Welding, Cutting & Brazing Safety

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Revision Date:
District:

The following safety related program is for informational purposes only. The SORT committee hopes that each participating district will look at this program and discuss how it compares to the district's own practices. This program is NOT a complete safety program, but intended as guidelines. There is no guarantee that following a given program will eliminate or substantially reduce the risk of claim or injuries. It is expected that member districts will consider this program and adapt or modify it to fit the district's particular needs and circumstances.

WELDING, CUTTING & BRAZING SAFETY PROGRAM

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WELDING, CUTTING & BRAZING SAFETY

PURPOSE / SCOPE

The purpose of the Welding, Cutting & Brazing Safety Program is to ensure that all employees who weld, cut or braze understand the District's program for protecting them from potential hazards to the greatest extent possible, and to establish the requirements for working safely in such an environment.

A number of inherent hazards exist in the use welding and cutting equipment. A thorough understanding of proper safe and operating procedures minimizes the hazards involved and adds to the pleasure and efficiency of your work. It is, therefore, necessary that proper safety and operating procedures are understood and adhered to prior to using such apparatus.

Safety procedures, techniques, and a thorough knowledge of all aspects of the job about to be performed, should be thoroughly understood before attempting to operate oxy-fuel welding, cutting, and heating apparatus. **Only trained and certified welders should be performing any structural work on equipment or items previously assembled by a certified welder or manufacturer.**

This is intended to be a universal document that describes precautions and procedures that must be followed in all cases. Field management and staff will develop Standard Operating Procedures for work at specific sites and for specific work tasks, which will take into account all safety issues and will define the most effective methods of accomplishing the work objectives safely and efficiently.

All employees are encouraged to actively participate in identifying opportunities for applying engineering controls that would reduce the hazards of welding.

Policy Statement

It is the primary policy of the District to use engineering controls wherever practical to eliminate the need for or reduce the hazards employees face while welding, cutting or brazing. Where such controls are limited or impractical, it is the policy of the District that the employees will re-evaluate their work procedures and comply fully with this Safety Program.

DEFINITIONS

Acetylene - gas composed of two parts of carbon and two parts of hydrogen. When burned in the atmosphere of oxygen, it produces one of the highest flame temperatures obtained.

Alloy- This is a mixture of two or more metals.

Annealing- softening metals by heat treating. This most commonly consists of heating the metals up to a critical temperature and then cooling them slowly.

ANSI- American National Standard Institute.

AWS - The American Welding Society.

Backhand welding- a welding technique in which the welding torch is directed opposite to the progress of welding.

Bond - The junction weld that lies between the base and applied metal sections.

Braze welding- A method of welding in which coalescence is produced by heating above 800°F (427°C) and by using a nonferrous filler metal having a melting point below that of the base metals; in distinction to brazing, capillary attraction does not distribute the filler metal in the joint.

Brazing- The metal joining process whereby a filler metal is heated above and distributed between two or more close-fitting parts by capillary action. The filler metal is brought slightly above its melting (liquidus) temperature while protected by a suitable atmosphere, usually a flux. It then flows over the base metal (known as wetting) and is then cooled to join the work pieces together. It is similar to soldering, except the temperatures used to melt the filler metal are above 450 °C (842 °F).

Buildup - A surfacing variation in which, surfacing metal is deposited to achieve the required dimensions.

Burned metal- term occasionally applied to the metal, which has been combined with oxygen so that some of the carbon changed into carbon dioxide and some of the iron into iron oxide.

Burning- a nonstandard term for oxygen cutting.

Case hardening- adding of carbon to the surface of a mild steel object and heat-treating to produce a hard surface.

Continuous weld - A weld that extends from one end of a joint to the other. Where the joint is essentially circular, it extends completely around the joint.

Filler wire- a nonstandard term used for welding wire.

Fillet- welded metal where the bead exists in the internal vertex, or corner, of the angle formed by two pieces of metal, giving the joint additional strength to withstand unusual stress.

Fillet weld- a welded bead on the triangular cross section, joining two surfaces approximately at right angles to each other in a lap joint, T-joint or corner joint.

Flux- materials used to prevent, dissolve or facilitate removal of oxides and other undesirable surface substances.

