



Welding and Cutting Guidelines

Environmental Health and Safety

Introduction

This document provides workers and supervisors with guidance on the hazards that may be present when welding and controls that should be followed to minimize the hazard. The following hazards may occur when welding:

- Exposure to [noise](#), [heat stress](#) and toxic substances (welding fumes, welding gases, flux vapours, metal dust, chemicals such as chlorinated solvents, coatings, etc.).
- Strains and sprains from lifting or moving heavy objects, repetitive motions, working in awkward positions, handling and holding welding guns.
- Eye injuries and skin damage/burns, “welder’s eye” or “arc eye” from the light or radiation (UV, ultraviolet radiation) emitted by welding arcs and flames.
- Cuts and lacerations from sharp metal edges, flying debris
- Burns from hot surfaces, flames, sparks, etc.
- Fires/explosions from sparks, flames or hot metals (a special situation includes when the surrounding atmosphere becomes oxygen enriched and thus easier to ignite.)
- Asphyxiation (lack of oxygen) and other toxic responses from welding in confined areas.
- Other general hazards, depending on the conditions of the work, may include: ergonomics, electric shock, [working at heights](#), [heat stress](#) and [asbestos](#).

Types of Welding and Cutting:

Two main types welding processes are [electric] arc welding and combustion gas welding.

Arc welding uses an electric arc to generate high temperatures. The arc is maintained at the gap between the workpiece and the electrode and a common pool of material develops, forming the new welding. Common types of arc welding are shield metal arc welding (most common), gas metal arc welding, flux arc welding, gas tungsten arc welding and plasma arc welding.

Combustion Gas Welding uses heat from the combustion of oxygen and another gas (acetylene, propane, hydrogen or butane). It is often used for repair work and light sheet metal. Temperatures are usually lower than for arc welding.

Oxyacetylene Welding and cutting uses a mixture of gases (oxygen and acetylene) to generate heat for welding. It is the most common fuel gas cutting and welding in construction.

Scope

This guideline applies to all UofT employees who perform or oversee welding operations. It also applies to external workers (e.g. contractors) who may conduct welding on University premises.



Responsibilities

The roles and responsibilities for management, supervisors and workers are listed below. Workers should report concerns to their supervisors and at any time, the Environmental Health and Safety (EHS) can be contacted for assistance or consultation.

Supervisors/Management/Principal Investigators

- Identify workers and work activities where welding is performed.
- Identify and anticipate any hazards that may be present (e.g. flammables, confined space, etc.).
- Develop, document, implement and maintain appropriate work procedures, measures, inspections, and precautions to control the hazards that may be present using these guidelines.
- Ensure written work procedure is completed where necessary and that they are readily available to workers. A [job safety analysis \(JSA\)](#) can be used to assist in developing procedures.
- Ensure controls identified in the [JSA](#) or work procedures are followed.
- Ensure that workers who conduct welding are provided with the equipment, personal protective equipment (PPE), appropriate training or other resources as identified by the JSA or work procedures.

Workers

- Report health and safety hazards or concerns, including unsafe welding practices or damaged equipment to the supervisor.
- Participate in appropriate training for welding techniques.
- Review and be familiar with applicable [JSA](#) or work procedures before start of work.
- Follow safety procedures and use equipment and/or PPE provided.
- Where requested, assist supervisors in identifying situations with potential welding hazards and participate in the development of the [JSA](#) or work procedure.

Environmental Health & Safety (EHS)

- Provide consultation and assist as needed.
- Update and maintain these guidelines on a regular basis and/or when new information becomes available.

General Controls for Welding

Controls for welding fall into 5 categories. Summaries of each are provided below. For more information, please refer to the [Infrastructure Health and Safety Association \(IHSA\)](#) and the [WorkSafe Manitoba Welding Guide](#).

- A. Substitution/Engineering controls
- B. Administrative controls and work practices
- C. Personal protective equipment (PPE)
- D. Training
- E. Emergency Preparedness

A: Substitution/Engineering Controls

Elimination

Welding should be conducted only when necessary. In particular, in confined spaces, less hazardous process should be considered. Depending on the work, alternatives such as fastening/bolting, using structural adhesives can be considered or using lower temperature processes such as soldering and brazing. Another example of elimination is removing flammable materials from the space before welding begins.

