to suit the individual's needs. (7-1-97)

<table>
<thead>
<tr>
<th>TABLE 230.04-A</th>
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<tbody>
<tr>
<td><strong>Welding Operation</strong></td>
</tr>
<tr>
<td>Shielded Metal-arc welding - 1/16, 3/32, 1/8, 5/32 - inch electrodes</td>
</tr>
<tr>
<td>Gas - shielded arc welding (nonferrous) - 1/16, 3/32, 1/8, 5/32 - inch electrodes</td>
</tr>
<tr>
<td>Gas - shielded arc welding (ferrous) - 1/16, 3/32, 1/8, 5/32 - inch</td>
</tr>
</tbody>
</table>
electrodes

<table>
<thead>
<tr>
<th></th>
<th>3/16, 7/32, 1/4 - inch electrodes</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shielded metal - arc welding:</td>
<td>5/16, 3/8 - inch electrodes</td>
<td>14</td>
</tr>
<tr>
<td>Atomic hydrogen welding</td>
<td></td>
<td>10 - 14</td>
</tr>
<tr>
<td>Carbon arc welding</td>
<td></td>
<td>14</td>
</tr>
<tr>
<td>Soldering</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Torch brazing</td>
<td></td>
<td>3 or 4</td>
</tr>
<tr>
<td>Light cutting, up to 1 inch</td>
<td></td>
<td>3 or 4</td>
</tr>
<tr>
<td>Medium cutting, 1 inch to 6 inches</td>
<td></td>
<td>4 or 5</td>
</tr>
<tr>
<td>Heavy cutting, 6 inches and over</td>
<td></td>
<td>5 or 6</td>
</tr>
<tr>
<td>Gas welding (light) up to 1/8 inch</td>
<td></td>
<td>4 or 5</td>
</tr>
<tr>
<td>Gas welding (medium) 1/8 inch to 1/2 inch</td>
<td></td>
<td>5 or 6</td>
</tr>
<tr>
<td>Gas welding (heavy) 1/2 inch and over</td>
<td></td>
<td>6 or 8</td>
</tr>
</tbody>
</table>

p. All filter lenses and plates shall meet the test for transmission of radiant energy prescribed in ANSI Z87.1 American National Standard Practice for Occupational and Educational Eye and Face Protection. (7-1-97)

q. Where work permits, the welder shall be enclosed in an individual booth painted with a finish of low reflectivity such as zinc oxide (an important factor for absorbing ultra-violet 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 flame proof screens or shields or shall be required to wear appropriate goggles. (7-1-97)

r. For the protection of the operators of nearby equipment, fire-resistant curtains or suitable shields shall be set up around welding operations and in such a manner that the welder's movements are not hampered. If the welding process cannot be isolated, all persons who may be exposed to the hazard of arc flash shall be properly protected. (7-1-97)

s. Employees exposed to the hazards created by welding, cutting, or brazing operations shall be protected by personal protective equipment in accordance with the requirements of section 050 of this standard. (7-1-97)

t. Except when engaged in light work, all welders shall wear flameproof gauntlet gloves. (7-1-97)
u. Flameproof aprons made of leather, or other suitable material shall be worn as protection against radiated heat and sparks. (7-1-97)

v. 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, shall be chemically treated to reduce its combustibility. All outer clothing such as jumpers or overalls shall be reasonably free of gas, oil, or grease. (7-1-97)

w. Sparks may lodge in rolled-up sleeves or pockets of clothing, or cuffs of overalls or trousers. Sleeves and collars shall be kept buttoned and pockets shall be eliminated from the front of overalls and aprons. Trousers or overalls shall not be turned up on the outside. NOTE: For heavy work, fire-resistant leggings, high boots, or other equivalent means shall be used. (7-1-97)

x. In production work, a sheet metal screen in front of the workers legs can provide further protection against sparks and molten metal in cutting operations. (7-1-97)

y. Capes or shoulder covers made of leather or other suitable materials should be worn during overhead cutting or welding operations. Leather skull caps may be worn under helmets to prevent head burns. (7-1-97)

z. For overhead welding and cutting, or welding and cutting in extremely confined spaces, ear protection shall be used. (7-1-97)

aa. When there is a hazard or exposure to sharp or heavy falling objects, or a hazard of bumping in confined spaces, hard hats or head protectors shall be used. (7-1-97)

05. Work in Confined Spaces: (7-1-97)

a. As used herein, confined space is intended to mean a relatively small or restricted space such as a tank, boiler, pressure vessel, etc., and the requirements of section 043 of this standard shall be complied with. (7-1-97)

b. Ventilation is a prerequisite to work in confined spaces. For ventilation requirements see sub-section 230.08 of this section. (7-1-97)

c. 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, portable equipment mounted on wheels shall be securely blocked to prevent accidental movement. (7-1-97)

d. 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 harnesses 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. An attendant with a pre-planned rescue procedure shall be stationed outside to observe the welder at all times and be capable of putting rescue operations into effect. (7-1-97)
e. 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. (7-1-97)

f. 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 fuel-gas and oxygen supply 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. (7-1-97)

g. After welding operations are completed, the welder shall mark the hot metal or provide some other means of warning other workers. (7-1-97)

06. Health Protection and Ventilation. (7-1-97)

a. The requirements in this sub-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 and are as follows: dimensions of space in which welding is to be done (with special regard to height of ceiling); number of welders; and possible evolution of hazardous fumes, gases, or dust according to the metals involved. (7-1-97)

b. It is recognized that in individual instances other factors may be involved in which case ventilation or respiratory protective devices shall be provided as needed to meet the equivalent requirements of this subsection. Such factors would include: atmospheric conditions; heat generated; and presence of volatile solvents. (7-1-97)

c. 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 two (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. (7-1-97)

d. Local exhaust or general ventilating systems shall be provided and arranged to keep the amount of toxic fumes, gases, or dusts below the maximum allowable concentration as specified in section 300 of this standard. NOTE: A number of potentially hazardous materials are employed in fluxes, coatings, coverings, and filler metals used in welding and cutting or are released to the atmosphere during welding and cutting. These include but are not limited to the materials itemized in sub-sections 230.09 through 230.16. of this section. (7-1-97)

e. The employer shall ascertain the potentially hazardous materials, associated with welding, cutting, etc. from the suppliers of welding materials and inform the employees of the same either through signs, labels, or other appropriate means. (7-1-97)

f. All filler metals and fusible granular materials shall carry the following notice, as a minimum, on tags, boxes, or other containers, "CAUTION" Welding may produce fumes and gases
hazardous to health. Avoid breathing these fumes and gases. Use adequate ventilation. See ANSI Z49.1 Safety in Welding and Cutting published by the American Welding Society. (7-1-97)

g. Brazing (welding filler metals containing significant amounts of cadmium shall carry the following notice on tags, boxes, or other containers: WARNING CONTAINS CADMIUM-POISONOUS FUMES MAY BE FORMED ON HEATING. Do not breathe fumes. Use only with adequate ventilation such as fume collectors, exhaust ventilators, or air supplied respirators. See ANSI Z49.1. If chest pain, cough, or fever develops after use, call a physician immediately. Keep children away when using. (7-1-97)

h. Brazing and gas welding fluxes containing fluorine compounds shall have a cautionary wording to indicate that they contain fluorine compounds. 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 that may irritate eyes, nose and throat. Avoid fumes - use only in well ventilated spaces. Avoid contact of flux with eyes or skin. Do not take internally. (7-1-97)