Forehand welding- a welding technique in which the welding torch is directed toward the process of welding.

Fusion- The process where filler-metal are blended or melted together into the base metal.

Gas cylinder- a portable container used for transportation and storage of a compressed gas.

Gas pockets- Cavities or blisters that are formed by entrapped gases within molten metal.

Heat-affected zone- The zone inside base metal undergoing structural changes but does not melt.

Hydrogen- a gas formed of the single element hydrogen. It is considered one of the most active gases. When combined with oxygen, it forms a very clean flame.

Intermittent weld- An interrupted weld or a weld where the continuity is not consistent.

Lap joint- Welded joints, existing between two overlapping metal members along parallel planes.

Layer- a certain weld metal thickness made of one or more passes.

Mixing chamber- that part of the welding torch or cutting torch in which the fuel gas and oxygen are mixed.

Neutral flame- an oxy-fuel gas flame in which the portion used is neither oxidizing nor reducing.

NFPA- National Fire Protection Association.

Outside corner weld- fusing two pieces of metal together with the fusion taking place on the under part of the seam.

Overhead position- Welding operations performed from the underside of the joint.

Oxidizing- combining oxygen with any other substance. For example, a metal is oxidized when the metal is burned, or when oxygen is combined with all the metal or parts of it.

Scarfing cutting tips – Heating or cutting tips used with specially designed propane/LPG regulators, or acetylene that are used primarily to remove impurities, defects or cracks that form in cast or ingot metal prior to rolling or forging. Scarfing blow tubes are the preferred method rather than engaging in dangerous hammer chipping.

Soldering- a group of welding processes that produces coalescence of materials by heating them to the soldering temperature and by using a filler metal having a liquid state not exceeding 840 F (4500 C) and below the solidus of the base metals. The filler metal is distributed between the closely fitted surfaces of the joint capillary action.

Tack weld- Temporary spot welds made prior to final welding.

Tensile strength- maximums pull stress, which a specimen is capable of withstanding.

Welder or welding operator – any operator of electric or gas welding and cutting equipment.

Yield strength- stress at which a specimen assumes a permanent set.

EXEMPTIONS / EXCLUSIONS

This safety program does not teach you how to weld. Only qualified, trained or certified welders should construct, repair or modify existing equipment in a manner regulated by state and federal laws. Workers considering doing so should consult first with their management and engineering departments. Any modification or repair to a structural object like a piece of machinery, trailers, water storage or treatment facilities should be planned at the management level.

HAZARD ANALYSIS

This safety program highlights many hazards associated with welding, cutting or brazing. Heat, flash, electrical, atmospheric and other hazards exist while performing these tasks. A basic knowledge of metal thicknesses, equipment amperage/current settings or gas pressures is essential when attempting to weld or braze metal. A thorough training program should be developed that includes input from the manufacturers or suppliers of your inventoried equipment or supplies. Adequate precautions for the use, transport or storage of your equipment is also essential. Consideration of how welding, cutting or brazing operation could impact buildings, vehicles or personnel should be analyzed and incorporated into your standard operating procedures.

Hazard Description

Welding gas contains hazardous metal fumes that can make you sick, cause Parkinson like symptoms, or even kill you. The extent of the welding gas hazard depends on many factors including materials, location, ventilation, surfaces, paints, solvents, as well as:

- The welding method that produces the welding gas (such as MIG, TIG, or stick)
- What the welding rod (electrode) is made of
- Filler metals and base metals (such as mild steel and stainless steel)

The welding gas hazards - According to the Center to Protect Workers Rights, "In confined spaces, welding can be much more dangerous. With less fresh air, toxic fumes and gases can be much stronger. Shielding gases, like argon, can displace the oxygen and kill you.

METALS

These are some of the toxic metals contained in welding gases include:

- Stainless steel contains nickel and chromium. Nickel can cause asthma. Nickel and chromium can cause cancer. Chromium can cause sinus problems and "holes" between the nostrils.
- Mild steel (red iron) and carbon steel contain manganese. Manganese can cause Parkinson's disease, which cripples the nerves and muscles.

- Zinc in galvanized metal or in paint can cause metal fume fever. It feels like the flu and goes away in a few hours or days after exposure ends."