Substitution

Examples of substitution are:

- Using the least hazardous welding materials/technique, for example, switching to shielded metal arc welding to gas metal arc welding with a solid or metal-coated wire.
- Using less hazardous materials, e.g. low-manganese filler metal help reduce the amount of hazardous fumes produced, using a mixture of argon and carbon dioxide (instead of straight carbon dioxide) to reduce fume generation by 25%, using nitric oxide in shield gas for aluminum during gas metal arc welding reduces ozone, using water-based cleaners or high flash point solvents.

Ventilation

Welding should be performed in a well-ventilated space where possible, especially when using portable welders powered by diesel, gasoline or propane engines. Welding exhaust should be vented away from the workplace and not be re-circulated. In addition to natural ventilation dilution and mechanical dilution ventilation (also known as general dilution ventilation), local exhaust ventilation specifically designed for the extraction and filtration of welding fume may be required in some situations (e.g. confined spaces, spaces with structural barriers to airflow). Similar to other equipment, ventilation equipment should be inspected and maintained per manufacturer instructions.

Local exhaust should be placed as close to the weld as possible. Examples of local exhaust ventilation are (source: [Infrastructure Health and Safety Association \(IHSA\)](#)):

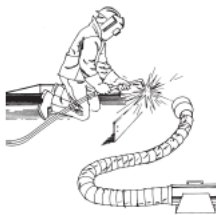


Figure 41-8: Portable Fume Extractor



Figure 41-9: Fume Extraction Gun

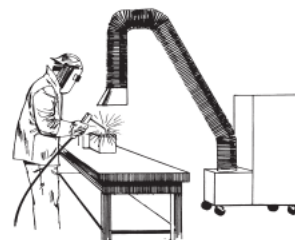


Figure 41-10: Bench with Portable Hood

Where local ventilation is not possible, the addition of a small fan that blows from behind the worker across the work area can help move fumes away from the breathing zone.



B: Administrative Controls and Work Practices

Before welding starts:

- Where applicable, ensure all required permits are in place such as: **hot work permit, fire protection and confined space.**
- Review the composition of the base metal and Safety Data Sheet (SDS) for welding rods, wires, electrodes, compressed gases, fluxes, metals, coatings, cleaners and degreasers.
- Inspect the area for potential hazards before you start the job.
- Know and follow the equipment manufacturer's instructions. Inspect all equipment and tools to verifying that it is in good operating order and properly grounded (where applicable). Have all installed equipment inspected by a qualified person regularly (e.g. local exhaust ventilation).
- Ensure power supply system is properly sized, rated and protected to handle the welding unit(s). Connect work cable as close as possible to area where welding will occur. Do not alternate circuits through scaffold cables, hoists chains and ground leads.
- Do not weld with cables coiled up or on spoils. Unwind, layout when in use and protect from damage.
- Remove all flammable, combustible and ignitable materials from the welding area (at least 15 metres or 50 feet away). This includes removing matches and butane lights from pockets. Look for combustible materials in structures (partitions, walls, ceilings).
- Chlorinated solvents should be shielded or at least 60 m away. Surfaces prepared with chlorinated solvents must be thoroughly dry before welding.
- If combustibles cannot be moved, cover them with fire resistant blankets or shields. Protect gas lines and equipment from falling sparks and hot materials and objects.
- Cover wall or ceiling surfaces with a fire resistant and heat insulating material to prevent ignition and accumulation of heat. Block off cracks between floorboards, along baseboards and walls, and under door openings, with a fire-resistant material.
- Cover or close all ducts or openings that could carry sparks.
- Close doors and windows.
- Sweep clean any combustible materials on floors around the work zone. Combustible floors must be kept wet with water or covered with fire resistant blankets or damp sand.
- Use water only if electrical circuits have been de-energized to prevent electrical shock.
- No smoking, eating or drinking in the welding area.
- Place adequate non-reflective barriers/welding screen to protect pedestrians from intense light/UV hazard. If there is no specific welding shop or station, warn and restrict work area prior to welding. Alternatively, schedule welding activity during least disturbance to occupants that may be affected in or around the work area. Allow for air circulation at the floor and ceiling levels.

