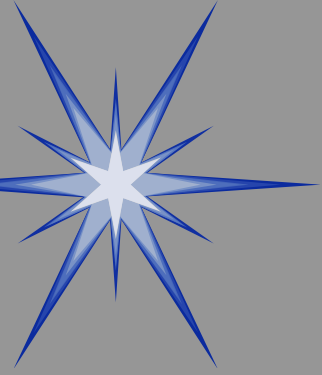


Welding Safety

AR Training 2012

DMME

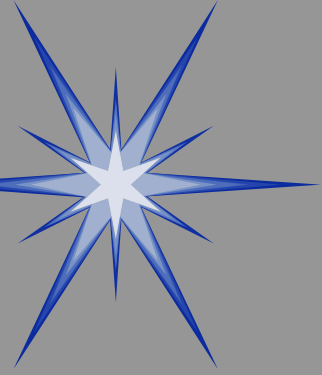
Division of Mineral Mining



Before Getting Started

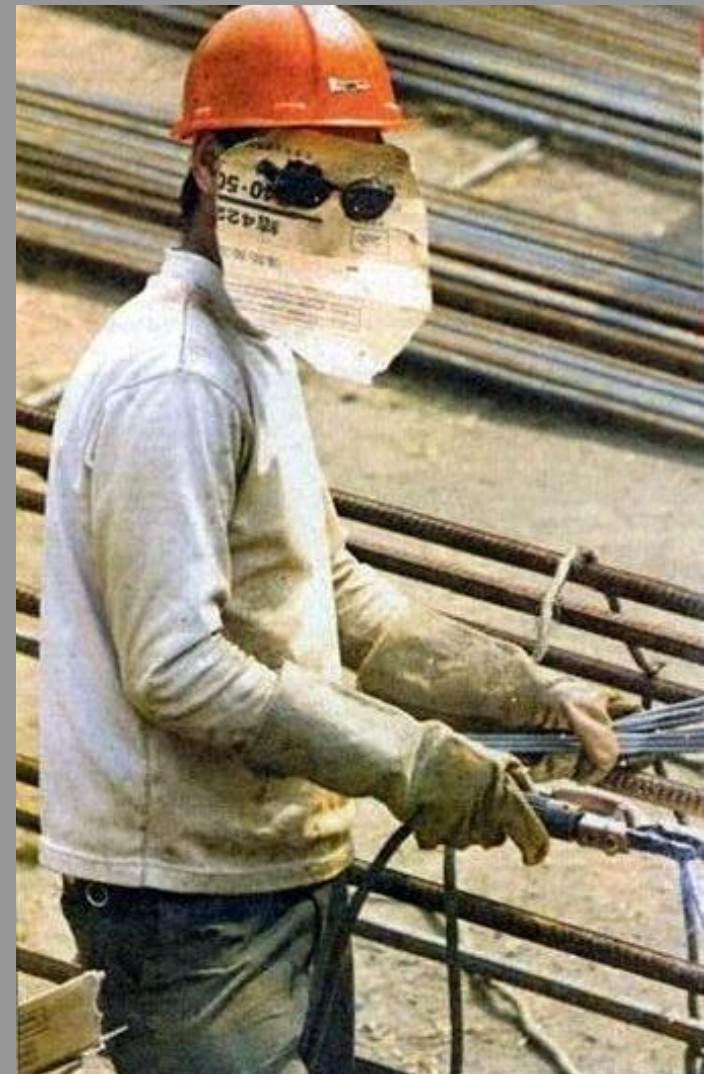
Check Your Welding Equipment

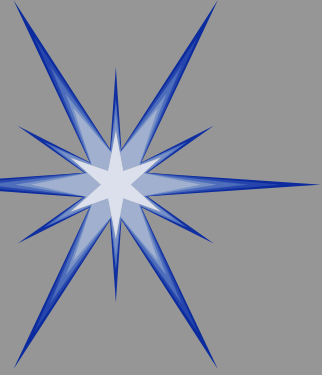
- Because arc welding involves an electric arc, the source of power is the first point to check. Be certain the engine/generator or transformer is in good order.
- Are all electrical connections tight and properly made?
- Is the generator or transformer safety-disconnect switch operable and have an adequate amperage rating? Are detaching plugs on smaller equipment easily accessible?
- Are all dials and gauges operable?
- Are your cables, clamps and electrode holder in good condition?
- Do you have the proper PPE for the job.



Protective Clothing And PPE

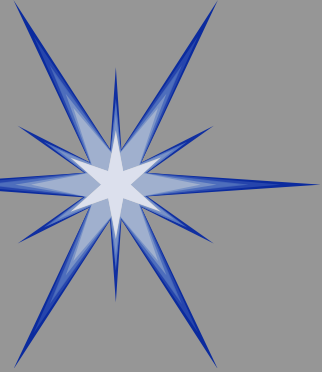
- **Clothing**: Made from flame retardant cloth (avoid high polyester and nylon content) , free of oil and grease. Avoid loose clothing, trousers with cuffs, open collared shirts with pockets.
- **“Leathers”**: Sleeves, apron or chaps should be available.
- **Steel Toed Shoes**: All leather, high-top shoes with rubber soles in good condition. Full metal toe covers should be available.





Clothing And PPE, cont.

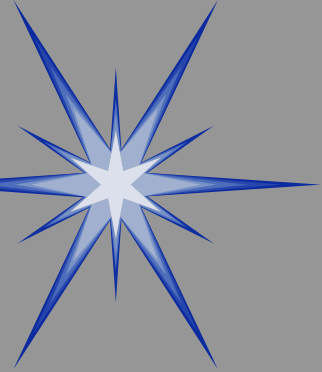
- **Gloves:** All leather or fire resistant *welding* gloves (gauntlet style) in good condition.
- **Goggles/Glasses:** Tempered lenses, shade #5, good fit with little or no gap/opening for protection against sparks, flying slag and bright torch flames.
- **Welding Helmet/Face Shield:** Good condition, tight fit with proper lens shade for the work at hand.
- **Hearing Protection:** Ear plugs and/or muffs should be worn during noisy operations such as air arcing or grinding. Most welding operations are noisy.
- **Job Specific Items:** Respirator, fall protection, etc.



Respirators



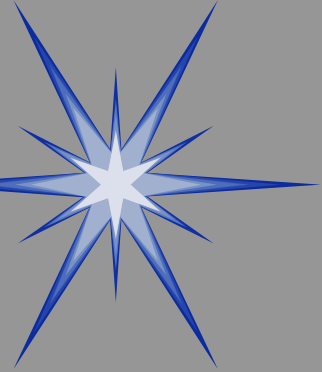
- Must be specific to the hazard.
- Must be fitted, cleaned, stored and maintained in accordance with regulations (MSHA) and manufacturer's specifications.
- NIOSH recommends respirators whenever a carcinogen is present.



Proper Guarding In Place



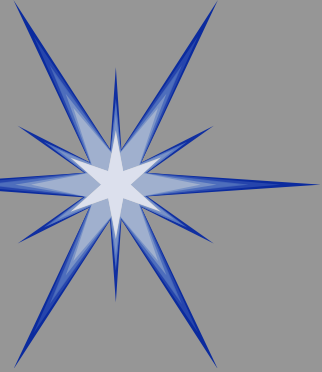
- To prevent accidental contact, welding machines must have mechanical and electrical protection.
- Guard all moving parts and insulate all current carrying components.
- Mechanical power transmission apparatus with clutches, gears and couplings should have these danger points screened or guarded.
- Have curtains/shields/barricades to protect those working near you.



