Welding - Fire and Exposure Control

PURPOSE

Portland Community College has adopted its Welding Safety Chapter to ensure that employees are aware of the hazards associated with welding and ensure proper fire protection. Welding is a hazardous operation, which must be performed in accordance with safety standards, and by qualified trained employees this chapter is to ensure work place safety and compliance with OSHA standards.

APPLICABLE LEGAL STANDARDS

- OAR 437, Division 2-1910.252, Gas and Electric Welding

CHAPTER FORMAT

This chapter reviews welding safety procedures. Specific information on the welding hazards is also found in the *Hazard Communication Program,* Chapter 8.

The last part of the chapter has an employee welding safety-training program for use by Physical Plant Supervisors and Instructional Managers with their employees.

DEFINITIONS

Welding and welding operator: means any operator of electric or gas welding and cutting equipment.

Approved: means listed or approved by a nationally recognized testing laboratory.

All other welding terms used in OSHA standard are in accordance with American Welding Society - Terms & Definitions A3-0.969.

POLICY

The following precautions are required to be taken by our employees who perform maintenance welding operations. Electric arc welders are also responsible to be trained in electrical hazards (See Chapter 6 Electrical Safety).

GENERAL RESPONSIBILITIES

1. **College Management:** Department Managers and supervisors are responsible to see that only trained employees are authorized to weld. Fire watch personnel will be trained in their duties by the Physical Plant Management. Management is required to see that adequate maintenance services are provided and used to ensure safe operating conditions and that all Energy Control Procedures (see Chapter 10) are followed as they relate to maintenance welding on equipment.

2. **Authorized Operators:** Employees who are authorized to perform welding must follow all safety procedures as outlined in this chapter, by OSHA rules and manufacturer's recommendations. Employees are required to inspect their equipment daily prior to operation to ensure that all safeguards are on the equipment. Any problems are to be reported immediately to the employee's supervisor. All accidents will be reported immediately to the supervisor.

3. **Safety & Risk Services Manager:** Assist in providing employee training and auditing facilities for compliance with this chapter and OSHA regulations.

4. **Safety Committee:** The safety committee will include review of welding safety and employee in their quarterly inspection activities.

PROCEDURES

1. **Basic Hazard Awareness**: Safety in the many processes of welding and cutting requires certain precautions and standardized operating procedures. Welding is associated with five principal hazards. It is the responsibility of the employee supervisor and/or Safety Coordinator to ensure that all welders and fire watch personnel understand these hazards.

   - Electric shock, and burns.
   - Fire.
   - Compressed gas hazards.
   - Radiant energy.
   - Inhalation exposure to gases, fumes and mists.

   a. Electric shock and burns must be guarded against when using welding equipment. The degree of risk depends on the type of welding process. Welders are to be trained in Chapter 6 Electrical Safety.

b. Fire Hazards:

- Flying sparks are the source of many industrial fires.
- In areas where flammable gases, vapors, and dusts are present, only a tiny spark is needed to set off a fire or explosion. Flying pieces of molten metal can fall through cracks and openings as small as nail holes and ignite combustibles that are beyond the welder's visual range.
- Hot metal that is being welded or cut can cause fires if allowed to contact flammable or combustible material such as drip pans, oily rags, or combustible materials.
- The torch flame used by the welder is another source of ignition and must be handled carefully. Compressed oxygen gas used in welding is a fire hazard because it supports and intensifies the rate of combustion of other materials.

c. Radiant energy hazards in welding include: ultraviolet light, infrared light and visible light

- Exposure to the welding arc (ultraviolet rays) may result in very painful irritation of the eyes and skin.
- Infrared rays act upon the eyes simply as heat and can cause a burn or irritation of the tissue affected.
- The glare of excessive visible radiation can cause headaches, eye fatigue, and loss of visual efficiency.
- Protective eyewear must be worn during welding to prevent harm to the eyes from light energy.

a. Inhalation of Welding Fumes: Welding produces airborne exposures to a variety of potentially harmful gases and fumes. Fumes are generated from both the base metal and the wire or rod used in the process. The hazard level from metal fumes depends on the type of metal. In steel welding exposures include iron oxides, chromium, manganese, and nickel. The gases also vary with the type of shield gases used in arc welding, type of rods and fluxes used.