COATINGS, RESIDUES, SOLVENTS and WELDING GAS HAZARDS

- Lead (in some paints) can cause lead poisoning — headaches, sore muscles and joints, nausea, stomach cramps, irritability, memory loss, anemia, and kidney and nervous system damage. If lead dust goes home on work clothes/shoes, it can make your family sick, most of all your children.
- Cadmium (in some paints and fillers) can cause kidney problems and cancer.
- Welding through or near some (chlorinated) solvents can produce phosgene, a poisonous gas. The gas can cause fluid in the lungs. You may not notice the problem until hours after you quit welding. But fluid in your lungs can kill you.
- When carbon dioxide is used for shielding, carbon monoxide can form and kill you. Carbon monoxide can form also in oxyacetylene welding.
- The welding arc can form ozone and nitrogen oxides from the air. MIG and TIG welding make the most ozone, most of all when aluminum is welded. These fumes irritate the eyes, ear, nose, throat, and lungs and can damage the lungs. Some nitrogen oxides can cause fluid in the lungs.

Hazard Evaluation

Hazards are generated by the process of welding, cutting and brazing, regardless of where the work is being performed. Additional hazards are often unseen but not unforeseeable. Good housekeeping, additional shielding or the presence of an additional worker to act as a spotter is crucial when preparing for and preventing dangerous conditions. Never store combustible materials in or adjacent to welding or cutting operations.

Methods of Evaluation (how hazards are evaluated)

- Use the safest welding method for the job. Stick welding makes much less fume than flux core welding.
- Use welding rods that produce a low fume. 90% of the fume can come from the rod. Welding guns that extract fumes can capture 95% of the fume.
- Use of atmospheric testing and monitoring devices are also helpful
- Never weld inside a building that operates its fire suppression system through the use of atmospheric sensors. An example of one such sensor technology would be Carbon sensors. These could detect an increase in carbon and activate suppression systems.

RESPONSIBILITES

You should outline the responsibilities in each of these categories.

District

Develop written procedures & policies for the use and storage of related equipment and supplies. Provide training and certify employee proficiency. Outline the type of processes or jobs that cannot be performed in house. Some projects require additional planning and/or outsourcing.

Designated Person or Safety Program Coordinator

Periodically monitored & inspect the district's equipment condition, use and maintenance. MSDS sheets for related supplies must be maintained and provided to the employees. Labeling requirements must be consistent according to the Department of Labor & Industries and the local fire department. Coordinate with management & your welding suppliers for periodic inspection or certification of your inventoried gas cylinders. The tare weight and certifications must be stamped on each cylinder. Cooperation with management on the enforcement of these guidelines is essential.

Employees

Employees must know the hazards associated with welding, cutting or brazing & follow safe procedures. They should not use any equipment unless properly trained. The guidelines with-in the district's safety program must be followed. Employees must utilize & follow all policies governing the safe transport and storage of gas cylinders. Inspect welding rods, other related supplies/equipment for defects prior to the commencement of any work. Faulty items should be tagged, removed from service and then notify the safety officer.

GUIDELINES/RULES

General information

Acetylene is a compound of carbon and hydrogen (C2H2). It is a versatile industrial fuel gas used in cutting, heating, welding, brazing, soldering, flame hardening, metalizing, and stress relieving applications. It is produced when calcium carbide is submerged in water or from petrochemical process. The gas from acetylene generator is then compressed into cylinders or fed into piping systems. Acetylene is very unstable above 15 PSI, and can be generated on site by using calcium carbide and water. Although this practice has been abandon in the United States, it is still used in third world countries. There has also been a push to eliminate suppliers of acetylene, and to use other sources such as propane and synthetic fuel mixture. The WAC's are more in depth then this program.

Only approved apparatus such as torches, regulators or pressure-reducing valves, acetylene generators, and manifolds shall be used. Replacement tips, made to the same specifications and approved by a nationally recognized testing laboratory as the original tip, will not nullify the approved apparatus status of a torch.

Any workers in charge of oxygen or fuel-gas supply equipment shall be instructed and judged competent by their employer. Rules and instruction covering the operation and maintenance shall be readily available.
Both natural gas and propane are used as industrial fuel gases for flame cutting, scarfing cutting tips, heating, flame hardening, stress relieving, brazing and soldering. Contact your fuel gas supplier for the specific properties of the fuel gas, if more detailed specifications are required.