During welding:

- Follow electrical safety procedures to prevent electrical hazards. In addition to the normal safety precautions, if welding must be performed under electrically hazardous conditions (in damp locations or while wearing wet clothing; on metal structures such as floors, gratings or scaffolds; when in cramped positions such as sitting, kneeling or lying, if there is a high risk of unavoidable or accidental contact with the workpiece or ground) use the following equipment:



- Semiautomatic DC Constant Voltage (Wire) Welder.
- DC Manual (Stick) Welder.
- AC Welder with Reduced Voltage Control.
- Work practices such as using lower currents, using smaller rods, reducing arc length and welding with straight polarity (workpiece positive) decreases fume generation.
- Refer to the manufacturer's manual for proper installation and grounding of equipment.
- Do not connect an American triple phase power supply directly to a Canadian triple phase voltage input. This will destroy the transformer and possibly cause injury.
- Do not point welding gun toward any part of your body, other people or any metal when threading welding wire.
- Do not change electrodes with bare hands or wet gloves or dip hot electrodes holders in water to cool them.
- Avoid awkward body positions, which cause fatigue, reduce concentration and lead to poor welds, which may need to be repeated. Position yourself in a stable, comfortable posture.
- Always use hand to lower helmet.
- Position the welding item as flat as possible, on a horizontal surface, between waist and elbow height.
- Avoid working in one position for long periods. Use a footrest if standing for long periods.
- Work with material slightly below elbow level when working in a sitting position.
- Work with material between waist and elbow heights for comfort and precision when working in a standing position.
- Always store materials and tools within normal reach.
- Keep weld cables as short as possible, close together, and on the floor.
- Avoid pinch points e.g. drive rolls.
- When leaving equipment unattended, remove electrode and place holder to prevent contact with other works or conducting objects and turn OFF the power supply.

Fumes/Particulate/Gases:

- Fumes form when a metal is heated above its boiling point and vapours condense into very fine particles (solid particulates). Welding creates fumes are a mixture of metallic oxides, silicates and fluorides and the composition depends on the materials being welded and the electrodes being used. Gases such as carbon monoxide, ozone and nitrogen oxides may be generated during certain welding processes.
- If the metal has a coating or paint, these too can decompose with the heat and become part of the fumes. Care should be taken when working near these fumes. Please refer to the information provided in the following link: https://www.ccohs.ca/oshanswers/safety_haz/welding/fumes.html
- Remove coatings from the weld area to minimize fumes. Use stripping products to remove coatings and remove any residues before welding.
- Avoid grind coatings. Grinding dust may be toxic and can be inhaled.
- Position the head and body away from the smoke fume where possible.
- Use the correct shield gas and shut off shielding gas supply when not in use.
- If required to weld in a confined space, air monitoring should be done to ensure ventilation and respiratory protection are adequate. See Confined Space Regulation 632/05.



- Certain types of welding such as hardfacing or welding on lead or cadmium-plated steel, on galvanized steel and on other metals with coatings can produce highly toxic fumes. Reduce exposure by using local ventilation. Respiratory protection may also be required.
- Do not block airflow to local ventilation unit.

Once welding is completed:

- Inspect the area to ensure that wall surfaces, studs, wires or dirt are not hot.
- Vacuum (fire-resistant type) away combustible debris from inside ventilation or other service duct openings to prevent ignition. Inspect ducts after work has concluded to check for sparks.
- Remember the metal you weld stays hot! Avoid burns by using appropriate hand protection or tongs.
- Remove stick electrode from holder or cut off welding wire at the contact tip when not in use.
- Welding and cutting equipment shall be **tested** monthly for leaks with a leak test solution. Defects in equipment must be fixed before reusing. (See Ontario Fire Code Section 5.17 Welding and Cutting)
- Close valves and bleed lines when equipment is not in use.
- Allow for a cooling period; follow the rated duty cycle. Reduce current or reduce duty cycle before starting to weld again.
- Practice hand hygiene; wash hands and face with soap and water before eating, drinking, smoking, etc.

Fire Safety:

- Post a trained firewatcher within the work area during welding and for at least 30 minutes after work has stopped.
- Appropriate fire extinguishers must be readily available in the area where you are welding.
- Fires/explosions may also result from flashbacks or equipment failure.
- Clothes soiled with oils or grease can burn more easily. Sleeves or cuffs that are folded or rolled up can "catch" sparks and increase the risk of fire.
- Do not weld or cut empty fuel tanks or drums.
- Cutting torches should be equipped with reverse flow check valves and flame arrestors to prevent flashback and explosion, installed per manufacturer's instructions.
- If welding drums, tanks and closed containers that previously contained flammable or combustible materials, thoroughly clean before welding or cutting. As an added precaution, purge with inert gas* (nitrogen or carbon dioxide) and fill with water to within an inch or two from the place to be welded or cut and vent to atmosphere. Consult the manufacturer or SDS for more details.*Care should be taken to avoid creating an oxygen-deficient atmosphere, especially in a confined space, when using or exhausting inert gas.

