

SAFE PRACTICES

Reprinted from the
Welding Handbook
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American Welding Society



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Safe Practices

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Labeling and Safe Practices

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Abstract

This document covers the basic elements of safety applicable to all welding, cutting, and related processes. Subjects such as fumes and gases, precautionary labeling, handling of compressed gases, and electrical safety, in addition to hazards that are unique to particular welding or cutting processes, are addressed. A supplementary reading list is included.



American Welding Society

550 N.W. LeJeune Road, P.O. Box 351040, Miami, FL 33135



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*Advisor

**Retired

Foreword

(This Foreword is not a part of *Safe Practices*, but is included for informational purposes only.)

This document is a reprint of Chapter 16 of the *Welding Handbook*, Volume 1, 8th Edition—Safe Practices. A chapter on safe practices has been included in every edition of the *Welding Handbook* to date, but this is the first time AWS has published the chapter as a monograph. The intent of this document is to make available safety information to those individuals that do not need the welding technology covered by the Handbook.

Comments and inquiries concerning this publication are welcome. They should be sent to the Technical Director, American Welding Society, 550 N.W. LeJeune Road, P.O. Box 351040, Miami, Florida 33135.

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SAFE PRACTICES

GENERAL WELDING SAFETY

THIS CHAPTER COVERS the basic elements of safety general to all welding, cutting, and related processes. It includes safety procedures common to a variety of applications. However, it does not cover all safety aspects of every welding process; especially not those involving sophisticated technology. For this reason, those chapters in the handbook devoted to specific processes should also be referenced for additional important safety information.

Safety is an important consideration in all welding, cutting, and related work. No activity is satisfactorily completed if someone is injured. The hazards that may be encountered and the practices that will minimize personal injury and property damage are discussed here.

MANAGEMENT SUPPORT

THE MOST IMPORTANT component of an effective safety and health program is management support and direction. Management must clearly state objectives and demonstrate its commitment to safety and health by consistent execution of safe practices.

Management must designate approved areas where welding and cutting operations may be carried on safely. When these operations must be done in other than designated areas, management must assure that proper procedures to protect personnel and property are established and followed.

Management must be certain that only approved welding, cutting, and allied equipment is used. Such equipment includes torches, regulators, welding machines, electrode holders, and personal protective devices. Adequate supervision must be provided to assure that all equipment is properly used and maintained.

TRAINING

THOROUGH AND EFFECTIVE training is a key aspect of a safety program. Adequate training is mandated under provisions of the U.S. Occupational Safety and Health Act (OSHA), especially those of the Hazard Communication Standard (29 CFR 1910.1200). Welders and other equipment operators perform most safely when they are properly trained in the subject.¹ Proper training includes instruction in the safe use of equipment and processes, and the safety rules that must be followed. Personnel need to know and understand the rules and the consequences of disobeying them. For example, welders must be trained to position themselves while welding or cutting so that their heads are not in the gases or fume plume.²

Before work begins, users must always read and understand the manufacturer's instructions on safe practices for the materials and equipment, and also the material safety data sheets.

Certain AWS specifications call for precautionary labels on consumables and equipment. These labels concerning the safe use of the products should be read and followed. A typical label is illustrated in Figure 1.

Manufacturers of welding consumables must provide on request a *Material Safety Data Sheet* (MSDS) that identifies those materials present in their products that have hazardous physical or health properties. The

1. The term *welder* is intended to include all welding and cutting personnel, brazers, and solderers.

2. Fume plume is the smoke-like cloud containing minute solid particles arising directly from the area of melting metal. In distinction to a gas, fumes are metallic vapors that have condensed to solid and are often associated with a chemical reaction, such as oxidation.

WARNING: PROTECT yourself and others. Read and understand this label.

FUMES AND GASES can be dangerous to your health. ARC RAYS can injure eyes and burn. ELECTRIC SHOCK can KILL.

- Read and understand the manufacturer's instructions and your employer's safety practices.
- Keep your head out of the fumes.
- Use enough ventilation, exhaust at the arc, or both, to keep fumes and gases from your breathing zone and the general area.
- Wear correct eye, ear, and body protection.
- Do not touch live electrical parts.
- See American National Standard Z49.1 "Safety in Welding and Cutting" published by the American Welding Society, 550 N.W. LeJeune Rd., P.O. Box 351040, Miami, Florida 33135; OSHA Safety and Health Standards, 29 CFR 1910, available from U.S. Government Printing Office, Washington, DC 20402.

