Edinburgh Napier UNIVERSITY

Health & Safety

Welding & Cutting Policy

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Amendment Control

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1.0	Dec 2022	

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Policy Summary

This policy is in place to ensure compliance and provide guidance in the identification, assessment and prevention of all risks associated with gas/arc welding and cutting.

This procedure has been developed to protect all Edinburgh Napier University staff, students, contractors and visitors from exposure to welding and cutting.

This procedure will apply to all staff, students, visitors, contractors and other persons who may enter or work on our University premises or who may be affected by these operations.

The information contained within this procedure can also be used as guidance for checking that non-University employees, e.g. contractors are compliant.

Policy Contents

1. Purpose and scope

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2. References

- Health & Safety at Work Act
- Control of Substances Hazardous to Health Regulations
- Electricity at Work Regulations
- Management of Health & Safety at Work Regulations
- Provision and Use of Work Equipment Regulations
- Personal Protective Equipment Regulations
- Pressure Systems Safety Regulations
- Fire (Scotland) Act
- EH 40 Workplace Exposure Limits
- Electrical Safety in Arc Welding HS(G)118
- BCGA The Safe Use of Oxy-Fuel Gas Equipment (Individual Portable or Mobile Cylinder Supply)
- INDG 297 Safety in Gas Welding
- INDG 327(rev1) Working Safely with Acetylene
- HSE 668/25 PPE/RPE for Welding

3. Definitions

Welding has been defined as the fusion of two work pieces, normally metal by heat or by pressure or a combination of both.

4. Types of welding

The commonest types of welding in construction are:

Electric Arc Welding, in particular:

- Manual Metal Arc Welding (M.M.A)
- Shielded Metal Arc Welding (S.M.A)
- Tungsten Inert Gas Welding (TIG)
- Metal Inert Gas Welding (MIG)
- Gas Welding
- Flux Cored Arc Welding (FCAW)
- Metal Cored Arc Welding (MCAW)

5. Summary of welding and cutting processes

Electric Arc Welding - in electric arc welding, the arc is struck between an electrode and the work piece at temperatures as high as 4000°C. At this temperature, melting and subsequent fusion of the work pieces occurs.

5.1. M.M.A and S.M.A Arc Welding

These are the simplest of the techniques. The electrode is coated with a baked flux which, in addition to contributing to the strength of the weld, forms gases during the welding process. These gases prevent oxidation of the weld by the air in the atmosphere as the electrode melts to form the weld.

5.2. T.I.G and M.I.G Welding

A nozzle wrapped around the electrode supplies an inert gas which flows over the weld. This gas replaces the flux in protecting the metal from oxidation. TIG uses a non-consumable tungsten electrode.

5.3. Gas Welding

In gas welding, metal fusion is achieved by the use of very high temperature flames produced by an ignited mixture of gases at a torch or blowpipe. The gases used are oxygen and a fuel gas such as acetylene or Liquefied Petroleum Gas (L.P.G).

5.4. Cutting (Burning)

Cutting is the reverse of the welding processes. The high temperatures produced melt and cut the metals. Cutting using oxygen and a fuel gas as above is a common process in demolition work and in fabrication shops. Given that the potential consequences of any incident involving acetylene far outweighs the benefits of using acetylene, acetylene is **banned** where a **practical alternative exists** such as cold-cutting, electric arc-based cutting and welding and brazing exist and therefore these alternatives should be used wherever practical.

Any laboratories using acetylene should review its use, handling and storage of such cylinders and ensure that they have an effective permit to work system in place. This will assist our goal of fire prevention, but we must always be ready for the unexpected /external events which may also require emergency action to be taken, this will mean that our procedures will need regular reviewing and personnel trained in these requirements, as well as carrying out evacuation drills. If acetylene has to be used, the quantities will be restricted to the size of the job and should not exceed 1 days use and stored securely at the end of each day. **Due to the instability of acetylene, it is strongly recommended that an oxygen/L.P.G. (Propane) combination only be used for external use.**

'Air arcing' using special rods and high electric currents is used in the deliberate destructive 'gouging' of metal, particularly where there are cracks. This process is the opposite of electric welding.

6. Typical operational faults when welding or cutting

It is not uncommon for incidents to occur during welding and cutting operations. Some are more alarming than harmful. Others can lead to very dangerous conditions.

Some operational faults include:

6.1. Flame snap outs

Caused by the accidental extinguishing of the flame out with the nozzle orifice.

Causes:

- Both regulators at incorrect pressure.
- Obstruction of the torch nozzle.
- Torch nozzle too close to the workpiece(s).
- Inadequate opening of blowpipe valves to allow free flow of gases.

Corrective Action:

- Completely shut both valves.
- Check regulator settings.
- Check nozzles.
- Re-light.
- Ensure adequate gas flow.

6.2. Backfire and/or Sustained Backfire

Backfire
Backfire is the retrogression of the flame towards the blowpipe mixer, the flame being either extinguished or re-ignited at the nozzle.

