



Welding, burning, & cutting

Improper welding, burning, and cutting can be dangerous, but they can be done safely by following set of procedures. This guide includes a list of potential hazards associated with these tasks and rules by which the hazards can be controlled.

The following information is intended for use on many different types of construction projects and is very general in nature. Specific job rules may dictate more stringent requirements or special procedures.

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This publication provides practical loss control and safety information to assist you in making your workplace safer. It is not legal advice. SAIF Corporation has made every effort to bring significant Oregon Occupational Safety and Health Administration (OR-OSHA) regulations to your attention. Nonetheless, compliance with OR-OSHA remains your responsibility. You should read and understand all relevant OR-OSHA regulations that apply to your job site(s). You may want to consult with your own attorney regarding aspects of OR-OSHA that may affect you.

Note: The information in this publication is time sensitive. Do not rely upon this document if its publication date is more than three years old. Please check the Employer Guide "Safety" section of our web site at www.saif.com/employer for a more recent, printable copy. You'll also find a variety of other valuable safety information designed to help your business prevent injuries and control costs.

Welding

General welding precautions

1. Electrode holders should be in good repair and rated for the maximum capacity of equipment used.
2. All cables and connectors should be in good repair, tightly attached, fully insulated, and rated for the maximum capacity of the work.
3. The welding lead will have a safe current capacity equal to, or greater than, the specified maximum output of the arc welding or cutting unit which it serves.
4. When a single work lead services more than one unit, its safe current carrying capacity should equal or exceed the total specified maximum output capacities of all the units which it services.
5. All electrical equipment (welding machines) and work should be properly grounded. The welding lead is not a ground lead. It is used only to complete the electrical circuit. A separate connection may be required to ground the work piece. Do not mistake the work lead for ground.
6. Pipelines containing gases or flammable liquids, or conduits containing electrical circuits, should not be used as a ground.
7. When electrode holders are to be left unattended, the electrode should be removed and the holders placed or protected so that they cannot make electrical contact with personnel or conducting objects. Always put stub ends in proper containers, not on the floor.
8. Do not weld while standing in water, or if clothing and gloves are wet.
9. Inspect equipment for loose connections or bare or damaged wires. Do not use faulty equipment.
10. Have workers turn off the welding machine at the end of the shift or when they will not be using it for an extended period.

Fire

1. Sparks or spatter from welding or arc gouging may ignite burnable items in the area. Always be sure hot work areas have a minimum 35-foot clear area free of combustible materials.
2. Burnable materials should be removed from the area where welding or arc gouging is to take place or protected with flame-retardant materials. Use a fire watch as appropriate.
3. When welding on decks, walls, or overhead, be sure to take the necessary precautions to prevent fire or heat damage in adjacent rooms. Use a fire watch in the other affected room(s) when appropriate.
4. Sparks and spatter from arc gouging travel considerable distances. Whenever possible, orient the spark stream to minimize concern for fire or damage resulting from the spark stream. Use fire-retardant shielding and/or fire watch as appropriate.
5. Be sure to have full knowledge of the location and use of all fire extinguishing equipment in the area.

Explosions

1. Do not weld or use arc gouging equipment when the smell of propane, acetylene, or any other fuel or gas is present. Determine the cause of the leak and get it corrected.
2. Do not perform any "hot work" (electric or gas welding, cutting, and brazing or similar flame-producing operations and grinding) in, or on, a tank or container unless it is properly vented.
3. Do not perform any "hot work" in, or on, any vessel, tank, or container which carries, or has carried, flammable materials, liquids, or gases until the container has been cleaned and tested and declared safe for "hot work" by the job safety authority.
4. Use appropriate ventilating devices before and during "hot work."
5. Ensure that hollow spaces are vented or purged prior to hot work activity.
6. Acetone and alcohol are commonly used for cleaning parts to be welded. Be sure to keep these containers and rags a safe distance from "hot work."
7. Disposable butane pocket lighters are not allowed where any "hot work" is being performed.

8. Never strike an arc on a compressed gas cylinder.

Burns

1. Exposed skin is an invitation to burns. Be sure to wear long-sleeved shirts that are not open at the chest and always fasten the top button of your shirt or jacket. Use leather jackets when appropriate.
2. Avoid polyester clothing since it melts easily and can result in serious burns.
3. Falling slag, spatter, or molten filler metal can cause burns to ankles and feet. Wear leather, steel-toed, high-topped boots during welding and cutting activities. Fire-resistant boot protectors may also be necessary. Avoid trousers with cuffs.
4. Never carry flammable items such as matches and lighters in your pockets while involved with "hot work." Disposable butane pocket lighters are not allowed where any "hot work" is carried on.
5. Always wear the appropriate type of leather gloves for the welding or cutting process being employed.
6. Be extremely cautious around weld joints that require high preheat temperatures and the use of added heat sources for maintenance of the required preheat temperature.
7. Before leaving a work area, always mark "hot work" pieces (with soapstone, crayon, etc.) to alert others of this hazard.

