



# AWS SAFETY AND HEALTH FACT SHEET BUNDLE FOR FABRICATORS

Includes the following concise and helpful fact sheets from the American Welding Society's Committee on Safety and Health

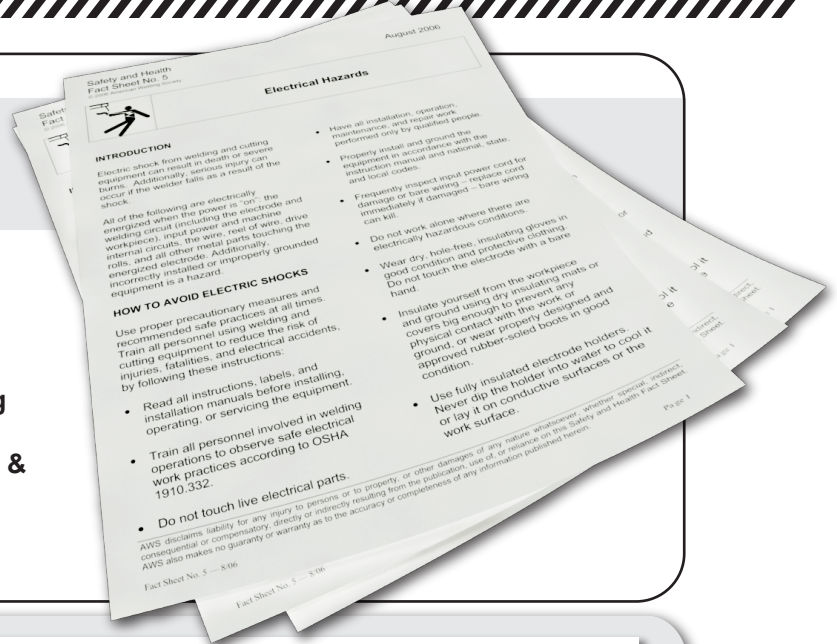
**Fact Sheet 9: Tripping and Falling**

**Fact Sheet 19: Laser Welding and Cutting Safety**

**Fact Sheet 26: Arc Viewing Distance**

**Fact Sheet 34: Coated Steels: Welding and Cutting Safety Concerns**

**Fact Sheet 36: Ventilation for Welding & Cutting**



The following safety fact sheets and the complete 66-page ANSI Z49.1 Safety in Welding, Cutting, and Allied Processes are available for free download at [www.aws.org/safety](http://www.aws.org/safety):

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## INFORMATION SOURCES

American National Standards Institute (ANSI). *Safety in Welding, Cutting, and Allied Processes* (ANSI Z49.1), published by the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126; telephone 800-443-9353; web site: [www.aws.org](http://www.aws.org).

Occupational Safety and Health Administration (OSHA). *Code of Federal Regulations*, Title 29 Labor, Parts 1910.1 to 1910.1450, available from the U.S. Government Printing Office, 732 North Capitol Street NW, Washington, DC 20401; telephone: 800-321-6742; web site: [www.osha.gov](http://www.osha.gov).

Mine Safety and Health Administration (MSHA). *Code of Federal Regulations* Title 30 Mineral Resources, Parts 1 to 199, available from the U.S. Government Printing Office, 732 North Capitol Street NW, Washington, DC 20401; telephone: 202-693-9400; web site: [www.msha.gov](http://www.msha.gov).

American Welding Society (AWS). *Safety and Health Fact Sheets*, published by the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126; telephone 800-443-9353; web site: [www.aws.org](http://www.aws.org).

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## **LASER WELDING AND CUTTING SAFETY**

### **INTRODUCTION**

A laser is a device which produces an intense, coherent, directional beam of light. The term LASER is an acronym for Light Amplification by Stimulated Emission of Radiation. Lasers can be designed to deliver a large amount of energy to a very small area. In welding and cutting operations, this energy can heat metals quickly to very high temperatures. Much of the radiation that strikes the workpiece is reflected into the environment, creating hazards. Some laser light used in laser welding equipment is invisible, so the hazard may not be readily apparent.

