

Hot Work Safety Program

Date: 12/2/2020

EMUDPS-EHS-P001

Revision: 1

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Number: 1 of 23**I. PURPOSE**

This Hot Work Safety Program is designed to eliminate or minimize the exposure to hazards associated with burning, welding, cutting, brazing, soldering, grinding, using fire and/or spark producing tools or other work that produces a source of ignition. This Hot Work Safety Program has been written to achieve compliance with the [Michigan Occupational Safety and Health Administration \(MIOSHA\)](#), [General Industry Standard Part 12. Welding and Cutting](#) and the [National Institute for Occupational Safety and Health \(NIOSH\) Health and Safety Aspects of Soldering and Brazing](#).

II. SCOPE

This program applies to all Eastern Michigan University employees and students involved in the use of flame and spark producing tools for maintenance and/or construction work including but not limited to welding, cutting, soldering, brazing, melting and burning. Outside contractors providing services to the University must comply with their company's Hot Work Program as well as comply with the requirements of the EMU Hot Work Safety Program.

III. DEFINITIONS

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

Brazing - A process of joining metals without melting them with a filler metal melting above 800° 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 (DOT) regulations or manufactured in accordance with specifications of the National Fire Protection Association (NFPA). For additional cylinder information, please see the EMU [Compressed Gas Cylinder Handling and Storage Guideline](#) (EMUDPS-EHS-P009).

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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 burning, welding, cutting, brazing, soldering, grinding, using fire- or spark-producing tools or other work that produces a source of ignition.

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 that 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°F 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 location where filled or empty cylinders are kept when not in use. An oxidizing and fuel gas cylinder or cylinders used as a unit are not 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 Operator - A person who operates a machine or automatic welding equipment.

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IV. RESPONSIBILITIES

A. Deans, Directors, Department Heads

1. Provide the leadership and the management systems necessary to ensure safe working conditions are maintained in their Colleges, Schools and Departments.
2. Ensure the Hot Work Safety Program is implemented in their area.
3. Motivate and assist faculty, forepersons, managers and supervisors with hot work safety implementation and compliance.
4. Provide the necessary resources for the Hot Work Safety Program.
5. Require faculty and staff to attend all applicable training sessions.
6. Ensure all graduate assistants and student employees receive appropriate hot work safety training.
7. Ensure disciplinary actions are taken when violations of the Hot Work Safety Program are egregious and/or repetitive.

B. Faculty

1. Implement the Hot Work Safety Program in their work area.
2. Train students doing hot work on the requirements of this program prior to conducting any hot work. The training must be documented.
3. Provide the engineering controls and safety equipment, for example welding curtains and fire extinguishers, to reduce the risk of flash burns, sparks, and foreign bodies to everyone in the area.
4. Ventilation must be provided in areas where toxic fumes may be generated by the hot work.
5. Ensure the necessary PPE is provided, used and maintained. This includes but is not limited to:
 - a. Face, eye and foot protection as necessary.
 - b. Other personal protective clothing or equipment, such as gloves, aprons, hearing protection devices and other required PPE as determined by the [PPE assessment](#) to protect the student(s) assigned hot work.

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- c. Except for long sleeve shirts required to protect the employee/student from ultraviolet rays to the arms and ankle length trousers, the personal protective clothing and equipment must be provided at no expense to the employee/student.
6. Remove defective PPE from service immediately.
7. Issue the [Hot Work Checklist](#) (emudps-ehs-f033), see Appendix A and [Hot Work Warning Sign](#) (emudps-ehs-f034) see Appendix B to EMU students conducting hot work.
8. Collect and review completed Hot Work Checklists. Then forward them to Environmental Health and Safety (EHS) for documentation.
9. Promptly investigate and report to Risk Management/Workers' Compensation and Environmental Health and Safety all hot work accidents and incidents.
10. Enforce the rules and requirements of the Hot Work Safety Program, including disciplinary action for repeated and/or egregious non-compliance.

