

EASTERN MICHIGAN UNIVERSITY

HOT WORK SAFETY PROGRAM



Department of Public Safety
Health and Safety Office
123 Structure Drive
Ypsilanti, MI 48197

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EASTERN MICHIGAN UNIVERSITY

HOT WORK

PURPOSE

The purpose of this Hot Work Program is to provide, in, about or around places of employment, reasonable safety to those involved in welding, cutting, soldering, brazing, work with flames and torches, and acetylene generating and to those exposed to these processes and the equipment and compressed gases used. This Hot Work Program has been written to achieve compliance with the Michigan Department of Consumer and Industry Services, Part 12 Welding and Cutting Standard.

SCOPE AND APPLICATION

This procedure applies to all Eastern Michigan employees involved in the use of flames and torches including but not limited to welding, cutting, soldering, brazing and melting.

DEFINITIONS

Arc Welding - A process for joining metals by heating with an electric arc with or without the use of pressure with or without a filler material.

Brazing - A process of joining metals without melting them with a filler metal melting about 800 degrees F.

Confined Space - A small or restricted space without proper life supporting atmosphere or in which mobility is restricted.

Cutting - A process in which the severing or removing of metal is effected by the use of an arc or flame.

Cylinders - Containers for storing compressed gases manufactured, labeled and periodically tested in accordance with specifications of the department of transportation regulations or manufactured in accordance with specifications of the national fire protection association.

Fire Resistant - The property of a material or assembly to withstand fire or give protection from it.

Gas Welding - A process for joining metals by heating with a gas flame with or without the use of pressure and with or without the use of a filler material.

Hot Work - Maintenance and/or construction work involving the use of flames and/or torches.

Inert Gas - Argon, carbon dioxide, helium or nitrogen gas.

Manifold - An assembly of pipe and fittings to interconnect either single or multiple sources to single or multiple outlets.

Noncombustible - Having properties which do not support combustion.

Psig - Pounds per square inch as measured by a gauge.

Resistance Welding - The joining of metals by the use of heat generated at the joint by the resistance to the flow of electric current and by the application of pressure.

Soldering - A process of joining metals without melting them using a filler metal melting at 800 degrees Fahrenheit, 427 degrees centigrade, or below.

Spot Welding - A form of resistance welding in which the current and pressure are restricted to the spot of metal surfaces directly in contact between the electrodes.

Storage - The storage of filled or empty cylinders not in use. An oxidizing and fuel gas cylinder or cylinders used as a unit shall not be considered to be in storage.

Water Capacity - The weight of water, as related to liquefied gas, of a volume equivalent to that of the cylinder.

Welder - A person capable of performing a manual or semiautomatic welding operation.

Welding Operation - A person who operates a machine or automatic welding equipment.

RESPONSIBILITIES

SUPERVISORS

- Shall train or test each employee before allowing him or her to use equipment for hot work.
- Shall provide face and eye protection and foot protection as necessary.
- Shall provide other personal protective clothing or equipment, such as gloves, aprons, hearing protection devices, respirators, lifelines, safety belts, and lanyards required to protect the employee from injury likely to be caused by the assigned hot work. Except for long sleeve shirts required to protect the employee from ultraviolet rays to the arms and ankle length

trousers, the personal protective clothing and equipment shall be provided without expense to the employee.

- Shall provide to an employee, at no expense to the employee, protective devices such as, but not limited to, curtains, safety glasses, or face shields to reduce the risk of flash burn, sparks, and foreign bodies to all employees in the area.
- Shall provide ventilation where necessary to protect an employee against toxic materials.

EMPLOYEES

- Shall use hot work equipment as trained and authorized.
- Shall use the required protective equipment.
- Shall not tamper with safety devices.
- Shall complete the hot work checklist or permit as required by the program.
- Shall notify DPS of hot work conductor during off hours.

An employee in charge of the operation of oxygen or fuel-gas systems, including generators, shall be instructed and judged competent by the supervisor for this work before being left in charge. Rules and instructions covering the operation and maintenance of oxygen or fuel-gas supply equipment, including generators, and oxygen or fuel-gas distribution piping systems shall be readily available.