### **HOW LASERS WORK**

Typical lasers use electricity to create the unique coherent light that is very different from ordinary non-coherent light, such as that from a light bulb. Coherent light can be tightly focused and is not diffused or scattered like ordinary light. This coherent light beam is parallel and can be focused to cut or weld metals. Laser light can be different colors of the visible light spectrum, or can be invisible when the light is ultraviolet or infrared. Lasers used for welding and cutting may be infrared, and therefore the beam may be invisible. It is very difficult to take precautions against things one cannot see. It is even more difficult to convince others to take precautions against hazards they cannot see and may not understand.

### **POTENTIAL HAZARDS**

- **RADIATION**—Both visible and invisible light radiation are produced when welding or cutting. Due to the interaction with the workpiece, high levels of hazardous blue light and ultraviolet radiation (secondary radiation) are produced. This light radiation is often reflected from the workpiece into the work area. Radiation from these processes can seriously burn eyes and skin quickly and permanently. These hazards are addressed in the American National Standards Institute Z136.1 standard.
- **FIRE**—Since the laser system produces a very small spot size with high energy, the hazard of fire is present if the beam hits flammable material. Keep flammables away from the welding or cutting area. Be sure to cover and protect anything flammable in the area, since reflected radiation could start fires in unexpected places. Protect the work area.

- **FUMES AND MISTS**—Lasers easily vaporize metals. In doing so, fumes and mists are created which can present a respiratory hazard. Often the fumes and mists cannot be seen, yet they can pose a serious health hazard. Always use adequate ventilation.
- **MECHANICAL**—The optical device on the robotic arm or other beam manipulator can malfunction and send the laser beam in unintended directions. Therefore, it is essential that the work cell be shielded in conformance with standards for the laser type and class.
- **ELECTRIC SHOCK**—Since lasers require a large amount of electrical power to accomplish specific tasks, electrical hazards are present. Conventional hazards associated with any electrical industrial power source are present. These require standard and common electrical safe practices as found in ANSI Z49.1 and in AWS Safety and Health Fact Sheet No. 5. Additionally, there are the unique electrical hazards common to lasers in general and the hazard of the individual application. Usually, the best source of safety information is provided in the instruction manual from the manufacturer of the laser system. Always read, understand, and follow the manufacturer's recommended safety procedures.
- **EYE AND SKIN DAMAGE**—Laser system eye and skin hazards are addressed in the ANSI Z136.1 standard. In many use situations, special laser eye protective devices are required. According to the ANSI Z136.1 standard, this eyewear must be labeled with both the optical density (protective factor) and wavelength(s) for which the protection is afforded. The protective eyewear must be compatible with the manufacturer's specifications for the laser system in use, to ensure that the eyewear is suitable. In addition to the primary hazard of the laser beam, there may be a considerable eye hazard from high levels of secondary radiation. The ANSI Z136.1 standard requires that the eyes be protected from this secondary radiation in addition to the primary laser beam. A precaution must be added here—standard safety glasses alone do not provide protection. Any laser eyewear, plain or prescription, must be labeled with the wavelength(s) of protection and the optical density at that wavelength(s). In some laser systems, ultraviolet light may be leaked into the workplace. Thus the eyewear should provide primary beam protection, secondary radiation protection, and also ultraviolet protection.

## **SAFETY NEEDS**

All laser welding and cutting installations are required to have a laser safety officer (LSO). The LSO is responsible for personnel protection, laser cell class conformance, and enforcement of all laser safety regulations. Be certain to follow recommendations from the laser system manufacturer. In addition, provide certified laser protective eyewear, clothing, and shields where required.

## INFORMATION SOURCES

American National Standards Institute (ANSI). *Safe Use of Lasers*, Z136.1, available from American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

Kokosa, J. *Hazardous Chemicals Produced By Laser Materials Processing*, Journal of Laser Applications, 6 (1994) pp. 195–201.

Laser Institute of America (LIA). *Guide for the Selection of Laser Eye Protection*, available from Laser Institute of America, 12424 Research Parkway, Orlando, FL 32826.

