Introduction

- Welding, Burning, and Hot Work Safety
- Objectives
  - 1. Identify major hazards associated with welding & cutting;
  - 2. Describe types of welding & cutting hazards;
  - 3. Protections from welding & cutting hazards;
  - 4. Recognize employer requirements to protect workers from exposure to welding & cutting hazards.
Introduction

• Welding, Burning, and Hot Work Safety
• Our objective is to familiarize you with the hazards, safe work practices, and control techniques of welding operations in order to better prepare you to do your job safely.
• OSHA has established regulations for welding safety.
• Visit OSHA’s web site at www.osha.gov or contact your own state OSHA office to learn more about welding regulations and safe work practices in welding.
• May be helpful to familiarize yourself with your company’s welding safety procedures.
Introduction

- Statistics
- Welding, cutting, brazing and other hot work are ...
  - Hazardous activities that pose a unique combination of both safety and health risks to more than 500,000 workers in a wide variety of industries.
  - The risk from fatal injuries alone is more than four deaths per thousand workers over a working lifetime.
Industry and Background

• Purpose of Welding
• Welding is the most common way ...
  – Of permanently joining metal parts.
  – Heat is applied to metal pieces, melting and fusing them to form a permanent bond.
  – Because of its strength, welding is used in shipbuilding, automobile manufacturing and repair, aerospace applications, and thousands of other manufacturing activities.
  – Welding also is used to join beams in the construction of buildings, bridges, and other structures and to join pipes in pipelines, power plants, and refineries.

TIP: Automated welding, done completely by robots, is increasingly being used in the manufacturing industry.
Industry and Background

- Industries
- Welding takes place and welders may work ...
  - In a wide variety of industries, from construction to manufacturing.
  - The work done in the different industries and the equipment used may vary greatly.
  - The most common and simplest type of welding today is arc welding, which uses electrical currents to create heat and bond metals together, but there are over 100 different processes that a welder can employ.
Industry and Background

• Welding Type
• The type of weld used is normally determined by ...
  – The types of metals being joined and the conditions under which the welding is to take place.
  – Steel, for instance, can be welded more easily than titanium.
  – Some of these processes involve manually using a rod and heat to join metals, while others are semiautomatic, with a welding machine feeding wire to bond materials.
Industry and Background

- Soldering and Brazing
- Like welders, soldering and brazing workers ...
  - Use molten metal to join two pieces of metal.
  - However, the metal added during the soldering and brazing process has a melting point lower than that of the piece, so only the added metal is melted, not the piece.
  - Soldering uses metals with a melting point below 840 degrees Fahrenheit; brazing uses metals with a higher melting point.

TIP: Because soldering and brazing do not melt the pieces being joined, these processes normally do not create the distortions or weaknesses in the pieces that can occur with welding.
Industry and Background

• Soldering and Brazing
• Soldering commonly is used to ...
  – Make electrical and electronic circuit boards, such as computer chips. Soldering workers tend to work with small pieces that must be precisely positioned.
  – Brazing often is used to connect copper plumbing pipes and thinner metals that the higher temperatures of welding would warp.
  – Brazing also can be used to apply coatings to parts to reduce wear and protect against corrosion.
Industry and Background

• Welders Skill
• Skilled ...
  – Welding, soldering, and brazing workers generally plan work from drawings, blueprints, or specifications and use their knowledge of welding processes and base metals to determine how best to join the parts.
  – The difficulty of the weld is determined by its position—horizontal, vertical, overhead, or 6G (circular, as in large pipes)—and by the type of metals to be fused.
Industry and Background

• Welders Skill

• Highly skilled welders ...
  – Often are trained to work with a wide variety of materials, such as titanium, aluminum, or plastics, in addition to steel.
  – Welders then select and set up welding equipment, execute the planned welds, and examine the welds to ensure that they meet standards or specifications.

TIP: Many of the activities and materials involved can be dangerous, even fatal.
Industry and Background

- Other Hot Work
- The work of arc, plasma, and oxy-gas cutters ...
  - Is closely related to that of welders.
  - However, instead of joining metals, cutters use the heat from an electric arc, a stream of ionized gas called plasma, or burning gases to cut and trim metal objects to specific dimensions.
  - Cutters also dismantle large objects, such as ships, railroad cars, automobiles, buildings, or aircraft.
  - Some operate and monitor cutting machines similar to those used by welding machine operators.
Industry and Background