GENERAL REQUIREMENTS

- A mixture of fuel gas with air or oxygen shall not be permitted except when consumed at a burner or torch.
- Only apparatus designed for use with fuel gas or oxygen shall be used for welding and cutting.
- The total volume of acetylene used per hour shall not exceed 1/7 of the total volume of the acetylene supply in the system.
- Liquid acetylene shall not be used.
- A cylinder to which a regulator is attached shall not be moved unless secured to a hand truck or powered truck designed or equipped for this purpose.
- A cylinder shall be closed in all of the following situations:
 - a) When the cylinder is moved.
 - b) When the work is finished or is left unattended during lunch, overnight, or for any prolonged period.
 - c) When the cylinder is empty.

- d) When the regulator is removed.
- Fuel gas should not flow from a cylinder or manifold through a torch or other device equipped with a shut off valve unless the pressure is reduced by a regulator attached to the cylinder or manifold.
 - An oxygen cylinder, cylinder valve, coupling regulator, hose, and apparatus shall be kept free from oily or greasy substances and shall not be handled with oily hands or gloves. Precautions shall be taken to prevent a jet of oxygen from striking an oily surface or greasy clothes or from entering a fuel, oil, or other storage tank.
 - Oxygen shall not be used as a substitute for compressed air or for any other use, except for welding or cutting or life support procedures.
 - Welders shall place welding cable and other equipment so that is clear of passageways, ladders, and stairways or it shall be protected against damage or hazards to an employee.
 - The hot work checklist ([see forms on the Health and Safety website](#)) shall be completed for all hot work conducted in areas other than confined spaces.

WORKING IN CONFINED SPACES

- When working in a confined space, the torch valves and the gas supply valve and oxygen valve outside the confined space shall be shut off during lunch, overnight, or for any other prolonged period. Where practicable, the torch and hose shall be removed from the confined space.
- When stick electrodes are used in a confined space, and welding is suspended during lunch, overnight, or for any other prolonged period, the electrode shall be removed from the holder and the machine shut off.
- The air in a confined space shall be tested and purged, if necessary, before any entry. Ventilation shall be provided in the confined space when an employee is present.
- A cylinder or welding power source used in a confined space shall be placed and secured on the outside of the space where work is being performed.
- A hot work permit shall be completed whenever hot work is conducted in a confined space. Contact the Health and Safety Office at 7.0794 for a permit.
- Arrangements shall be made to have EMU contracted rescue service on site whenever hot work is conducted in a confined space.
- An effective means of communication is established between employees in the confined space and the attendant.
- When necessary, safety belts and lifelines shall be provided, used and attached to the welder's body so that his or her body cannot be jammed in a small exit opening.
- After hot work operations are completed in a confined space, a sign or other warning shall be used to mark the hot metal.

CYLINDERS

CYLINDER MARKING

- Cylinders shall be legibly marked with either the chemical or trade name. Marking shall be by stenciling, stamping, or labeling and shall not be tampered with or readily removable. Whenever practical, the marking shall be located on the shoulder of the cylinder.
- Unlabeled cylinders shall not be used.
- Empty cylinders shall be so marked at time of depletion.

STORAGE

- An oxygen cylinder shall be stored not less than 20 feet from fuel gas cylinders or a highly combustible material, such as, but not limited to, oil, grease, excelsior, flammable gas, or a source of ignition, or shall be separated from the material by a noncombustible wall, not less than 5 feet (1.6 meters) high, having a fire-resistance rating of ½ hour. An oxygen cylinder shall not be stored in an acetylene generator compartment.
- A cylinder shall be stored away from heat in excess of 125 degrees Fahrenheit.
- A cylinder, including an empty cylinder, which is in storage, being shipped, or has the regulator removed shall have the cap secured in place, if a cap is provided in the design, or shall be otherwise protected.
- Storage shall be set up to ensure first in, first out usage.
- A cylinder storage area shall be posted with the names of the individual gases stocked, and a warning shall be posted against tampering by an unauthorized employee. An assigned storage area shall be located where a cylinder will not be knocked over or struck by a passing or falling object.
- Where different gases are stored, they shall be grouped by types. Groupings shall separate the flammable gases from the oxidizing gases as in subrule (1) of this rule.
- A storage area for cylinders shall be well ventilated. Cylinders shall not be stored in basements or pits, except where ventilation as specified by the department of public health is furnished to keep the area purged of any accumulation of gases.
- Storage of fuel gas in a building in 1 area within 100 feet (30 meters) of another fuel gas storage area and not protected by an automatic sprinkler system shall be limited to a total gas capacity of 2,000 cubic feet (56 cubic meters approximately) or 11.8 cubic feet (.33 cubic meters) of liquefied gas, which is 735 pounds (333 kilograms) water capacity. Storage in excess of this amount shall be in a separate room or compartment with an exterior wall and on the top floor of the building, outside or in a special building. All walls, floors, and ceilings shall be constructed of noncombustible material having a fire-resistance rating of 1 hour. The walls shall be continuous from the floor to the ceiling and shall be securely anchored. The separate room, compartment, or special building shall have no open flame for heat or light and shall be well ventilated. Openings from the separate storage room to other parts of the building shall be protected by a self-closing fire door for a class B opening and shall have a fire-resistance of not less than 1 hour. Windows in partitions shall be wired glass and approved metal frames with a fixed sash. Installation shall be in accordance with the

