

WELDING, CUTTING & BRAZING PROGRAM

PURPOSE/SCOPE

Welding, cutting and brazing is also known as “HOT WORK”. This chapter presents the basic safety requirements found in 29 CFR 1926, Subpart J and 29 CFR 1910, Subpart Q, as well as capsule summaries of the major health and safety hazards associated with the welding process.

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. If welding cannot be conducted safely the welding and cutting shall not be performed. 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 severe 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 changes, whereas inhalation of iron oxide plus certain other substances may 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, dry 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 (O₂) 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 burns 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.

All of the most common types of welding (shielded metal-arc or stick welding, gas metal-arc welding, and oxyacetylene welding) produce potentially harmful ultraviolet, infrared, and visible spectrum radiation. Damage from ultraviolet light can occur very quickly. Normally absorbed in the cornea and lens of the eye, ultraviolet radiation (UVR) often causes arc eye or arc flash, a very painful but seldom permanent injury that is characterized by eye swelling, tearing, and pain.

While most welding-related eye injuries are reversible, with more than half of injured workers returning to work in less than two days and 95 percent in less than seven days, some eye injuries are irreversible and permanent visual impairment occurs. This is especially true with infrared and visible spectrum (bright light) radiation. Both can penetrate through to the retina and--although this is rare--can cause permanent retinal damage, including cataracts, diminished visual acuity, and higher sensitivity to light and glare.

Beyond the immediate impact from radiation, welding also exposes workers to cumulative adverse effects that appear over time. A study in Denmark of 217 welders showed yellow spots on the white part of the eye in 57 percent of the welders and degeneration of the thin membrane over the eyeball in 24 percent. Researchers also found corneal scarring in about half of the subjects. Yet, despite the insidious damage radiation can cause, molten and cold metal particles striking the eye are still the most common sources of eye injuries.

And welders are not the only workers at risk. While the welding arc is the principal source of UVR, other workers in the area can sustain eye damage from the radiation as far as 50 feet away from UVR reflecting off shiny surfaces, concrete, or unpainted metals. Install shielding curtains when possible and require that all workers in the area wear appropriate eye protection. At no time should the arc be observed without eye protection.

PHYSICAL HAZARDS

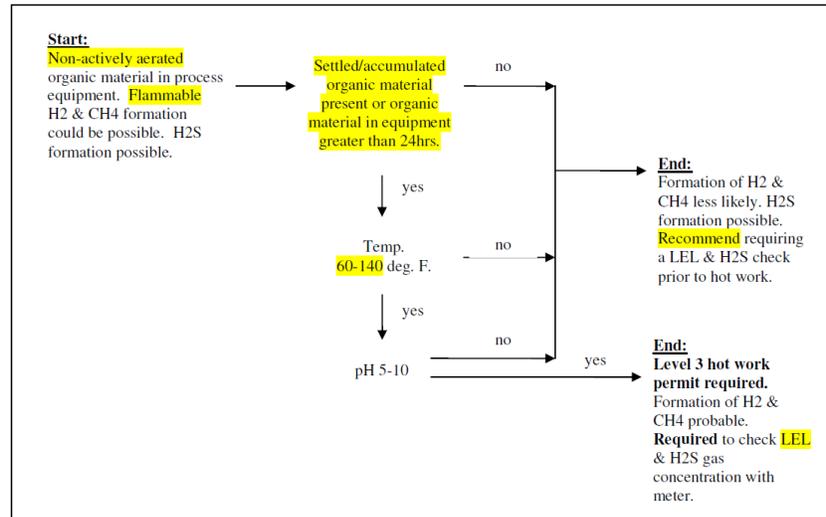
FACILITY DUST HAZARDS

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.



PROHIBITED AREAS. CUTTING OR WELDING SHALL NOT BE PERMITTED IN THE FOLLOWING SITUATIONS: [1910.252(A)(2)(VI)]

1. In areas not authorized by management.
2. In sprinklered buildings while such protection is impaired.
3. In the presence of explosive atmospheres (mixtures of flammable gases, vapors, liquids, or dusts with air), or explosive atmospheres that may develop inside uncleaned or improperly prepared tanks or equipment which have previously contained such materials, or that may develop in areas with an accumulation of combustible dusts.
4. In areas near the storage of large quantities of exposed, readily ignitable materials such as bulk sulfur, baled paper, or cotton.

AUTHORIZATION: Before cutting or welding is permitted, the area shall be inspected by the individual responsible for authorizing cutting and welding operations. He/she shall designate precautions to be followed in granting authorization to proceed preferably in the form of a written permit. [1910.252(a)(2)(iv)]

MANAGEMENT / SUPERVISOR ROLES

MANAGEMENT (OWNERS) [1910.252(A)(2)(XIII)]

1. Responsible for the safe usage of cutting and welding equipment on its property and:
2. Based on fire potential of plant facilities, establish areas for cutting and welding, and establish procedures for cutting and welding, in other areas.
3. Designate an individual responsible for authorizing cutting and welding operations in areas not specifically designed for such processes.
4. Insist that cutters or welders and their supervisors are suitably trained in the safe operation of their equipment and safe use of the process.
5. Advise all contractors about flammable materials or hazardous conditions of which they may not be aware.

SUPERVISORS [1910.252(A)(2)(XIV)]

1. Shall be responsible for the safe handling of the cutting or welding equipment and the safe use of the cutting or welding process
2. Shall determine the combustible materials and hazardous areas present or likely to be present in the work location.
3. Shall protect combustibles from ignition by the following:
 - A. Have the work moved to a location free from dangerous combustibles.
 - B. If the work cannot be moved, have the combustibles moved to a safe distance from the work or have the combustibles properly shielded against ignition.
 - C. See that cutting and welding are so scheduled that plant operations that might expose combustibles to ignition are not started during cutting or welding.
4. Shall secure authorization for the cutting or welding operations from the designated management representative.
5. Shall determine that the cutter or welding secures his approval that conditions are safe before going ahead.
6. Shall determine that fire protection and extinguishing equipment are properly located at the site.
7. Where fire watches are required, the supervisor shall see that they are available at the site.

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 and property damage, 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: [1910.252(a)(1)]

1. Fire hazards – if the object to be welded 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 welded 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.

GENERAL REQUIREMENTS

1. All hot work activities SHALL be performed by competent employees.
2. A Hot Work Permit is required under all Process Safety Management (PSM) regulated customers. Many of our other customers have their own Hot Work Permits that is required for contractors to work under.