• Work Environment.
• Welding, soldering, and brazing workers often are...
  – Exposed to a number of hazards, including very hot materials and the intense light created by the arc.
  – They wear safety shoes, goggles, masks with protective lenses, and other devices designed to prevent burns and eye injuries and to protect them from falling objects.
  – OSHA requires that welders work in safely ventilated areas to avoid the danger from inhalation of gases and particulates that can result from welding processes.
Industry and Background

• Work Environment
• Welders and cutters ...
  – Work outdoors, often in inclement weather, or indoors, sometimes in a confined area designed to contain sparks and glare.
  – Outdoors, they may work on a scaffold or platform high off the ground.
  – In addition, they may be required to lift heavy objects and work in a variety of awkward positions while bending, stooping, or standing to perform work overhead.
Welding Processes

• Definitions

• Welding
  – Two basic types:
    • (1) directly fusing two pieces of metal (Nelson studs)
    • (2) using additional metal to make the weld (stick or wire fed welding)
Welding Processes

• Arc Welding
  – Arc welding is a process ...
    • In which metals are fused together by heating them with an electric arc that is generated between an electrode and the surface of the base metal.
    • Electrodes are of two types.
      – The first is carbon or tungsten, whose only function is to carry current;
      – and the second is an electrode which as current is applied, melts supplying filler metal to the joint.
  – Arc welding types:
    • Stick welding
    • Shielded metal arc
    • Gas metal arc
    • Flux cored arc welding
    • Submerged arc welding
Welding Processes

• Gas Welding
  – Gas welding uses an ...
    • Oxygen and fuel gas welding apparatus which depends on the heat produced by the combustion of a fuel gas in the presence of oxygen.
    • The equipment is portable and does not require an electric source.
    • The basic equipment consists of a cylinder of oxygen, a cylinder of fuel gas (usually acetylene), two regulators with gauges, two hoses, and a welding torch.
  – Other welding types:
    • Thermal spraying
    • Electron Beam
    • Plasma Arc
    • Orbital
    • Brazing and others

TIP: In fact, the National Institute for Occupational Safety and health reports that there are more than 80 different types of welding and allied processes in commercial use.
Welding Hazards

- Welding Hazards
  - Fire and Explosions
  - Burns
  - Welder’s Flash
  - Electric shock
  - Noise
  - Radiation
  - Respiratory hazards and related Chemical Agent hazards
  - Lead, fumes, gases
Welding Hazards

• Fire and Explosions
  – Fire and explosions may occur during welding ...
    • Because of the extreme temperatures and sometimes improper use of a torch.
    • Welding should not be permitted in areas where flammable vapors, dust, or flammable or combustible liquids are present.
    • Avoid welding on or inside tanks or other containers which have held combustible or flammable types of materials until all fire and explosion hazards have been eliminated.
Welding Hazards

- OSHA Fatal Facts #53
- Case study from OSHA which resulted in the death of one employee and injuries to another.
- Open the PDF and study it before moving to the next screen.
Welding Hazards

- OSHA Fatal Facts #53
- OSHA cited four violations and made recommendations for each. Which two of these did they recommend?
  - Welding, cutting, or heating must not be done where the application of flammable paints, or the presence of other flammable compounds, or heavy dust concentrations creates a hazard. [correct]
  - Conduct a thorough deep weld analysis prior to any welding activity. [incorrect]
  - Drums, containers, or hollow structures which have contained toxic or flammable substances must be filled with water or cleaned of such substances and ventilated and tested before welding, cutting, or heating is undertaken on them. [correct]
  - Notify OSHA consultation prior to the start of any welding activity. [incorrect]
Welding Hazards

• Air Contamination

• Welding near certain solvents such as ...

  – Chlorinated solvent may produce toxic gas such as phosgene.

  – Testing for explosive and toxic atmospheres should be conducted prior to welding work.

  – When welding must be done near combustible materials, special precautions are necessary to prevent sparks and spatter from reaching and igniting the combustibles.
Welding Hazards

• Burns

• Welding sparks and spatters may ...
  – Cause serious burns if gotten on the skin or in the eyes.
  – Sparks and spatters may ignite clothing and nearby combustible materials causing a fire resulting in burns or property damage.
Welding Hazards

• Welder’s Flash
• Welders Flash is an injury that ...
  – Is caused by exposure to ultraviolet light.
  – Welders flash feels much like dust or sand in the eyes, or scratchy eyes.
  – Welders helmets and eye protection protect the welder from welders flash.
  – Welding curtains may protect other workers in the vicinity of the welding from it also.
Welding Hazards

- **Electrical Hazards**
- There are electrical hazards in welding.
  - In many welding operations an electric arc supplies the energy necessary to melt the metal and make the weld. Significant level of Alternating Current, AC and Direct Current DC, can be generated.
  - To protect against electric shock, welding cable and electrode holders must be well insulated and in good condition. Arc welding units operating on currents exceeding 50 volts must be grounded.