Electrical Shock

- Insulate welder from workpiece and ground using dry insulation, rubber mat or dry wood.
- If wet area and welder cannot be insulated from the workpiece with dry insulation, use a semi-automatic, constant-voltage welder or stick welder with a voltage reducing device.
- Wear dry, hole-free gloves. Change as necessary to keep dry.
- Do not touch electrically hot parts or electrodes with bare skin or wet clothing.
- Keep electrode holder and cable insulation in good condition. Do not use if insulation is damaged or missing.
- Disconnect power to equipment before servicing.
- Use double-insulated or properly grounded electrical equipment.



Storing and Handling Compressed Gas Cylinders:

- Never touch a cylinder with the electrode.
- Handle cylinders very carefully. Read and follow all cylinder labels and SDS information.
- Store cylinders upright in a clearly identified, dry, well-ventilated storage area away from doorways, aisles, elevators, and stairs. Store in the upright position and secure with an insulated chain or non-conductive belt.
- Ensure that the area is well ventilated. With outside storage, place on a fireproof surface and enclose in a tamper-proof enclosure.
- Protect cylinders from contact with ground, ice, snow, water, salt, corrosion, high temperatures, excess pressure, mechanical shock, slag, open flames, sparks and arcs.
- Store oxidizing materials separately from fuel-gas or combustible materials including oil and grease. Indoors, separate oxygen from fuel gas cylinders by at least 6 metres (20 feet), by a wall at least 1.5 m (5 ft) high, or rated for 1.5 hour fire resistance.
- Do not use a cylinder as an electrical ground connection.
- Do not fasten cylinders to a worktable or to structures where they could become part of an electrical circuit.
- Do not strike an arc on a cylinder.
- Do not use a flame or boiling water to thaw a frozen valve. Valves or cylinders may contain fusible plugs which can melt at temperatures below the boiling point of water.
- Mark or label them as "Empty cylinder" and store empty cylinders away from full cylinders.
- Remove regulators when not in use and store these away from grease and oil. Put valve protective caps on the fittings before moving a cylinder and when in storage. Secure the protective caps.
- Keep cylinders and fittings from becoming contaminated with oil, grease or dust.
- Always keep oxygen away from oils and grease, and keep oil and grease from getting into an oxygen regulator or hose. The only lubricants which can be used with oxy-acetylene equipment (ONLY on threads and O-rings) are special products approved for such use.
- Do not use a cylinder that is not identified or if the label is not legible. (Note: the colours of industrial gas cylinders are not standardized.)
- Move cylinders with appropriate carts. Use proper lifting cradles.
- Turn face away from valve outlet when opening cylinder valve.
- Do not lift a cylinder by the valve cap. Never sling with ropes or chains or lift with electromagnets.
- Do not drag cylinders or use slings or magnets for hoisting. Use appropriate cradles or platforms.
- Never place cylinders on their sides as rollers to move equipment.
- Do not lay acetylene cylinders on their sides. If an acetylene tank has accidentally been left on its side, set it upright for at least one hour before it is used.
- Do not try to refill a cylinder or mix gases in a cylinder.
- Do not smoke in cylinder storage areas.

C: Personal Protective Equipment

Eyes/Face/Head Protection:

- Permanent eye damage can occur from ultraviolet (UV) and infrared rays. UV rays can cause skin cancer. Protect your eyes by wearing a welder's helmet fitted with a filter shade that is suitable for the type of welding you are doing. The helmet will protect your eyes and face from flying particles and UV radiation. Wear goggles or safety glasses with side shields under your helmet.
- Select lens shade appropriate for the type of welding process. Refer to CAN/CSAW117.2-12-Safety in Welding, Cutting and Allied Processes.



