Introduction

Welders are exposed to many hazards during their work and often use Personal Protective Equipment (PPE) to reduce exposure to these hazards. The optical hazards they face from ultraviolet, infrared and visible light are typically addressed by the use of a welding shield. Protective clothing and gloves are used to protect the skin from metal spatter, heat and ultraviolet light. Hearing protection is worn if the welding technique used is particularly noisy, during associated activities e.g. grinding or if background noise levels are high. This Technical Bulletin discusses these hazards, their health effects and some of the control measures that may be used to reduce exposure to these hazards.

Eye hazards

Visible, UV and infrared light are generated by the welding process and can cause permanent damage to the eyes. Mechanical damage from pieces of metal generated whilst grinding, for example, or hot particles, such as welding spatter, can also present a risk.

Visible light

The most harmful form of visible light is intense blue light, like that produced in the arc welding process. Acute health effects are those which are experienced for a short time after exposure and include spots in vision caused by temporary overloading of the light protecting cells on the retina and a general feeling of discomfort. Long term, or chronic, health effects include impaired vision at night caused by damage to the delicate surface of the retina.

UV light

Ultraviolet light does not have an immediate, noticeable effect on the eye but the acute health effects, known as arc eye, do become apparent 4-8 hours after exposure. Arc eye is caused when the damaged outer cells of the cornea are shed, this exposes a mass of concentrated underlying nerve cells which rub against the inner eyelid every time the sufferer blinks – this can be extremely painful. Fortunately this is a temporary condition and does not cause any lasting damage. If exposure is repeated regularly, however, the cornea will be permanently damaged and cataracts (clouding of the lens) may develop.

Infrared light

Infrared light is a product of both arc and gas welding processes. The immediate effect of exposure to infrared light is a burning sensation of the skin surrounding the eye which will generally cause people to move away or cover their face with a welding shield, but if this exposure were to be prolonged the cornea and conjunctiva would suffer burns.

Regular exposure to infrared light over a long period of time (10-15 years) can cause cataracts.

Mechanical hazards

Mechanical hazards cause physical damage to the eye; their effects are generally immediate and sometimes cause permanent damage. Abrasion is the simplest mechanical hazard and occurs when small particles get between the eyelid and the eye causing irritation, if untreated this can lead to inflammation and infection. Impact damage occurs when large particles hit the eye with force. Sharp objects may cause cuts or even penetrate through to the eye. If the cornea is damaged in this way it may sustain permanent scarring and vision may be impaired. A further hazard is presented by hot particles which may fly into the eye, burning it as they hit it. This can cause serious damage to the outer surface of the cornea.

Controlling exposure

All of these hazards can be controlled by a welding shield, which will protect the wearer’s eyes from heat, spatter and light. Welding shields filter light using either a passive or an auto-darkening lens - passive lenses are made from tinted glass and are the more traditional option, whilst auto-darkening lenses use liquid crystals to instantly change from light to dark when an arc is struck, improving safety and accuracy. In addition, some shields allow the welding filter to be lifted revealing a grinding visor underneath.
Respiratory hazards

Welding generates respiratory hazards through the high temperatures involved, the action of ultraviolet light on the air and the presence of coatings and contamination on the metal being welded.

Metal fume

Metal fume is the primary particulate hazard generated during welding. Fume is a term that is often misused to describe vapours or odours. In fact, metal fume is a particle formed as a result of the intense heat applied to metals during welding. As metals are heated beyond their boiling point metal vapour is given off. This vapour oxidises in the air, cools and condenses into very fine metal oxide particles. The metal fume formed originates mainly from the consumables used, e.g. electrodes and filler wire, and the base metal. The composition of the fume, and therefore its toxicity, is determined by the metal being welding and electrode used. For example, metal fume from welding stainless steel may contain cancer causing chromium VI and nickel that is unlikely to be present in the fume produced when welding mild steel. Inhalation of metal fume leads to welders experiencing metal fume fever. This industrial illness has symptoms similar to flu e.g. chills, nausea, thirst, cough, aching limbs. Recovery is swift, generally within 24 hours. It is often caused by exposure to zinc oxide when welding galvanised steel. Frequent exposure to zinc fume produces a temporary immunity that is quickly lost therefore the symptoms are often noticed more on a Monday or after a holiday. Exposure to metal fumes can also cause irritation to the nose, throat and lungs and long term respiratory problems associated with a build up of scar tissue in the lungs.

Gases and vapours

Harmful and irritating gases are generated during arc welding, for instance, heat from the welding process can cause nitrogen in the air to be oxidised forming nitrogen dioxide whilst UV from the arc can cause oxygen molecules to react with one another forming ozone. The amount of gas generated varies depending on the welding method and the metal. As coatings burn carbon monoxide and carbon dioxide are given off. Applying high levels of heat to contamination such as oils and degreasing agents also generates potentially harmful gases e.g. phosgene, used as a poisonous gas in the First World War, can be generated from degreasing agents. Shielding gases, such as argon, can also present a risk as although they are not defined as hazardous to health under the Control of Substances Hazardous to Health Regulations (COSHH), they can act as asphyxiants by diluting the concentration of oxygen in the air. For this reason welders should ensure that their work area is well ventilated.

Controlling Exposure

In the UK, airborne hazards generated during welding fall under the requirements of COSHH. Employers are required to assess the risk from the hazards generated by their activities and control the risks to an acceptable level. PPE is one of the controls used to reduce the risk of hazards causing harm. However, employers should not immediately turn to PPE; they must first consider other engineering and administrative controls.

