



UNIVERSITY OF  
**NORTHERN COLORADO**

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**Environmental Health and Safety**

**Welding, Cutting and Brazing Safety  
Guidelines**

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## Welding, Cutting and Brazing Safety Guidelines

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## **Environmental Health and Safety**

### **Welding, Cutting and Brazing Safety Guidelines**

#### **I. Purpose**

The purpose of the University of Northern Colorado's Welding, Cutting and Brazing (WC&B) program is to protect faculty, staff, students and visitors from hazards associated with activities that requires the use of equipment involving open flames, sparks and heat that pose fire and other health hazards. This program establishes minimum requirements for performing work during such activities in a safe and cautious manner.

#### **II. Responsibilities**

The appropriate department shall be responsible for following in accordance with this guideline.

##### **A. Environment, Health & Safety (EHS) Department shall:**

- Review and approve, in coordination with the AVP Facilities Management the designated areas approved for welding and cutting activities.
- Maintain a list of designated areas.
- Inspect designated areas to be sure that conditions have not become unsafe for welding and/or cutting annually.
- Provide training for fire watches.
- Suspend welding and cutting work if conditions become unsafe for the work being performed.
- Investigate any incidents that may occur during operations.

##### **B. Supervisors shall:**

- Ensure employees who will be performing such operations are properly trained on this procedure before performing work on campus.
- Ensure the safe operation of equipment, incorporating information from Material Safety Data Sheets (MSDS) on welding materials used, appropriate Personal Protective Equipment (PPE), evaluation of combustible materials and hazardous areas present or likely to be present in the work location.
- Notify employees of the purpose and intent of the Hot Work Program.

- Make periodic inspections of areas where the hot work procedures are being used.
- Determine if the work will be done in an area which contains or has the potential to contain combustibles or other hazardous materials.
- Ensure that employees are provided with and using proper safety equipment, including personal protective equipment and fire extinguishing equipment.

C. Welding, Cutting, and Brazing Operators shall:

- Understand the University's guidelines on Welding, Cutting & Brazing.
- Inspect all welding equipment prior to use for proper working condition.
- Perform a hazard assessment before work or during any unusual welding operations.
- Ensure cable, hoses, and other equipment will be kept clear of passageways, elevators, ladders, and stairways.
- Ensure the public and standby personnel will be shielded from welding rays, flashes, sparks, molten metal, and slag.
- Use all required welder personal protective equipment for the specific job.
- Read and understand Material Safety Data Sheets (MSDSs), and safety requirements.
- If necessary, obtain a "Hot Work Permit" for any non-designated areas.
- Avoid welding or cutting operations where conditions ARE NOT SAFE.
- Stop operations when conditions change from those originally set when work was approved.
- Cease to operate if the provided Fire Watch leaves the work site and will remain at work site for thirty (30) minutes following job completion to monitor for fires.
- Ensure when work is stopped for an extended period of time, such as lunch breaks or overnight, the equipment must be shut down and secured.
- Report any unsafe condition immediately to the Supervisor.
- Ensure that the work area is given a final inspection one-half hour after job completion to locate and extinguish possible hot spots or fires.

D. Facilities Management Construction Services shall:

- Notify all contractors of the purpose and intent of these guidelines.
- Make periodic inspections of areas where the hot work procedures are being used by contractors.

### III. Hazard Identification and Prevention

Welding, cutting, and similar processes produce molten metal, sparks, slag, and hot work surfaces that can cause fire or explosion if precautionary measures are not followed. Flying sparks are the main cause of fires and explosions in welding and cutting.

#### A. Fire Prevention and Protection:

Sparks can travel up to 35 feet from the work area. Sparks and molten metal can travel greater distances when falling. Sparks can pass through or become lodged in cracks, clothing, pipe holes, and other small openings in floors, walls, or partitions. Welding and cutting can cause explosions in spaces containing flammable gases, vapors, liquids, or dusts.

