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SAFETY CONSIDERATIONS IN A WELDING PROCESS: A REVIEW

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Abstract: The present research work is aimed at highlighting the safety aspects in a welding process. The process of welding is being used extensively for the last several decades as one of the most commonly used joining techniques for various metallic structures including ships, airplanes, automobiles, bridges, pressure vessels, etc. In this research article, some issues related to the procedures adopted for ensuring safety in the welding process are dealt with. The paper is structured with a special focus on OSHA's standards as applicable in welding, hazard awareness and risk assessment from welding point of view.

Keywords: Welding Hazards, Safety, Risk Assessment.

I. INTRODUCTION

The process of welding is being used extensively for the last several decades as one of the most commonly used joining techniques for various metallic structures including ships, airplanes, automobiles, bridges, pressure vessels, etc. From performance point of view, it provides better performance in comparison to other joining techniques in terms of joint efficiency, mechanical properties, and applications [1]. Welding, cutting, and brazing are hazardous activities that pose a unique combination of both safety and health risks to more than 500,000 workers in a wide variety of industries [2].

Welding joins pieces of metal by the use of heat, pressure, or both. There are more than 80 different types of welding and associated processes. Some of the most common types of welding include: arc welding, which includes "stick" or shielded metal arc welding (SMAW), the gas-shielded methods of metal inert gas (MIG) and tungsten inert gas (TIG), plasma arc welding (PAW), and submerged arc welding (SAW). Some of the welding processes may use oxy-acetylene gas, electrical current, lasers, electron beams, friction, ultrasonic sound, chemical reactions, heat from fuel gas, and robots to carry out different operations. On the other hand, brazing or soldering, involves a filler metal or alloy (a combination of metals), which has a lower melting point than the metal pieces to be joined [2, 3]. The filler materials (such as lead and cadmium) can be very toxic.

Welding hazards include electric shock, burns, fire and explosions, radiation, heat, noise, fumes and gases. Exposure to any or all of these can be minimized by using an effective combination of control measures.

The aim of the present work is to present a holistic overview of the safety and the hazards involved in a welding environment. Some of the research work carried out in this direction has also been highlighted in this article. Although limited number of research articles are available till date, with these factors in consideration a review of hazards and safety aspects in welding is very mandatory. In general, a hazard may be defined as something that has the potential to cause injury or damage to some resource (health). The risk of injury or damage to health occurring depends on how hazards are dealt with or controlled. Some of the frequently encountered hazards as experienced by welders and other related workers include mainly the electricity, radiation, heat, flames, fire, explosion, noise, welding fumes, fuel gases, inert gases, gas mixtures solvents, etc. In order to provide safe working conditions in a manufacturing environment, it becomes mandatory to take into consideration the aspects related to hazards. Risk mitigation or risk assessment therefore needs to be carried out at various levels.

In view of these factors, various safety guidelines are issued by some regulatory bodies to deal with the issues of worker's safety and the hazards prevention system / methodologies. According to the reports from Occupational Safety and Health

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Administration (OSHA), the risk from fatal injuries alone is more than four deaths per thousand workers over a working lifetime. Therefore, there is a need to understand the hazards and the risks involved while carrying out the welding operations. It also involves the understanding of ways and means to control these hazards [3]. Various preventive measures have been outlined by welding experts in this direction. This includes avoiding eye injury, respiratory protection, and ventilation of the work area, protective clothing, and having safe equipment to use.

II. OSHA'S WELDING STANDARDS

OSHA has standards that cover many aspects of welding work, including welding safety, welding in confined spaces, handling of compressed gases, fire and electrical safety, ventilation, protective equipment, and worker training. Insist on safe working conditions before welding. Specific requirements for assuring the safety of welding, cutting, and brazing operations are covered under OSHA Standard 29 CFR 1910.252. Below are some selected requirements of the standard [3]:

• Compressed gas cylinders must be kept away from radiators and other heat sources and stored upright in a well ventilated, dry location at least 20 feet from highly combustible materials such as oil. Cylinders should be kept away from elevators, stairs, or other spaces where they can be knocked over or damaged.
• Piping systems must be tested and proved gastight at 1 1/2 times the maximum operating pressure, and shall be thoroughly purged with air, before being placed in service. Service piping systems must be protected by pressure relief devices.
• Hoses showing leaks, burns, worn places, or other defects must be repaired or replaced.
• Cutters and welders must be suitably trained in the safe operation of their equipment and the safe use of the process.
• The welder should be enclosed in an individual booth, or by non-combustible screens, that are
painted with a finish of low reflectivity such as zinc oxide or lamp black (to absorb ultraviolet radiation).Other people next to the welding area must be protected by noncombustible or flame proof screens or be required to wear appropriate goggles. The booths or screens should permit circulation of air at the floor level.
• All movable fire hazards in the vicinity of welding operations must be taken to a safe place. If all the fire hazards cannot be moved, guards must be used to contain the heat, sparks, and slag.
• Suitable fire extinguishing equipment must be maintained ready for instant use.
• Firewatchers are required whenever welding or cutting is performed in a location where other than a minor fire might develop. A fire watch must be maintained for at least 1/2 hour after completion of welding or cutting operations to detect and extinguish possible smoldering fires.
• No welding, cutting, or other hot work shall be performed on used drums, barrels, tanks, or other containers until they have been thoroughly cleaned (a purge with an inert gas is also recommended).
• Eye protection must be used during all arc welding or arc cutting operations, gas welding, oxygen cutting, resistance welding, or brazing operations (the proper shade number should be selected).
• When a welder must enter a confined space through a manhole or other small opening, an attendant with a pre-planned rescue procedure must be stationed outside to observe the welder at all times and to put the rescue operation into effect, if necessary.
• Special ventilation and/or respirators are required in confined spaces, for cleaning compounds, when fluorine compounds, zinc, lead, beryllium, cadmium, and mercury are encountered, and when cutting stainless steel.
• Warning labels are required for all filler metals and fluxes containing fluorine compounds (fluorides).

Labels and Other Information

Under OSHA's 29 CFR 1910.252 (c) (1) (iv) (A), all containers of filler metal, electrodes, and flux materials should carry warning labels alerting the welder that welding produces hazardous fumes and gases [8]. Base metals that contain or are coated with toxic materials (such as paints, lead, or mercury) should also be clearly labeled. Welding materials that contain carcinogens (cancer-causing agents) must carry a warning label stating that gases from the material may cause cancer.
The employer must also keep MSDSs for all of these hazardous materials, and make this information readily available to all exposed workers. The MSDS must contain information on chemical ingredients, hazardous decomposition products from welding, safe handling procedures, protective measures, first aid procedures, and health effects of the welding material. Signs OSHA's standard for signs and tags (29 CFR1910.145) requires that signs be used to warn workers of hazards that

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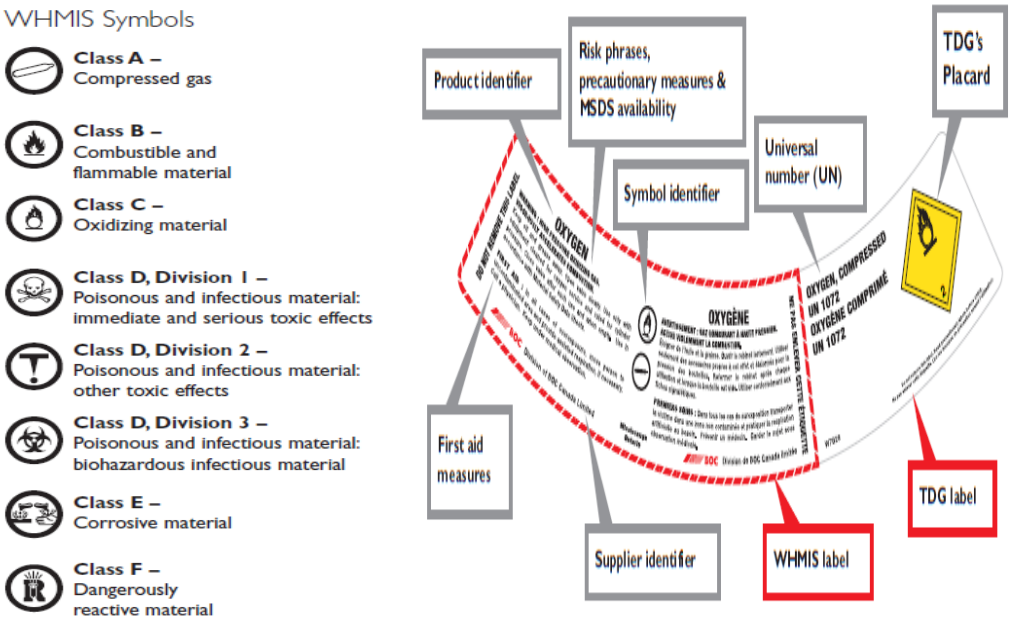
may lead to accidental injury. Appropriate signs must be available in welding zones to act as alarm for workers under a given welding environment.

