

## WELDING SAFETY

All common welding processes depend upon heat, in some form to melt metals in order to join them together. This heat and its by-products present hazards to ,everyone involved in a welding operation or to anyone working nearby. In order to work safely, certain safety precautions must be observed; first there are general safety procedures that are applied to the entire welding area, second there are more specific precautions that relate to the particular welding processes. This section will deal with general welding safety and will be applied whenever welding practice is being done. Safety for specific processes will be introduced as the process is introduced.

General safety can be discussed under the following main headings:

- a) protection from molten metals
- b) radiation of heat and light
- c) harmful fumes
- d) general shop safety

The proper procedures and precautions will be outlined so that each hazard in welding can be prevented from causing injuries. It is the individual's responsibility to learn these procedures and precautions in order to protect himself and others. Good safety practice is the best defense against injury.

**A. PROTECTION AGAINST MOLTEN METALS**

Since welding produces a molten puddle of metal, heat, light and quantities of sparks and fumes are radiated from it. Because of the welder's close position to this molten puddle, he or she must be properly clothed to protect themselves from its hazards.

**1. Leather Gauntlet Gloves**

The hands should be protected by a pair of good quality leather gauntlet gloves made from dry tanned leather. The dry tanning process makes the leather more heat resistant than the oil tan type. An oil tanned glove will shrink and harden when exposed to moderate heats. The welding glove should have a gauntlet to prevent sparks from rolling down the sleeves. The gauntlet also gives further heat protection to the forearm. In order to keep welding gloves soft and pliable - do not pick up extremely hot pieces of metal with them - extreme temperatures will cause the dry tan leather to

A. **PROTECTION AGAINST MOLTEN METALS** (continued)

1. **Leather Gauntlet Gloves** (continued)

- shrink and become very hard. Stiff, shrunken gloves make it difficult to hold materials properly and can result in the material slipping out of control, falling and causing an accident. When it is necessary to handle very hot material use pliers or any other tongs for this kind of work. Gloves should be kept away from grinders which can cut through the leather leaving holes which sparks can enter and cause unnecessary burns. When possible, during welding, hold the hand in such a position so as to allow the gloves to shed the most sparks. With reasonable care, a pair of welding gloves will give maximum protection and good service for a very long time.

2. **Protective Clothing**

The major task of the clothing worn during welding is to resist the large volume of sparks that are generated and to protect the body from the radiation produced. The outer clothing should be made of a material that resists burning and that is strong enough to stand the hard wear it receives in the welding area.

A. **PROTECTION AGAINST MOLTEN METALS** (continued)

2. **Protective Clothing** (continued)

• a) **leather**

leather garments - welding jackets or aprons - give the best possible body protection during welding. Sparks cannot penetrate the leather, it resists the radiation from the molten puddle and it will not burn. Disadvantages of leather garments are that they are heavier than cloth and they can be much hotter to wear in summer or when working in a confined or hot location. The initial cost of leather is also higher than that of cloth but it's length of service far exceeds that of any cloth garment. With reasonable care a leather welding jacket should last indefinitely.

b) **Wool**

Woolen materials offer the second best protection for welding because they do not burn. Wool will melt if a spark falls on it but it will not actually catch fire. The chief drawback of wool is that it is very expensive and sparks can melt through it and reach the skin.

A. **PROTECTION AGAINST MOLTEN METALS** (continued)

2. **Protective Clothing** (continued)

c) **Denim**

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Denim is the most popular type of clothing worn for welding and shop work. Blue jeans and blue jean jackets or coveralls give total body protection in a garment that is lighter than leather and tougher and more spark resistant than wool. Denim clothing used for welding should be in good condition. Clothing that has holes, frayed edges and which has been washed many times becomes soft and less spark resistant; if sparks fall on the frayed areas, denim will begin to burn.

d) **General Notes**

In general the clothing worn for welding should be proper fitting with long sleeves that can be fastened at the wrist and with a close fitting collar. The clothing should be dark in color so that the rays from the welding process will be absorbed rather than reflected. Reflected rays from light colors can enter the helmet or goggles and can cause some discomfort to the eyes or the skin on the face and neck. Most synthetic materials should be avoided for they burn

A. **PROTECTION AGAINST MOLTEN METALS** (continued)

2. **Protective Clothing** (continued)

very easily and can cause serious burns to the body. Clothing with cuffs or open breast pockets should be avoided for they only collect sparks which can set the clothing on fire. Matches and papers should not be carried in exposed breast pockets as they will ignite easily and can cause a serious burn.