standard for the installation of fire doors and windows, national fire protection association standard 80-1974.

- Where a liquid or gaseous oxygen system is used to supply gaseous oxygen for welding and cutting and the system has a storage capacity of more than 20,000 cubic feet (560 cubic meters), measured at 14.7 psia (101.34 kPa) and 70 degrees Fahrenheit (21.1 degrees Celsius), including unconnected reserves at the site, the system shall be as prescribed in national fire protection association standard 50-1971, bulk oxygen systems.
- A cylinder used for methylacetylene-propadiene, stabilized, shall be constructed of materials suitable for this fuel gas in the gaseous or liquid phases.

GENERAL RULES FOR CYLINDERS

- A chain, bracket or other restraining device shall be used at all times to prevent cylinders from falling.
- Acetylene or liquefied gas cylinders shall not be placed on their sides but shall be stood valve end up.
- A cylinder shall not be dropped, dragged, rolled on its side or struck violently.
- A cylinder shall be lifted only by cradles or enclosed platforms when using a crane or hoisting device. Electromagnets, hooks, ropes or slings shall not be used.
- A frozen or ice-clogged valve shall be thawed either by warm air or use of warm water and dried before using. Boiling water or a flame shall not be used. Force shall not be applied to a valve or cap to loosen a cylinder frozen in place.
- Gases shall not be mixed within a cylinder except by the supplier.
- A cylinder shall not be placed where it will become a part of the electrical circuit by accidental grounding or where it may be burned by electric welding arc. A cylinder shall not be placed so that hot slag or flame will reach it or it shall be protected by a fire resistant shield. An electrode shall not be tapped against a cylinder to strike an arc.
- A regulator, gauge, or hose shall not be interchangeable between fuel gas, oxidizing gas or inert gas. Connections for compressed gas cylinders shall be as prescribed in ASA B57.1-1965, Compressed Gas Cylinder Valve Outlet and Inlet Connections.
- A cylinder valve shall be opened slightly for an instant and then closed before connecting to a regulator or manifold to clear the valve of dust and dirt. This shall not be done near a source of ignition. Pressure to a regulator shall be introduced by slowly opening the cylinder valve. An acetylene cylinder valve shall not be opened more than 1 ½ turns of the spindle.
- Acetylene shall not be utilized or piped, except in cylinder manifolds, at a pressure in excess of 15 psig.
- Only the owner of the cylinder, if the owner is qualified, or a person trained, qualified, and authorized by the owner, shall refill a cylinder.

CYLINDERS; KEYS, HANDLES, OR WRENCHES; USE AS ROLLER OR SUPPORT PROHIBITED; REPAIR; PLACING ITEMS ON TOP PROHIBITED.

- A cylinder without fixed hand wheels shall have keys, handles, or nonadjustable wrenches on valve stems while in service. A multiple cylinder installation shall require only 1 key or

handle for each manifold. A hammer shall not be used to open a cylinder valve or loosen a cap.

- A cylinder, whether full or empty, shall not be used as a roller or support.
- A leaking cylinder or a cylinder with a valve stuck open or a valve in need of repair shall be taken outdoors away from sources of ignition, slowly emptied, and tagged with a warning sign and the manufacturer of distributor shall be notified. Complete removal of the stem from the cylinder valve shall be avoided.
- Nothing shall be placed on top of a cylinder which would damage a safety device or interfere with the quick closing of the valve.