Sustained Backfire
Is the retrogression of the flame in to the blowpipe neck or body, the flame remaining alight.

Occurrence on lighting up due to:

- Regulators not being set at correct pressure.
- Light being applied before flow of gas mixture is properly established.

Corrective action:

- Close both blowpipe valves, oxygen first.
- Check cylinder pressure.
- Check and adjust regulator setting.
- Check torch.
- Re-light when gas flow is properly established.

Occurrence during use due to:

- Regulators not set at correct pressure.
- Nozzle obstruction.
- Nozzle overheating.

Corrective action:

- Close both blowpipe valves, oxygen first.
- Check cylinder pressures.
- Check and adjust regulator settings.
- Cool torch, check then clear nozzle orifice of any obstruction.
- Re-light after purging both hoses.

6.3. Flashback

Flashback is the retrogression of the flame beyond the blowpipe body into the hose, with the possibility of a subsequent explosion. Therefore, it is the most dangerous of these occurrences.

The cause of flashbacks is gases mixing in the hose(s). Usually this occurs when the hoses have been disconnected from regulators and/or blowpipes, when new hose is being used for the first time or is sometimes due to loose connections. Usually, one of the hoses will have burst and ignited.

Preventative Action:

- Before use check that it looks safe for use and that it is clean with no obvious damage.
- Ensure all connections are tight.
- Ensure cylinder valves are open and blowpipe valves are closed.
- Set regulators to the required pressure.
- Purge each hose separately and consecutively by opening the blowpipe valve and allowing gas to flow for a sufficient length of time to ensure only pure gas remains in the hoses.
- Close the valves for each gas as the exercise is completed. This operation should be carried out in the open or a well-ventilated area

6.4. Heated cylinders

Where an acetylene cylinder becomes accidentally heated or gets hot due to internal decomposition, the operator should:

- Remove any external sources of heat if possible.
- Close cylinder valves if possible.
- Evacuate the area.
- Raise the alarm and ensure the Fire and Rescue Service is summoned.
- Liaise with the Fire and Rescue Service on arrival.

Supervision should:

- Ensure the area is kept clear of personnel.
- Direct the Fire and Rescue Service on arrival.
- Arrange for the suppliers to remove the cylinder after it has been dealt with by the Fire and Rescue Service.

7. Responsibilities

School/Service, staff and other individuals (e.g. contractors)

School/Service staff and other individuals (e.g. contractors) carrying out welding activities in the university have the following responsibilities and must ensure that:

- A risk assessment and method statement are prepared, and that suitable control measures are implemented to reduce any identified risk to as low as reasonably practicable.
- The workforce has been consulted on the formulation of risk assessments and method statements and the relevant control measures being proposed.
- All personnel involved in or who are likely to be affected by the work, receive adequate instruction and training to carry out their task.
- Work is carried out by trained and competent personnel instructed in the requirements of the risk assessment and method statement and the proposed control measures.
- Competent, trained personnel are appointed to supervise work areas covered by this procedure and related work activities.
- For specific welding workshops, e.g. Merchiston, one workshop method statement and risk and COSHH assessment will be sufficient for all the activities in that room, rather than one assessment per activity.
- If however welding activities take place outside these dedicated workshops, then a separate risk assessment needs to be carried out for the location, a permit to work may also be required.
- Control measures that have been put in place are implemented.
- Control measures are reviewed on a periodic basis or when an incident or significant change dictates, to evaluate their on-going suitability and effectiveness. The workforce will be

involved in this process. (Any changes deemed necessary will be implemented after proposals have been evaluated for hazards and risks, the method statement and risk assessment have been updated and briefed and any additional training requirements carried out).

- COSHH assessments for any welding work involving hazardous substances are in place.
- The exposure to hazardous substances, fumes, vapours etc are eliminated completely or controlled and exposure levels are monitored and reviewed.
- That the appropriate PPE and RPE are provided and used accordingly.
- That the health of staff, students and other individuals who may be exposed to welding activities is monitored.
- All welding equipment has been checked before use, regularly inspected, thoroughly examined and maintained as per legal and manufacturers specifications.
- Plans for emergencies, incidents and accidents are designed and implemented.
- Any inadequate or defective equipment and/or control measures is reported.
- Students are prohibited for doing any welding activities, welding activities will be completed for them.

8. Risk assessment

8.1. Hazards (note – this list is not exhaustive)

- Sources of heat
- Pressurisation
- Flashback
- Damaged hose/valve
- Gas leakage
- Vapours/gases/fumes/particulates
- Solvents
- Magnetic fields
- Falling objects
- Radiation
- Flames
- Noise
- Lifting heavy items
- Electrical hazards
- Insufficient distance from appliances
- Trips and falls from trailing hoses/leads
- Manual handling issues related to the movement of gas cylinders

8.2. Risks (note – this list is not exhaustive)

- Respiratory problems
- Asphyxiation from gas leaks
- Fire
- Explosion
- Damage to works
- Injury
- Possible fatality
- Electric shock
- Burns from hot or molten metal
- Burns from UV and IR radiation
- Eye damage
- Heat stress
- Metal fume
- Pneumococcal lobar pneumonia

8.3. Hazards and controls (preventative measures)

Welding presents serious hazards due to processes which emit high volumes of fumes that may be hazardous to health if breathed in, burns from hot components or flames and the risk of fire or explosion caused by poor welding practices producing hot spatter and sparks close to combustible materials.

