University of Nebraska Lincoln

Safe Operating Procedure

(Revised 7/09)

WELDING LENS SHADE & PERSONAL PROTECTIVE EQUIPMENT (PPE) SELECTION

(For assistance, please contact EHS at (402) 472-4925, or visit our web site at http://ehs.unl.edu/)

Appropriate eye and face protection is of utmost importance when conducting welding and cutting operations to protect against flying debris, sparks, heat, and optical radiation hazards. Because the optical radiation varies with the type and characteristics of the welding operation, the shade rating must be matched to the operation. The chart below provides guidance on the minimum shading necessary to provide adequate eye protection.

Lens Shade Selector Guide

Operation/Process	Electrode Size in. (mm)	Arc Current (Amperes)	Min Protective Shade	Suggested Shade No.
Shielded metal arc welding (SMAW)	Less than 3/32 (2.5) 3/32−5/32 (2.5−4) 5/32−1/4 (4−6.4) More than 1/4 (6.4)	Less than 60 60−160 160−250 250−550	7 8 10 11	— 10 12 14
Gas Metal Arc Welding (GMAW) & Flux Cored Arc Welding (FCAW)		Less than 60 60−160 160−250 250−550	7 10 10 10	— 11 12 14
Gas Tungsten Arc Welding (GTAW)		Less than 50 50−150 150−500	8 8 10	10 12 14
Air Carbon Arc Cutting (CAC−A)	(Light) (Heavy)	Less than 500 500−1000	10 11	12 14
Plasma Arc Welding (PAW)		Less than 20 20−100 100−400 400−800	6 8 10 11	6 to 8 10 12 14
Plasma Arc Cutting (PAC)		Less than 20 20−40 40−60 60−80 80−300 300−400 400−800	4 5 6 8 8 9 10	4 5 6 8 9 12 14
Torch Brazing (TB)		—	—	3 or 4
Torch Soldering (TS)		—	—	2
Carbon Arc Welding (CAW)		—	—	14

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	Plate thickness			
	in.	mm		
Oxyfuel Gas Welding (OFW) • Light • Medium • Heavy	 Under 1/8 1/8 to 1/2 Over 1/2	 Under 3.2 3.2 to 12.7 Over 12.7		 4 or 5 5 or 6 6 or 8
Oxygen Cutting (OC) • Light • Medium • Heavy	 Under 1 1 to 6 Over 6	 Under 25 25 to 150 Over 150		 3 or 4 4 or 5 5 or 6

Additional Eye and Face Protection Considerations

- As a rule of thumb, start with a shade that is too dark to see the weld or cut zone. Then go to a lighter shade which gives sufficient view of the weld or cut zone without going below the minimum. In oxyfuel gas welding, cutting, or brazing where the torch produces a high yellow light, it is desirable to use a filter lens that absorbs the yellow or sodium line in the visible light of the (spectrum) operation.
- Welders that use a self-darkening lens (battery or solar powered) should adjust the filters per the manufacturer's directions because different processes require different shade numbers. Welders must also be familiar with the delay and sensitivity factors of particular lenses used, since not all brands are the same or provide equal protection against flash.
- For laser beam welding, cutting, and drilling, the light emitted from most lasers is not visible but can cause permanent eye damage as well as skin burns. Additional protective eyewear suitable for the wavelength is necessary.
- Following is a summary of federal Occupational Safety and Health Administration (OSHA) standards for eye and face protection during welding:
    - Suitable goggles are required for brazing operations. Helmets and/or face shields are required as specified below:
        - Helmets or hand shields shall be used during all arc welding or arc cutting operations, excluding submerged arc welding. Helpers or attendants shall be provided with proper eye protection.
        - Goggles or other suitable eye protection shall be used during all gas welding or oxygen cutting operations. Spectacles without side shields, with suitable filter lenses are permitted for use during gas welding operations on light work, for torch brazing or for inspection.
        - All operators and attendants of resistance welding or resistance brazing equipment shall use transparent face shields or goggles, depending on the particular job, to protect their faces or eyes, as required.
    - Helmets and hand shields shall be made of a material which is an insulator for heat and electricity. Helmets, shields and goggles shall be not readily flammable and shall be capable of withstanding sterilization. All parts shall be constructed of a material which will not readily corrode or discolor the skin.
    - Helmets and hand shields shall be arranged to protect the face, neck and ears from direct radiant energy from the arc. Goggles shall be ventilated to prevent fogging of the lenses as much as practicable.
    - Helmets shall be provided with filter plates and cover plates designed for easy removal.