WHMIS/TDG Labels

Workers may come in contact with materials in their line of work that, if handled incorrectly, may pose a hazard to their health and safety The Workplace Hazardous Materials Information System (WHMIS) is Canada's hazard communication standard. The key elements of the system are cautionary labeling of Containers of WHMIS "controlled products" and the provision of MSDSs [1, 2]



Components of WHMIS and TDG Labels

Hazard Awareness and Risk Assessment: An important aspect in welding safety is the awareness about the hazards and the risk assessment. This section deals with these aspects of a welding environment.

1.1 Potential Hazards

There is a need for awareness among welders and others associated with a welding process about all the potential hazards and the sources of injury or damage to health, which is likely to encounter while carrying out the welding processes in a welding environment. The welders may experience a number of hazards associated with welding and cutting processes [2]. These include:

1. ***Physical hazards***: electricity, radiation, heat, flames, fire, explosion, noise and magnetic fields.
2. ***Chemical hazards***: welding fumes, fuel gases, inert gases, gas mixtures and solvents.
3. ***General safety hazards***: These hazards not directly associated with welding or cutting. These include movement of machinery, falling objects, forklift trucks, mobile cranes, overhead cranes, site transport and other related hazards which may creep in during manual handling of gas cylinders, tools, materials, equipment, consumables, etc.

It must be noted down that welders may not be aware of all the hazards which may creep in during the process of welding. As such, based on the past experience only, some conclusions can be drawn and not as a whole.

II.RISK ASSESSMENT

Owing to the tremendous pressure from legislation, there is a need to carry out the assessment of the associated risks in the concerned processes. It has been observed that every process will have some impact on the overall environment. Therefore,

it is essential to carry out this exercise prior to the start of the process. This facilitates in decision and policy making with respect to health and safety measures.

With a basic health and safety information and some understanding of the requirements of the proposed welding activity, a welder can make an effective evaluation of the potential dangers associated with the processes involved. By examining the work area, equipment, materials and consumables to be used, the welder can make a judgment as to the likelihood that an incident or exposure to a hazardous event will occur.

- Is the probability of an incident or exposure occurring low, moderate or high.
- In the event of such an incident or exposure, will the result be severe, moderate or mild.

By carrying out such an assessment, the worker can decide what precautions need to be taken and what safety equipment or clothing is required to do the job safely.
These hazards are discussed separately as under:

5.1 Electricity: The main electrical hazard is electric shock or electrocution. Electric shock from welding and cutting equipment can result in death or severe burns. Additionally, serious injury can occur if the welder falls as a result of the shock. All of the following are electrically energized when the power is "on": the welding circuit (including the electrode and work piece), input power and machine internal circuits, the wire, reel of wire, drive rolls, and all other metal parts touching the energized electrode. Additionally, in correctly installed or improperly grounded equipment is a hazard [1,2].