2. Authorized Employees: Welding shall be performed by qualified welders only.

3. Welding operations need to be performed away from flammable materials.

a. If the object to be welded cannot be moved to a safe location, all movable hazardous materials should be moved to a safe location.

b. If this cannot be done a **Hot Work Permit** will need to be issue by the Supervisor. The permit will describe the welding zone controls such as enclosing in fireproof blankets or other protective shields when materials in nearby areas can be affected by welding arcs, flames, sparks, spatter, slag, or heat. (See Hot Work Permit)

c. Fire protection equipment should be kept immediately at hand and ready for use. In critical areas, the fire protection equipment should be staffed while welding operations are being conducted.

4. Care must be taken against allowing mixtures of fuel gas and air to accumulate.

5. Flammable and other potentially hazardous materials should be cleaned from surfaces before welding is started.

(Note: The very high temperature of the welding air or flame can cause ignition of materials such as grease, oil or surface coating. Also, these materials will break down under heat to hazardous gases or fumes).

6. No welding, cutting, or similar work should be undertaken on tanks, barrels, drums or other containers, which have been contaminated with flammables unless the contamination is first removed so that there is no possibility of fire or emission of toxic vapors. (See Hot Work Permit)

7. Adequate ventilation should be provided as protection against accumulations of toxic fumes and gases. If such precautions cannot be taken, the welder should wear appropriate respiratory protection (See Chapter 12 Personal *Protective Equipment* and *Respiratory Protection*).

8. If welding is to be done in enclosed or confined spaces, a specific "confined space" work permit will be required to be obtained from the management staff. The permit will detail the specific precautions that are required to perform welding in confined areas (See Chapter 5. Confined *Space Procedures*).

9. Precautions need to be taken to avoid shock from electric welding operations.

a. The welder should not stand in water while doing electric welding.

b. Hot electrode holders should not be dipped in water.

c. Cables with damaged insulation or exposed conductors must not be used, and should be replaced before any such work is attempted. If necessary to join lengths of cable, is must be done using only connectors designed specifically for the purpose.

10. Personal Protective Equipment: The face, body and hands should be covered to prevent burns from splatter, slag, sparks, or hot metal. Flame proof, heat-insulating gloves should be worn during welding operations. Wet or excessively worn gloves should not be used.

11. The eyes and skin should be protected against the glare and radiation from a welding arc or flame.

a. Helpers and attendants should also be provided with eye protection.
b. Other personnel in the vicinity of welding operations should be protected from reflections by suitable shields and barriers.

12. Respiratory equipment may be necessary if ventilation is not sufficient. Specific operation requirements should be made by your supervisor.

13. Gas cylinders must be handled carefully (breaking the neck from a full cylinder can turn the bottle into a missile).

14. Cylinders shall be secured to keep them from falling.

15. Acetylene cylinders must always be maintained in an upright position.

16. Oxygen cylinders should be separated from fuel-gas cylinders or other combustible materials by at least 20 feet or by a fire-resistant barrier at least 5 feet high.

a. Oxygen from supply cylinders should be checked to make certain they are not leaking, especially in enclosed spaces, where it can cause ignition of materials that are not normally highly flammable.

b. Grease and oil should be kept away from, and never used to lubricate oxygen cylinder valves or regulators.

c. Do not handle oxygen cylinders with oily hands or gloves.

d. Before connecting an oxygen bottle, first open the valve slightly for an instant, then close and attach an oxygen regulator to the valve. Always stand to one side when opening the valve.

17. Empty gas cylinders should be marked and have their valves closed tightly. Valve protection caps should always be in place on those cylinders designed for caps, except when the cylinder is in use or being connected/disconnected.

18. Gas cylinders should be stored out of the direct rays of the sun and away from other sources of heat. Never strike an arc against a gas cylinder.

19. 19. Do not use a hammer or wrench to open cylinder valves; if valves will not open by hand, notify the supplier. Always open the cylinder valve slowly.

20. Do not tamper with cylinder valves or try to repair them. Send the supplier a prompt report of the trouble, including the cylinder serial number, and follow the supplier's instructions.

21. Backflow or flashback preventers shall be installed on all oxygen/flammable gas welding and cutting units between the torch or blowpipe and the hoses.

22. Gauges shall be maintained in good condition. Cracked or missing glass shall be replaced prior to use.

Welding Safety Training

Introduction: OREGON OSHA REQUIREMENTS - 1910.251-.257

Oregon OSHA has specific requirements for welders' training in the hazards of welding. Further the new Electrical Standard has additional requirements regarding electric welding hazard training.

Requires that only employees who have been properly instructed and are qualified shall be designated to operate welding equipment. Specifically the requirements include:

Maintenance - 437-66-015 (1): Periodic inspections of welding equipment shall be made by qualified maintenance personnel, and records of the same maintained.