C. Forepersons, Managers and Supervisors

1. Implement the Hot Work Safety Program in their work area.
2. Train employees doing hot work on the requirements of this program prior to conducting any hot work. The training must be documented.
3. Provide the engineering controls and safety equipment, for example welding curtains and fire extinguishers, to reduce the risk of flash burns, sparks and foreign body injuries to all employees in the area.
4. Ventilation must be provided in areas where toxic fumes may be generated by the hot work.
5. Ensure the necessary PPE is provided, used and maintained. This includes but is not limited to:
 - a. Face, eye and foot protection as necessary.
 - b. Other personal protective clothing or equipment, such as gloves, aprons, hearing protection devices and other required PPE as determined by the [PPE assessment](#) to protect the employee assigned hot work.
 - c. 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 must be provided at no expense to the employee.

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6. Remove defective PPE from service immediately.
7. Issue the [Hot Work Checklist](#) (emudps-ehs-f033), see Appendix A and [Hot Work Warning Sign](#) (emudps-ehs-f034), see Appendix B and/or the [Hot Work Permit](#) (emudps-ehs-f035), see Appendix C, to EMU employees and outside contractors as necessary.
8. Prior to starting hot work, notify Environmental Health and Safety (EHS).
9. Collect and review completed Hot Work Checklists and Hot Work Permits. Then forward them to EHS for documentation.
10. Promptly investigate and report to Risk Management/Workers' Compensation and EHS all hot work accidents and incidents.
11. Enforce the rules and requirements of the Hot Work Safety Program, including disciplinary action for repeated and/or egregious non-compliance.

D. Employees and Students

1. Attend all required training sessions.
2. Use hot work equipment as trained and authorized.
3. Use the required personal protective equipment (PPE) and report any defects to your supervisor or instructor.
4. Do not tamper with safety devices.
5. Complete the hot work checklist or permit as required by the program.
6. Notify DPS of hot work conducted before 7 a.m. and after 5 p.m. weekdays and at all times on weekends and holidays.

E. Environmental Health and Safety (EHS)

1. Provides oversight and guidance on the Hot Work Safety Program.
2. Provides consultation, training, exposure monitoring and inspections as needed.
3. Maintains documentation of completed hot work checklists and hot work permits.

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4. Periodically reviews and updates the Hot Work Safety Program.

F. Outside Contractors

1. Must comply with the requirements of their company's Hot Work Program, which at a minimum must meet the MIOSHA Welding and Cutting Standard requirements.
2. Outside contractors may use EMU Hot Work forms and signs from [Appendices A](#), [B](#) and/or [C](#) to achieve compliance with hot work safety requirements.
3. Must notify the EMU Foreperson, Manager or Supervisor prior to conducting hot work on campus.

V. PROCEDURES

A. General Requirements

1. A mixture of fuel gas with air or oxygen is not permitted except when consumed at a burner or torch.
2. Only apparatus designed for use with fuel gas or oxygen can be used for welding and cutting.
3. The total volume of acetylene used per hour must not exceed 1/7 of the total volume of the acetylene supply in the system.
4. Liquid acetylene is prohibited.
5. A cylinder with an attached regulator must not be moved unless secured to a hand truck or powered truck designed or equipped for this purpose.
6. Cylinder valves must 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.
7. Fuel gas must 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.

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8. An oxygen cylinder, cylinder valve, coupling regulator, hose and apparatus must be kept free from oily or greasy substances and must not be handled with oily hands or gloves.
9. Take precautions to prevent a jet of oxygen from striking an oily surface or greasy clothes or from entering a fuel, oil or other storage tank.
10. Oxygen must not be used as a substitute for compressed air or for any other use, except for welding or cutting procedures.
11. Welders must place the welding cable and other equipment so that is clear of passageways, ladders and stairways or it must be protected against damage or hazards to anyone.
12. The [Hot Work Warning Sign](#) (emudps-ehs-f034), see Appendix B, must be posted and the [Hot Work Checklist](#) (emudps-ehs-f033), see Appendix A, must be completed for all hot work conducted in areas other than confined spaces.
13. An employee in charge of the operation of oxygen or fuel-gas systems, including generators, must be instructed and judged competent by the supervisor for this work before being left in charge.
14. 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 must be readily available.

B. Confined Spaces

1. For hot work in a confined space, the [Hot Work Permit](#) (emudps-ehs-f035), see Appendix C, must be completed and the [Hot Work Warning Sign](#) (emudps-ehs-f034), see Appendix B, must be posted.
2. When working in a confined space, the torch valves and the gas supply valve and oxygen valve outside the confined space must be shut off during lunch, overnight or for any other prolonged period.
3. Whenever practicable, the torch and hose should be removed from the confined space when not in use for prolonged periods.
4. When stick electrodes are used in a confined space and welding is suspended during lunch, overnight or for any other prolonged period, the electrode must be removed from the holder and the machine shut off.

