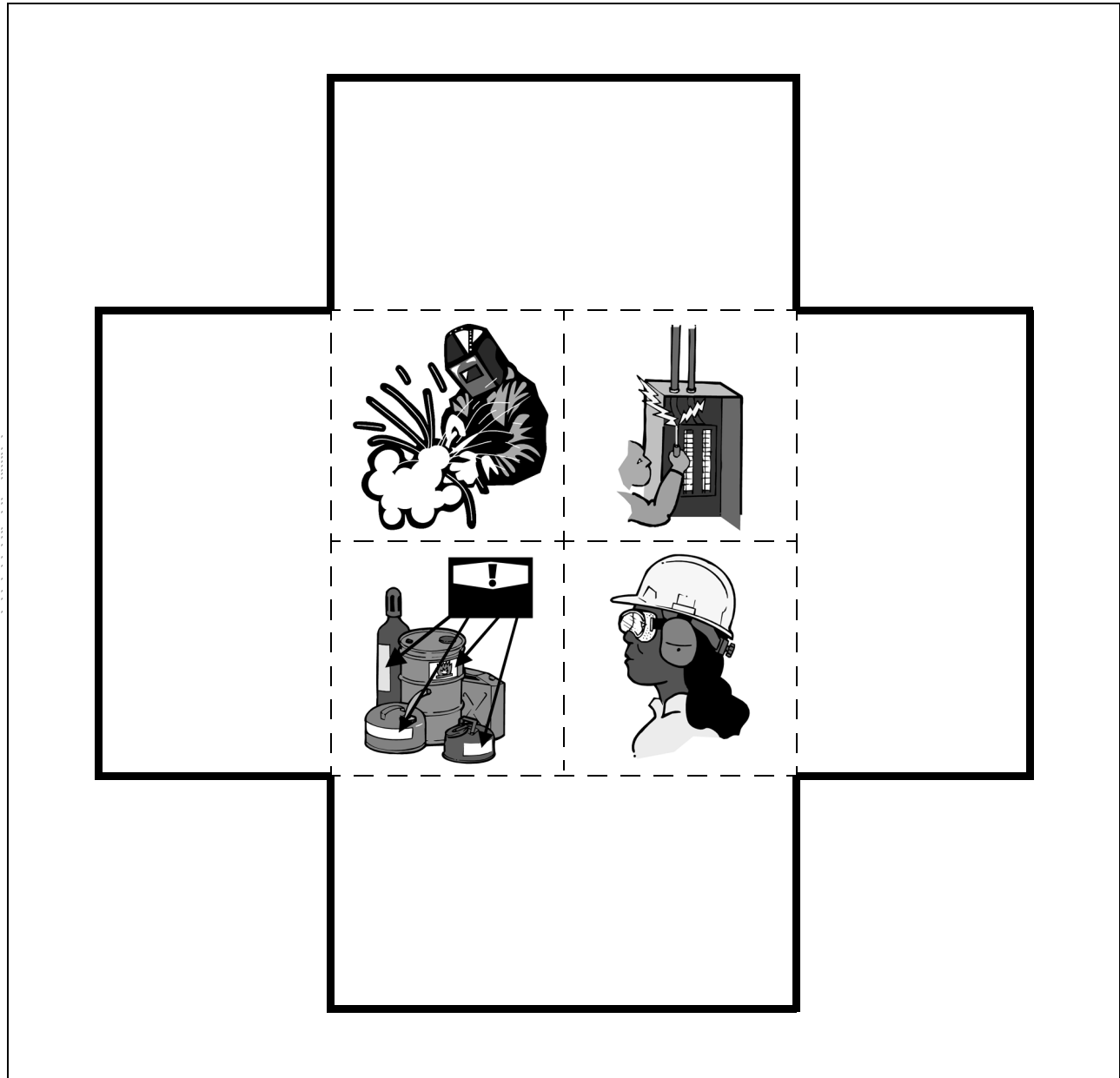


The Independent Shop's Guide to Welding Safety and Health



American Welding Society



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THE INDEPENDENT SHOP'S GUIDE TO WELDING SAFETY AND HEALTH

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Expert Services

The information contained in this publication is intended for general information purposes only and is provided to help guide independent shops to understand the safety matters they need to know to comply with regulations and to make their workers and workplace safe. This publication is not a substitute for a thorough review of the applicable government regulations and standards, or other standards from cited organizations, and should not be construed as legal advice or opinion. Readers with specific questions should refer to the cited regulation/standard/organization or consult with an attorney. This document is not a consensus standard. The publisher is not responsible for loss or damage resulting from use of this publication.



