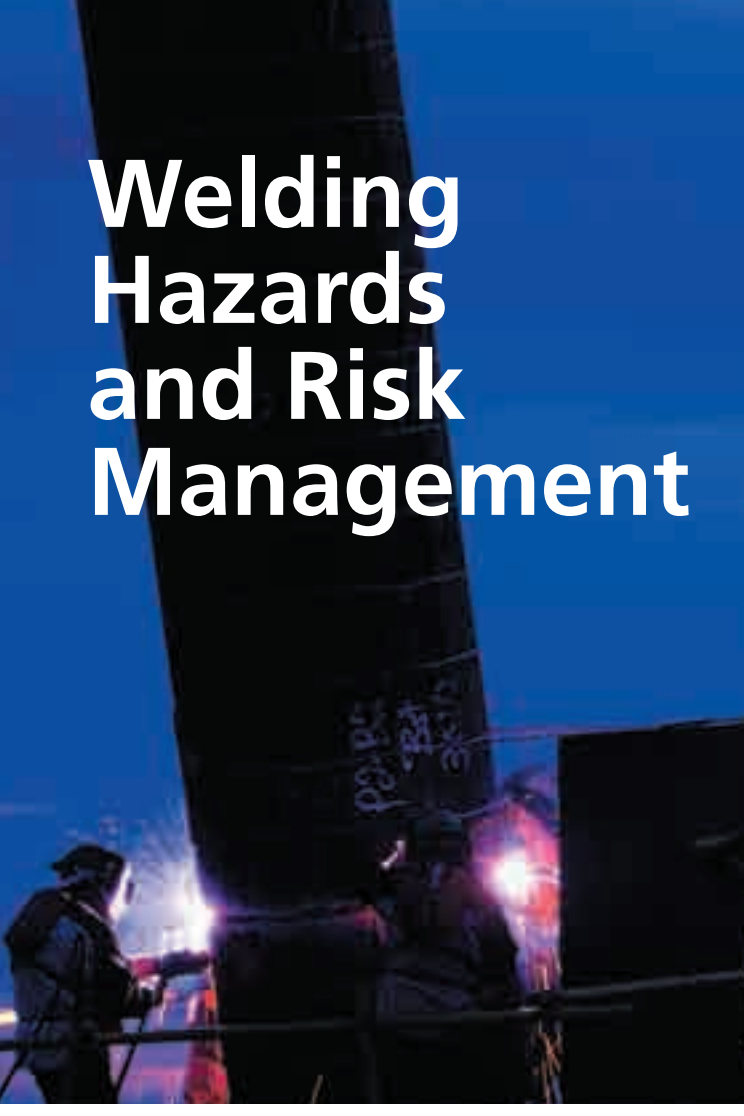


Welding Hazards and Risk Management

BOC

Contents

Overview

Everybody has a responsibility to work safely and not to endanger themselves or any other person at work. Welding, cutting and allied processes present numerous potential occupational hazards to welders and others.

A hazard may be defined as something that has the potential to cause injury or damage to health. The risk of injury or damage to health occurring depends on how hazards are dealt with or controlled.

The main potential welding-related hazards encountered frequently by welders and allied trades include electricity, radiation, heat, flames, fire, explosion, noise, welding fumes, fuel gases, inert gases, gas mixtures and solvents.

Other hazards not directly related to welding and to which welders may be exposed include manual handling, working at height, in confined spaces, or in wet, hot or humid situations, and working with moving plant, equipment, machinery and vehicles.

To work safely, it is essential that hazards are recognized and identified, risk is assessed and control measures are put in place. This forms the basis of risk management.

Basic information regarding hazards is available in the form of product labels, product safety data sheets, material safety data sheets (MSDSs) and technical books and papers dealing with many aspects of safety and the toxicity of industrial materials. Risk assessment involves an estimation of the probability of an incident or exposure occurring and

determining the likely result of such an incident or exposure. Risk control involves deciding what precautions need to be taken and what safety equipment or clothing is required to do the job safely. Training, instruction and supervision also form an essential part of risk management.

There is a considerable amount of legislation related to health and safety at work, and health and safety professionals should ensure they are aware of all the requirements.

Workers' Responsibilities

Let's Start at the Very Beginning…

Safety at Work Is Everybody's Responsibility!

This means that:

- Chief executives, chairpersons, managing directors, company presidents and vice-presidents, etc. are responsible for their own health and safety at work and the health and safety of everyone who works for them.
- Managers, overseers, foremen, team leaders and supervisors, etc., are also responsible for the health and safety of all workers who report to them or work with them, as well as for their own health and safety.
- Workers, welders, fitters, platers, fettlers, machinists, technicians, apprentices and labourers, etc., are responsible for their own health and safety at work and the well-being of all those they work with.

In addition, all employers and employees have a duty of care to visitors, contractors and the general public while at work. Visitors, contractors, sub-contractors and self-employed workers are also responsible for their own health and safety at work and owe the same duty of care to all others.

Employers have a duty to provide information, instruction, training and supervision to ensure health and safety at work. Employees have a duty to take care of their own health and safety and those of others, and must not intentionally or recklessly interfere with or misuse anything provided for health and safety.

These principles are generally embodied in health and safety legislation in the industrialized world and this means that everyone has statutory obligations (legal requirements) under the various ***Health and Safety at Work*** acts in place in the federal and provincial jurisdictions in which they are working.

Companies are generally required to have a health and safety policy that sets out how safety hazards are identified, how risks are assessed and how control measures are implemented and evaluated. All workers should make themselves familiar with the policy pertaining to their place of work and to ensure that they work within its requirements.

Hazard and Risk

In order to work safely in a welding environment, it is necessary to be able to identify hazards and assess risks. To do that, one needs information, education, training and experience in the appropriate field of work. This document is intended to provide information and assist in education and training in hazard awareness and risk assessment.

It is worth explaining here the difference between ***hazard*** and ***risk,*** because the two terms tend to be used indiscriminately without their precise meaning being fully understood – even some dictionaries define ***hazard*** as ***risk***! There is, however, a significant difference in the meanings of the two words.

- A ***hazard*** is something that has the potential to cause harm.
- The ***risk*** is the likelihood that the hazard will actually cause harm under the prevailing conditions.

Some aspects of welding present serious hazards, but the risk depends on how the hazards are dealt with or controlled. The following examples are used to illustrate the point:

Some welding processes emit high volumes of welding fumes and these may be hazardous to health if they are breathed in.

- If a welder keeps his or her head in the fume, a lot of fume will be breathed in, and hence the risk of harm being done may be **high**.
- If the welder tries to keep his or her head out of the fume, fewer fumes will be breathed and the risk may be reduced to **moderate**.
- If the welder uses fume extraction to take the fume away efficiently, the risk may be **low**.
- If the welder uses an approved welding respirator to prevent inhalation of fume, the risk may be **low**.
- If the welder uses fume extraction ***and*** wears a welding respirator, the risk may be very **low**.

