WELDING, CUTTING & BRAZING PROGRAM

INTRODUCTION/OVERVIEW

This chapter presents the basic safety requirements found in 29 CFR 1926, Subpart J as well as capsule summaries of the major health hazards associated with the welding process.

PURPOSE/SCOPE

Winger Companies, herein referred to as Winger, Welding, Cutting & Brazing Program is designed to ensure the safety of personnel that are required to perform these duties at the work site. All personnel are required to comply with the procedures established by this program. Winger provides training in hazard identification and awareness. Be aware of these hazards and take the requisite precautions.

HEALTH HAZARDS - CHEMICAL AGENTS

The following are brief descriptions of materials which may be found in some welding and cutting operations:

ACETYLENE AND OTHER FUEL GASES

Acetylene, propylene (FG-2), propane and butane at very high concentrations are simple asphyxiants, irritants, or anesthetics. Thus, depending on the concentration and exposure time, symptoms such as irritation to the mucous membranes of the eyes, nose, throat and respiratory tract; shortness of breath with rapid respiration; fatigue, dizziness, diminished mental alertness, and muscular incoordination, nausea, vomiting, loss of consciousness, convulsions, and finally coma and death may occur.

ALUMINUM

Fumes and gases can be dangerous to your health. Common entry is by inhalation. Other possible routes are skin contact and ingestion. Short-term exposure to welding fumes may result in discomfort such as metal fume fever, dizziness, nausea, or dryness or irritation of nose, throat, or eyes. May aggravate pre-existing lung respiratory problems such as asthma or emphysema. Long-term (chronic) exposure to welding fumes can lead to siderosis (iron deposits in lungs) and may affect pulmonary function. Bronchitis and some lung fibrosis have been reported.

BERYLLIUM

Beryllium and its compounds are highly toxic. They can cause serious injury or death. Exposure is capable of producing chronic lung changes which are permanent in nature. 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.

CADMIUM

Cadmium is used frequently as a rust-preventive coating on steel and also as an alloying element. Acute exposures to high concentrations of cadmium fumes can produce sever lung irritation. Long-term exposure to low levels of cadmium in air can result in emphysema (a disease affecting the ability of the lung to absorb oxygen) and can damage the kidneys.

Cadmium fumes or fine dust are capable of causing serious injury or death when inhaled. It is easy to mistake cadmium-plated steel for galvanized steel. However, when heated, cadmium leaves an olive-drab color as it oxidizes. Always know the metal you are working with. Cadmium oxide fumes often cause no symptoms until a few hours after exposure.

Carbon Monoxide

Carbon monoxide may cause illness or death. Carbon monoxide is a gas usually formed by the incomplete combustion of various fuels. Welding and cutting may produce significant amounts of carbon monoxide. In addition, welding operations that use carbon dioxide as the inert gas shield may produce hazardous concentrations of carbon monoxide in poorly ventilated areas. This is caused by a breakdown of shielding gas. Carbon monoxide is an odorless, colorless, toxic gas and cannot be detected. Common symptoms of overexposure include pounding of the heart, a dull headache, flashes before the eyes, dizziness, ringing in the ears, and nausea. Loss of consciousness occurs at only very high concentrations.

Chlorinated Hydrocarbon Solvents

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

Chromium

Acute exposure to chromium dust or fumes may cause coughing and wheezing, headache, shortness of breath, pain on deep breathing, and fever. Other symptoms may include irritation of the conjunctivae of the eye, nasal itch and soreness, ulceration and perforation of the nasal septum, chronic bronchitis, and discoloration of the skin. Certain forms of chromium (VI) have been found to cause increased respiratory cancer among workers.

Copper

The fumes and dust cause irritation of the upper respiratory tract, metallic taste in the mouth, nausea, metal fume fever, and in some instances, discoloration of the skin and hair. Copper dust can act as an irritant to skin causing itching, redness, and dermatitis. It may also cause conjunctivitis and small ulcers of the cornea.

Fluorides

Fluoride compounds are found in the coatings of several types of fluxes used in welding. Exposure to these fluxes may irritate the eyes, nose, and throat. Repeated exposure to high concentrations of fluorides in air over a long period may cause pulmonary edema (fluid in the lungs) and bone damage. Exposure to fluoride dusts and fumes has also produced skin rashes. Fluoride fumes can be very irritating to eyes, nose, and throat. Some fluorine compounds can cause death. Fluorides may be formed when welding with fluoride containing rods, and with some fluxes.

Iron Oxide

Iron is the principal alloying element in steel manufacture. During the welding process, iron oxide fumes arise from both the base metal and the electrode. The primary acute effect of this exposure is irritation of nasal passages, throat, and lungs. Inhalation of these fumes and dust may cause “metal fume fever” (an influenza-like illness lasting 24 to 48 hours), and may also cause a benign pneumoconiosis (siderosis). Pure iron oxide probably does not cause fibrotic pulmonary charges, whereas inhalation of iron oxide plus certain other substances my cause lung injury.

LEAD

The welding and cutting of lead-bearing alloys or metals whose surfaces have been painted with lead-based paint can generate lead oxide fumes. Lead fumes or fine dust, when inhaled, can cause lead poisoning, anemia, muscle weakness, nausea, vomiting, colic or death. Symptoms include metallic taste in the mouth, loss of appetite, nausea, abdominal cramps, and insomnia. In time, anemia and general weakness, chiefly in the muscles of the wrists, develop. Be careful to guard against lead poisoning when welding or cutting materials such as lead-coated containers and metals which have been painted. In all such cases, lead produces toxic fumes.