Electric Shock - 437-66-135 (2): Welding operators shall be instructed on avoiding electric shock.

Operation & Maintenance - 1910.254(d)(1): Workers assigned to operate or maintain arc welding equipment shall be acquainted with the requirements of this section and with 1910.252(a),(b), and (c) of this part, if doing gas-shielded arc welding, also the Recommended Safe Practices for Gas-Shielded Arc Welding, A6.1-1966 American Welding Society.

Arc Welding & Cutting - 1910.254 (a)(3): Workers designated to operate welding equipment shall have been properly instructed and qualified to operate such equipment.

Oxygen-Fuel Gas: Personnel - 1910.253(a)(4): Workers in charge of the oxygen or fuel-gas supply equipment, including generators, and oxygen or fuel-gas distribution piping systems shall be instructed and judged competent by their employers for this information work before being left in charge.

All welding and cutting shall be performed by competent operators who have demonstrated their ability in accordance with the type of work to be performed. This rule shall not preclude apprenticed or on-the-job training under the supervision of a competent instructor.

Oregon OSHA rules are organized by general requirements and then specific types of welding operations. This training program will review the overall hazards and then highlight the major requirements and safety factors. We will then review the overall regulations.

NOTE: *The following program is advisory only. It does not necessarily list all approaches to the control of hazardous energy or address all rule compliance issues. This information is not intended to be all inclusive of workplace safety/health issues. Other additional information may be necessary for compliance with safety and health regulations.*

WELDING HAZARDS: OVERVIEW

Safety in the many processes of welding and cutting requires certain precautions and standardized operating procedures. Welding is associated with seven principal hazards:

Hazards

- Electric shock and burns.
- Fire.
- Compressed gas hazards.
- Radiant energy.
- Noise; especially during carbon arc, and plasma cutting operations.
- Inhalation exposure to gases, fumes and mists.
- Ergonomic/Housekeeping issues.

Shock & Burns

Electric shock and burns must be guarded against when using welding equipment. The degree of risk depends on the type of welding process.

Fire

Flying sparks are the source of many industrial fires. In areas where flammable gases, vapors, and dusts are present, only a tiny spark is needed to set off a fire or explosion. Flying pieces of molten metal can fall through cracks and openings as small as nail holes and ignite combustibles that are beyond the welder's visual range.

Hot metal that is being welded or cut can cause fires if allowed to contact flammable or combustible material such as drip pans, oily rags, or combustible materials. The torch flame used by the welder is another source of ignition and must be handled carefully. Compressed oxygen gas used in welding is a fire hazard because it supports and intensifies the rate of combustion of other materials.

It is estimated that about 4% of all industrial fires are caused by the sparks, arcs and hot metal generated by welding and cutting.

Radiant Energy Radiant energy hazards in welding include:

- Ultraviolet light
- Infrared light
- Visible light

Exposure to the welding arc (ultraviolet rays) may result in very painful irritation of the eyes and skin. Infrared rays act upon the eyes simply as heat and can cause a burn or irritation of the tissue affected. The glare of excessive visible radiation can cause headaches, eye fatigue, and loss of visual efficiency. Protective eye wear must be worn during welding to prevent harm to the eyes from light energy.

The most common problem has been from UV during arc welding causing "arc eye" or "arc flash burns" This is a temporary condition in which the cornea of the eye is burned and it produces acute pain.

Inhalation Welding

Welding produces airborne exposures to a variety of potentially harmful gases and fumes. Fumes are generated from both the base **Fumes** metal and the wire or rod used in the process. The hazard level from metal fumes depends on the type of metal. In steel welding exposures include iron oxides, chromium, manganese, and nickel. The gases also vary with the type of shield gases used in arc welding, type of rods and fluxes used.

Thus to some degree most welding and cutting processes produce by-products which maybe irritating or potentially toxic to the personnel exposed.

Arc welding and cutting processes produce particulate fume and gases that enter the breathing zone of the welder. These products are formed primarily by the high temperature existing in the arc, which causes chemical reactions to take place, producing such gases as carbon monoxide, and nitrogen oxides. The particulate matter usually consists of finely divided metal oxides - fumes.

The quantity of fume and gas liberated varies from process to process ranging from very small quantities for gas tungsten arc welding to relatively large quantities for flux core arc welding. The concentration of fume and gas is highest in the "fume plume" which normally rises directly upward from the arc and poses a special threat to the welding operator. Local ventilation, to remove the contaminants from the welder's breathing zone and to avoid general contamination of environment is the most effect method of fume and gas control.