e) **Skull Caps**

Skull Caps made from hard woven cotton are used to protect the hair and scalp from the sparks generated when welding. Human hair will actually catch fire if exposed to enough, heat. The skull cap also helps to keep the hair and scalp cleaner when working in the shop area. The hair is protected from smoke, grindings and general dust created in the welding shop. It also prevents hair from being caught in the head band of the welding helmet or goggles.

f) **Footwear**

A good quality leather, high-cut boot with a safety toe and neoprene sole will give the best foot protection when working in the welding area. Oxfords

A. **PROTECTION AGAINST MOLTEN METALS** (continued)

2. **Protective Clothing** (continued)

and other low shoes allow sparks to run in causing burns to the feet. Running shoes and other soft foot wear should be avoided as they can burn and they do not offer any support or protection to the feet. Steel clickers and leather soles should be avoided as they can be very slippery when walking on steel. Boots should always be properly laced and the pant leg pulled over the boot top to keep sparks out.

3. **Burns from Molten Metals**

The main source of skin burns in welding is contact with hot metals. This is usually a result of carelessness or lack of concentration on the individual's part. When working in a welding area it is important to develop heat awareness to prevent this problem.

Every piece of metal should be treated as though it had just been welded. By holding your hand just above the piece, you can tell if it is hot or cold. Do not rely on colour to indicate how hot a piece is for there is no change in the colour of mild steel until

A. PROTECTION AGAINST MOLTEN METALS (continued)

3. Burns from Molten Metals (continued)

- it is over 550°C. If you receive a burn, report it to an instructor and it can be treated with the first aid kit. It is then important to keep the burn area clean to prevent infection. In order to help prevent burns it is a common practice to use chalk to print HOT on a piece of metal which has been welded to alert passers-by that there is a danger of burning themselves. In the shop area it is also recommended that the practice coupons be cooled in the water buckets to prevent burns when handling them. By using pliers or tongs to handle hot metals, by wearing proper gloves and protective clothing and by developing heat awareness a welder can completely protect themselves against burns.

B. RADIATION OF HEAT AND LIGHT

The various welding processes use high levels of energy to produce temperatures high enough to melt metals. This high energy and the resulting molten metals radiate energy that can cause damage to the exposed parts of the body. It is for this reason that welding goggles or helmets are worn at all times. The special optical lenses used filter out **all** harmful radiation but allow a clear view of the weld puddle so that the operator can closely control the welding operation.



B. RADIATION OF HEAT AND LIGHT (continued)

The radiation from welding is composed of three rays:

- a) Infrared rays.
- b) Ultraviolet rays.
- c) Visible light rays.

1. Infrared Rays

Infrared rays make up the largest portion of the radiant energy released and they are the most dangerous rays. Infrared rays are also known as heat rays. Its energy is released when it hits an object and is stopped. It is these rays that melt the metal being welded and if they are allowed to strike exposed skin they release heat and begin to cook the flesh. If enough infrared strikes a portion of the body, the exposed areas are actually destroyed and this damage is permanent. Fortunately, infrared rays will not penetrate clothing and their intensity decreases quickly as you move away from the centre of the welding process. By wearing proper protective clothing and by always using a proper welding helmet or goggles, infrared rays cannot cause damage.

B. RADIATION OF HEAT AND LIGHT (continued)

2. Ultraviolet Rays

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The ultraviolet ray is the second most dangerous type of ray released during welding. This is the ray that causes sunburn; over-exposure results in inflammation of the skin, blistering and peeling. If one over-exposes the eyes to ultraviolet, the membrane of the eye will begin to swell and blister and it will feel as though the eyes are very dry or that dirt is lodged in them. Again ultraviolet light is unable to penetrate cloth of any other type of material. Wearing protective clothing that fully covers the body, having a close fitting collar and always using a proper welding helmet or goggles will prevent any burns from ultraviolet rays.

3. Visible Light Rays

The intense visible light rays released by welding processes are the least dangerous. These will cause eye strain or temporary blindness if one looks directly at them without a proper face shield. This is the same as looking directly into the sun; the intense light will overpower the retina of the eye so that spots appear when you look away. Exposure for an extended period will cause failure of the retina and will result in temporary loss of vision.

B. **RADIATION OF HEAT AND LIGHT** (continued)

3. **Visible Light Rays** (continued)

Using a proper welding helmet or goggles will prevent this problem.