Whenever possible the following shall be implemented to mitigate possible unwanted fires:

- If possible, relocate the work from the work site to the welding/maintenance shop area. Welding and cutting operations shall ideally be conducted in a separate, well ventilated room equipped for these types of work activities.
- Remove combustible materials for a minimum radius of 35 feet around the work area or move the work to a location well away from combustible materials.
- Protect combustibles with covers made of fire-resistant materials.
- If possible, enclose the work area with portable, fire-resistant screens.
- Cover or block all openings, such as doorways, windows, cracks, or other openings with fire resistant material.
- When needed, have a qualified Fire watch in the work area during and for at least 30 minutes after hot work is finished.
- Do not dispose of hot slag in containers holding combustible material.
- Fire extinguishers shall be maintained in a state of readiness for instant use.
- Welding or cutting is not permitted in or near rooms containing flammable or combustible liquids, vapors, or combustible dusts. Do not weld or cut in atmospheres containing reactive, toxic, or flammable gases, vapors, liquids, or dust.
- Do not apply heat to a work piece covered by an unknown substance or coating that can produce flammable, toxic, or reactive vapors when heated.
- Provide safety supervision for outside contractors conducting hot work. Inform contractors about site-specific hazards including the presence of flammable materials.

#### B. Hot Work Permit Requirements and Locations:

Employees that perform hot work outside of a designated area must complete a UNC Hot Work Permit (refer to the UNC Hot Work Program) prior to conducting hot work operations. The Supervisor, Permit Authorizing Individual, and Hot Work Operator are responsible for ensuring compliance with the permit requirements.

Hot work is never permitted in certain types of locations where safe conditions do not exist and cannot be created. Hot work is allowed in *two* types of locations, Designated and Controlled. Refer to the UNC Hot Work program for further details regarding requirements and restrictions.

#### C. Approved Fire-Resistant Materials For Welding, Cutting & Brazing

*Welding Blanket:* A heat-resistant fabric designed to be placed in the vicinity of a hot work operation. Intended for use in horizontal applications with light to moderate exposures such as that resulting from chipping, grinding, heat treating, sand blasting, and light horizontal welding. Designed to protect machinery and prevent ignition of combustibles such as wood that are located adjacent to the underside of the blanket. They are made from different materials such as fiberglass, Silica, and other fire-resistant materials.

*Welding Pads:* A heat-resistant fabric designed to be placed directly under a hot work operation such as welding or cutting. Welding pads are intended for use horizontal applications with severe exposures such as that resulting from molten substances of heavy horizontal welding. Designed to prevent the ignition of combustibles that are located adjacent to the underside of the pad.

*Welding Curtain:* A heat-resistant fabric designed to be placed in the vicinity of a hot work operation. Intended for use in vertical application with light to moderate exposures such as that resulting from chipping, grinding, heat treating, and light horizontal welding. Designed to prevent sparks from escaping a confined area.

#### D. Electric Shock Hazards and Safety Precautions:

Electric shock from electrical welding and cutting equipment can result in death or severe burns. Additionally, serious injury can occur if the welder falls as a result of the shock. This safety hazard is associated with operations that use electricity to generate heat, such as arc and resistance welding and cutting.

Employees are to use proper precautionary measures and recommended safe practices at all times to avoid electrical shocks. Personnel using electrical welding and cutting equipment must be trained on safe work practices and procedures before use of this equipment. Some measures to prevent electrical shock include:

- Never use a bare hand or wet glove to change electrodes.
- Do not touch an energized electrode while you are in contact with the work circuit.
- Never stand on a wet or grounded surface when changing electrodes.
- Do not allow the electrode holder or electrode to come in contact with any other person or any grounded object.
- Ground the frames of welding units.
- Insulate yourself from the work piece and ground using dry insulating mats or covers big enough to prevent any physical contact with the work or

ground or wear properly designed and approved rubber-soled boots in good condition.

- If utilizing long lengths of cable, suspend them overhead whenever possible. If run along the floor, be sure they do not create a tripping hazard, become damaged, or tangled.