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5. The air in a confined space must be tested with an approved device and purged, if necessary, before any entry. Ventilation must be provided in the confined space when an employee is present and air monitoring must be continuous.
6. A cylinder or welding power source used in a confined space must be placed and secured on the outside of the space where the work is being performed.
7. An employee who is trained in rescue procedures and with the necessary equipment to effect a rescue, if needed, must be stationed outside the confined space during welding or cutting operations.
8. An effective means of communication must be established between the entrants and the attendant.
9. When safety belts and lifelines are used, they must comply with the [MIOSHA PPE](#) standard and attach to the welder's body so that his/her body cannot be jammed in a small exit opening.
10. Upon completion of welding operations in a confined space, a sign or other warning must be used to mark the hot metal.

C. Cylinders, Hoses and Regulators

1. Cylinders
 - a. Cylinders used in hot work must comply with labeling, storage, and handling requirements.
 - b. Additional information regarding cylinders can be found in the [EMU Compressed Gas Cylinder Handling and Storage Guideline](#) (EMUDPS-EHS-P009).
2. Cylinder marking
 - a. Compressed gas cylinders must be legibly marked, for identifying the gas content, with either the chemical or trade name of the gas. Such marking must be by means of stenciling, stamping or labeling and must not be readily removable. Whenever practical, the marking must be located on the shoulder of the cylinder.
 - b. Unlabeled cylinders must not be used.
 - c. Empty cylinders must be so marked at time of depletion.

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3. Storage

- a. An oxygen cylinder must be stored not less than 20 feet from fuel gas cylinders or a highly combustible material, such as, but not limited to, oil, grease, fine wood shavings, flammable gas, or a source of ignition, or must be separated from the material by a noncombustible wall, not less than 5 feet (1.6 meters) high, having a fire-resistance rating of 1/2 hour.
- b. An oxygen cylinder must not be stored in an acetylene generator compartment.
- c. A cylinder must be stored away from heat in excess of 125°F.
- d. A cylinder, including an empty cylinder, which is in storage, being shipped, or has the regulator removed must have the cap secured in place or must be otherwise protected.
- e. Storage must be set up to ensure first-in, first-out usage.
- f. A cylinder storage area must be posted with the names of the individual gases stocked and a warning must be posted against tampering by unauthorized personnel. An assigned storage area must be located where a cylinder will not be knocked over or struck by a passing or falling object.
- g. Where different gases are stored, they must be grouped by types. Groupings must separate the flammable gases from the oxidizing gases.
- h. A storage area for cylinders must be well ventilated. A cylinder must not be stored in basements or pits, except where ventilation as specified by the Michigan Occupational Safety and Health Administration (MIOSHA) standards is furnished to keep the area purged of any accumulation of gases.
- i. Storage of fuel gas in a building in one area within 100 feet (30 meters) of another fuel gas storage area and not protected by an automatic sprinkler system must 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 must 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 must be constructed of noncombustible material having a fire-resistance rating of 1 hour. The walls must be continuous from the floor to the ceiling and must be securely anchored. The separate room, compartment or special building must have no open flames for heat or light and must be well ventilated. Openings from the separate storage room to other parts of the building must be protected by a self-closing fire door for a class B opening and must have a fire-resistance rating of not less than 1 hour. Windows in partitions must be wired glass and approved metal frames with a fixed sash.
- j. 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

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(101.34 kPa) and 70°F (21.1°C), including unconnected reserves at the site, the system must be as prescribed in [NFPA 55](#).