Arc Radiation

1. Infrared or ultraviolet radiation from the arc can burn the eyes or skin. Intense light can cause an irritation in the eyes known as "welder's flash," "arc-eye," or flash burn. Always view the arc when protected with a shield using protective altered lenses of the appropriate shade. The following are recommended shade numbers from ANSI Z49.1:2005 "Guide for Shade Numbers":

Process	Electrode Size In. (mm)	Arc Current (amperes)	Minimum Protective Shade	Suggested Shade No. (Comfort)
Shielded metal arc welding (SMAW)	Less than 3/32 (2.4)	Less than 60	7	-
	3/32 - 5/32 (2.4- 4.0)	60 - 160	8	10
	5/32 - 1/4 (4.0- 6.4)	160 - 250	10	12
	More than 1/4 (6.4)	250 - 550	11	14
Gas metal arc welding and flux-cored arc welding (GMAW/FCAW)		Less than 60	7	-
		60 - 160	10	11
		160 - 250	10	12
		250 - 500	10	14
Gas tungsten arc welding (GTAW)		Less than 50	8	10
		50 - 150	8	12
		150 - 500	10	14
Plasma arc welding (PAW)		Less than 20	6	6 to 8
		20 - 100	8	10
		100 - 400	10	12
		400 - 800	11	14
Torch brazing (TB)		-	-	3 or 4
Torch soldering (TS)		-	-	2
Carbon arc welding (CAW)		-	-	14

ANSI Z49.1:2005 Guide for Shade Numbers

2. Always wear safety glasses with top and side shield protection, or goggles, under the welding helmet.
3. Avoid light, thin clothing and ensure that all skin is covered completely.

Eye Injuries

1. Grinding or welding sparks or slag can cause eye injuries. Full face shields and safety glasses should be worn at all times. (Specific job requirements may be more stringent.)
2. Protect other employees from welding, cutting, or grinding operations. Use approved welding curtains or flash screen in and around active work areas.
3. Use care in removing safety glasses, face shields, and welding hoods so as not to cause residual dust particles to enter the eyes.

Ear injuries/hearing damage

1. Welding, cutting, or grinding sparks can enter the ear and possibly cause permanent damage. Ensure eye and face protection complies with ANSI Z78.1 standard.
2. High noise levels from carbon-arc cutting, plasma-arc cutting, thermal spraying, and grinding can affect your hearing.
3. Always wear protective ear equipment as appropriate. Protection which covers the entire ear is recommended (e.g. fire-resistant welder's cap).

Falls

1. Welding cables, hoses, and lines lying about the floor or deck are tripping hazards. Always keep cables, hoses, and lines off the decks and floors and on hangers and out of main walkways.
2. Electrode stubs lying on floors or decks are slipping hazards. Always use the appropriate stub end containers.
3. While welding, the welding hood prevents an individual from relating to the immediate surroundings. Be aware of the hazards in your area, and use safety belts when appropriate, or as required by job rules.
4. Ensure the work area is clean and dry. Be aware of clutter, obstructed views, open drawers, and uneven walking surfaces.

Welding fumes

1. Avoid breathing fumes and gases. Always try to keep your head out of the direct path of the fume plume.
2. Use the proper particulate and vapor-type respirators and additional ventilation, as required, when welding, cutting, gouging, or burning on coated materials such as galvanized or heavily painted materials.

3. Make sure adequate ventilation is available and used when welding or cutting in confined areas.
4. Remove rust inhibitors, paints, degreasers, and other coatings prior to performing hot work.

Ventilation

1. When welding in a confined or enclosed space, provide mechanical ventilation as needed.
2. When welding galvanized metal, be especially careful to provide adequate ventilation and an appropriate respirator.

Confined Spaces

1. Inert gases, such as argon, helium, nitrogen, and carbon dioxide, displace air in confined space as they build up. Poisonous carbon monoxide can be formed by the flame of any oxy-fuel torch.
2. Always be sure there is adequate ventilation when using these inert gases, especially in confined areas.
3. Always use mechanical ventilation when space is <10,000 cubic feet (ft³) and ceiling height is <16 feet. Ventilation is required at a minimum of 2,000 ft³ per minute per welder or local exhaust ventilation at 100 linear feet per minute/ per welder.
4. Shut off compressed gas bottles when not in use.
5. Never enter a confined space without proper authorization.

