

An Approach to Best Welding Practice : Part – XII

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“AN APPROACH TO BEST WELDING PRACTICE, Part – XII” is the Twelfth Detail Part of **“AN APPROACH TO BEST WELDING PRACTICE”** which was written as a General and Overall approach to the subject matter.

AN APPROACH TO BEST WELDING PRACTICE. Part – XII is particularly focused on the Arc Radiation Safety Aspects especially for Fusion Welding Processes to obtain the best possible Accident free shop floor operation.

This is a Working Guideline for Supervisors and Operators working in an Engineering Fabrication Plant using welding as the main manufacturing process to initiate awareness for observing Safety Rules and regulations.

SAFETY

Safety has been defined in many ways and in different formats.

- ❖ Safety means protection and freedom from Hazards.
- ❖ Safety means keeping away from danger
- ❖ Safety means systematically tackling dangerous and hazardous situations.

In general, dangers and hazards are caused by :

- * Tools and Tackles
- * Manufacturing Process
- * Machineries and Plants
- * Human errors.


Every manufacturing factory using machineries and equipment impose Hazards which are to be mitigated by all concerned. In order to make the working environment as much safe as possible we must understand, evaluate and mitigate dangers and hazards arising out of the process and associated tools, plant and equipment. At the same time we must formulate the safety rules to follow.

HAZARDS OF WELDING

- * Fire and Explosion hazards
- * Electric shock.
- * Radiation from Arc
- * Work-Related Musculoskeletal Disorders

RADIATION FROM WELDING ARC

Physical Hazards – Radiation



Non-ionizing Radiation

- ultraviolet light from sunlight
- infrared radiation from torch welding and cutting
- radio waves from radio towers
- lasers used for aligning, ranging, and surveying are usually low-powered but can cause eye injuries if directly viewed for extended time
- microwaves

Health effects:

- skin cancer
- premature skin aging
- eye damage
- weakening of immune system

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INTRODUCTION

Most arc welding and cutting processes, laser welding, and torch welding, plasma cutting, resistance welding and brazing, or soldering produce substantial radiation requiring precautionary measures for safety of operators of the processes. Some cold pressure welding, ordinarily produce negligible quantities of radiant energy.

DEFINITION

Radiation is electromagnetic energy given off arc or flame that can injure eyes by the UV Rays and burn skin. An operator sees

visible light radiation. However, he does not see ultraviolet or infrared radiation. Radiation is often silent and undetected, yet injury occurs.

TYPES OF RADIATION

There are two types of radiation associated with welding operations:

- ❖ Ionizing (such as X-rays) . .
- ❖ Non ionizing (such as ultraviolet, visible light, or infrared)

EFFECTS OF RADIATION

The effects of radiation depend on the wavelength, intensity, and length of time one is exposed to the radiant energy. Although a variety of effects is possible, UV radiation is known to cause adverse health effects over both the short and long term. UV radiation is normally absorbed in the skin and the adverse health effects are mostly confined to the skin and eyes. In most cases it is considered that shorter wavelengths (UVB) are more harmful than longer wavelengths (UVA).

Ultraviolet (UV) radiation is a known cause of the following most common injuries:

- skin cancer,
- skin ageing,

- eye damage, and
- may affect the immune system.

Effects of UV radiation on the skin

Short-term exposure to UV radiation causes reddening of the skin, sunburn and swelling, which may be very severe. In some people this sunburn is followed by increased production of melanin, and is recognised as a suntan. Tanning is a sign that damaged skin is attempting to protect itself from further harm. The most serious long-term effect of UV radiation is the induction of skin cancer. The non-melanoma skin cancers (NMSCs) are basal cell carcinomas and squamous cell carcinomas.

Effects of UV Radiation on the Eyes

Responses of the human eye to acute over exposure of UV radiation include photokeratitis and photoconjunctivitis (inflammation of the cornea and the conjunctiva, respectively), more commonly known as snow blindness or welder's flash. Symptoms range from mild irritation to sever pain and possibly irreversible damage. There is evidence that chronic exposure to intense levels of solar radiation is a contributory factor in the development of age-related macular degeneration of the retina and cortical cataracts, both are causes of blindness.