i. Mechanical ventilation shall be provided when welding and cutting is done on metals not covered in sub-sections 230.09 through 230.16 of this section (for specific material, see the ventilation requirements of sub-sections 230.09 through 230.16 of this section.) (7-1-97)

j. Mechanical ventilation shall be provided for in a space of less than ten-thousand (10,000) cubic feet per welder. (7-1-97)

k. Mechanical ventilation shall be provided in a room having a ceiling height of less than sixteen (16) feet. (7-1-97)

l. Mechanical ventilation shall be provided whenever welding fumes could enter the welders breathing zone. (7-1-97)

m. Mechanical ventilation shall be provided for in confined spaces or where the welding space contains partitions, balconies, or other structural barriers to the extent that they significantly obstruct cross ventilation. (7-1-97)

n. Mechanical ventilation shall be at the minimum rate of two-thousand (2,000) cubic feet per minute per welder, except where local exhaust hoods and booths as per sub-section 230.07 of this section, or airline respirators approved by the U.S. Bureau of Mines for such purposes are provided. Natural ventilation is considered sufficient for welding or cutting operations where the restrictions in sub-section 230.06.i. through 230.06.m. of this section are not present. (7-1-97)

**07. Local Exhaust Hoods and Booths.** (7-1-97)

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 airflow sufficient to maintain a velocity in the direction of the hood of one-hundred (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 three (3) inch wide flanged suction opening are shown in Table 230.07-A. (7-1-97)

<table>
<thead>
<tr>
<th>Welding zone</th>
<th>Minimum air flow¹ cubic feet/minutes</th>
<th>Duct diameter inches²</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 to 6 inches from arc or torch</td>
<td>150</td>
<td>3</td>
</tr>
<tr>
<td>6 to 8 inches from arc or torch</td>
<td>275</td>
<td>3 1/2</td>
</tr>
<tr>
<td>8 to 10 inches from arc or torch</td>
<td>425</td>
<td>4 1/2</td>
</tr>
<tr>
<td>10 to 12 inches from arc or torch</td>
<td>600</td>
<td>5 1/2</td>
</tr>
</tbody>
</table>

¹When brazing with cadmium bearing materials or when cutting on such materials increased rates of ventilation may be required.

²Nearest half-inch duct diameter based on 4,000 feet per minute velocity in pipe.

b. A fixed enclosure with a top and not less than two (2) sides which surround the welding or cutting operation and with a rate of airflow sufficient to maintain a velocity away from the welder of not less than one-hundred (100) linear feet per minute. (7-1-97)

08. Ventilation in Confined Spaces. (7-1-97)

a. 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. All air replacing that withdrawn shall be clean and respirable. (7-1-97)

b. In such circumstances where it is impossible to provide such ventilation, airline respirators or hose masks approved by the U.S. Bureau of Mines or NIOSH for this purpose shall be used. (7-1-97)

c. In areas immediately hazardous to life, hose masks with blowers or self-contained breathing equipment shall be used. The breathing equipment shall be approved by the U.S. Bureau of Mines or NIOSH. (7-1-97)

d. Where welding operations are carried on in confined spaces and where welders and helpers are provided with hose masks, hose masks with blowers or self-contained breathing equipment approved by the U.S. Bureau of Mines or NIOSH, a worker shall be stationed on the outside of such confined spaces to insure the safety of those working within. (7-1-97)

e. Oxygen shall not be used for ventilation. (7-1-97)
09. Fluorine Compounds: (7-1-97)

a. In confined spaces, welding, or cutting involving fluxes, coverings, or other materials which contain fluorine compounds shall be done in accordance with sub-section 230.08. of this section. A fluorine compound is one that contains fluorine, as an element in chemical combination, not as a free gas. (7-1-97)

b. The need for local exhaust ventilation or airline respirators for welding or cutting in other than confined spaces will depend upon the individual circumstances. However, experience has shown that such protection is desirable for fixed-location production welding and for all 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. (7-1-97)

10. Zinc: (7-1-97)

a. 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 sub-section 230.08 of this section. (7-1-97)

b. Indoors, welding or cutting involving zinc-bearing base or filler metals coated with zinc-bearing materials shall be done in accordance with sub-sections 230.07.a. and 230.07.b. of this section. (7-1-97)

11. Lead: (7-1-97)

a. In confined spaces, welding involving lead-base metals (erroneously called lead-burning) shall be done in accordance with sub-section 230.08 of this section. (7-1-97)

b. Indoors, welding involving lead-base metals shall be done in accordance with sub-sections 230.07.a. and 230.07.b. of this section. (7-1-97)

c. In confined spaces or Indoors, welding or cutting involving metals containing lead, other than as an impurity, or involving metals containing lead, or coated with lead-bearing materials, including paint shall be done using local exhaust ventilation or airline respirators. (7-1-97)

d. Outdoors, welding or cutting involving metals containing lead, other than as an impurity, or involving metals containing lead, or coated with lead-bearing materials, including paint shall be done using respiratory protective equipment approved by the U.S. Bureau of Mines or NIOSH for such purposes. In all cases, workers in the immediate vicinity of the cutting operation shall be protected as necessary by local exhaust ventilation or airline respirators. (7-1-97)

12. Beryllium: (7-1-97)

a. Welding or cutting indoors, outdoors, or in confined spaces involving beryllium-containing base or filler metals shall be done by using local exhaust ventilation and airline respirators unless
atmospheric tests under the most adverse conditions have established that the workers' exposure is within the acceptable concentration. In all cases, workers in the immediate vicinity of the welding or cutting operations shall be protected as necessary by local exhaust ventilation or airline respirators. (7-1-97)

13. Cadmium: (7-1-97)

a. Welding or cutting indoors or in confined spaces involving cadmium-bearing or cadmium-coated base metals shall be done using local exhaust ventilation or airline respirators unless atmospheric tests under the most adverse conditions have established that the workers' exposure is within the acceptable concentration. Outdoors, such operations shall be done using respiratory protective equipment such as fume respirators approved by the U.S. Bureau of Mines or NIOSH for such purposes. (7-1-97)

b. Welding, or cutting indoors or in confined spaces involving cadmium-bearing filler metals shall be done using ventilation as prescribed in sub-sections 230.06 of this section. If the work is to be done in a confined space then the requirements of sub-section 230.08 of this section shall be used. (7-1-97)

14. Mercury: (7-1-97)

a. 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 airline respirators unless atmospheric tests under the most adverse conditions have established that the workers' exposure is within the acceptable concentration. (7-1-97)

b. Outdoors, such operations shall be done using respiratory protective equipment approved by the U.S. Bureau of Mines or NIOSH for such purposes. (7-1-97)

15. Cleaning Compounds: (7-1-97)

a. In the use of cleaning materials, because of their possible toxicity or flammability, appropriate precautions such as manufacturer's instructions shall be followed. (7-1-97)

b. 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. In addition, trichlorethylene and perchlorethylene shall be kept out of atmospheres penetrated by the ultraviolet radiation of gas-shielded welding operations. (7-1-97)