MANGANESE

Manganese dust and fumes are irritants to the eye and mucous membranes of the respiratory tract. Early recognition of chronic manganese poisoning is difficult. Progression of disease manifestations can vary widely among individuals. Signs and symptoms may include apathy, irritability, loss of appetite, headache, weakness of the muscles in the legs, and joint aches. Speech disturbances are common. Chronic exposure to high concentrations of manganese fumes and dusts may adversely affect the central nervous system with symptoms including languor, sleepiness, weakness, emotional disturbances, spastic gait, mask-like facial expression and paralysis. Chronic manganese poisoning, although disabling, is usually not fatal. Animal studies indicate that manganese exposure may increase susceptibility to bacterial and viral infections.

The new TLV for manganese by the ACGIH was published in the 2013 Edition of its TLVs and Biological Exposure Indices (BEIs) publication. The new TLV of 0.02 mg/m3 for respirable manganese, which is applicable to welding fumes, represents a ten-fold reduction from the previous 0.2 mg/m3 TLV. The new TLV for manganese includes a 0.1 mg/m3 limit for inhalable manganese particulate. The Permissible Exposure Limit (PEL) of 5.0 mg/m3, ceiling, remains the US exposure limit for manganese enforced by OSHA.

If there is any potential employee exposure to manganese or other compounds above their respective PELs, OSHA requires that engineering and work practice controls be installed first. The control options listed below should be used before considering a respirator. The use of ventilation/exhaust is often the most feasible method for controlling exposures. Respirators can further reduce exposures and can only do so to those who wear them.

1. Substitution – Review your current welding process, consumable, gas, welding procedure and equipment technology to determine if it's feasible and practical to replace it to generate less welding fume.
2. Isolation – Review your welding operation to determine if it's feasible and practical to isolate and separate the operation by moving it to a regulated area, by automating/ventilating the welding process and/or placing a barrier between the worker(s) and the source.
3. Ventilation/Exhaust – Review the welding fume path to determine if it's feasible and practical to control the path between the source and the worker through source, local and/or general shop ventilation/exhaust equipment.

If adequate ventilation is not feasible, it may be necessary to protect employees with the use of personal protective equipment (PPE), such as a respirator.

MERCURY

Mercury compounds are used to coat metals to prevent rust or inhibit foliage growth (marine paints). Under the intense heat of the arc or gas flame, mercury vapors will be produced. Exposure to these vapors may produce stomach pain, diarrhea, kidney damage, or respiratory failure. Long-term exposure may produce tremors, emotional instability, and hearing damage.

MOLYBDENUM

Exposure may result in anemia, hyperthyroidism, and abnormal liver function tests. Headache, muscle and/or joint pain, weakness, fatigue, anorexia, impaired pulmonary function, renal dysfunction, skin/hair changes, cry cough and chest pains have been reported following long-term inhalation exposure.

Nickel

Skin sensitization or "nickel itch" is a commonly seen toxic reaction to nickel dusts. Nickel dust and fumes may also irritate the conjunctivae of the eye and mucous membranes of the upper respiratory tract. Nickel and its compounds have been reported to produce an increased incidence of cancer of the lung and nasal passages.

Nitrogen Oxides

Nitrogen oxides may irritate the eyes and mucous membranes. High concentrations may produce shortness of breath, chest pain, fluid in the lungs (pulmonary edema), severe pulmonary irritation and methemoglobinemia. This gas is irritating to the eyes, nose and throat but dangerous concentrations can be inhaled without any immediate discomfort. Acute exposure to high concentrations may produce immediate fatigue, cyanosis ("blue lips and skin"), cough, shortness of breath, chills, fever, head-ache, nausea, and vomiting. Collapse and death may occur if the exposure is sufficiently high. Survivors may develop severe and increasing shortness of breath due to chronic lung disease.

The ultraviolet light of the arc can produce Nitrogen Dioxide (NO2), from the nitrogen (N) and oxygen (02) in the air. Nitrogen oxides are produced by gas metal arc welding (GMAW or short-arc), gas tungsten arc welding (GTAW or hell-arc), and plasma arc cutting. Even greater quantities are formed if the shielding gas contains nitrogen. Nitrogen dioxide (NO2), one of the oxides formed, has the greatest health effect.

Plasma cutting should be performed in well ventilated areas. In areas that do not have adequate ventilation a meter or sensor that detects Nitrogen Dioxide (NO2) must be used to ensure the buildup of gases do not exceed the PEL (permissible exposure limit)

Oxygen

Oxygen occurs in persons exposed to high concentrations of oxygen for an extended period of time and may include the following signs and symptom: nausea, dizziness, muscular twitching, irritability, chest pain, numbness, and visual disturbances.

Ozone

Ozone is a form of gaseous oxygen. It is produced around every electric arc, particularly when welding aluminum. It has a noticeable odor and exposure may produce irritations of the eyes, nose, and throat. Overexposure may cause death. Ozone (O3) is produced by ultraviolet light from the welding arc. Ozone is produced in greater quantities by gas metal arc welding (GMAW or short-arc), gas tungsten arc welding (GTAW or hell-arc), and plasma arc cutting. Ozone is a highly active form of oxygen and can cause great irritation to all mucous membranes. Symptoms of ozone exposure include headache, chest pain, and dryness of the eyes, nose and throat. Excessive exposure can cause fluid in the lungs (pulmonary edema). Both nitrogen dioxide and ozone are thought to have long-term effects on the lungs.