Natural gas is available throughout most areas of the USA and Canada. It is collected in oil fields and transmitted by pipelines. Physical properties vary according to the geographical location. A typical analysis shows methane content of approximately 93% with a heating value of approximately 1000 BTU/cu. Ft.

Propane is recovered from natural gas associated with or dissolved in crude oil and from petroleum refinery gases. It is known in popular terms as LPG (Liquefied Petroleum Gas), the term used also for butane and mixtures of propane and butane. Propane cylinders have safety valves that can shut down if the operator attempts to feed too much gas at one time. Propane feed rates should be gradual.

Natural gas is transmitted by pipeline to most installations that use natural gas as a fuel gas. Natural gas/methane is authorized for shipment in a non-liquefied compressed gas cylinder under DOT regulations. Propane is available in on-site bulk storage tanks. It is also available in 6 lb. cylinders or larger.

Propylene and proylene based fuel gases are hydrocarbon based products. They are industrial fuel gases used for flame cutting, scarfing, heating, flame hardening, stress relieving, brazing and soldering. They are used in certain applications for welding cast iron and aluminum. This type of fuel gas is available in on-site bulk storage tanks. It is also available in probable 30 lb. Cylinders, and in larger 60/70 lb. cylinders.

Fuel gases with natural gas or propane base plus liquid hydrocarbon additive consist of a natural gas or propane base, which is enriched by a liquid hydrocarbon additive. The liquid hydrocarbon additive is usually a low-boiling point, petroleum ether fraction of n-pentane and/or iso-pentane. N-pentane has a heating value of approximately 4249 BTU/cu. ft. Pentane added to natural gas will show a greater percentage increase in heating value, as the BTU heat value of natural gas is approximately 1050 BTU/cu. ft. This is not meant to imply that all fuel gases listed above use n-pentane or iso-pentane as liquid hydrocarbon additive. The physical and combustion properties of these fuel gases vary according to the percentage of additives added to the base of natural gas or propane. Use the general specifications for natural gas and propane as listed above as a guide only. Contact your fuel gas supplier for the specific properties of the fuel gas, if more detailed specifications are required.

Typical oxy-fuel work stations normally include the following items, each designed to perform a specific function: oxygen and fuel supply, regulators, hose, torch handle, cutting attachment and tip(s), welding nozzle(s), and operator safety

equipment. There are two types of workstations, portable and stationary. Cylinders mounted on a cart usually supply the portable station. Cylinders chained to a wall or post near the worktable supply the stationary type. Some stationary units are supplied by piping or manifold systems. The stationary system restricts the operator to the length of hose attached to the welding torch.

The Washington Administrative code (WAC 296-307-50011) & OSHA require: (Move the WAC & OSHA title references to appendix)

That you must remove all paint and solvents from metal surfaces before welding or torch cutting. Make sure all residues are removed.

- In a confined space, follow all appropriate confined-space rules — like air monitoring, not storing torches in the space, and ventilation.
- Maintain good ventilation. Use local-exhaust ventilation to remove fumes and gases at their source in still air. It is best to keep the exhaust hood opening 4" to 6" from the fume source.
- Use air blowers to blow fumes away from you when you are outdoors and it's windy.
- Keep your face far from the welding plume.
- If the ventilation is not good, use a respirator. Your employer must have a full respiratory protection program. This means proper selection and fitting of respirators, medical screening to be sure a worker can wear a respirator, and worker training. Correct respirator storage and cleaning and an evaluation of the program are needed.
- Knowledge of the limits for exposure to metals, gases, and total fumes during welding is helpful (see your product MSDS sheets). But these limits may not protect you enough, because they are generally out of date. The National Institute for Occupational Safety and Health (NIOSH) states that welding fumes may cause cancer, so keep the fume levels as low as possible.

WAC 296-307-50013 (No agency filings affecting this section since 2003)

What ventilation must be provided for general welding and cutting?

