An Approach to Best Welding Practice : Part – IX

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"AN APPROACH TO BEST WELDING PRACTICE, Part – IX" is the Ninth 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 – IX is particularly focused on the Safety Aspects by Personal Protective Equipment 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

PERSONAL PROTECTIVE EQUIPMENT

To mitigate HAZARDS effectively, compulsory use of PERSONAL PROTECTIVE EQUIPMENT is absolutely necessary. Personal Protective Equipment are those which protect our body from the Hazards and Dangers arising out of Materials, Tools, Machineries and Process used in and working environment at our work place.

The most commonly used PPE are :

- Overall or Boiler Suit
- Apron
- Hand Gloves
- Elbow Guards.
- Safety Helmets / Head Guard.
- Hand Shield.
- Goggles.
- Leg Guards
- Safety Shoes, Ear Plugs/ Ear Muffs

Protective Clothing to the Body

Welders must wear clothing to protect them from burns. Burns are the most common injuries to welders due to sparks landing on bare skin. Welding arcs are very intense and can cause burns to skin and eyes with just a few minutes of exposure.

The actual safety clothing varies with the job being performed, but generally protective clothing must be not loose, nor tight to

allow freedom of movement while providing adequate coverage against burns from sparks, weld spatter, and arc radiation. Many types of clothing will protect welders from ultra-violet radiation exposure, which appears as a skin burn (much like sunburn). Under the worst conditions, however, severe burns and skin cancer may result from excessive radiation.

Because of its durability and resistance to fire, wool clothing is suggested over synthetics (which should never be worn because it melts when exposed to extreme heat). Thick cotton, specially treated for fire protection is equally good. All types of safety clothing must be cleaned to be free from of grease and oil, as these substances may ignite and burn uncontrollably in the presence of oxygen.

Sleeves and pant-cuffs must not be rolled up, because sparks or hot metal could deposit in the folds; also, trousers to be worn in such a way that the legs are outside work boots, not tucked in, to keep particles from falling into the boots. Leather high-tops with steel toes is better to wear (especially when doing heavy work).

Other protective wear for heavy work or especially hazardous situations includes: flame-resistant suits, aprons, leggings, leather sleeves/shoulder capes, and caps worn under the helmet. As to preventing electric shock, the key word is dry! It

OVERALL

APRON

LEG GUARDS

HELMET

HEAD SHIELD

HAND SHIELD

HAND GLOVES

SAFETY SHOES

SAFETY GLASS

must be kept in mind that moisture can increase the potential for and severity of electric shock. When working in wet conditions, or when perspiring heavily, welders must be even more careful to insulate the body from electrically "live" parts and work on grounded metal.

FOOT PROTECTION

All safety footwear should conform to EN ISO 20345

Foot Protection. When work endangers feet or requires special foot protection, employees must wear protective footwear that meets the requirements in ANSI Z41, "Protective Footwear."

HAND PROTECTION

Heavy, flame-resistant gloves, such as leather, should always be worn to protect hands from burns, cuts, and scratches. In addition, as long as they are dry and in good condition, they will offer some insulation against electric shock. Always wear dry, hole-free, insulated welding gloves in good condition. They will help protect the welder's hands from burns, sparks, heat, cuts, scratches, and electric shock. ANSI Z49.1 requires all welders to wear protective flame-resistant gloves, such as leather welder's gloves. They generally provide the heat resistance and general hand protection needed for welding.

EYE AND FACE PROTECTION

Eye and face protection required Protective eyewear, which includes safety goggles, protective glasses and face visors and spectacles are regulated by European directives and require 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.

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
- 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 ½ " = #5 or #6
- Heavy Gas Welding over ½ " = #6 or #8
- Plasma Arc Cutting - Light <300 amp = #9,
  Medium 300 - 400 amp = #12
  Heavy > 400 amp = #14

NOISE

There are two good reasons to wear ear muffs or plugs:

1. To keep out flying sparks or metal from entering into the ears; and
2. To prevent hearing loss as a result of working around noisy arc welding equipment, power sources, and processes (like air carbon arc cutting or plasma arc cutting).

As with radiation exposure to the eyes, the length and number of times that the welders are exposed to high levels of noise determine the extent of the damage to the hearing. It must therefore to be ensured to avoid repeated exposure to noise. If it is not possible to reduce the level of noise at the source (by moving either the welding site or the equipment, utilizing sound shields, etc.), then welders should wear adequate ear protection. If the noise in the work area becomes un-comfortable, causing a headache or discomfort of the ears, everybody working in that area could be damaging their hearing and should immediately put on ear muffs or plugs.

In fact, the use of ear protection at all times is a good idea, as hearing loss is both gradual and adds up over time. Damage to hearing is difficult to notice as it is a slow process and can be noticed only after a complete hearing test, and then it could be too late.

The following table summarizes the differences between ear plugs and ear muffs.