Phosgene

Phosgene is formed by decomposition of chlorinated hydrocarbon solvents by ultraviolet radiation. It reacts with moisture in the lungs to produce hydrogen chloride, which in turn destroys lung tissue. For this reason, any use of chlorinated solvents should be well away from welding operations or any operation in which ultraviolet radiation or intense heat is generated.

SILICA

The crystalline forms of silica are responsible for producing silicosis. However, attempts to locate crystalline phases of silica in welding fumes have so far been unsuccessful.

SILICONE

Silicon dusts are a low health risk by inhalation and should be treated as a nuisance dust.

SULFUR

Sulfur compounds, present in the fumes, may irritate the skin, eyes, lungs and gastrointestinal tract.

ULTRAFINE TITANIUM DIOXIDE

Ultrafine (UF) titanium dioxide is defined as synthetic, amorphous titanium dioxide with particle sizes that range from 20-50 nm. These particles agglomerate in air so that the mass median aerodynamic diameter exposures to UF titanium dioxide are similar to those of pigmentary titanium dioxide, ranging from 1-1.5 µm. UF titanium dioxides are used as catalysts. Exposures occur to UF titanium dioxide smoke when welding with rutile-coated welding rods. As with pigmentary titanium dioxide, exposures to UF titanium dioxide have only been found to cause tumors in rats when inhaled at levels associated with particle overload and persistent inflammation.

ZINC

Zinc is used in large quantities in the manufacture of brass, galvanized metals, and various other zinc alloys. Inhalation of zinc oxide fumes can occur when welding or cutting on zinc-coated metals. Exposure to these fumes is known to cause metal fume fever commonly called “zinc chills” or “galo”. Symptoms usually occur a few hours after exposure of metal fume fever are very similar to those of common influenza. They include fever (rarely exceeding 102°F), chills, nausea, dryness of the throat, cough, fatigue, and general weakness and aching of the head and body and a metal taste in the mouth. The victim may sweat profusely for a few hours, after which the body temperature begins to return to normal. The symptoms of metal fume fever have rarely, if ever, lasted beyond 24 hours. The subject can therefore appear to be more susceptible to the onset of this condition on Mondays or on weekdays following a holiday than they are on other days.

HEALTH HAZARDS - RADIATION

ULTRAVIOLET RADIATION

Ultraviolet radiation (UV) is generated by the electric arc in the welding process. Skin exposure to UV can result in severe burns, in many cases without prior warning. UV radiation can also damage the lens of the eye.

Many arc welders are aware of the condition known as "arc-eye", a sensation of sand in the eyes. This condition is caused by excessive eye exposure to UV. Ultraviolet rays also increase the skin effects of some industrial chemicals (coal tar and cresol compounds, for example).

INFRARED RADIATION

Exposure to infrared radiation (IR), produced by the electric arc and other flame cutting equipment may heat the skin surface and the tissues immediately below the surface. Except for this effect, which can progress to thermal

bums in some situations, infrared radiation is not dangerous. Most welders protect themselves from IR (and UV) with a welder's helmet (or glasses) and protective clothing.

INTENSE VISIBLE LIGHT

Exposure of the human eye to intense visible light can produce adaptation, pupillary reflex, and shading of the eyes. Such actions are protective mechanisms to prevent excessive light from being focused on the retina. In the arc welding process, eye exposure to intense visible light is prevented for the most part by the welder's helmet. However, some individuals have sustained retinal damage due to careless "viewing" of the arc. At no time should the arc be observed without eye protection.