**TIP:** Arc welding and plasma cutting is the discharge of electricity through combination of ionized air and vaporized conductor material.
Delete Welding Hazards

- Electrical Hazards
- A SHOCK may occur when:
  - Equipment isn't properly grounded
  - Direct contact is made with energized leads
  - Contacting leads with moist/damp gloves, clothing, or floors.
  - Environmental conditions – such as wet or cramped/confined spaces - may make the likelihood of shock greater.
  - Shock could throw a welder out of position or cause falls resulting in potential major injuries.

TIP: The avoidance of electrical shock is largely within control of every welder. Electric shock can kill! AC or DC welding has the power to cause electrocution if electrode touches bare skin (damp or wet gloves &/or clothing) while you are grounded.
Welding Hazards

- Electrical Hazards
- Metal and carbon electrodes not in use should be ...
  - Removed from holders and placed so that they cannot make electrical contact with persons, conducting objects, flammable liquids, or compressed gasses.
  - Electric shock can be avoided by keeping gloves and clothing dry, wearing shock resistant footwear, and avoiding contact with hot or electrically charged wires.
Welding Hazards

- Welding Death in Aiken SC
- An experienced welding supervisor died from cardiac arrhythmia due to electrocution.
- According to the Aiken Standard News, he inadvertently “grounded out the welder and sent electricity through himself instead of the welding rod.” It was a hot day and he was sweaty according to reports.
- Reports indicated he had been welding for years.
- Complacency and working conditions may have played a role in this fatality. Don’t get lax and start taking shortcuts.
Welding Hazards

• Noise
• Welding operations can produce noise levels
  – Which can cause hearing loss.
  – Actual welding work can produce noise levels exceeding OSHA’s action level of 85 decibels.
  – Noise levels from manual grinding and slag chipping or removal of excess melted metal can produce sound levels of 105 decibels and higher.
  – Ear protection should be worn to minimize exposure to noise and prevent potential hearing loss.

  TIP: Hearing loss is gradual and may not be recognized for many months or years.
Welding Hazards

• Physical Agents
  – Welding can produce intense bright light
    • ultraviolet
    • Infrared
    • visible
  – Skin burns/eye damage
  – Protection: welder’s helmet, goggles, long-sleeved protective clothing
Welding Hazards

- Ultraviolet Radiation
- Ultraviolet radiation (UV), a physical agent...
  - 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.
  - Exposure to ultraviolet rays may also increase the skin effects of some industrial chemicals (coal tar and cresol compounds, for example).
Welding Hazards

- 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 to welders.
    - Most welders protect themselves from IR (and UV) with a welder's helmet (or glasses) and protective clothing.
Welding Hazards

• 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.

TIP: At no time should the arc be observed without eye protection.
Welding Hazards 2

• Chemical Agents
  – Welding produces fumes and gases
  – Fumes composed of metals, metal oxides, and from base metal, electrode, metal coating, or electrode covering (flux)
  – Fume hazard depends upon the type and amount of fume generated
Chemical Agents

- Fumes and Gases:
- Fumes and gases enter the body through the respiratory route.
- Inhalation of metallic fumes during welding and cutting may cause:
  - Short term, acute
  - Long term, chronic
  - Lung illnesses
Welding Hazards

• Chemical Agents
  – Fume Types
    • ZINC
    • CADMIUM
    • BERYLLIUM
    • IRON OXIDE
    • MERCURY
    • LEAD
    • Other Metals
Welding Hazards

• Zinc

Zinc is used in large quantities in the ...
  – Manufacture of brass, galvanized metals, and various other 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”.

Symptoms of metal fume fever are ...
  • Very similar to those of common influenza.
  • Include fever (rarely exceeding 102o F), chills, nausea, dryness of the throat, cough, fatigue, and general weakness and aching of the head and body.
  • Victim may sweat profusely for a few hours, after which the body temperature begins to return to normal.
  • Symptoms have rarely, if ever, lasted beyond 24 hours.
  • Subject can then 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.
Welding Hazards

• Cadmium
• Cadmium is used frequently as ...
  – A rust-preventive coating on steel and also as an alloying element.
  – Acute exposures to high concentrations or cadmium fumes can produce severe lung irritation, pulmonary edema, and in some cases, death.
  – 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.