All operations including hot work will be covered by a hot work permit. All persons must be aware of the situations for which a permit is required.

The principal hazards associated with welding and cutting:

a) Fumes and gases

All welding processes produce fumes and gases.

Welding Fume consists of particulate fume, which is visible as clouds of rising smoke, and gaseous fume which cannot be seen but may sometimes be detectable by smell. FCAW, MCAW, plasma cutting, air arc gouging and MMA gouging all produce high fume levels and due to the high currents, MMA and MIG welding also present high fume risks because as welding current or power increases, so does the level of fume.

The highest risk factors are associated with ozone (irritation of the eyes, nose and throat and also pulmonary oedema), chromium (especially CR6+), nickel, cadmium and lead, but health risks are also high with consumables containing zinc, manganese, barium or fluorides. The only way to establish the contents and concentration of the fume in the welder's breathing zone is by sampling and analysis.

Potential effects on health from exposure to the fine particulate dust contained in the fume can include irritation of the upper respiratory tract (nose and throat), tightness of the chest, wheezing, metal fume fever, lung damage, bronchitis, pneumonia, emphysema and siderosis (Welder's Lung)

from iron particulates. Many of these effects are long term and may not develop as symptoms for many years.

Other common fume hazards when cutting, are lead from lead based paint or storage tanks used for storing lead based products. Other sources of fume arise when cutting plated metal such as cadmium.

Gases released during gas welding can be toxic; the principals being nitrogen oxide (nitrous fumes), caused by heating of atmospheric gases, especially during flame processes like cutting, and carbon monoxide, produced when combustion in the process is incomplete. Some inert gases used in arc welding can, particularly in confined spaces, cause breathing difficulties or asphyxiation due to the displacement of breathable air.

The longer a welder keeps their head in the fumes, the more the health risks from breathing in such gases increase. Such risk is lessened by the use of adequate ventilation/fume extraction or an approved welding respirator. Local Exhaust Ventilation (LEV) should normally provide protection to personnel from metal fume fever in a workshop environment; however depending upon the circumstances other respiratory protective equipment such as “airstream” powered respiratory systems or similar, can be used.

Besides their inherent flammability, fuel gases such as hydrogen, acetylene, propane and propylene can also form explosive mixtures with air of oxygen. Acetylene also forms explosive compounds with copper, silver and mercury therefore acetylene lines should never be connected using copper pipes or fittings.

Before carrying out any welding or cutting, the main hazards presented by the specific process and consumables should be assessed at the risk assessment stage. Information on consumables can be obtained from safety labels and safety data sheets provided by manufacturers and suppliers. In addition to ensuring that control measures are in place to prevent or reduce exposure to welding or metal fume, a vaccination might be an appropriate or interim step to manage any residual risk. (See 8 r) for more details).

b) Solvents

Solvents used in welding processes may be flammable or may have flammable constituents that present a fire or explosion risk. Therefore, good housekeeping standards are essential to ensure that all solvents are stored away from risky processes when they are not in use. All solvents need to be put on the hazardous database, if they are explosive then they need to be part of the DSEAR risk assessment.

Some solvents break down under the action of the welding arc to form toxic or irritant by-products, the most toxic being phosgene which can be produced from welding in the presence of chlorinated hydrocarbon degreasing solvents. Exposure to these in vapours or fumes may cause acute or chronic health effects, but most industrial solvents and their breakdown products can be detected by their distinctive smells.

All traces of solvents and their vapours should be allowed to disappear from material surfaces before welding to reduce exposure to breakdown products.

c) Electric Shock

Risk assessment should take into account the electrical rating, duty cycles and capabilities of all electrical welding equipment as well as the environment in which they are to be used. The work area should be examined for potentially live structures and wet areas, as welding work in wet, damp or humid conditions should be avoided if possible due to the moisture in the air increasing the electrical conductivity of the human body. Such conditions often apply in confined spaces, and the possible restrictions on movement increase the risk of contact with live electrical equipment.

Welding power sources should be of the correct rating and duty cycle for the job. In common with all types of electrical welding equipment, they should be properly installed by qualified electricians and maintained in a good condition. Any equipment that is damaged or faulty should not be used until it is repaired and made safe.

All electrical welding equipment should be well maintained, installed, and checked by a qualified electrician. It should have all side panels secured in place and all terminals, connections and live components should be properly protected. Welders should never remove the panels from welding power sources and only a qualified electrician should ever investigate faults. Wherever possible during MMA welding, LVSD (Low Voltage Safety Devices) should be used, particularly if the activity is otherwise high risk, e.g. in a confined space or in damp conditions.