- k. A cylinder used for methylacetylenepropadiene, stabilized, must be constructed of materials suitable for this fuel gas in the gaseous or liquid phases.
4. General rules for cylinders–I
 - a. A chain, bracket or other restraining device must be used at all times to prevent cylinders from falling.
 - b. Acetylene or liquefied gas cylinders must not be placed on their sides but must be stood valve end up.
 - c. A cylinder must not be dropped, dragged, rolled on its side or struck violently.
 - d. A cylinder must be lifted only by cradles or enclosed platforms when using a crane or hoisting device. Electromagnets, hooks, ropes or slings must not be used.
 - e. A frozen or ice-clogged valve must be thawed by either warm air or use of warm water and dried before using. Boiling water or a flame must not be used. Force must not be applied to a valve or cap to loosen a cylinder frozen in place.
 5. General rules for cylinders–II
 - a. Gases must not be mixed within a cylinder except by the supplier.
 - b. A cylinder must not be placed where it will become a part of the electrical circuit by accidental grounding or where an electric welding arc may burn it. A cylinder must not be placed so that hot slag or flame will reach it or a fire resistant shield must protect it. An electrode must not be tapped against a cylinder to strike an arc.
 - c. A regulator, gauge or hose must not be interchangeable between fuel gas, oxidizing gas or inert gas. Connections for compressed gas cylinders must comply with [ANSI B57.1 “Compressed Gas Cylinder Valve Outlet and Inlet Connections](#).
 - d. A cylinder valve must 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 must not be done near a source of ignition. Pressure to a regulator must be introduced by slowly opening the cylinder valve. An acetylene cylinder valve must not be opened more than 1-1/2 turns of the spindle.
 - e. Acetylene must not be utilized or piped, except in cylinder manifolds, at a pressure in excess of 15 psig.
 - f. Only the owner of the cylinder, if the owner is qualified, or a person trained, qualified, and authorized by the owner, must refill a cylinder.

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6. General rules for cylinders-III

- a. A cylinder without fixed hand wheels must have keys, handles, or nonadjustable wrenches on valve stems while in service. A multiple cylinder installation must require only 1 key or handle for each manifold. A hammer must not be used to open a cylinder valve or loosen a cap.
- b. A cylinder, whether full or empty, must not be used as a roller or support.
- c. A leaking cylinder or a cylinder with a valve stuck open or a valve in need of repair must be taken outdoors away from sources of ignition, slowly emptied, and tagged with a warning sign and the manufacturer or distributor must be notified. Complete removal of the stem from the cylinder valve must be avoided.
- d. Nothing must be placed on top of a cylinder that would damage a safety device or interfere with the quick closing of the valve.

7. Hoses and Connections

- a. Only approved hoses and connections must be used. A hose connection must 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 must be used for the test.
- b. Parallel lengths of hose taped together must not have more than 4 inches out of each 12 covered by tape.
- c. Parallel hoses must be color coded as follows:
 - i. Red – fuel gases.
 - ii. Green – oxygen.
 - iii. Black – inert gas or air.
- d. A hose must be repaired or replaced when it shows burns, leaks, worn places or other defects that could affect the safety of employees.

8. Regulators

- a. A regulator, gauge or hose must not be interchangeable between fuel gas, oxidizing gas or inert gas. Connections for compressed gas cylinders must be as prescribed in ANSI B57. "[Compressed Gas Cylinder Valve Outlet and Inlet Connections.](#)"
- b. Must be inspected for faulty seats and repaired when found defective.
- c. Must be repaired by authorized and trained personnel or be returned to the supplier for calibration or repairs.
- d. Do not remove the regulator until the cylinder valve is closed and the regulator has been drained.
- e. Mark gauges used for oxygen "Use No Oil."

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D. Manifolds

At this time, EMU does not have any manifold systems for welding and cutting.

E. General Fire Rules

1. Fire Precautions

- a. Cutting and welding must be done in designated areas free of flammables or conditions favorable to fire or explosion. If it is not practical to perform the work in a designated area, a person must be assigned responsibility for a fire watch of the job and must take the following action after inspecting the job site and designating precautions to be taken:
 - i. 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.
 - ii. 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.
 - iii. 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 must be protected from shock.
 - iv. Have appropriate portable fire extinguishers on hand for use by trained employees.
 - v. 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.
2. An observer must be assigned whenever welding or cutting is done in an area where a fire could start or one (1) of the following conditions exists:
 - a. Appreciable combustible material in the building construction or contents is less than 35 feet (10.7 m) from the point of operation.
 - b. Appreciable combustible material is more than 35 feet (10.7 m) away but easily ignited by a spark.
 - c. A wall or floor opening is 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 that is likely to ignite by conduction or radiation.
3. Welding and cutting by gas utility firms on live mains is exempt from this rule when the main if it is filled under positive pressure with natural or manufactured gas and air movers are used to ventilate areas where fumes might accumulate.