TIP: Cadmium is classified by OSHA, NIOSH, and EPA as a potential human carcinogen.
Welding Hazards

• Beryllium

• Beryllium is sometimes used as ...
  – A 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.
Welding Hazards

• 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.
  – Primary acute effect of this exposure is irritation of nasal passages, throat, and lungs.
  – Long-term exposure to iron oxide fumes may result in iron pigmentation of the lungs, most authorities agree that these iron deposits in the lung are not dangerous.
Welding Hazards

• 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.
Welding Hazards

- **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.
  - Inhalation and ingestion of lead oxide fumes and other lead compounds will cause lead poisoning.
- **Symptoms of lead poisoning 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.
  - Lead adversely affects the brain, central nervous system, circulatory system, reproductive system, kidneys, and muscles.

**LINK:** [http://www.osha.gov/SLTC/lead/](http://www.osha.gov/SLTC/lead/)
Welding Hazards

• Lead Paint

• Welding, Cutting or Heating of Metals Coated with Lead-Bearing Paint.
  – In the Construction Industry, when welding, cutting or heating is performed in an enclosed space on metal coated with lead-bearing paint, employers must provide local exhaust ventilation or to protect employees with airline respirators.
  – Employers must take steps to ensure that the paint is stripped back at least 4 inches from the area of heat application or to protect the employees with airline respirators.
  – If the concentration of airborne lead exceeds the specified limits, local exhaust ventilation must be provided in addition to the stripping back procedure.

• Learn more by clicking on the link shown.

Welding Hazards

- 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.

TIP: In metallurgy, a flux (derived from Latin fluxus meaning “flow”), is a chemical cleaning agent, flowing agent, or purifying agent. Fluxes may have more than one function at a time. Source: Wikipedia, 2012
Welding Hazards

• Other Metal Fumes
  – Aluminum
  – Chromium
  – Nickel
  – Vanadium
• Acute effects
  – nose, throat, lung irritation
• Chronic effects
  – skin irritation, nasal ulceration, lung cancer

TIP: Hexavalent chromium, a known carcinogen, can be formed when performing "hot work" such as welding on stainless steel or melting chromium metal. In these situations the chromium is not originally hexavalent, but the high temperatures involved in the process result in oxidation that converts the chromium to a hexavalent state.
Welding Hazards

- Interactive
- Bill, a welder for ACE welding wakes up Saturday morning after a long day welding and cutting on Friday with flu-like symptoms including fever, chills, nausea, headache, fatigue, muscle aches, and joint pains. He also has a sweet metallic taste in his dry mouth. Bill’s symptoms are classic for what illness associated with welding activities?
  - Cutter’s disease (incorrect)
  - Welder’s throat (incorrect)
  - Metal Fume Fever (correct)
  - Welder’s Saturday disease (incorrect)
Welding Hazards

- Gases
  - Ozone
  - Nitrogen oxides
  - Carbon monoxide
  - Oxygen-depleting:
    - Argon
    - Carbon dioxide
    - Helium
    - Nitrogen
    - Others
Welding Hazards

• Chlorinated Hydrocarbon Solvents

• Various chlorinated hydrocarbons are...
  – Used in degreasing or other cleaning operations.
  – 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.
Welding Hazards

- 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.
Welding Hazards

- Carbon Monoxide
- Carbon monoxide is a gas ...
  - Usually formed by the incomplete combustion of various fuels.
  - Welding and cutting may produce significant amounts of carbon monoxide.
  - 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.
  - Odorless, colorless and tasteless and cannot be readily detected by the senses.
  - Common symptoms of overexposure include pounding of the heart, a dull headache, flashes before the eyes, dizziness, ringing in the ears, and nausea.
Welding Hazards

- **Ozone**
- **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 heli-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 upper respiratory tract.
  - 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.
Welding Hazards

• Nitrogen Oxides
  The ultraviolet light of the arc can ...
  – Produce nitrogen oxides (NO, 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 heli-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.
  – This gas is irritating to the eyes, nose and throat but dangerous concentrations can be inhaled without any immediate discomfort.
  – High concentrations can cause shortness of breath, chest pain, and fluid in the lungs (pulmonary edema).
Hazard Evaluation and Standards

- Hazard Evaluation
- Certain materials used or released ...
  - In the welding process have very low permissible exposure levels (PELs).
  - Permissible exposure levels are established by OSHA for many compounds to minimize or prevent adverse health exposures.
  - To determine if exposures may be above the permissible exposure level, air sampling conducted by an industrial hygienist may be necessary.