- Do not substitute modified glasses, sunglasses, smoked plastic or other materials for proper welding lenses.
- ALWAYS wear goggles when chipping or grinding a work piece if you are not wearing a welding helmet.
- For arc welding, a helmet must be used instead of gas welding goggles
- Wear a fire-resistant skull cap or balaclava hood under your helmet to protect your head from burns and UV radiation.
- Protect the back of your head by using a hood.
- Wear hearing protection in areas of elevated noise. Use fire resistant ear muffs when sparks or splatter may enter the ear rather than earplugs.
- Welding curtains also protect bystanders (other workers, members of the public) from UV rays.
- Contact lenses should not be worn due to airborne dust and dirt causing excessive irritation of the eyes under the lenses.

Clothing:

- Wear tight-fitting clothes. Avoid exposed skin. Wear long-sleeved shirt sleeves and collars rolled down and button up. Wear flaps over pockets. Wear pants with no cuffs.
- Make sure that all fabric garments are resistant to spark, heat and flame. Keep the fabrics clean and free of oils, greases and combustible materials that could be ignited by a spark. Launder flame retardant clothing per manufacturer instruction.
- Wear clothing made from heavyweight, tightly woven, 100% wool or cotton to protect from UV radiation, hot metal, sparks and open flames. Flame retardant treatments become less effective with repeated laundering.
- Do not wear clothing made from synthetic or synthetic blends. The synthetic fabric can burn vigorously, melt and produce severe skin burns. Wear non-synthetic materials such as wool.
- Wear dark colours prevent light reflection.
- Tape shirt pockets closed to avoid collecting sparks or hot metal or keep them covered with flaps.
- Pant legs must not have cuffs and must cover the tops of the boots. Cuffs can collect sparks.
- Repair all frayed edges, tears or holes in clothing.
- Wear high top CSA Grade 1 footwear, fully laced, to prevent sparks from entering into the boots.
- Use fire-resistant boot protectors or spats strapped around pant legs and boot tops, to prevent sparks from entering in the top of the boots.
- Wear gauntlet-type cuff leather welding gloves or protective sleeves of similar material, to protect wrists and forearms. Leather is a good electrical insulator if kept dry.
- Direct any spark spray away from your clothing.
- Wear leather aprons to protect your chest and lap from sparks when standing or sitting.
- Wear layers of clothing. To prevent sweating, avoid overdressing in cold weather. Sweaty clothes cause rapid heat loss. Leather welding jackets are not very breathable and can make you sweat if you are overdressed. Keep clothing dry.
- Do not wear rings or other jewelry. Tie back long hair.

Respiratory Protection:

- Appropriate respiratory protection is needed when ventilation is not sufficient to remove welding fumes to acceptable regulated exposure limits or when there is risk of oxygen deficiency. If using an air-purifying respirator, the respirator should be equipped with HEPA filters.
- Respiratory protection should be worn for certain welding processes that generate more hazardous fumes: e.g., stainless steel or exposure to beryllium.



- If wearing a respirator under a welding helmet, ahead of time, verify that the respirator can fit under the helmet. In some cases, a flatter, low-profile style respirator may be needed to fit under the welding mask. Departments can work with their vendors to identify the respirator model that will fit under the specific welding mask used by workers. Alternatively, a welding respiratory assembly can be used.

D: Training

Departments are responsible for ensuring that employees who perform welding have the appropriate training and/or licensing with respect to welding to perform their work safely (hazard identification, safe practices, fire safety precautions, controls for reducing hazards and use/maintenance/and limitations personal protective equipment).

In addition, the following minimum training requirements for workers and their supervisors that perform welding is also recommended:

- EHS576 WHMIS training for non-lab staff
- EHS519 Lead in building materials: evaluating and controlling the hazard
- EHS532 [Respiratory and Fit Testing Training](#)

EHS Training webpage: <https://ehs.utoronto.ca/training/my-ehs-training/>

Other training may be appropriate depending on the conditions of work (e.g. Confined Space, Working At Heights, Asbestos). Workers are also encouraged to take training on [how to use a fire extinguisher](#), offered by UofT F&S Fire Prevention.

E: Emergency Preparedness

Users of welding equipment should know the location of and how to use any emergency equipment that may be in the area such as fire extinguishers, first aid kits, eyewash stations or showers and alarms.

Elements of emergency preparedness may include the following:

- First aid stations are available, easy to identify, routinely inspected and re-stocked as needed.
- First aiders are identified and fully trained. Generally, a list of contacts and phone numbers are posted near the First Aid Station.
- A list of emergency numbers should be posted or available.