These examples should be kept in mind as you read the rest of this document and consider the risk presented by hazards encountered at work.

Health and Safety Information

Basic information regarding hazards presented by products and materials is often needed in order to assess the potential risk to health and safety. Such information is widely available in the form of product labels, MSDSs, technical books and papers dealing with many aspects of safety and the toxicity of industrial materials, etc.

For the welder at work, the most frequently available information is a product label, MSDS or even an internal report summarizing the results of the employer's evaluation of the hazard. These are very important sources of information and they should not be ignored.

In many countries, all welding consumable packaging is required by law to have safety labels. These set out the main hazards presented by the welding process and the consumable.

Additionally, consumable manufacturers and suppliers are able to provide MSDSs that include much more detail, particularly regarding welding fume composition. In some countries, welding consumables are classified according to the amount and the composition of fume they generate, and so the relative hazard of different consumables may be compared. Many companies employ safety managers or occupational hygienists who carry out in-house evaluations of welding hazards and issue reports describing the results and the precautions to be taken when dealing with them.

Welders and others should always read product labels to obtain information regarding the hazards likely to be encountered. If MSDSs are available, these also should be read. Ask questions of health and safety management if you are unsure what some of them mean. Do not start work until you understand the potential hazards associated with what you are doing and the potential risk to yourself or others.

If, for any reason, labels and MSDSs are unavailable, ask (via management where appropriate) the manufacturer or supplier for hazard information and advice on risk management. They should be able to help.

The "Hazard Awareness and Risk Assessment" section takes you through various aspects and hazards of the welding environment to highlight how hazards can be recognized and how assessment of potential risk may be made.

Figure 1
Example of material safety data sheet (MSDS)

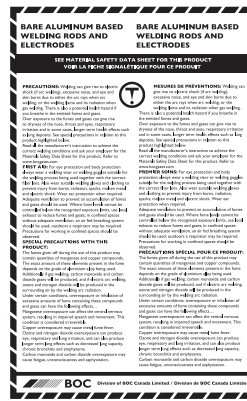


Figure 2
Example of welding consumable safety label

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 labelling of containers of WHMIS "controlled products" and the provision of MSDSs. You can download MSDSs at www.boccanada.com.

CAUTION

DO NOT USE CYLINDER COLOUR ALONE TO IDENTIFY GAS CONTENTS; ALWAYS IDENTIFY CONTENTS BY CYLINDER LABELLING

The colour of paint on the cylinders is used by most manufacturers to aid easy recognition of the service in which these cylinders are usually used. Colour coding should never be used as the means of identifying the gas content in a cylinder. A particular gas may have as many as three (3) different colours on the cylinder depending upon the gas manufacturer or private owner of the cylinder. In addition, dirt, grime, foreign matter and the infinite number of paint shades make positive identification by colour alone impossible. The contents of a cylinder should always be identified by legible labels (TDG, WHMIS) attached by the supplier. The fill pressure should be determined by the DOT/TC rating stamped on the cylinder, with due allowance for 10 per cent overfilling where applicable.

WHMIS Symbols

Class A –
Compressed gas

Class B –
Combustible and
flammable material

Class C –
Oxidizing material

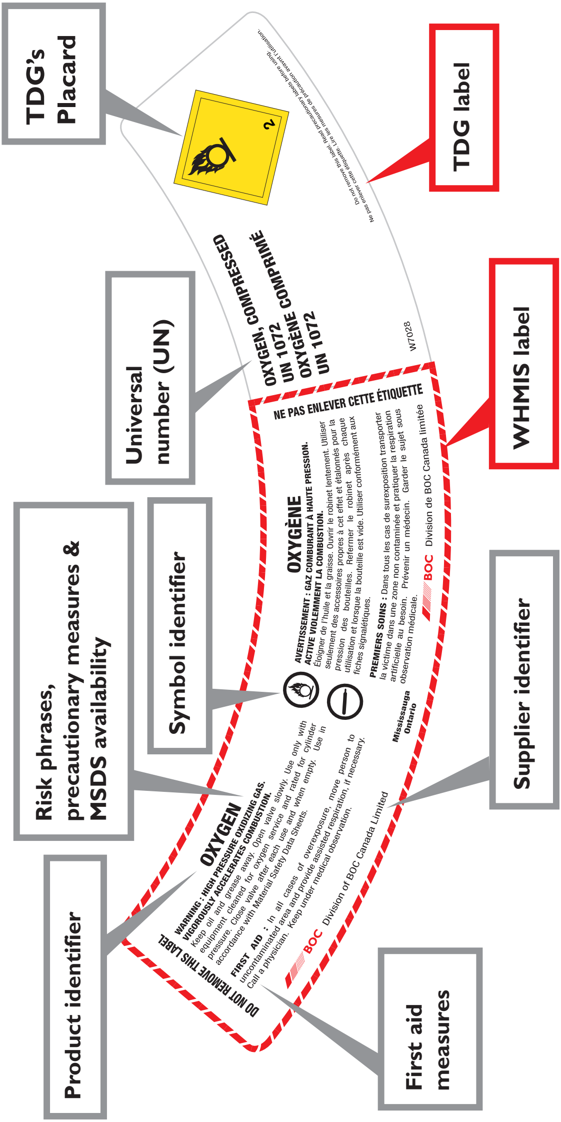
Class D, Division 1 –
Poisonous and infectious material:
immediate and serious toxic effects

Class D, Division 2 –
Poisonous and infectious material:
other toxic effects

Class D, Division 3 –
Poisonous and infectious material:
biohazardous infectious material

Class E –
Corrosive material

Class F –
Dangerously
reactive material



Components of WHMIS and TDG Labels

Hazard Awareness and Risk Assessment

Potential Hazards

Welders and others need to be aware of all the potential hazards and the sources of injury or damage to health they are likely to encounter while at work. They may be exposed to numerous hazards associated with welding and cutting processes. These include:

- ***Physical hazards***: electricity, radiation, heat, flames, fire, explosion, noise and magnetic fields.
- ***Chemical hazards***: welding fumes, fuel gases, inert gases, gas mixtures and solvents.
- ***General safety hazards***: hazards not directly associated with welding or cutting that are also present in the workplace and to which welders and others may be exposed. These include moving machinery, falling objects, forklift trucks, mobile cranes, overhead cranes, site transport and hazards presented during manual handling of gas cylinders, tools, materials, equipment and consumables.

The effects that hazards have on the body may be described as "acute" or "chronic," and here the terms acute and chronic do not refer to the severity of the effect but to how long it takes to become apparent.

- An "acute" effect is one that occurs or manifests itself quickly, such as a burn caused by contact with hot metal.
- A "chronic" effect is one that takes time to develop, such as impairment or loss of hearing due to long-term exposure to noise.