Additional SOPs may be required. Always predetermine the required procedures and follow them before starting work. All customer permits must be returned at the end of the shift.

3. For those customers that do not provide a Hot Work Permit, Winger employees shall utilize the Winger Hot Work Permit. This permit must be filled out before hot work activities begin. When the hot work is finished the permit shall be completed and turned into the safety department for retention of one year.
4. **All equipment, hoses, leads shall be inspected daily before each use. Look for cuts, abrasions, stress factors on insulation, stingers and ground clamps.** Any equipment that does not pass inspection, shall be tagged and taken out of service immediately. Only qualified personnel are authorized to make repairs. Welding cables may only be repaired by using specifically designed heat-shrink material.
5. Good housekeeping standards must remain in place to provide a safe and hazard-free work area.
6. Welders SHALL position welding cable, gas hoses and other equipment overhead or so that is clear of passageways, ladders, and stairways to minimize possible damage and to eliminate potential tripping hazards to personnel. [1910.252(b)(1)(ii)]
7. All employees involved in hot work activities SHALL wear the correct personal protective eye / face and clothing protection at all times.
8. Keep your head out of the fumes. 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.
9. OSHA states 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 and follow them.
10. 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. 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 without taking proper precautions.
11. Spark containment shall be utilized during all welding, burning, cutting, and grinding operations. Spark containment may include erecting welding screens, laying fire blankets, placing barricades, using 100% spark containment, or by the use of one or more fire watchers. Employees working around or below the welding, burning or grinding operation within 50 feet shall be protected from light, falling debris, or flying sparks.
12. A suitable cylinder truck, **chain**, or other steadying device **shall be used** to keep cylinders from being knocked over while in use. 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. All cylinders MUST be chained or otherwise secured during storage and MUST have the valves closed and the valve protection caps in place. Empty cylinders must be marked and separated from full cylinders. Write EMPTY on the cylinder or use a "EMPTY" band around the neck.
13. Welding and cutting assemblies SHALL be equipped with flashback protective equipment.
14. Ground connections shall be made directly to the material being welded, and as close to the weld as possible. Keep welding leads protected from sparks and slag.
15. Place used rods in properly labeled "ROD" metal buckets. Do not dispose of hot slag or rods in containers holding combustible material.
16. Used containers. No welding, cutting, or other hot work shall be performed on used drums, barrels, tanks, hollow structures or other containers which have contained toxic or flammable substances until they have been cleaned so thoroughly as to make absolutely certain that there are no flammable materials present or any substances such as greases, tars, acids, or other materials which when subjected to heat, might produce flammable or toxic vapors. These shall either be filled with water or thoroughly cleaned of such substances, ventilated and tested. Any pipe lines or connections to the drum or vessel shall be disconnected or blanked. [[1910.252(a)(3)(i)] & [1926.352(i)]
17. Venting and purging. All hollow spaces, cavities or containers shall be vented to permit the escape of any built-up pressure or gases before preheating, cutting or welding. Purging with inert gas is recommended. [1910.252(a)(3)(ii)] [1926.352(j)]

18. One or more fire watchers 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.
19. Suitable Winger fire extinguishing equipment SHALL be immediately available in all areas where hot work activities are performed. When performing Hot Work, many customers require a 20-pound ABC fire extinguisher. DO NOT proceed with any hot work activities without a suitable fire extinguisher immediately accessible (within 10 feet).
20. Welding, cutting and heating in way of preservative coatings: [1926.354]
 - A. Before work commences on any surface with a preservative coating whose flammability is unknown, a test shall be made by a competent person to determine its flammability or toxicity.
 - B. Precautions shall be taken to prevent ignition of highly flammable hardened preservative coatings. When coatings are determined to be highly flammable, they shall be stripped from the area to be heated to prevent ignition.
 - C. In enclosed spaces, all surfaces covered with toxic preservatives shall be stripped of all toxic coatings for a distance of **at least 4 inches** from the area of heat application OR the employees shall be protected by airline respirators meeting requirements of subpart 1926.253(e).
 - D. In open air, employees shall be protected by respirators meeting requirements of subpart 1926.253(e).
 - E. The preservative coatings shall be removed a sufficient distance from the area to be heated to ensure that the temperature of the unstripped metal will not be appreciably raised. Artificial cooling of the metal surrounding the heating area may be used to limit the size of the area required to be cleaned.
21. X-ray inspection. The use of X-rays and radioactive isotopes for the inspection of welded piping joints shall be in conformance with the American National Standard Safety Standard for Non-Medical X-ray and Sealed Gamma-Ray Sources, ANSI Z54.1 — 1963. [1910.252(d)(2)(ii)]
22. Health & Welfare – Winger maintains Safety Data Sheets (SDS) on all potentially hazardous welding materials such as fluxes, coatings, coverings, rods, filler metals and metals which are used in welding and cutting or are released to the atmosphere during these activities. Each employee has access to Winger SDS on www.sdsbinderworks.com username: *winger office*; password: *winger*. [1910.252(c)(1)(iv)]
23. Additional considerations for hazard communication in welding, cutting and brazing – Suppliers shall determine and shall label in accordance with §1910.1200. Where brazing (welding) filler metals contain cadmium in significant amounts, the labels shall indicate the hazards associated with cadmium including cancer, lung and kidney affects, and acute toxicity effects. Where brazing and gas welding fluxes contain fluorine compounds, the labels shall indicate the hazards associated with fluorine compounds including eye and respiratory tract effects. Additional labeling according to [1910.252(c)(1)(v) – (vi) may be required. “Caution Contains Fluorides”; “Warning Contains Cadmium – Poisonous Fumes May Be Formed on Heating”, etc.