(1) Mechanical ventilation must be provided when welding or cutting is done on metals not covered in WAC 296-307-50019 through 296-307-50029 in the following locations:

(a) In a space of less than 10,000 cubic feet per welder.

(b) In a room with a ceiling height of less than 16 feet.

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

(2) Ventilation must be at the minimum rate of 2,000 cubic feet per minute per welder.**Exception:**
This requirement does not apply where local exhaust hoods and booths that meet the requirements of WAC 296-307-50015, or airline respirators approved by the Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Safety and Health (NIOSH) for such purposes are provided. Natural ventilation is considered sufficient for welding or cutting operations where the restrictions in subsection (1) of this section are not present.

Applicable SOPs

Arc Welding

While arc welding, some unusual service conditions may exist. In these circumstances machines shall be especially designed to safely meet the requirements of the service. Some concerns among these conditions are exposure to: unusually corrosive fumes, steam or excessive humidity, excessive oil vapor, flammable gases, abnormal vibration or shock, excessive dust, weather, or wet/moist environments.

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

Workers assigned to operate or maintain arc welding equipment shall be acquainted with the requirements of WAC 296-24-68501 through 296-24-68505, 296-24-69501 through 296-24-69507, 296-24-70001 through 296-24-70007 and 296-24-71501 through 296-24-71525; if doing gas-shielding arc welding, also Recommended Safe Practices for Gas-Shielded Arc Welding, A6.1-1966, American Welding Society.

Before starting arc-welding operations all connections to the machine shall be checked to make certain they are properly made. The work lead shall be firmly attached to the work; magnetic work clamps shall be freed from adherent metal particles of spatter on contact surfaces. Coiled welding cable shall be spread out before use to avoid serious overheating and damage to insulation.

Check all grounding of the welding machine frame. Special attention shall be given to safety ground connections of portable machines. Note: never remove a ground while a welding machine is turned on. A static charge may develop and then discharge through the grounded worker causing possible shock or injury. Never hold onto a ground connection while welding. Always disconnect vehicle or equipment grounds to prevent polarization damage to gauges.

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 supporting systems.

Manufactures' instructions and printed rules, coving the operation shall be strictly followed.

Electrode holders shall not be allowed to come in contact with persons, conducting objects, fuel, or compressed gas tanks.

Cables with splices within 10 feet of the holder shall not be used. The welder should not coil or loop welding electrode cable around parts of the body.

Machines that become wet shall be thoroughly dried and tested before being used.

Qualified maintenance personnel shall make periodic inspections, and records of the same maintained. The operator shall be instructed to report any equipment defects to the supervisor and the use of the equipment shall be discontinued until safety repairs have been completed.

Wherever there are floor openings, cracks, holes in walls, open doorways, and open or broken windows that cannot be closed, covered, or blocked. Precautions shall be taken so that no combustible materials will be exposed to sparks or hot slag.

Required PPE

PPE for welding shall include flameproof gauntlet gloves. Flameproof aprons made of leather, or other suitable material may also be desirable as protection against radiated heat and sparks. Woolen clothing is preferred to cotton because it is not so readily ignited and helps protect the welder from changes in temperature. Cotton clothing, if used, should be chemically treated to reduce its combustibility. All outer clothing such as jumpers or overalls should be reasonably free from oil and grease.

Wear goggles or shields with tempered lenses to protect eyes from injury and to provide good visibility of the work. With arc welding, people near work or looking towards work can get flash burns to the eyes. This is very painful and feels as if you have sand in your eyes. Refer to WAC 296-24-70003 for more specifications or recommendations for the proper shade number.

Sparks may lodge in rolled-up sleeves or pockets of clothing, or cuffs of overalls or trousers. It is therefore recommended that sleeves and collars are kept buttoned and pockets are eliminated from the front of overalls and aprons. Trousers or overalls should not be turned up on the outside. For heavy work, fire-resistant leggings, high boots, or other equivalent means should be used. For more specifications, and recommendations with protective clothing refer to WAC 296-24-70005.

In production work, a sheet metal screen set up in front of the worker can add more protection.

Overhead Welding or Cutting Operations: Head caps or shoulder covers made of leather or other suitable materials should be worn. Leather skullcaps may be worn under helmets to prevent head burns.

