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WELDING AND CUTTING

MODULE DESCRIPTION

This module provides information on safety concerns and precautions when using welding and cutting equipment.

OBJECTIVES

Upon completion of this module, the participant will be able to:

Identify the requirements placed on employers by the General Duty Clause.
Describe how to safely use the equipment associated with gas welding and cutting.
Describe how to safely use the equipment associated with arc welding and cutting.
List the various methods of ventilation and protection used in various working environments.
Understand the dangers associated with both chemical and physical agents when welding and cutting.

MODULE OUTLINE

1. Introduction to the Welding and Cutting Module.
   - According to the General Duty Clause, it is your companys responsibility to make sure both the work that you do and your workplace itself are free from recognized hazards that are causing or are likely to cause death or serious physical harm. They are also required to comply with OSHAs standards.
2. Guidelines for Gas Cylinders
   - Cylinder Condition:
     Never use a damaged or defective cylinder.
     Regardless of whether they are empty or full, cylinders should never be used as rollers or supports.
     Whenever a cylinder is in use, a cylinder truck, chain, or other steadying device should be used to keep the cylinders from being knocked over.
     When a cylinder is empty or not in use, or when a cylinder is being transported, the valve should be closed and the valve protection cap should be secured in place.
   - Cylinder Contents:
     Only the gas supplier should attempt to mix gasses in a cylinder.

Only the gas supplier, or the person authorized by them, should attempt to refill a cylinder.
The cylinders contents should only be used by those intended by the supplier.

- Cylinder Placement:
  - Cylinders should be kept far enough away from the actual welding or cutting operation so that sparks and flames will not reach them. When this is impractical, fire resistant shields must be provided.
  - Cylinders should be placed where they cannot become part of an electrical circuit.
  - When in use, fuel gas cylinders should be placed with the valve end up, and they should never be used in a location where they would be subject to a heat source.
  - Cylinders containing oxygen or acetylene shall not be placed in confined spaces.
- Fire Precautions:
  - Buckets of water or sand, water hoses, or portable extinguishers need to be kept readily available.
  - The Fire Watch is required when combustible materials are within 35 feet of welding and cutting activities. They are also required when combustible materials are on the opposite side of a metal structure from welding or cutting activities.
  - The Fire Watch needs to be equipped with fire extinguishing equipment and be properly trained to use it.
  - The Fire Watch needs to be able to sound the fire alarm if they are unable to extinguish the fire.
  - Fire watch must continue for at least 30 minutes after completion of welding and cutting activities.

3. Transporting, Moving, and Storing Gas Cylinders

- Transporting:
  - When cylinders are hoisted, they should be secured on a cradle, slingboard, or pallet. They should never be hoisted or transported by means of magnets or choker slings.
  - When cylinders are transported by powered vehicles, they should be secured in a vertical position.
  - Regulators should be removed and valve protection caps put in place before cylinders are moved, unless cylinders are firmly secured on a special carrier intended for this purpose.
- Moving:
  - Cylinders shall be moved by tilting and rolling them on their bottom edges. They should never be intentionally dropped, struck, or allowed to strike each other violently.
  - Valve protection caps should not be used for lifting cylinders from one vertical position to another, and bars should not be used under valves or valve protection caps to pry cylinders loose when frozen.
  - Since cylinders are designed to accept valve protection caps, they should always be in place, hand-tight, except when in use or connected for use.
  - Acetylene cylinders shall be stored valve up.
  - Cylinder valves shall be closed before moving the cylinders.
  - Before a regulator is removed from a cylinder valve, the cylinder valve should be closed and the gas released from the regulator.
- Storage:
  - When oxygen cylinders are in storage, they should be separated from fuel gas cylinders or combustible materials, either by a

minimum distance of 20 feet or by a non-combustible barrier with a fire-resistant rating of at least one-half hour.

Inside of buildings, cylinders should be stored in a well-protected, well-ventilated, dry location.