DO NOT REMOVE THIS LABEL

Figure 1—Minimum Warning Label for Arc Welding Processes and Equipment

MSDS provides the OSHA Permissible Exposure Limit (PEL), and any other exposure limit used or recommended by the manufacturer.

Employers that use consumables must make the applicable MSDS readily available to their employees, as well as train them to read and understand the contents. The MSDS contain important information about the ingredients contained in welding electrodes, rods, and fluxes, the composition of fumes which may be generated in their use, and means to be followed to protect the welder and others from hazards which might be involved.

Under OSHA Hazard Communication Standard 29 CFR 1910.1200, employers are responsible for the training of employees with respect to hazardous materials used in their workplace. Many welding consumables are included in the definition of hazardous materials according to this standard. Welding employers must comply with the communication and training requirements of this standard.

The proper use and maintenance of the equipment must also be taught. For example, defective or worn electrical insulation cannot be tolerated in arc welding or cutting, nor can defective or worn hoses be used in oxyfuel gas welding and cutting, brazing, or soldering.

Proper training in equipment operation is fundamental to safe operation.

Persons must be trained to recognize safety hazards. If they are to work in an unfamiliar situation or environment, they must be thoroughly briefed on the potential hazards involved. For example, consider a person who must work in a confined space. If the ventilation is poor and an air-supplied helmet is required, the need and instructions for its proper use must be thoroughly explained to the employee. The consequences of improperly using the equipment must be covered. When employees believe that the safety precautions for a given task are not adequate, or not understood, they should question their supervisors before proceeding.

GENERAL HOUSEKEEPING

GOOD HOUSEKEEPING IS essential to avoid injuries. A welder's vision is often restricted by necessary eye protection. Persons passing a welding station must shield their eyes from the flame or arc radiation. The limited vision of the welder and passers-by makes them vulnerable to tripping over objects on the floor. Therefore,

welders and supervisors must always make sure that the area is clear of tripping hazards. Management must lay out the production area so that gas hoses, cables, mechanical assemblies, and other equipment do not cross walkways or interfere with routine tasks.

When work is above ground or floor level, safety rails or lines must be provided to prevent falls as a result of restricted vision from eye protection devices. Safety lines and harnesses can be helpful to restrict workers to safe areas, and to catch them in case of a fall.

Unexpected events, such as fire and explosions, do occur in industrial environments. All escape routes must be identified and kept clear so that orderly, rapid, and safe evacuation of an area can take place. Storage of goods and equipment in evacuation routes should be avoided. If an evacuation route must be temporarily blocked, employees who would normally use that route must be trained to use an alternate route.

PROTECTION IN THE GENERAL AREA

EQUIPMENT, MACHINES, CABLES, hoses, and other apparatus should always be placed so that they do not present

a hazard to personnel in passageways, on ladders, or on stairways. Warning signs should be posted to designate welding areas, and to specify that eye protection must be worn.

Protective Screens

PERSONS IN AREAS adjacent to welding and cutting must be protected from radiant energy and hot spatter by (1) flame-resistant screens or shields, or (2) suitable eye and face protection and protective clothing. Appropriate radiation-protective, semi-transparent materials are permissible.

Where operations permit, work stations should be separated by noncombustible screens or shields, as shown in Figure 2. Booths and screens should permit circulation of air at floor level as well as above the screen.

Wall Reflectivity

WHERE ARC WELDING or cutting is regularly carried on adjacent to painted walls, the walls should be painted