TIP: Exposure to welding fumes can occur through inhalation and eye contact.
Hazard Evaluation and Standards

- Air Sampling / Testing
- Air sampling for specific chemical compounds such as...
  - Welding fume and gases is an investigative tool used to characterize the nature and extent of contaminants in air and to determine whether contaminant sources affect a worker’s air quality.
  - Measurements is necessary for measuring occupational health hazards and determining the need for environmental controls.
  - No one best sampling strategy or plan for all work and exposure situations (decision made by a competent person such as a certified industrial hygienist).

TIP: The following basic considerations can be used to help develop a sampling strategy:
- type and nature of contaminants
- worker location, nature of work operations/exposure duration
- number of samples required to evaluate the exposure
- availability of sampling equipment
- availability of sample analytical facilities
- availability of personnel for surveillance
Hazard Evaluation and Standards

- MSDS
- Material Safety Data Sheet
  - If you are exposed to welding fume, gases or other hazardous substances your employer must obtain a Material Safety Data Sheet, called an MSDS.
  - MSDSs provide general and specific safety and health information.
  - It is important to know the hazards, safe work practices such as the use of ventilation, and the appropriate personal protective equipment.
Welding Hazards Control

• Types of Controls
• Controlling exposure to the safety and health hazards encountered in...

  – Welding operations includes engineering controls (e.g. ventilation from local exhaust fans); administrative or work practice controls (e.g. welding training and not getting too close to an arc welder’s arc); and personal protective equipment, such as welder’s helmets and respiratory protection.

TIP: Engineering controls are the preferred method because they generally provide a wider margin of safety and are longer lasting.
Welding Hazards Control

• General Considerations
• General Safety Guidelines
  – Avoid prolonged breathing of gases, fumes, and dusts
  – Never weld in a damp or wet area without protective equipment
  – Wear appropriate PPE (e.g. eye and face protection), leather welding gloves, a welding helmet, and fire resistive protective clothing.
Welding Hazards Control

- General Safety Guidelines
- Keep the area clear of combustibles ...
  - At least 35 feet from the hot work area
  - Regularly inspect all equipment to check that it is in good working condition.
  - Use an approved respirator for fumes and other controls that do not control gases, fumes, or dusts at their safe established levels.
  - Use fire resistant welding curtains or shields constructed of non-combustible materials positioned so that others do not see the welding arc.
  - Have a charged fire extinguisher readily available and know how to use it.

TIP: Combustibility is a measure of how easily a substance will set on fire, through fire or combustion.
Gas Welding and Cutting

• Gas Welding

• Before gas welding ...
  – Be sure to review the MSDS and follow all engineering, work practice and personal protective equipment controls, and you may need to check the Material Safety Data Sheets.
  – Gas welding generally involves flammable gases.

• Gas Welding DOs
  – Avoid ignition sources
  – Inspect for and remove combustibles
  – Keep cylinders away from sparks and spatter
  – Take care of hoses, carts, and cylinders
  – Store cylinders secured upright and oxygen away from fuel gases
  – Anti-flashback valves
Gas Welding and Cutting

• Gas Welding
• When gas welding or working in an area with gas welding:
  – Don’t smoke
  – Never store cylinders near stairways, gangways or elevators and don’t store oxygen cylinders in the same area as oil, grease, gasoline, fuel gases, or other petroleum products.
  – Do not repair hoses with tape

TIP: To test for leaks, open the fuel or oxygen cylinder valves with the valves on the torch closed. Adjust the regulator to normal working pressures and either immerse the hose under water such as in a bucket of water or apply soapy water to connections and hose with a brush or spray bottle. If bubbles form, a leak is present and the leak must be corrected. Do not repair hoses with tape and do not use any other testing method.
Gas Welding and Cutting

- Gas Cylinders
- Gas cylinders like those used in welding are ...
  - Pressurized and can create a hazardous condition.
  - Cylinders must meet strict Department of Transportation DOT inspection and certification requirements published in Title 49 of the Code of Federal Regulations.
  - Heat, fire, or rough handling can detonate gas cylinders with extreme force.

TIP: Before using a cylinder, make sure you read and understand the label. If the cylinder does not have a label, do not use it and talk to your supervisor.
Gas Welding and Cutting

• Cylinders

• When transporting, moving and storing compressed gas cylinders:
  – Valve protection caps must be in place and secured.
  – When cylinders are hoisted, they must be secured on a cradle, sling-board, or pallet. They must not be hoisted or transported by means of magnets or choker slings.
  – Cylinders must be moved by tilting and rolling them on their bottom edges. They must not be intentionally dropped, struck, or permitted to strike each other violently.