16. Cutting of Stainless Steels: (7-1-97)

a. Oxygen cutting, using either a chemical flux or iron powder or gas-shielded arc cutting of stainless steel, shall be done using mechanical ventilation adequate to remove the fumes generated. (7-1-97)
17. Fire Prevention and Protection. (7-1-97)

a. For elaboration of these basic precautions and of the special precautions of sub-section 230.17.c. through 230.17.r. of this section as well as a delineation of the fire protection and prevention responsibilities of welders and cutters, their supervisors (including outside contractors), and those in management on whose property cutting and welding is to be performed, see Standard for Fire Prevention in Use of Cutting and Welding Processes, NFPA 51B. (7-1-97)

b. The basic precautions for fire prevention in welding or cutting work are: if the object to be welded or cut cannot be readily moved, all movable fire hazards in the vicinity shall be taken to a safe place; 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; or if the requirements stated above cannot be followed, then welding and cutting shall not be performed. (7-1-97)

c. Whenever 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. (7-1-97)

d. 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, or portable extinguishers depending upon the nature and quantity of the combustible material exposed. (7-1-97)

e. Fire watchers shall be required whenever welding or cutting is performed in locations where other than a minor fire might develop, if any of the following conditions exist: appreciable combustible material, in building construction or contents, closer than thirty-five (35) feet to the point of operation; wall or floor openings within a thirty-five (35) foot radius expose combustible material in adjacent areas including concealed spaces in walls or floors; appreciable combustibles are more than thirty-five (35) feet away but are easily ignited by sparks; combustible materials are adjacent to the opposite side of metal partitions, walls, ceilings, or roofs and are likely to be ignited by conduction or radiation. (7-1-97)

f. Fire watchers shall have fire extinguishers equipment readily available and be trained in its use. They shall be familiar with facilities for sounding an alarm in the event of a fire. They shall watch for fires in all exposed areas, try to extinguish them only when obviously within the capacity of the equipment available, or otherwise sound the alarm. A fire watch shall be maintained for at least a one-half (1/2) hour after completion of welding or cutting operations to detect and extinguish possible smoldering fires. (7-1-97)

g. Before cutting or welding, the area shall be inspected by the individual responsible for authorizing cutting and welding procedures. He shall disseminate precautions to be followed in granting authorization to proceed in the form of a written procedure. (7-1-97)
h. Where combustible materials such as paper clippings, wood shavings or textile fibers are on the floor, the floor shall be swept clean for a radius of thirty-five (35) feet. Combustible floors shall be kept wet, covered with damp sand, or protected by fire-resistant shields. Where floors have been wet down, personnel operating arc welding and cutting equipment shall be protected from possible shock. (7-1-97)

i. Cutting or welding shall not be permitted in the following areas or situations: in areas not authorized by management; in sprinklered buildings while such protection is impaired; in the presence of explosive atmospheres (mixtures of flammable gases, vapors, liquids, or dusts with air), or explosive atmospheres that may develop inside uncleaned or improperly prepared tanks or equipment which have previously contained such materials, or that may develop in areas with an accumulation of combustible dusts; or in areas near the storage of large quantities of exposed, readily ignitable materials, such as bulk sulphur, baled paper, or cotton. (7-1-97)

j. Where practicable, all combustibles shall be relocated at least thirty-five (35) feet from the work site. Where relocation is impossible, combustibles shall be protected with a flameproof cover or otherwise shielded with metal or fire proof curtains. Edges of covers at the floor should be tight to prevent sparks from going under them. This precaution is also important at overlaps where several covers are used to protect a large pile. (7-1-97)

k. Ducts and conveyor systems that might carry sparks to distant combustibles shall be suitably protected or shut down. (7-1-97)

l. Where cutting or welding is done near walls, partitions, ceiling, or roof of combustible construction, fire resistant shields or guards shall be provided to prevent ignition. (7-1-97)

m. If welding is to be done on a metal wall, partition, ceiling, or roof, precautions shall be taken to prevent ignition of combustibles on the other side, due to conduction or radiation, preferably by relocation of combustibles. Where combustibles are not relocated, a fire watch on the opposite side from the work shall be provided, to prevent ignition. (7-1-97)

n. Welding shall not be attempted on a metal partition, wall, ceiling, or roof having a combustible covering nor on walls or partitions of combustible sandwich-type panel construction. (7-1-97)

o. Cutting or welding on pipes or other metal in contact with combustible walls, partitions, ceilings, or roofs shall not be undertaken if the work is close enough to cause ignition by conduction. (7-1-97)

p. Management shall recognize its responsibility for the safe usage of cutting and welding equipment on its property, and: based on fire potentials of facilities, establish areas for cutting and welding, in other areas; designate an individual responsible for authorizing cutting and welding operations in areas not specifically designed for such processes; insist that cutters or welders and their supervisors are suitably trained in the safe operation of their equipment and the safe use of the process; and advise all contractors about flammable materials or hazardous conditions of which they may not be aware. (7-1-97)
q. The supervisor: (7-1-97)

i. Shall be responsible for the safe handling of the cutting or welding equipment and the safe use of the cutting and welding process; (7-1-97)

ii. Shall determine the combustible materials and hazardous areas present or likely to be present in the work location; (7-1-97)

iii. shall protect combustibles from ignition in accordance with sub-section 230.17.b. of this section; (7-1-97)

iv. Shall see that authorizations from the proper management representative are secured; (7-1-97)

v. Shall determine that the cutter or welder secures his approval that conditions are safe before going ahead; (7-1-97)

vi. Shall determine that fire protection and extinguishing equipment are properly located at the site; (7-1-97)

vii. Where fire watchers are required, shall see that they are available at the site. (7-1-97)

r. Cutting or welding shall be permitted only in areas that are or have been made fire safe. Within the confines of a building or specifically designated facility or area, cutting and welding should preferably be done in a specific area designed for such work, such as a maintenance shop or a detached outside location. Such areas should be of non-combustible and nonflammable contents, and suitably segregated from adjacent areas. When work cannot be moved practically, as in most construction work, the area shall be made safe by removing combustibles or protecting combustibles from ignition areas. (7-1-97)

s. Before welding, cutting, or heating is commenced on any surface covered by a preservative coating whose flammability is not known, a test shall be made by a competent person to determine its flammability. Preservative coatings shall be considered to be highly flammable when scrapings burn with extreme rapidity. (7-1-97)

t. Precautions shall be taken to prevent ignition of highly flammable hardened preservative coatings. When coatings are determined to be highly flammable, they shall be stripped from the area to be heated to prevent ignition. (7-1-97)

u. In enclosed spaces, all surfaces covered with toxic preservatives shall be stripped of all toxic coatings for a distance of at least four (4) inches from the area of heat application, or the employees shall be protected by airline respirators, meeting the requirements specified in this section for this type of work. (7-1-97)

v. The preservative coatings shall be removed a sufficient distance from the area to be heated to ensure that the temperature of the unstripped metal will not be appreciably raised. Artificial
cooling of the metal surrounding the heating area may be used to limit the size of the area required to be cleaned. (7-1-97)

18. Welding on or Cutting of Containers: (7-1-97)

a. 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. (7-1-97)

b. 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. (7-1-97)