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AUTHOR NOTES

This project began as the brainchild of the AWS Safety and Health Committee. They recognized the need for a clear and direct guide to help independent shops get answers to their unique questions. Independent shops lack the resources of large companies, which have safety professionals on staff to keep up with the latest codes, regulations, and needed training. As a result of this perceived gap, this booklet sprang to life. An author and style was chosen, and the work began in earnest in cooperation with the AWS New Product Development Committee. In the process, the AWS Safety and Health Committee and the AWS SH4 Committee on Labeling and Safe Practices reviewed the publication at all of its stages and provided feedback to the author. These two groups of nationally recognized experts shared their knowledge and wisdom regularly, including technical information, helpful suggestions, and other details noticed during their reviews of the drafts. Special recognition goes to the following persons who took the time to share their expertise and comments on a variety of areas and saw the project through to completion:

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Truly the author stood on the shoulders of giants throughout this job. For their help and ever-available assistance, he is deeply grateful and indeed humbled to have worked with people of this caliber.

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Introduction

The purpose of this publication is to provide the owners of small welding and cutting shops with a practical guide to help ensure the safety and health of employees and the protection of property. The maintenance of the health and safety of employees is vital to the successful operation of any business. Healthy and safe workers are productive and contribute to the profitability of the business. Conversely, workers exposed to unhealthy and unsafe work environments can be costly to a business through decreased productivity, absenteeism, increased medical expenses, increased property damage, and fines up to a maximum allowable penalty of \$70,000.00¹ for a willful or repeated safety or health violation.

This document describes the common potential health and safety hazards that may be present in a small welding and cutting shop and provides practical advice on protecting workers and property. It should be understood that not every potential hazard can be addressed in an overview publication, but additional sources of help are identified throughout the publication. Some aspects of health and safety, for example the assessment of worker exposures to welding fumes, may require personnel with professional training and equipment not normally employed in an independent shop. The shop owner may have to hire professional assistance in certain circumstances. When outside assistance is necessary, AWS recommends the shop owner consider engaging a Certified Safety Professional (see "Websites," page 23).

How to Use This Guide

Study the information carefully. There are a series of emphasis blocks, each identified by an icon. These blocks will summarize the situation, directly and quickly. Examples follow of the different types of blocks and what you will find in them:

1. A willful violation is defined by OSHA as one committed with an intentional disregard of, or plain indifference to, the requirements of the Occupational Safety and Health Act (1970) and regulations. The maximum fine that can be proposed for a willful violation is \$70,000.



Helpful Hints

In this type of box, you will find advice on avoiding the problem/hazard or simple ways to deal with the topic under discussion.



Rapid Review

Information in this type of box is a summary and is generally found at the end of each subject area.



Technical Tips

In this type of box, you will find additional technical information that helps explain the topic under discussion.



Fundamentals

In this type of box, you will find basic things you need to know about the topic under discussion.

What is OSHA?

OSHA stands for the Occupational Safety and Health Administration. Since 1970, OSHA has published requirements, called *regulations*, that spell out what safety measures must be taken for a variety of situations. They also are enforcers of these requirements and have the power to fine employers who fail to comply. And keep in mind that ignorance of the regulations is *not* an accepted excuse. If you violate, you are fined. Period. OSHA sets the requirements and assesses fines. Fines range up to \$70,000 per incident. Fines are adjusted for the size of the company and if the company is making a good faith effort to provide a safe and healthy workplace.

OSHA publishes its regulations to ensure safe and healthy working conditions. OSHA has contributed toward the 50% decline in work-related fatalities and 40% decline in occupational injuries in the U.S. since its establishment. It has accomplished this goal by requiring that information, practice train-

ing, and education be provided for all workers. OSHA's current welding and cutting standards are based on AWS/ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes* (see "Information Sources," page 21), and the National Fire Protection Association's (NFPA) 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*. The underlying rationale and available provisions for ensuring a safe and informed workforce and workplace are indeed admirable. But, you must know what's required and how to comply. In this, you have several options: You can acquire the skill and knowledge yourself and apply it in your operation, or you can hire a safety consultant to come into your business and evaluate it for you. Additionally, you can ask OSHA directly for help.