Additional safety precautions are required when welding is performed under any of the following electrical hazardous conditions:

- In damp locations or while wearing wet clothing
- On metal floors, gratings, scaffolds, or other metal structures
- In cramped positions such as sitting, kneeling, or lying
- When there is a high risk of unavoidable or accidental contact with the work piece and ground.

Where these conditions are present, use one of the following types of equipment presented in order of preference:

- Semiautomatic DC constant voltage metal electrode (wire) welder,
- DC manual covered electrode (stick) welder,
- AC welder with reduced open-circuit voltage. In most situations, use of a DC constant voltage wire welder is recommended. And do not work alone!

#### **IV. Protection of Personnel**

Employees exposed to the hazards created by welding, cutting, or brazing operations shall be protected by PPE. Appropriate protective clothing required for any welding operation will vary with the size, nature and location of the work to be performed. PPE must protect against hazards such as burns, sparks, spatter, electric shock, and optical radiation.

##### **A. General Protective Equipment**

The following are the minimum requirements for proper personal protective equipment needed for the scope of work outlined in this guideline.

- Clothing with adequate body coverage
- Leather boot and leg protection
- Hand protection
- Hearing protection (where sound levels may be above regulated decibels)

##### **B. Respiratory Protective Equipment:**

When controls such as ventilation fail to control airborne contaminants to allowable levels or when the implementation of such controls is not feasible, respiratory protective equipment shall be used to protect employees from hazardous concentrations of air contaminants.

### C. Eye and Face Protection:

Welding, cutting, and brazing processes present various hazards to the welder's eyes and face: the intense heat from arc rays and welding sparks can cause burns to the skin and eyes, during electric welding and welding processes. Personal Protective Equipment for the eyes and face is very important for both the welder and other personnel working near welding operations. Filter lens shall be in accordance with ANSI Z87.1.

Helmets with filter lenses and cover lenses shall be used by operators and nearby personnel when viewing the arc. A darker shade is necessary because the presence of the gas increases the reflective intensity of the arc.

Appendix A is a guide for the selection of the proper shade number for welding and cutting eye protection. These recommendations may be varied to suit the individual's needs to protect against infrared and ultraviolet light

Welding helmets with filter lenses are intended to protect users from arc rays and from weld sparks and spatter which impinge directly against the helmet. They are not intended to protect against slag chips, grinding fragments, wire wheel bristles, and similar hazards. Spectacles with side shields or impact safety goggles, combined with the use of a face shield is required for protection against these hazards.

## V. Health Protection / Ventilation Requirements

The heat caused by welding, cutting or brazing creates fumes and gases (fume plume). Fumes contain respiratory particles. Gases include the shielding gas, and combustion products. The heat from the arc or flame causes the fume plume to rise. Over exposure to welding fumes and gases can cause dizziness, illness, and even unconsciousness and death. The following measures and precautions are to be instituted to protect employee health.

Ventilation is used to control overexposures to the fumes and gases during welding and cutting will keep the fumes and gases from the welder's breathing zone. Adequate ventilation shall be provided for all welding and cutting and related operations and shall be enough ventilation such that personnel exposures to hazardous concentrations of airborne contaminants are maintained below the allowable limits. There are two forms of ventilation that are utilized with these types of work to mitigate health problems.



## A. Natural Ventilation

Natural ventilation is the movement of air through a workplace by natural forces. Roof vents, open doors and windows provide natural ventilation. The size and layout of the area/building can affect the amount of airflow in the welding area. Natural ventilation can be acceptable for welding operations if the contaminants are kept below the allowable limits.

Natural ventilation is considered sufficient for welding or cutting operations where the following restrictions are not present.

- In a space of less than 10,000 cubic feet (284 m<sup>3</sup>) per welder.
- In a room having a ceiling height of less than 16 feet (5 m).
- In confined spaces or where the welding space contains partitions, balconies, or other structural barriers to the extent that they significantly obstruct cross ventilation.