A welding lead takes the current from the power source to the electrode and then an earth lead carries that returning current from the welding equipment back to the power source. Incorrect establishment of this return, e.g. clamping the earth lead to the steel frame of a building, can result in making the entire frame 'live' and put others at risk from electric shock, therefore it is essential that the earth lead is established correctly away from danger. A separate earthing conductor should also be provided unless the equipment only requires a welding return cable.

Dry leather gloves, insulated footwear and other appropriate PPE should be worn and in case of an emergency, the equipment should have an easily accessible means of switching off the power source at the mains and the use of fully insulated electrode holder should be considered.

Extra care should be taken if working at height. The risk from electric shock is no different; however the secondary risk from falling is increased.

d) Radiation

Welding and cutting arcs produce several types of electromagnetic radiation according to the type of process being used and the operating conditions:

- **Electric arc and fuel gas processes**
  Produce 'non-ionising' radiation that can cause damage to the skin and eyes.
- **Electric arc and laser welding**
  These produce ultraviolet (UV), visible light and infrared (IR). Exposure to UV can cause burns to unprotected skin and eyes (arc-eye), but some effects of IR and UV may not be felt until some time after exposure. There are also hazards relating to UV and IR radiation in particular when using Argon.
- **Gas Welding and cutting**
  Visible light and infrared (IR).

- **Electron beam welding**
  Emits X-rays which can cause serious damage to body tissues, including skin damage, cancer, leukemia and fertility problems. Equipment should be suitably protected to prevent the escape of x-rays.

Radiation from electric welding arcs and gas flames is usually apparent, but arc flashes can occur without warning.

Welding screens should be used to screen off welding bays and fabrication areas to protect other personnel from exposure to radiation from welding processes.

Flame-retardant, heavy canvas screens are very common, but many people prefer to be able to see if someone is welding inside. This means that many screens are made of 'semi-transparent' plastic. These semi-transparent screens allow you to see enough to know that someone is welding, but the material filters out the harmful parts of the light. If there is no need to see the person welding or for screening in between welding bays, darker or opaque screens and curtains should be used. They should be appropriate for the job and be in good condition. If possible, the use of dark-coloured wall coatings can be used to reduce reflections.

Welding curtains and screens should conform to the British Standard BS EN ISO 25980 or at least offer the same level of protection as this standard. Some welding equipment suppliers may refer to this as EN ISO 25980. At the moment, HSE is not aware of any clear welding curtains that conform to BS EN ISO 25980.

The standard does not specify any particular colour, it just requires the curtain to attain certain levels of performance. This means that suitable curtains may be available in a variety of colours and levels of 'darkness'. A reputable supplier should be able to confirm if a curtain conforms to the British Standard.

Filter glasses or screens must be of the correct shade for the welding process, current and flame intensity. An auto-darkening welding screen must darken to an appropriate shade and be fail-safe. A filter shade that is too dark, while protecting against radiation can increase the risk of eyestrain.

Specific eye protection including filters for welding operatives (to prevent arc eye) should conform to relevant British and European standards. There are standards covering impact resistance, auto-darkening welding filters and fixed filters.

Electric arc welding inside a vessel increases the risk of exposure to radiation, particularly if the inside surfaces are highly reflective

e) Burns from hot or molten metal

Skin burns of all levels of severity may result from metal spatter, from touching hot work pieces or from arc rays, gas flames or lasers. Work equipment such as welding guns and torches, electrode holder and stubs are also likely to be extremely hot. The hands, arms, legs and feet are particularly vulnerable and these should be protected by gloves, gauntlets, spats and jackets made from chrome leather. Flame retardant overalls and leather safety footwear are also recommended. Wear goggles when chipping slag or wire brushing welds during preparation or finishing off work.

Workers should ascertain where there are potential sources of heat in their welding area. Unless it is red or white hot, hot metal appears the same as it does cold and the potential burn hazard may not be obvious. Where necessary, work or equipment should be marked as 'hot'.

f) Fire and explosion

The potential for fires and explosions, particularly with gas welding, is always present unless gas cylinders are stored and handled correctly. Because gases such as acetylene, propane and hydrogen may be required within the welding area, regular checks should take place to ensure that all connections are sound and that cylinders and bottles have no leaks. Gas cylinders, especially acetylene, should never be laid horizontally due to the high risk of leakage and they should be firmly secured during use, transport and storage to prevent them being knocked over. In addition, gas cylinders should always be moved using the correct equipment and must never be rolled along the ground, as this can cause the valve to become damaged.