- All glass for lenses shall be tempered, substantially free from striae, air bubbles, waves and other flaws. Except when a lens is ground to provide proper optical correction for defective vision, the front and rear surfaces of lenses and windows shall be smooth and parallel.
- Lenses shall bear some permanent distinctive marking by which the source and shade may be readily identified. All filter lenses and plates shall meet the test for transmission of radiant energy prescribed in ANSI Z87.1.
- Protection from arc welding rays. Where the work permits, the welder should be enclosed in an individual booth painted with a finish of low reflectivity such as zinc oxide (an important factor for absorbing ultraviolet radiations) and lamp black, or shall be enclosed with noncombustible screens similarly painted. Booths and screens shall permit circulation of air at floor level. Workers or other persons adjacent to the welding areas shall be protected from the rays by noncombustible or flameproof screens or shields or shall be required to wear appropriate goggles.

Other Apparel and PPE Considerations

Following are general guidelines for apparel and PPE. The appropriate ensemble for a specific operation/task will vary with the size, nature, and location of the work to be performed.

- Use leather gauntlet welders' gloves.
- Wear flame-resistant pants and long-sleeved shirts or coveralls made of treated (flame resistant) heavy cotton or wool. Do not wear synthetic blend materials. Keep sleeves and collars buttoned on clothing. In some cases, leather chaps, sleeves, aprons, and/or chaps may be appropriate.
- Wear leather ankle-height or higher work boots.
- Do not tuck pants into boots, wear cuffed pants, or other garments/features (i.e., shirt pockets, rolled sleeves, etc.) that provide a "trap zone" for sparks or slag.
- Respiratory protection equipment or specialized ventilation may be necessary when working in areas that do not have adequate ventilation or when using toxic materials. See the Appendix to this SOP for additional information on hazardous welding fumes and gases. Use of a respirator requires full participation in UNL's Respiratory Protection Program, including medical qualification, and annual training and fit-testing. As a general rule, the need for respiratory protection or other ventilation provisions should be evaluated when any of the following conditions may be present:
    - Toxic materials are used or may be generated in the process (e.g., lead, cadmium, beryllium, zinc, mercury, fluorine, and when using chlorinated hydrocarbon degreasers or cutting stainless steel).
    - General exhaust is re-circulated to other areas of the building.
    - Work is conducted in relatively small or restricted spaces such as a tank, boiler, pressure vessel, etc.
    - The welding area is indoors and it is not equipped with local exhaust ventilation (general mechanical ventilation of the space may be sufficient provided that minimum ventilation rates specified by OSHA are achieved and barriers to cross ventilation are not present).
- Hearing protection may be needed for noisy processes such as plasma arc cutting. Hearing protection may also be needed to prevent materials from getting in the ears when welding overhead. If the noise exposure exceeds 85 decibels (as an 8-hr. TWA), then full participation in UNL's Hearing Conservation Program, including annual audiograms and training is required.

Appendix

Toxic metal fumes are generated from vaporization of molten metal from the metal being welded and the welding rods. Hazardous vapors or gases are associated with compressed gases used in welding or cutting operations or formed as combustion products or breakdown of cleaning or coating agents. The table below lists potentially toxic fumes and gases often associated with welding. This list is not comprehensive; nor is it a substitute for the Material Safety Data Sheet for specific gases, rods, or other products.