SHIELDING / SCREENS

1. Whenever practicable, all 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 the direct rays of the arc. [1926.351(e)]
2. Protection from arc welding rays. Where the work permits, the welder should be enclosed in an individual booth painted with a finish of low reflectivity such as zinc oxide (an important factor for absorbing ultraviolet radiations) and lamp black, or shall be enclosed with noncombustible screens similarly painted. Booths and screens shall permit circulation of air at floor level. Workers or other persons adjacent to the welding areas shall be protected from the rays by noncombustible or flameproof screens or shields or shall be required to wear appropriate goggles. [1910.252(b)(2)(iii)]
3. When welding must be performed in a space entirely screened on all sides, the screens shall be so arranged that no serious restriction of ventilation exists. It is desirable to have the screens so mounted that they are about 2 feet above the floor unless the work is performed at a so low a level that the screen

must be extended nearer to the floor to protect nearby workers from the glare of welding.
[1910.252(c)(1)(ii)]

PORTABLE WELDERS

1. Welding machines must be inspected before each use.
2. Lug connections must be covered with insulated rubber boot.
3. To prevent electrical shock, GFCIs must be tested to ensure outlet is working correctly. GFCI outlets must be replaced immediately if they do not pass inspection.
4. Typically, a portable welding machine produces its own power and is not necessary to ground to earth if it is NOT connected to premises wiring such as a shop for auxiliary power. If a welding machine must be grounded, it shall be of a nut and bolt type connection to the ground lug on the machine to ensure the connection is complete and secure. Do not use a spring clamp device. Ground rods need to be inserted into the ground a minimum of 10 feet.
5. When refilling fuel gas powered machines, the engine must be turned off and fuel nozzle must touch fuel opening to prevent spark from static electricity. Leave room in the neck of the tank for expansion. DO NOT top off the tank.

INDUSTRIAL APPLICATIONS. [1910.252(D)]

1. Field shop operations. Where field shop operations are involved for fabrication of fittings, river crossings, road crossings, and pumping and compressor stations the requirements of paragraphs (a), (b), and (c) of this section and §§1910.253 and 1910.254 of this part shall be observed. [1910.252(d)(1)(ii)]
2. Electric shock. When arc welding is performed in wet conditions, or under conditions of high humidity, special protection against electric shock shall be supplied. [1910.252(d)(1)(iii)]
3. Pressure testing. In pressure testing of pipelines, the workers and the public shall be protected against injury by the blowing out of closures or other pressure restraining devices. Also, protection shall be provided against expulsion of loose dirt that may have become trapped in the pipe. [1910.252(d)(1)(iv)]
4. Construction standards. The welded construction of transmission pipelines shall be conducted in accordance with the Standard for Welding Pipe Lines and Related Facilities, API Std. 1104 — 1968, which is incorporated by reference as specified in §1910.6. [1910.252(d)(1)(v)]
5. Flammable substance lines. The connection, by welding, of branches to pipelines carrying flammable substances shall be performed in accordance with Welding or Hot Tapping on Equipment Containing Flammables, API Std. PSD No. 2201 — 1963, which is incorporated by reference as specified in §1910.6. [1910.252(d)(1)(vi)]
6. X-ray inspection. The use of X-rays and radioactive isotopes for the inspection of welded pipeline joints shall be carried out in conformance with the American National Standard Safety Standard for Non-Medical X-ray and Sealed Gamma-Ray Sources, ANSI Z54.1 — 1963, which is incorporated by reference as specified in §1910.6. [1910.252(d)(2)(ii)]

FIRE PREVENTION §1910.252 & §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 to practice good fire prevention.

Fire prevention precautions. Cutting or welding shall be permitted only in areas that are or have been made fire safe. When work cannot be moved practically, as in most construction work, the area shall be made safe by removing combustibles or protecting combustibles from ignition sources. [1910.252(a)(2)(xv)]

4. When practical, objects to be welded, cut, or heated shall be moved to a designated safe location or, if the objects to be welded, cut, or heated cannot be readily moved, all movable fire hazards in the vicinity shall be taken to a safe place, or otherwise protected. [1926.352(a)]
5. If the object to be welded, cut, or heated cannot be moved and if all the 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. [1926.352(b)]
6. No welding, cutting, or heating shall be done where the application of flammable paints, or the presence of other flammable compounds, or heavy dust concentrations creates a hazard. [1926.352(c)]
7. Suitable fire extinguishing equipment shall be immediately available in the work area and shall be maintained in a state of readiness for instant use. [1926.352(d)]
8. When the welding, cutting, or heating operation is such that normal fire prevention precautions are not sufficient, additional personnel shall be assigned to guard against fire while the actual welding, cutting, or heating operation is being performed, and for a sufficient period of time after completion of the work to ensure that no possibility of fire exists. Such personnel shall be instructed as to the specific anticipated fire hazards and how the firefighting equipment provided is to be used. [1926.352(e)]
9. When welding, cutting, or heating is performed on walls, floors, and ceilings, since direct penetration of sparks or heat transfer may introduce a fire hazard to an adjacent area, the same precautions shall be taken on the opposite side as are taken on the side on which the welding is being performed. [1926.352(f)]
10. Except when the contents are being removed or transferred, drums, pails, and other containers which contain or have contained flammable liquids shall be kept closed. Empty containers shall be removed to a safe area apart from hot work operations or open flames. [1926.352(h)]
11. Where combustible materials such as paper clippings, wood shavings, or textile fibers are on the floor, the floor **shall be swept clean for a radius of 35 feet** (10.7 m). Combustible floors shall be kept wet, covered with damp sand, or protected by fire-resistant shields. Where floors have been wet down, personnel operating arc welding or cutting equipment shall be protected from possible shock. [1910.252(a)(2)(v)]
12. 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. [1910.252(a)(2)(vii)]
13. Ducts and conveyor systems that might carry sparks to distant combustibles shall be suitably protected or shut down. [1910.252(a)(2)(viii)]
14. 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.
15. Where cutting or welding is done near walls, partitions, ceiling or roof of combustible construction, fire-resistant shields or guards shall be provided to prevent ignition. [1910.252(a)(2)(ix)]
16. If welding is to be done on a metal wall, partition, ceiling or roof, precautions shall be taken to prevent ignition of combustibles on the other side, due to conduction or radiation, preferably by relocating combustibles. Where combustibles are not relocated, a fire watch on the opposite side from the work shall be provided. [1910.252(a)(2)(x)]
17. Welding shall not be attempted on a metal partition, wall, ceiling or roof having a combustible covering nor on walls or partitions of combustible sandwich-type panel construction. [1910.252(a)(2)(xi)]
18. Cutting or welding on pipes or other metal in contact with combustible walls, partitions, ceilings or roofs shall not be undertaken if the work is close enough to cause ignition by conduction. [1910.252(a)(2)(xii)]

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.

Suitable fire extinguishing equipment shall be maintained in a state of readiness for instant use. Such equipment may consist of pails of water, buckets of sand, hose or portable extinguishers depending upon the nature and quantity of the combustible material exposed.