## B. Mechanical Ventilation

Mechanical ventilation is the movement of air through a workplace by a mechanical device such as a fan. Mechanical ventilation is reliable. It can be more effective than natural ventilation. An example is a local exhaust ventilation system that includes a capture device, ducting, hood, and a fan. The capture devices remove fumes and gases at their source. Some systems filter the airflow before exhausting it. Fixed or moveable capture devices are placed near or around the work. They can keep contaminants below allowable limits. When using mechanical ventilation remember to:

- Locate the hood as close as possible to the work.
- Position the hood to draw the plume away from the breathing zone.
- Curtains may be used to direct airflow.

Mechanical ventilation shall be provided when welding, cutting, burning or soldering is conducted on metals other than the following items listed: Fluorine compounds, Zinc, Lead, Beryllium, Cadmium, Mercury, and stainless steels.

- In a space of less than 10,000 cubic feet per welder.
- In a room having a ceiling height of less than 16 feet.
- In confined spaces or where the welding space contains partitions, balconies, or other structural barriers to the extent that they significantly obstruct cross ventilation.

Mechanical local exhaust ventilation may be by means of either of the following:

1. Hoods. Freely movable hoods intended to be placed by the welder as near as practicable to the work being welded and provided with a rate of air-flow sufficient to maintain a velocity in the direction of the hood of 100 linear feet

per minute in the zone of welding when the hood is at its most remote distance from the point of welding. The rates of ventilation required to accomplish this control velocity using a 3 inch (7.6 cm) wide flanged suction opening are shown in the following table:

Minimum air Duct - Welding zone flow		
Distance from arc	Cubic feet/Minute	Duct Size
4 to 6 inches from arc or torch	150	3
6 to 8 inches from arc or torch	275	3 1/2
8 to 10 inches from arc or torch	425	4 1/2
10 to 12 inches from arc or torch	600	5 1/2

2. Fixed enclosure (Booths). A fixed enclosure with a top and not less than two sides which surround the welding or cutting operations and with a rate of airflow sufficient to maintain a velocity away from the welder of not less than 100 linear feet (30 m) per minute.

#### Ventilation in confined spaces

All welding and cutting operations carried on in confined spaces shall be adequately ventilated to prevent the accumulation of toxic materials or possible oxygen deficiency. This applies not only to the welder but also to helpers and other personnel in the immediate vicinity. All replacement air shall be clean and reparable. Because of its flammable properties, Oxygen shall never be used for ventilation.

### VI. Operational Safety

The following sections are general safety precautions for the most commonly used welding techniques. In no way do they supersede any department standard operating procedures but are more of a safety precautions that cover these types of operations.

#### A. Gas Welding Operational Safety

Oxygen cylinders and ancillary parts shall be:

- Kept free from oil, grease, and other flammable or explosive substances.
- Oxygen cylinders or apparatus shall not be handled with oily hands or gloves.
- Oxygen cylinders and apparatus shall not be used interchangeable with any other gas. Oxygen shall not be used as a substitute for compressed air.
- Oxygen shall not be used for any other work purpose other than welding and cutting (e.g. do not use to blow out pipelines, to dust clothing, do not strike against an oily surface, greasy clothing, or enter fuel oil other storage tanks, etc.)
- Empty cylinders shall have their valves closed.
- Connections shall be checked for leaks after assembly and before lighting the torch.

- Before lighting the torch for the first time each day, hoses shall be purged individually.
- Hoses shall not be purged into confined spaces or near ignition sources.
- Hoses shall be purged after a cylinder change.
- Torches shall be lit by a friction lighter or other approved device, not by any form of flame.
- Whenever work is suspended, Torch valves shall be closed, and the gas supply shut off.
- Hose connections shall be clamped or otherwise securely fastened in a manner that will
- With stand, without leakage, twice the pressure to which they are normally subjected in service, but in no case less than a pressure of 300 PSI.
- Hose showing leaks, burns, worn places, or other defects rendering it unfit for service shall be repaired or replaced.

## B. Electric Arc Welding

This section contains safety precautions specific to the operations of arc welding and cutting equipment.

Arc Welding Machines shall be designed and constructed to carry their rated load with rated temperature rises where the temperature of the cooling air is sufficient and shall be suitable for operation in atmospheres containing gases, dust, and light rays produced by the welding arc.