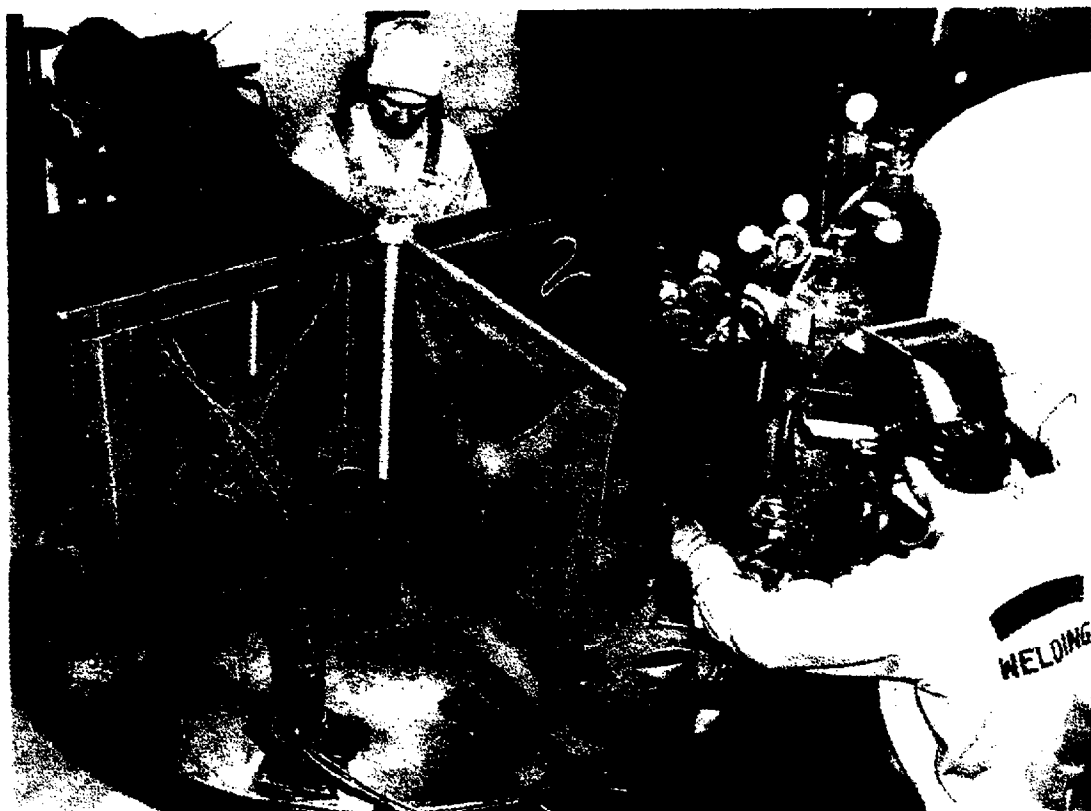


Figure 2—Protective Screens Between Work Stations

with a finish having low reflectivity of ultraviolet radiation.³ Finishes formulated with certain pigments, such as titanium dioxide or zinc oxide, have low reflectivity to ultraviolet radiation. Color pigments may be added if they do not increase reflectivity. Pigments based on powdered or flaked metals are not recommended because they reflect ultraviolet radiation.

PUBLIC DEMONSTRATIONS

PERSONS PUTTING ON public demonstrations involving observation of arc or oxyfuel gas welding or cutting processes are responsible for the safety of observers and the general public. Observers are not likely to have the necessary protective equipment to let them observe demonstrations safely. For exhibits involving observation of arc or oxyfuel gas welding and cutting processes, appropriate eye protection for both observers and passers-by is mandatory.

Fume exposure must be controlled by appropriate ventilation. Electric cables and hoses must be routed to avoid audience exposure to possible electric shock or tripping hazards. Protection must be provided against fires from fuels, combustibles, and overheated apparatus and wiring.

Fire extinguishers must be on hand in case of fire. Combustible materials must be removed from the area or shielded from flames, sparks, and molten metal.

Safety precautions at public events should be passive types, that is, they should not require the audience to take action to protect itself. For example, a protective, moveable transparent screen allows an audience to observe a welding operation with the screen in place. After welding is completed, the screen can be moved to allow the audience to observe the completed weld. Additional information is given in ANSI/ASC Z49.1, *Safety in Welding and Cutting*.

FIRE

IN MOST WELDING, cutting, and allied processes, a high-temperature heat source is present. Open flames, electric arcs, hot metal, sparks, and spatter are ready sources of ignition. Many fires are started by sparks, which can travel horizontally up to 35 feet from their source and fall much greater distances. Sparks can pass through or lodge in cracks, holes, and other small openings in floors and walls.

The risk of fire is increased by combustibles in the work area, or by welding or cutting too close to combustibles that have not been shielded. Materials most commonly ignited are combustible floors, roofs, partitions, and building contents including trash, wood, paper, tex-

tiles, plastics, chemicals, and flammable liquids and gases. Outdoors, the most common combustibles are dry grass and brush.

The best protection against fire is to perform welding and cutting in specially designated areas or enclosures of noncombustible construction that are kept free of combustibles. Combustibles should always be removed from the work area or shielded from the operation.