PHYSICAL HAZARDS

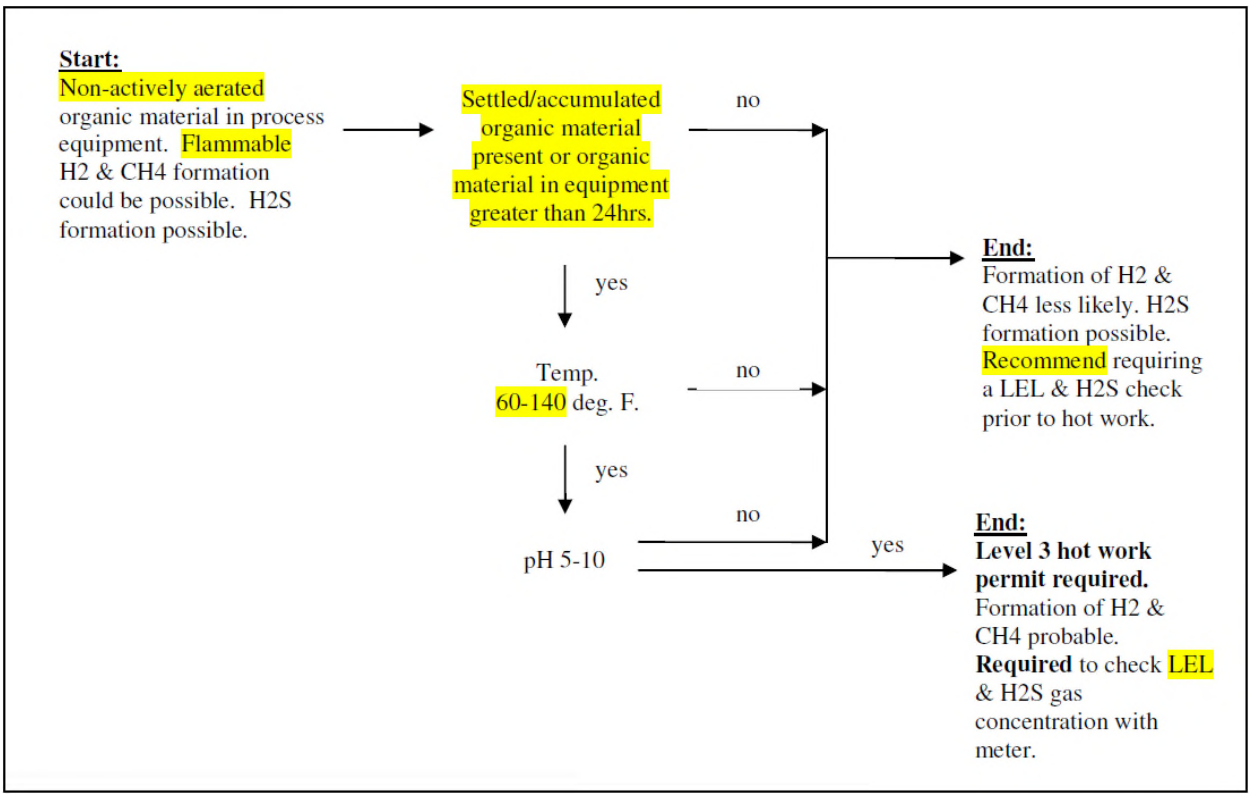
FACILITY DUST HAZARDS

A combustible dust explosion hazard may exist in a variety of industries, including: food (e.g., candy, starch, flour, feed), plastics, wood, rubber, furniture, textiles, pesticides, pharmaceuticals, dyes, coal, metals (e.g., aluminum, chromium, iron, magnesium, and zinc), and fossil fuel power generation. The vast majority of natural and synthetic organic materials, as well as some metals, can form combustible dust. All precautions must be taken to ensure our hot work activities are safe and compliant. If fire hazards cannot be taken to a safe place or guards cannot be used to confine heat, sparks, slag and protect the immovable fire hazards, the welding and cutting shall not be performed.

EXPLOSIVE HAZARDS

When are under certain conditions, anaerobic fermentation can occur. Anaerobic fermentation can produce gases such as hydrogen (H2) methane (CH4), & hydrogen sulfide (H2S) which are flammable. There have been previous incidents in the industry where hot work activities have ignited gases emanating from fermenting materials left in process system which caused property damage, serious injury, and even death. Additionally, H2S gas, when inhaled, can cause injury or death.

Use this flow chart to help you recognize conditions when hot work areas become a higher level of concern that are due to potential formation of H2 & CH4 gas for systems that contain organic materials. Flow chart will also indicate when to testing of H2S gas is required. Systems can include: tanks, piping, aspiration ductwork, equipment, etc. Examples of Organic Materials: heavy steep water, starch slurry, corn syrup, high fructose, corn syrup, germ, gluten, fiber, dextrin, etc.



PERSONAL PROTECTIVE EQUIPMENT

1. Welding Helmets and safety glasses or goggles must be worn by all employees performing the task of welding. These shields will be provided to protect employees' eyes and face from infrared or radiant light burns, flying sparks, metal spatter and slag chips encountered during welding, brazing, soldering, resistance welding, bare or shielded electric arc welding and oxyacetylene welding and cutting operations.

2. Helmet lenses shall provide protection from direct radiant energy from the arc and must meet OSHA 1910.252(b)(2)(ii) regulations.

3. Appropriate protective clothing will be provided to all workers exposed to welding or cutting hazards. The appropriate protective clothing will vary according to the size, nature, and location of the work to be performed.

4. Hearing protection must be worn during all grinding operations.

5. If respirators are required, Winger Respiration Protection Program must be followed.

EMERGENCY AND FIRST AID PROCEDURES

First aid is immediate, temporary treatment given in the event of accident or illness. Immediate first aid (within four minutes) may be the difference between complete recovery, permanent impairment, or death.

First aid equipment shall be available at all times. All injuries shall be reported as soon as possible for medical attention. First aid shall be rendered until medical attention can be provided.

INHALATION

Workers with symptoms of exposure to fumes and gases should go to an uncontaminated area and inhale fresh air or oxygen. If unconscious, immediately remove to an uncontaminated area and call 911.

EYE

For arc welding "flash burns" tell your foreman immediately. Irrigate the eyes immediately with large amounts of water for 15 minutes. Occasionally hold the eyelids apart to insure complete irrigation. Don't rub the eye. Apply Industrial Eye Drops, 1 to 2 drops, 4 times daily to eyes. Due to contamination and infection do not share eye drop bottles. Remove contact lenses before applying eye drops. Cover the eye with cold iced compresses for 5 to 10 minutes; then repeat. Place a barrier between your skin and the ice to prevent skin damage. Over the counter (OTC), Ibuprofen can help reduce swelling and Tylenol can help reduce pain. Old welders used sliced potatoes or moist tea bags to help reduce inflammation and soreness. Eyelids and eyeballs can temporarily become swollen. If condition worsens or persists more than 72 hours, inform your foreman and safety director to get proper medical attention.