Comparison of Hearing Protection	
Ear Plugs	**Ear Muffs**
Advantages	**Advantages**
● small and easily carried ● convenient to use with other personal protection equipment (can be worn with ear muffs) ● more comfortable for long-term wear in hot, humid work areas ● convenient for use in confined work areas	● less attenuation variability among users ● designed so that one size fits most head sizes ● easily seen at a distance to assist in the monitoring of their use ● not easily misplaced or lost ● may be worn with minor ear infections
Disadvantages	**Disadvantages**
● requires more time to fit ● more difficult to insert and remove ● require good hygiene practices ● may irritate the ear canal ● easily misplaced ● more difficult to see and monitor usage	● less portable and heavier ● more inconvenient for use with other personal protective equipment. ● more uncomfortable in hot, humid work area ● more inconvenient for use in confined work areas ● may interfere with the wearing of safety or prescription glasses: wearing glasses results in breaking the seal between the ear muff and the skin and results in decreased hearing protection.

Steps to take care for hearing protection device

- Follow the manufacturer's instructions.
- Check hearing protection regularly for wear and tear.
- Replace ear cushions or plugs that are no longer pliable.
- Replace a unit when head bands are so stretched that they do not keep ear cushions snugly against the head.
- Disassemble ear muffs to clean.
- Wash ear muffs with a mild liquid detergent in warm water, and then rinse in clear warm water. Ensure that the sound-attenuating material inside the ear cushions does not get wet.
- Use a soft brush to remove skin oil and dirt that can harden ear cushions.
- Squeeze excess moisture from the plugs or cushions and then place them on a clean surface to air dry. (Check the manufacturer's recommendations first to find out if the ear plugs are washable.

RESPIRATORY PROTECTIVE EQUIPMENT

- Respiratory protection equipment falls under the BS EN 149:2001 and BS EN 140:1999 classifications. Protective equipment provides basic breathing defence, such as filtering half masks to protect against dust and dangerous particles. Respiratory protection devices are often referred to by their differing levels of protection, for instance: Type 1, 2 or 3 or P1, P2 or P3.
- For information on respirators, ANSI Z49.1 and Fact Sheet 37. Also OSHA
- and NIOSH regulations can be referred.

USE OF SAFETY BELTS

Often welders are required to work at a height. Use of safety belts with a connection of a life line is essential. It is imperative that both the hands of the welder working at a height is essential for manipulation of the welding cable, torch, head shield etc. and therefore a platform with a good width to stand and work must be provided when working at a height.

CONCLUSION

When working for quality of weld welders must feel comfortable and safe from working hazards. Providing Safety Apparel and making it a habit to use this is by the welders a management responsibility in addition to make the working area hazard free.

STANDARDS AND SPECIFICATIONS FOR PPE

Often it is required to refer to the relevant Standards/ Specifications in procurement and use of specific purpose PPE. A list is appended below for ready reference.

- ANSI Z49.1 : It gives a full explanation of the protective clothing needed when welding or cutting. In brief, Z49.1 states that "Clothing shall provide sufficient coverage, and be made of suitable materials, to minimize skin burns caused by sparks, spatter, or radiation."
- When welding or engaging in similar activities which might produce small splashes of molten metal, safety workwear (Boiler suit/ Overall) and equipment needs to meet the specifications of protection level EN1161.
- EN ISO 11612 : 2008 Protective clothing to protect against heat and flame.
- EN ISO 14116 : 2008 Protective Clothing to protect against heat and flame - limited flame spread (replaces EN 533 - still accepted for garments already certified). Protection for workers against occasional and brief contact with small igniting flames, where there is no significant heat hazard and without the presence of another type of heat.
- EN 1149 Protective clothing with electrostatic properties.
- Industrial safety gloves designed to provide protection EN12477 is the standard for the protective gloves used for welding.
- Eye and face protection required Protective eyewear, which includes safety goggles, protective glasses and face visors and spectacles are regulated by European directives and require 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.
- ANSI Z87.1, "Practice for Occupational and Educational Eye and Face Protection."
- ANSI Z87.1 : helmet with filter lens and cover plate complies with for protection from radiant energy, flying sparks, and spatter.
- ANSI Z49.1 and OSHA 29 CFR 1910.252, "Helmets and hand shields shall protect the face, forehead, neck, and ears to a vertical line in back of the ears, from the direct radiant energy from the arc and from direct weld spatter."

- Helmets shall be made of material that complies with ANSI Z49.1.
- Filter lenses and cover plates must meet the tests prescribed in ANSI Z87.1.
- A filter lens shade according to the Lens Shade Selector Chart in ANSI Z49.1 or AWS F2.2. Lens Shade Selector.
- AWS Fact Sheet 31, Eye and Face Protection for Welding and Cutting Operations.
- ANSI Z87.1-2003 : 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.
- All safety footwear should conform to EN ISO 20345.
- ANSI Z41, "Protective Footwear."
- ANSI Z49.1 requires all welders to wear protective flame-resistant gloves, such as leather welder's gloves. They should provide the heat resistance and general hand protection needed for welding.
- Respiratory protection equipment falls under the BS EN 149 : 2001 and BS EN 140:1999 classifications.
- European legislation for ear defenders and ear plugs requires a minimum protection level of EN352.

WELDING SAFETY FAQS - PERSONAL PROTECTIVE EQUIPMENT

Clothing

Q: What is the most common injury to a welder?