Check The Cables Frequently

- It is important that the neutral wire (often referred to as the ground' wire) be fully insulated. When DC current is used this is a **current-carrying wire, and becomes the 'hot' wire.**
- Always keep them in good repair and out of water, oil, or ditches.
- Try to avoid abrasion caused by rubbing against sharp corners or being dragged over objects.
- Do not leave cables in the paths of workers and vehicles/equipment. If it is necessary to cross the line of traffic, suspend cables overhead, or cover, if possible.



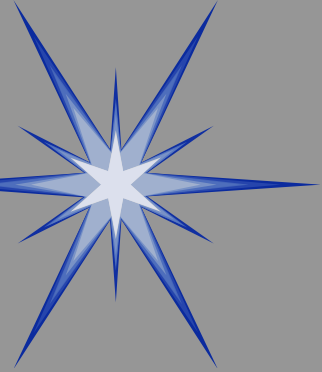


Watch Those Splices

- When splicing cables, make sure the connectors are well insulated and have a capacity equal to or greater than the cable.
- Make splices with insulated pressure connectors or welded joints.
- Connecting lugs should have more than one bolt for a reliable, tight connection, and complete insulation.
- Cables with splices within 10 feet of the holder should not be used.

Maintain Safe Electrode Holders

- Holders should be kept fully insulated because they support the electrode and transmit the current from the cable to the electrode. Fully insulated holders are an added safety factor for operation in close quarters reducing the danger of striking an accidental arc. Inspect frequently and replace insulation parts as needed!



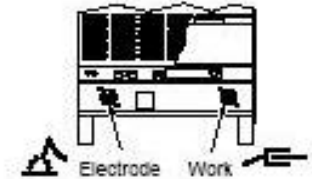
Choosing Cables

- Welding cables need high-quality insulation and should be very flexible as well.
- They should be large enough for any current draw that may arise.
- Size the cable to avoid overloading. This burns away the insulation, causing both shock and fire hazards.
- As the chart indicates, the length of the cable is a key factor in determining the size.
- Amperage and duty cycle capabilities of your welding machine are the other sizing factors.

Weld Cable Selector Guide*



- ▲ Turn Off power before connecting to weld output terminals.
- ▲ Do not use worn, damaged, undersized, or poorly spliced cables.



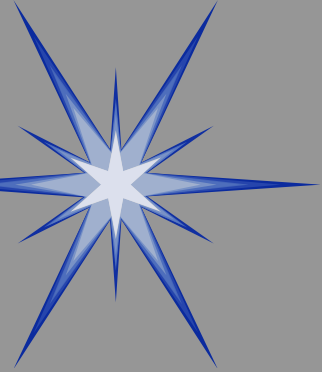
Welding Amperes	Weld Cable Size** And Total Cable (Copper) Length In Weld Circuit Not Exceeding***			
	100 ft (30 m) Or Less		150 ft (45 m)	200 ft (60 m)
	10 – 60% Duty Cycle	60 – 100% Duty Cycle	10 – 100% Duty Cycle	
100	4	4	4	3
150	3	3	2	1
200	3	2	1	1/0
250	2	1	1/0	2/0
300	1	1/0	2/0	3/0
350	1/0	2/0	3/0	4/0
400	1/0	2/0	3/0	4/0
500	2/0	3/0	4/0	2 ea. 2/0
600	3/0	4/0	2 ea. 2/0	2 ea. 3/0
700	4/0	2 ea. 2/0	2 ea. 3/0	2 ea. 4/0
800	4/0	2 ea. 2/0	2 ea. 3/0	2 ea. 4/0
900	2 ea. 2/0	2 ea. 3/0	2 ea. 4/0	3 ea. 3/0
1000	2 ea. 2/0	2 ea. 3/0	2 ea. 4/0	3 ea. 3/0
1250	2 ea. 3/0	2 ea. 4/0	3 ea. 3/0	4 ea. 3/0

*This chart is a general guideline and may not suit all applications. If cable overheating occurs (normally you can smell it), use next size larger cable.

**Weld cable size (AWG) is based on either a 4 volts or less drop or a current density of at least 300 circular mils per ampere. Contact your distributor for the mm² equivalent weld cable sizes.

***For distances longer than those shown in this Guide, call a factory applications representative.

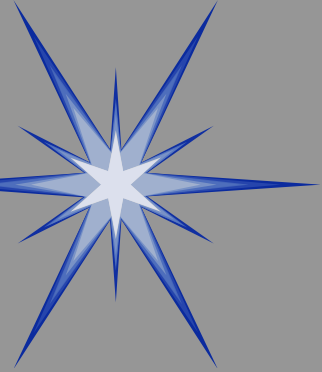
The above information furnished by: Miller Electric Company www.millerwelds.com and Hobart Electric Company www.hobartwelders.com



Using The Correct Current Is Important

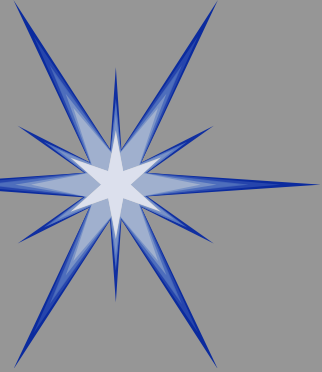


- Too little current reduces the efficiency of the operation.
- Too much current causes inferior welds, overloads and damages equipment.
- For the correct current, refer to the operations manual supplied with the equipment.
- Check the current load with an amp meter if there seems to be variation.



Welding Fire Hazards

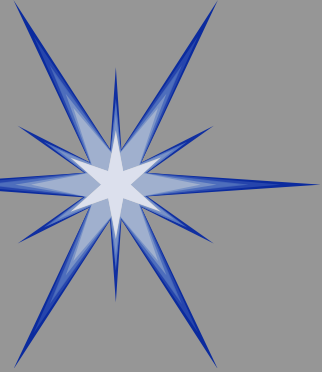
- Do not use welding equipment near flammable vapors, liquids, dust or any other combustible materials.
- Move welding work to a safe location whenever possible, or try to remove all movable combustibles to a safe place. If neither is possible, use spark proof curtains (not tarpaulins) to confine the sparks. Weigh the fireproof curtain down tightly against the floor.
- An extra person is recommended as a fire guard if ignition of material is possible.
- A fire inspection should be performed prior to leaving a work area and for at least 30 minutes after the operation is completed.
- Keep shop clean in areas where welding is to be done.



Fire Hazards, cont.

- Never weld or cut on containers that have held a flammable or combustible material unless the container is thoroughly cleaned or filled with an inert gas.
- Fire extinguishers should be nearby, of proper size, type and number for the hazards involved.
- Concrete floors are the safest welding locations.
- Wood floors can be made fire-safe by covering them with a fireproof cloth.
- Do not weld near electrical fittings or lines.