4. **Arc Flash**

Arc flash occurs whenever the harmful rays from the electric arc strike eyes that are not protected by a proper filter lens. The intensity of the flash will depend upon the distance from the arc and the length of time the eyes were exposed. During exposure to the arc, all three types of harmful rays strike the eyes. In most cases the period of time of the exposure is so short that the infrared and ultraviolet rays have little chance to accumulate and to cause damage to the eyes. In a short flash, like the one which occurs when the tip of the electrode accidentally touches the base metal before the helmet is properly in place, it is only the intense visible light that really affects the eyes. In this case, a spot or spots will appear to swim before the eyes making it difficult to focus on small items for a few minutes. After this type of flash you can close your eyes for a few moments to rest them and to allow the retina in the eyes time to readjust itself. After this rest period you should be alright.

B. **RADIATION OF HEAT AND LIGHT** (continued)

4. **Arc Flash** (continued)

- The arc flash that people receive from working as
- fitters or from just being in the arc welding area for long periods of time can be more serious than a short flash. Even though the person is far enough away from the arc to prevent immediate discomfort, working for longer periods of time will permit infrared and particularly ultraviolet rays time to accumulate and begin to cause irritation or blistering on the eyelids or on the surface of the eye. This will result in a gravel feeling, or a feeling that some foreign particle is in the eye. The visible light given off by the arc over long hours can lead to a headache and general discomfort for the individual.

If the eye irritation is not too severe the eyes can be treated to provide satisfactory relief. The headache can be treated with aspirin or other types of headache remedies commonly available at drug stores. For the next few hours avoid strong light, wear dark glasses and rest until the discomfort passes.

B. **RADIATION OF HEAT AND LIGHT** (continued)

4. **Arc Flash** (continued)

- If the discomfort is severe, or continues more than overnight, you should see a doctor and have him examine
- your eyes. There is a possibility that a metal chip or other foreign particle could be in the eye and it could feel like the result of arc flash. If this condition should occur it is important to have the article removed before it has a chance to become embedded in the eyeball.

To prevent this type of eye problem, those who work as fitters or at other jobs in the welding area should always wear flash goggles. These goggles, which are light welding lenses, will prevent infrared and ultraviolet rays from entering the eyes and they will keep the visible light from causing eye strain. If the goggles have proper sides, they will also prevent slag and other particles from getting into the eyes.

5. **Contact Lenses**

Contact lenses, worn to correct eyesight problems, should not be worn when working in the welding area and especially when arc welding. The smoke and dust generated by arc welding can collect in the space between the lens and the eye. This can cause eye irritation.

**B. RADIATION OF HEAT AND LIGHT** (continued)

**5. Contact Lenses** (continued)

- There are reports that an accidental flash or arc
- strike may cause the moisture, in the space between the contact lens and the eye, to evaporate rapidly. If this happens, the contact lens would almost fuse itself to the surface of the eye and this could lead to some very serious eye problems.

**6. Filter Lens**

The dark coloured filter lens used for welding is designed to filter out infrared and ultraviolet rays and to reduce visible light to a comfortable level. Since the welding operation must be controlled very closely, it is important that the weld puddle be seen very clearly. Filter lenses are made in various densities for different types of work. Each shade is numbered, starting at #1 for a very light shade, similar to ordinary sunglasses through #14 which is a very dark lens and allows very little normal light through it. The following will indicate some shade numbers and what they are used for.

#1 and #2 - Flash Goggles

#3 and #4 - Light oxy-acetylene welding

#5 and #6 - General oxy-acetylene welding and cutting

**B. RADIATION OF HEAT AND LIGHT (continued)****6. Filter Lens (continued)**

#7 and #8 - Heavy oxy-acetylene cutting

- #9 - Light arc welding

#10 - General arc welding

#11 - Heavier arc welding

#12 -- #14 - Heavy semi-automatic or automatic welding

The choice of shade density will vary to some degree between individuals but generally a #5 lens for oxy-acetylene work and a #10 lens for general arc welding is suitable for most people. If at any time your filter lens is cracked, chipped or broken due to heat or dropping on the floor, have it replaced immediately. Welding and cover lenses that are pitted or severely scratched should also be replaced.

**Types of Filter Lenses**

There are two basic types of filter lenses used for welding:

1. The absorbing type
2. The reflecting type

**B. RADIATION OF HEAT AND LIGHT (continued)**

**6. Filter Lens (continued)**

**The absorbing lens**

- The absorbing type of filter lens is probably the most common type of filter lens available today. It is made of high quality optical glass that has certain iron oxides added to it which absorb infrared and ultraviolet radiation. The oxides give the filter its green or green-brown colour and because the filter absorbs infrared radiation it can become quite hot.

**The reflecting lens**

In recent years, and as a result of the need for high quality filters to protect astronauts from the infrared and ultraviolet radiation in space and on the moon's surface, reflective filter lenses were developed. By placing a very thin layer of gold over the lens it was found that almost all (99%) of the harmful radiation was reflected and the the natural light was allowed through with no loss of colour.



