

## **J. Safety in Welding and Cutting Operations**

### 1. General

Before starting welding operations outside shop areas, use Hot Work Cutting/Welding Permit in the Appendix.

### 2. Protective Clothing and Equipment

- a. Protective clothing and equipment shall be suitable for the type of work to be performed, kept in good repair, and kept free of oil and grease.
- b. Sleeves shall be kept buttoned at the wrist.
- c. Collars shall be kept buttoned.
- d. Fire resistant gauntlet gloves, aprons of leather or asbestos, and leggings shall be used as protection against radiated heat or sparks.
- e. Front pockets on overalls and aprons, and cuffs on pants shall be eliminated.
- f. Capes or shoulder covers made of leather or other flame and heat-resistant material shall be worn during overhead welding or cutting operations. Leather skull caps worn under helmet provide protection against head burns. When working in a confined space or an overhead location, ear plugs shall be worn or the ears covered with wire screen protectors.
- g. Hard hats or other types of head protectors shall be used where there is exposure to falling objects.
- h. Low cut shoes shall not be worn unless the ankles are covered with protective leggings.
- i. Employees required to wear respirators shall keep them clean and sterilized. When not in use, such equipment shall be stored in closed containers.
- j. The airline to supplied-air respirators shall be provided with a filter which will remove pipe scale, water, oil, mist, and noxious vapors. It shall also be equipped with a pressure reducing valve to prevent the supplied-air pressure from exceeding 25Psi.
- k. Insulating mats of sufficient size shall be used when sitting on the same metal which is being welded. Rubber gloves shall be worn under welding gloves when welding in wet or damp locations.
- l. After a welding job is completed, the material shall be chalk marked "HOT," or a warning sign shall be posted to caution other employees.

### 3. Eye Protection

- a. Goggles, helmets, hand shields, or other suitable eye protection having the proper lens shade for the work being done shall be worn during all welding or cutting operations. (See attached tables.)
- b. Goggles, helmets, and hand shields shall be checked frequently. Equipment with light leaks shall not be worn, as radiation burns will result. Cracked, broken, or loose filter plates must be replaced immediately.
- c. Protective colored flash goggles with side shields shall be worn under a hood for protection against harmful rays, flying chips, and sparks when an arc is struck prematurely

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before the helmet is lowered. The lenses shall be No. 1 or No. 3 shade. Inert gas metal-arc welding by nearby welders requires goggles under the helmet with lens shade as per table.

- d. NOTE: Momentary observation of an arc without protective lenses can cause a retinal burn, which, in turn, may result in a permanent dark area in the field of vision.
- e. When arc welding operations are performed in an area that is not enclosed or isolated, workers or other persons near the welding area (generally within 75' of the arc) shall wear appropriate goggles.
- f. Flash shields shall be carried on portable welding carts as standard equipment and shall be used when necessary.

#### 4. Work in Confined Spaces

- a. All confined spaces such as tanks, boilers, and compartments shall be ventilated when welding operations are being performed within. When impracticable to provide such ventilation, supplied-air respirators shall be used.
- b. When welding, cutting, or burning is performed in confined spaces, the cylinders shall be left outside. When welding operations are interrupted for coffee breaks, lunch, or at the end of the day, the cylinder valves shall be closed to prevent gas leaks into the confined space as this may cause oxygen depletion or an explosion hazard. Before re-entry, the tank atmosphere shall be checked for signs that oxygen depletion, flammable gases, or toxic vapors are not present.
- c. In confined spaces where the means of exit is a manhole or other small opening, a means for quickly removing workers in an emergency should be provided, such as a life belt and life line. An attendant shall be stationed outside the exit at all times while work is in progress. See Item, "Work in Confined Spaces".

#### 5. Ventilation

- a. Mechanical ventilation shall be used as a precaution against breathing welding fumes and dust. When this is not provided, approved respiratory protection is required.
- b. When welding on brass, bronze, galvanized iron, or cadmium plated metals, adequate ventilation shall be provided to carry off welding fumes. Metals containing or coated with lead, cadmium, zinc, mercury, beryllium, and similar materials produce toxic fumes when welded or cut.
- c. For local exhaust suction devices to be effective, the exhaust hood entrance shall be within 9" of the weld or cut.