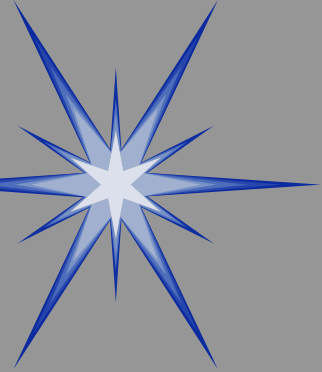




Electric Shock Hazards

Whatever the location of the arc welding operation, follow these precautions to prevent electric shock:

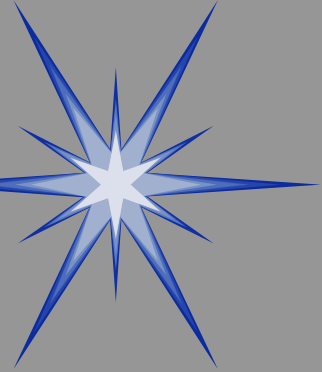
- Ground the frame of portable and stationary welding machines; as specified in the Grounding Section of the National Electrical Code.
- Approved plugs and receptacles are recommended for cables of portable welding machines capable of carrying full-load machine circuits.
- Keep welding supply cables away from power supply cables and other high tension wires.



Shock Hazards, cont.

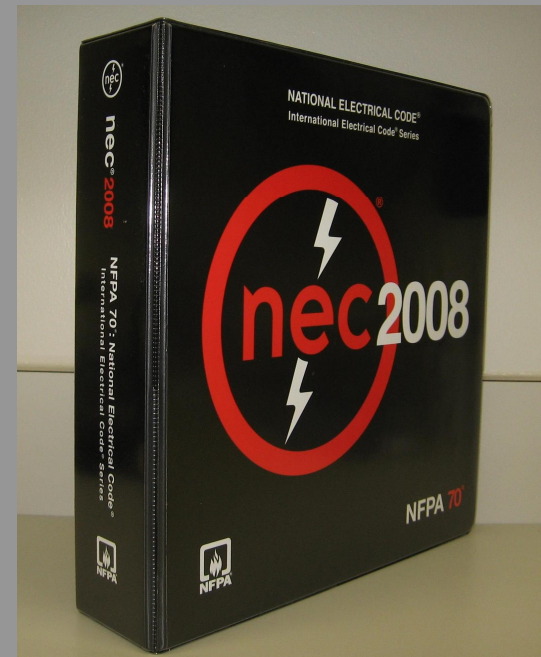


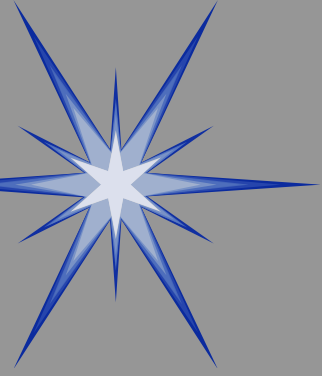
- When working on electrically powered machinery, make sure the frame is grounded.
- If the work lead or electrode lead becomes worn and the conductor is exposed during operation, cover the exposed area immediately with rubber or friction tape. Replace the cable as soon as possible.
- Keep insulation on all welding equipment and components dry and in good condition.
- Perspiring increases the danger of shock. Never permit any part of the electrode holder to touch bare skin or wet clothing.



Shock Hazards, cont.

- When changing electrodes, never stand on wet or ungrounded surfaces; never use bare hands or wet gloves.
- Always use dry gloves and wear rubber soled shoes.
- Do not cool electrode holders by emersion in water.
- Turn off power supply when welder is not in use and before performing maintenance.
- Operating procedures are covered in the Electric Welding Section of the National Electrical Code.

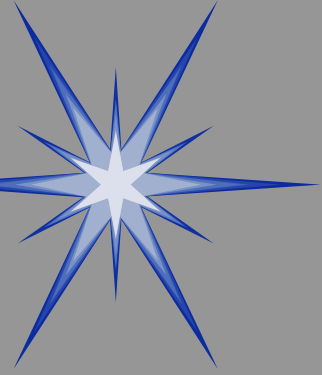




Welding Hazards In Confined Spaces

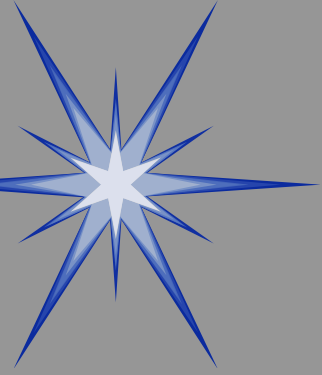
A confined space is any work area with limited access, little or no airflow, not intended for continuous occupation.

- May have dangerous atmospheres or other hazards.
- All employees working in or around confined spaces must be trained in the associated hazards.
- All pipes, valves, ducts, conveyors, power lines, etc. that are not necessary for the work should be disconnected and locked out/tagged out.
- No one shall work in an atmosphere with less than 19.5% or more than 23.5% oxygen content. Atmospheres should be checked for hazardous concentrations of other gases.



Confined Space Hazards, cont.

- Use continuous mechanical ventilation.
- Never ventilate with oxygen.
- Always use all necessary Personal Protective Equipment (PPE).
- Never work in confined space without a trained attendant.
- Never weld or cut in explosive, flammable, combustible or other dangerous environments.
- Always leave gas cylinders and welding power sources outside the confined space. Only take hoses or welding leads into the confined space.
- Always remove hoses and/or leads when leaving confined space for breaks, shift or crew changes, etc.

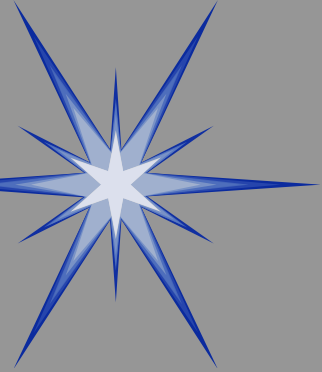


Welding Ventilation Hazards

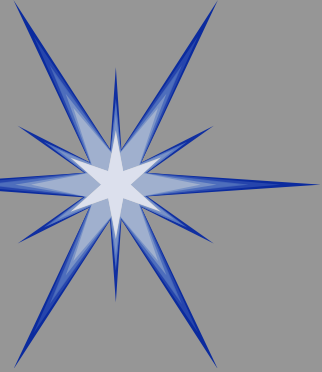
When checking for sufficient ventilation in a welding area consider:

- the size of the area, particularly the ceiling height.
- the number of workers in the area.
- the possibility of fumes, gases or dust resulting from the operation.

An exhaust fan in an exterior wall of a welding room is not the complete answer. Too often the fan only removes the contaminated air after it has been inhaled and exhaled by the worker.