8. RADIATION OF HEAT AND LIGHT (continued)6. Filter Lens (continued)Advantages and Disadvantages

## • The absorbing lens advantages are:

1. low initial cost
2. easy to clean

## Disadvantages:

1. tints the view with green
2. glass breaks easily
3. glass becomes hot because it absorbs infrared

## The reflecting lens advantages are:

1. allows true colours to come through
2. the lens is almost unbreakable
3. it is very light weight
4. it reflects heat therefore is cooler

## Disadvantages of reflector lenses:

1. higher cost
2. the thin gold film is very delicate and must be treated with care

B. RADIATION OF HEAT / \ND LIGIIT (cont inucd)

7. Cover Lens

- The glass filter lens is very easily pitted by sparks
- from welding, and would be impossible to see through in a very short time if used alone. For this reason a clear plastic cover lens is placed on either side of the filter lens to protect it. The plastic is designed to resist the sparks from welding and remain clear. The cover lens is easily scratched so care must be taken when cleaning the cover lens. Rinsing it in water or gently wiping the lens with a soft cloth will keep it in good condition for a long time. It is important to have a clean filter lens and cover lenses, free from pits and scratches so that a clear view of the weld is possible at all times. The puddle determines the quality of the weld and if vision is reduced due to dirty lenses then the quality of the weld will be affected.

C. HARMFUL FUMES

In any welding operation, smoke and fumes are produced as by-products of combustion and the generation of heat. These fumes are made up of the residue of electrode coatings as they are melted, from the melting of fluxes or

C. **HARMFUL FUMES** (continued)

- from the burning of mill scale, grease, paint and other dirt on the surface of the plate being welded. These
- particles of dust float in the air and enter the lungs where they can cause irritation and damage to lung tissue; this in turn can cause infections and other respiratory problems. Working in a dusty environment does not usually result in immediate problems but over a period of time the number of colds, sore throats or chest colds will increase. This could end in more serious lung problems in later years.

For safety and health it is recommended that the ventilation system in a welding area be able to completely change the air three to four times per hour. Many shops are now adding an air cleaner to their ventilation system in an effort to further reduce the levels of dust in the air.

**C. HARMFUL FUMES (continued)**

**Toxic Fumes**

- The general type of smoke and fumes mentioned in the above section are irritating and should be avoided, but they are not toxic; that is, they do not have definite and immediate effects on the body. Some welding conditions do produce toxic fumes and these must be carried out with care.

The most common toxic fumes encountered in welding are those of zinc oxide. Zinc oxide is produced when fusion welding galvanized iron, the zinc in the galvanized coating is vapourized in the welding process. Zinc oxide is very easily recognized for it is a very heavy, dense, white smoke that rises from the weld area. Inhaling this smoke or fumes will, in most cases, result in what welders call "brass chills". "Brass chills" or "the shakes" are very similar to a severe case of 24 hour flu; one usually has a headache, feels nauseated and extremely cold. The best treatment at this stage is to rest in bed as well as possible until the body has time to rid itself of the zinc oxide it has inhaled.

C. HARMFUL FUMES (continued)Toxic Fumes (continued)

- The most effective measure is to work in a very well ventilated area, outside is the best location or in a
- location where there is a strong draft. The draft should be directed against the welder's back so that it blows most of the fumes away from his face.

Other processes such as lead soldering or welding through layers of lead based paints also produces toxic fumes which should be avoided. Lead has the ability to collect in the human body and remain there for a number of years; therefore, small amounts of lead, absorbed from many exposures, can finally add up to a lethal dose and lead poisoning results. This can come to light after many years.

C. HARMFUL FUMES (continued).

Toxic Fumes (continued)

- It cannot be stressed enough that by working in a well ventilated area or by using a respirator or any other
- safety precautions that are necessary for a particular situation serious problems or accidents can be avoided.

D. GENERAL SHOP SAFETY

When working in a welding area it is important to use good safety practices to prevent accidents. The various machines and processes used in welding and steel fabrication must be properly handled in order for them to function effectively and to prevent accidents.

1. Explosions

In the welding shop an important rule is never to weld on a container of any kind until it is positively proven that it has never been used to hold combustible materials. If a container is suspected of having held gasoline or other flammable materials, then the proper procedures for cleaning the tank must be followed before any welding takes place. (A future section will discuss these methods.) Do not take anyone's word that a tank has never held combustibles; the welder himself must be sure, for he stands to lose the

D. **GENERAL SHOP SAFETY** (continued)

1. **Explosions** (continued)

most if the container explodes while he is working on it.