A: Burns are the most common injury to welders due to sparks landing on the skin. Welding arcs are very intense and can cause burns to skin and eyes with just a few minutes of exposure.

Q: What protective clothing is needed in arc welding?

A: Protective clothing needed for welding includes general fire resistant clothing, safety glasses, shoes, gloves, helmet and leathers.

Q: Can oxy-fuel tinted goggles be used to protect your eyes while arc welding?

A: No, oxy-fuel goggles do not protect your eyes from the intense ultraviolet radiation (UV) produced by the welding arc. A welding helmet with the proper shaded lens must be used whenever welding.

Q: What types of fabric are recommended for clothing worn when arc welding?

A: Because of its durability and resistance to fire, wool clothing is suggested over synthetics. Synthetics should never be worn because it melts when exposed to extreme heat. Cotton can be worn if it is specially treated for fire retardation.

Q: What are steps that you can take to prevent hot sparks from being trapped in your clothing?

A: Avoid rolling up your sleeves or pant cuffs, because sparks or hot metal could deposit in the folds. Also, wear your pants outside your work boots, not tucked in, to keep particles from falling into your boots.

Safety Glasses

Q: Is it necessary to wear safety glasses if you are already wearing a welding helmet?

A: Even when wearing a helmet, Z87.1 approved safety glasses with side shields, or goggles, should always be worn to protect your eyes from flying particles.

Shoes

Q: What types of footwear are recommended for welders?

A: Leather boots with six- to eight-inch ankle coverage are the best foot protection. Where heavy work is done, safety-toe protection boots should be worn. Metatarsal guards over the shoe laces can protect them from falling objects and sparks.

Gloves

Q: What types of gloves are suitable for protecting your hands while welding?

A: Heavy, flame-resistant gloves (from materials such as leather) should always be worn to protect your hands and wrists from burns, cuts and scratches. As long as they are dry and in good condition, they will offer some insulation against electric shock.

Helmets and Arc Rays

Q: What are the two forms of radiation given off by the welding arc?

A: The two types of radiation are Infrared (IR) and Ultraviolet (UV) radiation. IR radiation can cause retinal burning and cataracts. IR can usually be felt as heat. UV radiation,

which cannot be felt, can cause an eye burn known as "Welder's Flash."

Q: How can exposure to IR and UV radiation injure your eyes?

A: It is essential that your eyes are protected from radiation exposure. IR radiation can cause retinal burning and cataracts. IR can usually be felt as heat. UV radiation, which cannot be felt, can cause an eye burn known as "Welder's Flash." This condition may not be apparent until several hours after exposure. It can cause 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.

Q: Is it safe to weld without a welding helmet for a brief period of time, such as during tack welding?

A: Even brief exposure to UV rays can result in a burn to the eyes known as "Welders Flash" which may not be evident until several hours after exposure. It causes extreme discomfort and can result in swelling, fluid excretion from the eyes and even temporary blindness. Normally, this condition is temporary, but repeated overexposure to UV radiation can result in permanent eye damage.

Q: How do you select the proper filter lens for your welding helmet?

A: The general rule of thumb is to choose a filter too dark to see the arc and then move to the next lighter setting without dropping to below the minimum recommended rating.

Q: How can you tell that you are being overexposed to radiation from the welding arc?

A: Infrared (IR) radiation cannot be seen but is felt as heat. And there is no way to sense if you are being overexposed to Ultraviolet (UV) radiation - so just do not take any chances and always wear eye and face protection with the proper protective shading.

Q: How can overexposure to the UV radiation from the welding arc injure you?

A: UV radiation can also burn exposed skin. This process is similar to getting sunburn from overexposure to the sun. Long exposure to arc rays without protection can lead to second and third degree skin buns. Repeated overexposure to ultraviolet radiation is a known cause of skin cancer.

Q: Is it safe to wear contact lenses while arc welding?

A: Welders should be able to wear contact lenses safely in most situations - provided they wear appropriate industrial eye wear and use the protection we've already discussed with respect to protection against arc rays. Anyone wearing contacts on the job should consult with their company medical staff and their own ophthalmologist.

Noise and Hearing Protection

Q: How can you protect your hearing when arc welding?

A: Earplugs and earmuffs keep metal sparks and airborne particles from entering your ear canal and protect your hearing from the effects of excessive noise.

Q: How do you know when the noise level to which you are exposed is potentially hazardous?

A: Levels of noise over 85 decibels, averaged over an eight-hour workday, are potentially hazardous to your hearing. When noise levels are painful or are loud enough to interfere with your ability to hear others speaking at a normal conversational volume this is an indication that levels are potentially hazardous.

Q: How does exposure to high noise levels damage your hearing?

A: The length and number of times you are exposed to high levels of noise determines the extent of the damage to your hearing. High noise levels cause damage to the ear drum and other sensitive parts of your inner ear.

Q: In addition to wearing hearing protection, what measures can you take to protect yourself from high noise levels?

A: If it is not possible to reduce the level of noise at the source by moving either yourself or the equipment, or by using sound barriers, then you should wear adequate ear protection.