HOSES AND REGULATORS

HOSES AND CONNECTIONS

- Only approved hoses and connections shall be used. A hose connection shall be fastened to withstand twice the working pressure without leaking, but not less than 300 psig (2070 kPa). Oil-free air or an oil-free inert gas shall be used for the test.
- Parallel lengths of hose taped together shall have not more than 4 inches out of each 12 covered by tape.
- Parallel hoses shall be color coded as follows:
 - a) Red - fuel gases.
 - b) Green - oxygen.
 - c) Black - inert gas or air.
- A hose shall be repaired or replaced when it shows burns, leaks, worn places or other defects which could affect the safety of employees.

REGULATORS

- A regulator, gauge, or hose shall not be interchangeable between fuel gas, oxidizing gas or inert gas. Connections for compressed gas cylinders shall be as prescribed in ASA B57.1-1965, Compressed Gas Cylinder Valve Outlet and Inlet Connections.
- Shall be inspected for faulty seats and repaired when found defective.
- Shall be repaired by authorized and trained personnel, or be returned to the supplier for calibration or repairs.
- Shall not be removed until the cylinder valve is closed and the regulator is drained.
- Shall have gauges marked "Use No Oil" when used for oxygen.

GENERAL FIRE RULES

FIRE PRECAUTIONS

- Cutting and welding shall be done in designated areas free of flammable or conditions favorable to fire or explosion. If it is not practical to perform the work in a designated area, a person shall be assigned responsibility for fire safety off the job and shall take the following action after inspecting the job site and designating precautions to be taken:
 - a) Move flammables a minimum of 35 feet (10.7 m) from the area, cover the flammables with a fire resistant covering or schedule the work for a time when the flammables have been removed.
 - b) Cover cracks in the floor or walls that are within 35 feet (10.7 m) of the welding or cutting process if they could pass sparks to other areas.
 - c) Wet down wooden floors, except when laid over concrete, and provide a bucket or pan containing water or sand or cover with a fire resistant shield. Where the floor has been wet down, arc welding operators shall be protected from shock.
 - d) Have appropriate portable fire extinguishers on hand for use by trained employees.
 - e) If there is a possibility that a smoldering fire may have started, keep an observer at the scene of the work for at least 30 minutes after the welding and cutting has stopped.
- An observer shall be assigned whenever welding or cutting is done in an area where a fire could start or 1 of the following conditions exists:
 - a) Appreciable combustible material in the building construction or contents less than 35 feet (10.7 m) from the point of operation.
 - b) Appreciable combustible material more than 35 feet (10.7 m) away but easily ignited by spark.
 - c) Wall or floor opening less than a 35 foot (10.7 m) radius from exposed combustible materials in adjacent areas including concealed spaces in walls and floors.
 - d) Combustible material adjacent to the opposite side of a metal partition, wall, ceiling, or roof which is likely to ignite by conduction or radiation.
- Welding and cutting by gas utility firms on live mains is exempt from this rule when the main is filled under positive pressure with natural or manufactured gas and air movers are used to ventilate areas where fumes might accumulate.
- Welding or cutting shall not be permitted in the following situations:
 - a) In an area not authorized by management.
 - b) In a sprinklered building while such protection is impaired unless a fire watch is provided.
 - c) In the presence of an explosive atmosphere such as mixtures of flammable gases, vapors, liquids or dusts with air.
 - d) In an area nearer than 35 feet of storage of large quantities of exposed, readily ignitable materials such as bulk sulfur, baled paper or cotton.
- Conveyor and exhaust systems that might carry sparks to a distant combustible shall be protected or shut down.

WELDING DRUMS, BARRELS, TANKS, OR OTHER CONTAINERS

- Welding or cutting shall not be performed on drums, barrels, tanks, or other containers until they have been cleaned of all flammable combustible or toxic materials or fumes.
- All pipe lines or other connections to drums, barrels, or tanks shall be disconnected or blanked.
- Hollow spaces or cavities shall be vented and either filled with water or purged with an inert gas before preheating, cutting or welding.
- An opening shall be maintained during welding and cutting to vent gases or vapors.
- The welded construction of a transmission pipeline welding pipe lines and related facilities, API Standard 1104-1973.
- The connection, by welding, of branches to a pipeline carrying a flammable substance shall be performed in accordance with the publication Welding or Hot Tapping on Equipment Containing Flammables, API Standard PSD No. 2201-1963.