SKIN

For skin contract with irritants, flush the areas with large amounts of water, and then wash with soap and water. Remove contaminated clothing. If mucous membranes are irritated, flush with water. Wash cuts and scrapes with mild soap and water. Avoid contamination. Apply a dry sterile dressing.
For thermal burns, cold water is an effective first aid measure. If skin is not broken, immerse burn part in clean cold water or apply clean ice to relieve pain. Do not disturb or open blisters. Prevent contamination. Bandage loosely with a clean dry dressing. Get medical assistance.

ELECTRICAL SHOCK AND ELECTRICAL BURNS

Disconnect and turn off the power. Use non-conducting materials, such as dry insulated gloves, if you must resort to pulling the victim from live contact. If the victim is not breathing, administer CPR as soon as contact is broken. Call 911. Keep comfortably warm and horizontal until there is no longer any further evidence of shock. Treat electrical burns as thermal burns.

GENERAL REQUIREMENTS FOR HOT WORK ACTIVITIES

Welding, brazing, cutting, brazing, and grinding or similar spark producing activities during fabrication and construction are commonly referred to as "HOT WORK". Because of the high temperatures involved, and the potential for fire and serious personal injury, specific procedures must be followed to ensure that work activities are performed safely.

Basic precautions are responsibilities of welders and cutters, supervisors, subcontractors and those in management on whose property cutting and welding is to be performed. Basic precautions for fire prevention in welding or cutting work are:

1. Fire hazards – if the object to be welding or cut cannot readily be moved, all movable fire hazards in the vicinity shall be taken to a safe place.

2. Guards – if the object to be welding or cut cannot be moved and if all the fire hazards cannot be removed, then guards shall be used to confine the heat, sparks and slag, and to protect the immovable fire hazards.

3. Restrictions – if these two requirements cannot be met, then welding and cutting shall not be performed.

4. When required, obtain a Hot Work Permit for all welding, brazing, cutting, and grinding operations.

5. Many of our customers have their own Hot Work Permits for contractors to work under. For those customers that do not provide a Hot Work Permit, Winger employees shall use the Winger Hot Work Permit. This permit must be filled out before hot work activities begin. When the hot work is completed the permit shall be turned into the safety department for retention of one year.

6. Any equipment that does not pass inspection, shall be tagged and taken out of service immediately. Only qualified personnel are authorized to make repairs.

7. Good housekeeping standards must remain in place to provide a safe and hazard-free work area.

8. All hot work activities SHALL only be performed by qualified employees.

9. All employees involved in hot work activities SHALL wear appropriate personal protective clothing and eye / face protection.

10. ALWAYS ensure that the ventilation is adequate before you start welding or cutting operations. Approved respiratory protection equipment may be required if adequate ventilation cannot be achieved.

11. A fire watch SHALL be provided as required by location procedures and SHALL be maintained for at least 30 minutes after completion of the job. A fire watch shall not perform any other activities.

12. Suitable Winger fire extinguishing equipment SHALL be immediately available in all areas where hot work activities are performed. Some customers require a 20-pound ABC fire extinguisher. DO NOT proceed with any hot work activities without a fire extinguisher immediately accessible (within 10 feet).

13. Welding screens should be used around welding and cutting areas to protect other employees passing by the work area from light and sparks.

14. Combustible materials within a 35-foot radius of the hot work to be performed SHALL either be moved or protected. Some customers have a safe work practice of a 50-foot radius. Know your customer requirements.

15. Spark containment SHALL be utilized during all welding, burning and grinding operations. Spark containment may include laying fire blankets, placing barricades, using 100% spark containment or by the use of a fire watch. Consideration SHALL be given to open flooring and grating to make sure that combustibles on lower levels are shielded or protected. Employees working around or below the welding, burning or grinding operation SHALL be protected from falling or flying sparks.

16. Welding cables and gas hoses SHALL be positioned to minimize possible damage and to eliminate potential tripping hazards to personnel.

17. Welding cables SHALL NOT have connectors within 10 feet of the holder.

18. Welding cables may only be repaired by using specifically designed heat-shrink tape.

19. Welding and cutting assemblies SHALL be equipped with flashback protective equipment.

20. All requirements laid out in this program must be met and followed or welding and cutting shall not commence. If welding cannot be conducted safely the welding and cutting shall not be performed.

ARC WELDING AND CUTTING § 1926.351

1. Before starting to weld each day, check all ground connections to ensure they are properly connected and have suitable capacity for the specified maximum current.

2. Ensure that the ground return cable can safely carry the specified maximum amount of current generated by the arc welding unit.

3. Verify that the frames of the electric arc welding units are grounded with a third wire in the cable containing the circuit conductor, or through a separate wire that is grounded to the source of the current.

4. Whenever possible, ground connections SHALL be made directly to the material being welded.

5. Arc welding and cutting cables SHALL be of the completely insulated, flexible type, capable of handling the maximum current requirements of the work in progress.

6. Cables in need of repair SHALL NOT be used.

7. Arc welding and cutting operations SHALL be shielded by noncombustible or flameproof screens, which will protect employees and other persons working in the vicinity from direct rays of the arc.