The health effects of breathing fumes and gases depend on the concentration, the composition and the duration of exposure. Irritation of the bronchial tract, metal fume fever, pneumoconiosis, systemic poisoning and cancer may be encountered depending on the exposure.

Housekeeping

To minimize tripping/falling hazards, welding cables must be kept out of the walkways. When not in use the cables must be coiled up and removed from work areas.

Neatness and orderliness are very important in overall safety and health programs in general as well as for welding operations. Not only does good housekeeping reduce the potential for injuries. There needs to be sufficient and adequate storage accommodations for the equipment and storage of metal and waste materials. These materials and debris need to be kept out of walkways and off the floor.

Ergonomics

Poor work postures, manual material handling and inadequate workstation design may result in bone or soft tissue injuries such as sprains/strains. To reduce the potential for such incidence, consideration should be given to the following:

- Use two person lifts for heavier loads
- Utilize cranes, hoists, forklifts, mobile cranes, hand carts and floor jacks to move materials.
- Avoid working with the back bent for prolonged periods of time
- When working at a fixed table or workbench, use fatigue mats, raise or lower the table/bench height so that it fits your body height, alternate between sitting and standing whenever possible.
- Use hand/held powered tools, which allow the wrist to be in a neutral or straight position.

The following precautions are required to be taken by welding operators. All welders also need to be trained in the skills of welding.

Welders

Welding shall be performed by qualified welders only. Qualification can be developed through special training programs or on-the-job supervised apprenticeship type training.

Fire Prevention

1. Welding operations need to be performed away from flammable and combustible materials.

    a. If the object to be welded cannot be moved to a safe location, all movable hazardous materials should be moved to a safe location.

    b. If this cannot be done, the welding zone should be enclosed in fireproof blankets or other protective shields when materials in nearby areas can be affected by welding arcs, flames, sparks, spatter, slag, or heat.

    c. Fire protection equipment should be kept immediately at hand and ready for use. In critical areas, the fire protection equipment shall be staffed (Fire Watch) while welding operations are being conducted.
    SEE OSHA RULES: 1910.252 (a)(1)-(2)(xv)

2. Care must be taken against allowing mixtures of fuel gas and air to accumulate.

3. Flammable and other potentially hazardous materials should be cleaned from surfaces before welding is started. **(Note:** The very high temperature of the welding air or flame can cause ignition of materials such as grease, oil or surface coating. Also, these materials will break down under heat to hazardous gases or fumes).

Welding on Containers

No welding, cutting, or similar work should be undertaken on tanks, barrels, drums or other containers, which have been contaminated with flammables unless the contamination is first removed so that there is no possibility of fire or emission of toxic vapors.
SEE OSHA RULES: 437-02-297

Confined Spaces

1. If welding is to be done in enclosed or confined spaces, a specific "confined space" work permit will be required to be obtained from the management staff. The permit will detail the specific precautions that are required to perform welding in confined areas.

2. When any hot work involving sources of ignition including welding and burning is done in a confined space, then all fire hazards and flammable atmospheres must be controlled. All combustible material shall be protected.

   a. The atmosphere in a confined space must be tested by a combustible gas indicator.

   b. Tests must be made frequently enough to assure safe working conditions.

   c. Hot work permits are required prior to entry.

   d. Where hot work involves the generation of toxic gases, vapors or fumes, local exhaust ventilation and/or respiratory equipment shall be used.

   e. Compressed gas cylinders shall not be allowed in the confined space.

   f. Compressed gas cylinders or electric generators shall be attended at all times.

   Welding Regulation: 1910.252 (b)(4) - Work In confined spaces;
   1910.252(c)(4) - Ventilation in confined spaces

   NOTE: OSHA HAS A SEPARATE REGULATION ON CONFINED SPACE THAT WOULD BE REQUIRED TO BE FOLLOWED.

Personnel Protective Equipment

1. The face, body and hands should be covered to prevent burns from splatter, slag, sparks, or hot metal. Flameproof heat-insulating gloves should be worn during welding operations. Wet or excessively worn gloves should not be used.

2. The eyes and skin should be protected against the glare and radiation from a welding arc or flame.

   a. Helpers and attendants should also be provided with eye protection.

   b. Other personnel in the vicinity of welding operations should be protected from reflections by suitable shields and barriers. The regulations set out the shade protection number in rule 437-02-284(H).

c. Portable screens should be tall enough to minimize the opportunity to directly view the weld point. The bottom of the screen should be at least 2 feet from floor level to allow for circulation of air. The screen must be constructed of non-combustible material and should be of a low reflectivity material to absorb ultraviolet rays.