X-rays

1. X-rays are commonly used for weld inspection. Excessive exposure to X-rays can pose a hazard to your health. Never cross radiation barriers.

Musculoskeletal

1. Welding and cutting processes place physical demands on the knees, wrists, elbows, arms, shoulders, neck, and back.
2. Eliminate excessive reaching, bending, heavy lifting, repetitive motion, and awkward postures.

Burning and Cutting

Improper use of any oxy-fuel equipment has the potential to cause personal injury and/or property damage. Oxy-fuel equipment is used extensively in construction operations to aid in performing work.

General Safety Precautions

1. Do not use leaking or defective equipment.
2. Compressed gas cylinders must always be stood upright and be properly secured. Protective valve caps should be installed when cylinders are not in use.
3. In storage, oxygen must be separated from fuel gases and combustible materials and liquids by at least 20 feet or have a noncombustible barrier five feet high with a minimum one-half hour fire rating. Store full and empty containers separately and mark empty containers.
4. Cylinder and manifold valves should be closed when not in use. When closing valves, do not over-tighten. A snug-tight fit is sufficient. If a cylinder valve becomes frozen, thaw it at room temperature or with warm water (not more than 125 degrees Fahrenheit). Never use an open flame or electric heating device to heat cylinder valves.

Gas Cylinders and Associated Equipment

1. Keep oil and grease away from oxygen regulators, hoses, and fittings. Do not store wrenches, dies, cutter, or other grease-covered tools in the same compartment with oxygen gauges or equipment.
2. Bleed off regulator back pressure when not in use to prevent regulator burnout.
3. Wear approved burning goggles.
4. Do not strike an arc on a cylinder.

Compressed Gas Cylinders

General

1. Serious accidents may result from the misuse, abuse, or mishandling of compressed gas cylinders. The two most commonly used compressed gas cylinders found on construction sites are oxygen and acetylene.

2. Employees whose work involves compressed gas cylinders are to be trained in safe handling and storage methods.

Storage Requirements

1. Inside a building, cylinders, except those in actual use or attached for use, must be limited to a total gas capacity of 2,000 cubic feet to 300 pounds of liquefied petroleum gas.
2. Cylinders must be kept far enough away from actual welding or cutting operations so sparks, hot slag, or flame will not reach them.
3. Protection from solar radiant heat should be provided where cylinders are directly exposed to sunlight.
4. Cylinders, when not in use, must be turned off and the hoses and regulators must be bled off.
5. Valve protection caps, where the cylinder is designed to accept a cap, should always be in place and hand-tight, except when cylinders are in use or connected for use.
6. Storage of empty cylinders should be separate from fully charged cylinders.
7. Empty cylinders should have their valves closed.
8. A fire extinguisher should be no closer than 25 feet, but not farther than 50 feet, from fuel gas storage places. If storage area is at a dock height, appropriate guard railing and safe access shall be provided.
9. Warning signs must be conspicuously placed and should read "Danger - No Smoking, Matches, or Open Lights or Flames," or equivalent wording.
10. Cylinders should be kept away from radiators and other sources of heat.
11. Isolate cylinders to prevent contact with welding or other electric lines. Do not let cylinders become part of an electrical circuit.
12. Compressed gas cylinders should be secured in an upright position at all times except, if necessary, for short periods of time, while cylinders are actually being hoisted or carried.
13. A suitable cylinder truck, chain, or other secure fastening must be used to keep cylinders from being knocked over while in use.