Effects of UV radiation on the skin

UV Rays and your Eyes

- Extended exposure to UV rays, from staying too long in direct sunlight, could lead to a host of eye problems
- UV radiation can be categorized into three sets of invisible rays:
 - ★ **UVC rays**, which are the most dangerous, but so far virtually blocked by the atmospheric ozone layer
 - ★ **UVB rays**, which can cause dangers ranging from a simple skin tan to even skin cancer
 - ★ **UVA rays**, which have been linked to the formation of certain types of cataracts.



Other Dangers

- Eye damage from flash burns or Ultraviolet (UV) Radiation ("Welder's Eye")
- Flash burns to the welder or surrounding workers
- Inhalation of dangerous fumes ("Metal Fume Fever")
- Heat stress

ARC EYE

Arc eye, also known as **arc flash** or **welder's flash** or **corneal flash burns**, is a painful condition sometimes experienced by **welders** who have failed to use adequate **eye** protection.

It can also occur due to light from **sunbeds**, light reflected from **snow** (known as **snow blindness**), **water** or **sand**. The intense **ultraviolet** light emitted by the arc causes a **superficial and painful keratitis**.

Symptoms tend to occur a number of hours after exposure and typically resolve spontaneously within 36 hours. It has been described as having sand poured into the eyes.

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ULTRAVIOLET RADIATION AS A HAZARD IN THE WORKPLACE

I. SUN RAYS

Welders who work outdoors are the most likely of all workers to suffer health damage from exposure to UV radiation in addition to UV Rays from the welding arc. Other people may be exposed to UV radiation at indoor work from non-solar sources such as arc welding, the curing of paints, inks etc.

In relation to non-solar sources of UV radiation, well designed engineering and administrative controls and in the case of arc welders, personal protective equipment can keep the risks to a minimum. However with outdoor welders who are regularly exposed to the sun for long periods of time, a more comprehensive strategy is required to minimize risks. This is because the sun (exposure source) cannot be controlled like other workplace exposure hazards. Factors that affect Solar UV radiation include the following:

- ❖ **Sun elevation:** The higher the sun in the sky, the more intense the UV radiation.

Therefore the UV radiation levels are highest around solar noon and in summer

- ❖ **Latitude:** The closer to equatorial regions, the higher the UV radiation levels.
- ❖ **Cloud cover:** Solar UVR can penetrate through light cloud cover, and on lightly overcast days the UV radiation intensity can be similar to that of a cloud-free day. Heavy cloud can reduce the intensity of UV radiation. Scattered cloud has a variable effect on UV radiation levels, which rise and fall as clouds pass in front of the sun.
- ❖ **Altitude:** At higher altitudes, the atmosphere is thinner and absorbs less UV radiation.
- ❖ **Ozone:** Ozone absorbs some of the UV radiation that would otherwise reach the Earth's surface.
- ❖ **Ground reflection:** Grass, soil and water reflect less than 10% of UV radiation; fresh snow reflects as much as 80%; dry beach sand about 15% and sea foam about 25%.

As UV radiation can neither be seen nor felt, it is important therefore that workers who have the potential to be exposed to intense levels of UV radiation are aware of the risks and are regularly reminded to take prompt, appropriate protective action.

II. ELECTRIC WELDING ARC

Very high Welding arcs can exceed the UV radiation guidelines in seconds within a few meters of the arc. Workers, bystanders and passers-by can be overexposed to UV from the arcs if engineering controls are inadequate.

The arcs associated with arc welding emit high levels of ultraviolet radiation (UVR), and this often causes acute injuries in the workplace, particularly photokerato conjunctivitis. It is important to know the level of UVR emitted by arc welding under various conditions, as this information will help in evaluating potential UVR hazards in welding workplaces and taking protective measures against it.