3. Where the lift front welder's helmet is used, there shall be a stationary safety glass on the inside of the frame next to the eyes, to protect welder against flying particles when the front is lifted. Where lens containers will not permit use of such safety glass, safety goggles shall be worn.

4. Adequate ventilation should be provided as protection against accumulations of toxic fumes and gases. If such precautions cannot be taken, the welder should wear appropriate respiratory protection. If welding on toxic metals is not controlled to within the Permissible Exposure Limits specific respiratory protection is required. See RULE: 437-02-288, page 6 of the standard.

   There are additional requirements for welding on fluorine compounds, zinc, lead, beryllium (note beryllium can be an alloy in some specialty aluminum metals), cadmium, mercury, working around degreasers containing chlorinated hydrocarbon compounds, toxic coatings and preservative coatings, and cutting stainless steel.

5. Precautionary labels are required on all filler metals and electrodes and specific wording is required on Cadmium containing metals, fluorides, and zinc.

Gas Welding

1. Gas cylinders must be handled carefully (breaking the neck from a full cylinder can turn the bottle into a missile).

2. Cylinders shall be secured to keep them from falling. Cylinder storage must meet the OSHA rules 1910.253(b)(2), (3), and (4) and 437-02-293.

3. Acetylene cylinders must always be maintained in an upright position.

4. Oxygen cylinders shall be separated from fuel-gas cylinders or other combustible materials by at least 20 feet or by a fire-resistant barrier at least 5 feet high.

   a. Oxygen from supply cylinders should be checked to make certain they are not leaking, especially in enclosed spaces, where it can cause ignition of materials that are not normally highly flammable.

   b. Grease and oil shall be kept away from, and never used to lubricate oxygen cylinder valves or regulators.

   c. Do not handle oxygen cylinders with oily hands or gloves.

d. Before connecting an oxygen bottle, first open the valve slightly for an instant, then close and attach an oxygen regulator to the valve. Always stand to one side when opening the valve.
SEE OSHA RULES 1910.253(b)(5) Operating Procedures for cylinders.

5. Empty gas cylinders should be marked and have their valves closed tightly. Valve protection caps should always be in place on those cylinders designed for caps, except when the cylinder is in use or being connected/disconnected.

6. Gas cylinders should be stored out of the direct rays of the sun and away from other sources of heat. Never strike an arc against a gas cylinder.

7. Do not use a hammer or wrench to open cylinder valves; if valves will not open by hand, notify the supplier. Always open the cylinder valve slowly.

8. Do not tamper with cylinder valves or try to repair them. Send the supplier a prompt report of the trouble, including the cylinder serial number, and follow the supplier's instructions.

9. Backflow or flashback preventers shall be installed on all oxygen/flammable gas welding and cutting units between the torch or blowpipe and the hoses. Torches shall be ignited using only friction lighters, stationary pilot flames etc.

10. When welding or cutting is stopped for an extended period of time, for example, during the lunch break, overnight or longer:

- The oxygen and fuel-gas cylinder or manifold valves shall be closed;
- Torch valves shall be opened momentarily to release all gas pressure from the hoses and then closed;
- The regulator pressure adjusting screws shall be released; and
- When the welding or cutting has stopped for a few minutes, the closure of torch valves only is allowed.

11. Gauges shall be maintained in good condition. Cracked or missing glass shall be replaced prior to use.

Arc Welding Cutting

1. Precautions need to be taken to avoid shock from electric welding operations. All the equipment and installation must meet the OSHA requirements designed to prevent electrical hazards.
SEE RULES: 1910.254(b)(2) - Environmental Conditions
1910.254(b)(3) Voltage, (4) Design,
1910.254(c) Installation of arc welding equipment.

2. Operation and Maintenance:

   a. Machine Hook-up: Before starting 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.

      - The welder should not stand in water while doing electric welding.

   b. Grounding of the welding machine fame shall be checked. Special attention shall be given to safety ground connections of portable machine.

   c. Manufacturer's instructions shall be strictly followed.

   d. Hot electrode holders should not be dipped in water.

   e. Cables with damaged insulation or exposed conductors must not be used, and should be replaced before any such work is attempted. If necessary to join lengths of cable, is must be done using only connectors designed specifically for the purpose.