



## **Welding Guidelines**

Office of Environmental Health and Safety

### **1.0 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 excessive noise, heat and toxic substances (welding fumes/particulates, flux vapours).
- 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 from flying debris, “welder’s eye” from the radiation emitted by welding arcs and flames.
- Cuts and lacerations from sharp metal edges.
- 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: electric shock from improper installation or grounding of equipment, working at heights, working around asbestos

#### Types of Welding:

1. Electric arc: electric arc is applied to melt the base metals and filler metals. There are different types of electric arc welding depending on the amount of fumes produced – flux core, shielded metal, gas metal, metal inert gas, gas tungsten, tungsten inert gas.
2. Gas: a flame from a burning gas (usually acetylene) is applied to melt the base metal at the joint to be welded.
3. Thermite: employs a chemical reaction to produce intense heat instead of using gas fuel or electric current (exothermic welding).

#### Scope

This guideline applies to all University of Toronto employees. It also applies to external workers or visitors (e.g. contractors, drivers, etc.) who may conduct welding on University property.

### **2.0 Responsibilities**

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

#### Supervisors/Management/Principal Investigators

- Identify workers or work activities where workers may be required to conduct welding.
- Identify and anticipate any hazards that may be present (e.g. flammables, asbestos.).



- Develop, document, implement and maintain appropriate work procedures, measures, inspections, and precautions to control the hazards that may be present using these guidelines.
- Ensure that a Job Safety Analysis (JSA) or written work procedure is completed where necessary and that they are readily available to workers.
- Ensure controls identified in the JSA or other work procedures are followed for safe work when welding.
- 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 other work procedures.
- Where work is contracted to external parties, equivalent procedures should be followed.

#### Workers

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

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

## **3.0 General Controls for Welding**

Controls for welding fall into 5 categories:

- 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. An example would be not performing welding in a confined space, or eliminate the hazards in the space before welding begins. 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.

#### Substitution



If possible, use the least hazardous welding materials/technique. An example would be switching to shielded metal arc welding to gas metal arc welding with a solid or metal-coated wire. Another example would be to use low-manganese filler metal to reduce the amount of hazardous fumes produced.

### Ventilation

Welding should be performed in a well-ventilated space where possible. Avoid breathing fumes/smoke by keeping your head to the side of, not above, your work. Weld Fume Control Units specifically designed for the extraction and filtration of welding fume may be required. Where this 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:

- Ensure all required permits are in place such as: **hot work permit, fire protection and confined space.**
- Refer to Safety Data Sheet (SDS) for more information on welding rods, wires, electrodes, compressed gases, fluxes, metals, coatings, cleaners and degreasers that you may be using.
- Look around the area for potential hazards before you start the job.
- Know and follow the equipment manufacturer's instructions.
- Inspect to make sure that all equipment is in good operating order before work starts. Have all installed equipment inspected by a qualified person regularly.
- Ensure power supply system is properly sized, rated and protected to handle any welding units.
- Remove all flammable and combustible materials from the work area (must be at least 11 metres/35 feet away from the welding area)
- If combustibles cannot be moved, cover them with fire resistant blankets or shields. Protect gas lines and equipment from falling sparks, hot materials and objects.
- Cover or close all ducts or openings that could carry sparks.
- 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.
- Inspect the work area thoroughly before starting. Look for combustible materials in structures (partitions, walls, ceilings).
- Block off cracks between floorboards, along baseboards and walls, and under door openings, with a fire resistant material. Close doors and windows.
- Cover wall or ceiling surfaces with a fire resistant and heat insulating material to prevent ignition and accumulation of heat.
- Remove all ignition sources such as matches and butane lighters from pockets. Hot welding sparks may light the matches or ignite leaking lighter fuel.
- Absolutely no smoking, eating or drinking in the welding area.
- Place adequate 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.



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.
- Refer to the manufacturer's manual for proper installation and grounding of equipment.
- Never connect an American triple phase power supply directly to a Canadian triple phase voltage input. You will destroy the transformer and possibly injure yourself.
- Never point welding gun toward any part of your body, other people or any metal when threading welding wire.
- 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.
- 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.
- Use a footrest if standing for long periods.
- 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.

Fumes/Particulate:

- Welding creates fumes, which are a complex mixture of metallic oxides, silicates and fluorides.
- Fumes form when a metal is heated above its boiling point and vapours condense into very fine particles (solid particulates).
- Welding fumes normally contain oxides of the materials being welded and of the electrodes being used.
- 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](https://www.ccohs.ca/oshanswers/safety_haz/welding/fumes.html)
- Remove coatings from the weld area to minimize the fume. Use stripping products to remove coatings. Make sure to remove any residues before welding.
- Avoid grind coatings. Grinding dust may be toxic.
- Shut off shielding gas supply when not in use. Ensure the correct shielding gas is used.
- 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.
- When welding hardfacing (see instructions on container or SDS) or on lead or cadmium plated steel and other metals or coatings which produce highly toxic fumes, keep exposure as low as possible and within applicable legislated limits using local exhaust or mechanical ventilation unless



exposure assessments indicate otherwise. In confined spaces or in some circumstances, outdoors, a respirator may also be required. Additional precautions are also required when welding on galvanized steel.

Once welding is completed:

- Inspect the area following work 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. Prevent sparks from entering into the ductwork. Cover duct openings with a fire resistant barrier and inspect the ducts after work has concluded.
- 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 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 cooling period; follow rated duty cycle. Reduce current or reduce duty cycle before starting to weld again.
- Do not block or filter airflow to unit.

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. Please note that clothes soiled with oils or grease can burn more easily.
- In addition, 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.

Storing and Handling Compressed Gas Cylinders:

- Handle cylinders very carefully. Read and follow all cylinder labels and SDS information.
- Store cylinders in a clearly identified, dry, well-ventilated storage area away from doorways, aisles, elevators, and stairs.
- Store cylinders in the upright position and secure with an insulated chain or non-conductive belt.
- Secure the protective caps.
- 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, mechanical shock, slag, open flames, sparks and arcs.
- Store oxygen and fuel gases separately. 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 work table 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 protective caps on the fittings when in storage.
- 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.)
- Remove the regulator and replace the valve protection cap before moving a cylinder.
- 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, slide, or drop cylinders.
- 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

## **C: Personal Protective Equipment**

### Eyes/Face/Head Protection:

- Permanent eye damage can occur from UV and infrared rays. 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 safety glasses with side shields under your helmet.
- 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. UV rays can cause skin cancer.
- Protect the back of your head by using a hood.
- Wear hearing protection in areas of elevated noise.
- Welding curtains

### Clothing:

- Button your shirt to protect the skin on the throat and neck.
- Wear long sleeves and pant legs. Shirts must have sleeves with buttoned cuffs and a collar.
- 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.
- 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
- 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 boots 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 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.
- 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.

**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.

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

- WHMIS training
- Lead in building materials: evaluating and controlling the hazard
- Respiratory and Fit Testing Training

Other training may be appropriate depending on the conditions of work (e.g. Confined Space, Working At Heights, Asbestos)



## **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.
- A first aid hazard assessment is not required, but conducting one will ensure the workplace is prepared to respond appropriately to common welding related injuries such as burns, welding flash, chemical exposure to eye or skin, etc.