- Cylinders that hold compressed gasses such as oxygen and acetylene are never to be welded on. If an arc is struck on a loaded cylinder the heat will increase the internal pressure and the heating of the side wall may be great enough to allow the pressure to blow out the molten section where the weld puddle was formed. If the tank is empty when it is welded on there is no danger at the time but the weld may have cause sufficient stress in the cylinder wall so that it would fail when the tank is recharged to its maximum pressure.

2. **Fires**

The three requirements for a fire are air, fuel and ignition. In welding the air is always available as is the heat for ignition. It is therefore important to keep the fuel for a fire well away from the welding area. Paper and wood products are not left to collect in corners or in piles about the shop. Paints, solvents and gasoline are stored in proper containers which are kept away from the actual welding area. A clean orderly shop reduces the danger of fires.

D. **GENERAL SLOP SAFETY** (continued)

2. **fires** (continued)

Fires are classified in three groups:

1. Class A fire - wood, rubber, paper, cloth, etc.
- 2. Class B fire - liquids (gasoline, oil, etc.) and chemical fires.
3. Class C fire - electrical fires.

3. **Fire Extinguishers**

There are various methods of extinguishing a fire. Water is the most common type of extinguisher used. Other types of extinguishers are:

1. Combinations of water and chemicals such as soda. (
2. Liquid chemicals such as pyrene which smothers the fire.
3. Carbon dioxide (CO<sub>2</sub>) which keeps oxygen away from the fire.
4. Dry chemicals which smother the fire.

For a Class A fire any type of extinguisher can be used. For a Class B fire use a dry chemical or CO<sub>2</sub> extinguisher, using water or liquids may only spread the fire rather than put it out. (Gasoline will float on top of water and continue to burn.) For a Class C fire use only dry chemicals as extinguishers for water and liquid



0. **GENERAL SHOP SAFETY** (continued)

3. **Fire Extinguishers** (continued)

chemicals could conduct electricity and result in severe or fatal shocks to anyone using them.

Fire extinguishers are usually located near entrances or in risk areas where they will be handy when needed.

Check the location of each extinguisher and observe how it operates so that if an emergency arises you can react quickly. When using chemical or CO<sub>2</sub> extinguishers be careful not to discharge the contents on exposed skin; the chemical can burn while the CO<sub>2</sub> can freeze the skin immediately as its temperature as it leaves the extinguisher is -78° C.

D. GENERAL SHOP SAFETY (continued)

4. Grinding and Sanding

When using the floor grinders or hand sanders always use proper face protection. There are face shields on each of the grinders and they are to be used. Each helmet has a clear plastic lens under the flip front and they too can be used for face protection. When using a floor grinder be sure to have a firm grip on the work piece. Do not use excessive pressure so that the hand does not slip into the stone. Use pliers or tongs and wear gloves when doing any grinding on a small work piece.

The hand sander must be firmly gripped before the ON switch is pressed. The spark stream from a disc grinder may reach 5 to 6 meters so watch where you are directing the stream.

If someone is working and you shower him with sparks it can be very dangerous for the eyes or for exposed skin. The disc on a hand sander should always be stopped before the sander is placed on the bench. It is also recommended that the disc be turned up, for if the sander were to accidentally start it would not move and therefore would not cause any injury. Sanding discs must always be kept in

D. **GENERAL SHOP SAFETY** (continued)

4. **Grinding and Sanding** (continued)

good condition; if one is found that is chipped or cracked, it could fly apart in use. Have it checked by an instructor.

5. **Shop Equipment**

All students will be advised as to the proper use of the remaining shop equipment as the course progresses.

Do not attempt to use any equipment with which you have not had previous experience. This is to prevent personal injury and to prevent damage to the machine itself. If, at any time, you are not sure that you remember the proper procedures to follow when operating a particular machine, then ask an instructor for further directions.

6. **Good Housekeeping**

The Workman's Compensation Board carries out inspections of shops to prevent the excessive accumulation of junk in the work area which can increase the risk of accident. It is the individual's personal responsibility to protect themselves from accidents. By learning to keep the work area clean and tidy one will have more than safety as a reward.

D. GENERAL SHOP WELDING (continued)

6. Good Housekeeping (continued)

- A clean, tidy shop is more pleasant to work in; it is easier to do a good job if the work area is not cluttered with junk. Tools that are put away in their proper place are easy to find when they are needed again. A clean floor is easier on the feet and legs; it is less tiring than standing on piles of rod ends and scraps of steel and less dust is raised to be inhaled and absorbed by the lungs.

If each person contributes to cleaning and tidying the shop area, the result will be fewer accidents, less fatigue, a healthier environment and better workmanship.