8. The power supply switch to the equipment SHALL be “opened” or “shut-off” whenever the equipment is being moved or not being used.

9. Electrodes SHALL NOT be left in the holder when unattended or not in use.

10. Precautions must be taken during long pauses in arc welding in confined spaces to prevent accidental contact of electrodes torch valve gas leaks in gas welding.

11. Do not use pipelines containing gases or flammable liquids, or conduits containing electrical circuits, as a ground return.

12. Ensure that the required electrical contact exists at all joints when a structure or pipeline is employed as a ground return circuit. The generation of an arc, sparks, or heat at any point shall cause rejection of the structures as a ground circuit.

13. Ground the frames of all arc welding and cutting machines either through a third wire in the cable containing the circuit conductor or through a separate wire which is grounded at the source of the current.

14. Open the power supply switch to the equipment when the arc welder or cutter has occasion to leave his work or to stop work for any appreciable length of time, or when the arc welding or cutting machine is to be moved.

15. Objects to be welded, cut or heated shall be moved to a designated safe location or, if they cannot be readily moved, all movable fire hazards in the vicinity shall be taken to a safe place. If fire hazards cannot be removed, positive means shall be taken to confine the heat, sparks and slag and to protect the immovable fire hazards from them.

16. Spark containment shall be utilized during all welding, burning and grinding operations. Spark containment may include laying fire blankets, placing barricades, using 100% spark containment or by the use of a fire watch. Employees working around or below the welding, burning or grinding operation shall be protected from falling or flying sparks.

17. Arc welding and cutting operations shall be shielded by non-combustible or flameproof screens, which will protect employees and other persons working in the vicinity from direct rays of the arc.

18. Arc welding and cutting cables shall be of the completely insulated, flexible type, capable of handling the maximum current requirements of the work in progress. Cables in need of repair shall not be used.

19. When the welder or cutter has occasion to leave work or to stop work for any appreciable length of time, or when the welding or cutting machine is to be moved, the power supply switch to the equipment shall be opened.

20. All ground return cables and all arc welding and cutting machine grounds shall have a safe current-carrying capacity equal to or exceeding the specified maximum output capacity of the arc welding or cutting unit which it services. When a single ground return cable services more than one unit, its safe current-carrying shall exceed the total specified maximum output capacities of all of the units which it services.

21. Ground connections shall be made directly to the material being welded, and as close to the weld as possible.

22. Any repairs done to a welding cable must be protected by means of rubber and friction tape or other equivalent insulation.

OXYGEN-FUEL GAS WELDING & CUTTING § 1926.350

1. Oxygen and fuel gas pressure regulators, including their related gauges, shall be in proper working order while in use.

2. Valve protection caps shall be in place and secured.

3. All hoses and torches in use carrying acetylene, oxygen, fuel gas or any substance which may ignite or be harmful to employees shall be inspected at the beginning of each working shift.

4. Defective hoses and torches shall be tagged “Do Not Use” and immediately removed from service.

5. Oil or grease shall not e permitted on any oxygen-acetylene equipment.

6. Torches shall be lighted from friction lighters and not by stationary pilot lights, matches, cigarette lighters or from hot work.

7. Directional gas flow fittings (back-flow valves) shall be provided on hoses to prevent reverse gas flow or back flow.

8. Clogged torch tip openings shall be cleaned with suitable cleaning wires, drills, or other devices designed for such purpose.

9. Torches shall be turned off and removed from confined spaces when not in use.

10. Cylinders containing oxygen or acetylene or other fuel gas shall not be taken into confined spaces.

11. All gas cylinders must be appropriately marked to identify the gas content.

12. Cylinders shall be placed where they cannot become part of an electrical circuit. Electrodes shall not be struck against a cylinder to strike an arc.

13. Oxygen and acetylene cylinders must be separated from fuel gas cylinders of combustible material by a distance of at least 20 feet or by a non-combustible barrier at least five (5) feet high and having a fire resistance of at least one have hour.

14. Cylinders, cylinder caps and valves, couplings, regulators, hose, and apparatus shall be kept free from oil or greasy substances and shall not be handled with oily hands or gloves.

15. Fuel gas cylinders shall be placed with valve end up whenever they are in use. They shall not be placed in a location where they would not be subject to open flame, hot metal, or other sources of artificial heat.

16. All cylinders must be chained or otherwise secured during storage and must have the valves closed and the valve protection caps in place.

17. Before a regulator to a cylinder valve is connected, the valve shall be opened slightly and closed immediately. (This action is generally termed “cracking” and is intended to clear the valve of dust or dirt that might otherwise enter the regulator.) The person cracking the valve shall stand to one side of the outlet, not in front of it. The valve of a fuel gas cylinder shall not be cracked where the gas would reach welding work, sparks, flame, or other possible sources of ignition.

18. The cylinder valve shall always be opened slowly to prevent damage to the regulator. For quick closing, valves of fuel gas cylinders shall not be opened more than 1 turn. When a special wrench is required, it shall 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 manifolded or coupled cylinders, at least one such wrench shall always be available for immediate use. Nothing shall be placed on top of a fuel gas cylinder, when in use, which may damage the safety device or interfere with the quick closing of the valve.

19. Before a regulator is removed from a cylinder valve, the cylinder valve shall always be closed and the gas released from the regulator.