Many hazards are fairly easy to recognize and to be aware of, but others, particularly some of the chemical hazards, are not. For example, most gases, including Air (Oxygen and Nitrogen), are colourless and have no smell, and so a tank full of inert gas, also colourless and odourless, would seem no different to a tank filled with normal Air. However, someone entering the tank full of inert gas would probably be killed by asphyxiation.

More details regarding hazards can be found in documents pertaining to the various hazards, and it is recommended that these be consulted if you are unsure or require further information.

Risk Assessment

Before work commences, an assessment of the risks presented by the potential hazards of the job should be carried out. This sounds very formal, and indeed formal risk assessments are normally made by competent and suitably qualified personnel in many working environments, ranging from factories, building sites and demolition sites, to schools, hospitals, shops and even offices. These assessments are then used to manage the risk and to implement health and safety measures to allow work to be carried out as safely as possible. In these situations, welders and associated workers should be provided with the necessary information, safety equipment and a safe method of working before they start a job.

However, it is not always the case that risk assessments have already been carried out and it is then up to welders to assess their own risk. A simple risk assessment can be done informally by welders and others applying experience, job knowledge, training and education – and common sense – to identify the risks presented by potential hazards in the job they are about to do.

Armed with basic health and safety information and an understanding of the requirements of the proposed welding activity, the welder can make a mental evaluation of the potential dangers associated with the job. 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.

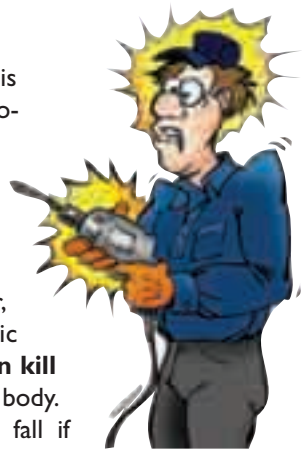
- Is the probability of an incident or exposure occurring low, moderate or high?
- In the event of such an incident or exposure, will the result be severe, moderate or mild?

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. The following sections are intended to highlight the main things to look for as you assess the potential hazards and the risks associated with certain aspects of a welding activity.

When assessing risks it should be kept in mind that working at height, in confined spaces, in cramped conditions or in humid or wet conditions can significantly increase the risk of harm from many of the potential hazards.

Electricity

Potential Hazards



The main electrical hazard is electric shock or electrocution. Touching "live" electrical equipment or components, including the electrode and the workpiece, can result in serious burn injury or, more seriously, electric shock. **Electric shock can kill** by direct action on the body. It can also cause you to fall if working at height.

Electricity can cause burns if sufficient current and voltage passes through the body. While the actual surface size of the burn may be small, deep tissue damage may have occurred. High voltage machinery and cables are particularly dangerous sources.

Electrical hazards are frequently not obvious and caution is essential when working with electric welding processes, equipment and machinery.

Risk Assessment

Assessment of the potential risk of an electrical incident is not always easy and the welder must take into account the welding process, the state of the equipment to be used, where it is to be used and the likelihood of contact with live components.

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

1. Gather information on the welding equipment to be used. Consult equipment labels and instruction manuals for electrical rating, duty cycles and capabilities.
2. Ascertain if equipment has been properly installed by qualified electricians and maintained in good condition.
3. Examine and inspect power switches, equipment, terminals, connections, cables, inter-connectors and insulation for condition and current-carrying capacity.
4. Examine the working area to check for potentially live structures or components and wet areas.

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.

Risk Assessment Guidance

- Welding power sources should be of correct rating and duty cycle for the job; they should be properly installed by qualified electricians and maintained in good condition. If the equipment meets these criteria, then the risk of an electrical incident should be low. The potential risk increases if the equipment does not meet all the criteria. If equipment is faulty or badly damaged, you may consider the risk too high.

- Welding equipment should have all side panels in place and secured; all terminals, connections and live components should be properly protected. If this is the case, then there should be a low risk of making accidental contact with live components. If panels are missing or live components are exposed, then there is a high risk of electric shock by contact with an exposed live component. In this case, until the faults are rectified, you may consider the risk too high.
- The current-carrying capacity of cables, inter-connectors, terminals, etc., should be high enough to carry the maximum operating current. If they are not of sufficient capacity, then they may overheat, giving an increased risk of burns or starting a fire.
- There should be a separate earthing conductor, unless the equipment requires only a welding return cable. Lack of an earthing conductor can give an increased risk of electric shock.
- All welding cables, electrode holders, welding torches and guns, wire feed units, etc., should be in good condition and properly insulated. Any piece of equipment that is damaged or unsafe gives a potentially high risk of electric shock and should not be used until it is repaired and made safe.
- There should be an easily accessible means of switching off the welding power source at the mains, in the event of an emergency. If there is no means of switching it off and a fault occurs, it may not be possible to isolate an electrical problem, giving an increased risk of electric shock, burn or fire.

- Working in wet, damp or humid conditions increases the risk of electric shock, as moisture increases the electrical conductivity of the body.
- Working in a confined space gives an increased risk of electric shock as conditions are cramped and often damp or humid, and contact with equipment may be unavoidable.
- Working on a fabrication that constitutes part of the electric circuit (as in shipbuilding) gives a potentially high risk of electric shock, since an electrical fault could result in the fabrication becoming "live."

Risk Control Measures

- 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.
- 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.
- Fully insulated electrode holders are also available, to reduce the risk of electric shock.
- 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.

Radiation

Potential Hazards

Welding and cutting arcs produce electromagnetic radiation. The type of radiation produced by electric arc and fuel gas processes is known as "non-ionizing" radiation. Electric arc and laser welding emit ultra-violet (UV), visible light and infrared (IR). Gas welding and gas cutting emit visible light and IR radiation. The potential effect of radiation on the body depends on the type and intensity of radiation, the distance you are from it and the duration of exposure.

Non-ionizing radiation from welding can cause damage to skin and eyes. UV radiation can cause burns to unprotected skin and eyes (arc-eye).

Electron beam welding emits X-rays. Exposure to X-rays can cause serious damage to body tissues, including skin damage, cancer, leukemia and reduced fertility; it can also lead to premature death.

Thorium oxide, used in thoriated tungsten electrodes for TIG welding, is radioactive. In welding, it presents a minor hazard and only if dust particles are ingested or inhaled.

Radiation from electric welding arcs and gas flames is usually apparent, but arc flashes can occur without warning. The effects of IR and UV radiation are not normally felt until some time after exposure. Radiation from lasers is less obvious than from electric welding arcs, and from electron beam processes can be not obvious at all, but both are serious hazards.

Risk Assessment

All welding processes produce radiation of some kind and so the risk of exposure is always present. To assess the potential risk from radiation, the welder must take into account the welding process being used, where it is being used, the protective equipment and clothing being used and who else is in the vicinity.

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

1. Gather information on the welding process to be used. Consult welding process health sheets and MSDSs for what type of radiation is emitted during use.
2. An assessment of the type and intensity of the radiation may be made from the guidance below, and appropriate risk controls can then be applied.
3. The welder should also assess the risk of exposure to radiation from other welding or cutting activities in the vicinity.