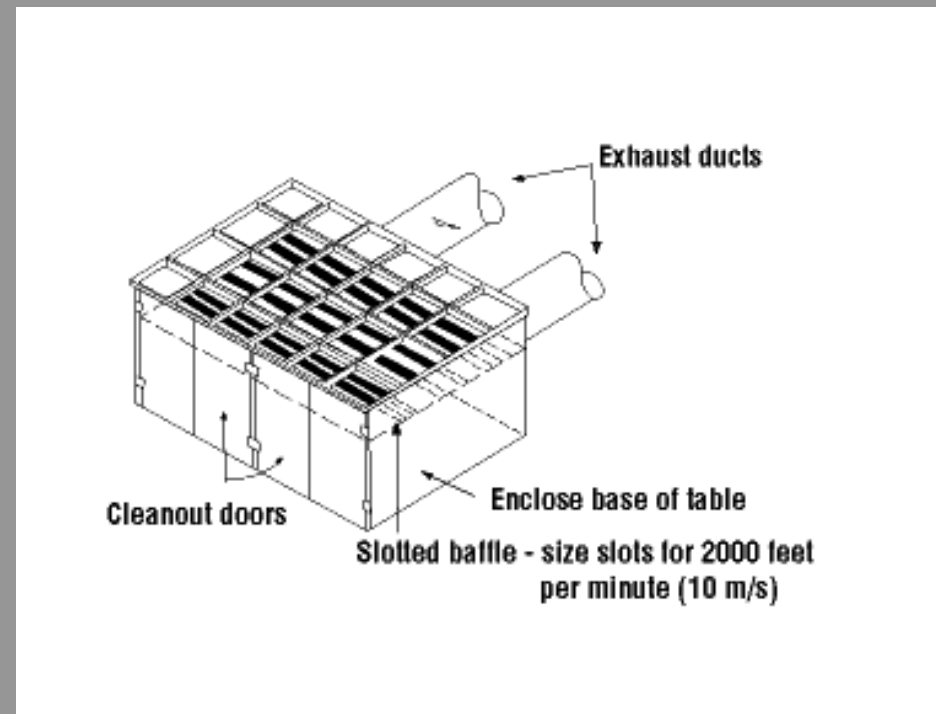
- Stay out of the plume. Use a tight fitting welding helmet to shield you from the plume.
- A well-designed welding helmet can help reduce a welder's exposure to welding fumes by diverting the plume away from the welder's breathing zone.
- Local exhaust ventilation (LEV) is always the preferred method of removing welding fumes and gases. It exhausts or removes the toxic gases, fumes, dusts and vapors before they can mix with the room air.

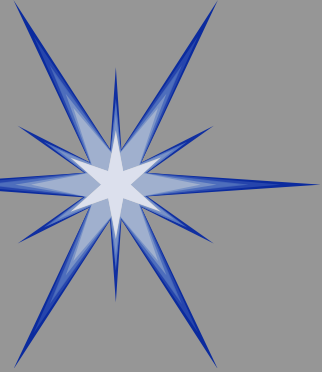


What Is Local Exhaust Ventilation?

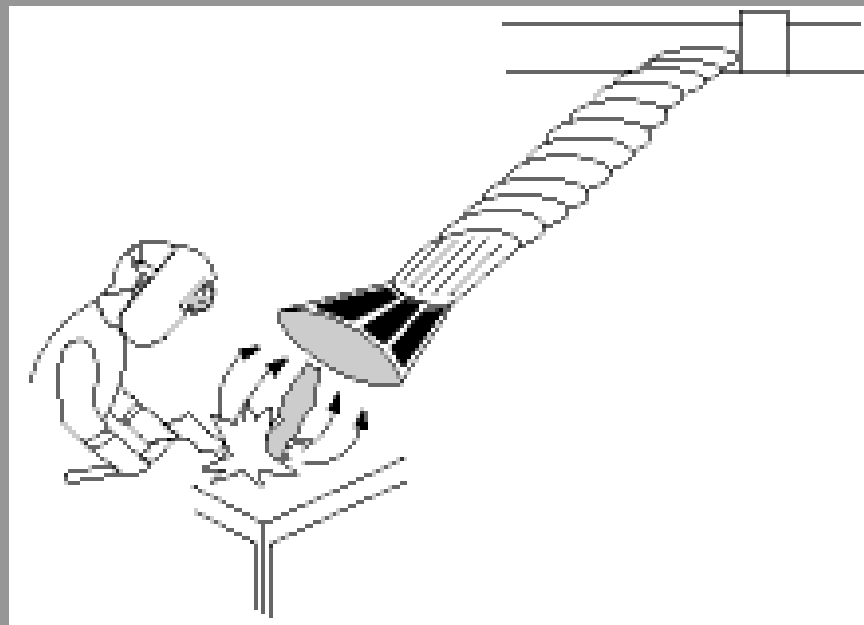
Downdraft Bench

A downdraft bench has an open grid work surface. Air is drawn downward through the grid, drawing contaminants into exhaust ducting. Air speed must be great enough to keep contaminants from rising into your breathing zone. If work pieces are too large they may block the ventilation airflow.



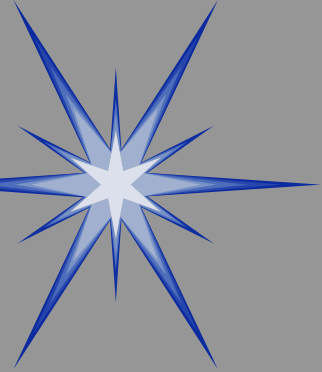


LEV Examples, cont.

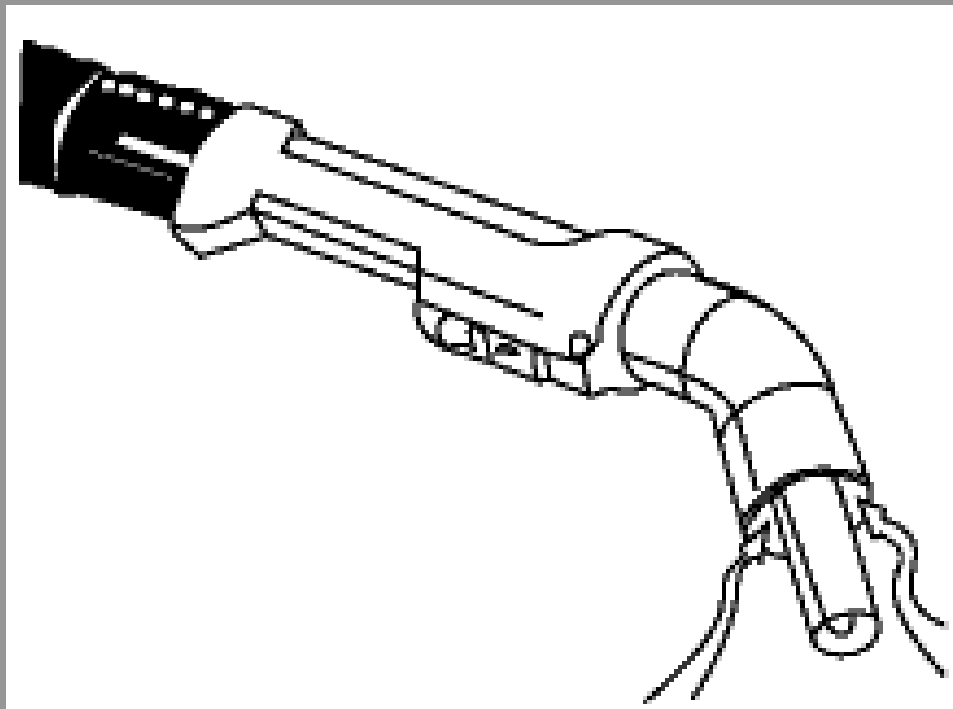


Moveable Hood

Flexible ducting allows the capture hood to be moved where required. Provide an air velocity of at least 100 ft/min (0.5 m/s) across the welding arc. Place the hood as close as practical to the work. The optimal location for the hood is about 1 duct diameter from the arc.