Risk Assessment (Electricity)
Use proper precautionary measures and recommended safe practices at all times. Train all personnel using welding and cutting equipment to reduce the risk of injuries, fatalities, and electrical accidents by following these instructions:

- Read all instructions, labels, and installation manuals before installing, operating, or servicing the equipment.
- Train all personnel involved in welding operations to observe safe electrical work practices according to **OSHA 1910.332.**
- Ascertain if equipment has been properly installed by qualified electricians and maintained in good condition.
- Do not touch live electrical parts.
- Examine and inspect power switches, equipment, terminals, connections, cables, inter-connectors and insulation for condition and current carrying capacity.
- Do not work alone where there are electrically hazardous conditions. Wear dry, hole-free, insulating gloves in good condition and protective clothing. Do not touch the electrode with a bare hand.
- Insulate yourself from the workpiece and ground using dry insulating mats or covers big enough to prevent any physical contact with the work or ground, or wear properly designed and approved rubber-soled boots in good condition.
- Do not touch an energized electrode while you are in contact with the work circuit
- Examine the working area to check for potentially live structures or components and wet areas.
- Do not wrap cables carrying electric current around any part of your body.

If working at height, the risk of an electrical incident should be no greater than on the ground, but an electric shock gives a high risk of falling with potentially fatal consequences.

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Risk Control Measures

1. Ensuring that all electrical equipment is installed properly, in accordance with regulations, and is maintained in good condition are the normal control measures taken to prevent electrical incidents. Welders should never remove panels from welding power sources and should always get a qualified electrician to investigate faults in electrical equipment.
2. Using LVSD (low voltage safety devices) whenever possible when MMA welding reduces the risk of electric shock. They are particularly recommended when welding is taking place in confined spaces or other high-risk situations, such as wet environments, when the result of a shock could be particularly serious.
3. Use only well maintained equipment. Frequently inspect welding equipment and repair or replace all damaged parts before further use.
4. Use of Fully insulated electrode holders , to reduce the risk of electric shock.
5. Wearing dry leather gloves, insulated footwear and other appropriate protective clothing is

a practical risk control measure that can be taken by individual welders to reduce the risk of electric shock.

5.2 Gases and Fumes.

Welding fume is a mixture of airborne fine particles. Toxic gases may also be generated during welding and cutting. More than 90% of the fume arises from vaporisation of the consumable electrode, wire or rod as material is transferred across the arc or flame. The range of welding fume particle size is shown in relation to more familiar types of dust and fume. The respirable fraction of particles (especially less than 3µm) are potentially more harmful as they can penetrate to the innermost parts of the lung [4]

Gases

Gases encountered in welding may be [5]:

- Fuel gases which, on combustion, form carbon dioxide and, if the flame is reducing, carbon monoxide
- Shielding gases such as argon, helium and carbon dioxide, either alone or in mixtures with oxygen or hydrogen
- Carbon dioxide and monoxide produced by the action of heat on the welding flux or slag
- Nitric oxide, nitrogen dioxide and ozone produced by the action of heat or ultraviolet radiation on the atmosphere surrounding the welding arc
- Gases from the degradation of solvent vapours or surface contaminants on the metal.

The degree of risk to the welder's health from fume/gases will depend on:

- composition
- concentration
- the length of time the welder is exposed

Many welding, cutting, and allied processes produce fumes and gases, which may be harmful to health. Welding “smoke” is a mixture of very fine particles (fumes) and gases. Many of the substances in welding smoke, such as chromium, nickel, arsenic, asbestos, manganese, silica, beryllium, cadmium, nitrogen oxides, phosgene, acrolein, fluorine compounds, carbon monoxide, cobalt, copper, lead, ozone, selenium, and zinc can be extremely toxic. Generally, welding fumes and gases come from:

• Base material being welded or the filler material that is used;
• Coatings and paints on the metal being welded, or coatings covering the electrode;
• Shielding gases supplied from cylinders;
• chemical reactions which result by the action of ultraviolet light from the arc, and heat; • process and consumables used; and
• contaminants in the air, for example vapors from cleaners and degreasers.

Risk Assessment

1. Depending on material involved ranges from irritation of eyes, skin, and respiratory system to more severe complications.
2. Effects may occur immediately or at some later time.