Helpful Hint: OSHA Can Be Your Free Consultant

OSHA plays a vital role in preventing on-the-job injuries and illnesses through outreach, education, and compliance assistance. OSHA offers an extensive website at www.osha.gov. It includes a special section devoted to assisting small business as well as interactive e-Tools to help employers and employees. Free workplace consultations are available in every state for small businesses that want onsite help in establishing safety and health programs and identifying and correcting workplace hazards. A list of the consultation offices can be found at www.osha.gov/osmdir/consult.html. In addition, OSHA has a network of Compliance Assistance Specialists in local offices available to provide tailored information and training to employers and employees.

Basic Safety Hazard Sources and Accident Results

There are many possible sources of accidents. Here are some of the most common ones:

- Tools and equipment
- Chemicals
- Ladders
- Electricity
- Improper Lifting
- Flammable liquids and gases
- Confined spaces
- Oxidizers

The results of accidents involving these typical sources can include:

- Amputations
- Cuts and bruises
- Broken bones
- Chemical burns
- Loss of eyesight
- Fires causing personal injury and property loss
- Electric shock
- Chemical exposure

In plain language, accidents just do not happen out of the blue. They are either the result of an unsafe act or an unsafe condition or both. Common sense is not very common. *Unsafe acts* cause most accidents. These unsafe acts include operating tools or equipment without training or permission; failure to use lockout procedures; horseplay; running; failure to inspect equipment; attempting repairs when not qualified to do so; not following common safety procedures; improper lifting; not using proper personal protective equipment (PPE); and the improper use of chemicals.

Unsafe conditions are everywhere. They include such things as damaged equipment or tools; poor lighting; slippery walking surfaces; missing machine guards; inadequate training or supervision; exposed electrical circuits; worn or damaged PPE; improper storage; trash accumulation and poor housekeeping; overloaded electrical circuits; congested walkways; trip hazards; missing hazard warning signs; and unlabeled or incorrectly labeled chemicals or cylinders.

Responsibilities of Management—The Shop Owner or Manager/Boss

Who is "management"? The term "management" means "all persons who are responsible for welding operations such as owners, contractors, and others."² OSHA requires that management show their commitment to the safety and health of employees by establishing guidelines and insisting that everyone, including management, follow safe practices consistently. Without this from-the-top emphasis, on-the-job safety can become spotty and neglected. People, like electricity, tend to take the path of least resistance, and safety usually suffers.

2. AWS/ANSI Z49.1:1999, page 3.

The owner/boss needs to do a number of things to ensure safe welding and cutting in the shop. The major responsibilities include the following:

- Provide approved and inspected equipment that is in safe condition and ready for use.
- Designate areas where welding and cutting can be done safely. If it becomes necessary to do the work in a different place, ensure that proper safety procedures are followed to protect workers and property.
- Train persons using the equipment in its safe operation and in safe use of the process.
- Train workers in emergency procedures—who to see, where to go, and what to do.
- Provide adequate supervision to ensure that all equipment is properly used and maintained.
- Have any repairs made by qualified persons before the equipment is returned to use.
- Follow the manufacturer's recommendations and instructions for operating and maintaining equipment.
- Communicate the hazards and safety precautions about the job before the work is started.
- Select contractors who know the risks and have qualified and trained workers who will work safely.
- Understand what flammable and combustible materials are present or nearby, and explain the procedures to follow to prevent fire and explosion.
- Have approved fire extinguishers of the correct type nearby and be sure all know how to use them.
- Use a hot work permit system when required.

How is an independent shop supposed to get this done? Where will the owner get the information? First, use the information provided by the manufacturers of the equipment. Most provide complete instructions about the proper use, handling, and maintenance of their equipment—take it out and use it. These manuals normally contain safety information as well. In addition, there are labels on the product/machine to alert you to possible hazards and show you how to avoid them. Follow the labels. Obtain and read the Material Safety Data Sheets (MSDSs) for the metal being welded or cut, for coatings, residual materials or liquids, and any consumables, such as rods, wires, and fluxes, before starting. These MSDSs have a wealth of information about the item and its hazards and use. Get to know the MSDSs—a Glossary starts on page 23.



Rapid Review

- OSHA was established in 1970 and has the authority to regulate safety and health issues and to impose fines for noncompliance.
- Management must show commitment to the safety and health of employees by establishing guidelines and ensuring employee compliance.
- Manufacturers of welding and cutting equipment supply operation manuals including safety requirements.
- “MSDS” stands for Material Safety Data Sheet.