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 watchers must be aware of the inherent hazards involved in hot work.
3. Fire watchers must have a clear view of and immediate access to all areas included in the fire watch.
4. Fire watchers must be able to stop work if necessary and restore safe conditions within the hot work area.
5. Fire watchers shall have fire extinguishing equipment readily available and be trained in its use.
6. They shall be familiar with facilities for sounding an alarm in the event of a fire.
7. They shall watch for fires in all exposed areas and try to extinguish them only when obviously within the capacity of the equipment available, or otherwise sound the alarm.
8. 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.
9. Fire watchers may NOT perform any other duties that would take their attention away from the area where the hot work is performed.
10. Fire watchers 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. Assign additional personnel (Fire Watch) as needed 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.
12. Fire watchers must 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 & §1910.252

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.

1. Welding, cutting and heating not involving confined spaces, metals of toxic significance, or inert-gas metal-arc welding, 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. [1926.353(e)]
2. Provide adequate ventilation as necessary to maintain welding fumes and smoke within safe limits as defined in OSHA Subpart D §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, or in confined space, or where the welding space contains partitions, balconies, or other structural barriers to the extent that they significantly obstruct cross ventilation, natural ventilation is adequate for general purpose welding. If in doubt, an environmental laboratory can run tests to determine the degree of hazard. [1910.252(c)(2)(i)]

3. Minimum rate. Such ventilation shall be at the minimum rate of 2,000 cubic feet (57 m³) per minute per welder, except where local exhaust hoods and booths as per paragraph (c)(3) of this section, or airline respirators. Natural ventilation is considered sufficient for welding or cutting operations where the restrictions in paragraph (c)(2)(i) of this section are not present. [1910.252(c)(2)(ii)]
4. Mechanical ventilation, shall consist of either general mechanical ventilation systems or local exhaust systems. [1926.353(a)(1)]
5. General mechanical ventilation shall be of sufficient capacity and so arranged as to produce the number of air changes necessary to maintain welding fumes and smoke within safe limits, as defined in subpart D of this part. [1926.353(a)(2)]
6. Local exhaust ventilation shall consist of freely movable hoods intended to be placed by the welder or burner as close as practicable to the work. This system shall be of sufficient capacity and so arranged as to remove fumes and smoke at the source and keep the concentration of them in the breathing zone within safe limits as defined in subpart D of this part. [1926.353(a)(3)]
7. Contaminated air exhausted from a working space shall be discharged into the open air or otherwise clear of the source on intake. [1926.353(a)(4)]
8. All air replacing that withdrawn shall be clean and respirable. [1926.353(a)(5)]
9. Oxygen shall not be used for ventilation purposes, comfort cooling, blowing dust from clothing, or for cleaning the work area. [1926.353(a)(6)]

WELDING, CUTTING, OR HEATING OF METALS OF TOXIC SIGNIFICANCE. [1926.353(c)]

1. Welding, cutting, or heating in any enclosed spaces involving the metals specified in this subparagraph **shall be performed with either general mechanical or local exhaust ventilation** meeting the requirements [1926.353(c)(1)]
 - 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 such as stainless steel.
 - E. Fluorine compounds as one that contains fluorine, as an element in chemical combination, not as a free gas. [1910.252(c)(5)]
2. Welding, cutting, or heating in any enclosed spaces involving the metals specified in this subparagraph **shall be performed with local exhaust ventilation** in accordance with the requirements of paragraph (a) of this section, **or** employees shall be protected by airline respirators: [1926.353(c)(2)]
 - 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.
 - D. Beryllium containing base or filler metals.
 - E. Mercury bearing materials, including paint. [1910.252(c)(10)]
3. Degreasing and other cleaning operations involving chlorinated hydrocarbons shall be so located that no vapors from these operations will reach or be drawn into the atmosphere surrounding any welding operation. In addition, trichloroethylene and perchlorethylene should be kept out of atmospheres penetrated by the ultraviolet radiation of gas-shielded welding operations.

CONFINED SPACES 1910.252 & 1926.353

For this section, confined space is intended to mean a relatively small or restricted space such as a tank, boiler, pressure vessel, or small compartment of a ship. [1910.252(b)(4)(i)]

1. Ventilation is always a prerequisite to work in confined spaces. Either general mechanical or local exhaust ventilation shall be provided whenever welding, cutting, or heating is performed in a confined space. [1910.252(b)(4)(ii)] & [1926.353(b)(2)]
2. When sufficient ventilation cannot be obtained without blocking the means of access, employees in the confined space shall be protected by airline respirators in accordance with Subpart E and an employee on the outside of such a confined space shall be assigned to maintain communication with those working within it and to aid them in an emergency. [1926.353(b)(2)]
3. 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 that his body cannot be jammed in the small exit opening. An attendant with a pre-planned rescue procedure shall be stationed outside to observe the welder at all times and be capable of putting rescue operations into effect. [1910.252(b)(4)(iv)] & [1926.353(b)(3)]
4. 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. [1910.252(b)(4)(iii)]
5. Accidental Contact / 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. [1910.252(a)(4)(i)]
6. Torch Valve / Gas cylinder shutoff - In order to eliminate the possibility of fire and gas escaping through leaking or 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 left unattended or not to be used for a substantial period of time, such as during lunch, change of shift, or overnight. Open end fuel gas and oxygen hoses shall be immediately removed from enclosed spaces when they are disconnected from the torch or other gas-consuming device. [1910.252(a)(4)(ii)]
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. [1910.252(b)(4)(vii)]

ARC WELDING AND CUTTING § 1926.351

MANUAL ELECTRODE HOLDERS. [1926.351(a)]

1. Only manual electrode holders which are specifically designed for arc welding and cutting, and are of a capacity capable of safely handling the maximum rated current required by the electrodes, shall be used.
2. Any current-carrying parts passing through the portion of the holder which the arc welder or cutter grips in his hand, and the outer surfaces of the jaws of the holder, shall be fully insulated against the maximum voltage encountered to ground.

WELDING CABLES AND CONNECTORS. [1926.351(b)]

1. All 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, taking into account the duty cycle under which the arc welder or cutter is working.
2. Only cable free from repair or splices for a minimum distance of 10 feet from the cable end to which the electrode holder is connected shall be used, except that cables with standard insulated connectors or with splices whose insulating quality is equal to that of the cable are permitted.
3. When it becomes necessary to connect or splice lengths of cable one to another, substantial insulated connectors of a capacity at least equivalent to that of the cable shall be used. If connections are affected by means of cable lugs, they shall be securely fastened together to give good electrical contact, and the exposed metal parts of the lugs shall be completely insulated.