20. If, when the valve on a fuel gas cylinder is opened, there is found to be a leak around the valve stem, the valve shall be closed and the gland nut tightened. If this action does not stop the leak, the use of the cylinder shall be discontinued, and it shall be properly tagged and removed from the work area.

21. In the event that fuel gas should leak from the cylinder valve, rather than from the valve stem, and the gas cannot be shut off, the cylinder shall be properly tagged and removed from the work area.

22. If a regulator attached to a cylinder valve will effectively stop a leak through the valve seat, the cylinder need not be removed from the work area.

23. If a leak should develop at a fuse plug or other safety device, the cylinder shall be removed from the work

area.

INERT-GAS METAL-ARC WELDING § 1926.351

No employee is to engage in, or be exposed to, the process of inert-gas metal-arc welding until the following special precautions have been taken. These precautions are required since the inert-gas metal-arc welding process involves the production of ultraviolet radiation of intensities of 5 to 30 times that produced during the shielded metal-arc welding as well as the liberation of toxic fumes and gases and the decomposition of chlorinated solvents by ultraviolet rays.

1. No chlorinated solvents are to be used within 200 feet of the exposed arc, unless shielded.

2. Ensure that all surfaces prepared with chlorinated solvents are thoroughly dry before welding is permitted on such surfaces.

3. Ensure that filter lenses meeting the requirements of OSHA Subpart E protect all employees in the area who are not protected from the arc by screening.

4. Ensure that all welders and other employees who are exposed to radiation are suitably protected so that the skin is covered completely to prevent burns and other damage by ultraviolet rays.

5. Provide local exhaust ventilation or airline respirators to all employees who perform inert-gas metal-arc welding on stainless steel in any enclosed spaces. These ventilation and respiratory protection requirements must be met to protect against dangerous concentrations of nitrogen dioxide.

FIRE PREVENTION § 1926.352

Welding and flame cutting operation present serious fire hazards that can lead to significant injury and/or property damage. Flying sparks are the main cause of fires and explosions in welding and cutting. Sparks can travel up to 35 feet from the work area. Sparks and molten metal can travel greater distances when falling. Sparks can pass through or become lodged in cracks, clothing, pipe holes, and other small openings in floors, walls, or partitions. The arc welder is capable of producing over 10,000° F, therefore it is very important practice good fire prevention. The following are fire prevention requirements when welding:

1. When required, obtain a Hot Work Permit.

2. Never permit welding, cutting or heating where the application of flammable paints or the presence of other flammable compounds creates a hazard.

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

4. Always maintain suitable fire extinguishing equipment in the work area. This equipment must be readily accessible and in a state of readiness for instant use.

5. Assign additional personnel (Fire Watch) to guard against fire whenever the welding, cutting or heating operation is such that normal fire prevention precautions are not sufficient. These additional personnel are to be present while the actual welding, cutting, or heating operation is being performed and for at least 30 minutes after completion of the work to ensure that no possibility of fire exists.

6. Never weld in areas near the storage of large quantities of exposed, readily ignitable materials, such as paper or cotton or other combustible and flammable materials.

7. Whenever an object is to be welded, cut, or heated it must be moved to a designated safe location. If the object cannot be moved and/or all fire hazards removed, positive means must be taken to confine the heat, sparks, and slag, and to protect the immovable fire hazards from them.

8. All combustibles should be relocated at least 35 feet from your work area. If relocating the combustibles is impracticable, then protect them with flame-proof covers or other suitable guards or curtains.

9. Keep floors swept clean for a radius of 35 feet from welding operations.

10. Combustible floors should be kept wet, covered with damp sand, or protected by fire-resistant shields. Where floors have been wet down, employees operating arc welding or cutting equipment should be protected from possible shock.

11. If possible, enclose the work area with portable, fire-resistant screens.

12. Protect or shut down ducts and conveyor systems that may carry sparks.

13. Whenever there are cracks or holes in floors, walls, open doorways or windows, precautions should be taken to prevent sparks from falling through openings and onto combustible materials.

14. To prevent ignition where cutting or welding is performed near walls, partitions, ceiling or roof of combustible construction, use fire-resistant shields or guards.

15. If welding on a metal wall, partition, ceiling or roof, temporarily relocate combustibles on the other side. The combustibles may ignite due to conduction or radiation. When it is not practical to relocate the combustible material, a fire watch on the opposite side from the work should be provided.

16. Never weld on a metal partition, wall, ceiling or roof that has a combustible covering or on walls or partitions of combustible sandwich-type panel construction.

17. Never weld too close to combustible walls, partitions, ceilings or roofs that may cause ignition by conduction.

18. Do not dispose of hot slag or rods in containers holding combustible material.

19. Connect the work cable to the work as close to the welding area as possible, keeping welding leads protected from sparks and slag.

FIRE WATCH - OSHA CFR 1910.252 (A) (2) (III)

This Fire Watch section serves as a guideline to watch for hazards during and after hot work has been performed on a project. It also applies whenever a Fire Alarm System or Automatic Fire Sprinkler System is not operational.

Operations such as welding, cutting, burning, heating, grinding or similar spark, slag, or intense heat producing activities, that are capable of igniting combustible materials or flammable atmospheres or providing a source of ignition for a fire. Also, defined as cutting and welding operations for construction/demolition activities that involve the use of portable gas or arc welding equipment open flame or spark-producing apparatus.