Safety procedures:

Ventilation

1. Welding can produce toxic fumes that with short or long term exposure could damage lungs & cause illnesses. Gases could also build up and create potentially dangerous explosive environments. Adequate ventilation & approved respiratory protection should be provided:

    a. During all welding operations
    b. When working in enclosed areas
    c. In confined areas
    d. In confined spaces (see confined space program)
    e. During hot weather
    f. When working adjacent to other employees or work areas.

Welding operations has the potential to expose workers to harmful atmospheric by products of zinc, brass, bronze, stainless steel, galvanized,-lead coated materials, or other metals & contaminates.

Always be aware of the gases in use at the workstation. Use only the type of apparatus designed for use with those gases.

The work area must have a fireproof floor. Concrete floors are recommended. No combustible materials can be within a 35-foot radius around work area.

- The floors shall be kept wet, or
- Covered with damp sand, or
- Protected with fire-resistant shields.

Where floors have been wet down, personnel operating welding or cutting equipment shall be protected from possible shock. *Note: dispose of hot materials in flame/fire proof containers with lids.*

Cutting and welding shall not be permitted in the following situations:

- In areas not authorized by management.
- In sprinkled buildings while such protection is impaired.
- In the presence of explosive atmospheres or atmospheres that may become explosive, such as: inside unclean or improperly prepared tanks or equipment which have previously contained such materials, or that may develop in areas with an accumulation of combustible dusts.
- In areas near the storage of large quantities of exposed or readily ignitable materials such as bulk sulfur, baled paper, or cotton.

The operator and any helpers during the welding or cutting operations shall wear:

- Approved eye protection
    - Confirm eye shielding is impact/heat resistant

- Heat or flame resistant gloves (usually leather)
- Heat or flame resistant:
    - Coveralls
    - Jacket
    - Chaps
    - Head gear, like caps, hats to protect hair and scalp
    - Appropriate flame/heat/spark resistant footwear.

Flash protection should cover the entire face & protect from burns while arc or wire-feed welding, or using excessive amounts of gas & flame in combination.

Anyone in the area shall not observe arc welding, unless approved eye/face protection is used.

Whenever other persons, nearby walls, or unprotected flooring could be exposed to the arc of the welding process. Welding (heat-resistant) screens shall be used when feasible.

Welding or soldering shall not be done on, any vessel that may have contained flammable or explosive substances until the vessel has been purged by steam (or filled with an inert gas, water or otherwise handled by special safety procedures as authorized by the field operations supervisor).

When electrode holders are left unattended, the electrodes shall be removed from the holders.

Firewatchers shall be required whenever welding or cutting is performed in locations where other than a minor fire might develop, or any of the following conditions exist:

- Appreciable combustible material, in building construction or contents or contents, closer than 35 feet to the point of operation.
- Appreciable combustibles are more than 35 feet away but are easily ignited by sparks.
- Wall or floor openings within a 35-foot radius expose combustible material in adjacent areas including concealed spaces in walls or floors.
- 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.

Firewatchers shall have fire-extinguishing 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 half an hour after completion of welding or cutting operations to detect and extinguish possible smoldering fires.

Cylinders and containers

All portable cylinders used for the storage and shipment of compressed gases shall be constructed and maintained in accordance with the regulations of the United States Department of Transportation, 49 CFR parts 171-179.

Cylinders must be secured UPRIGHT. They must have ADEQUATE GAS SUPPLY TO AVOID DANGEROUS EMPTY CYLINDER CONDITIONS, WHICH CAN RESULT IN REVERSE GAS FLOW. The valves must be closed when not in use, moving, when work is finished or empty and always use protective caps on the stored or empty cylinders. Cylinder outlet valves shall be inspected for cleanliness and damage before connecting to the regulator inlet. IF DAMAGED DO NOT USE. OSHA 29 CFR 1910.253 iii C states, “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.

Note: All cylinder valves are made of a fusible, threaded metal designed to break away under extreme over-pressured conditions. If this area of a cylinder is subjected to an impact or extreme heat, it should be:

1. Removed from service
2. Emptied of all gas in a safe outside area
3. Inspected by a certified cylinder technician prior to re-use.

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

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

Never tamper with the stamped markings, numbers, or tags on the cylinders.