Risk Assessment Guidance

- In terms of type of radiation, gas welding and cutting processes emit IR and visible radiation, but do not emit UV; electric arc and laser welding and cutting processes emit radiation; electron beam welding processes emit X-rays.
- Welding processes (electric arc) that produce high intensity UV radiation give greater risk of burns to skin and arc-eyes. In general, MIG welding, FCAW, MCAW and electro-gas welding present the

highest risk, particularly at high current levels. MMA, TIG and plasma welding present a slightly lower risk but at high currents can also present high risk. SAW and electro-slag welding present a low risk when operated properly. Resistance welding and friction welding processes present very low risk from radiation.

- Electric arc cutting processes present a high risk of burns due to the relatively high current levels used.
- Fuel gas welding and cutting processes do not emit UV and so present no risk of burns from UV radiation; they instead present risk of thermal burns to skin and eyes.
- Welding helmets or hand screens for electric arc welding processes should be appropriate for the process and the job, and be in good condition. If good appropriate equipment is available and used properly, then the risk of burns to welders' faces or eyes should be low. Use of unsuitable or defective equipment and clothing increases the risk of radiation burns to the skin or eyes.

Figure 3
"Reactor light" type welding helmet

- Filter glasses or screens must be of the correct shade for the welding process and welding current. An auto-darkening welding screen must darken to an appropriate shade and be fail-safe. Using a filter shade that is too light gives an increased risk of arc-eye or eyestrain. An auto-darkening screen failing "light" gives a high risk of arc-eye from UV radiation. A filter shade that is too dark, while protecting against radiation hazards, is likely to increase the risk of eyestrain.
- Gas welding goggles or screens must have a filter shade that is suitable for the process and flame intensity. Using a filter shade that is too light gives an increased risk of glare and eyestrain.
- Protective clothing must be in good condition to ensure no areas of skin are left exposed to arc rays. Using correct protective clothing, in good condition, gives a low risk of burns to the skin due to radiation. Using inadequate protective clothing or not using some items of protective clothing gives a high risk of burns to the areas of unprotected skin.
- A welder working alone should have a low risk of exposure to arc radiation, but working in close proximity to other welders increases the risk of accidental exposure to arc radiation. Such exposures may result in arc-eye or serious skin burns, particularly to the back of the neck and ears.
- Electric arc welding inside a vessel increases the risk of exposure to arc radiation, particularly if the inside surfaces are highly reflective. UV radiation can reflect and result in arc-eye or burns to exposed areas of skin.

Risk Control Measures

- Protective equipment and clothing for the face, head, hands, arms and body are the normal risk control measures used to reduce exposure to radiation of the welder and others in the immediate vicinity of the process being used.
- Welding screens (physical barriers) are the most common risk control measures to reduce exposure to radiation for other personnel (passers-by, etc.) who are not directly involved with the welding process. Welding bays and fabrication areas should be screened off to contain radiation from electric arc welding within the immediate welding area. Suitable screens, whether opaque or transparent, when properly positioned, reduce the risk of exposure to radiation of other personnel. If screens are not in use, the risk of others in the vicinity being subjected to "arc flash" and radiation is increased.
- Electron beam welding equipment must be suitably protected to prevent the escape of X-rays. Welders must make themselves familiar with operational safety procedures to reduce the risk of exposure of themselves and others to X-rays from such equipment.

Heat, Flames, Fire and Explosion

Potential hazards

are faced by welders every working day, since welding is a process that frequently involves heat, flames, molten metal and high-temperature welding arcs. The source of the hazard may be arc rays, gas flames, lasers, consumables or hot metal, whether this is a welded component or part of the welding equipment, like the nozzle on a MIG gun. Burns may range from superficial "first degree burns" to deep and severe "third degree burns." Burns may occur to the skin or, potentially very seriously, to the eyes.

Fire and explosion are serious hazards in the welding environment. Heat and flames can result in fire or even explosion in the presence of combustible materials, dust, flammable liquids, gases or vapours.

Working in a hot environment can also cause the body to overheat. This is known as heat stress. It can happen when a sufficient amount of fluid is not consumed to replace that lost by sweating. In the extreme, heatstroke may occur and this condition can be fatal.

Heat may be felt readily, but hot metal appears the same as cold metal, unless it is red hot or white hot. Thus, the burn hazard may not be obvious. Flames are

usually obvious (the exception being a Hydrogen flame, which is invisible). An explosion hazard is often not apparent and usually occurs without warning. Heat exhaustion can creep up slowly over a period of time without the worker being aware of it and can thus be very dangerous.

Risk Assessment

Many welding processes involve heat (electric arc or flames) and a risk assessment should take account of the welding process, where it is being used and the safety equipment and clothing available.

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

1. Observe the welding area to ascertain whether there are sources of heat, naked flames, electric arcs, flammable liquids or combustible materials in the vicinity.
2. Gather information regarding any liquids or materials in the vicinity. Consult MSDSs for fire and explosion data on the substances.
3. Identify other potential sources of flammable vapours or explosive dusts remote from the welding area.
4. Identify location of fire fighting equipment and escape routes.
5. If conditions are hot and humid, an assessment should take account of how long welding is to be carried out and when breaks may be taken.

Risk Assessment Guidance

- Fabrications or plates in the welding area are likely to be hot. Unmarked hot metal in a welding area gives a high risk of serious burn injury. The risk of accidental burn injury is reduced if hot plates and welded components are marked "hot."
- Welding guns and torches, electrode holders and electrode stubs, etc., in the welding area are likely to be hot. Hot welding equipment and consumables in a welding area give a high risk of burn injury. Handling hot items without suitable gloves gives a high risk of burns.
- Flammable liquids, substances and vapours must be absent from the welding environment. If the immediate area is free from flammable materials there should be a low risk of fire or explosion. Flammable substances in the vicinity give a high risk of fire or explosion. Removing all flammable materials reduces the risk. Flammable vapours may drift in from other areas and the risk may be difficult to determine.
- Gases, such as Acetylene, Propane and Hydrogen, in the welding area also present a fire and explosion hazard. It may be necessary for cylinders of such gases to be in the area. Checking for and sealing leaks and ensuring all connections are sound will reduce the risk.
- Readily combustible materials like paper and cardboard should not be present in the welding area. If there are no such materials in the immediate vicinity, then there should be low risk of fire, but welding in the presence of combustibles gives a high risk of fire. Clearing the area of combustible materials before welding starts reduces the risk of fire.

- Welding in a confined space increases the risk of burns due to contact with hot metal or equipment. It may also increase the risk of heat stress and particularly so if work is carried out in a pre-heated vessel.