14. While moving cylinders, a cradle or suitable platform shall be used. Slings, hooks, or electric magnets must not be used. Valve protection caps must always be in place during transportation.
15. Cylinders handled by cranes shall be secured in a specially made rack or material skip box. Never use magnets or slings to handle compressed gas cylinders.
16. Inside of buildings, oxygen cylinders should be stored in a well-ventilated, well-protected, dry location at least 20 feet from fuel gases and highly combustible materials such as oil or shavings. Cylinders should be stored in clearly assigned places away from elevators, stairs, or gangways. Assigned storage spaces should be located where cylinders will not be knocked over or damaged by passing or falling objects or subject to tampering by unauthorized persons. Cylinders should not be kept in unventilated enclosures such as lockers or cupboards.
17. Oxygen cylinders in storage must be separated from fuel gas cylinders or combustible materials (especially oil or grease) a minimum of 20 feet or by a noncombustible barrier at least five feet high having a fire-resistant rating of at least one-half hour.
18. Always refer to oxygen as **OXYGEN** and not as air. Oxygen must not be used for ventilation purposes, comfort cooling, blowing dust from clothing, or for cleaning the work area.
19. All propane and oxygen cylinders should be opened all the way and seated at the full open position to reduce the possibility of valve stem leakage.
20. Acetylene in cylinders is dissolved in liquid acetone. Never lay an acetylene cylinder on its side because the acetone liquid can get into the regulator and hoses and cause flashbacks. Occasionally, liquid acetone may be drawn out of the cylinder along with the acetylene gas when a very large gas flow is required. Evidence of this will be erratic "spitting" of the flame. Manifolding two or more cylinders together will eliminate this problem.
21. Acetylene cylinder valves should be opened only 3/4 to 1-1/2 turns. This will permit adequate flow of gas and restrict flow rates which could draw acetone out of the cylinders.
22. Never set acetylene outlet pressure above 15 PSI as acetylene gas becomes unstable at pressure greater than 15 PSI and may explode.

Hose and Hose Connections

1. Inspect hoses for leaks and other defects such as nicks, cuts, and abrasion.
2. Frequently (at least daily) inspect all connection seats and fittings. If warped, scarred, or damaged in any way, do not use the part. Repair or replace.
3. Never use tape to correct a deficiency; get another piece of hose.
4. Keep caps and plugs on, and in, gas outlets to prevent foreign trash and liquid from entering the system and/or damaging the threads.
5. Before installing regulators on cylinders or manifolds, open the cylinder or manifold valve slightly (standing to one side) and quickly close the valve. This activity, known as "blowing out" the valve seat area, cleans the seating area of dust, dirt, and debris.
6. Before connecting regulators, first drain them by turning the adjusting screw clockwise and then release them or turn counterclockwise.
7. Never stand in front of the gauges on the regulator when opening the discharge valve of the tank. Open discharge valve slowly. Sudden pressure may destroy the gauge and blow out glass and parts.
8. Connections must be cared for so that the brass fitting will not leak and will be able to withstand twice the maximum delivery pressure of the regulators provided.
9. Oxygen hoses must be of a different color from hoses used for fuel gas lines (oxygen – green; fuel - red).
10. Ensure flashback arrestors are installed on both regulators (oxygen line and fuel line) or at the torch inlet lines.
11. Standard oxygen equipment has right-hand threads; fuel gas equipment has left-hand threads. Never force connections.
12. Always removed open-ended oxy-fuel hoses from confined spaces immediately or cap the ends of the hose with approved hose caps.

Torch Safety

1. Do not handle torch roughly or use it as a hammer, hook, or prybar.
2. Use only tips that have clear passages and clean seats free from bruises or scars. A bruised or dented tip makes a leaky seat and scores the torch head.

3. Keep tips clean.
4. Do not attempt to improve the performance of a tip by drilling, pinning, bending, or otherwise modifying the original design.
5. Torch tip cleaning should only be done with special tip cleaners.
6. Always perform a safety check on all torch equipment. Blow out the torch and hoses before you attempt to operate the equipment.
7. When lighting a torch, light it quickly, keeping the torch flame away from you, other gas equipment, and combustibles. Remember not to let too large a volume of gas escape before igniting the torch.
8. Prior to lighting your torch, but after all hose and torch connections have been safely made, the regulators shall be opened for a short interval of time to permit complete fillings of the hoses. The supply valve will then be closed and the pressure on the gauges watched for 60 seconds. Any drop in pressure indicates a leak. (Torch valves must be closed.) Do not turn on the supply valve again until the leak has been repaired. This activity is known as your "Torch Safety Check."
9. After your "Torch Safety Check" has been performed, go back to the torch, and if it is not already in an open space (preferably outside), carry it to an open area where it will be safe to blow it out. Never blow out a torch or hose in a confined or enclosed space.
10. Never attempt to relight a torch from "hot-work," especially in a confined space.
11. When lighting a torch, open the fuel gas valve and light it before opening the oxygen valve.
12. Always use approved striker lighter for igniting oxy-fuel torches. Never use matches or a cigarette lighter. Do not try to reignite a torch on "hot work" as accumulated gas may cause an explosion.
13. To minimize leaks, fuel gas control valves on hand torches have soft nylon seats. These valves should be closed only to the point where the flow of gas is stopped. Forcing them beyond this point will cause damage and impair the proper operation of the equipment.
14. Do not let the torch tip contact work when using an acetylene torch. Flashback or backfires will almost certainly occur. If the flame pops or goes out for any reason, turn off torch valves immediately and investigate the problem.