#### 6. Fire Prevention

- a. When practicable, the object to be welded shall be moved to a safe location designated for welding. If the object to be welded cannot be moved to a safe location, all movable fire hazards in the vicinity shall be taken to a safe place.
- b. Welding and cutting operations shall not be done in rooms, compartments, or confined places containing flammable vapors or dusts, nor on containers that have held flammable liquids or gases until all fire and explosion hazards have been eliminated. This is in

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accordance with recommendations of the American Welding Society, "Standard A6.0–Welding and Cutting Containers Which Have Held Combustibles." For petroleum storage tanks, the recommendations of the American Petroleum Institute contained in their Manual No. RP2015, "Cleaning Petroleum Storage Tanks," shall be followed. Also see Section, "Recycling of Used Steel Drums and Containers."

- c. Welding and cutting operations shall be performed only in areas that are free of fire hazards.
- d. Welding shall not be performed on the outside or inside of tanks that contain flammable liquids until all explosion or fire hazards have been removed.
- e. Before starting welding or cutting operations on tanks or similar surfaces, an inspection shall be made to see that no combustible material is present on either side of the surface.
- f. Approved fire extinguishing equipment in good operating condition shall be kept close to all welding or cutting operations.
- g. Sheet metal guards or other similar protection shall be used to prevent sparks (which can travel up to 35') from falling on wooden floors, partitions, or on flammable materials that cannot be moved. A fire watcher with fire extinguishing equipment shall be in attendance where combustible materials may be ignited by welding sparks. After the job is done careful inspection of these areas shall be made to ascertain that no sparks are left in flammable materials. The watcher shall be assigned to inspect the area for at least a half hour after work has been completed.
- h. To prevent explosions, welding or other burning torches shall not be taken into confined spaces until pressures have been regulated and unless they are to be used immediately. Remove torches as soon as the work is finished.
- i. When required, welding permits shall be made available for review by interested parties.

## 7. Gas Welding and Cutting

### a. Storage, Handling, and Use of Cylinders:

- i. Special care shall be used in the identification and selection of cylinders to insure that the proper type of gas is used. Identification shall be made from the cylinder tag instead of depending on the cylinder color code.
- ii. Cylinders shall be handled carefully. They shall not be dropped or jarred.
- iii. The loading and storage platform shall be used for outdoor storage of cylinders so that they can be transferred between delivery trucks and the platform without being dropped or jarred. Full and empty cylinders of each type of gas shall be stored separately.
- iv. Cylinders shall be stored so that they will not be knocked over or damaged by falling objects, passing vehicles, or persons.
- v. Cylinders shall not be stored near radiators, stoves, or any other sources of heat.
- vi. O<sub>2</sub> cylinders shall be stored 20' away from fuel gas cylinders and combustible materials, or if closer, separated by a non-combustible barrier (at least 5' high) with a fire resistance rating of one-half hour.
- vii. All cylinder storage rooms shall be well ventilated.