19. Oxygen/Fuel Gas Systems for Welding and Cutting. (7-1-97)

a. Mixtures of fuel gases and air or oxygen may be explosive and shall be guarded against. No device or attachment facilitating or permitting mixtures of air or oxygen with flammable gases prior to consumption, except at the burner or in a standard torch, shall be allowed unless approved for the purpose. (7-1-97)

b. Only approved apparatus such as torches, regulators, or pressure-reducing valves, acetylene generators, and manifolds shall be used. (7-1-97)

c. Workers in charge of the oxygen or fuel-gas supply equipment including any oxygen or fuel-gas distribution piping systems shall be instructed and judged competent by their employers for this important work before being left in charge. Rules and instructions covering the operation and maintenance of oxygen or fuel-gas supply equipment including oxygen or fuel-gas distribution piping systems shall be readily available. (7-1-97)

d. All portable cylinders used for the storage and shipment of compressed gases shall be constructed and maintained in accordance with the regulations of the U.S. Department of Transportation, 49 CFR Parts 171-179 and shall meet the requirements of section 210 of this standard. (7-1-97)

e. 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. (7-1-97)

f. Oxygen cylinders in storage shall be separated from fuel-gas cylinders or combustible materials (especially oil or grease), a minimum distance of twenty (20) feet or by a noncombustible barrier at least five (5) feet high having a fire-resistant rating of at least one-half (1/2) half hour. (7-1-97)
g. Where a liquid oxygen system is to be used to supply gaseous oxygen for welding or cutting and the system has a storage capacity of more than thirteen-thousand (13,000) cubic feet of oxygen (measured at fourteen-point-seven (14.7) psia and seventy (70) degrees Fahrenheit), connected in service or ready for service, or more than twenty-five-thousand (25,000) cubic feet of oxygen (measured at fourteen-point-seven (14.7) psia and seventy (70) degrees Fahrenheit), including unconnected reserved on hand at the site, it shall comply with the provisions of the Standard for Bulk Oxygen Systems at Consumer Sites, NFPA 50. (7-1-97)

h. Cylinders, cylinder valves, couplings, regulators, hose, and apparatus shall be kept free from oily or greasy substances. Oxygen cylinders or apparatus shall not be handled with oily hands or gloves. A jet of oxygen must never be permitted to strike any oily surface, greasy clothes, or enter a fuel oil or other storage tank. (7-1-97)

i. Unless cylinders are secured on a special truck regulators shall be removed and valve protection caps, when provided for, shall be put in place before cylinders are moved. (7-1-97)

j. Cylinders not having fixed hand wheels shall have keys, handles, or non-adjustable wrenches on valve stems while these cylinders are in service. In multiple cylinder installations only one key or handle is required for each manifold. (7-1-97)

k. Cylinder valves shall be closed before moving cylinders. (7-1-97)

l. Cylinder valves shall be closed when work is finished. (7-1-97)

m. Regulators shall have the pressure released when not in use. (7-1-00)

n. Valves of empty cylinders shall be closed. (7-1-97)

o. Cylinders shall be kept far away from the actual welding or cutting operation so that sparks, hot slag or flame will not reach them, or fire-resistant shields shall be used. (7-1-97)

p. Cylinders shall not be placed where they might become part of an electric current. 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. (7-1-97)

q. Cylinders shall never be used as rollers or supports, whether full or empty. (7-1-97)

r. Unless connected to a manifold, oxygen from a cylinder shall not be used without first attaching an oxygen regulator to the cylinder valve. Before connecting the regulator to the cylinder valve, the valve shall be opened slightly for an instant and then closed. (Always stand to one side of the outlet when opening the cylinder valve.) (7-1-97)

s. A hammer or wrench shall not be used to open cylinder valve. If valves cannot be opened by hand, the supplier shall be notified. (7-1-97)
t. Complete removal of the stem from a diaphragm type cylinder valve shall be avoided. (7-1-97)

u. Fuel-gas cylinders shall be placed with valve end up whenever they are in use. Liquefied gases shall be stored and shipped with the valve end up. (7-1-97)

v. Cylinders shall be handled carefully. Cylinders shall not be subjected to rough handling, knocks, or falls which are liable to damage the cylinder, valve or safety devices and cause leakage. (7-1-97)

w. Before connecting a regulator to a cylinder valve, the valve shall be opened slightly and closed immediately. The valve shall be opened while standing to one side of the outlet; never in front of it. Fuel-gas cylinder valves shall not be cracked near other welding work or near sparks, flame, or other possible sources of ignition. (7-1-97)

x. Before a regulator is removed from a cylinder valve, the cylinder valve shall be closed and the gas released from the regulator. (7-1-97)

y. 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. (7-1-97)

z. If cylinders are found to have leaky valves or fittings which cannot be stopped by closing of the valve, the cylinders shall be taken outdoors away from sources of ignition and slowly emptied. (7-1-97)

aa. A warning shall be placed near cylinders having leakage, 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. (7-1-97)

bb. Safety devices shall not be tampered with. (7-1-97)

c. Fuel-gas shall not be used from cylinders through torches or other devices equipped with shutoff valves without reducing the pressure through a suitable regulator attached to the cylinder valve or manifold. (7-1-97)

d. The cylinder valve shall always be opened slowly. (7-1-97)

e. An acetylene cylinder valve shall not be opened more than one and one-half (1 1/2) turns of the spindle, and preferably no more than three-fourths (3/4) of a turn. (7-1-97)

ff. 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 (1) such wrench shall always be available for immediate use. (7-1-97)
**gg.** When cylinders are transported by powered vehicle, they shall be secure in a vertical position. (7-1-97)

**hh.** A suitable cylinder truck, cart, chain, or other steadying device shall be used to prevent all cylinders from being knocked over while in use, or in storage, empty or full. (7-1-97)

**ii.** Each oxygen and fuel gas cylinder shall have a back flow valve and a flash back arrester between the torch and the regulator. (7-1-97)

### 20. Manifolding of Oxygen/Fuel Gas Cylinders: (7-1-97)

**a.** Manifolds shall be approved either separately for each component part or as an assembled unit. (7-1-97)

**b.** Except as provided in sub-section 230.20.c. of this section, oxygen or fuel gas cylinders connected to one (1) manifold inside a building shall be limited to a total capacity not exceeding six-thousand (6,000) cubic feet of oxygen, three-hundred (300) pounds of liquefied petroleum gas, or three-thousand (3,000) cubic feet of other fuel-gas. More than one (1) such manifold with connected cylinders may be located in the same room provided the manifolds are at least fifty (50) feet apart or separated by a fire-resistant barrier at least five (5) feet high having a fire-resistance rating of at least one-half (1/2) half hour. (7-1-97)

**c.** Oxygen cylinders or fuel-gas cylinders connected to one manifold having an aggregate capacity exceeding six-thousand (6,000) cubic feet of oxygen, three-hundred (300) pounds of liquefied petroleum gas, or three-thousand (3,000) cubic feet of other fuel-gas shall be located outdoors, or in a separate building or room constructed in accordance with the following: The walls, partitions, floors, and ceilings shall be of noncombustible construction having a fire-resistance rating of at least one (1) hour. The walls or partitions shall be continuous from floor to ceiling and shall be securely anchored. At least one (1) wall of the room shall be an exterior wall. Openings from an inside generator room to other parts of the building shall be protected by a swinging type self-closing fire door for a Class B opening and having a rating of at least one (1) hour. Windows in partitions shall be wired glass and approved metal frames with fixed sash. Installation shall be in accordance with the Standard for the Installation of Fire Doors and Windows, NFPA 80. Rooms or outside houses shall be well ventilated with vents located at floor and ceiling levels. (7-1-97)

**d.** Separate manifold buildings or rooms may also be used for the storage of cylinders containing fuel gases as provided in sub-section 230.19. of this section and section 210 of this standard. Such building or rooms shall have no open flames for heating or lighting and shall be well ventilated. (7-1-97)