\_\_\_\_\_. OSHA Instruction Publication 8-1.7, *Guidelines for Laser Safety and Hazard Assessment*, available from Laser Institute of America, 12424 Research Parkway, Orlando, FL 32826.

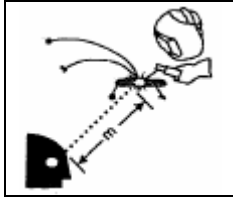
\_\_\_\_\_. *Industrial Laser Safety Reference Guide*, available from Laser Institute of America, 12424 Research Parkway, Orlando, FL 32826.

\_\_\_\_\_. *Laser Safety Guide*, available from Laser Institute of America, 12424 Research Parkway, Orlando, FL 32826.

Shannon, G., et al. *Investigation Into the Underwater Laser Welding of Steel*, Journal of Laser Applications, 6 (1994), pp 112-229.

Sliney, D. and Wolbarsht, M. *Safety with Lasers and Other Optical Sources*, Plenum Press, New York, available from Laser Institute of America, 12424 Research Parkway, Orlando, FL 32826.

Varanelli, A. *Electrical Hazards Associated with Lasers*, Journal of Laser Applications, 7 (1995) pp. 62–64.



## Arc Viewing Distance

### PREFACE

This Fact Sheet is the AWS Labeling and Safe Practices Subcommittee's response to requests for information on hazard distances from the arc for skin and corneal exposures. Our committee decided to present the work of Mr. Terry Lyon, a physicist with the U.S. Army Laser/Optical Radiation Program, U.S. Army Center for Health Promotion and Preventive Medicine.

These hazard distances are for actinic ultraviolet radiation exposure to the skin and cornea. These are not safe viewing distances for viewing a bright light source.

Brief viewing of an arc, limited by natural aversion or the blink response, do not exceed personnel exposure limits for the retina. Staring at the arc should never be permitted without appropriate eye protection.

Mr. Lyon published his work in an article in the *AWS Welding Journal* (December 2002). With Mr. Lyon's permission, we decided to include his entire article as the substance of this Fact Sheet. His complete article appears on the following pages.

# KNOWING THE DANGERS of Actinic Ultraviolet Emissions

Those who work around electric arc welding and cutting operations should be aware of the potential health hazards caused by these electromagnetic waves

**BY TERRY L. LYON**

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While open arc welding operations are common worldwide, the general population is largely unaware of the potential hazards. Before the mid 1970s, measures of optical radiation hazards and protection were largely empirically determined, even for welders and their helpers.

Today, we know serious potential hazards can exist wherever there are lines of sight to open arcs created by invisible emissions called “actinic ultraviolet radiation (UVR).” These UVR emissions are simply electromagnetic waves, like light, that travel in straight lines at the speed of light. A summary of the actinic UVR hazards to persons working around electric arc welding and cutting operations is contained in Table 1.

**Table 1 — Distances<sup>(a)</sup> to Common Electric Arc Welding or Cutting Processes<sup>(b)</sup> at which the Actinic Ultraviolet Radiation (UVR)<sup>(c)</sup> Is Below the U.S. Daily Threshold Limit Value (TLV)<sup>(d)</sup> for Various Exposure Times<sup>(e)</sup>.**

Arc Welding/Cutting Process	Base Metal	Shielding Gas	Arc Current in Amperes	Distance in m for 1 min	Distance in m for 10 min	Distance in m for 8 h		
Shielded Metal Arc (Stick) GMAW	Mild steel	None	100–200	3.2	10	71		
			Mild steel	CO <sub>2</sub>	90	0.95	3.0	21
					200	2.2	7.0	48
	350	4.0			13	87		
	Mild steel	CO <sub>2</sub>			175	1.1	3.6	25
					350	2.3	7.3	51
					150	2.9	9.3	65
	Al	95% Ar + 5% O <sub>2</sub>	350	6.7	21	150		
			Ar	150	3.2	10	70	
				300	5.0	16	110	
	He		150	1.6	5.0	34		
			300	3.2	10	69		
GTAW	Mild steel	Ar	50	0.32	1.0	6.9		
			150	0.90	2.8	20		
			300	1.7	5.5	38		
	Mild steel	He	250	3.0	9.5	66		
			Al	Ar	50 AC	0.32	1.0	6.9
					150 AC	0.85	2.7	19
	250 AC	1.6			5.0	35		
	Al	He	150 AC	0.94	3.0	21		
			Mild steel	Ar	200–260	1.5	4.9	34
					100–275	1.7	5.5	38
	He		100	3.0	9.4	65		
			PAC (dry)	Mild steel	65% Ar + 35% H <sub>2</sub>	400	1.4	4.4
PAC (H <sub>2</sub> O)	Mild steel	N <sub>2</sub>	1000	2.4	7.5	52		
			300	3.3	10	72		
			750	1.7	5.5	38		