TIP: Only trained employees should handle compressed gas cylinders. Check with the supervisor, supplier or manufacturer whenever you have a cylinder handling question or concern.
Gas Welding and Cutting

- Cylinders
- When transporting, moving and storing compressed gas cylinders:
  - When cylinders are transported by powered vehicles, they must be secured in a vertical position.
  - Valve protection caps must not be used for lifting cylinders from one vertical position to another. Bars must not be used under valves or valve protection caps to pry cylinders loose when frozen. Warm, not boiling, water must be used to thaw cylinders loose.

TIP: Unless cylinders are firmly secured on a special carrier intended for this purpose, regulators must be removed and valve protection caps put in place before cylinders are moved.
Gas Welding and Cutting

• Cylinders

• When transporting, moving and storing compressed gas cylinders:
  – A suitable cylinder truck, chain, or other steadying device must be used to keep cylinders from being knocked over while in use.
  – When work is finished, when cylinders are empty, or when cylinders are moved at any time, the cylinder valve must be closed.

TIP: Compressed gas cylinders must be secured in an upright position at all times, if necessary, for short periods of time while cylinders are actually being hoisted or carried.
Gas Welding and Cutting

- Cylinders
- Oxygen cylinders in storage must 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.

TIP: OSHA requires that handling, storage, and utilization of compressed gases in cylinders, portable tanks, rail tank cars, or motor vehicle cargo tanks be in accordance with Compressed Gas Association Pamphlet P-1-1965. Click on the link to view NIOSH’s Compressed Gases Self-Inspection Checklist. http://www.cdc.gov/niosh/docs/2004-101/chklists/r1n29c~1.htm
Gas Welding and Cutting

- Treatment of Cylinders
- Cylinders, whether full or empty, must not be used as rollers or supports.
  - No person other than the gas supplier must attempt to mix gases in a cylinder.
  - No one except the owner of the cylinder or person authorized by him, must refill a cylinder.
  - No one must use a cylinder's contents for purposes than those intended by the supplier.
  - No damaged or defective cylinder must be used.

TIP: All cylinders used must meet the Department of Transportation requirements.
Gas Welding and Cutting

• Hose
• When parallel sections of oxygen and fuel gas hose are taped together,
  – Not more than 4 inches out of 12 inches must be covered by tape.
  – 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, must be inspected at the beginning of each working shift.
  – Defective hose must be removed from service.

TIP: Hose which has been subject to flashback, or which shows evidence of severe wear or damage, must 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, must not be used.
Gas Welding and Cutting

• Hose

• Hose couplings must be of the type that ...
  – Cannot be unlocked or disconnected by means of a straight pull without rotary motion.
  – Boxes used for the storage of gas hose must be ventilated.
  – Hoses, cables, and other equipment must be kept clear of passageways, ladders, and stairs.
Gas Welding and Cutting

• Torches
• Clogged torch tip openings must be cleaned with suitable cleaning wires, drills, or other devices designed for such purpose.
• Torches in use must be inspected at the beginning of each working shift for leaking shutoff valves, hose couplings, and tip connections. Defective torches must not be used.
• Torches must be lighted by friction lighters or other approved devices, and not by matches or from hot work.

Safety Tip: Oxygen and fuel gas pressure regulators, including their related gauges, must be in proper working order while in use.
Gas Welding and Cutting

- Oil and Grease Hazards
- Oxygen cylinders and fittings must be ...
  - Kept away from oil or grease.
  - Cylinders, cylinder caps and valves, couplings, regulators, hose, and apparatus must be kept free from oil or greasy substances and must not be handled with oily hands or gloves.
  - Oxygen must not be directed at oily surfaces, greasy clothes, or within a fuel oil or other storage tank or vessel.

TIP: For additional details not covered in this you can refer to the American National Standards Institute, Z49.1-1967, Safety in Welding and Cutting.
Arc Welding and Cutting

- Manual Electrode Holders
- Only manual electrode holders ...
  - Specifically designed for arc welding and cutting, and are of a capacity capable of safely handling the maximum rated current required by the electrodes, must be used.
  - 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, must be fully insulated against the maximum voltage encountered to ground.
Arc Welding and Cutting

• Welding Cables and Connectors
• All arc welding and cutting cables must be ...
  – 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.
  – 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 must be used.