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

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

The oxygen cylinder valve should be opened slowly and sufficiently to provide adequate flow. The fuel-gas cylinder valve should be opened a maximum of 3/4 of a turn. Where a special wrench is required, it should 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 an emergency.

ACTIVATING EQUIPMENT

Gas Welders: Never open fuel-gas cylinder valves near work areas, items generating sparks, flame, or other possible sources of ignition.” Never stand in back of the regulator when opening or closing the cylinder valve. Always stand to the

side with the cylinder valve between you and the regulator. Use proper ventilation when flowing & adjusting regulator pressures.

SHUTTING EQUIPMENT DOWN

Sometimes an electrical charge can build up between the machine and the metal being welded. To avoid injury, follow these steps:

1. Ventilate the work area.
2. Shut down regulator isolation valves, and then bleed off hose pressure.
3. Electrical equipment: Always leave ground connected until gas is bled off (see step 5).
4. A common practice involves striking excess wire against the grounded metal to reduce the amount protruding from the trigger tip. This is generally done after the gas is bled off to avoid initiating the welding process.
5. Finally, turn power off and then remove the ground connection. Failure to follow these steps could result in shock

STORAGE

Welding equipment should not be stored with lines that are connected & charged. The gas pressure could cause a bleed-off effect, emptying the contents inside the storage area. Gas also stored inside the flexible lines could leak by slowly. The subsequent build up inside a room could ignite or explode.

Acetylene cylinders shall be in the upright position (valve end up) for use and storage. If cylinder had been stored on its side, it is recommended to place in the upright position 24 hours before use. Acetylene cannot be stored in a hallow cylinder under high pressure the way oxygen, for example, is stored. Acetylene cylinders are filled with a porous material creating, in affect, a solid as opposed to a hollow cylinder. The porous filling is then saturated with liquid acetone throughout the porous filling. It is held in a stable condition. Filling acetylene cylinders is a delicate process requiring special equipment and training. They must be refilled only by an authorized gas distributor, and must never be filled by transferring from another cylinder.

DO NOT store cylinders and equipment in unventilated confined spaces, closed vehicles or trucks, or rooms used for habitation.

Fuel-gas cylinder storage inside a building, except for those in actual use or attached ready for use, shall be limited to a total gas capacity of two thousand cubic feet or three hundred pounds of liquefied petroleum gas.

For storage in the excess of two thousand cubic feet or three hundred pounds of liquefied petroleum gas, see requirements specified in WAC 296-24-68211 (6)(h) and (i). Special buildings, rooms or compartments shall have no open flame for heating or lighting and shall be well ventilated. They may also be used for storage

of calcium carbide in quantities not to exceed six hundred pounds, when contained in metal containers complying with WAC 296-24-68213 (1)(a) and (b). Signs should be conspicuously posted in such rooms reading, “Danger--No Smoking, matches or open lights,” or equivalent wording.

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

Compressed gas cylinders shall be equipped with connections complying with the American National Standard Compressed Gas Cylinder Valve Outlet and Inlet Connections, ANSI B 57.1-1965.

All cylinders with a water weight capacity of over thirty pounds shall be equipped with means of connecting a valve protection cap or with a collar or recess to protect the valve.

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

Inside buildings, cylinders shall be stored in a well- protected, well-ventilated, dry location, at least twenty feet from highly combustible materials. Cylinders shall be stored in distinctively assigned places away from elevators, stairs, or gangways. Assigned storage spaces shall be located where cylinders will not be knocked over or damaged by passing or falling objects, or subject to tampering by unauthorized persons. Cylinders shall not be kept in unventilated enclosures such as lockers and cupboards.

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

Oxygen cylinders in storage shall be separated from fuel-gas cylinders or combustible materials, a minimum distance of twenty feet or by a noncombustible barrier at least five feet high having a fire-resistance rating of at least one-half hour. When stored in outside generator houses or an enclosed room, they shall be separated by a noncombustible partition having a fire-resistance rating of at least one hour. This partition shall be without openings and shall be gastight.

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

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

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

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

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.

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

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

If valves cannot be opened by hand, the supplier shall be notified. If other trouble is experienced, the supplier should be sent a report promptly indicating the character of the trouble and the cylinder's serial number. Supplier's instructions as to its disposition shall be followed.