**e.** High-pressure fuel gas manifolds shall be provided with approved pressure regulating devices. (7-1-97)

**f.** An oxygen manifold or oxygen bulk supply system which has storage capacity of more than thirteen-thousand (13,000) cubic feet of oxygen (measured at fourteen-point-seven (14.7) psia
and seventy (70) degrees Fahrenheit), connected in service or ready for service, or more than twenty-five-thousand (25,000) cubic feet of oxygen (measured at fourteen-point-seven (14.7) psia and seventy (70) degrees Fahrenheit), including unconnected reserves on hand at the site, shall comply with the provisions of the Standard for Bulk Oxygen Systems at Consumer Sites, NFPA No. 50. (7-1-97)

g. High-pressure oxygen manifolds shall be provided with approved pressure-regulating devices. (7-1-97)

h. Manifolds shall be of substantial construction suitable for use with oxygen at a pressure of two-hundred-fifty (250) psig. They shall have a minimum bursting pressure of one-thousand (1,000) psig and shall be protected by a safety relief device which will relieve at a maximum pressure of five-hundred (500) psig. NOTE: DOT-4L200 cylinders have safety devices which relieve at a maximum pressure of two-hundred-fifty (250) psig (or two-hundred-thirty-five (235) psig if vacuum insulation is used). (7-1-97)

i. Hose and hose connections subject to cylinder pressure shall comply with sub-section 230.25. of this section. Hose shall have a minimum bursting pressure of one-thousand (1,000) psig. (7-1-97)

j. The assembled manifold including leads shall be tested and proven gas-tight at a pressure of three-hundred (300) psig. The fluid used for testing oxygen manifolds shall be oil-free and not combustible. (7-1-97)

k. The location of manifolds shall comply with the provisions of this sub-section. (7-1-97)

l. The following sign shall be conspicuously posted at each manifold: "LOW PRESSURE MANIFOLD, DO NOT CONNECT HIGH-PRESSURE CYLINDERS; MAXIMUM PRESSURE, 250-PSIG." (7-1-97)

21. Portable Outlet Headers: (7-1-97)

a. Portable outlet headers shall not be used indoors except for temporary service where the conditions preclude a direct supply from outlets located on the service piping system. (7-1-97)

b. Each outlet on the service piping from which oxygen or fuel-gas is withdrawn to supply a portable outlet header shall be equipped with a readily accessible shutoff valve. (7-1-97)

c. Hose and hose connections used for connecting the portable outlet header to the service piping shall comply with sub-section 230.22. of this section. (7-1-97)

d. Master shutoff valves for both oxygen and fuel-gas shall be provided at the entry end of the portable outlet header. (7-1-97)

e. Portable outlet headers for fuel-gas service shall be provided with an approved hydraulic back-pressure valve installed at the inlet and preceding the service outlets, unless an approved
pressure-reducing regulator, an approved back-flow check valve, or an approved hydraulic back-pressure valve is installed at each outlet. Outlets provided on headers for oxygen service may be fitted for use with pressure-reducing regulators or for direct hose connection. (7-1-97)

f. Each service outlet on portable outlet headers shall be provided with a valve assembly that includes a detachable outlet seal cap, chained or otherwise attached to the body of the valve. (7-1-97)

g. Materials and fabrication procedures for portable outlet headers shall comply with sub-section 230.23.a. through 230.23. aa. of this section. (7-1-97)

h. Portable outlet headers shall be provided with frames which will support the equipment securely in the correct operating position and protect them from damage during handling and operation. (7-1-97)

22. Manifold Operating Procedures: (7-1-97)

a. Cylinder manifolds shall be installed under the supervision of someone familiar with the proper practices with reference to their construction and use. (7-1-97)

b. All manifolds and parts used in manifolding shall be used only for the gas or gases for which they are approved. (7-1-97)

c. When acetylene cylinders are coupled, approved flash arresters shall be installed between each cylinder and the coupler block. For outdoor use only, and when the number of cylinders coupled does not exceed three (3), one (1) flash arrester installed between the coupler block and regulator is acceptable. (7-1-97)

d. Each fuel-gas cylinder lead shall be provided with a back-flow check valve. (7-1-97)

e. The aggregate capacity of fuel-gas cylinders connected to a portable manifold inside a building shall not exceed three-thousand (3,000) cubic feet of gas. (7-1-97)

f. Acetylene and liquefied fuel-gas cylinders shall be manifolded in a vertical position. (7-1-97)

g. The pressure in the gas cylinders connected to and discharged simultaneously through a common manifold shall be approximately equal. (7-1-97)

23. Service Piping Systems: (7-1-97)

a. Piping and fittings shall comply with Section 2, Industrial Gas and Air Piping Systems, of the American National Standard Code for Pressure Piping, ANSI B31.1, insofar as it does not conflict with sub-sections 230.23.b. and 230.23.c. of this section. (7-1-97)

b. Pipe shall be schedule forty (40) and fittings shall be at least standard weight in sizes up to and including six (6) inch nominal. (7-1-97)
c. Copper tubing shall be Types K or L in accordance with the Standard Specification for Seamless Copper Water Tube, ASTM B88-66a. (7-1-97)

d. Piping shall be steel, wrought iron, brass, or copper pipe, or seamless copper, brass, or stainless steel tubing except as provided in sub-sections 230.23.e. through sub-section 230.23.i. of this section. (7-1-97)

e. Oxygen piping and fittings at pressures in excess of seven-hundred (700) psig shall be stainless steel or copper alloys. (7-1-97)

f. Hose connections and hose complying with sub-section 230.24. of this section may be used to connect the outlet of a manifold pressure regulator to piping providing the working pressure of the piping is two-hundred-fifty (250) psig or less and the length of the hose does not exceed five (5) feet. Hose shall have a minimum bursting pressure of one-thousand (1,000)-psig. (7-1-97)

g. When oxygen is supplied to a service piping system from a low-pressure oxygen manifold without an intervening pressure regulating device, the piping system shall have a minimum design pressure of two-hundred-fifty (250) psig. A pressure regulating device shall be used at each station outlet when the connected equipment is for use at pressures less than two-hundred-fifty (250) psig. (7-1-97)

h. Piping for acetylene or acetylenic compounds shall be steel or wrought iron. (7-1-97)

i. Unalloyed copper shall not be used for acetylene or acetylenic compounds except in listed equipment. (7-1-97)

j. Joints in steel or wrought iron piping shall be welded, threaded, or flanged. Fittings, such as "L", "T", couplings, and unions may be rolled, forged, or cast steel, malleable iron, or nodular iron. Gray or white cast iron fittings are prohibited. (7-1-97)

k. Joints in brass or copper pipe shall be welded, brazed, threaded, or flanged. If of the socket type, they shall be brazed with silver-brazing alloy or similar high melting point (not less than eight-hundred (800) degrees Fahrenheit) filler metal. (7-1-97)

l. Joints in seamless copper, brass, or stainless tubing shall be approved gas tubing fittings or the joints shall be brazed. If of the socket type, they shall be brazed with silver-brazing alloy or similar high melting point (not less than eight-hundred (800) degrees Fahrenheit) filler metal. (7-1-97)

m. Distribution lines shall be installed and maintained in a safe operating condition. (7-1-97)

n. Piping located inside or outside of buildings may be placed above or below ground. All piping shall be run as directly as practicable, protected against physical damage, proper allowance being made for expansion and contraction, jarring and vibration. Pipe laid underground in earth shall be located below the frost line and protected against corrosion. After assembly piping shall be
thoroughly blown out with air or nitrogen to remove foreign materials. For oxygen piping, only oil-free air, oil-free nitrogen, or oil-free carbon dioxide shall be used. (7-1-97)