The naked flame or arc in welding can provide the source of ignition to any combustible materials, flammable gas, or vapour in the vicinity. Wherever possible, all flammable liquids, substances and vapours and dust, paper and cardboard should be kept out of any area where welding or cutting has to take place. If this is impracticable, then fire resisting sheets or screens should be established to protect the surroundings from the flame and any spatter. At least one dry powder fire extinguisher should always be immediately available in the areas of welding and cutting operations. The work will normally need to be done under the control of a hot work permit.

During operation, hazards associated with gas welding equipment include:

Backfire (a retrogression of the flame into the blowpipe neck or body)
Flashback (a retrogression of the flame into the hose which has a potential to explode)
Backflow (where a gas at higher pressure flows into the hose of a gas at lower pressure producing the conditions of a flashback)
Decomposition (where acetylene breaks down into carbon and hydrogen in the absence of oxygen, giving rise to high pressures and temperatures)

'Snifting' (or opening of a valve) of hydrogen cylinders must never be carried due to the high risk of spontaneous combustion of the gas.

g) Eye damage

Eye damage from sparks, spatter and slag penetrating the eyes is an obvious hazard in welding and cutting activities, but ultraviolet radiation from arc welding can also cause temporary 'arc-eye' or serious damage to the retina. To avoid these possible injuries, welders must use a welding helmet or hand screen (Housing to BS.EN 175 and suitable filters to BS.EN 169 & 170).

During gas welding, infra-red and visible light is emitted instead of ultraviolet light and box goggles (Housing to BS.EN 175 and suitable filters 169 &170) should be worn to protect the eyes during this work.

As welders will normally wear eye protection, the main risk is to passers-by and exposed persons in the vicinity of the work, therefore suitable screens must be placed around the welding operation. This requirement will form part of a hot work permit.

Most welding and cutting operations tend to be of a local nature with effective control measures relatively easily addressed

h) Heat stress

Working in a hot environment can cause the body to overheat. If fluid is not taken to replace those lost through sweat, this heat stress can result in heat exhaustion which, because it builds slowly over time without a worker being aware of it, can be very dangerous and in extreme cases can lead to heat stroke that has the potential to be fatal.

The longer the duration of welding and cutting, the hotter the surroundings become and this heat is intensified where work is carried out in cramped and confined situations. In extreme cases welders have been known to pass out with heat stress.

If there is a potential for working conditions to lead to heat stress, then the risk assessment and detailed system of work needs to consider as a minimum:

- The selection of personnel including medical examination for suitability
- Lone working
- Ventilation
- Work and rest periods
- Emergency arrangements
- Hot work permit-to-work
- Confined space permit-to-work if applicable

A strict work regime including periods of rest should be set to reduce the risk of heat stress, although factors such as the ambient temperature, the nature of the work and the type of protective clothing required will all affect the suitable duration of work periods. To prevent dehydration, it is essential to intake liquids to offset fluid loss.

i) Noise

Exposure to noise over time can result in impairment or loss of hearing. In addition, permanent hearing damage or tinnitus can be caused by a single, intense burst of noise like an explosion.

All welding processes generate noise but some, like plasma cutting and air arc gouging, are much nosier than others and can produce noise of higher frequencies, for example pulsed MIG welding. Where noise levels are high and measurements in db(A) are taken and exceed allowable levels, warning notices are required either close to the process or if excessive throughout the laboratories or workshops, at the entrances. Suitable ear protection should be worn to reduce the risk of hearing damage around noisy processes, which if possible, should be segregated from other work areas.

j) Magnetic fields

Strong magnetic fields given off by power sources and current carrying cables are often located close to or touching the body of the welder. While the risk to most workers from these fields is small, they can be strong enough to affect the function of some heart pacemakers which might result in the heart stopping or slowing enough to induce a fainting fit. A worker may not be aware of the hazard of the magnetic field until the pacemaker operates erratically.

Where there is a potential for strong magnetic fields to be generated, signs warning those fitted with pacemakers to avoid the area should be on prominent display.

Welders fitted with pacemakers should not use electrically powered welding equipment.

k) Confined spaces

Welding in a confined space increases the risks from all hazards and a permit to work in a confined space must be obtained before any welding operations begin.

If welding tanks or vessels have contained flammable substances, then they must be purged to remove any combustible or explosive residues before work starts.

Shielding gases used in arc welding and cutting contain high percentages of inert gas. Because inert gases are non-reactive, have no odour and are impossible to detect directly, they therefore pose a serious danger of asphyxiation where ventilation is poor within a confined space. Additionally, fuel gases present a significant hazard of fire and explosion if they are allowed to collect in pockets, and because they will displace the breathable air, they will also cause asphyxiation if allowed to build up. Hydrogen and acetylene, being lighter than air, will collect at the top of a confined space whereas propane and propylene will sink. Forced ventilation should be used to lower the risk from dangerous atmospheres along with the use of suitable breathing apparatus and monitoring systems; however, if possible, the use of such gases should be avoided in confined areas.

Due to the restrictions on space, hot metal or equipment is more likely to be in close proximity to the user and the likelihood of receiving burns from contact is increased.

l) Regulators

Regulators must always be fitted to cylinders during welding and cutting using L.P.G. to reduce the gas pressure from the cylinder to the working pressure of the blowpipe.