Fuel for engine driven equipment should be stored and used with care. Equipment manufacturer's instructions should be followed because fuels and their vapors are combustible and can be explosive under some conditions.

Fuel gases, such as acetylene or propane, are other common flammables often found in cutting and welding areas. Special attention should be given to fuel gas cylinders, hoses, and apparatus to prevent gas leakage.

Combustibles that cannot be removed from the area should be covered with tight fitting, flame resistant material. These include combustible walls and ceilings. Floors should be free of combustible materials for a radius of 35 feet around the work area. All doorways, windows, cracks, and other openings should be covered with a flame-resistant material or, if possible, the work area should be enclosed with portable flame-resistant screens.

If welding or cutting is to be performed on or adjacent to a metal wall, ceiling, or partition, combustibles on the other side must be moved to a safe location. If this cannot be done, a fire watcher should be stationed where the combustibles are located. Heat from welding can be conducted through metal partitions and ignite combustibles on the opposite side. A thorough examination for evidence of fire should be made before leaving the work area. Fire inspection should be continued for at least 30 minutes after the operation is completed.

Welding or cutting should not be performed on material having a combustible coating or internal structure, as in walls or ceilings. Hot scrap or slag must not be placed in containers holding combustible materials. Suitable fire extinguishers should always be available nearby.

Welding, brazing, or cutting should not be performed on combustible floors or platforms that may readily be ignited by heat from the operation. Welders must be alert for traveling vapors of flammable liquids. Vapors are often heavier than air and can travel along floors and in depressions for distances of several hundred feet from where the flammable liquid is stored. Light vapors can travel along ceilings to adjacent rooms.

HOT WORK PERMIT SYSTEM

WHEN WELDING, CUTTING, or similar hot working operations are to be performed in areas not normally assigned for such operations, a hot work permit system

3. For further guidance, see *Ultraviolet Reflectance of Paint*. Miami: American Welding Society, 1976.

should be used. The purpose of the hot work permit system is to alert area supervisors to an extraordinary danger of fire that will exist at a particular time. The permit system should include a check list of safety precautions that includes an inspection for fire extinguishers, establishment of fire watches if necessary, search for flammable materials, and safety instructions for personnel in the area who are not involved in the hot work.

EXPLOSION

FLAMMABLE GASES, VAPORS, and dusts, when mixed with air or oxygen in certain proportions, present danger of explosion as well as fire. To prevent explosions, avoid all sources of ignition. Welding, brazing, soldering, cutting, or operating equipment that can produce heat or sparks must not be done in atmospheres containing flammable gases, vapors, or dusts. Such flammables must be kept in leak-tight containers or be well removed from the work area. Heat or sparks may cause otherwise low-volatile materials to produce flammable vapors.

Hollow containers must be vented before applying heat. Heat must not be applied to a container that has held an unknown material, a combustible substance, or a substance that may form flammable vapors on heating.⁴ The container must first be thoroughly cleaned or filled with an inert gas. Heat should never be applied to a workpiece that is covered by an unknown substance, nor to a substance that may form flammable or toxic vapors on heating.

Adequate eye and body protection must be worn when operations involve a risk of explosion.

BURNS

BURNS OF THE eye or body are serious hazards of welding, brazing, soldering, and cutting. Eye, face, and body protection for the operator and others in the work area are required to prevent burns from ultraviolet and infrared radiation, sparks, and spatter.

Eye and Face Protection

Arc Welding and Cutting. Welding helmets or handshields containing appropriate filter lenses and cover plates must be used by welders and welding operators and nearby personnel when viewing an arc.⁵ Suggested shade numbers of filter plates for various welding, braz-

ing, soldering, and thermal cutting operations are given in Table 1.

Safety spectacles, goggles, or other suitable eye protection must also be worn during welding and cutting operations. Such devices must have full conforming side shields when there is danger of exposure to injurious rays or to flying particles from grinding or chipping operations. Spectacles and goggles may have clear or colored lenses, depending on the intensity of the radiation that may come from adjacent welding or cutting operations when the welding helmet is raised or removed. Number 2 filter lenses are recommended for general purpose protection.