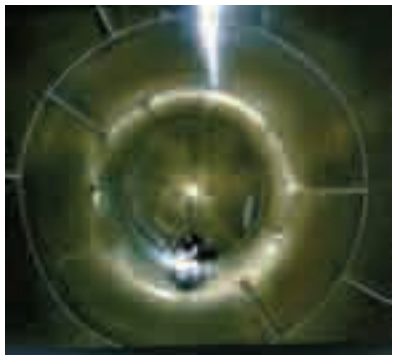


Figure 4
Welder TIG welding within a stainless steel vessel

- Protective clothing must be in good condition to ensure no areas of skin are left exposed to heat, arcs or flames. Using correct protective clothing in good condition gives a low risk of burns, as skin is protected. Using inadequate protective clothing or not using some items of protective clothing gives a high risk of burns to unprotected skin.

Risk Control Measures

- Normally protective clothing is the main control measure used to reduce the risk of burns due to hot metal, welding arcs and welding flames. Hot metal items should be marked "hot" and checked that they are cool before handling, even if wearing gloves.
- Elimination of all flammable substances and unnecessary combustible materials from the welding area is the usual control measure to reduce risk of fire and explosion during welding.
- Fire fighting equipment must be readily available. Fire extinguishers allow small fires to be tackled but a lack of fire fighting equipment increases the risk of a small fire growing and getting out of hand; by having such equipment on hand, a company follows the fire prevention safety requirement for a fire watch person.
- If welding is to be carried out in or on tanks or vessels that have contained flammable substances, they must be purged to remove all traces of anything flammable or explosive. The vessel or tank must be given written clearance (permit to work) for work to proceed. Welding on such a vessel without clearance potentially gives a very high risk of fire or explosion.
- A strict regime of welding followed by set periods of rest is the normal control measure used to reduce the risk of heat stress and heat exhaustion. The duration of the work and rest period depends on the ambient temperature, the nature of the work (light, moderate or heavy) and the type of clothing that has to be worn. Intake of liquid is essential to offset the fluid loss that can result in dehydration.

Noise

Potential Hazards

Noise is an everyday occurrence and an industrial workshop can be a very noisy place. All welding and cutting processes generate noise but some are much noisier than others and some generate noise of a higher frequency.

Ancillary processes like grinding, chipping, gouging and hammering also generate varying levels of noise; associated practices, such as crane operation and forklift truck operation, also generate noise.

Exposure to noise over a period of time can result in impairment or loss of hearing. In traditional boiler shops where continuous riveting and hammering took place every day, hearing loss was commonplace and many platers and others became deaf after years of exposure to the noise.

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 overlooked.

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:

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 Assessment Guidance

- Metal fabrication areas are generally noisy places. Wearing ear protection reduces the risk of exposure to noise and damage to hearing. Not using ear protection increases the risk that hearing will be impaired over a period of time.

- Processes that are often very noisy include plasma cutting and air arc gouging. Pulsed MIG welding may give off noise at a high frequency. Using these processes gives an increased risk of exposure to noise compared to most other processes. Using suitable ear protection reduces the risk of exposure.
- Working inside a metallic fabrication, such as a ship or pressure vessel, can increase the risk of exposure to noise due to other workers hammering, grinding, etc., on the fabrication but at a distance from the welding area. Using suitable ear protection reduces the risk of exposure.

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 sound-proof 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.

Magnetic Fields

Potential Hazards

Anything that is powered by electricity, when it is operating and current is flowing, is a source of a magnetic field. In industry, all electrical equipment – including arc and resistance welding machines and leads, induction furnaces, electric cranes, even photo-copiers, word processors and VDUs – are sources of very small magnetic fields.

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.

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:

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 Assessment Guidance

- People fitted with a pacemaker run a high risk of heart problems when visiting welding areas, but they can reduce or eliminate the risk by staying well away from welding power sources and cables.
- Welders fitted with pacemakers run a high risk of problems, particularly if they wrap current-carrying welding cables around their body or work close to electric welding power sources.

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.

Welding and Cutting Fumes

Potential Hazards

All welding processes generate welding fume but some produce very little fume while others produce considerable amounts. Welding fume consists of particulate fume, the cloud of smoke you can see rising, and gaseous fume that you cannot see but can sometimes smell. In most cases, welding fume is formed close to the arc, near the welder, but some of the gaseous fume (ozone) can be generated well away from the arc.

The potential effect on the body of exposure to welding or cutting fume depends mainly on the amount of fume produced, what is in it and the length of time the worker is exposed to the fume. Any effect may be increased by a particular susceptibility that the welder or other worker may have (e.g., asthma).

While all components of welding or cutting fume may present a risk to health, given a high enough concentration, some present a greater hazard than others. Those of the more commonly encountered pollutants thought to carry the highest risk factors include ozone, chromium particularly in its hexavalent state (Cr^{6+}), nickel (potential carcinogens), cadmium and lead.

The health effects of exposure to fume can include irritation of the upper respiratory tract (nose and throat), tightness in the chest, wheezing, metal fume fever, lung damage, bronchitis, pneumonia or emphysema.

Particulate welding fume is usually fairly easy to see, but gaseous fume is invisible.

Sampling and analysis is the only way to detect what is in the fume and how much is in the welder's breathing zone. Therefore, the precise hazard of exposure to welding fume is not usually apparent.

Risk Assessment

The assessment of risk of damage to health from welding fume is not easy. It is easier to assess the risk of inhaling welding fume and this, to a large extent, depends on how the welder carries out the task. When assessing the risk, the following aspects must be taken into account: welding process, the consumables, the welding conditions, the area where the welding is taking place, how long it takes and the fume control equipment available.

These factors influence how much fume is produced by the welding process/consumables, what the fume contains, how much fume the welder breathes in and how long the welder is exposed to the fume.

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

1. Gather information on the welding process and consumable used. Consult the MSDS for what is in the consumable and what fume is produced during welding.
2. An estimate of fume exposure being acceptable or excessive may be able to be made from the guidance below and appropriate risk controls can then be applied. Where this is not possible, fume exposure measurements will need to be taken.
3. By examining the fume data for the consumable, it should be possible to determine if total fume or specific metal fume measurements are required.
4. The fume exposure levels can then be compared to the respective exposure limits for welding fume or individual metallic elements to determine the risk to health.

Risk Assessment Guidance

- Welding processes that produce high volumes of particulate fume give greater risk of inhalation of fume. FCAW and MCAW tend to produce high fume levels and so present a high risk; MMA and MIG welding at high currents can also present high risk. TIG, SAW and oxy-fuel gas welding tend to give low fume levels and so present lower risk of fume inhalation.
- Cutting processes that produce high volumes of particulate fume also give greater risk of inhalation of fume. Plasma cutting, air arc gouging and MMA gouging tend to give high volumes of fume and so present a high risk. Oxy-fuel gas cutting tends to give low fume levels and so presents lower risk.
- Welding and cutting processes that produce high volumes of gaseous fume give greater risk of inhalation. MIG (in Argon-rich gas) and TIG at high currents can give high volumes of ozone and so present a high risk of inhalation. Plasma cutting can give high volumes of Nitrogen Oxides and so present a high risk of inhalation.
- Consumables that generate fume containing chromium, nickel, zinc, manganese, barium or fluorides give a potentially higher risk of health damage. Consumable data sheets give guidance on fume composition and these are constituents to look out for during the risk assessment.
- Generally, as welding current or power increases, so the fume generation rate increases. The more fume there is, the higher the risk of inhalation.