Filters within these regulators can be easily choked with dust, therefore the cylinder valves should be ‘cracked open’ before the regulator is fitted to blow all the dust and any other foreign matter from the regulator.

The adjusting screw of the regulator must always be released before the cylinder valve is opened. The cylinder valve must be opened gradually because if it is opened suddenly, the abrupt compression of the gas will generate excessive heat which could ignite the valve seat material or damage the gauge.

Before use, a visual examination should be undertaken by the user to determine suitability for service e.g. gas, pressure rating, damage, condition of threads and sealing surfaces, oil or grease contamination, together with a leak test at all joints at working pressure. Regulators that have been damaged, modified, poorly maintained, are incorrect, or are more than five years old should be replaced before fitting.

At regular intervals they should have a formal inspection, after which a report on their condition should be produced and kept. After these periodic checks, gas control equipment must be tagged to indicate the date of inspection and the 'next due' inspection date or replaced in accordance with their stated service life.

Weekly checks should be made to ensure no gas is leaking from the regulator when the pressure regulating screw is set to zero. Such a leak will cause a buildup of pressure in the hose to the torch when the blowpipe valve is closed.

Annual checks should include the 'Before Use' instructions together with functional tests to ensure correct operation of internal components – undertaken by a person with sufficient technical competence.

Gas regulators must be in good condition, they usually have a 'life-span' that is typically five years. Once they reach this age they must be replaced or professionally refurbished, irrespective of how much they have been used.

Only a 'bubble test' using water containing detergent should be undertaken to check for gas leakage from any part of the equipment (excepting for oxygen regulators, where proprietary sprays and liquids should be used). These checks should be recorded in compliance with the PUWER 98 regulations and the equipment 'tagged' to indicate the date and when the next inspection is due.

m) Hoses

Hoses should be restricted to one type of gas only and colour coded:

- RED for Acetylene and other gases except LPG;
- BLUE for Oxygen;
- ORANGE for LPG.

Inspection of hoses should be before use. They should be effectively secured to the equipment with crimped fittings (not jubilee clips) and protected from sharp edges, sparks, traffic and falling metal at all times. This inspection should be recorded in compliance with the PUWER 98 Regulations.

n) Non Return Flashback Arrestors

If a mixture of oxygen and the fuel gas occurs in one of the hoses, a mixed explosion or 'flashback' can result. To avoid the risk of igniting such an explosive mixture, each hose should be purged with its own gas before the blow pipe is lit. This should be done in a well-ventilated area away from any source of ignition.

When using oxy-fuel gas processes, a hazardous flashback due to the ignition of oxygen and fuel gas which has mixed in the fuel gas supply line can occur. 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. Correct lighting up and shutting down procedures must be observed.

To prevent this mixture arising while equipment is in use, e.g. when the blow pipe nozzle becomes blocked, non-return valves must be fitted to each blowpipe inlet connection. In addition, flashback arrestors (flame arrestors) fitted between cylinder gauges and hose must be used.

o) Blowpipes

As there is a possibility of blowpipes being blocked by fume particles or spatter leading to a build-up of pressure, a subsequent reverse flow of gas and a flashback, blowpipes should be dismantled and cleaned at regular intervals.

p) Atmospheric monitoring

Gas users should be aware of the properties and risks of the gas they are using before they start their tasks. All areas where gases are used should be appropriately ventilated.

Before gas cylinders are used, the need to monitor atmospheres must have been considered at the risk assessment stage.

q) General gas welding precautions

Only proprietary fittings, including flashback arrestors which must be fitted, are to be used on gas welding equipment and these must only be fitted by trained and competent persons.

Damaged equipment must be taken out of service.

Gas cylinders should always be kept upright and secured when in use, transportation or storage. They should always be moved using the correct equipment and must never be rolled along the ground, as this can cause the valve to become damaged.

The contents of a gas cylinder should not be identified only by the colour of the cylinder.

Leaking cylinders which cannot be closed with a spanner should be closed at the valve and immediately returned to the supplier labelled with the fault details.

Leaking cylinder valves must never be packed with washers.

Substances such as grease, oil or even soap should not be permitted to come in contact with oxygen regulators as these are explosive in the presence of high pressure oxygen.

Flame from the cutting and welding equipment must never be allowed to come in contact with the cylinders.

It is dangerous to rest blowpipes on empty oil drums or other similar containers, even with extinguished flames. Vapours in such containers have been known to explode from the heat of a recently extinguished blowpipe.

Leaking oxygen cylinders, leading to oxygen enrichment can be minimised by correct maintenance and inspection of equipment.