The Hazard Communication Standard (HCS)

The Hazard Communication Standard (HCS) is applicable to all workers covered by the Occupational Safety and Health Act. The HCS is based on a simple concept: Employees have both a need and the right to know the hazards and chemicals they are exposed to, and how to protect themselves from any exposure while working. Simply put, the HCS requires that all chemicals produced, imported, or used in U.S. workplaces be evaluated, and that hazard information be communicated to affected employees by means of both precautionary information placed on containers and material safety data sheets (MSDSs) supplied with materials.

What does this mean for shop management? It means employers have to inform workers of potential hazards in the workplace and provide training regarding the safe handling of hazardous materials. In addition, employers must have a *written* Hazard Communication Program and an inventory list of the chemicals they use. This standard identifies many welding and cutting consumables as hazardous materials. Sounds very complicated, doesn't it? Well, again, methods of communication are provided as part of the regulations: precautionary labels, MSDSs, and a written program. Plus, OSHA offers its Publication 3111 (2000), as a 33-page PDF. This document will aid employers in understanding the Hazard Communication Standard and in implementing a hazard communication program. (See “Web Resources,” page 23.) The key is to read and follow this information—nothing difficult here. Precautionary labels are usually located on the carton, box, or equipment, and are brief and direct in communicating the hazards involved with the use

of the item. An example of precautionary information for arc welding equipment and for containers of consumables (rods, wire, electrodes) from AWS/ANSI Z49.1 is shown in Figure 1.

There are other examples of precautionary information in AWS/ANSI Z49.1 (i.e., Oxyfuel Gas Processes and Equipment) as well as other things. By now the point should be striking home: Get a copy of AWS/ANSI Z49.1 and keep it handy! And remember, users should be trained to read and understand all safety documentation before work begins. "All safety documentation" means the instruction manual, the precautionary information, and the MSDSs. Also, remember employers must have a written Hazard Communication Program. It is worthwhile to engage a certified safety consultant to help you with this part of the job.

WARNING:

PROTECT yourself and others. Read and understand this information.

FUMES AND GASES can be hazardous to your health.

ARC RAYS can injure eyes and burn skin.

ELECTRIC SHOCK can KILL.

Before use, read and understand the manufacturer's instructions, Material Safety Data Sheets (MSDSs), 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, Cutting, and Allied Processes*, published by the American Welding Society, 550 N.W. LeJeune Road, Miami, Florida 33126; OSHA *Safety and Health Standards*, available from the U.S. Government Printing Office, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954.

DO NOT REMOVE THIS INFORMATION

Figure 1. Precautionary Information for Arc Welding Processes and Equipment

Material Safety Data Sheets

The next communication tool you and your workers need to read, understand, and follow are the Material Safety Data Sheets (MSDSs). To make things simple, an example follows so you will know what they are and how they are presented (see Figure 2).

Notice the way the MSDS is laid out. In this example, there are nine separate sections (the number of sections varies depending on the manufacturer) clearly telling you what each section is about (an actual MSDS will include all the data you need to know about the material in regard to that aspect of the item). You do not need to create MSDSs, but you do need to read and follow them! Know what they are and you are light years ahead of most everyone else. No rocket science here, just a standard way of communicating all necessary information to the user of a product. The people who create MSDSs are experts working with the people who make the product. You just need to read and follow them, but if you have questions, there is even a phone number to call. Make it a point to become familiar with all the MSDSs for the materials in your shop, and tell workers about them. Creating a MSDS "station" right in the shop, with the MSDSs collected in a binder, is one way to keep these important documents readily available to workers.

Protection of the Work Area and Personnel

Housekeeping

Protection of the work area is first on the list since a messy and cluttered workplace readily lends itself to accidents. Most safety and health professionals find there is a direct relationship between messiness and the number of safety violations found in that location. People involved in welding and cutting have to wear safety glasses and helmets. Eye protection may interfere with vision and can cause welders and cutters to easily trip over any objects on the floor. Organize the work area so that equipment, cables, and hoses do not clutter the area, but rather are routed so that workers can easily walk through without stumbling or tripping over the things normally needed for the operation. Also, use safety rails, body harnesses, or lifelines to keep workers away from any hazardous areas and to prevent falls if working above floor level. In short,