ARC WELDING AND CUTTING

ARC WELDING MACHINES

- An arc welding machine shall be capable of operating safely in the environment in which it is located. The design and construction shall enable the machine to carry its rated load with rated temperature rise where the temperature of the cooling air is not more than 104 degrees Fahrenheit and where the altitude is not more than 3300 feet (1000 m approx.).
- Where unusual service conditions, such as corrosive fumes, steam, oil vapor, flammable gases, vibration, shock, dust or weather exist, a specially designed machine shall be used.

OPEN CIRCUIT AND NO LOAD VOLTAGES OF ARC WELDING MACHINE

- When an arc welding machine is operated without being connected to a load, the open circuit voltage shall not exceed the values shown in Table 1 when rated voltage is applied to the primary winding or when a generator type arc welding machine is operating at maximum rated no-load speed.
- When welding and cutting processes require values of open circuit voltages higher than 100, insulation or other means shall be provided to prevent the operator from making accidental contact with the high voltage.
- Equipment working through resistors from DC trolley voltages of 250 to 600 volts shall have a protective device for automatically disconnecting the power during arc off periods.
- Automatic control devices for reducing no-load voltage below 50 volts shall be provided where AC welding is to be done under wet conditions that could provide a shock hazard.

Table 1
MAXIMUM OPEN CIRCUIT AVOLTAGES
OF WELDING MACHINES

Welding Current	Max. Open Circuit (no-load) Voltage	
	Manual and Semiautomatic Machines	Automatic Machines
ac 80 rms	100rms	
dc>10%Ripple voltage	80rms	100 average
dc<10%Ripple voltage	100 average	100 average

DESIGN REEQUIREMENTS FOR ARC WELDING MACHINES

- A controller integrally mounted in an electric motor driver welder shall have the capacity for carrying rated motor current and shall be capable of making and interrupting stalled rotor current of the motor.
- Control apparatus shall be enclosed except for the operating wheels, levers or handles. The handles and wheels shall be large enough to be grasped by a gloved hand.
- Input power terminals, tap change devices and live metal parts connected to input circuits shall be completely enclosed and accessible only by use of tools.
- Welding lead terminals shall be protected from accidental electrical contact by personnel or metal objects. If a welding lead terminal normally used for connection to the work is connected to a grounded enclosure, it shall be done by a conductor at least 2 sizes smaller than the grounding conductor and it shall be so marked.
- Portable control devices, such as push buttons, shall not be connected to an AC circuit of more than 120 volts. Exposed metal parts of a portable control device operating above 50 volts shall be grounded.
- Auto transformers or AC reactors shall not be used to draw welding current directly from any AC power source having a voltage of more than 80 volts.

INSTALLATION

- The frame or case of a welding machine shall be grounded unless the manufacturer does not recommend it.
- The work on which the operator welds shall be grounded by a grounded metal floor, platen, connection to a grounded building frame or by a direct ground to the machine. A wire used for grounding a work piece shall be capable of carrying the full welding current.
- A conduit containing an electrical conductor shall not be used for completing a work lead circuit.
- A pipe line in service shall not be used as a permanent part of a work lead circuit, but may be used during construction, extension, or repair if current is not carried through threaded joints, flanged bolted joints, or caulked joints and if special precautions are used to avoid sparking at connection of the work-lead cable.
- Chains, wire ropes, cranes, hoists, and elevators used for carrying loads shall not be used to carry a welding current.
- A welding cable shall be protected against damage, entanglement, or contact with power supply or high tension wires.
- A welding machine not provided with a controller or disconnect switch as an integral part shall have a controller or disconnect switch with overload protection provided. A disconnect switch with overload protection or overload disconnect protection or equivalent shall be provided for each outlet used by a portable welding machine.
- The rated current carrying capacity of the supply conductors for individual machines shall not be less than the rated primary current for the welding machine. The rated current carrying capacity of conductors for a group of welding machines may be less than the sum of the rated primary currents of the welding machines supplied. The conductor rating shall be determined in each case according to the machine loading based on the use to be made of each welding machine and the allowance permissible if all the machines supplied by the conductor will not be in use at the same time.
- Where a welding machine is working sufficiently close to another machine so that a welding operator is likely to touch the exposed parts of more than 1 electrode holder simultaneously, the machine shall be connected so as to minimize shock hazard as follows:
 - a) DC machines shall be connected with the same polarity
 - b) AC machines shall be connected to the same phase of the supply circuit and with the same instantaneous polarity.