4. Cables in need of repair shall not be used. When a cable, other than the cable lead referred to in paragraph (b)(2) of this section, becomes worn to the extent of exposing bare conductors, the portion thus exposed shall be protected by means of rubber and friction tape or other equivalent insulation.

GROUND RETURNS AND MACHINE GROUNDING. [1926.351(c)]

1. A ground return cable 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 capacity shall equal or exceed the total specified maximum output capacities of all the units which it services.
2. Pipelines containing gases or flammable liquids, or conduits containing electrical circuits, shall not be used as a ground return.
3. When a structure or pipeline is employed as a ground return circuit, it shall be determined that the required electrical contact exists at all joints. The generation of an arc, sparks, or heat at any point shall cause rejection of the structures as a ground circuit.
4. When a structure or pipeline is continuously employed as a ground return circuit, all joints shall be bonded, and periodic inspections shall be conducted to ensure that no condition of electrolysis or fire hazard exists by virtue of such use.
5. The frames of all arc welding and cutting machines shall be grounded 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. Grounding circuits, other than by means of the structure, shall be checked to ensure that the circuit between the ground and the grounded power conductor has resistance low enough to permit sufficient current to flow to cause the fuse or circuit breaker to interrupt the current.
6. All ground connections shall be inspected to ensure that they are mechanically strong and electrically adequate for the required current.

OPERATING INSTRUCTIONS. EMPLOYERS SHALL INSTRUCT EMPLOYEES IN THE SAFE MEANS OF ARC WELDING AND CUTTING AS FOLLOWS: [1926.351(d)]

1. When electrode holders are to be left unattended, the electrodes shall be removed and the holders shall be so placed or protected that they cannot make electrical contact with employees or conducting objects.
2. Hot electrode holders shall not be dipped in water; to do so may expose the arc welder or cutter to electric shock.
3. 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, the power supply switch to the equipment shall be opened or shut-off.
4. Any faulty or defective equipment shall be reported to the supervisor.

INERT-GAS METAL-ARC WELDING § 1926.353(d)

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, the decomposition of chlorinated solvents by ultraviolet rays, and the liberation of toxic fumes and gases, employees shall not be permitted to engage in, or be exposed to the process until the following special precautions have been taken:

1. The use of chlorinated solvents shall be kept at least 200 feet, unless shielded, from the exposed arc, and surfaces prepared with chlorinated solvents shall be thoroughly dry before welding is permitted on such surfaces.
2. Filter lenses must meet requirements for 1926 Subpart E (see Shade Guide Table under PPE Section).
3. When two or more welders are exposed to each other's arc, filter lens goggles of a suitable type shall be worn under welding helmets. Hand shields to protect the welder against flashes and radiant energy shall be used when either the helmet is lifted or the shield is removed.
4. Welders and other employees who are exposed to radiation shall be suitably protected so that the skin is covered completely to prevent burns and other damage by ultraviolet rays. Welding helmets and hand

shields shall be free of leaks and openings, and free of highly reflective surfaces.

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.

OXYGEN-FUEL GAS WELDING & CUTTING §1910.253 & 1926.350

TRANSPORTING, MOVING, AND STORING COMPRESSED GAS CYLINDERS. [1926.350(a)]

1. Valve protection caps shall be in place and secured. [1926.350(a)(1)]
2. When cylinders are hoisted, they shall be secured on a cradle, sling board, or pallet. They shall not be hoisted or transported by means of magnets or choker slings. [1926.350(a)(2)]
3. Cylinders shall be moved by tilting and rolling them on their bottom edges. They shall not be intentionally dropped, struck, or permitted to strike each other violently. [1926.350(a)(3)]
4. When cylinders are transported by powered vehicles, they shall be secured in a vertical position. [1926.350(a)(4)]
5. Valve protection caps shall not be used for lifting cylinders from one vertical position to another. Bars shall not be used under valves or valve protection caps to pry cylinders loose when frozen. Warm, not boiling, water shall be used to thaw cylinders loose. [1926.350(a)(5)]
6. Unless cylinders are firmly secured on a special carrier intended for this purpose, regulators shall be removed and valve protection caps put in place before cylinders are moved. [1926.350(a)(6)]
7. A suitable cylinder truck, **chain**, or other steadying device shall be used to keep cylinders from being knocked over while in use. [1926.350(a)(7)]
8. When work is finished, when cylinders are empty, or when cylinders are moved at any time, the cylinder valve shall be closed. [1926.350(a)(8)]
9. All gas cylinders must be appropriately marked to identify the gas content.
10. All cylinders must be chained or otherwise secured during storage and must have the valves closed and the valve protection caps in place.

OXYGEN STORAGE

1. **Oxygen cylinders shall not be stored near** highly combustible material, especially oil and grease; or near reserve stocks of carbide **and acetylene or other fuel-gas cylinders**, or near any other substance likely to cause or accelerate fire; or in an acetylene generator compartment. [1910.253(b)(4)(i)]
2. Oxygen cylinders stored in outside generator houses shall be separated from the generator or carbide storage rooms by a noncombustible partition having a fire-resistance rating of at least 1 hour. This partition shall be without openings and shall be gastight. [1910.253(b)(4)(ii)]
3. Oxygen cylinders in storage shall be separated from fuel-gas cylinders or combustible materials (especially oil or grease), a minimum distance of 20 feet (6.1 m) or by a noncombustible barrier at least 5 feet (1.5 m) high having a fire-resistance rating of at least one-half hour. [1910.253(b)(4)(iii)] & [1926.350(a)(10)]
4. Inside of buildings, cylinders shall be stored in a well-protected, well-ventilated, dry location, at least 20 feet from highly combustible materials such as oil or excelsior. Cylinders should be stored in definitely assigned places away from elevators, stairs, or gangways. Assigned storage places shall be located where cylinders will not be knocked over or damage by passing or falling objects, or subject to tampering by unauthorized person. Cylinders shall not be stored in unventilated enclosures such as lockers or cabinets. [1926.350(a)(11)]

PLACING CYLINDERS. [1926.350(b)]

5. 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. [1926.350(b)(1)]
6. 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. [1926.350(b)(2)]

7. 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 be subject to open flame, hot metal, or other sources of artificial heat. [1926.350(b)(3)]
8. Cylinders containing oxygen or acetylene or other fuel gas shall not be taken into confined spaces. [1926.350(b)(4)]

TREATMENT OF CYLINDERS. [1926.350(c)]