4. Safe Use of Fuel Gas Cylinders

- While all cylinders should be handled carefully according to OSHA standards, there are additional guidelines that deal specifically with fuel gas cylinders.
- Regulator use:

  When using fuel gas through torches or other devices which are equipped with shutoff valves, you should always reduce the pressure by attaching a suitable regulator attached to the cylinder valve or manifold. Before removing a regulator from a cylinder valve, always close the valve and release it from the regulator.
- Cracking:

  Before a regulator or cylinder valve is connected, you should open the valve slightly and close it immediately. This is generally referred to as cracking, and is intended to clear the valve of dust or dirt that might otherwise enter the regulator.

  When cracking the valve, stand to one side of the outlet, never in front of it. Never crack a fuel gas valve where the gas could reach welding work, sparks, flame, or other possible sources of ignition.
- Valve Wrench Use:

  Always open the cylinder valve slowly to prevent damage to the regulator. For quick closing, never open a fuel gas valve more than one turn. When a special wrench is required, it should be left in position on the stem of the valve while the cylinder is in use, so that the fuel gas flow can be shut off quickly in case of an emergency. In the case of manifold or coupled cylinders, at least one such wrench should always be available for immediate use.
- Leaks:

  If a leak is found around the valve stem when the valve on a fuel gas cylinder is opened, close the valve and tighten the gland nut. If this action does not stop the leak, discontinue use of the cylinder, properly tag it, and remove it from the work area, unless a regulator attached to a cylinder valve stops the leak.

  If a leak should develop at a fuse plug or other safety device, discontinue use of the cylinder and remove it from the work area.

5. Proper Use of Welding Equipment

- Hoses

  Fuel gas and oxygen hose should be easily distinguishable from each other. Oxygen and fuel gas hoses are not interchangeable, and a single hose having more than one gas passage should not be used. When parallel sections of oxygen and fuel gas hoses are taped together, not more than 4 inches out of every 12 should be covered in tape.

  At the beginning of each working shift, all hoses in use that are carrying a substance that could ignite, combust, or be in any way harmful to employees should be inspected. Do not use a defective hose or one in poor condition.
- Torches:

  You must never use a defective torch. Therefore, at the beginning of each working shift, torches in use should be inspected for leaking shutoff valves, clogged tip connections, and other defects. Clogged torch tip openings should only be cleaned

with suitable cleaning wires, drills, or other devices designed for this purpose. Additionally, only light torches using friction lighters or other approved devices.

- Regulators:

  Oxygen and fuel gas regulators, including their related gauges, must be in proper working order. Do not use defective regulators.

6. Proper Use of Arc Welding Equipment

Manual Electrode Holders:

-You should only use manual electrode holders which are specifically designed for arc welding and cutting, and are capable of safely handling the maximum rated current required by the electrodes. Also, any current-carrying parts passing through the portion of the holder which the welder or cutter grips in his hand should be fully insulated against the maximum voltage encountered to ground the manual electrode holder.

Cables and Connectors:

-All cables used for arc welding and cutting should be completely insulated and flexible, capable of handling the maximum current requirements of the work in progress. Also, you should only use cables that are free from repair or splices for a minimum distance of 10 feet from the cable end to which the holder is connected, unless the insulating quality of the splice or connector is equal to that of the cable itself. Finally, never use a cable that is in need of repair.

- Machine Grounding:

  A ground return cable should have a safe current-carrying capacity equal to or exceeding the specified maximum capacity of the arc welding or cutting unit it services.

  Never use pipelines containing gases or flammable liquids, or conduits containing electrical circuits, as ground returns. Also, when a structure or pipeline that is employed as a ground return circuit generates an arc, a spark, or heat at any time, discontinue use of the structure as a circuit.

- Shielding:

  Whenever possible, all arc welding and cutting operations should be protected by non-combustible or flammable shields, which will guard employees and other persons in the vicinity from the direct rays of the arc. Also, when practical, objects to be welded, cut, or heated should be moved to a designated safe location. If the object cannot readily be moved, all moveable fire hazards in the vicinity should be taken to a safe place.