MATERIAL SAFETY DATA SHEET

SECTION 1 - PRODUCT IDENTIFICATION AND USE				
PRODUCT IDENTIFIER ⇨			PRODUCT IDENTIFICATION NUMBER (PIN)	
PRODUCT USE ⇨				
MANUFACTURER'S NAME		SUPPLIER'S NAME		
STREET ADDRESS		STREET ADDRESS		
CITY	PROVINCE	CITY	PROVINCE	
POSTAL CODE	EMERGENCY TELEPHONE NO.	POSTAL CODE	EMERGENCY TELEPHONE NO.	
SECTION 2 - HAZARDOUS INGREDIENTS				
HAZARDOUS INGREDIENTS	%	CAS NUMBER	LD ₅₀ OF INGREDIENT (Specify species & route)	LD ₅₀ OF INGREDIENT (Specify species)
SECTION 3 - PHYSICAL DATA				
PHYSICAL STATE	ODOUR AND APPEARANCE			ODOUR THRESHOLD (ppm)
VAPOUR PRESSURE (mm Hg)	VAPOUR DENSITY (AIR = 1)	EVAPORATION RATE	BOILING POINT (°C)	MELTING POINT (°C)
pH	SPECIFIC GRAVITY	COEFF. WATER/OIL DIST.		
SECTION 4 - FIRE AND EXPLOSION DATA				
FLAMMABILITY YES ☐ NO ☐ IF YES, UNDER WHICH CONDITIONS? ⇨				
MEANS OF EXTINCTION				
FLASHPOINT (°C) AND METHOD	UPPER FLAMMABLE LIMIT (% BY VOLUME)		LOWER FLAMMABLE LIMIT (% BY VOLUME)	
AUTOIGNITION TEMPERATURE (°C)	HAZARDOUS COMBUSTION PRODUCTS			
EXPLOSION DATA ⇨ SENSITIVITY TO IMPACT		SENSITIVITY TO STATIC DISCHARGE		
SECTION 5 - REACTIVITY DATA				
CHEMICAL STABILITY YES ☐ NO ☐ IF NO, UNDER WHICH CONDITIONS? ⇨				
INCOMPATIBILITY WITH OTHER SUBSTANCES YES ☐ NO ☐ IF SO, WHICH ONES ⇨				
REACTIVITY, AND UNDER WHAT CONDITIONS				
HAZARDOUS DECOMPOSITION PRODUCTS				

Figure 2. Sample of a Material Safety Data Sheet (MSDS)

PRODUCT IDENTIFIER			
SECTION 6 - TOXOLOGICAL PROPERTIES			
ROUTE OF ENTRY SKIN CONTACT ☐ SKIN ABSORPTION ☐ EYE CONTACT ☐ INHALATION ☐ INGESTION ☐			
EFFECTS OF ACUTE EXPOSURE TO PRODUCT			
EFFECTS OF CHRONIC EXPOSURE TO PRODUCT			
EXPOSURE LIMITS	IRRITANCY OF PRODUCT	SENSITIZATION TO PRODUCT	CARCINOGENICITY
TERATOGENICITY	REPRODUCTIVE TOXICITY	MUTAGENICITY	SYNERGISTIC PRODUCTS
SECTION 7 - PREVENTATIVE MEASURES			
PERSONAL PROTECTIVE EQUIPMENT			
GLOVES (SPECIFY)	RESPIRATOR (SPECIFY)	EYE (SPECIFY)	
FOOTWEAR (SPECIFY)	CLOTHING (SPECIFY)	OTHER (SPECIFY)	
ENGINEERING CONTROL (SPECIFY E.G., VENTILATION, ENCLOSED PROCESS)			
LEAK AND SPILL PROCEDURE			
WASTE DISPOSAL			
HANDLING PROCEDURES AND EQUIPMENT			
STORAGE REQUIREMENTS			
SPECIAL SHIPPING INFORMATION			
SECTION 8 - FIRST AID MEASURES			
SPECIFIC MEASURES			
SECTION 9 - PREPARATION DATE OF MSDS			
PREPARED BY (GROUP, DEPARTMENT, ETC.)	PHONE NUMBER	DATE	

Figure 2 (Continued). Sample of a Material Safety Data Sheet (MSDS)

use *good housekeeping* to keep the work areas orderly and clutter-free. Arrange for safe movement of materials into and out of the work area when parts are being made or moved regularly.