A STUDY

A study made for the ACGIH effective irradiance for UVR was measured experimentally for CO₂ arc welding in order to evaluate its UVR hazards. A welding robot was used in the experiment in order to realize reproducible and consistent welding operations. The effective irradiance at 1 m from the arc was in the range 0.28-7.85 W/m² (28-785 μW/cm²) under the study conditions. The coefficient of variation (standard deviation/mean) for repeated measurements was 15% on average for the solid wire and 10% on average for the flux-cored wire. The corresponding permissible exposure time per day is only 4-100 s, suggesting that UVR from CO₂ arc welding is actually hazardous for the eye and skin. It was found that the effective irradiance is inversely proportional to the square of the distance from the arc, is strongly dependent on the direction of emission from the arc with a maximum at 50-60° from the plate surface, and tends to increase with welding current. (2001 British Occupational Hygiene Society. Published by Elsevier Science Ltd.)

The UVR level at the position of welders will be several times higher, because the welder is usually less than 1 m away and the effective irradiance is inversely proportional to the square of the distance, as shown in this study. Thus, welders should always wear an appropriate face protector (welding helmet or shield) and appropriate clothing to protect eyes and skin against UVR when conducting CO₂ arc welding. UVR may also be hazardous at greater distances from the arc. For example, at 10 m, although the UVR level decreases to 1 % of the level at 1 m, the permissible time per day is still only 6 min to 3 h. exposure

HOW TO MANAGE RADIATION HAZARDS IN THE WORKPLACE

There are a number of measures that can be put in place to control risks in the workplace. This would involve;

1. **Engineering controls** - for outdoor workers this would include the provision of shade cover or canopies. In the context of non-solar sources of UV radiation, suitable engineering controls measures would include opaque barriers, UV radiation blocking filters and door interlocking power supplies.
2. **Administrative controls** - for outdoor workers this would include rescheduling outdoor work programs where possible to be performed outside the peak UV radiation period (2 hours either side of solar noon), Training of supervisors and employees should be undertaken for workers exposed to solar and non-solar sources of radiation.
3. **Personal protective equipment (PPE)** - Outdoor workers should be provided with protective clothing that is

loose fitting, made of close weave fabric and provides protection to the neck and preferably to the lower arms and legs. Welding Head Shields / Handshields must be worn. Sunscreen should be a minimum SPF 15, and be broad-spectrum, that is block UVA and UVB, and be applied regularly and liberally to exposed skin.

4. Training should be offered to all employees exposed to medium to very high levels of UV radiation at work so that they understand the risks and what is expected of them while at the workplace.

EYE AND FACE PROTECTION

Eye and face protection require Protective eyewear, which includes safety goggles, protective glasses and face visors and spectacles regulated by a minimum protection level of EN166. Further classifications include EN169 which are filtered for welding, brazing, plasma cutting, etc., EN170 for protection against sources of UV light (sunlight for instance), and EN172 for protection against sun glare.

ARC RAYS can cause burn. Eye, ear and body must be



protected with proper PPE. It is essential that the eyes are protected from radiation exposure. Infrared radiation has been known to cause retinal burning and cataracts. And even a brief exposure to ultraviolet (UV) radiation can cause an eye burn known as "welder's flash." While this condition is not always apparent until several hours after exposure, it causes extreme discomfort, and can result in swelling, fluid excretion, and temporary blindness. Normally, welder's flash is temporary, but repeated or prolonged exposure can lead to permanent injury of the eyes.

Other than simply not looking at an arc, the primary preventive measure the welder can take is to use the proper shade lens in the Head and Hand Shield. For various arc welding processes the welder must refer to the lens shade selector chart for the recommended shade numbers. The general rule is to choose a filter too dark to see the arc, then move to lighter shades without dropping below the minimum rating. The filters are marked as to the manufacturer and shade number, the impact-resistant variety are marked with an "H."

Head Shields and hand-held Face Shields offer the most complete shielding against arc radiation. The shade slips into a window at the front of the shield so that it can be removed and replaced easily. The shields are made from a hard plastic or fiberglass to protect head, face, ears, and neck from electric shock, heat, sparks, and flames. The welders should also use safety glasses with side shields or goggles to protect the eyes from flying particles.