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4. Welding or cutting must 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 closer than 35 feet of storage of large quantities of exposed, readily ignitable materials such as bulk sulfur, baled paper or cotton.
5. Exhaust systems that could carry sparks to a distant combustible must be protected or shutdown.

F. Welding Drums, Barrels, Tanks or Other Containers

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

G. Arc Welding and Cutting

1. Arc Welding Machines
 - a. An arc welding machine must be capable of operating safely in the environment in which it is located. The design and construction must enable the machine to carry its rated load with rated temperature rise where the temperature of the cooling air is not more than 104°F and where the altitude is not more than 3300 feet (1000 m approx.).

- b. Where unusual service conditions, such as corrosive fumes, steam, oil vapor, flammable gases, vibration, shock, dust or weather exist, a specially designed machine must be used.

2. Open Circuit and No Load Voltages of Arc Welding Machine

- a. When an arc welding machine is operated without being connected to a load, the open circuit voltage must 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.
- b. When welding and cutting processes require values of open circuit voltages higher than 100, insulation or other means must be provided to prevent the operator from making accidental contact with the high voltage.
- c. Equipment working through resistors from DC trolley voltages of 250 to 600 volts must have a protective device for automatically disconnecting the power during arc off periods.
- d. Automatic control devices for reducing no-load voltage below 50 volts must be provided where AC welding is to be done under wet conditions that could provide a shock hazard.

Table 1 MAXIMUM OPEN CIRCUIT A VOLTAGES OF WELDING MACHINES		
Welding Current	Max. Open Circuit (no-load) Voltage	
	Manual and Semiautomatic Machines	Automatic Machines
ac	80 rms	100 rms
dc>10% Ripple voltage	80 rms	100 average
dc<10% Ripple voltage	100 average	100 average

3. Design Requirements for Arc Welding Machines

- a. A controller integrally mounted in an electric motor driver welder must have the capacity for carrying rated motor current and must be capable of making and interrupting stalled rotor current of the motor.
- b. Control apparatus must be enclosed except for the operating wheels, levers or handles. The handles and wheels must be large enough to be grasped by a gloved hand.
- c. Input power terminals, tap change devices and live metal parts connected to input circuits must be completely enclosed and accessible only by use of tools.
- d. Welding lead terminals must 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

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must be done by a conductor at least 2 sizes smaller than the grounding conductor and it must be so marked.

- e. Portable control devices, such as push buttons, must not be connected to an AC circuit of more than 120 volts. Exposed metal parts of a portable control device operating above 50 volts must be grounded.
- f. Autotransformers or AC reactors must not be used to draw welding current directly from any AC power source having a voltage of more than 80 volts.

4. Installation

- a. The frame or case of a welding machine must be grounded unless the manufacturer does not recommend it.
- b. The work on which the operator welds must 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 must be capable of carrying the full welding current.
- c. A conduit containing an electrical conductor must not be used for completing a work-lead circuit.
- d. A pipe line in service must 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.
- e. Chains, wire ropes, cranes, hoists and elevators used for carrying loads must not be used to carry a welding current.
- f. A welding cable must be protected against damage, entanglement, or contact with power supply or high-tension wires.
- g. A welding machine not provided with a controller or disconnect switch as an integral part must have a controller or disconnect switch with overload protection provided. A disconnect switch with overload protection or overload disconnect protection or equivalent must be provided for each outlet used by a portable welding machine.
- h. The rated current carrying capacity of the supply conductors for individual machines must 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 must 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 not all the machines supplied by the conductor will be in use at the same time.
- i. 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 must be connected so as to minimize shock hazard as follows:

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- i. DC machines must be connected with the same polarity
- ii. AC machines must be connected to the same phase of the supply circuit and with the same instantaneous polarity.