Deliberate discharge of oxygen known as “sweetening the atmosphere” must never be permitted. This action can lead to an atmosphere which has the potential to be highly explosive.

r) Pneumonia Vaccination

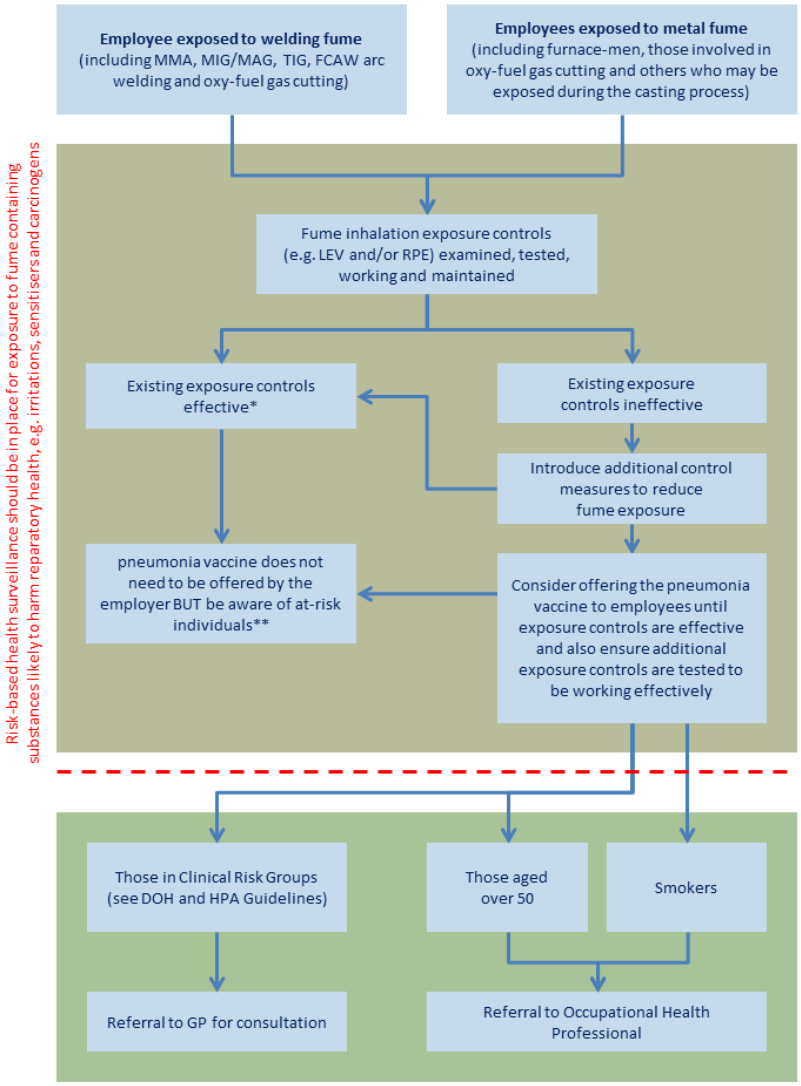
As a part of the risk assessment, engineering controls must be provided where required. These must be maintained and workers must be aware of how to use them. Workers should be monitored to ensure that they are using the specified controls correctly.

If the control relies on respiratory protective equipment (RPE) it must be suitable, maintained and worn with a good face fit. This is not a one-off activity, but checks need to be repeated to ensure the effectiveness of the RPE.

Where appropriate, air monitoring may be necessary.

Even if fume exposure is being well controlled and managed, the risk assessment should consider whether the further control measure of offering a ‘pneumonia vaccination’ should be given to employees in critical risk groups, for example those aged 50 (e.g. that may have pre-existing health conditions) and smokers. This should only be considered after all the control measures specified by COSHH have been implemented and are effective.

Note: This guidance on providing a pneumonia vaccine (PPV) goes further than the minimum needed to comply with the law, but should not replace the need for measures to prevent or reduce exposure or be a substitute for ineffective control measures



9. Maintenance, examination and testing of LEV and RPE

The Control of Substances Hazardous to Health Regulations (COSHH) require the maintenance and thorough examination and testing of control measures at specific intervals to ensure the control measures are effective at all times. Controls mean more than just the hardware (LEV and/or RPE) but also safe systems of work, provision of an RPE programme and supervision.

All controls measures are required to be maintained:

- in an efficient state
- in efficient working order
- in good repair and in clean condition

Most welding fumes are easy to see, so you can assess control by observing how well the LEV captures the fume. For TIG welding, where there is little visible fume, a dust lamp can be used to assess how well the controls are working.

9.1. Local exhaust ventilation (LEV)

LEV performance can be tested for comparison to the capture velocity range 0.5m/s to 1m/s as described in the HSE guidance Controlling airborne contaminants at work (PDF) as appropriate for welding fume, soldering and liquid transfer. Higher-capture velocities may be required when there are draughts interfering with the flow of air into the hood.

Capture velocity measurement is not appropriate for testing on-torch extraction though. In this case total volumetric flow may be checked for comparison to the manufacturer's recommendations in the user manual.

Thorough examination and testing of LEV (PDF) must be carried out at least every 14 months.