- Where the welding takes place has a significant influence on risk of inhalation of fume and this should be carefully considered. Welding outside carries a low risk factor, welding in a large workshop increases the risk factor, welding in a small workshop further increases the risk factor and welding in a confined space can greatly increase the risk factor.
- The amount of welding fume inhaled is also influenced by how long welding is carried out. As the accumulated duration of welding increases, not just on one day but over many years, so the risk of inhaling a lot of fume increases. The effects of inhaling welding fume may take a long time – years maybe – to show and this must be considered during the risk assessment.

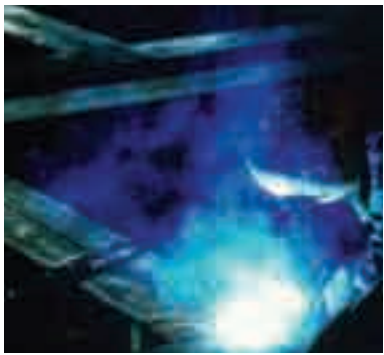


Figure 5
MMA welding can produce large amounts of particulate fume

Risk Control Measures

Control measures should be aimed at keeping the particulate and gaseous fume levels as low as possible. Methods that can be used include:

- Ensuring adequate ventilation and/or local fume extraction is provided.
- Where extraction and ventilation is not sufficient to reduce fume levels to those required, the use of personal respiratory protective equipment such as respirators, air-fed helmets, welding hoods, etc., should be considered.
- Train the welder to use welding conditions that produce lower fume levels and to use good posture to keep his or her head out of the fume plume.

Fuel Gases

Potential Hazards

Hydrogen, Acetylene, Propane, Propylene and Methylacetylene-Propadiene (MAPD) are all fuel gases.

Fuel gases are flammable (obviously) and they also form explosive mixtures with Air or Oxygen, with the amounts needed differing for each gas. Acetylene also forms explosive compounds with copper, silver and mercury.

Hydrogen and Acetylene are lighter than Air and will tend to accumulate at the top of a confined space, whereas Propane, Propylene and MAPD are heavier than Air and will tend to accumulate in low-lying areas, presenting a potential explosion hazard.

Acetylene, Propane, Propylene and MAPD gases each have a distinctive smell and so are readily detected. Hydrogen gas is odourless and when ignited has a virtually invisible flame, and is therefore difficult to detect and presents a serious explosion, fire or burn hazard.

When using oxy-fuel gas processes, a flashback, due to Oxygen and fuel gas mixing in the fuel gas supply line and igniting, can be very hazardous. In a flashback, the flame and associated pressure wave travel extremely quickly back towards the fuel gas cylinder and can result in the cylinder exploding.

Oxygen is vital to life and is all around us, and so the tendency is to think of it as being harmless. Nothing could be more untrue. The following outlines the hazards of working with Oxygen.

- **Oxygen is NOT compressed Air** – Do NOT refer to it or use it as compressed Air. Oxygen is not flammable, but even materials that do not burn in Air usually burn in Oxygen. Those that burn slowly in Air can ignite easily and burn violently in an Oxygen-enriched atmosphere.

- **Never use Oxygen to ventilate confined spaces** – Use Air to replace atmospheric Oxygen consumed by welding or cutting.

- **Leaks** should be avoided, particularly in confined spaces.

- **Oxygen-enriched (over 23 per cent) or Oxygen-depleted (under 19 per cent) atmospheres** should be avoided. Do NOT work in or create such hazardous conditions.

- **Oxygen-saturated clothes** – It is dangerous to clean clothing with an Oxygen stream or hang clothing on Oxygen cylinders. Clothing saturated with Oxygen will burn intensely when ignited. Should clothing become permeated, do not weld, cut, light a cigarette, or start any kind of spark or flame for at least 20 minutes after welding, or until clothing is aired.

- **Grease, oil and oil-bearing materials** – Greasy gloves and rags, and other combustibles that can readily ignite in the presence of Oxygen, must be kept away from any Oxygen equipment.

- **Oxygen equipment** should not be contaminated by use in any other service. If equipment is used for any other service, do not use it again for Oxygen.

- **Never use Oxygen** as a substitute for Air in air-driven tools, in oil preheating burners, to start an internal combustion engine, to blow out pipelines, or to build pressure (as in a container).

- **Cylinder storage** – Keep Oxygen cylinders at least 20 feet from fuel gas cylinders or other readily combustible materials – particularly grease or oil (or separated by a five-foot, non-combustible barrier having a fire resistance rating of at least half an hour).

- **Never attempt to clean an Oxygen gauge that has been contaminated with oil** – Replace it with a new oil-free gauge.

- **When liquid Oxygen** is used, cylinders must be transported, stored and used in an upright position, to maintain the gaseous state for safety devices and to prevent liquid from reaching the regulator.

Risk Assessment

The assessment of risk when using fuel gases should take into account how they are being used, where they are being used and the safety measures in place.

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

1. Gather information and identify fuel gases 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 fuel gas systems.
3. Examine gas cylinders and gas lines for flashback arrestors.
4. If Acetylene gas is involved, check what material has been used for joining gas lines.

Risk Assessment Guidance

- When using fuel gases with Oxygen for welding or cutting, there is always a risk of a flashback. If correct lighting up and shutting down procedures are used, this reduces the risk. Using incorrect lighting up or shutting down procedures may present a high risk.

Figure 6
Badly maintained hoses will eventually fail

- A flashback gives a very high risk of the cylinder exploding. Flashback arrestors fitted to oxy-fuel gas lines greatly reduce the risk of a flashback causing a serious fire or explosion incident. Working without a flashback arrestor in the system greatly increases the risk of a serious incident.
- Welding and cutting equipment for use with fuel gases must be of high quality, in good condition and well maintained to keep the risk as low as possible. Using sub-standard equipment or equipment in a poor state of repair increases the risk of a flashback or other fire hazard.
- Acetylene cylinders laid horizontally give a high risk of leaking and a high risk of fire or explosion.
- Fuel gases, used in confined spaces, give a high risk of gas collecting in pockets with a high risk of fire or explosion. They also present a high risk of asphyxiation due to displaced Air.
- "Snifting" of Hydrogen cylinders must not be carried out. It gives a very high risk of the Hydrogen gas igniting spontaneously. Hydrogen flames are virtually invisible and so the risk of burns, fire and explosion are very high.
- Acetylene lines should not be connected using copper pipes or fittings. Lines connected in this way present a high risk of explosion during use.
- Leak detection of fuel gas cylinders must be carried out using soap solutions or proprietary products. This gives no risk of ignition of the gas. Looking for leaks with naked flames gives a very high risk of fire or explosion when the gas ignites.