(a) These distances are approximate. To convert to feet, multiply the distance in meters by 3.3.  
 (b) The distances are based upon the worst-case exposure conditions; maximum UVR for exposure angle, arc gap, and electrode diameter.  
 (c) Invisible actinic UVR poses a potential hazard to cornea (called welder's flash) and skin (much like sunburn) and exposure is cumulative with each exposure over an 8-h workday per 24-h period.  
 (d) TLVs are published by the ACGIH, Cincinnati, Ohio.  
 (e) These distances were based upon data from Lyon, T. L. et al, 1976, *Evaluation of the Potential Hazards for Actinic Ultraviolet Radiation Generated by Electric Welding and Cutting Arcs*. U.S. Army Environmental Hygiene Agency.

### Exposure Effects

Since the beginning of arc welding, welders have known welding and cutting operations can cause acute effects such as severe "sunburn" (erythema) of the skin and painful "welder's flash" (photokeratitis) of the cornea of the eye. Consequently, early welders empirically selected protective clothing and eyewear for comfortable viewing. Also, the U.S. Army adopted a measure to prevent eye injuries in industrial areas. Ordinary safety glasses were prescribed for all Army personnel, including welders and their helpers. As a by-product of physical injury prevention, the eyewear resulted in a dramatic drop in the incidence of welder's flash. Any stray invisible actinic UVR was also blocked by the transparent lenses.

### Exposure Limits

The first actinic UVR exposure guidelines were published by the American Conference of Governmental Industrial Hygienists (ACGIH) in 1972 (Ref. 1). These guidelines were intended to pre-

vent the acute effects of actinic UVR. The International Non-Ionizing Radiation Committee (INIRC) of the International Radiation Protection Association (IRPA) (Ref. 2) proposed similar guidelines in 1985. After considerable review, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) (Ref. 3) revalidated and endorsed those limits. Besides being concerned about acute effects, these standards have also been shown to minimize any adverse effects and pose an extremely small risk for delayed effects.

### Instrumentation

By the early 1970s, several instruments were available to measure actinic UVR but many simpler instruments presented significant measurement errors primarily from a flaw called "stray light." The actinic UVR resulting in an acute injury followed a narrow range of wavelengths (from around 200–315 nm) with a varying "action spectrum" (peaking sharply at 270 nm). Producing an instrument with this wavelength response was difficult with known filters at that time. The better in-

struments were the traditional ultraviolet spectrometers that could manually scan UVR wavelengths, weigh the results against the exposure standard for each wavelength, then sum them for the net result.

### Joint Effort

In 1974, a joint effort was planned to determine the optical radiation hazards from electric arc welding and cutting operations. Testing was planned for six processes: gas tungsten arc welding (GTAW), gas metal arc welding (GMAW), flux cored arc welding (FCAW), plasma arc cutting (PAC), plasma arc welding (PAW), and shielded metal arc welding (SMAW). Organizations that provided personnel and equipment for the effort included Union Carbide Corp., the American Welding Society (AWS), Battelle Memorial Institute, National Institute of Occupational Safety and Health (NIOSH), and the U.S. Army Environmental Hygiene Agency (USAEHA, now U.S. Army Center for Health Promotion and Preventive Medicine [USACHPPM]).

In 1974 a joint effort was undertaken by various public and private organizations to determine the optical radiation hazards of electric arc welding and cutting operations.