3. Fumes can cause symptoms such as nausea, headaches, dizziness, and metal fume fever.
4. In confined spaces the gases might displace breathing air and cause asphyxiation.

Risk Control Measures

- Keep your head out of the fumes.
- Do not breathe the fumes.
- Use enough ventilation or exhaust at the arc, or both, to keep fumes and gases from your breathing zone and general area.
- Where ventilation is questionable, use air sampling to determine the need for corrective measures.
- Use mechanical ventilation to improve air quality.
- Follow OSHA guidelines for permissible exposure limits (PELs) for various fumes.
- Have a recognized specialist in Industrial Hygiene or Environmental Services check the operation and air quality and make recommendations for the specific welding or cutting situation [2, 3].

5.3) Noise

Potential Hazards

All welding and cutting processes generate noise but some are much noisier than others and some generate noise of a higher frequency. Exposure to noise over a period of time can result in impairment or loss of hearing. It is also possible that permanent hearing damage can be caused by a single, intense impact noise, like an explosion. Loud impact noises can also induce "tinnitus," a continuous or intermittent ringing, or other noises, in the ear. Noise is fairly easy to detect but the effects can accumulate over
a long period of time and so noise hazard can, surprisingly, be over looked [3]

Risk Assessment

The risk of exposure to noise and damage to hearing in a production area shop is usually quite high. To assess the risk, account must be taken of the welding or cutting process to be used, the general and intermittent noise levels in the work area, the duration of exposure to noise and the protective equipment available. In most cases, the following steps will be necessary to carry out a risk assessment [2, 3]:

1. Where noise levels exceed allowable levels laid down in health and safety legislation, warning notices will be required either at the machine/process or, if excessive generally throughout a workshop, at all entrances. A workshop with such notices presents a very high risk of exposure to noise. Wearing of suitable ear protection reduces the risk of exposure to noise and damage to hearing.

2. Noise level measurements in dB (A) may need to be taken to identify where noise levels are excessive and also which operations are producing the highest noise levels. In some cases, it may be necessary to wear hearing protection only while performing specific fabrication processes.

Risk Control Measures

- Ear protection equipment (ear defenders, ear plugs, etc.) is the most prevalent risk control measure used to reduce personal exposure to noise. Ear protection devices must be in good condition and have sufficient noise attenuation properties. Poorly fitting or inadequate ear protection gives a high risk of exposure to noise. Not using ear protection increases the risk of hearing impairment over a period of time.
- Segregation of noisy processes to one area of the workshop, away from the general work area, can be used as a control measure to reduce exposure to noise for the majority of workers. In the segregated area, there is a high risk of exposure to loud noise, but outside the area there should be a lower risk of exposure to continuous noise. In all areas, there may still be a high risk of exposure to intermittent loud noise. Using suitable ear protection reduces the risk of exposure.

- Some operations may have noise emissions contained completely by enclosing them in soundproof booths (e.g., shot blasting, fettling and plasma spraying).This effectively reduces exposure to noise for the majority of workers, but those involved in the operations must wear suitable ear protection.

5.4) Magnetic Fields

Potential Hazards

In welding, strong magnetic fields can be produced close to the power source and the current-carrying cables, and these cables are often close to or touching the welder's body. However, the main hazards are that these magnetic fields can affect the functioning of some heart pacemakers, perhaps causing the heart to stop or slow down and this may induce fainting. A worker will not be aware of magnetic field hazard unless a heart pacemaker behaves irregularly [3].

Risk Assessment

The assessment of risk from magnetic fields boils down to whether you are fitted with a heart pacemaker or not. In most cases, the following steps will be necessary to carry out a risk assessment [2,3,8]:

1. Company sites where strong magnetic fields are present should have safety warning notices regarding heart pacemakers on prominent display. Entering such areas presents a high risk of exposure to magnetic fields. Keeping clear of these areas reduces or eliminates the risk of a pacemaker being affected.
2. To welders and others who do not have heart pacemakers, magnetic fields present a very low risk of causing harm.