Only manual electrode holders specifically designed for arc welding and cutting of a capacity capable of safely handling the maximum rated current required by the electrodes may be used.

All current carrying parts of the holder that are gripped by the welder or cutter, and the outer jaws of the holder, shall be fully insulated against the maximum voltage encountered to ground.

Cables shall be completely insulated, flexible, capable of handling the maximum current requirements of the work in progress, and in good repair.

Voltage: The following limits shall not be exceeded:

- Alternating-current machines: Manual arc welding and cutting - 80 volts.
- Automatic (machine or mechanized) arc welding and cutting - 100 volts.
- Direct-current machines: Manual arc welding and cutting - 100 volts.
- Automatic (machine or mechanized) arc welding and cutting - 100 volts.

Grounding the frames of arc welding and cutting machines shall be adequately grounded in accordance with the manufacture, Federal electrical standards, and ANSI standards.

Care shall be taken in applying arc welding equipment to ensure that the ampere rating chosen is adequate to handle the job. Welding machines shall not be operated above the ampere ratings and corresponding rated duty cycles as specified by the manufacturer and shall not be used for applications other than those specified by the manufacturer.

When using alternating current (AC) or direct current (DC) arc welding machines, the welding operator shall take special care to prevent electrical shock. The manufacturer shall be consulted, and a hazard assessment shall be performed before unusual service conditions are encountered. Unusual service conditions may exist, and in such circumstances, machines shall be especially designed to safely meet the requirements of the service. Most important among these conditions are:

- Exposure to unusually corrosive fumes.
- Exposure to steam or excessive humidity.
- Exposure to excessive oil vapor.
- Exposure to flammable gases.
- Exposure to abnormal vibration or shock.
- Exposure to excessive dust.
- Exposure to weather.

Note: Water or perspiration may cause electrically hazardous conditions. Electrical shock may be prevented by performing a hazard assessment before work, relocating work to a safe location, avoiding contact with live electrical parts, and lastly by use of personal protective equipment the use of nonconductive gloves, clothing, and shoes.

## **VII. Training and Record Keeping**

It is the responsibility of each department to ensure that their employees receive the required training. Training can be provided by the Environmental Health and Safety department. Training records will be retained by the Environmental Health and Safety office for three years.

### UNC Welding, Cutting, & Brazing Safety Guidelines Appendix A: Filter Shade Selection for Types of Welding

Operation	Electrode Size (mm)	Arc Current (A)	Min Shade	Suggested Shade
Shielded Metal	< 2.5 mm	< 60	7	*
Arc Welding	2.5 - 4mm	60 - 160	8	10
	4 - 6.4mm	160 - 250	10	12
	> 6.4mm	250 - 550	11	14
Gas Metal Welding and Flux Cored Arc		< 60	7	*
		60 - 160	10	11
		160 - 250	10	12
		250 - 500	10	14
Gas Tungsten Arc Welding		< 50	8	10
		50 - 150	8	12
Air Carbon Arc Cutting		150 - 500	10	14
		< 500	10	12
		500 - 1000	11	14
Torch Brazing				3 or 4
Torch Soldering				2
Carbon Arc Welding				14
Gas Welding (plate under 1/8" thick, light)				4 or 5
Gas Welding (plate 1/8" to 1/2" thick, medium)				5 or 6
Gas Welding (plate over 1/2" thick, heavy)				6 or 8
Oxygen Cutting (plate under 1" thick, light)				3 or 4
Oxygen Cutting (plate 1" to 6" thick, medium)				4 or 5
Oxygen Cutting (plate over 6" thick, heavy)				5 or 6

\*As a rule of thumb, start with a shade that is too dark to see the weld zone. Then go to a lighter shade that gives sufficient view of the weld zone without going below the minimum. In Oxy-fuel Gas Welding or Cutting where the torch produces a high yellow light, it is desirable to use a filter lens that absorbs the yellow or sodium line in the visible light of the operation.

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