5. Operation

- a. Engine fuel, cooling water or shielding gas must not be allowed to leak.
- b. A welding machine must be disconnected when being moved and turned off when not in use.
- c. Electrodes must be retracted or removed when not in use. Electrode holders not in use must be placed so that they cannot make electrical contact with an employee, fuel or gas tanks or conducting objects.
- d. A welder must not let live electrodes or holders touch his/her bare skin or damp clothing. When arc welding is performed in wet conditions or under a condition of high humidity, the welder must be protected against electric shock.
- e. Electrode holders must not be cooled by immersion in water.
- f. Welding must not be permitted where fumes of chlorinated hydrocarbons are present unless specific ventilation and personal protective equipment is provided as specified by EHS.
- g. Before starting a welding operation, the welder must:
 - i. Make sure the work-lead is secured to the work.
 - ii. Make sure the magnetic work clamps are free of spatter on the contact surfaces.
 - iii. Spread out the welding cable, if necessary, to prevent overheating and damage.
 - iv. Make sure grounding connections are secured to a good ground.
 - v. Make sure the required switching equipment for shutting down the machine has been provided.
- h. A welder must not curl or loop the welding cable around his/her body.

H. Soldering Irons

1. General Information

- a. Ensure the soldering iron is equipped with a properly insulated holder before using it.
- b. When not in use, a soldering iron should be placed in a fireproof holder (or back in the stove) and never allowed to come in contact with combustible materials or accidentally be touched by anyone.
- c. Never leave a hot soldering iron unattended. If it is electric, make sure it is disconnected.

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2. Electrically Heated Irons

- a. Before using an electrically-heated iron, ensure the following:
- b. Check the thermostatic control (if the soldering iron has one) to ensure that it is working properly and that it is adjusted to the proper temperature.
- c. Check the lead cord for proper insulation and ensure that it is free from grease and oil.
- d. Ensure the cord is not laying in walkways where it could present a trip hazard.
- e. Check all electric tools and extension cords. They should be fitted with three-prong plugs and the cords should not be frayed.
- f. Electric soldering irons should be stored in a dry place. Check the iron before using it to ensure it is dry.

3. Flame Heated Irons

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

I. Torch Soldering and Brazing/Flame Heated Soldering Irons

1. Cylinder Placement And Storage

- a. Please see the EMU [Compressed Gas Cylinder Handling and Storage Guideline](#) (EMUDPS-EHS-P009) for cylinder placement and storage information.

2. Regulator Attachment and Regulator Check

- a. Before attaching the regulator, “crack” the cylinder valve to remove any dust and dirt.
- b. When attaching the regulator to the cylinder, use only a properly sized, open-end wrench.
- c. Cylinder valves that 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.
- d. Check the regulator for “creep” (“creeping” of a regulator is indicated by a gradual increase in pressure after the regulator valves are closed). If creep is present, have the regulator repaired immediately.

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3. Hoses, Torch Valves and the Regulator Connections

- a. Hoses showing leaks, burns, or worn places must be replaced or repaired.
- b. Hoses should be color-coded to avoid accidental mixing.
- c. 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.
- d. Test the hose for leaks by immersing it - under normal working pressure - in water. Do not try to repair hoses with tape.
- e. 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.
- f. 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.

J. Resistance Soldering and Brazing

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

K. Work Practices

After performing the preliminary safety checks, safe work practices must be followed, including but not limited to:

1. Always point cylinder outlets away from each other before hookup.
2. To prevent injury from malfunctioning valves, never stand directly in front of a gauge while opening a cylinder valve - stand to one side.

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3. To light a welding torch:
 - a. The hoses must be purged.
 - b. Open the valve on the acetylene cylinder. This should never be opened more than one and one-half turns. Three-fourths of a turn is preferable.
 - c. Open the acetylene torch valve one-fourth turn.
 - d. 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.
 - e. Close the acetylene torch valve.
4. Follow the same procedure with the oxygen cylinder and torch;
 - a. Slowly open the oxygen cylinder all the way.
 - b. Open the oxygen torch valve one-half turn. Adjust the oxygen to working pressure with the gas regulator screw.
 - c. Close the oxygen torch valve.
5. The final steps are the actual lighting of the torch:
 - a. Reopen the acetylene torch valve one-fourth turn and light the gas with a friction lighter. (Never use matches.)
 - b. Open the oxygen valve one-fourth turn.
 - c. Adjust the flame of the torch solder and gas cylinders.
6. There is also a proper way to shut off the torch that 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:
 - a. Close the torch valve, oxygen first, then acetylene.
 - b. Close the cylinder valves, again oxygen first, then acetylene.
 - c. Open both torch valves to release the pressure.
 - d. Shut off the regulator adjusting the handle until you no longer feel any spring tension.
 - e. Close the torch valves.
7. Leave the valve wrench on the acetylene cylinder whenever the valves are open. This permits emergency shut-off of the gas.
8. 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.
9. 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.