**o.** 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 pipelines, provided there is good natural or forced ventilation. (7-1-97)

**p.** Low points in piping carrying moist gas shall be drained into drip pots constructed so as to permit pumping or draining out the condensate at necessary intervals. Drain valves shall be installed for this purpose having outlets normally closed with screw caps or plugs. No 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. (7-1-97)

**q.** 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 whenever possible. There shall also be provided a shutoff valve in the discharge line from the generator, gas holder, manifold or other source of supply. (7-1-97)

**r.** Shutoff valves shall not be installed in such a manner that the safety relief device can be rendered ineffective. (7-1-97)

**s.** Fitting and lengths of pipe shall be examined internally before assembly and, if necessary, freed from scale or dirt. Oxygen piping and fittings shall be washed out with a suitable solution which will not react with the oxygen. NOTE: Hot water solutions of caustic soda or trisodium phosphate are effective cleaning agents for this purpose. (7-1-97)

**t.** Piping shall be thoroughly blown out after assembly to remove foreign materials. For oxygen piping, oil-free air, oil-free nitrogen, or oil-free carbon dioxide shall be used. For other piping, air or inert gas may be used. (7-1-97)

**u.** When flammable gas lines or other parts of equipment are being purged of air or gas, open lights or other sources of ignition shall not be permitted near uncapped openings. (7-1-97)

**v.** No welding or cutting shall be performed on an acetylene or oxygen pipeline, including the attachment of hangers or supports, until the line has been purged. Only oil-free air, oil-free nitrogen, or oil-free carbon dioxide shall be used to purge oxygen lines. (7-1-97)

**w.** Underground pipe and tubing and outdoor ferrous pipe and tubing shall be covered or painted with a suitable material for protection against corrosion. (7-1-97)

**x.** Aboveground piping systems shall be marked in accordance with the American National Standard Scheme for the Identification of Piping Systems, ANSI A13.1. (7-1-97)
y. Station outlets shall be marked to indicate the name of the gas. (7-1-97)

z. Piping systems shall be tested and proved gas-tight at one and one-half (1 1/2) times the maximum operating pressure, and shall be thoroughly purged of air before being placed in service. The material used for testing oxygen lines shall be oil free and noncombustible. Flames shall not be used to detect leaks. (7-1-97)

aa. When flammable gas lines or other parts of equipment are being purged of air or gas, sources of ignition shall not be permitted near uncapped openings. (7-1-97)

24. Protective Equipment: (7-1-97)

a. Equipment shall be installed and used only for the service for which it is approved and as recommended by the manufacturer. (7-1-97)

b. Service piping systems shall be protected by pressure relief devices set to function at not more than the design pressure of the systems, and discharging upwards to a safe location. (7-1-97)

c. The fuel-gas and oxygen piping systems, including portable outlet headers shall incorporate the protective equipment shown in Figures 230.24-A, 230.24-B, and 230.24-C. When only a portion of a fuel-gas system is to be used with oxygen, only that portion need comply with subsection 230.24.c. of this subsection. (7-1-97)

d. Approved protective equipment (designated Pf in Figures 230.24-A, 230.24-B, and 230.24-C) shall be installed in fuel-gas piping to prevent: back-flow of oxygen into the fuel gas supply system; passage of a flashback into the fuel gas supply system; excessive back pressure of
oxygen in the fuel gas supply system. The three (3) functions of the protective equipment may be combined in one device or may be provided by separate devices. (7-1-97)

e. The protective equipment shall be located in the main supply line, as in Figure 230.24-A or at the head of each branch line as in Figure 230.24-B, or at least location where fuel gas is withdrawn, as in Figure 230.24-C. Where branch lines are of two (2) inch pipe size or larger or of substantial length, protective equipment (designated as Pf) shall be located as shown in either Figure 230.24-B or 230.24-C. (7-1-97)

f. Back-flow protection shall be provided by an approved device that will prevent oxygen from flowing into the fuel-gas system or fuel from flowing into the oxygen system (see Sf, Figures 230.24-A and 230.24-B.) (7-1-97)

g. Flash back protection shall be provided by an approved device that will prevent flame from passing into the fuel-gas system. (7-1-97)

h. Back-pressure protection shall be provided by an approved pressure-relief device set at a pressure not greater than the pressure rating of the back-flow or the flashback protection device, whichever is lower. The pressure-relief device shall be located on the downstream side of the back-flow and flashback protection devices. The vent from the pressure-relief device shall be at least as large as the relief device inlet and shall be installed without low points that may collect moisture. If low points are unavoidable, drip pots with drains closed with screw plugs or caps shall be installed at the low points. The vent terminus shall not endanger personnel or property through gas discharge; shall be located away from ignition sources; and shall terminate in a hood or bend. (7-1-97)

i. If pipeline protective equipment incorporates a liquid, the liquid level shall be maintained, and a suitable antifreeze shall be used to prevent freezing. (7-1-97)

j. Fuel gas for use with equipment not requiring oxygen shall be withdrawn upstream of the piping protective devices. (7-1-97)

k. A check valve pressure regulator, hydraulic seal, or combination of these devices shall be provided at each station outlet, including those on portable headers to prevent back-flow, as shown in Figures 230.24-A, 230.24-B, and 230.24-C and designated as Sf and So. (7-1-97)

l. When approved pipeline protective equipment (designated Pf) is located at the station outlet as in Figure 230.24-C, no additional check valve, pressure regulator, or hydraulic seal is required. (7-1-97)

m. A shutoff valve (designated Vf and Vo) shall be installed at each station outlet and shall be located on the upstream side of other station outlet equipment. (7-1-97)

n. If the station outlet is equipped with a detachable regulator, the outlet shall terminate in a union connection that complies with the Regulator Connection Standards, Compressed Gas Association. (7-1-97)
o. If the station outlet is connected directly to a hose, the outlet shall terminate in a union connection complying with the Standard Hose Connection Specifications, Compressed Gas Association. (7-1-97)

p. Station outlets may terminate in pipe threads to which permanent connections are to be made, such as to a machine. (7-1-97)

q. Station outlets shall be equipped with a detachable outlet seal cap secured in place. This cap shall be used to seal the outlet except when a hose, a regulator, or piping is attached. (7-1-97)

r. When station outlets are equipped with approved back-flow and flashback protective devices, as many as four torches may be supplied from each station outlet through rigid piping, provided each outlet from such piping is equipped with a shutoff valve and provided the fuel gas capacity of any one torch does not exceed fifteen (15) cubic feet per hour. This rule does not apply to machines. (7-1-97)

25. Hose and Hose Connections: (7-1-97)

a. Hose for oxygen gas service shall comply with Specification for Rubber Welding Hose, Compressed Gas and Rubber Manufacturers Association. (7-1-97)

b. The colors for hose shall be red for acetylene and other fuel-gas hose, green for oxygen hose, and black for inert gas and air hose. (7-1-97)

c. When parallel lengths of oxygen and acetylene hose are taped together for convenience and to prevent tangling, not more than four (4) inches out of twelve (12) inches shall be covered by tape. (7-1-97)

d. Hose connections shall comply with the Standard Hose Connection Specifications, Compressed Gas Association. (7-1-97)

e. 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 three-hundred (300) psi. Oil free air or an oil free inert gas shall be used for this test. (7-1-97)

f. Hose showing leaks burns, worn places, or other defects rendering it unfit for service shall be repaired or replaced. (7-1-97)