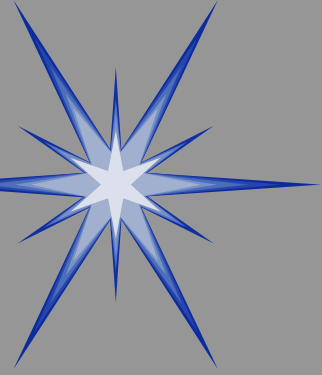


LEV Examples, cont.



Fume Extraction Welding Guns

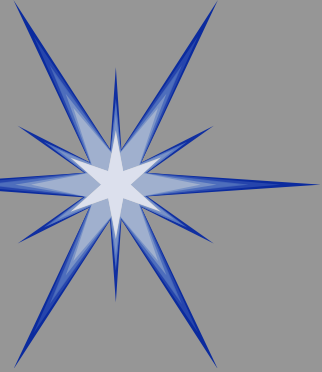
The contaminants are removed very close to the source of generation and are drawn through a hose into the exhaust system. They can be very effective on flat and vertical surfaces or in corners and around flanges.



Hazards Of Welding Fumes/Gases

Welding fumes are a complex mixture of metallic oxides, silicates and fluorides. Fumes are formed when a metal is heated above its boiling point and its vapors condense into very fine particles (solid particulates).

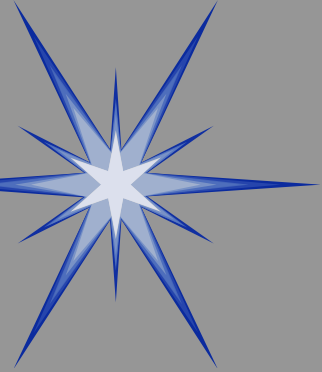
- Fluxes containing silica or fluoride produce amorphous silica, metallic silicates and fluoride fumes.
- Fumes from mild steel welding contain mostly iron with small amounts of additive metals (chromium, nickel, manganese, molybdenum, vanadium, titanium, cobalt, copper etc.).
- Stainless steels have larger amounts of chromium or nickel in the fume and lesser amounts of iron.
- Nickel alloys have much more nickel in the fume and very little iron.



More Than Just Smoke

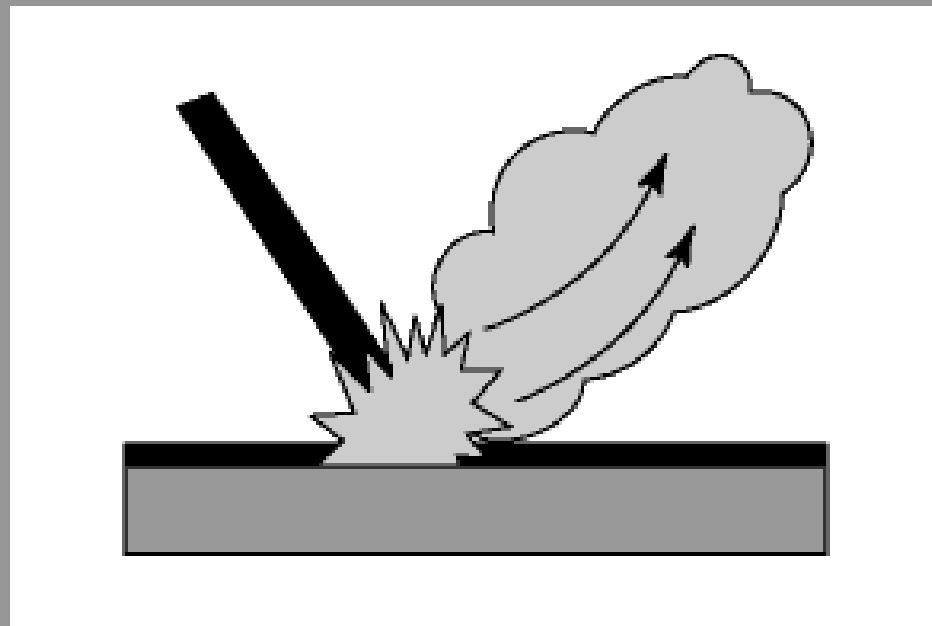
- Beyond those previously mentioned, welding “smoke” can contain the following in various combinations and amounts: arsenic, asbestos, silica, beryllium, cadmium, nitrogen oxides, phosgene, fluorine compounds, carbon monoxide, lead, ozone, selenium, zinc and more.



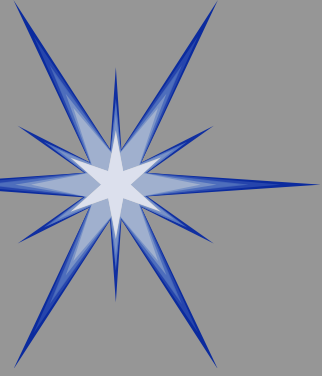


Metal Coatings

A Source of Hazardous Fumes



- Remove coatings from the weld area to minimize the fumes.
- The removal of coating will also improve weld quality.
- Use stripping products to remove coatings. Make sure to remove any residues before welding.
- Use wet slurry vacuum removal techniques for removing very toxic coatings.
- Do not grind coatings. Grinding dust may be toxic.



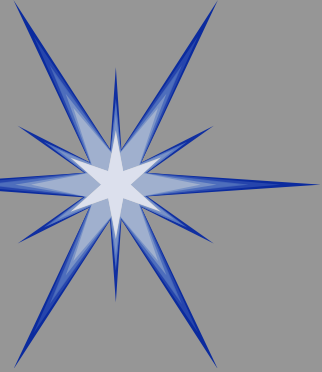
Gases Are Produced From Coatings

- Polyurethane coatings can produce hydrogen cyanide, formaldehyde, carbon dioxide, carbon monoxide, oxides of nitrogen, and isocyanine vapors.
- Epoxy coatings can produce carbon dioxide and carbon monoxide.
- Vinyl paints can produce hydrogen chloride.
- Phosphate rust-inhibiting paints can release phosphine during welding processes.
- Minimize exposure to degreasing solvent vapors. They can contain various cancer causing chemicals.



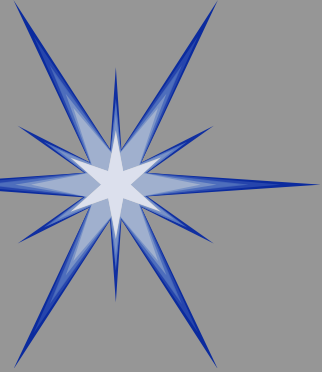
Gases Are Produced In The Welding And Cutting Process

- Carbon monoxide from the breakdown of carbon dioxide shielding gas in arc welding. Argon and helium may be present as well.
- Carbon dioxide from the decomposition of fluxes.
- Fuel gases such as acetylene, propane, butane and others.
- Ozone from the interaction of electric arc with atmospheric oxygen.
- Nitrogen oxides from the heating of atmospheric oxygen and nitrogen.
- Hydrogen chloride and phosgene produced by the reaction between ultraviolet light and the vapors from chlorinated hydrocarbon degreasing solvents (e.g., trichloroethylene, TCE).