TIP. One exception is that cables with standard insulated connectors or with splices whose insulating quality is equal to that of the cable are permitted.
Arc Welding and Cutting

- Welding Cables and Connectors
- Cables in need of repair must not be used.
  - When a cable becomes worn to the extent of exposing bare conductors, the portion thus exposed must be protected by means of rubber and friction tape or other equivalent insulation.
  - 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 must be used.

TIP: If connections are effected by means of cable lugs, they must be securely fastened together to give good electrical contact, and the exposed metal parts of the lugs must be completely insulated.
Arc Welding and Cutting

• Ground Returns and Machine Grounding

• A ground return cable must 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 must exceed the total specified maximum output capacities of the all the units which it services.

TIP: Pipelines containing gases or flammable liquids, or conduits containing electrical circuits, must not be used as a ground return.
Delete Arc Welding and Cutting

- Ground Returns and Machine Grounding
- When a structure or pipeline is employed as a ...
  - Ground return circuit, it must be determined that the required electrical contact exists at all joints.
  - Generation of an arc, sparks, or heat at any point must cause rejection of the structures as a ground circuit.
  - When a structure or pipeline is continuously employed as a ground return circuit, all joints must bebonded, and periodic inspections conducted to ensure that no condition of electrolysis or fire hazard exists by virtue of such use.

Safety Tip: Whenever practicable, all arc welding and cutting operations must be shielded by noncombustible or flameproof screen which will protect employees and other persons working in the vicinity from the direct rays of the arc.
Arc Welding and Cutting

- Ground Returns and Machine Grounding
- Frames of arc welding and cutting machines must 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 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.

TIP: All ground connections must be inspected to ensure that they are mechanically strong and electrically adequate for the required current.
Fire Prevention

- Fire Prevention
- Before starting welding work, some safe work practices:
  - Test the area for flammable and combustible gasses and vapors
  - Perform welding in a fire resistant area or use fire resistant covers on material or equipment that could catch fire.
  - Move all flammables and combustibles away from the welding area
  - Eliminate or cover cracks, openings, doorways, ducts that could carry sparks and spatter to unprotected areas.
  - Use a hot work permit and have a trained fire-watch. Keep an eye on the area of welding for at least 30 minutes after welding to check for resulting fires or smoldering materials.
Fire Prevention

• Fire Prevention
• Hot Work Permit
  – In locations with combustibles and flammable materials it is recommended to have a hot work permit issued by the welding supervisor or other qualified person.
  – Inspection of the area
  – Isolation of combustibles and flammable materials where work is to be done
  – Establishment of trained fire watches
  – Standby employee with portable fire extinguishing equipment
  – Communications
  – Authorizations to conduct the work.
Fire Prevention

• Containers / Pipes
  • Welding or cutting on containers or pipes can be ...
    – Very dangerous and even fatal.
    – Because of the explosion and fire dangers, the cutting or welding of containers or pipes which hold or have held flammable substances is prohibited except in rare instances and only by highly experienced and trained individuals.
    – Check with your company safety officer or supervisor before attempting any hot work on such pipes or containers.
Other Hazards Control

- Confined Spaces
- OSHA Fatal Facts #25
- OSHA had three accident prevention recommendations. In addition to training employees what else did OSHA recommend?
  - Post guards at all pipe entry points. [incorrect]
  - Do not use oxygen for ventilation, cooling or cleaning in welding operations. [correct]
  - Make sure the attendant knows exactly where to put the oxygen. [incorrect]
  - Comply with OSHA's required confined or enclosed space entry program. [correct]
Other Hazards Control

- Confined Spaces
- Welding in a confined space can ...
  - Cause a build up of fumes, gasses and heat.
  - Certain types of welding may use gasses such as argon, helium and carbon dioxide which may displace oxygen in a confined space.
  - Testing of the air for solvent vapors, oxygen levels and other hazards is required before entry.
  - Only trained workers are allowed to enter, supervise, and attend to confined spaces entry operations.

Other Hazards Control

- Eye and Face Protection
- Personal Protective Equipment (PPE) for welders is ...
  - Required to protect the welder's eyes from radiation and the eyes of others working in the area of welding operations and to protect the operator from hot spatter.
  - Specially designed helmets equipped with filter plates to protect against ultraviolet, infrared, and visible radiation should be worn when welding.
  - Welding helmets and hoods provide the best protection.
• Eye and Face Protection
• Shaded lens used in welder’s helmets and goggles must ...
  – Meet the test for transmission of radiant energy prescribed in ANSI Z87.1
  – In general:
    • Light cutting use shade numbers 3 or 4
    • Medium and heavy cutting shades use 4, 5, or 6
    • Shade numbers from 4 through 8 should be worn for gas welding
    • Arc welding use shades of 10 or more are recommended.