FIRE WATCH RESPONSIBILITIES

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

    - Combustible material, in building construction or contents, closer than 35 feet to the point of operation.

    - Combustibles are more than 35 feet away but are easily ignited by sparks.

    - Wall or floor openings within a 35-foot radius expose combustible material in adjacent areas including concealed spaces in walls or floors.

    - Combustible materials are adjacent to the opposite side of metal partitions, walls, ceilings, or roofs and are likely to be ignited by conduction or radiation.

2. Fire watch may only be performed by a trained individual, who is NOT performing any other duties that would take their attention away from the area where the hot work is performed.

3. Fire watchers must be aware of the inherent hazards involved in hot work.

4. Fire watchers must have a clear view of and immediate access to all areas included in the fire watch.

5. Fire watchers must remain in a location that allows immediate communication with the individual(s) performing hot work for instant communication if a fire breaks out.

6. Fire watchers must be able to stop work if necessary and restore safe conditions within the hot work area.

7. Fire watchers shall have fire extinguishing equipment readily available and be trained in its use.

8. They shall be familiar with facilities for sounding an alarm in the event of a fire.

9. They shall watch for fires in all exposed areas.

10. A fire watch shall watch for fires in all exposed areas for a minimum of thirty (30) minutes (including lunch and break times) after hot work is completed to detect and extinguish possible smoldering fires and/or sound the alarm if necessary.

11. Sign off on Hot Work Permit (if applicable) that the job is completed and fire watch has determined that there are no longer any fire hazards that will lead to a hazardous situation in the hot work area.

VENTILATION § 1926.353

1. Welding, cutting and heating may normally be done without mechanical ventilation or respiratory equipment, but where an unsafe accumulation of contaminants exists, suitable mechanical ventilation or respiratory protective equipment shall be provided.

2. Provide adequate ventilation as necessary to maintain welding fumes and smoke within safe limits as defined in Subpart D (OSHA 1926.55). Generally, if you are welding in an open space of more than 10,000 square feet, or if the ceiling height is more than 16 feet, natural ventilation is adequate for general

purpose welding. If in doubt, an environmental laboratory can run tests to determine the degree of hazard.

3. Mechanical ventilation, if required, should have sufficient capacity and be arranged to produce the number of air changes necessary to maintain safe limits. Local ventilation, if required, consists of freely movable hoods intended to be placed by the welder as close as possible to the work.

4. Provide suitable mechanical ventilation or respiratory protective equipment whenever unusual physical or atmospheric conditions create an unsafe accumulation of contaminants even if the process of welding, cutting, and heating, not involving the materials of toxic significance outlined below, does not normally require the use of such mechanical ventilation or personal protective systems.

5. Provide either general mechanical or local exhaust ventilation when welding, cutting or heating in any enclosed spaces the metals of toxic significance listed below.

    a. Zinc bearing base or filler metals or metals coated with zinc-bearing materials.

    b. Lead base metals.

    c. Cadmium bearing filler materials.

    d. Chromium bearing metals or metals coated with chromium bearing materials.

6. Provide either local exhaust ventilation in accordance with the requirements of 1926.353(a) or provide employees with air line respirators in accordance with the requirements of OSHA Subpart E when welding, cutting, or heating in any enclosed spaces the metals of toxic significance listed below.

    a. Metals containing lead, other than as an impurity, or metals coated with lead bearing materials.

    b. Cadmium bearing or cadmium coated base metals.

    c. Metal coated with mercury-bearing metals.

CONFINED SPACES

1. For this section, confined space means a relatively small or restricted space such as a tank, boiler pressure vessel, or small compartment of a ship.

2. Ventilation is always a prerequisite to work in confined spaces.

3. Securing cylinders and machinery - When welding or cutting is being performed in any confined spaces the gas cylinders and welding machines shall be left on the outside. Heavy portable equipment mounted on wheels shall be securely blocked to prevent accidental movement.

4. Lifelines - When welding in confined spaces, a rescue plan must be in place before entry. Where a welder must enter a confined space through a manhole or other small opening, a means shall always be provided to quickly remove the welder in case of emergency. When lifelines are used for this purpose they shall be attached to the D-ring of the welder's harness so as to not jam in the small exit opening. An attendant shall be available at all times to provide external rescue if necessary.

5. Electrode removal - When arc welding is suspended for any substantial period of time, such as during lunch or overnight, all electrodes shall be removed from the holders and the holders carefully located so that accidental contact cannot occur and the machine disconnected from the power source.

6. Gas cylinder shutoff - In order to eliminate the possibility of gas escaping through leaks of improperly closed valves, the torch valves shall be closed and the fuel-gas and oxygen supply to the torch positively shut off at some point outside the confined area whenever the torch is not to be used for a substantial period of time, such as during lunch or overnight. Where practical, the torch and hose shall also be removed from the space.

7. Warning signs for hot metal - After welding operations are completed, the welder shall mark the hot metal or provide some other means of warning other workers.

TRAINING REQUIREMENTS

1. Employees who perform welding, cutting and brazing work shall be trained in the safe use of their equipment.

2. Employees shall be instructed in the safe use of fuel gas.

3. Employees shall be instructed in the safe means of arc welding and cutting in accordance with 29 CFR 1926.351 (d) (1) – (5).

4. Fire watches shall be trained in accordance with 29 CFR 1910.252 (a) (2) (iii).

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