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VI. Health Hazards

A. General Information

1. 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.
2. It is important to know what materials you are working with and what hazards/symptoms they present. Consult the SDS for health hazard information.
3. If you begin to experience any exposure symptoms (see below), report them to your supervisor and seek prompt medical attention.

B. Cleaning Methods

1. Acids

- a. Acids used for cleaning should be diluted with water. ALWAYS PUT THE ACID INTO THE WATER; NEVER PUT WATER INTO ACID.
- b. Wear a full-face shield and protective gloves. Work with acids should be carried out in a well-ventilated area with face shield and protective gloves worn.
- c. Some specific acids that you might encounter include:
 - i. **Hydrochloric or Muriatic Acid:** A corrosive acid, yellowish in color, inhalation of hydrochloric acid fumes will cause a choking sensation.
 - ii. **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.
 - iii. **Phosphoric Acid:** Although not as hazardous as sulfuric acid, exposure to phosphoric acid can result in inflammation of mucous membranes and skin irritation.
 - iv. **Nitric Acid:** This acid can cause severe skin burns and severe irritation of the respiratory tract.

2. Alkalis

- a. Alkali mixtures used in cleaning operations typically contain sodium or potassium hydroxide.
- b. 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.
- c. Skin contact with these alkalis will cause irritation.
- d. Alkalis should be worked with in well-ventilated areas.

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3. Organic Solvents

- a. Most organic solvents are flammable and thus are potential fire and explosion hazards.
- b. Exposure to vapors of organic solvents can result in irritation of the eyes, nose, throat, and lungs; dizziness; headaches; and sensations of drunkenness.
- c. 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.
- d. Prolonged or continued skin contact with most organic solvents will remove essential skin oils that will lead to dry, cracking skin and possibly irritation and/or infection.

4. Ultrasonic Cleaning

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

C. Soldering Fluxes

1. The fluxing agent is determined by the metals to be joined.
2. In most cases, fluxes give off acid or alkali fumes when heated. Because they contain acids and/or alkalis, they can irritate the skin.
3. Conduct soldering and brazing operations in well-ventilated areas
4. The use of protective clothing and gloves is recommended.

5. Corrosive Fluxes

- a. These fluxes leave a chemically active residue after soldering.
- b. 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. Skin contact with this fluxing agent can cause chemical burns.
- c. Ammonium Chloride: Inhalation of these fumes will be irritating to respiratory passages.

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- d. Stannous Chloride: Not considered a serious health hazard. Fumes are irritating to respiratory passages.
- e. Acids: Frequently used as ingredients with fluxes.

6. Intermediate Fluxes

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

7. Noncorrosive Fluxes

- a. Rosin dissolved in an organic solvent is the common type of noncorrosive flux.
- b. Typical solvents are alcohol, turpentine or petroleum spirits - all of which are flammable.
- c. Exposure to these solvents can result in irritation of respiratory passages and some central nervous system effects (see Organic Solvents).
- d. Rosin dissolved in trichloroethylene - which is non-flammable - is also used.
 - i. **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.**
- e. Fumes generated from the decomposition of these fluxes are irritating to respiratory passages.

VII. REFERENCES

- A. [MIOSHA General Industry Part 12 Welding and Cutting Standard](#)
- B. [National Institute for Occupational Safety and Health \(NIOSH\) Health and Safety Aspects of Soldering and Brazing \(78-197\)](#)
- C. [EMUDPS-EHS-P009 Cylinder Handling and Storage](#)
- D. [EMU PPE Hazard Assessment Form \(emu-dps-ehs-f079\)](#)
- E. [MIOSHA General Industry Part 33 Personal Protective Equipment](#)
- F. [NFPA 55 Compressed Gases and Cryogenic Fluids Code](#)
- G. [ANSI B57.1-1965 Compressed Gas Cylinder Valve Outlet and Inlet Connections](#)
- H. [API Standard PSD No. 2201-1963 Welding or Hot Tapping on Equipment Containing Flammables](#)
- I. [API 1104: Standard for Welding Pipelines and Related Facilities](#)