Risk Control Measures

- Welders using electric welding processes can reduce exposure to magnetic fields by keeping

Welding cables together and to one side of them and not wrapping any electric leads around
the body. The further the magnetic field is from the body, the weaker it will be.

- Welders fitted with pacemakers can reduce exposure by using welding processes, like oxy-fuel gas welding, that do not require electricity and do not, therefore, generate strong magnetic fields.

5.5) Manual Handling and General Safety

Potential Hazards

There are many general safety hazards not directly associated with welding but that are present in the workplace [3, 5]. These include hazards when manually handling equipment, consumables and tools, etc., and physical and mechanical hazards in the workplace. lowering, Manual handling can present a hazard during lifting, carrying, pushing, pulling or moving of cylinders, tools, materials, equipment and consumables, etc. One of the most common injuries experienced by workers is back injury during manual handling. The work area itself is likely to present a variety of safety hazards associated with access and exit points, where the work area is situated, gangways, cranes, steps, ladders, staging, scaffolding, pits, materials, tools, cables, machinery, plant and equipment, etc. What hazards are actually present depends on the type of welding work being carried out, but critical observation of the site can reveal a lot. General safety hazards and hazards encountered during manual handling are usually easy to recognize with some training, plus a little thought and common sense [2, 3].

Risk Assessment

There is always a risk of an incident at work caused by manual handling or general physical or mechanical hazards. An assessment of how great the risk is should look at the general condition of the workplace and where the welding is to be carried out, what other activities are taking place and the safety systems in operation.

- In most cases, the following steps will be necessary to carry out a risk assessment.

Gather information on processes, materials and work being carried out throughout the relevant parts of the site. Consult MSDSs for potential hazards and safety reports where appropriate.

- Ascertain what equipment is available for lifting, moving, carrying and supporting, etc., materials and plant.

- Observation of the workshop and welding area to ascertain the conditions under which work will take place, work taking place nearby, hazards presented by moving vehicles and plant, and hazards presented by obstructed or untidy areas.

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Risk Control Measures

- The risks presented by general hazards and hazards during manual handling activities can be controlled and significantly reduced if proper safety training is given and acted upon, if safe working practices and emergency procedures are in place, and if equipment and tools are maintained in good condition.
- The risks presented by general hazards and hazards during manual handling activities can be controlled and significantly reduced if proper safety training is given and acted upon, if safe working practices and emergency procedures are in place, and if equipment and tools are maintained in good condition. of incidents.
- For the welder or operator, control measures include following instructions and applying lessons learned in training, working in a safe manner, maintaining concentration and awareness, and not "cutting corners." All these will help to reduce the risk of incidents.

5.6) Inert Gases, Gas Mixtures and Compressed Gases

Potential Hazards

Shielding gases used in arc welding and cutting contain high percentages of inert gas. The most common inert gases are Argon and Helium. Carbon dioxide is not an inert gas but is used in many welding mixtures. None of these gases will support life and may present asphyxiation hazards when used in a confined space or where ventilation is extremely poor and a concentration of gas can occur. Compressed gases in cylinders are stored at pressures of up to 300 bar [3, 5]. For safe use, this is reduced to the working pressure by a regulator. However, a sudden release of gas at high pressure can cause serious physical injury. Inert gases are non-reactive, have no odor and are therefore impossible to detect directly. They therefore present a potentially serious hazard of asphyxiation.

Risk Assessment

The assessment of risk when using shielding gases must consider where the gases are being used. It should also take into account whether the gases are supplied in cylinders at high pressure or whether they are piped in from external gas storage units. In most cases, the following steps will be necessary to carry out a risk assessment:

1. Gather information and identify inert gases and gas mixtures in the vicinity, even if not being used personally. Consult MSDSs for the properties and potential hazards of each gas.
2. Examine gas cylinders and gas lines for condition and connections. It may be necessary to carry out leak testing to eliminate the risk of gas leaks from gas systems.
3. Check regulators for type and maximum pressure.