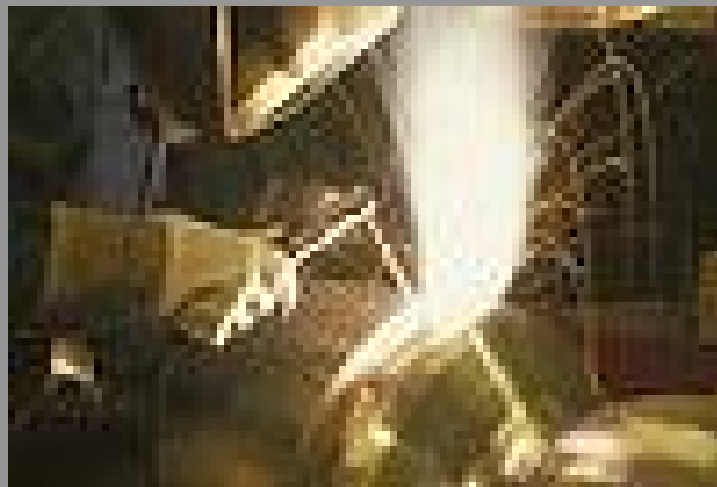
Short-Term Exposures

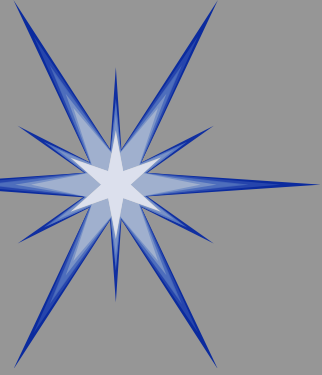
- Exposure to zinc, magnesium, copper and copper oxide can cause “metal fume fever”.
- Symptoms of metal fume fever may occur 4 to 12 hours after exposure.
- Symptoms include: chills, thirst, fever, muscle ache, chest soreness, coughing, wheezing, fatigue, nausea, and metallic taste in the mouth.
- Welding “smoke” can irritate the eyes, nose, chest and respiratory tract as well as cause nausea, loss of appetite, vomiting, cramps, and slow digestion.



Short-Term Exposures

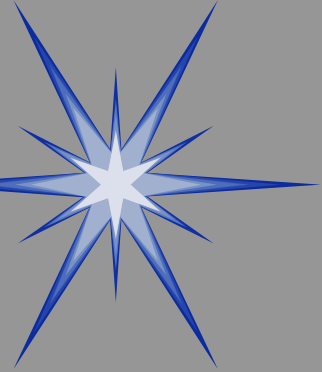
- Ultraviolet radiation can react with oxygen and nitrogen to form ozone and nitrogen oxides. These gases are deadly at high concentrations and can also cause irritation of nose and throat and cause serious lung disease.
- Exposure to cadmium can be fatal in a short time.





Long-Term Exposures

- Studies of welders, flame cutters, and burners have shown that welders have an increased risk of lung cancer.
- Possibly cancer of the larynx and urinary tract.
- Remember, welding “smoke” can include cancer causing agents such as: cadmium, nickel, beryllium, chromium, and arsenic.
- Welders may experience a variety of chronic respiratory problems, including: bronchitis, asthma, pneumonia, emphysema, pneumoconiosis, decreased lung capacity, and silicosis.
- Other health problems include: heart disease, skin diseases, hearing loss, chronic gastritis, ulcers of the stomach and small intestine and reproductive risks.

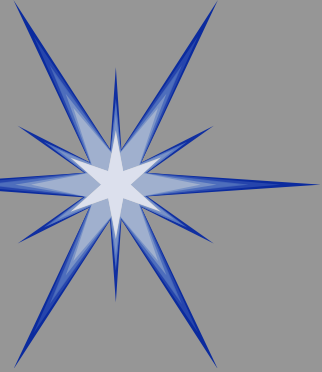


Key Hazards Summary

- Asphyxiation (lack of oxygen).
- Fire and explosion.
- Toxicity (including both short and long-term exposures).

Key Preventive Measures

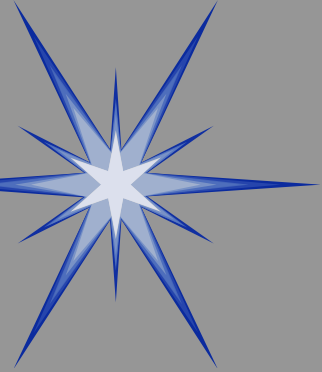
- Always refer to MSDS, manufacturer's instructions and safety protocols for proper procedures.
- Always be aware of the types of coatings present as well as any degreasers/solvents that may have been used to prepare the welding surface. Take proper precautions.
- Always maintain adequate work area ventilation and use recommended PPE.



“Arc Eye”

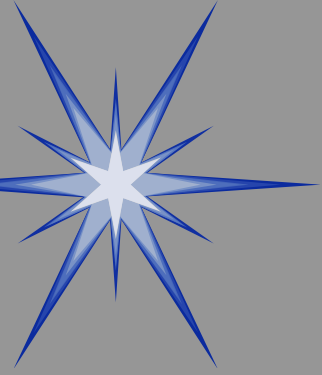
Certain types of UV radiation can produce an injury to the surface and mucous membrane (conjunctiva) of the eye called "arc eye," "welders' eye" or "arc flash." These names are common names for "conjunctivitis" - an inflammation of the mucous membrane of the front of the eye. The symptoms include:

- Pain - ranging from a mild feeling of pressure in the eyes to intense pain in severe instances.
- Tearing and reddening of the eye and membranes around the eye.
- Sensation of "sand in the eye" or abnormal sensitivity to light.
- Inability to look at light sources (photophobia).