Risk Control Measures

- Fitting of good quality flashback arrestors, hose check valves and regulators are the main control measures used to reduce risks from flashbacks when using fuel gases.
- Use of additional protective and air-monitoring equipment are control measures used to reduce risk when working with fuel gases in a confined space.
- For the operators, using correct lighting up and shutting down procedures reduces the risk of an accidental flashback occurring.
- Correct storage, transportation and use of fuel gases, use of appropriate materials to join fuel lines and adoption of correct leak detection techniques are measures that will reduce risk of incidents with fuel gases.

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.

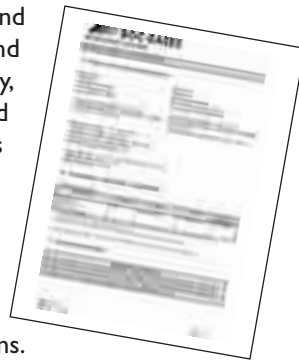
Compressed gases in cylinders are stored at pressures of up to 300 bar. For safe use, this is reduced to the working pressure by a regulator. However, a sudden release of gas at high pressure can cause serious physical injury.

Inert gases are non-reactive, have no odour 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 Assessment Guidance

- In confined spaces with poor ventilation, inert gas can build up and concentrate, displacing Oxygen and giving a potentially high risk of asphyxiation. Using forced ventilation and supplying fresh Air into the area lowers the risk. Using air-fed breathing apparatus also lowers the risk.

- Gas mixtures with high proportions of inert gas or other gases that do not support life present a similar risk of asphyxiation as inert gases if used in confined spaces.
- Inert gases and gas mixtures stored in cylinders give a high risk of physical injury when the cylinder is "snifted" and high-pressure gas is released suddenly.
- Correct regulators, in good condition and used properly, give a low risk of accidental release of gas at high pressure. The use of modified, incorrect, poorly maintained or damaged regulators gives a potentially high risk of injury due to release of gas at high pressure.
- Free-standing gas cylinders present a high risk of serious injury if they fall or are knocked over. Properly securing cylinders during storage, transportation and use eliminates these risks.

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.

Solvents

Potential Hazards

Solvents used in the welding industry may be flammable, contain constituents that are flammable or be non-flammable. The most frequently encountered flammable solvents are acetone, petroleum, ether and white spirits. The most frequently encountered non-flammable solvents are chlorinated hydrocarbon degreasing agents such as trichloroethylene and 1-1-1 trichloroethane.

Some solvents break down under the action of the welding arc to form toxic or irritant by-products, the most toxic breakdown product being phosgene.

Flammable solvents present a fire or explosion hazard in the vicinity of welding arcs and flames, and hot metal and components.

Exposure to solvent vapour, or to breakdown by-products, may have acute effects or chronic effects, depending on the solvent, the concentration and the length of time of exposure.

Most industrial solvents have distinctive smells and can be detected by these. Breakdown products may also have recognizable smells or effects on the nose and throat, making them easy to detect, too.

Risk Assessment

Solvents and solvent vapours in welding areas always present a risk of fire, explosion or formation of toxic by-products. In most cases, the following steps will be necessary to carry out a risk assessment:

1. Gather information and identify the solvents being used and whether they are in the immediate vicinity. Consult MSDSs for the properties and potential hazards of each solvent.
2. Identify solvents being used remote from the immediate vicinity (in degreasing tanks, for example), to assess if they pose a risk.
3. Identify other materials that may contain solvent. Consult MSDSs for the properties and potential hazards of each material.

Risk Assessment Guidance

- Flammable solvents left in the welding area during welding give a high risk of fire or explosion. Returning containers of solvents to storage after being used to clean components in a welding area significantly reduces the risk of fire or explosion.
- Welding in the presence of vapours from chlorinated hydrocarbon degreasing solvents gives a high risk of exposure to breakdown by-products like phosgene. This in turn gives a high risk of damage to health.
- The siting of vapour degreasing plants close to welding areas significantly increases the risk of welders being exposed to breakdown by-products during welding.
- Use of cold chlorinated hydrocarbon degreasers in welding areas gives a high risk of exposure to breakdown by-products during welding. Banning such use eliminates the risk.
- Use of solvents gives a high risk of exposure to vapours that may be toxic, irritant, narcotic or intoxicating. The risk will be increased if used in confined spaces, and here they may also cause asphyxiation. The risk of fire or explosion with flammable solvents will also be increased when used in a confined space.

Risk Control Measures

- Storing flammable solvents well away from welding areas is an important control measure in reducing the risk of fire or explosion from heat and flames from welding.
- Siting of vapour degreasing plants well away from welding activity is a control measure that greatly reduces the risk of exposure to breakdown by-products.
- Allowing all traces of solvents and solvent vapours to disappear from material surfaces before welding greatly reduces the risk of fire and exposure to breakdown by-products.
- For the operator, use of suitable respiratory protection will reduce the risk of inhalation of solvent vapours.

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. These include hazards when manually handling equipment, consumables and tools, etc., and physical and mechanical hazards in the workplace.

Manual handling can present a hazard during lifting, lowering, 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.

There are also hazards due to falling objects from work taking place at height. Other general sources of hazard on industrial premises include forklift trucks, mobile cranes, overhead cranes, moving machinery, site transport, delivery vehicles and so forth.

General safety hazards and hazards encountered during manual handling are usually easy to recognize with some training, plus a little thought and common sense.

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:

1. 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.
2. Ascertain what equipment is available for lifting, moving, carrying and supporting, etc., materials and plant.
3. 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.

Risk Assessment Guidance

- Moving, lifting, carrying, etc., presents a high risk of injury if the things moved are heavy, large or awkward, or not lifted, carried or moved properly. Using specialized or dedicated lifting equipment and systems reduces the risk of injury. If proper training in correct manual handling is undertaken, the risk of injury due to lifting or carrying, etc., should be reduced.
- Untidy work areas, obstructed walkways, welding cables trailed along the floor or over fabrications, discarded items of equipment or consumable packaging, etc., all present high risk of falls, trips, slips, collisions, etc., resulting in physical injury. Maintaining tidy work areas and removing obstructions and discarded items greatly reduces the risk of injury.
- Work taking place above the area in which welding is taking place presents a high risk of being hit by a falling object and a potentially serious injury. Using physical barriers to prevent objects from falling will reduce the risk. Suspending work while welding takes place will eliminate the risk altogether, but may not be practical.
- Moving cranes and vehicles present a high risk of accidental collision and potential serious injury. If visible and audible warning systems are used, this

reduces the risk of people being unaware of the movement of vehicles and cranes. If fully trained and competent drivers and operators are used, this will also reduce the risk of incident.