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- viii. Unless other suitable provisions have been made to prevent cylinders from upsetting during use, they shall be securely tied to a substantial stationary object.
- ix. Cylinder valves shall be closed and valve protection caps replaced before cylinders are moved or placed into storage.
- x. Special cylinder carts shall be used for moving cylinders.
- xi. All cylinders shall be placed in an upright position whether in use or in storage. This prevents fuel gas liquids in LP-Gas or MAPP Gas (Methylacetylene-Propadiene) cylinders or acetone liquid in acetylene cylinders from being discharged through the regulator.
- xii. Cylinders shall be used in the order they are received from the supplier. When empty, their valves shall be closed, caps replaced, and the cylinders marked "MT Storage" to indicate that they are empty. Also see Section, "Handling, Using, and Storage of Compressed Gas Cylinders."
- xiii. Cylinders shall not be permitted to come in contact with electrical wires.
- xiv. Cylinders shall be placed in locations where they will not come in contact with sparks or flames from welding or cutting work.
- xv. When cylinders are to be hoisted or lowered by derrick, they shall be securely placed on a suitably designed carrier or platform and attached to the derrick hook by means of a choker sling. Cylinders shall not be lifted by their valve or caps. Electric magnets shall never be used.
- xvi. Oxygen or acetylene cylinders shall be used only when equipped with proper regulators or reducing valves.
- xvii. Regulators or automatic reducing valves shall be used only with the gas for which they are intended and at pressures for which they are intended.
- xviii. While acetylene cylinders are in use, the valve key wrench shall be kept in place. It shall be removed after closing the valve.
- xix. The fusible safety plug on acetylene cylinders shall not be tampered with.
- xx. Warm water, never a flame or boiling water, shall be used to remove ice from around the outlet valve of an acetylene cylinder.
- xxi. Leaking acetylene cylinders shall not be placed in service. When uncontrollable leaks are present, the cylinder shall be moved to a well ventilated open area, and the valve shall be opened slightly to permit the acetylene to escape slowly. Warning signs shall be displayed to keep persons with cigarettes or other sources of ignition at a safe distance.
- xxii. The tops of acetylene cylinders shall be kept free of tools or other objects.
- xxiii. Fuel gas and acetylene cylinders shall be stored and used valve end up.
- xxiv. Fuel gas cylinders shall not be used as a substitute for compressed air, as a source of pressure, nor used for ventilation or dusting operations.
- xxv. 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.

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xxvi. Acetylene shall not be used at a pressure >15psi.

b. Hose Lines and Connections

- i. Only hose in good condition shall be used. At regular intervals, examine pressurized hose while it is immersed in water to detect leaks.
- ii. Only hose designated to be used with a specific gas shall be used. In general, hoses can be identified by their color: red=fuel gas, green=oxygen, and black=inert gas.
- iii. Hose shall be protected from damage by trucks, falling objects, sharp edges, sparks, slag, and open flame.
- iv. Hose shall be placed so that it will not create a tripping hazard. Excess hose shall be coiled to prevent kinks and tangles.
- v. Standard oxygen hose or regulator outlet connections have right-hand threads; fuel gas connections have left-hand threads with a grooved hex on the nut or shank. Connections shall never be forced.
- vi. Oil or grease shall not be used in making up connections.
- vii. Tape shall not be used to repair hose. Hose may be spliced using standard brass fittings (not copper tubing) and ferrules or hose clamps designed for this purpose.
- viii. Welders shall not stand in front of the gauges on the regulator when opening the discharge valve of the tank. Sudden pressure may destroy the gauge, blowing out the glass and parts.

c. Torches

- i. Torches shall not be lighted by cigarette lighters, pilot lights, or matches. Torches shall not be relighted from hot work, especially when operating in a small confined space—if gases do not light instantly, ignition could be violent.
- ii. Purge oxygen and fuel gas lines individually to remove air and other contaminants before using each day. Do not purge in a confined space.
- iii. When torches are changed or welding is discontinued for longer than five minutes, all cylinder valves shall be closed.
- iv. A clear, unobstructed space shall be maintained between the work and the cylinders so that pressure reducing regulators can be reached quickly in an emergency.
- v. If a flashback occurs because of combustible gas mixtures burning inside the tip, torch or hose, faulty equipment or misuse is generally the cause. In an oxy-fuel torch, when hissing or squealing is heard, flame has passed the mixer and the torch and cylinder valves shall be shut off and the area vacated for about five minutes. If the torch, regulator, and cylinder are cool, inspect the torch and regulator for inner damage. Discard the hose unless it will pass a pressure test—the greater of either 300psi or twice the operating pressure.

8. Electric Arc Welding

a. Equipment and Cables:

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- i. Before starting operations, all electrical connections shall be checked to determine that they are securely made and firmly attached to the work.
- ii. Work leads shall be kept as short as possible.
- iii. Equipment shall be examined frequently to determine that all electrical connections and insulations on holders and cables are in good condition. Loose cable connections may overheat or arc and cause a fire.
- iv. Safety devices such as circuit breakers and interlocks shall not be shunted out or disconnected. Power sources or line fuses shall be locked out or removed when equipment is being installed, inspected, or serviced.
- v. Report any missing enclosures or defects in the motor or generator to your supervisor.
- vi. Terminals of the welding generator shall not contact the frame of the welder. This produces an electrical ground.
- vii. Only electrode holders designed to safely handle the maximum rated current required shall be used.
- viii. Electrode holders that are not fully insulated shall be replaced. Holders with protruding screws shall not be used.
- ix. Electrodes shall be removed from the holder when not in use.
- x. An arc shall not be struck on a gas cylinder or any pressure vessel as it may seriously weaken the vessel.
- xi. Only welding cables that are completely insulated, flexible, and of proper size for the maximum current requirements of the work shall be used. Cables shall be regularly inspected for cracks, wear, or damage and repair or replace if necessary.
- xii. Lengths of cable shall be connected by fully insulated lock-type connectors having a capacity equal to that of the cable.
- xiii. Cable lugs shall be soldered to the cable and shall be securely fastened to give full electrical contact.
- xiv. The exposed metal parts of lugs shall be completely covered with rubber tape and protected with friction tape. Exposed parts of electrical units shall have insulating covers in place before the power is turned on.
- xv. Proper electrical contact shall exist at all joints when a building structure or pipeline is used temporarily as a ground-return circuit.
- xvi. When a structure or pipe is continuously used as a ground for the machine, all joints shall be electrically bonded to establish a good ground.
- xvii. Pipe containing gases, flammable liquids, or conduits carrying electrical conductors shall not be used as a ground-return circuit.
- xviii. Welders shall make every effort to keep welding cables dry, grease and oil-free, and protected from sparks or hot metal.
- xix. Cables shall be supported from overhead when practical.
- xx. Cables laid on the floor or ground shall be protected so they will not be damaged or cause a tripping hazard.
- xxi. Welding cables shall not be located close to other power supply cables or other high-tension leads.

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- xxii. When discontinuing work, the power supply switch in the equipment shall be opened and the unit disconnected from the source of power.
- xxiii. Welding rods shall be stored in the container on the welding machine; not thrown on floors or staging.
- xxiv. Welding shall never take place in damp areas without insulation to protect workers against electrical shock. Dry duckboard or a mat shall be used if necessary.
- xxv. Gas or diesel electric generators shall have the exhaust gases vented to the outside to avoid the toxic effects of carbon monoxide and other gaseous byproducts.

Note: The hazards connected with atomic hydrogen and heli-arc welding are essentially the same as described herein for arc welding.

b. Spot Welding

The use of this type of welding presents certain hazards inherent to the nature of spot welding equipment.

- i. Prior to spot welding, the material is usually cleaned in a caustic or slightly acid bath. Employees performing these wash operations shall be protected from splashing liquid.
- ii. Under no circumstances shall the operator of a spot welding machine adjust the contactors. This shall be done by a trained electrician.
- iii. In hand spot welding installations, eye protection shall be required to protect the operator from the spattering metal.
- iv. Operators shall exercise extreme care when cleaning the tips of the contactors to prevent having their fingers crushed between tips.
- v. Welding of materials such as stainless and high carbon steels causes excessive spattering of metal. Operators shall be cautioned to protect against the possible penetration of the metal into the tips of the fingers.

Filter Lens Shade Numbers for Protection

Against Radiant Energy

<u>Gas Welding Operation</u>	<u>Shade Number</u>
Soldering	2
Torch brazing	3 or 4
Light cutting, up to 1"	3 or 4
Medium cutting, 1" to 6"	4 or 5
Heavy cutting, over 6"	5 or 6
Gas welding (light), up to 1/8"	4 or 5

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Gas welding (medium), 1/8" to 1/2"	5 or 6
Gas welding (heavy), over 1/2"	6 or 8

<u>Electric Arc Welding Operation</u>	<u>Shade Number</u>
Shielded metal-arc welding 1/16, 3/32, 1/8, 5/32inch diameter electrodes	10
Gas-shielded arc welding (nonferrous) 1/16, 3/32, 1/8, 5/32inch diameter electrodes	11
Gas-shielded arc welding (ferrous) 1/16,3/32, 1/8, 5/32inch diameter electrodes	12
Shielded metal-arc welding 3/16, 7/32, 1/4inch diameter electrodes	12
5/16, 3/8inch diameter electrodes	14
Atomic hydrogen welding	10 – 14
Carbon-arc welding	14