Workers

Since eye protection is required, and the vision of welders is restricted by dark filter lenses, machinery guarding is necessary. Actually, machine guarding is required whether vision is restricted or not! All machinery in the area must have proper guards installed and working correctly, because it is difficult to see in welding gear. Spinning blades, pinch points, moving fixtures, belts, fans, etc., require careful guarding to prevent accidents. Place signs in readily visible locations. These signs should clearly indicate that this is a welding area and that all persons should wear eye protection. If additional hazards are present, post the information about them on signs, too.

Since unexpected events, such as fire or explosion, can occur, be sure to identify proper escape routes in case evacuation of the area is necessary. Train workers how to respond and where to go in case of emergency.



Helpful Hints: Work Area

- Use common sense—keep the work area clutter free.
- Install proper guards on all machinery.
- Post signs to require eye protection in welding areas.
- Understand hot work permits.
- Know about the Noise and Hearing Conservation requirements.
- Read OSHA General Industry Standards:
 - Definitions (1910.251)
 - General Requirements (1910.252)
 - Oxygen-Fuel Gas Welding and Cutting (1910.253)
 - Arc Welding and Cutting (1910.254)
 - Resistance Welding (1910.255)

Persons involved in welding and cutting need the proper protective gear and clothing to remain safe on the job. Be sure it is available and used! This includes proper eye and face protection appropriate to the job, such as a helmet, goggles, and ear protection. This means the use of the correct shade of filter

for each application (see Table 1). Here's the standard from the AWS F2.2. Use it, apply it, insist on it for everyone doing welding and cutting. Period.

The welding arc can also cause skin damage, similar to the damaging UV (ultraviolet) rays of the sun. But the UV rays of a welding arc are many times more damaging than the sun's rays. So, don't allow arc burn. Always insist on heavy, durable long pants, long sleeves, buttoned collars, and be sure any exposed skin areas are covered when welding is in progress (cotton t-shirts shouldn't be allowed). Remember the reason for all this equipment: *Prevent* injury from electric shock, burns, fire, arc rays, and flying sparks. AWS/ANSI Z49.1 contains the full explanation of protective equipment—read and follow it. Note that all personal equipment should be approved for use in the specific application. Ask your suppliers about it—don't cut corners with cheap or flimsy gear. Remember, this equipment is your first line of defense from injury!



Fundamentals: Equipment That's Worn

- Always wear dry insulating leather gloves in good condition (without holes or tears).
- Wear a welding helmet with the correct shade of filter.
- Wear safety glasses with side shields under your welding helmet or face shield and at all times in the work area; wear a welders cap under your helmet.
- Use ear protection, such as earplugs, when welding out of position or in confined spaces.
- Wear oil-free protective clothing made of wool or heavy cotton, no-cuff pants, and high leather shoes or boots; button the shirt collar. Don't wear synthetic (man-made) fabrics such as rayon, nylon, or plastic rain gear because they can burn easily or melt into your skin.
- Keep all clothing clean and in good repair—no holes or frayed edges.

Ventilation

Welding and cutting processes generate fumes and gases that may be harmful. The fumes contain airborne particles of the base metal, consumables (rods, wires, fluxes), and any coatings present on the workpiece. The persons doing the welding or

Table 1. Lens Shade Selector

Shade numbers are given as a guide only and may be varied to suit individual needs.

Process	Electrode Size	Arc Current (Amperes)	Minimum Protective Shade	Suggested* Shade No. (Comfort)
	in. (mm)			
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 (GMAW) and Flux Cored Arc Welding (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
Air Carbon Arc Cutting (CAC-A)				
	(Light)	Less than 500	10	12
	(Heavy)	500–1000	11	14
Plasma Arc Welding (PAW)		Less than 20	6	6–8
		20–100	8	10
		100–400	10	12
		400–800	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
Torch Brazing (TB)		—	—	3 or 4
Torch Soldering (TS)		—	—	2
Carbon Arc Welding (CAW)		—	—	14
	Plate Thickness			Suggested* Shade No. (Comfort)
	in.	mm		
Oxyfuel 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
*As a rule of thumb, start with a shade that is too dark to see the weld zone. Then go to a lighter shade which gives sufficient view of the weld zone without going below the minimum. In oxyfuel gas welding, cutting, or brazing where the torch and/or the flux produces a high yellow light, it is desirable to use a filter lens that absorbs the yellow or sodium line of the visible light spectrum.				