Risk Control Measures

- A control measure adopted in many industries is to prohibit use of inert gas in confined spaces, to remove the risk of Oxygen depletion altogether.
- When use of inert gases in a confined space is permitted, breathing apparatus is a commonly used risk control measure. The fitting and use of calibrated meters to continuously monitor Oxygen content is also a control measure used to reduce the risk of being caught out by a dangerous reduction in Oxygen level. Providing a source of fresh Air is also used to control the atmosphere of a confined space.
- Fitting and correct use of good quality regulators is the main control measure used to reduce risks from accidental release of gas at high pressure.
- The main control measures to reduce risk of physical injury from gas cylinders during handling are use of correct safety equipment and personal protective clothing and ensuring that cylinders are properly secured during storage, transportation and use.

Risk Management

Employers have a responsibility to safeguard the health and safety of their employees and other people. The most effective way to ensure that health and safety at work is maintained at a high level is by using risk management. Risk management

and control in welding is a process whereby risks to health are reduced to an acceptable level and one that is as low as is practical. The risk management process is usually carried out in several well-defined stages [3],

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Hazard awareness: recognition and identification of the potential sources of injury or damage to health in the welding environment.

Risk assessment: estimation of the likelihood that the hazard will cause harm.

Control: implementation of measures to eliminate or reduce risk.

Evaluation: appraisal of the effectiveness of the control measures in eliminating or reducing risk
.
Review: critical re-examination of the process, to ensure it is working effectively to identify hazards.

Control on hazards:

Hazards have been identified and risk has been assessed; now control measures to minimize risk are required. Risk control involves consideration of hazard and risk, and deciding what actions need to be taken to prevent or reduce injury or damage to health. Possible control measures are normally considered in order of their proven effectiveness. The following measures are listed in the usual order of preference:

Design – By designing-in certain features or designing-out certain features, hazards may be eliminated. For instance, fabrications may be designed to include many pre-cast components or extruded shapes to eliminate a considerable amount of welding.

Substitution – Replacing a hazardous process or material with one that is less hazardous will reduce the hazard, and hence the risk. For instance, using submerged arc welding instead of flux-cored wire welding will reduce the risk of exposure to radiation and fume. In welding, such types of substitution are not always practical or technically suitable.

Separation – Removing the welder from the hazard or isolating or screening the hazard from the welder effectively reduces the risk of exposure to the hazard. In welding, ancillary processes like plasma cutting, gouging, grinding, fettling and guillotining can be carried out in specified areas away from general fabrication, to reduce risk of exposure to loud noise at the welding station.

Removal – Use of engineering control measures to remove the hazard at the source. Welding fume extraction equipment can be used to take fumes away from welders and so reduce the risk of exposure to particulate and/or gaseous fume.

Protection – If engineering controls are impractical, then the welder must be protected from the hazard. If the welder has to stand on metallic surfaces that form part of the electric circuit and so may become live, then the use of rubber-soled boots will reduce the risk of electrocution.

Limitation – If engineering controls plus personal protection cannot reduce the risk sufficiently, then the exposure time must be regulated. If a welding operation takes place in a very hot environment, then allowing the welder to weld for a set time, followed by a suitable rest and cooling-off period, will reduce the risk of heat exhaustion.

Whatever the hazard may be, risk control by engineering methods is preferred to control by provision of personal protection, since the former generally gives more effective and longer lasting remedies. Personal protection may be acceptable if it is used in conjunction with other methods to give additional control or when engineering methods are not practical. It may also be used in emergency situations to provide immediate protection to those who are at risk.

Robot Welders

Many industries are beginning to use robot welders in place of human workers on the assembly line. This removes workers from the hazard, but focuses on job elimination rather than workplace improvements.

CONCLUSION

Owing to the fact that very limited number of articles involving review of safety aspects in welding are available to the researchers till date, an attempt has been made through this research article to present a holistic overview of the safety aspects in a welding process.
In this research article, following aspects of welding have been considered.

- Hazards in welding.
- Safety Aspects.
- Risk Assessment

This paper will help system designers, industrialists and welding professionals to overcome the issues being faced by the present day welders in a manufacturing environment, thus ensuring greater safety.

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