  No welding, cutting, or heating should be done in an area where the application of flammable paints or the presence of flammable compounds could create a hazard. Suitable fire extinguishing equipment should be immediately available in the work area and should be maintained in a state of readiness for instant use.

  Before welding, cutting, or heating a drum, container, or hollow structure which has contained a toxic or flammable substance, you should either fill the structure with water or thoroughly clean it of such hazardous substances. Also, before applying heat to a drum, container, or hollow structure, be sure to open a vent to provide an escape route for any pressure built up during the application of heat.

7. Proper Ventilation

In typical welding, cutting, and heating situations not involving toxic materials, either mechanical ventilation or respiratory

protective equipment are considered sufficient. When sufficient ventilation cannot be obtained without blocking the means of access, employees must be protected by air line respirators. Welding, cutting, or heating in any enclosed spaces involving toxic metals should be performed with local exhaust ventilation, or employees should be provided with air line respirators.

Mechanical ventilation consists of either general mechanical ventilation systems or local exhaust systems. It shall be considered adequate if it is of sufficient capacity and properly placed so as to remove fumes from the source and keep their concentration in the breathing zone within the same limits.

Contaminated air from a working space should be discharged well clear of the intake source, so that all air replacing the contaminated air withdrawn is clean and breathable.

The general guidelines for ventilation are considered sufficient in a typical welding, cutting, or heating situation. However, there are situations in which more is required.

1. Confined Spaces: When sufficient ventilation cannot be obtained without blocking the means of access, employees must be protected by air line respirators. An employee on the outside of the confined space should be assigned to maintain communication with those within and aid them in case of an emergency.
2. Toxic Metals: Welding, cutting, or heating in any enclosed spaces involving certain metals should either be performed with local exhaust ventilation or employees should be provided with air line respirators.
3. These metals include:
    1. Lead-bearing or lead-coated metals.
    2. Cadmium-bearing or cadmium-coated metals.
    3. Metal coated with mercury-bearing metals.
    4. Beryllium-bearing base or filler metals.
4. Preservative Coatings:
    1. In enclosed spaces, all surfaces covered with toxic preservatives must be stripped of toxic coatings a distance of at least 4 inches from the area of heat application, or the employee must be protected by a respirator.
    2. In the open air, employees must be protected by a respirator.

8. Chemical Agents

- Hazardous chemical agents related to welding and cutting include Zinc, Cadmium, Beryllium, Iron Oxide, Mercury, Lead, Fluorides, Chlorinated Hydrocarbon Solvents, Phosgene, Carbon Monoxide, Ozone, and Nitrogen Oxides.
- Hazardous physical agents related to welding and cutting include Ultraviolet Radiation, Infrared Radiation, and Intense Visible Light.

Zinc is used in large quantities in the manufacturing of brass, galvanized metals, and various other alloys. Zinc Oxide fumes can occur when welding or cutting zinc-coated metals, and exposure to these fumes is known to cause Metal Fume Fever. Symptoms of Metal Fume Fever are very similar to those of common influenza, and rarely, if ever, last beyond 24 hours.

Cadmium is used frequently as a rust-preventative coating on steel and also as an alloying element. Acute exposure to high concentrations of cadmium fumes can produce severe lung irritation, fluid in the lungs (pulmonary edema), and, in some cases, even death. Long-term exposure to low levels of cadmium in the air can result in emphysema and kidney damage.

Beryllium is sometimes used as an alloying element with copper and other base metals. Acute exposure to high concentrations of beryllium can result in chemical pneumonia. Long-term exposure can result in shortness of breath,

chronic cough, and significant weight loss, accompanied by fatigue and general weakness.

Iron is the principle alloying element in steel manufacturing. During the welding process, iron oxide fumes can be emitted from both the base metal and the electrode. The primary acute effect of this exposure is irritation of the nasal passages and the lungs. Although long-term exposure to iron oxide fumes may result in iron pigmentation of the lung tissue, authorities agree that these iron deposits in the lung are not dangerous.