Oxyfuel Gas Welding and Cutting, Submerged Arc Welding. Safety goggles with filter lenses (Table 1) and full conforming side shields must be worn while performing oxyfuel gas welding and cutting. During submerged arc welding, the arc is covered by flux and not readily visible; hence, an arc welding helmet is not needed. However, because the arc occasionally flashes through the flux burden, the operator should wear tinted safety glasses.

Torch Brazing and Soldering. Safety spectacles with or without side shields and with appropriate filter lenses are recommended for torch brazing and soldering. As with oxyfuel gas welding and cutting, a bright yellow flame may be visible during torch brazing. A filter similar to that used with those processes should be used for torch brazing.

Resistance, Induction, Salt-Bath, Dip, Infrared Welding, and Brazing. Operators and helpers engaged in these processes must wear safety spectacles, goggles, and a face shield to protect their eyes and face from spatter. Filter lenses are not necessary but may be used for comfort.

Protective Clothing

STURDY SHOES OR boots, and heavy clothing similar to that in Figure 3 should be worn to protect the whole body from flying sparks, spatter, and radiation burns. Woolen clothing is preferable to cotton because it is not so readily ignited. Cotton clothing, if used, should be chemically treated to reduce its combustibility. Clothing treated with nondurable flame retardants must be retreated after each washing or cleaning. Clothing or shoes of synthetic or plastic materials which can melt and cause severe burns should not be worn. Outer clothing should be kept reasonably free of oil and grease, especially in an oxygen-rich atmosphere.

Cuffless pants and covered pockets are recommended to avoid spatter or spark entrapment. Pockets should be emptied of flammable or readily ignitable materials

4. Additional information is given in AWS F4.1, *Recommended safe practices for the preparation for welding and cutting of containers and piping that have held hazardous substances*. Miami: American Welding Society (latest edition).

5. Standards for welding helmets, handshields, face shields, goggles, and spectacles are given in ANSI Z87.1, *Practice for occupational and educational eye and face protection*. New York: American National Standards Institute (latest edition).

Table 1
Suggested Viewing Filter Plates

Operation	Plate Thickness		Welding Current, A	Lowest Shade Number	Comfort Shade Number ^a
	in.	mm			
Shielded metal arc welding	—	—	Under 60	7	—
			60-160	7	10
			160-250	10	12
			250-550	11	14
Gas metal arc and flux cored arc welding	—	—	Under 60	7	—
			60-160	10	11
			160-250	10	12
			250-500	10	14
Gas tungsten arc welding	—	—	Under 50	8	10
			50-150	8	12
			150-500	10	14
Plasma arc welding	—	—	Under 20	6	6-8
			20-100	8	10
			100-400	10	12
			400-800	11	14
Oxyfuel gas welding (steel) ^b	Under 1/8	3.2	—	—	4, 5
	1/8-1/2	3.2-12.7	—	—	5, 6
	Over 1/2	12.7	—	—	6, 8
Plasma arc cutting ^c	—	—	Under 300	8	9
			300-400	9	12
			400-800	10	14
Air-carbon arc cutting	—	—	Under 500	10	12
			500-1000	11	14
Oxyfuel gas cutting (steel) ^b	Under 1	25	—	—	3, 4
	1-6	25-100	—	—	4, 5
	Over 6	150	—	—	5, 6
Torch brazing	—	—	—	—	3, 4
Torch soldering	—	—	—	—	2

a. To select the best shade for the application, first select a dark shade. If it is difficult to see the operation properly, select successively lighter shades until the operation is sufficiently visible for good control. However, do not go below the lowest recommended number, where given.

b. With oxyfuel gas welding or cutting, the flame emits strong yellow light. A filter plate that absorbs yellow or sodium wave lengths of visible light should be used for good visibility.

c. The suggested filters are for applications where the arc is clearly visible. Lighter shades may be used where the arc is hidden by the work or submerged in water.

before welding because they may be ignited by sparks or weld spatter and result in severe burns. Pants should be worn outside of shoes. Protection of the hair with a cap is recommended, especially if a hairpiece is worn. Flammable hair preparations should not be used.

Durable gloves of leather or other suitable material should always be worn. Gloves not only protect the hands from burns and abrasion, but also provide insula-

tion from electrical shock. A variety of special protective clothing is also available for welders. Aprons, leggings, suits, capes, sleeves, and caps, all of durable materials, should be worn when welding overhead or when special circumstances warrant additional protection of the body.

Sparks or hot spatter in the ears can be particularly painful and serious. Properly fitted, flame-resistant ear