- If working at height or on staging, there is a potential risk of falling. Working with guardrails in place, wearing safety harnesses attached to an approved device and keeping walkways and staging clear of obstructions all help to reduce risk.

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.
- Posting warning notices on sites and workshops where moving vehicles are in use alerts workers to potential hazards. Using visible and audible warning systems whenever vehicles and cranes are moving is a control measure to reduce the risk 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.

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, as outlined below:

- ***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 and manage risk.

Hazard Awareness

It is important that all sources of injury or damage to health in the welding environment are identified and recognized. Guidance on some of the more frequently encountered hazards in welding is given in the previous section.

Potential hazards in specific situations may be identified in a number of different ways, including:

- General observation of the work area.
- Examination or inspection of machinery, equipment, tools, etc.
- Reading of product labels, MSDSs, manufacturers' instruction manuals, etc.
- Talking to safety managers, safety officers or safety representatives.
- Talking to manufacturers, suppliers, industry associations, health and safety specialists, academic bodies, etc.
- Reading health and safety survey reports or incident reports.
- Reading health and safety legislation, technical literature, research papers, etc.

Once potential hazards in the workplace have been identified by whatever methods, they should be recorded in a report or as a list that can be referred to and revised as necessary. The record of hazards should also note where the hazard would be encountered and whether its effects would be chronic or acute.

Risk Assessment

Following the identification of potential hazards, it is necessary to estimate the likelihood of each hazard actually causing harm in a specific situation. Hazards should be assessed along with activities related to welding processes and equipment. Guidance on the assessment of risk in welding is given in the previous section. The following questions may help to assess the risk:

- Is the likelihood of exposure to the hazard low, moderate or high?
- How often, and for how long, will exposure to the hazard occur?
- In the event of exposure to the hazard, will the outcome be severe, moderate or mild?
- What are the conditions under which welding is carried out?
- What are the skills, competence and experience of the welder?
- Has the welder been through safety training courses?

The assessment of the risks presented by hazards in the workplace should be recorded, along with the factors taken into consideration in that assessment. It is now possible to decide which hazards present low risk, which present high risk and which are in-between.

Control

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.

Evaluation

Control measures must be evaluated once they are in place, to ascertain whether they do reduce or eliminate risk presented by hazards. This may involve, for example, Air sampling to measure the amount of welding fume in the welder's breathing zone following introduction of fume extraction equipment.

If the control is working effectively, the volume of welding fume measured should be considerably lower than it was without extraction and certainly within prescribed health and safety limits. If it is not, then the control method needs to be reconsidered and further remedial action taken. This may be one case where personal respiratory protection may have to be provided to supplement fume extraction, if the latter is unable to give adequate risk control.

Evaluation of risk control measures should be routinely re-evaluated to ensure that they continue to reduce or eliminate the risk of injury or damage to health. If this is not carried out, then changes in process, materials, procedures, gases or consumables may result in risk increasing without anyone being aware that it has increased.

Review

The whole process of risk management should be reviewed periodically to assess whether it continues to identify hazards and manage risk control effectively. If it is found to be wanting, then the protocol and methodology may need to be adjusted.

Training

It is essential for effective risk management that personnel at all levels are adequately trained. Indeed, in many acts and statutory instruments, it is mandatory that training be given to ensure that welders and others operate equipment and use processes safely. They are also required to recognize and have an understanding of potential hazards and the safety procedures designed to eliminate or reduce risk.

Welders and others also need to be instructed in their responsibilities to work safely and not to endanger others or put them at risk by their actions or inactions.

Welders and others should be trained to understand the information contained in safety data sheets, on product labels and in equipment instruction manuals.

Those employed in positions of responsibility in safety or occupational hygiene and health must be properly trained and attain a level of competence. Professional qualifications are an advantage and may indeed be mandatory in many countries and many industries.

Those responsible for risk management programs should be properly trained and fully conversant with relevant protocols, methodologies and legislation.

Legislation

There are numerous statutory instruments and standards around the world that deal with health and safety at work. Health and safety professionals should make themselves familiar with the requirements of all relevant legislation. Some of the statutory instruments are listed here for information and for further reading.

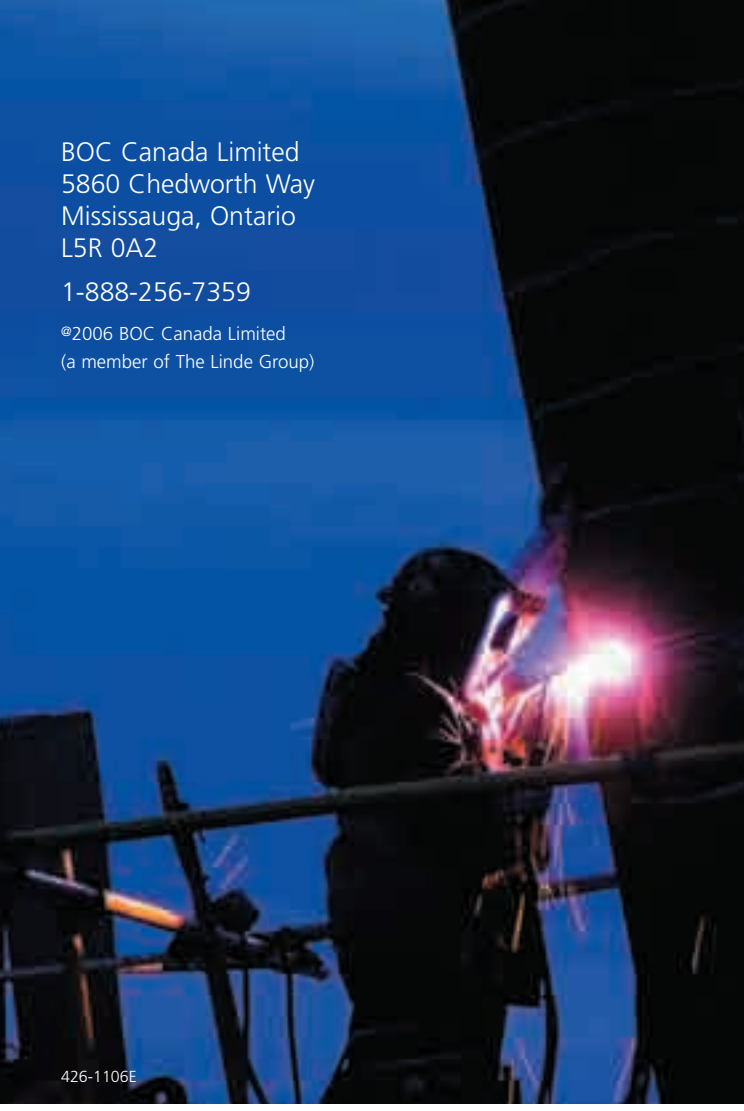
Canada

- Federal and Provincial Health and Safety Regulation
- CSA Standards

Notes

Notes

Notes



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