TIP: Helpers often must wear shaded goggles that are the same shade that the welder wears. Others who normally work near welding operations should also wear shaded eye protection such as goggles.
Other Hazards Control

- Toxic Substances
- When hazardous substances are used as ...
  - Base metals, fluxes, plating, or filler metals, local exhaust ventilation must be used.
  - Beryllium, cadmium, chromium, fluorides, lead, mercury, zinc, inert gas metal-arc welding, and oxygen cutting of stainless all require the use of local exhaust ventilation to bring toxic concentrations within the Permissible Exposure Limits.
  - If this is not possible to supply adequate ventilation, respiratory protection and specifically supplied air respirators may be necessary.
Other Hazards Control

• Toxic Substances: Protection
• Remove coatings ...
  – Along the line of the weld such as lead paint, galvanized materials, coal tar pitch, and plastic, so they can’t burn, releasing toxic substances.
  – Clean all work that has been degreased and do not operate electric arc welding equipment near a degreasing operation to avoid potentially dangerous gasses such as phosgene.
Other Hazards Control

• Ventilation
• There are several types of ventilation,
  – Including natural ventilation provided by the natural environment afforded by outdoors and very large welding areas.
  – Mechanical local exhaust ventilation, the preferred method of ventilation. It means fixed or movable exhaust hoods placed as close as possible to the work, with a capture velocity that will remove generated welding airborne contaminants.
  – Local forced ventilation, such as blower fans
  – General area mechanical ventilation.
Other Hazards Control

• Training
• Only employees that have been specifically trained ...
  – Should attempt any welding operation.
  – OSHA regulations require employers to inform employees about the hazards to which they are exposed.
    • Physical and health hazards of the materials
    • Measures employees should take to protect themselves
    • Details of the hazard communication program
    • Explanation of material safety data sheets.

TIP: Specific training is required for employees who may have the opportunity to wear respiratory and other personal protection, and for those that may participate in confined spaces entry.
Other Hazards Control

• Management/Supervision
  – Effective supervision is necessary.
  – Management should designate a competent person.
  – Supervisor should make sure that only approved equipment is used and that all workers and supervisors are trained in the safe use of welding and cutting equipment, including its use in confined spaces and fire prevention.

TIP: Supervisors and management must ensure that toolbox or tailgate safety meetings are held frequently enough to keep employees informed and knowledgeable of new or recognized hazards, so that they’re able to discuss the job hazards and safety precautions.
Summary

- Employer Responsibility
- Selected employer responsibilities under the Occupational Safety and Health Act of 1970.
  - Provide a workplace free from serious recognized hazards
  - Comply with standards, rules and regulations.
  - Inspect the worksite and examine workplace conditions.
  - Make sure employees have and use safe tools, equipment and maintain them.
  - Establish or update operating, safety and health procedures and communicate them.
  - Provide medical examinations and training when required.
  - Keep records of work-related injuries and illnesses.
  - Provide access to employee medical records and exposure records.

Summary

- There are many different kinds of welding hazards:
  - fumes and gases
  - fire and explosions
  - electric shock
  - burns
  - radiation and other risks
- Review MSDS
Delete Summary

• Welders and those in the vicinity of welding must know what kind of protective eye and face protection, respiratory protection, flame resistant clothing, safety shoes, safety hats, and other protective equipment is necessary.

• Safety training and safety supervision is vital for welders and cutters before the actual work.

• For more information, talk with your supervisor or safety officer and remember “Safety First”.

Summary

• Sources of Information and Assistance

• OSHA’s Welding, Cutting and Brazing Topics Page
  http://www.osha.gov/SLTC/weldingcuttingbrazing/

• American Welding Society
  http://www.aws.org/w/a/

• Fabricators and Manufacturers Association
  http://www.fmanet.org/
Summary

• Employer Responsibility
• Specifically to hot work; employers must:
  – Provide suitable fire extinguishing equipment maintained in a state of readiness for instant use.
  – Permit cutting or welding only in areas that are or have been made fire safe.
  – Ensure fire watchers in locations where a fire might develop.
  – Ensure the safe usage of cutting and welding equipment.
  – Ensure eye / face and other personal protective equipment is properly selected and used.
  – Provide local exhaust or general ventilating systems, arranged to keep the amount of toxics below the maximum allowable concentration.