OPERATION

- Engine fuel, cooling water, or shielding gas shall not be allowed to leak.
- A welding machine shall be disconnected when being moved and turned off when not in use.
- Electrodes shall be retracted or removed when not in use. Electrode holders not in use shall be placed so that they cannot make electrical contact with an employee, fuel or gas tanks or conducting objects.
- A welder shall not let live electrodes or holders touch his bare skin or damp clothing. When arc welding is performed in wet conditions or under a condition of high humidity, the welder shall be protected against electric shock.

- Electrode holders shall not be cooled by immersion in water.
- Welding shall not be permitted where fumes of chlorinated hydrocarbons are present unless specific ventilation and personal protective equipment is provided as specified by the department of public health.
- Before starting a welding operation, the welder shall:
 - a) Make sure the work lead is secured to the work.
 - b) Make sure the magnetic work clamps are free of spatter on the contact surfaces.
 - c) Spread out the welding cable, if necessary, to prevent overheating and damage.
 - d) Make sure grounding connections are secured to a good ground.
 - e) Make sure the required switching equipment for shutting down the machine has been provided.
- A welder shall not curl or loop welding cable around his body.

SOLDERING IRONS

Ensure that the soldering iron is equipped with a properly insulated holder before using it. When not in use, your soldering iron should be placed in a fireproof holder (or back in the stove) and never allowed to lie on the floor, chairs, or tables where it can come in contact with combustible materials or accidentally be touched by any person. Never leave a hot soldering iron unattended. If it is electric, make sure it is disconnected.

ELECTRICALLY HEATED IRONS

Before you use an electrically-heated iron, you should make the following safety checks:

- Check the thermostatic control (if the soldering iron has one) to make sure that it is working properly and that it is adjusted to the proper temperature.
- Check the lead cord for proper insulation and make sure that it is free from grease and oil. Also make sure the cord is not laying in walkways where it could present a tripping hazard.
- Check all electric tools and extension cords. They should be fitted with a three-prong plug for proper grounding.
- All electric soldering irons should be stored in a dry place. Check the iron before using it to be sure it's dry.

FLAME HEATED IRONS

- Check the hose connections, particularly the stove connection, for gas leaks. Also check the connections at the cylinder valve if a "bottled" fuel gas is used. (Soap and water may be used).
- If you are using an internally-fired bit, see the following section.
- Remember that gas-fired irons are not thermostatically controlled so care must be taken to prevent overheating of the metals which could result in generation of excess fumes.

TORCH SOLDERING AND BRAZING AND FLAME HEATED SOLDERING IRONS

CYLINDER PLACEMENT AND STORAGE

- All gas cylinders stored inside must be located in a well-protected, well-ventilated, dry location. They must be located at least 20 feet from highly combustible materials, sparks, open flames, excessive heat, and away from elevators, stairs, or gangways.
- Cylinders connected for use must be lashed or chained to prevent them from toppling over. Stored cylinders must also be secured.
- All acetylene cylinders must be stored with the valve end up.
- When cylinders are not connected for use, valve protection caps must be in place unless the cylinder is not designed to accept a cap.
- Stored oxygen cylinders must be separated from stored fuel gas cylinders or combustible materials (especially oil or grease) by at least 20 feet by a noncombustible barrier. This barrier must be at least 5 feet high and have a fire resistance rating of one-half hour.
- All cylinders must be legibly marked to identify their contents.
- Indoor storage of fuel gas is limited to a total capacity of 2,000 cubic feet or 300 pounds of liquified petroleum gas.
- Be careful that cylinders are not placed so as to become a part of an electrical circuit.
- Mark empty tanks “MT”, close the valves, and replace valve caps securely.