1. Cylinders, whether full or empty, shall not be used as rollers or supports. [1926.350(c)(1)]
2. No person other than the gas supplier shall attempt to mix gases in a cylinder. No one except the owner of the cylinder or person authorized by him, shall refill a cylinder. No one shall use a cylinder's contents for purposes other than those intended by the supplier. [1926.350(c)(2)]
3. No damaged or defective cylinder shall be used. [1926.350(c)(3)]

USE OF FUEL GAS. THE EMPLOYER SHALL THOROUGHLY INSTRUCT EMPLOYEES IN THE SAFE USE OF FUEL GAS, AS FOLLOWS: [1926.350(d)]

1. 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. [1926.350(d)(1)]
2. The cylinder valve shall always be opened slowly to prevent damage to the regulator. For quick closing, valves on fuel gas cylinders shall not be opened more than 1½ turns. 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. [1926.350(d)(2)]
3. Fuel gas shall not be used from cylinders through torches or other devices which are equipped with shutoff valves without reducing the pressure through a suitable regulator attached to the cylinder valve or manifold. [1926.350(d)(3)]
4. Before a regulator is removed from a cylinder valve, the cylinder valve shall always be closed and the gas released from the regulator. [1926.350(d)(4)]
5. 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. 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. 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. [1926.350(d)(5)]
6. If a leak should develop at a fuse plug or other safety device, the cylinder shall be removed from the work area. [1926.350(d)(6)]

FUEL GAS AND OXYGEN MANIFOLDS. [1926.350(e)]

1. Fuel gas and oxygen manifolds shall bear the name of the substance they contain in letters at least 1- inch high which shall be either painted on the manifold or on a sign permanently attached to it. [1926.350(e)(1)]
2. Fuel gas and oxygen manifolds shall be placed in safe, well ventilated, and accessible locations. They shall not be located within enclosed spaces. [1926.350(e)(2)]
3. Manifold hose connections, including both ends of the supply hose that lead to the manifold, shall be such that the hose cannot be interchanged between fuel gas and oxygen manifolds and supply header connections. Adapters shall not be used to permit the interchange of hose. Hose connections shall be kept free of grease and oil. [1926.350(e)(3)]

4. When not in use, manifold and header hose connections shall be capped. [1926.350(e)(4)]
5. Nothing shall be placed on top of a manifold, when in use, which will damage the manifold or interfere with the quick closing of the valves. [1926.350(e)(5)]

HOSE. [1926.350(f)]

1. Fuel gas hose and oxygen hose shall be easily distinguishable from each other. The contrast may be made by different colors or by surface characteristics readily distinguishable by the sense of touch. Oxygen and fuel gas hoses shall not be interchangeable. A single hose having more than one gas passage shall not be used. [1926.350(f)(1)]
2. When parallel sections of oxygen and fuel gas hose are taped together, not more than 4 inches out of 12 inches shall be covered by tape. [1926.350(f)(2)]
3. All hose in use, carrying acetylene, oxygen, natural or manufactured fuel gas, or any gas or substance which may ignite or enter into combustion, or be in any way harmful to employees, shall be inspected at the beginning of each working shift. Defective hose shall be removed from service. [1926.350(f)(3)]
4. Hose which has been subject to flashback, or which shows evidence of severe wear or damage, shall be tested to twice the normal pressure to which it is subject, but in no case less than 300 p.s.i. Defective hose, or hose in doubtful condition, shall not be used. [1926.350(f)(4)]
5. Hose couplings shall be of the type that cannot be unlocked or disconnected by means of a straight pull without rotary motion. [1926.350(f)(5)]
6. Boxes used for the storage of gas hose shall be ventilated. [1926.350(f)(6)]
7. Hoses, cables, and other equipment shall be kept clear of passageways, ladders and stairs. [1926.350(f)(7)]
8. Directional gas flow fittings (back-flow valves) shall be provided on hoses to prevent reverse gas flow or back flow.

TORCHES. [1926.350(g)]

1. 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 for leaking shutoff valves, hose couplings, and tip connections.
2. Defective hoses and torches shall be tagged "Do Not Use" and immediately removed from service.
3. Clogged torch tip openings shall be cleaned with suitable cleaning wires, drills, or other devices designed for such purpose. [1926.350(g)(1)]
4. Torches shall be turned off and removed from confined spaces when not in use.
5. Torches shall be lighted by friction lighters or other approved devices, and not by stationary pilot lights, matches, cigarette lighters or from hot work. [1926.350(g)(3)]

REGULATORS AND GAUGES. Oxygen and fuel gas pressure regulators, including their related gauges, shall be in proper working order while in use. [1926.350(h)]

OIL AND GREASE HAZARDS. Oxygen cylinders and fittings shall be kept away from oil or grease. 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. Oxygen shall not be directed at oily surfaces, greasy clothes, or within a fuel oil or other storage tank or vessel. [1926.350(i)]

PERSONAL PROTECTIVE EQUIPMENT

Burns are the most common injury to welders due to sparks landing on the skin. Welding arcs are very intense and can cause burns to the skin and eyes with just a few minutes of exposure. Protective clothing needed for welding includes general fire-resistant clothing, safety glasses, work boots, gloves, helmets and leathers.

Protective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in a sanitary and reliable condition whenever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact.

Helmets and protective clothing shield welders from "sunburn" and "welder's flash," but with the majority of their work performed with the helmet up, welders also need to wear goggles or safety glasses with side shields. These shields will be provided to protect employees' eyes and face from particles sent flying during pre-job grinding, hammering, and power chipping, 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.