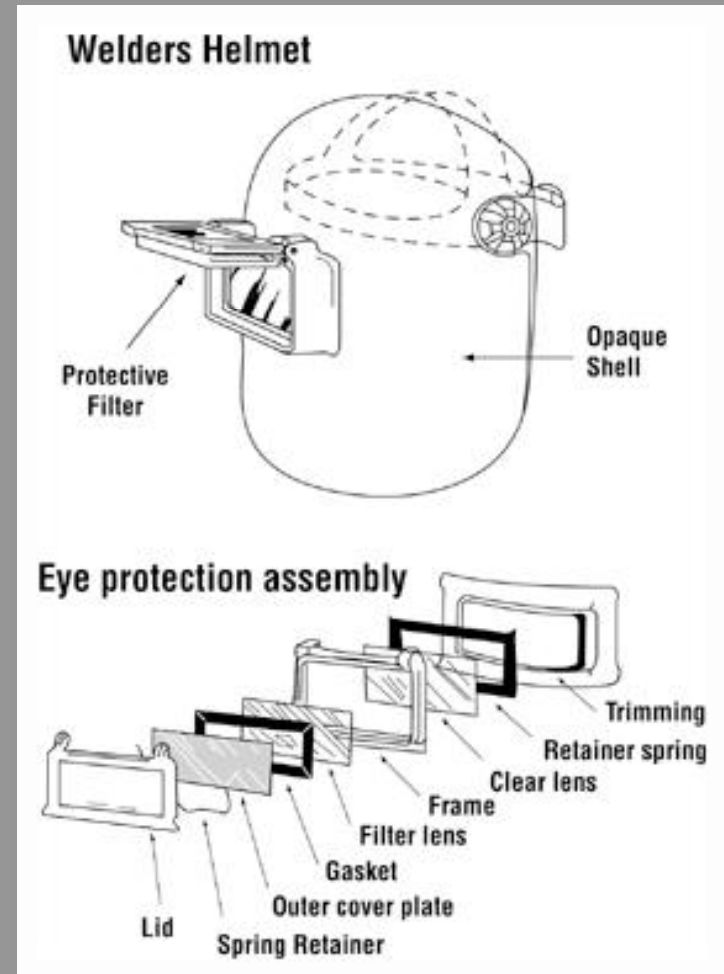
Other Eye Hazards

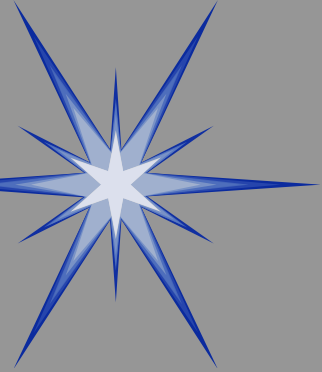
- Long-term exposure to UV/infrared light can produce cataracts in some persons.
- Visible light from welding processes is very bright and can overwhelm the ability of the iris of the eye to close sufficiently and rapidly enough to limit the brightness of the light reaching the retina. The result is that the light is temporarily blinding and fatiguing to the eye.
- A serious concern is the "blue light hazard" which is the temporary or permanent scarring of the retina due to its sensitivity to blue light. Blindness may result.



The Keys To Eye Protection

- Minimize reflective materials in the work area (paints, other wall coverings, etc.)
- A tight fitting helmet in good condition.
- All lens components in place and in good condition.
- Utilizing the proper lens shade.....





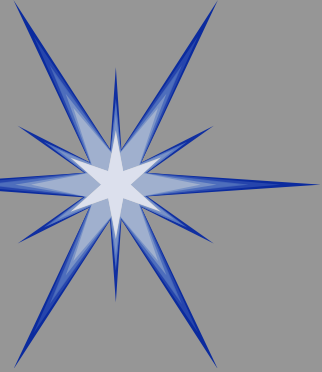
What You Should Know About Lens Shade Selection

- The correct filter shade is selected according to the welding process, wire diameter, and operating current. The table gives the correct shade numbers for different situations.
- **ALWAYS** use the suggested shade numbers instead of the minimum.

Lens Shade Selector Guide

Operation/Process	Electrode Size In. (mm)	Arc Current (Amperes)	Minimum Protective Shade	Suggested* Shade No. (Comfort)
Shielded metal arc welding (SMAW)	Less than 3/32 (2.5)	Less than 60	7	—
	3/32–5/32 (2.5–4)	60–160	8	10
	5/32–1/4 (4–6.4)	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
		250–550	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) (Heavy)	Less than 500	10	12
		500–1000	11	14
Plasma arc welding (PAW)		Less than 20	6	6 to 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			
	In.	mm		
Oxyfuel gas welding (OPW)	Light	Under 1/8	Under 3.2	4 or 5
	Medium	1/8 to 1/2	3.2 to 12.7	5 or 6
	Heavy	Over 1/2	Over 12.7	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

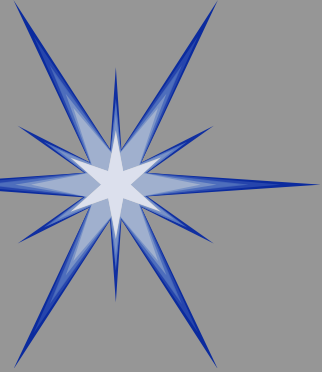
* As a rule of thumb, start with a shade that is too dark to see the weld or cut zone. Then go to a lighter shade which gives sufficient view of the weld or cut zone without going below the minimum. In oxyfuel gas welding, cutting, or brazing where the torch produces a high yellow light, it is desirable to use a filter lens that absorbs the yellow or sodium line in the visible light of the (spectrum) operation.
 Guide adapted from ANSI Z49.1, 1999.
 Low Current Plasma arc cutting data (0–80 Amperes) supplied by Miller Electric Mfg. Co.



Arc Welding Shade Numbers

- SMAW(shielded metal arc welding) – 1/16 - 5/32 = #10
- Gas SAW - 1/16 - 5/32 = #11 (nonferrous)
- Gas SAW – 1/16 – 5/32 = #12 (ferrous)
- SMAW – 3/16 – 1/4 - = #12
- 5/16 & 3/8 electrodes = #14
- Atomic Hydrogen Welding = #10 - #14
- Carbon Arc Welding CAW = #14

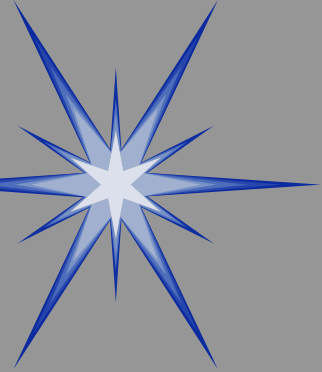




Oxygen & Acetylene Welding/Cutting Shade Numbers

- Soldering = #2
- Torch Brazing = #3 or #4
- Light cutting up to 1 inch = #3 or #4
- Medium cutting 1 inch to 6 inches = #4 or #5
- Heavy cutting over 6 inches = #4 or #6
- Light gas welding up to 1/8" = #4 or #5
- Medium gas welding 1/8" to 1/2 " = #5 or #6
- Heavy Gas Welding over 1/2 " = #6 or #8

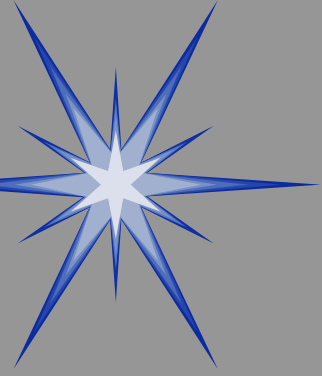




Preventing Burns

- Protect eyes and face from flying particles by use of safety glasses or face shield.
- Wear adequate protective clothing.
- Always wear leather gloves.
- Wear high top shoes.
- Keep collar, shirt pockets, etc. buttoned.
- Handle hot metal with pliers or tongs.
- Dispose of electrode stubs properly.

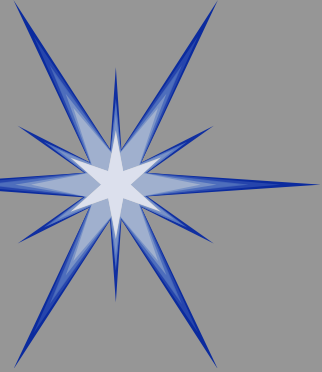




Skin Hazards

Welding arcs and flames emit intense invisible, ultraviolet, and infrared radiation.

- UV radiation in a welding arc will burn unprotected skin just like UV radiation in sunlight. This is true for direct exposure to UV radiation as well as radiation that is reflected from metal surfaces, walls, and ceilings. Surface finishes and certain paint colors can reduce the amount of UV radiation that is reflected.
- Long-term exposure to UV radiation can cause skin cancer.
- Infrared radiation and visible light normally have very little effect on the skin.