If manifolds are used in your workplace, refer to the WAC 296-24-68205.

Hot water solutions of caustic soda or tri-sodium phosphate are effective cleaning agents for oxygen piping or fittings that need grease or dirt removed that may react with oxygen.

If you need information on service piping systems, materials, design, joints, and installation, refer to WAC 296-24-68207

Regulators WAC 296-24-68209

Regulators must be clean and free of oil. The regulator inlet connections must be wrench-tight and have no leaks. The regulator must be turned off before opening the cylinder valve and closed after the work is completed to avoid any leaks from the cylinder. Always open the cylinder valve slowly.

To adjust a regulator turn the pressure adjusting screw clockwise (to the right) to increase the pressure and counterclockwise (to the left) to decrease the pressure and turn off the regulator.

DO NOT USE THE EQUIPMENT UNTIL ALL CONNECTIONS AND EQUIPMENT ARE LEAK FREE. To check for leaks close the cylinder valve and turn the adjusting

screw one turn counterclockwise (to the left). If the high pressure gauge reading drops, there can be a leak in the cylinder valve connection or high pressure gauge connection. If the low pressure gauge drops, there can be a leak in the equipment valves, hose connections, hose, low pressure gauge connection or check for diaphragm leak at the bonnet vent hole. Check for leaks using proper leak testing solution. If the high pressure gauges drops and at the same time the low pressure gauge rises, there is a leak in the regulator seat. **DO NOT USE THE EQUIPMENT UNTIL THERE ARE NO LEAKS IN THE SYSTEM.**

Oxygen and fuel pressure regulators are attached to the cylinders or manifold outlets to reduce high cylinder or supply pressures to suitable low working pressures for cutting and welding applications. Never use high-pressure gases directly from the cylinder without a suitable pressure-reducing regulator. Become familiar with the external parts of a regulator: inlet connection with filter, pressure adjusting screw, high pressure gauge, low pressure gauge, outlet connection, relief valve (where provided).

The internal working parts of the regulator are precision units. Only qualified technicians should clean or repair a regulator.

It is recommended to use reverse flow check valves on the regulator and/or torch handle to reduce the possibility of mixing gases in the hoses and regulators. Mixed gases will burn rapidly once the torch is lit. Mixed gases can explode in the hoses, regulators, or cylinders, resulting in serious damage to the equipment or injury to the operator. It is also recommended to use flashback arrestors to prevent a flashback from reaching upstream equipment.

If you experience a backfire or flashback (flame disappears and/or a shrill hissing sound when the flame is burning inside the cutting attachment) immediately turn off the preheat oxygen control valve on the cutting attachment. Then, turn off the torch handle fuel valve. Allow the cutting attachment to cool before attempting to relight. If backfire and flashback reoccurs, have the apparatus checked by a qualified repair technician before using again.

WELDING OPERATIONS

The individual responsible for authorizing cutting or welding operations shall inspect the area. This individual shall designate precautions to be followed in granting authorization to proceed, preferably in the form of a written permit.

Maintain adequate ventilation to prevent the concentration of oxygen/fuel gas, flammable gases and/or toxic fumes. It is important to remember that oxygen itself will not burn. The presence of pure oxygen, however, serves to accelerate combustion and causes materials to burn with great intensity. Oil, grease and wet items can ignite and burn violently in the presence of elevated levels of oxygen.

During oxy-fuel processes use workbenches or tables with fireproof tops. Firebricks commonly top these surfaces and support the work.

The generally recognized colors for supply hoses are red for acetylene and other fuel-gas mixtures, green for oxygen, and black for inert gas and compressed air.

REFERENCES / RESOURCES

This section would include what references are used in developing, enforcing, reviewing, or pertinence to this program. For example this section would reference all the pertinent WAC/RCW's, the ANSI standards, or the NFPA standards used.

This section would also include resources used in the program – internet, library sources, or vendors and businesses that are useful in the application of this program.

REVISION RECORD

Revision No.	Revision Date	Approval Date	Change
1.0.0	08-09-07		Initial design.

APPROVALS

Safety Committee Chairperson Date

General Manager Date