Mercury compounds are used to coat metals in order to prevent rust or inhibit foliage growth. Under the intense heat of an arc or gas flame, mercury vapors are produced. Exposure to these vapors may produce stomach pain, diarrhea, kidney damage, or respiratory failure. Long-term exposure may produce hearing damage.

The welding and cutting of lead-bearing alloys or metals, whose surfaces have been painted with lead-based paint, can generate lead oxide fumes. Inhalation and ingestion of lead oxide fumes and other lead compounds can cause lead poisoning. Symptoms include a metallic taste in the mouth, loss of appetite, nausea, and abdominal cramps. Over time, anemia and general weakness, primarily in the wrist, develop. Lead adversely affects the central nervous system, circulatory system, reproductive system, kidneys, and muscles.

Fluoride compounds are found in the coatings of several types of fluxes used in welding. Exposure can irritate the eyes, nose, and throat; and may eventually result in pulmonary edema and bone damage.

Various chlorinated hydrocarbons are used in degreasing or other cleaning operations. The vapors of such solvents are a concern when welding and cutting because the heat and ultraviolet radiation from the arc may decompose and form highly toxic and irritating phosgene gas (see Phosgene).

Phosgene is formed when chlorinated hydrocarbon solvents are decomposed by ultraviolet radiation, such as that produced by arc welding and cutting. When inhaled, phosgene causes moisture in the lungs to form hydrogen chloride, which, in turn, destroys lung tissue. For this reason, chlorinated solvents should be kept well away from welding operations or any operations in which ultraviolet radiation or intense heat is generated.

Carbon monoxide is a gas usually formed by the incomplete combustion of various fuels. Welding and cutting produce significant amounts of carbon monoxide. In addition, welding operations that use a carbon dioxide gas shield may produce hazardous concentrations of carbon monoxide in poorly ventilated areas. This is called a breakdown of shielding gas. Carbon monoxide is colorless, odorless, and tasteless. Common symptoms of overexposure include pounding of the heart, a dull headache, flashes behind the eyes, dizziness, ringing in the ears, and nausea.

Ozone is produced by ultraviolet light from the welding arc. It is a highly active form of oxygen that can cause great irritation to all mucous membranes. Symptoms of ozone exposure include headache, chest pain, and dryness of the upper respiratory tract. Excessive exposure can cause damage to the lungs. Both nitrogen dioxide and ozone are thought to have long-term effects on the lungs.

The ultraviolet light of the arc can produce nitrogen oxides from the nitrogen and oxygen in the air. Nitrogen oxides, especially nitrogen dioxide, are irritating to the eyes and throat, but dangerous concentrations can be inhaled without any immediate discomfort. High concentrations can cause shortness of breath, chest pain, and fluid in the lungs (pulmonary edema).

9. Physical Agents

- Ultraviolet (UV) radiation is generated by the electric arc in the welding process. Skin exposure to UV rays can cause severe burns, in many cases without prior warning. UV radiation can also damage the lens of the eye, causing what is commonly known as arc-eye, a sensation of sand in the eyes. Exposure to UV rays may also increase the effects of some chemical agents.
- Exposure to infrared radiation (IR), produced by the electric arc and other flame cutting equipment, may harm the skins surface and the tissues immediately below the surface. Except for this effect, which can sometimes progress to thermal burns in some situations, infrared radiation is not dangerous to welders. Most welders protect themselves from IR with a welders helmet or glasses and protective clothing.
- Exposure of the human eye to intense visible light can produce adaptation, papillary reflex, and shading. Such actions are protective mechanisms to prevent excessive light from being focused on the retina. In the welding process, eye exposure to visible light is mainly prevented by the welders helmet, but some individuals have sustained retinal damage due to careless viewing of the arc. At no time should the arc be observed without eye protection.