In the case of welding, the control typically applied is local exhaust ventilation i.e. an extraction system to draw contaminants away from the welder. These systems must be designed properly and inspected and maintained to ensure they function correctly. Some systems have fixed inlets but welders often use systems with inlets that they position to suit their work. The position of the inlet significantly influences the protection offered so welders must be trained in the correct use of the system.

PPE in the form of respiratory protective equipment (RPE) is often used as a secondary control measure with an extraction system. In certain situations, e.g. one-off on-site jobs RPE may be the primary control measure.

Points to consider when selecting respiratory protection

RPE must be adequate and suitable for the work. Different types offer different levels of protection and the level of protection selected must be adequate to reduce exposure to a safe level. The RPE mentioned later in this bulletin is of a type generally considered adequate for welders. The RPE must also suit the wearer and the situation e.g. it must fit the wearer, be comfortable to wear, be robust enough for the environment in which it will be used and be compatible with other PPE. There are disposable and reusable types of RPE. Consideration must be given to the storage and maintenance of reusable types to ensure both welders and the investment in PPE are protected. Maintenance of RPE will involve ensuring spare parts are available and an administration system to keep records. Welders commonly use either powered or supplied air respirators as these are more comfortable when worn for a long period. Powered respirators use a fan and motor to draw air through filters and up a breathing tube into the wearer’s breathing zone whilst supplied air respirators use breathable quality air from a compressed air source.

Burns

Burns to welders are generally caused by either radiant heat or welding spatter. Radiant heat refers to the infrared radiation emitted by the process that heats up objects in its path. This hazard is often faced when welding cast iron (which must be pre-heated), when long pieces of aluminium are welded very accurately in a continuous weld or where welders are doing piece or intricate work and will position themselves very close to their work to ensure a high quality finish. Many welding shields have optional leather or fabric attachments which help protect the wearer’s neck and head from burns.

Noise

Although the welding process itself is not especially noisy, welders may be exposed to noise generated from grinding or other nearby processes and many different types of hearing protectors are available.

Other potential hazards

Fire, explosion and electric shock are other hazards which are associated with welding, but they rely more on safe working practices and assessments than PPE. The risk of fire or explosion is particularly high when welding tanks with traces of fuel still inside or welding around flammable materials. Arc welding relies on a controlled electrical short circuit!
Frequently Asked Questions

Q. What causes an auto darkening filter to darken?
A. Auto Darkening Filters (ADFs) contain photo sensors which are able to detect the flicker and brightness of welding light, whilst ignoring other light sources. Even when an ADF is positioned very close to an incandescent light source, such as ordinary light bulbs, halogen lamps and spotlights, it will not usually react. Fluorescent lights, however, may cause an ADF to activate whilst they are warming up, although, once on, a welder would have to be positioned within around 20cm of the light to experience any false activation. Strobe lighting can be more of a challenge, as older versions will cause ADFs to darken unnecessarily. Some people solve this problem by using curtains to block strobe lighting from the welding area and newer strobe lights which use LEDs instead of bulbs, can be used to eliminate this problem entirely.

How 3M can help

3M is able to offer a wide range of Personal Protective Equipment which includes a selection of products designed specifically for welders, a small sample of which is featured below. For more information please visit www.3m.co.uk/ohes or call our helpline on 0870 60 800 60 (UK), 1 800 320 500 (Ireland).

Welding Shields

3M™ Speedglas™ 9100 Welding Shield
3M™ Speedglas™ 9100 FX Welding Shield
3M™ Speedglas™ 9100 Air Welding Shield with 3M™ Adflo™ Powered Air Turbo Unit
3M™ Speedglas™ 9100 FX Air Welding Shield with 3M™ Adflo™ Powered Air Turbo Unit
3M™ Speedglas™ 9100 Air Welding Shield with 3M™ FreshAir C Supplied Air Unit

Stand Alone Respiratory Protection

Many of our welding shields are available with integrated respiratory protection, but disposable and reusable respirators which can be worn underneath stand alone shields are available.

3M™ 9928 Disposable Respirator
• Specially designed for welders.
• Filters welding fume, provides protection against ozone gas and relief from nuisance odours.
• Flame retardant material
• Assigned Protection Factor (APF) = 10.

3M™ 7500 Half Mask
• Fully maintainable with a comfortable silicone facepiece.
• Range of filters available for both particulate and gas and vapour hazards.
3M Safety Services

3M is able to offer a range of services to help you meet your PPE needs.
These include:

✔ Care & Maintenance Packs
✔ Noise Level Check Service
✔ Hearing Conservation Programme
✔ Respiratory Service Life Software

✔ Fit Testing (Quantitative and Qualitative)
✔ Fit Testing Workshops
✔ EarFit Validation System (Hearing Protective Equipment)
✔ Air Quality Testing

Hearing Protection

3M™ Ear Classic Uncorded Ear Plugs
- Excellent hearing protection & all day comfort
- Moisture resistant
- Reusable up to 3 washes

3M™ Earfit Ultrafit Uncorded
- Reusable
- No roll down required
- Moisture resistant

3M™ EarMuff-Peltor Optime I Headband
- Low profile with generous inner depth
- Wide comfortable sealing rings
- Headband, folding headband & helmet mounted versions also available

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3M™ Earfit Ultrafit Uncorded
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