## Joint Effort Results

Arc measurements were conducted in 1975 at Union Carbide Corp. in Florence, S.C., and later at Plasma in Lebanon, N.H., and Caterpillar in Peoria, Ill. A variety of detectors were employed but the final results of the first study were based upon traditional UVR spectrometer results. The arc location and root opening were stabilized for measurements by employing a rotating pipe fixture, and all measurements were made at a measurement distance of one meter and at the worst-case angle for emissions. The results of that study were published as a US-AEHA report (Ref. 4) in 1976 employing the ACGIH threshold limit value. That study contained results for more than 100 different conditions and processes and yielded the relationships between arc current, arc length, shielding gas, base metal, and actinic UVR that resulted in the derivation of formulas for those relationships.

## Table Summary

A summary of actinic UVR hazards posed to persons working around electric arc welding and cutting operations are contained in Table 1 and are summarized as follows.

- **Hazardous Exposure.** The level of hazardous exposure affecting welders' helpers and other personnel (forklift and overhead crane operators, for example) located in the vicinity of open arc welding and cutting operations can now be determined. The intensity and wavelengths of nonionizing radiant energy produced depend on many factors such as the process type, welding parameters, electrode and base metal composition, fluxes, and any coating or plating on the base material. Some processes such as resistance welding, cold-pressure welding, and submerged arc cutting ordinarily produce negligible quantities of radiant energy. Later, Europeans conducted UVR measurements on pulsed welding.
- **Exposure Time.** Exposure to actinic UVR is considered to be cumulative with each exposure over an 8-h workday and within a 24-h period. Therefore, two 5-min exposures during a workday could be considered as a single 10-min exposure.

- **Reflections.** Actinic UVR can reflect significantly from some common surfaces and these reflections might also create potentially harmful exposure to unprotected personnel. Unpainted metals (particularly aluminum) and concrete floors readily reflect actinic UVR. On the other hand, lightly colored paints often use pigments of zinc oxide or titanium oxide and have a low reflectance of actinic UVR. Therefore, even lightly pigmented paints are good absorbers of actinic ultraviolet radiation (Ref. 5).

- **Safety Information.** Welders, welders' helpers, and their supervisors should periodically include a discussion of actinic UVR hazards in normal safety reviews and within written safety procedures. Concern for actinic UVR is especially important to discuss with new employees and personnel who work in the vicinity of open arcs.

- **Nearby Persons.** Persons in the vicinity of welding operations can be protected from exposure to actinic UVR by use of screens, curtains, or adequate distance from aisles, walkways, etc. Welders' helpers, overhead crane operators, and forklift operators who have a line of sight to any open arcs should consider wearing appropriate safety equipment such as safety glasses with sideshields or even a clear, full-face shield and long-sleeved shirts.

- **Skin Protection.** While standards exist for welders and their helpers, skin protection has not been uniformly prescribed for other personnel who work in the vicinity of open arcs. Fabric measurements have shown that natural materials (leather, cotton, wool) are better for absorbing actinic ultraviolet radiation than synthetic materials (polyester, nylon) (Ref. 6). Incidental personnel should consider wearing a long-sleeved shirt.

- **Warning Signs.** Warning signs are useful when persons unfamiliar with actinic UVR and other welding hazards are nearby. Such warnings are especially important to have on portable welding screens that can be used at field sites near the general population. A suitable sign could simply state "Danger" or "Warning" and be posted conspicuously at entry points or doors to welding areas. Such signs might also include the warning "Avoid Exposure of Eye and Skin to Arc and Harmful Ultraviolet Emissions."

## Retinal Exposure

In addition to actinic UVR measurements, another study was published as a USAEHA report (Ref. 7) in 1977 containing an evaluation of potential retinal exposure hazards. The eye can focus an open arc onto the retina where an injury might result that was photochemical or thermal in nature. Photochemical injury is the result of exposure to intense blue light sources, whereas thermal injury can result from all visible and some near-infrared radiation, which is largely invisible. Measurements of blue light and other retinal-thermal emissions suggest momentary viewing of electric welding and cutting arcs does not exceed retinal exposure limits; however, staring at an open arc can readily exceed these standards. While staring at the arc should never be permitted, actual retinal injuries are rare (Ref. 8) and would likely result only from chronic staring.