REGULATOR ATTACHMENT AND REGULATOR CHECK

Before you attach the regulator, “crack” the cylinder valve to clean the dust and dirt from it. When attaching the regulator to the cylinder, use only an open-end wrench of proper size. Cylinder valves which do not have fixed hand wheels must have a key, handle, or non-adjustable wrench on the valve stem while the cylinder is in use. Check the regulator for “creep” (“creeping” of a regulator is indicated by a gradual increase in pressure after the regulator valves are closed). If it does, have it repaired immediately.

HOSES, TORCH VALVES, AND CONNECTIONS

- Hoses showing leaks, burns, or worn places must be replaced or repaired.
- Hoses should be color-coded to avoid accidental mixing.
- Check hose connections for proper threading. Standard hose connections are threaded right-hand for oxygen and left-hand for acetylene or other fuel gas. This will prevent an accidental switch of oxygen and fuel gas hoses.
- Test the hose for leaks by immersing it - under normal working pressure - in water. Do not try to repair hoses with tape.
- Use only approved bronze or brass fittings. Copper fittings must never be used on acetylene cylinders. Under certain conditions, the acetylene might react with the copper to produce an explosive compound.
- Do not use oil, grease, or similar substances on any torch or regulator. Oil and grease in the presence of oxygen may burn with explosive force.

WORK PRACTICES

After the preliminary safety checks have been performed, safe work practices are in order. Some good practices to follow are:

- Always point cylinder outlets away from each other before hookup.
- To prevent injury from malfunctioning valves, never stand directly in front of a gauge while opening a cylinder valve - stand to one side.
- There is a proper way to light a welding torch:

First, the hoses must be purged:

Open the valve on the acetylene cylinder. This should never be opened more than one and one-half turns, and three-fourths of a turn is preferable. Open the acetylene torch valve one-fourth turn. Adjust the acetylene to working pressure [less than 15 pounds per square inch on the gauge (psig) or absolute (psia)] with the gas regulator screw. Close the acetylene torch valve.

Follow the same procedure with the oxygen cylinder and torch;

Slowly open the oxygen cylinder all the way. Open the oxygen torch valve one-half turn. Adjust the oxygen to working pressure with the gas regulator screw. Close the oxygen torch valve.

The final steps are the actual lighting of the torch:

Reopen the acetylene torch valve one-fourth turn and light the gas with a friction lighter. (Never use matches.)

Open the oxygen valve one-fourth turn. Adjust the flame.
Torch Solderer and Gas Cylinders

- There is also a proper way to shut off the torch:
Close the torch valve, acetylene first, then oxygen.
Close the cylinder valves, again acetylene first, then oxygen.
Open both torch valves to release the pressure.
Shut off the regulator adjusting handle until you no longer feel any spring tension.
Close the torch valves.
This procedure reduces the possibility of regulator fires when the oxygen cylinder valve is opened again. It will also prevent leaks of acetylene or oxygen while the equipment is not in use.
- Leave the valve wrench on the acetylene cylinder whenever the valves are open. This permits emergency shut-off of the gas.

- Do not leave pressure in the hoses when leaving the area. Shut off the oxygen and acetylene at the cylinder and “bleed” the remaining acetylene and oxygen out of the hose - first one line and then the other.
- Never use a hard, sharp tool for cleaning tips, except where such tools may be specifically recommended by or supplied by the tip manufacturer. Use appropriate tip cleaners or a copper or brass wire.

RESISTANCE SOLDERING AND BRAZING

Resistance soldering and brazing is used for joints which have simple configuration - since uniform current distribution is important for proper fusion. When using resistance heating with carbon blocks for soldering or brazing, make sure that the operating voltage is set properly for the work done. Check to see that equipment is grounded securely. Be careful not to touch the energized electrodes or heated parts as these can cause severe burns. Also, when working with the equipment, do not apply too much pressure to the electrode because it can crack. Do not interrupt pressure during current flow, as arcing may occur.

HEALTH HAZARDS

The health hazard potential of any soldering or brazing operation depends on, among other things, the types of filler metals, fluxes, coatings, cleaning agents, gases, and base metals used. It is important to know what materials you are working with and what hazards/symptoms they present. If you begin to experience any of these symptoms, report them to your supervisor and see prompt medical advice.