Personal Protection

- When burning or cutting operations are taking place, personnel should be protected with proper burning goggles having the shade number required for the type of work being performed. The following are recommended shade numbers from ANSI Z49.1:2005 "Guide for Shade Numbers":

Process	Electrode Size In. (mm)	Arc Current (amperes)	Minimum Protective Shade	Suggested Shade No. (comfort)
Arc Carbon Arc Cutting (CAC-A)	(light)	Less than 500	10	12
	(heavy)	500 – 1000	11	14
Plasma Arc Cutting (PAC)		Less than 20	4	4
		20-40	5	5
		40-60	6	6
		60-80	8	8
		80-300	8	9
		300-400	9	12
		400-800	10	14

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Process	Plate Thickness		Suggested Shade No. (Comfort)
	In.	Mm	
Oxy-fuel Gas Welding (OFW)			
• Light	Under 1/8	Under 3	4 or 5
• Medium	1/8 to 1/2	3 to 13	5 or 6
• Heavy	Over 1/2	Over 13	6 or 8
Oxygen Cutting (OC)			
• Light	Under 1	Under 25	3 or 4
• Medium	1 to 6	25 to 150	4 or 5
• Heavy	Over 6	Over 150	5 or 6

ANSI Z49.1:2005 Guide for Shade Numbers

2. Long-sleeve leather gloves, high-top shoes, hard hats, a leather jacket, and other protective clothing and equipment as required must always be used.
3. When selecting clothing, consideration must be given to the flammability of the material.
4. Always use ear protection to guard against hot sparks and molten metal.
5. Use the proper particulate and vapor-type respirators plus additional ventilation, as required, when welding, cutting, gouging, or burning on coated materials, such as galvanized or heavily painted materials.
6. Do not make a cut in such a manner that sparks, slag, hot metal, or the other cut parts will fall on you, other workers, or on flammable materials.
7. Do not smoke when connecting or disconnecting regulators, torches, or hoses.
8. Do not start burning or heating operations until you have checked to see that sparks or heat will not cause damage or personal injury.
9. Always use a fire watch anytime an operator is heating, brazing, or burning on material where the other side cannot be seen and/or the possibility of fire exists.
10. Wear high-top boots to protect ankles.
11. Wear the proper welding hood with shaded lens. Prior to welding, check the hood for leaks.
12. Wear long pants without cuffs.
13. Don't wear greasy or dirty clothing.
14. Button your collars and sleeves to prevent sparks from entering.

Fire Protection

1. Check perimeter area, floor, and wall openings.
2. Use fire watch when combustible materials are greater than 35 feet or having easily ignitable combustible materials greater than 35 feet.
3. Use fire retardant blankets or curtains where needed.
4. Remove combustible materials.
5. Recheck areas after breaks and at quitting time.

6. Do not disable fire sprinkler systems during hot work.

Emergency Situations

1. In case of a flashback and/or ruptured hose, the operator's first duty is to stop the flow of gases. This can be done either directly behind the damaged or burning area (if it can be done safely) or at the cylinder or manifold.
2. If it can be done safely, the torch and hose should be moved out of confined areas to an open space (preferably outside).
3. Any equipment that has been involved in a flashback, fire, or explosion must be completely inspected prior to being put back into service.

Compressed Air

1. Inspect all hoses and couplings before using them.
2. Never crimp, couple, or uncouple pressurized hoses. Shut off the valve and bleed the hose down slow.
3. Use hose that is designated for compressed air only.
4. Use guards whenever they can be used. If you must remove a guard for any reason, get authorization from your supervisor, and replace it as soon as possible.

Grinding

1. Always use proper protective equipment.
2. Use guards whenever they can be used. If you must remove a guard for any reason, get authorization from your supervisor, and replace it as soon as possible.
3. Use flash screens or nonflammable poly sheeting to confine flying particles whenever anyone else is exposed.
4. Inspect grinding wheels before using them. Use only wheels that are rated (RPM) for the machine you are using.
5. On bench grinders, keep tongue guards no more than 1/4" and work rest no more than 1/8" away from grinding wheel.

Resources

Oregon OSHA

1910.251 – 1910.255 Subdivision Q: Welding, Cutting, and Brazing
http://www.oroSHA.org/pdf/rules/division_2/div2_q.pdf

1910.211 – 1910.219 Subdivision O: Machinery and Machine Guarding
http://www.oroSHA.org/pdf/rules/division_2/div2_o.pdf

American National Standards Institute (ANSI)

ANSI Z49.1:2005 – Safety in Welding, Cutting, and Allied Processes
<http://www.aws.com/safety>

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