Auto-Darkening Helmets. The sensors on an auto-darkening helmet darken the lens in a fraction of a second. All auto-darkening helmets must meet ANSI standards, the most recent being ANSI Z87.1-2003.

Visible light can also be harmful, but it is easy to tell if the light is dangerous: if it hurts to look at, then it's too bright. The same is true for infrared radiation: it can usually be felt as heat. However, there's no real way to predict if the welder or the onlookers being over exposed to UV radiation, so no chances should be taken and welders must always take eye protection with recommended lens for the process.

Filter Lens Shade Numbers

- ❖ SMAW – 1/16 - 5/32 Electrodes = #10
- ❖ SMAW – 3/16 – ¼ - Electrodes = #12
- ❖ SMAW - 5/16 & 3/8 Electrodes = #14

- ❖ GMAW - 1/16 - 5/32 Electrodes = #11 (nonferrous)
- ❖ GMAW – 1/16 – 5/32 Electrodes = #12 (ferrous)
- ❖ GTAW – All Electrodes = # 11
- ❖ Plasma Arc welding – All = # 12
- ❖ Carbon Arc Gouging – Light # 12, Heavy # 14
- ❖ Atomic Hydrogen Welding = #10 - #14
- ❖ Plasma cutting protection
- ❖ Carbon Arc Welding CAW = #14
- ❖ 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
- ❖ Plasma Arc Cutting – Light <300 amp = #9,
 - Medium 300 – 400 amp = #12
 - Heavy > 400 amp = #14

Plasma Cutting Protection

ANSI Z49.1:2005 Recommendations		
Arc Current (Amperes)	Minimum Protective Shade	Suggested Shade Number
Less than 20	4	4
20 - 40	5	5
40 - 60	6	6
60 - 80	8	8
80 - 300	8	8
300 - 400	9	12
400 - 800	10	14

TO PROTECT YOURSELF AS A WELDER

1. As a rule of thumb, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.



2. Protect against arc flashes, mechanical injury, or other mishaps. Wear spectacles or goggles with No. 2 shade filter lens and side shields inside the welding helmet or hand shield. Helpers and observers should wear similar protection-Be sure "lift front" welding helmet has plastic plate inside and safety glass cover on the outside.
3. Wear protective clothing such as heat resistant jackets, aprons, and leggings. Exposure to prolonged or intense arc radiation can cause injury. Thin cotton clothing is inadequate protection. Cotton deteriorates with this type of radiation.
4. Wear high, snug fitting shoes. Avoid wearing low or loose shoes which would allow hot spatter to get inside.
5. Wear cuffless pants. By wearing pants with no cuffs, you eliminate a dangerous spark and spatter trap- Pants legs should overlap shoe tops to prevent spatter from getting into your shoes.
6. Wear clean clothes. Do not wear clothing that has been stained with oil and grease. It may burn if ignited by the heat of the arc.
7. Wear ear protection, not only where there is noise, but where there is a chance that spatter or sparks could get into your ears.
8. Wear a leather cap or other protection to protect the head from sparks or spatter.
9. Protect neighboring workers from exposure to arc radiation. Shield your station with metal or heat resistant

shields. If your station cannot be shielded, everyone within about 75 ft. should wear eye protection when welding or cutting is in progress.

10. Keep your pockets, sleeves and collars buttoned. Sparks may lodge in them and cause fires or burns. Be sure your pockets are emptied of combustibles such as matches and other flammables.

WELDING CURTAINS

Fitters, Gas Cutters, Grinders and other operators working in and around the welding workplace must also be protected from the Arc Radiation. Welding curtains complying with EN1598 to block out welding light. The curtains are provided with seams all around with snap fasteners on both sides for joining. Portable curtain frame for use when welding are ideal for moving to and from work areas. Supplied complete with reinforced holes and steel suspension rings can be set up in the frames very quickly.



CONCLUSION

All Arc Welding Processes emit UV rays which cause harmful effects on skin and eyes of the welders and associated operators if exposed for prolonged periods. Preventive and Protective actions can and must be taken in a planned way to reduce these to minimum.