### References

1. American Conference of Governmental Industrial Hygienists (ACGIH). 2001. *TLVs and BEIs, Threshold Limit Values for Chemical Substances and Physical Agents*. Cincinnati, Ohio: ACGIH.
2. International Commission on Non-Ionizing Radiation Protection (ICNIRP). 1996. Guidelines on UV radiation exposure limits. *Health Phys.* 71(6): 978.
3. Sliney, D. H. 2000. Ultraviolet radiation exposure criteria. *Radiation Protection Dosimetry* 91(1-3): 213-222.
4. Report No. 42-0053-77/ADA033768, *Evaluation of Potential Hazards from Actinic Ultraviolet Radiation Generated by Electric Welding and Cutting Arcs*, Dec. 1975-Sept. 1976. U.S. Army Environmental Hygiene Agency.
5. Sliney, D. H., and Wolbarsht, M. L. 1980. *Safety with Lasers and Other Optical Sources*. New York, N.Y.: Plenum Press.
6. Sliney, D. H., Benton, R. E., et al. 1987. Transmission of potentially hazardous actinic ultraviolet radiation through fabrics. *Applied Industrial Hygiene* 2(1): 36-44.
7. Report No. 42-0312-77/ADA043023, *Evaluation of the Potential Retinal Hazards from Optical Radiation Generated by Electric Welding and Cutting Arcs*, Dec. 1975-Apr. 1977. U.S. Army Environmental Hygiene Agency.
8. Naidoff, M. A., and Sliney, D. H. 1974. Retinal injury from a welding arc. *American Journal of Ophthalmology* 77(5): 663-668.



## Coated Steels: Welding and Cutting Safety Concerns

### INTRODUCTION

Steels are coated to provide a protective covering or a decorative finish. Protective coatings are designed to prevent rusting or to shield the steel from chemical attack.

Coatings found on steels can become airborne or give off fumes, smoke, or dust, during joining and cutting. Some of the coating's dusts, fumes or gases can harm you and their exposure limits should not be exceeded. Exposure limits include:

- Permissible Exposure Limit (PEL): The PEL is set by the Occupational Safety and Health Administration (OSHA) and is a legal employee exposure limit in the U.S.
- Threshold Limit Value (TLV<sup>®</sup>): The TLV<sup>®</sup> is published by the American Conference of Governmental Industrial Hygienists (ACGIH) and is a guideline for employers to consider in controlling employee exposures.

### OVERVIEW OF HEALTH HAZARDS

Employers need to know which chemical may be released into the air that may injure welders. Welders must be trained in how to do each process the correct way, and they shall cut or weld only after proper safety precautions have been taken.

Coatings may give off fumes and gases when welding or cutting is performed. A health hazard may be created when its dusts, fumes or gases get into the air in large enough amounts that safe levels are exceeded.

Protective coatings on steels can contain chromium, lead, tin, zinc or other materials. It is always good for the welder to understand the coating types for the materials he works with. If not, the welder should get this information from his supervisor or employer.

Paints are made up of compounds that may release hazardous materials into the air when heated. Paints are usually used on a "phosphated" and passivated (often with chromium) metal surface. The heat from the arc can cause paints to give off unsafe amounts of gases like carbon monoxide and carbon dioxide. These also increase the risk of suffocation in confined work areas, or those with poor air movement.

Steels coated with plastic materials should not be cut or welded unless proper precautions are taken. It is best to remove coating to a distance away from the weld or cut where the temperature won't go above the point where the material starts to break down.

For additional information, see AWS Fact Sheet 1, *Fumes and Gases*.