26. Pressure-Reducing Regulators: (7-1-97)

a. Pressure-reducing regulators shall be used only for the gas and pressures for which they are intended. The regulator inlet connections shall comply with Regulator Connection Standards, Compressed Gas Association. (7-1-97)
b. When regulators or parts of regulators, including gages, need repair, the work shall be performed by skilled mechanics who have been properly instructed. (7-1-97)

c. Gages on oxygen regulators shall be marked "USE NO OIL". (7-1-97)

d. Union nuts and connections on regulators shall be inspected before use to detect faulty seats which may cause leakage of gas when the regulators are attached to the cylinder valves. (7-1-97)

27. Exhibitions and Demonstrations: (7-1-97)

a. Installation and operation of welding, cutting, and related equipment shall be done by, or under the supervision of a competent operator to insure the personal protection of viewers and demonstrator as well as the protection from fire, for materials in and around the site and the building itself. (7-1-97)

b. Cylinders containing compressed gases for use at the site shall not be charged in excess of one-half (1/2) their maximum permissible content. (Cylinders of non-liquefied gases shall be charged to not more than one-half (1/2) of their maximum permissible charged pressure in psig. Cylinders of liquefied gases shall be charged to not more than one-half (1/2) the maximum permissible capacity in pounds). (7-1-97)

c. Cylinders located at the site shall be connected for use except that enough additional cylinders may be stored at the site to furnish approximately one (1) days consumption of each gas used. Other cylinders shall be stored, in an approved storage area preferably outdoors, but this storage area shall not be located near a building. (7-1-97)

d. Cylinders in excess of forty (40) pounds total weight being transported to or from the site shall be carried on a hand or motorized truck. (7-1-97)

e. The site shall be constructed, equipped and operated in such a manner that the demonstration will be carried out so as to minimize the possibility of injury to viewers. (7-1-97)

f. Sites involving the use of compressed gases shall be located so as not to interfere with the egress of people during an emergency. (7-1-97)

g. The fire department shall be notified in advance of use of the site. (7-1-97)

h. Each site shall be provided with a portable fire extinguishers of appropriate size and type and with a pail of water. (7-1-97)

i. Observers and combustible materials at the site shall be protected from flames, sparks, and molten metal. (7-1-97)

j. Hoses shall be located and protected so that they will not be physically damaged. (7-1-97)

k. Cylinder valves shall be closed when equipment is unattended. (7-1-97)
l. Where caps are provided for valve protection, such caps shall be in place except when the cylinders are in service or connected ready for service. (7-1-97)

m. Cylinders shall be located or secured so that they cannot be knocked over. (7-1-97)

28. Arc Welding and Cutting: (7-1-97)

a. Welding equipment shall be chosen for safe application to the work to be done as specified in sub-section 230.28. of this section. (7-1-97)

b. Welding equipment shall be installed safely as specified by sub-section 230.28. of this section. (7-1-97)

c. Workmen designated to operate arc welding equipment shall have been properly instructed and qualified to operate such equipment as specified in sub-section 230.28. of this section. (7-1-97)

d. Assurance of consideration of safety in design is obtainable by choosing apparatus complying with the requirements of Electric Arc Welding Apparatus NEMA EW-1, National Electrical Manufacturers Association or the Safety Standard of Transformer-Type Arc Welding Machines. ANSI C33.2, Underwriters Laboratories. (7-1-97)

e. Standard machines for arc welding service shall be designed and constructed to carry their rated load with rated temperature rises where the temperature of the cooling air does not exceed 104-degrees Fahrenheit and where the altitude does not exceed 3,300-feet, and shall be suitable for operation in atmospheres containing gases, dust, and light rays produced by the welding arc. (7-1-97)

f. Unusual service conditions may exist, and in such circumstances, machines shall be especially designed to safely meet the requirements of the intended service. Chief among these conditions are: unusually corrosive fumes, steam or excessive humidity, excessive oil vapor, flammable gases, abnormal vibration or shock, excessive dust, or weather. (7-1-97)

g. Open circuit (no load) voltages or arc welding and cutting machines shall be as low as possible consistent with satisfactory welding or cutting being done. The following limits shall not be exceeded: alternate current machines, manual arc welding and cutting -- eighty (80) volts; automatic (machine or mechanized) arc welding and cutting -- one-hundred (100) volts; direct current machines, manual arc welding and cutting -- one-hundred (100) volts; automatic (machine or mechanized) arc welding and cutting -- one-hundred (100) volts. (7-1-97)

h. When special welding and cutting processes require values of open circuit voltages higher than the above, means shall be provided to prevent the operator from making accidental contact with the high voltage by adequate insulation or other means. NOTE: For a.c. welding under wet conditions or warm surroundings where perspiration is a factor, the use of reliable automatic controls for reducing no load voltage is recommended to reduce the shock hazard. (7-1-97)
i. A controller integrally mounted in an electric motor driven welder shall have capacity for carrying rated motor current, shall be capable of making and interrupting stalled rotor current of the motor, and may serve as the running over-current device if provided with the number of over-current units as specified by the National Electric Code. Starters with magnetic under voltage release shall be used with machines installed more than one (1) to a circuit to prevent circuit overload caused by simultaneously starting of several motors upon return of voltage. (7-1-97)

j. On all types of arc welding machines, control apparatus shall be enclosed except for the operating wheels, levers, or handles. Control handles and wheels shall be large enough to be easily grasped by a gloved hand. (7-1-97)

k. 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. (7-1-97)

l. Terminals for welding leads shall be protected from accidental electrical contact by employees or by metal objects i.e., vehicles, crane hooks, etc. Protection may be obtained by use of: dead-front receptacles for plug connections, recessed openings with nonremovable hinged covers, heavy insulating sleeving or taping or other equivalent electrical and mechanical protection. If a welding lead terminal which is intended to be used exclusively for connection to the work is connected to the grounded enclosure, it must be done by a conductor at least two AWG sizes smaller than the grounding conductor and the terminal shall be marked to indicate that it is grounded. (7-1-97)

m. No connections for portable control devices such as push buttons to be carried by the operator shall be connected to an a.c. circuit of higher than one-hundred-twenty (120) volts. Exposed metal parts of portable control devices operating on circuits above fifty (50) volts shall be grounded by a grounding conductor in the control cable. (7-1-97)

n. Auto transformers or a.c. reactors shall not be used to draw welding current directly from any a.c. power source having a voltage exceeding eighty (80) volts. (7-1-97)

o. Installation including power supply shall be in accordance with the requirements of the National Electrical Code. (7-1-97)

p. 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 National Electrical Code. (7-1-97)

q. 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. (7-1-97)
r. Chains, wire ropes, cranes, hoists, and elevators shall not be used to carry welding current. (7-1-97)

s. 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 shall be conducted to ascertain that no condition of electrolysis or shock, or fire hazard exists by virtue of such use. (7-1-97)

t. All ground connections shall be checked to determine that they are mechanically strong and electrically adequate for the required current. (7-1-97)

u. A disconnecting switch or controller shall be provided at or near each welding machine which is not equipped with such a switch or controller mounted as an integral part of the machine. The switch shall be in accordance with the National Electrical Code. Over-current protection shall be provided as specified in the National Electrical Code. 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. (7-1-97)

v. 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. (7-1-97)

w. For groups of welding machines, the rated current carrying capacity 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. (7-1-97)