1. Helmets or hand shields shall be used during all arc welding or arc cutting operations. Helpers or attendants shall be provided with proper eye protection. [1910.252(b)(2)(i)[A]]
2. Goggles or other suitable eye protection shall be used during all gas welding or oxygen cutting operations. Spectacles without side shields, with suitable filter lenses are permitted for use during gas welding operations on light work, for torch brazing or for inspection. [1910.252(b)(2)(i)[B]]
3. All operators and attendants of resistance welding or resistance brazing equipment shall use transparent face shields or goggles, depending on the particular job, to protect their faces or eyes, as required. [1910.252(b)(2)(i)[C]]
4. Eye protection in the form of suitable goggles shall be provided where needed for brazing operations not covered in paragraphs (b)(2)(i)(A) through (b)(2)(i)(C) of this section. [1910.252(b)(2)(i)[D]]
5. Helmets and hand shields shall be arranged to protect the face, neck and ears from direct radiant energy from the arc. [1910.252(b)(2)(ii)[B]]
6. Goggles shall be ventilated to prevent fogging of the lenses as much as practicable. [1910.252(b)(2)(ii)[E]]
7. The employer shall ensure that each affected employee wears a protective helmet when working in areas where there is a potential for injury to the head from falling objects. [1910.135(a)(1)]
8. The employer shall ensure that a protective helmet designed to reduce electrical shock hazard is worn by each such affected employee when near exposed electrical conductors which could contact the head. [1910.135(a)(2)]
9. For Inert Gas Metal Arc (Tungsten) Welding: Welders and other employees who are exposed to radiation shall be suitably protected so that the skin is covered completely to prevent burns and other damage by ultraviolet rays. Welding helmets and hand shields shall be free of leaks and openings, and free of highly reflective surfaces. [1926.353(d)]

EYE PROTECTION

1. Safety glasses/goggles are your primary protection for your eyes. ANSI Z87.1 approved safety glasses with side shields, or goggles, shall be worn to protect your eyes from flying metal, slag chips, grinding fragments, wire wheel bristles, and similar hazards, which can ricochet under the welding helmet.
2. Filter lenses and cover plates must be ANSI 87.1 compliant.
3. Oxy-fuel goggles do not protect your eyes from the intense ultraviolet radiation (UV) produced by the welding arc.

USE THE SHADE GUIDE TABLE FOR THE SELECTION OF THE PROPER SHADE NUMBERS. THESE RECOMMENDATIONS MAY BE VARIED TO SUIT THE INDIVIDUAL'S NEEDS. [1910.252(b)(2)(ii)[H]]

Welding Process		Arc Current (Amperes)																						
		0.5	1	2.5	5	10	15	20	30	40	60	80	100	125	150	175	200	225	250	275	300	350	400	450
SMAW									9	10			11			12					13			14
MIG (heavy)												10	11			12						13		14
MIG (light)												10	11			12					13		14	15
TIG, GTAW						9	10			11			12			13						14		
MAG/CO2										10	11			12			13					14		15
SAW													10	11	12		13				14		15	
PAC													11			12						13		
PAW						8	9	10	11					12			13					14		15

NOTE:

SMAW – Shielded Metal Arc Welding

TIG, GTAW – Gas Tungsten Arc Welding

PAC – Plasma Arc Cutting

SAW – Shielded Semi-Automatic Arc Welding

MIG (heavy) – MIG on Heavy Metals

PAW – Plasma Arc Cutting

MAG/CO2 – Metal Active Gas

MIG (light) – MIG on Light Alloys

FOOT PROTECTION

Leather boots with safety toes (composite or steel toe), slip resistant and puncture resistant soles, six- to eight-inch ankle coverage are the best foot protection. EH rated boots help protect from electrical hazards. Metatarsal guards over the shoe laces can protect from falling objects and sparks.

HANDS / WRISTS / GLOVES

ANSI Z49.1 requires all welder to wear protective flame-resistant gloves. **Heavy, leather flame resistant welding gloves in good condition shall be provided with 6-inch cuffs** to protect the hands and wrists from electric shock, UV radiation, burns, sparks, cuts, scratches, and radiation of heat. As long as they are dry and in good condition, they will offer some insulation against electric shock.

HEAD / FACE PROTECTION

1. Wear hard hats where there is a potential for objects falling from above, bumps to the head from fixed objects, or of accidental head contact with electrical hazards. **Winger has chosen ANSI Z49.1, Type 1, Class E hardhats. Bump caps are not ANSI Z49.1 rated and do not provide protection in industrial settings from falling objects.**
2. Hard hats – routinely inspect them for dents, cracks or deterioration; replace after a heavy blow or electrical shock; maintain in good condition.
3. A welding helmet with the proper shaded lens must be used whenever welding. Helmets shall be ANSI Z49.1 compliant.
4. Fire resistant welder's cap or head covering under your welding helmet will protect your hair/head/neck from flying sparks spatter, burns and radiation.
5. Faceshields must be worn for all grinding, chipping, or other tasks that cause flying debris.
6. **Protect the back of your head by using a hood or extra leather protector while welding around reflective surfaces.**

HEARING PROTECTION

1. Earplugs and earmuffs keep spatter, metal sparks and airborne particles from entering your ear canal and protect your hearing from the effects of excessive noise.
2. Hearing protection must be worn during all grinding operations or work tasks with a sound level greater than 85 decibels (dBA). Levels of noise over 85 dBA, averaged over an eight-hour workday, are potentially hazardous to your hearing. When noise levels are painful or are loud enough to interfere with your ability to hear others speaking at a normal conversational volume this is an indication that levels are potentially hazardous.

RESPIRATORS

If half mask or full-face respirators, PAPRs, or air supplied inline respirators are worn, Winger Respiratory Protection Program must be followed.

BODY PROTECTION / CLOTHING

Protective clothing — General requirements. Employees exposed to the hazards created by welding, cutting, or brazing operations shall be protected by personal protective equipment in accordance with the requirements of §1910.132. Appropriate protective clothing required for any welding operation will vary with the size, nature and location of the work to be performed. [1910.252(b)(3)]

1. Watch your body positioning to prevent sparks, spatter, metal slag, causing burns and serious injury.
2. Wear clothing made from heavyweight, tightly woven, 100% wool or cotton, to protect from hot metal, sparks and open flames and UV radiation from reaching your skin. Welding jackets and sleeves are provided to reduce the amount burns and UV exposure.
3. Make sure that all fabric garments are resistant to spark, heat and flame. Keep the fabrics clean and free of combustible materials that could be ignited by a spark. Some locations require NFPA 2012 FR Clothing.
4. Do not wear clothing made from synthetic or synthetic blends for hot work. The synthetic fabric can burn vigorously, melt and adhere to your skin producing bad skin burns if they get over heated or catch on fire.