## HOW TO AVOID HEALTH HAZARDS FROM OVEREXPOSURE

The welder should make sure he or she knows what a coating might give off when heated or burned:

- Obtain the Material Safety Data Sheets (MSDSs) for all materials used.
- Read and understand the specification for coating type and coating weights.
- Find out what hazardous materials are present or might be given off by the coating when it is exposed to the arc or high temperatures.
- Use adequate ventilation whenever an airborne fume gas or dust must be controlled. Use enough ventilation, exhaust, or both to keep the air the welder breathes below recommended safe levels such as the PEL and TLV®.
- Have air monitoring done as necessary to test for exposure levels in the breathing zone of the welder and other persons working nearby.
- Use a respirator when required.
- Orient the work so the welder's head is kept out of the fume plume.
- See AWS Fact Sheet 1, *Fumes and Gases*.
- See AWS Fact Sheet 25, *Metal Fume Fever*.
- See AWS Fact Sheet 11, *Hot Work in Confined Spaces*.

## SUMMARY

Coatings on steels may be a source of exposure to fumes and gases during welding, brazing and cutting. Steel coatings and paints contain materials that can cause harmful overexposure when breathed. This is why coatings must also be looked at in order to remove hazards from welding and cutting. The joining of some coated steels require special types of ventilation. In some cases, the welder must wear a respirator to keep safe.

## INFORMATION SOURCES

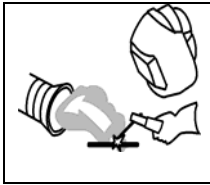
American National Standards Institute (ANSI). *Safety in Welding, Cutting, and Allied Processes* (ANSI Z49.1), published by the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126; telephone 800-443-9353; web site: [www.aws.org](http://www.aws.org).

Occupational Safety and Health Administration (OSHA). *Code of Federal Regulations*, Title 29 Labor, Parts 1910 and 1915, available from the U.S. Government Printing Office, 732 North Capitol Street NW, Washington, DC 20401; telephone: 800-321-6742; web site: [www.osha.gov](http://www.osha.gov).

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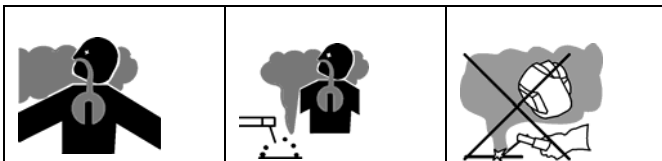


## Ventilation for Welding and Cutting

### INTRODUCTION

Ventilation is used to control overexposures to the fumes and gases during welding and cutting. Adequate ventilation will keep the fumes and gases from the welder's breathing zone.

NOTE: This safety and health fact sheet does not address ventilation in confined spaces. Also, the term "welding" includes "cutting."



### NATURE OF THE HAZARD— THE FUME PLUME

The heat of the arc or flame creates fumes and gases (fume plume). Fumes contain respirable particles. Gases include the shielding gas, and combustion products. The heat from the arc or flame causes the fume plume to rise.

Fumes contain hazardous substances. Overexposure to them may cause acute (short term) or chronic (long term) health effects. Fumes and gases may be produced at toxic levels and they can displace oxygen in the air causing asphyxiation. Overexposure to welding fumes and gases can cause dizziness, illness, and even unconsciousness and death.

### HOW TO AVOID THE HAZARD — VENTILATION

Keep your head out of the fumes. Reposition the work, your head, or both to keep from breathing the fumes.

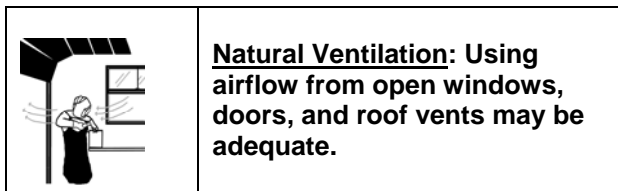
Use ventilation to control the fumes and gases produced from cutting and welding. Adequate ventilation keeps exposures to airborne contaminants below allowable limits. Have a technically qualified person evaluate the exposure to determine if the ventilation is adequate. Wear an approved respirator when ventilation is not adequate or practical.

Adequate ventilation depends on:

- Size and shape of the workplace
- Number and type of operations
- Contents of the fume plume
- Position of the worker's and welder's head
- Type and effectiveness of the ventilation

Adequate ventilation can be obtained through natural or mechanical means or both.