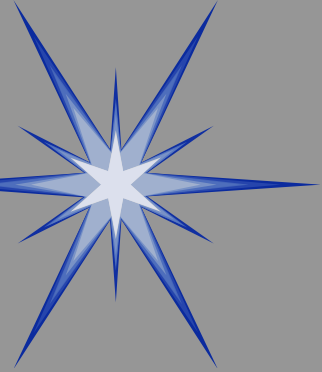


Ergonomics

What are some tips for a good working posture while welding?

- Learn to recognize symptoms of work-related musculoskeletal disorders (WMSDs; also called repetitive strain injuries or RSIs). Repeated uncomfortable postures and tasks can cause injury.
- Avoid awkward body positions which cause fatigue.
- Always use your hand to lower your helmet. Do not use a "jerking" motion of your neck and head.

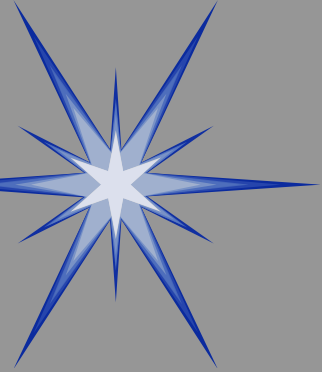




Ergonomics, cont.

- Position the welding item as flat as possible, on a horizontal surface, between waist and elbow height (Yea, right!).
- Position yourself in a stable, comfortable posture.
- Avoid working in one position for long periods of time.
- Work with material slightly below elbow level when working in a sitting position.

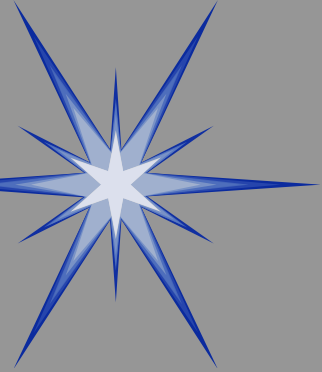




Ergonomic Tips, cont.

- Position scaffolding at a comfortable height to allow working in a seated position.
- Work with material between waist and elbow heights for comfort and precision when working in a standing position.
- Use a foot rest if standing for long periods.
- Always store materials and tools within normal reach.
- Use positioning aids to accommodate good work posture.





Common Postures In Welding



Working in front



Working at ground level, precision work



Working at ground level



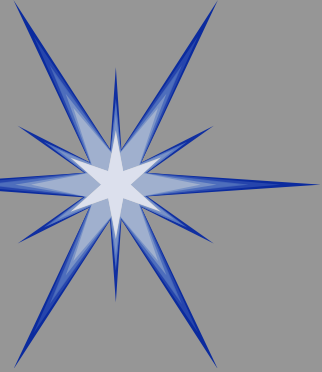
Working at ground level, confined space



Working above the shoulders



Working above shoulders, confined space



Ergonomic Improvements

To reduce working with the back bent at ground level, any work table will help to adopt a safer posture.

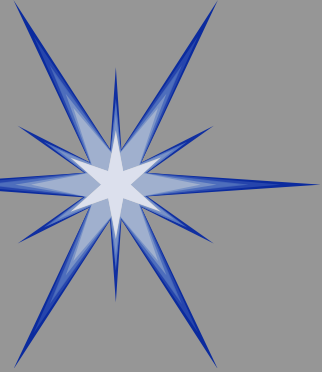


BEFORE



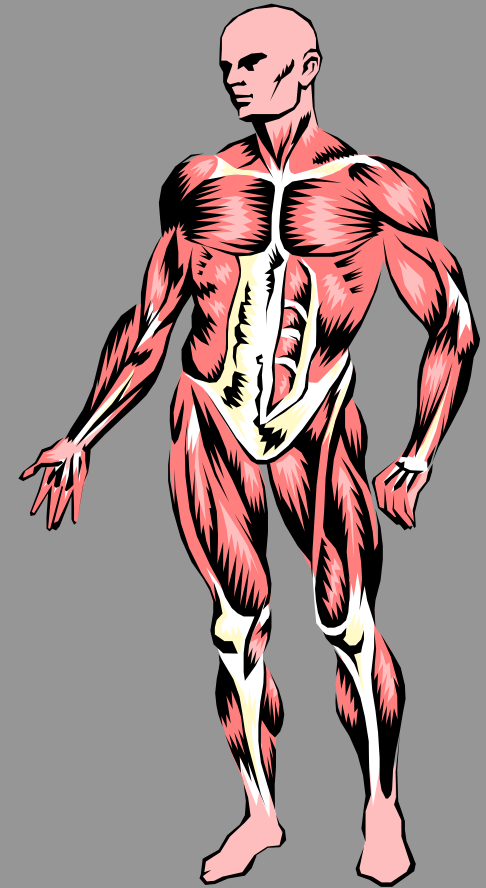
AFTER

Be careful of combustible materials!!

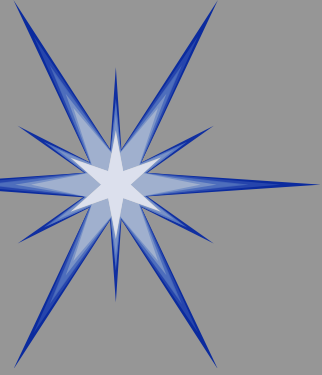


Musculoskeletal Injuries

- Back injuries, shoulder pain, tendonitis, reduced muscle strength, carpal tunnel syndrome, knee joint diseases and white finger (caused by prolonged use of vibrating handheld equipment).
- Injuries may be caused by overhead or other awkwardly positioned work, vibration and heavy lifting.



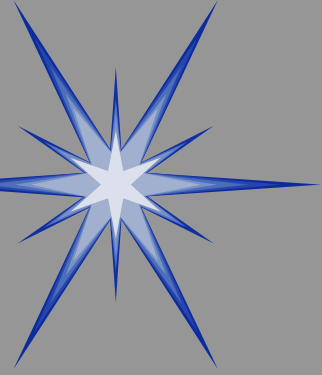
Take the time to prepare for and perform the job in a way that protects you and those working around you, now, and for the long term.



Oxygen and Acetylene Safety

- Always use friction lighters.
- Check pressures carefully:
 - Welding - 5 psi Acet/5 psi Oxy
 - Cutting – 5 psi Acet/20 psi Oxy
- Do not open the acetylene valve more than one turn (1/4 to 1/3 is usually enough).
- Open oxygen valve all the way.
- Turn pressures into gauges gradually.
- Use caution when welding or cutting in dusty or gassy locations.
- Use care that hoses are not damaged,
 - Watch where hoses are when cutting.





Oxygen and Acetylene Safety

- Extinguish the torch flame by closing the acetylene valve first and then the oxygen.
- Be prepared to extinguish any fire.
- Keep flashbacks and backfires to a minimum:
 - Keep tips clean.
 - Maintain proper gas pressures.
 - Avoid leaks and loose connections.
 - Avoid overheating the metal and tip.
 - Do not dip luminous cone in the molten pool.
 - Watch for and repair or replace damaged equipment.
 - Have check valves and flashback arrestors in place.



END