5. Wear layers of clothing all through the year. To prevent sweating, avoid overdressing in cold weather. Sweaty clothes cause rapid heat loss and hypothermia.
6. Wear long pants and long-sleeved shirts with buttoned cuffs and a collar to protect your neck. Dark colors prevent light reflection. Button up your shirt to protect the skin on the throat and neck.
7. Avoid rolling up your sleeves, gloves, or pant cuffs, because sparks or hot metal could deposit in the folds. Rolling up your sleeves or rolling down your gloves also reduces the protection factor by 15% or more, which increases your exposure to UV rays. Always, wear your pants outside your work boots, not tucked in to keep particles from falling into your boots.
8. Tape or button shirt pockets closed to avoid collecting sparks or hot metal or keep them covered with flaps.
9. Remove all ignition sources such as matches and butane lighters from pockets. Hot welding sparks may light the matches or ignite leaking lighter fuel.
10. Keep clothing clean and free of oils, greases and combustible contaminants which can degrade the fabric and make it catch on fire easily.
11. Repair all frayed edges, tears or holes in clothing. Frayed edges can also catch on fire easily.
12. Wear gauntlet-type cuff leather gloves or protective sleeves of similar material, to protect wrists and forearms.
13. Use a shield can help keep any sparks spray away from your clothing. If necessary, wear leather aprons to protect your chest and lap from sparks when standing or sitting.
14. Wear high top boots fully laced to prevent sparks from entering into the boots.
15. Do not wear rings or other jewelry.

LAUNDERING FLAME RESISTANT GARMENTS AT HOME:

1. Wash separately in a Normal or Cotton cycle at any water temperature **up to a maximum of 140°F (60°C)**. Use any typical home laundry detergent. Do not use soap (tallow soap containing animal fats).
2. **Turn garments inside out before wash to reduce streaking from abrasion. Fill the washer no more than 2/3 full and use high water level.**
3. **DO NOT use chlorine bleach or liquid nonchlorine bleach.**
4. **Do not use starch or fabric softeners as they may coat fibers and mask FR performance and/or serve as fuel in the event of garment ignition.**
5. The use of conditioned or soft water can help improve removal of contaminants from garments. Hard water precipitates soaps and can result in the build-up of calcium and magnesium salts. These can serve as fuel in the event they are exposed to a source of ignition.
6. It is important that all soils and other contaminants are completely removed from garments during the wash process. This may require the use of stain removal products, such as Shout®, Spray 'n Wash®, or Zout®; or presoaking garments prior to washing. The use of hot water can often make detergents more effective in the removal of soils. If all contaminants cannot be removed in home care, garments should be dry cleaned.
7. Do not over dry garments. If desired, you may press with an iron on the Permanent Press/Low setting.
8. Always consult the garment manufacturer for detailed instructions and precautions.

STAIN REMOVAL ON FR GARMENTS

1. If garments become contaminated with flammable substances, they should be removed immediately and replaced with clean flame-resistant apparel. Either home or industrial laundering may successfully remove most types of both flammable and non-flammable soils. However, home laundry detergents may not successfully remove some types of soil found in industry, especially heavy greases and oily soils. If flammable soils are not completely removed, the flame resistance of the garment may be compromised.
2. It may be difficult to determine that flammable soils have been completely removed, but indicators would include the presence of stains and/or odors after laundering. However, staining alone is not an indication that the soil has not been adequately removed. If it appears that the garments may still be contaminated after home wash, laundering at a local commercial or industrial laundry may be required. Dry cleaning may be used to remove oils and greases. Finally, if questions remain Bulwark will conduct flame resistant

testing of the garment in question to determine its flame resistance. Please be aware that this is a destructive test and the garment will be destroyed.

3. Flammable materials are for the most part volatile substances that dissipate into the atmosphere, for example, gasoline. Stains remaining after laundering on the other hand are either un-removed contaminants or, more likely, simply discoloration of the fabric.
4. Always consult the garment manufacturer for detailed instructions and precautions.
5. Essentially, all repairs must be made with materials equivalent to the original materials in the garments. In other words, Nomex® sewing thread and FR mending fabrics equal to the materials used in the original garment. Heat seal FR patches are available and are often used to make small repairs.

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. [1910.252(c)(13)] In the event of a medical emergency, know the Emergency Action Plan (EAP) and phone number of the location you are working. If a designated EAP is not designated, call 911, then contact your foreman and safety director.

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 the Emergency Action Plan number or 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 contact 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. If you must resort to pulling the victim from live contact, use non-conducting materials, such as dry insulated gloves or hardhat to assist release from energized circuit. If the victim is not breathing, administer CPR as soon as contact is broken. Call the Emergency Action Plan or 911. Keep comfortably warm and horizontal until there is no longer any further evidence of shock. Treat electrical burns as thermal burns.

TRAINING REQUIREMENTS

Employers shall instruct employees in the safe means of arc welding and cutting as follows: [1926.351(d)]

1. When electrode holders are to be left unattended, the electrodes shall be removed and the holders shall be so placed or protected that they cannot make electrical contact with employees or conducting objects. [1926.351(d)(1)]
2. Hot electrode holders shall not be dipped in water; to do so may expose the arc welder or cutter to electric shock. [1926.351(d)(2)]
3. 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, the power supply switch to the equipment shall be opened. [1926.351(d)(3)]
4. Any faulty or defective equipment shall be reported to the supervisor. [1926.351(d)(4)]
5. Fire watches shall be trained in accordance with 29 CFR [1910.252(a)(2)(iii)[B]]
 - (a.) Fire watchers shall have fire extinguishing equipment readily available and be trained in its use.
 - (b.) They shall be familiar with facilities for sounding an alarm in the event of a fire.
 - (c.) They shall watch for fires in all exposed areas, try to extinguish them only when obviously within the capacity of the equipment available, or otherwise sound the alarm.
 - (d.) A fire watch shall be maintained for at least a half hour after completion of welding or cutting operations to detect and extinguish possible smoldering fires.

SOURCE CREDITS

U.S. Department of Labor, Occupational Safety and Health Administration, www.osha.gov
Mechanical Contractors Association of America, www.mcaa.org
Lincoln Electric: The Welding Experts, www.lincolnelectric.com
NJ Work Environment Council
NC Department of Labor (NCDOL), Division of Occupational Safety and Health
J.J Keller & Associates, Inc
Freeport-McMoRan Copper & Gold
Lab Safety Supply: Industrial & Safety Supplies, www.lss.com
University of California, Irvine: Environmental Health & Safety (EH&S)
Southern Methodist University, Dallas TX
ESAB Welding & Cutting Products
Miller Electric Mfg. Co., www.millerwelds.com
Hobart Welding Products, www.hobartwelders.com
Agriculture and Food Development Authority
Cargill Corn Milling North America
OHS Occupational Health & Safety <https://ohsonline.com>
The Eastwood Company www.eastwood.com
American Welding Society www.aws.org

DOCUMENT CONTROL

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