**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.



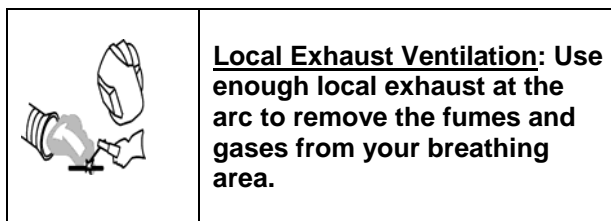
**Mechanical Ventilation** – is the movement of air through a workplace by a mechanical device such as a fan. Mechanical Ventilation is reliable. It can be more effective than natural ventilation. Local exhaust, local forced air, and general ventilation are examples of mechanical ventilation.

Local exhaust ventilation systems include a capture device, ducting and a fan. The capture devices remove fumes and gases at their source. Fixed or moveable capture devices are placed near or around the work. They can keep contaminants below allowable limits.

One or more of the following capture devices are recommended:

- Vacuum nozzle at the arc
- Fume Hoods
- Gun mounted fume extractor

Some systems filter the airflow before exhausting it. Properly filtered airflow may be recirculated.



Local forced air ventilation is a local air moving system. A fan moves fresh air horizontally across the welder's face. A wall fan is an example of Local Forced Air Ventilation.

When using localized ventilation, remember:

- 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.
- Some toxic materials or chemicals may require increased airflows.
- Velocities above 100 feet per minute at the arc or flame may disturb the process or shielding gas.
- The capture device can depend on the type of job.

## SUMMARY

Adequate ventilation removes the fumes and gases from the welder's breathing zone and general area. It prevents overexposure to contaminants. Approved respirators may be required when ventilation is not adequate.

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To minimize worker overexposure to fumes and gases:

- Keep your head out of the fumes, and do not breathe the fumes.
- Reposition the work and your head to avoid the fumes.
- Choose the correct ventilation method(s) for the specific operation.
- Use enough ventilation, exhaust at the arc, or both, to keep fumes and gases from your breathing zone and the general area.
- Understand what is in the fumes.
- Have a technically qualified person sample your breathing air and make recommendations.
- Keep hazardous air contaminants below allowable limits.
- Wear the proper respirator when necessary.

## INFORMATION SOURCES

American National Standards Institute (ANSI). *Safety in Welding, Cutting, and Allied Processes* (ANSI Z49.1), published by the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126; telephone 800-443-9353; web site: [www.aws.org](http://www.aws.org).

Occupational Safety and Health Administration (OSHA). *Code of Federal Regulations*, Title 29 Labor, Parts 1910.1 to 1910.1450, available from the U.S. Government Printing Office, 732 North Capitol Street NW, Washington, DC 20401; telephone: 800-321-6742; web site: [www.osha.gov](http://www.osha.gov).

National Fire Protection Association (NFPA). *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work* (NFPA 51B), available from National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101, telephone: 800-344-3555, web site: [www.nfpa.org](http://www.nfpa.org).

American Conference of Governmental Industrial Hygienists (ACGIH), *Industrial Ventilation – A Manual of Recommended Practice* 21<sup>st</sup> edition, published by the ACGIH, 6500 Glenway Avenue, Building D-7, Cincinnati, OH 45211-4438; telephone , 513-742-2020; web site: [www.acgih.org](http://www.acgih.org).

American Welding Society (AWS). *Ventilation Guide for Weld Fume* (AWS F3.2), published by the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126; telephone 800-443-9353; web site: [www.aws.org](http://www.aws.org).

Edison Welding Institute (EWI). *Reduction of Worker Exposure and Environmental Release of Welding Emissions* (NSRP report No. 43149GTH, November 30, 2003), available from the Edison Welding Institute, 1250 Arthur E. Adams Drive, Columbus, OH 43221; telephone: 614-688-5000; web site: [www.ewi.org](http://www.ewi.org).

Occupational Safety and Health Administration (OSHA). *OSHA Technical Manual (OTM)*, Section III Health Hazards, Chapter 3 Ventilation Investigation, available from OSHA, Room N3655, 200 Constitution Ave., N.W., Washington, DC 20210; telephone: 202-693-2095; web site: <http://www.osha.gov>.

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