x. In operations involving several welders on one structure, d.c. welding process requirements may require the use of both polarities; or supply circuit limitations for a.c. welding may require distribution of machines among the phases of the required distribution of machines among the phases of the supply circuit. In such cases, no load voltages between electrode holders will be two (2) times normal in d.c. or one (1), one-point-four (1.4), one-point-seventy-three (1.73), or two (2) times normal on a.c. machines. Similar voltage differences will exist if both a.c. and d.c. welding are done on the same structure. All d.c. machines shall be connected with the same polarity. All a.c. machines shall be connected to the same phase of the supply circuit and with the same instantaneous polarity. (7-1-97)

y. Workmen assigned to operate or maintain arc welding equipment shall be acquainted with the requirements of sub-sections 230.28 and 230.17. of this section, if doing gas-shielded arc welding, also Recommended Safe Practices for Gas-Shielded Arc Welding, A6.1 American Welding Society. (7-1-97)

z. Before starting operations, all connections to the machine shall be checked to make certain they are properly made. The work load shall be firmly attached to the work; magnetic work clamps shall be freed of adherent metal particles of spatter on contact surfaces. Coiled welding
cable shall be spread out before use to avoid serious over-heating and damage to insulation. (7-1-97)

aa. Grounding of the welding machine frame shall be checked. Special attention shall be given to safety ground connections of portable machines. (7-1-97)

bb. There shall be no leaks of cooling water, shielding gas, or engine fuel. (7-1-97)

c. It shall be determined that proper switching equipment for shutting down the machine is provided. (7-1-97)

dd. Printed rules and instructions covering operation of equipment supplied by the manufacturers shall be strictly followed. (7-1-97)

e. Electrode holders when not used shall be so placed that they cannot make electrical contact with persons, conducting objects, fuel, or compressed gas tanks. (7-1-97)

ff. Cables with splices within 10-feet of the holder shall not be used. The welder shall not coil or loop welding electrode cable around parts of his body. (7-1-97)

gg. The operator shall 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. (7-1-97)

hh. Machines which have become wet shall be thoroughly dried and tested before being used. (7-1-97)

ii. Work and electrode lead cables should be frequently inspected for wear and damage. Cables with damaged insulation or exposed bare conductors shall be replaced. Jointing lengths of work and electrode cables shall be done by the use of connecting means specifically intended for the purpose. The connecting means shall have insulation adequate for the service conditions. (7-1-97)

29. Resistance Welding: (7-1-97)

a. All equipment shall be installed by a qualified electrician in conformance with the National Electrical Code. There shall be a safety-type disconnecting switch or a circuit breaker or circuit interrupter to open each power circuit 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. (7-1-97)

b. Ignition tubes used in resistance welding equipment shall be equipped with a thermal protection switch. (7-1-97)

c. Workers designated to operate resistance welding equipment shall have been properly instructed and judged competent to operate such equipment. (7-1-97)
d. Controls of all automatic or air and hydraulic clamps shall be arranged or guarded to prevent
the operator from accidentally activating them. (7-1-97)

e. Spot and seam welding machines (nonportable) shall have all external weld initiating control
circuits operating on low voltages, not over one-hundred-twenty (120) volts. (7-1-97)

f. Stored energy or capacitor discharge type of resistance welding equipment and control panels
involving high voltage (over five-hundred-fifty (550) volts) shall be suitably insulated and
protected by complete enclosures, all doors of which shall be provided with suitable interlocks
and contacts wired into the control circuit (similar to elevator interlock). Such interlocks or
contacts shall be so designed as to effectively interrupt power and short circuit all capacitores
when the door or panel is open. A manually operated switch or suitable positive device shall be
installed, in addition to the mechanical interlocks or contacts, as an added safety measure
assuring absolute discharge of all capacitors. (7-1-97)

g. All doors and access panels of all resistance welding machines and control panels shall be kept
locked and interlocked to prevent access by unauthorized persons, to live portions of the
equipment. (7-1-97)

h. All press welding machine operations, where there is a possibility of the operators fingers
being under the point of operation, shall be effectively guarded by the use of a device such as an
electronic eye safety circuit, two (2) hand controls or protections similar to that prescribed for
mechanical press operations in sub-section 250.21. of this standard. All chains, gears, operating
bus linkage, and belts shall be protected by adequate guards, in accordance with sub-section
250.04. of this standard. (7-1-97)

i. The hazard of flying sparks shall be wherever practical, eliminated by installing a shield guard
of safety glass or suitable fire resistant plastic at the point of operation. Additional shields or
curtains shall be installed as necessary to protect passing persons from flying sparks. (See sub-
section 230.04 of this section.) (7-1-97)

j. All foot switches shall be guarded to prevent accidental operation of the machine. (7-1-97)

k. Two (2) or more safety emergency stop buttons shall be provided on all special multi-spot
welding machines, including two (2) post and four (4) post weld presses. (7-1-97)

l. On large machines, four (4) safety pins with plugs and receptacles (one (1) in each corner)
shall be used so that when safety pins are removed and inserted in the ram or platen, the press
becomes inoperative. (7-1-97)

m. Where technically practical, the secondary of all welding transformers used in multi-spot,
protection and seam welding machines shall be grounded. This may be done by permanently
grounding one side of the welding secondary current circuit. Where not technically practical, a
center tapped grounding reactor connected across the secondary for the use of a safety disconnect
switch in conjunction with the welding control are acceptable alternates. Safety disconnect shall
be arranged to open both sides of the line when welding current is not present. (7-1-97)
n. All portable welding guns shall have suitable counter-balanced devices for supporting the
guns, including cables, unless the design of the gun or fixture makes counterbalancing
impractical or unnecessary. (7-1-97)

o. All portable welding guns, transformers and related equipment that is suspended from
overhead structures, eye beams, trolleys, etc., shall be equipped with safety chains or cables.
Safety chains or cables shall be capable of supporting the total shock load in the event of failure
of any component of the support system. (7-1-97)

p. When trolleys are used to support portable welding equipment, they shall be equipped with
suitable forged steel clevis for the attachment of safety chains. Each clevis shall be capable of
supporting the total shock load of the suspended equipment in the event of trolley failure. (7-1-
97)

q. All initiating switches, including retraction and dual schedule switches, located on the portable
welding gun shall be equipped with suitable guards capable of preventing accidental initiation
through contact with fixturing, operator's clothing, etc.. Initiating switch voltage shall not exceed
twenty-four (24) volts. (7-1-97)

r. The movable holder, where it enters the gun frame shall have sufficient clearance to prevent
the shearing of fingers carelessly placed on the operating movable holder. (7-1-97)

s. Grounding. The secondary and case of all portable welding transformers shall be grounded.
Secondary grounding may be by center tapped secondary or by a center tapped grounding reactor
connected across the secondary. (7-1-97)

30. Flash Welding Equipment: (7-1-97)

a. Flash welding machines shall be equipped with a hood to control flying flash. In cases of high
production, where materials may contain a film of oil, and where toxic elements and metal fumes
are given off, ventilation shall be provided in accordance with sub-sections 230.06 through
230.07 of this section. (7-1-97)

b. For the protection of the operators of nearby equipment, fire-resistant curtains or suitable
shields shall be set up around the machine and in such a manner that the operators movements
are not hampered. (7-1-97)

c. If the welding process cannot be isolated, all persons who may be exposed to the hazard of arc
flash shall be properly protected. (7-1-97)

231.--239. (RESERVED)