CLEANING AGENTS

ACIDS

- Acids used for cleaning should be diluted with water. ALWAYS PUT THE ACID INTO THE WATER; NEVER PUT WATER INTO ACID.
- Wear a full face shield and protective gloves. Work with acids should be carried out in well-ventilated area and face shield and protective gloves worn.
- Some specific acids that you might encounter include:
 - a) *Hydrochloric or Muriatic Acid*: A corrosive acid, yellowish in color, inhalation of hydrochloric acid fumes will cause a choking sensation,
 - b) *Sulfuric Acid*: Sulfuric acid is intensely irritating to the respiratory system and skin. When used to remove rust, scale, and oxide from metals, it can form hydrogen, a flammable gas,
 - c) *Phosphoric Acid*: Although not as hazardous as sulfuric acid, exposure to phosphoric acid can result in inflammation of mucous membranes and skin irritation,

- d) *Nitric Acid*: This acid can cause severe skin burns and severe irritation of the respiratory tract.

ALKALIES

- Alkali mixtures used in cleaning operations typically contain sodium or potassium hydroxide.
- When sodium or potassium hydroxide is put into water to make a solution, it can cause the water, depending on the amount added, to boil. This causes bubbling and splashing, so personal protective equipment (gloves and full face shield) should be worn.
- Skin contact with these alkalies will cause irritation.
- Alkalies should be worked with in well ventilated areas.

ORGANIC SOLVENTS

- Most organic solvents are flammable and thus are potential fire and explosion hazards.
- Exposure to vapors of organic solvents can result in irritation of the eyes, nose, throat, and lungs; dizziness; headaches; and sensations of drunkenness.
- Organic solvents containing chlorine may break down due to the heat and generate phosgene gas which at low concentration (less than 1 part per million), has a sweet odor. At about 1 ppm it smells like musty or new mown hay. Phosgene is a severe pulmonary irritant and, in high concentrations, can cause death.
- Prolonged or continued skin contact with most organic solvents will remove essential skin oils which will lead to dry, cracking skin and possibly irritation and/or infection.

ULTRASONIC CLEANING

Passing an ultrasonic sound wave through a solution creates a vibratory force which breaks off particles and contaminants from small metal parts that were placed in the solution for cleaning. If you use ultrasound cleaning methods, follow the manufacturer's instructions and check with your supervisor for any special protective clothing required.

SOLDERING FLUXES

The fluxing agent is determined by the metals to be joined. In most cases they fluxes give off acid or alkali fumes when heated. Because they contain acids and/or alkalis, they can irritate the skin. Again, conducting soldering and brazing operations in well-ventilated areas (see section on Ventilation) and use of protective clothing and gloves is recommended.

CORROSIVE FLUXES

These fluxes leave a chemically active residue after soldering,

- **Zinc Chloride**: The main ingredient in corrosive fluxes used in soldering of stainless steel, galvanized iron, cast iron, and aluminum. Zinc Chloride fumes can irritate the eyes, nose, and lung tissue, and skin contact with this fluxing agent can cause chemical burns,

- Ammonium Chloride: Inhalation of these fumes will be irritating to respiratory passages,
- Stannous Chloride: Not considered a serious health hazard. Fumes are irritating to respiratory passages,
- Acids: Frequently used as ingredients with fluxes. See discussion under Cleaning Agents.

INTERMEDIATE FLUXES

Lactic, benzoic, and glutamic acids frequently are used in the mild intermediate fluxes. These organic acids can produce mild irritation of the skin upon contact. Fumes can be mildly irritating to respiratory passages.

NONCORROSIVE FLUXES

Rosin dissolved in an organic solvent is the common type of noncorrosive flux. Typical solvents are alcohol, turpentine, or petroleum spirits - all of which are flammable. Exposure to these solvents can result in irritation of respiratory passages and some central nervous system effects (see Organic Solvents). Rosin dissolved in trichloroethylene - which is non-flammable - is also used. If trichloroethylene is the solvent, special attention must be given to providing adequate ventilation when soldering with this type of flux due to its potential for generation of phosgene. Fumes generated from the decomposition of these fluxes are irritating to respiratory passages.