Fume or Gas	Source	Potential effects of exposure
Acetylene	Cutting Gas	Simple asphyxiant; flammable gas
Argon	Welding Gas	Simple asphyxiant
Aluminum	Metal alloys of copper, steel, zinc	Pneumonoconiosis, dyspnea and cough
Beryllium	Copper alloys	Chronic lung disease (called Chronic Beryllium Disease); carcinogen
Cadmium	Metal alloys, rust-preventative and other coatings, welding electrodes, silver solder	Pulmonary irritation and/or edema, emphysema, and kidney damage
Carbon Monoxide	Incomplete combustion of fuels, breakdown of carbon dioxide shielding gases	Inhaled carbon monoxide binds with blood hemoglobin, greatly reducing the blood's ability to transport oxygen. Depending on levels and duration of exposure, symptoms may include headache, dizziness, heart palpitations, weakness, confusion, nausea, and even convulsions, eventual unconsciousness and death.
Chromium VI	Steel alloy, stainless steel	Skin irritation, pulmonary edema, increased risk of lung cancer.
Copper	Metal alloys (especially brass, bronze, and monel) and electrodes	Respiratory irritation and metal fume fever.
Fluorine	Electrodes, flux, chlorinated cleaning compounds	Pulmonary edema, corrosion of skin and mucous membranes
Hydrogen chloride	Formed by the decomposition of hydrocarbon solvents by UV radiation	Tissue damage in the respiratory tract.
Iron	Main component of steel	Respiratory irritation, fibrosis of the lung.
Lead	Solder, brass, bronze, metal primers, steel coatings, paints	Anemia, fatigue, abdominal pain, reduced fertility, kidney and nerve damage.
Magnesium	Magnesium alloys, some aluminum alloys	Metal fume fever, eye irritation, pulmonary irritation
Manganese	Steel alloys	Metal fume fever, manganese poisoning, headaches
MAPP Gas (methylacetylene-propadiene)	Brazing, cutting, heating, soldering	Central nervous system
Mercury	Metal coatings	Stomach pain, diarrhea, kidney and nerve damage, respiratory failure
Nickel	Metal alloys, stainless steel	Eye and throat irritation
Nitrogen Oxides	Incomplete combustion product	Eye and throat irritation at low concentrations; higher concentrations

		may result in pulmonary edema and other severe lung conditions
Ozone	Formed upon exposure of air to UV light	Prolonged exposure may result in severe changes in lung function
Phosgene	Formed by the decomposition of chemical cleaners and degreasers.	Tissue damage in the respiratory tract
Tin	Bronze alloys and solders	Lung abnormalities
Vanadium	Some alloys, electrode coatings	Eye and respiratory irritation, bronchitis, pulmonary edema
Zinc	Brass, galvanized metals, other alloys, metal coatings	Metal fume fever

Avoiding Exposure

- Use local exhaust and supply ventilation systems with adequate capacity to prevent the accumulation of fumes and gases and oxygen-deficient atmospheres. The exhaust system should not draw contaminants through the breathing zone of the operator.
- In the absence of adequate ventilation, appropriate respiratory protection devices are needed.
- Avoid use of metals, rods, flux, coatings, and cleaning agents containing fluorine or hydrofluorocarbons, zinc, lead, beryllium, cadmium, and mercury. When possible, select mild steel or iron over stainless steel. Remove surface coatings, such as paint, prior to welding or cutting.
- Avoid cutting or welding used metal containers that once held hazardous materials.
- Wash hands and other potentially contaminated body parts after welding or cutting, and before eating, drinking, smoking, or other activities that could result in inadvertent ingestion of contaminants.
- Check all gas connections with a bubble solution for leaks. Do not weld or cut until the system is free of gas leaks.
- Read the Material Safety Data Sheets (MSDS) for all materials used (consumables, base metals, coatings, and cleaners).