9.2. Respiratory protective equipment (RPE)

Any RPE must be thoroughly inspected before each use, and for reusable RPE a record kept of regular examinations, maintenance, repairs and, where appropriate, testing. The HSE publication Respiratory protective equipment at work (PDF) gives more guidance on this.

9.3. Controlling the risks from welding

If welding is the main part of the work activity, the risk assessment must identify what measures are required to control the risks from exposure to welding fume.

- **Regular welders** will weld for most of their shift and carry out different types of welding and other associated activities in the same day, depending on the requirements of their job. Their exposure to welding fume will be regular and of a significant duration or high intensity. They will require adequate controls to protect them from the risk of developing occupational lung diseases.
- **Sporadic welders** will carry out welding infrequently when it is incidental to their main manufacturing operation. Engineered fume controls will not normally be expected for occasional welding carried out less than once each week and lasting less than 1 hour.

  In these situations, the respiratory protective equipment (RPE) and good general ventilation is critical to controlling exposure to welding fume. The protection of others nearby must be considered, and the general ventilation is effective at removing and dispersing the welding fume.

  For example, a car mechanic wearing RPE with good general ventilation in the workplace, carrying out an occasional short welding job on a car with a broken exhaust support bracket, would meet the minimum requirement for compliance.

Without controls in place, workers will be exposed to welding fume.

The assessment should consider factors such as the:

- welding process, volume of work and level of fume generated
- size of the component being welded
- metal being welded (mild steel, stainless etc)
- consumable being used in the welding process

9.4. LEV for the most common types of manual welding processes

The most effective way to reduce welding fume is to capture it at source, protecting the welder and preventing fume spreading. To adequately control exposure to welding fume various LEV can be adopted. These may vary depending on the welding activity. All extract equipment will be subject to inspections and thorough examinations to ensure the equipment complies with legal H&S requirements under PUWER and for insurance purposes. All such equipment must be recorded in the Universities Asset Register of Equipment.

a) On-torch extraction
   On-torch extraction can be very effective for MIG welding, also modern, bespoke, high-efficiency welding guns with built in on-torch extraction can provide good control.

b) Extracted benches
   Extracted benches are a good choice for medium and smaller welding jobs that can be brought over to the bench. When welding larger articles, extracted booths large enough to house the workpiece with it mounted on a turntable to ensure the fume is drawn towards the extraction at the back of the booth can be suitable.

c) Movable LEV
   Movable LEV units with swing-arm hoods are dependent on workers correctly placing hoods and moving the hood as they work. Some tasks require bespoke hoods.

When LEV discharges within the work area, the discharged air must be filtered to reduce the particulates to a negligible concentration.

Extracted air discharged outside the work area should leave the building at a high enough level to ensure it will be dispersed.

9.5. Respiratory protective equipment (RPE)

Where it is difficult achieve adequate control from LEV alone, or it is not reasonably practicable to provide LEV, workers must be provided with suitable respiratory protective equipment (RPE). Also consider any other workers exposed to the welding fume, taking account of the level of general ventilation provided and excluding unprotected people from welding areas.

Note : It is not always possible for LEV to effectively capture welding fume at outdoor operations. So, for any welding outdoors, suitable RPE must be provided and consideration of others nearby.

A powered air respirator or a supplied air respirator which combines respiratory, eye and face protection, with an APF of at least 20, is the best option for arc welders. For work not expected to

exceed one hour, a FFP3 tight-fitting disposable mask or re-usable half-mask with a P3 filter may be adequate to protect against particulates if the wearer is clean shaven, but these particulate filters will not protect workers from welding gases contained in the fume.

RPE must be suitable for each wearer. Face fit testing for devices with a tight-fitting face seal will ensure the equipment selected is suitable for each worker.

For any RPE, the following must be available:

- suitable face-fit testing regime and users trained in the use of RPE
- a stock of spare parts for example, batteries and filters
- a programme for servicing, changing filters and cleaning in place
- clean storage of RPE when not in use
- compatibility with other personal protective equipment (PPE) provided for the task, for example a welding visor

All RPE must be checked before use.

All RPE must be stored in accordance with manufacturer's instructions and must be checked on a monthly basis for maintenance and defect purposes (See Appendix A).

9.6. Other workers in the area

Workers operating automated or mechanised welding machines or other workers nearby are unlikely to need RPE if:

- Effective general ventilation provides rapid fume clearance and a through draught to ensure that fume generated from welding is dispersed and removed. In most welding workshops mechanical general ventilation will be required because natural ventilation from open doors and windows is not sufficient to disperse the fume generated from the work tasks.
- They can see fumes generated, but are working far enough away that they are not near any fume generated and there is no haze of fume lingering in the air.

It may not be possible to have an LEV system in robotic cells capable of capturing all the fume. So how far away the operators can work becomes one of the main factors in deciding whether mechanical general ventilation is needed. Mechanical general ventilation uses fans mounted in the ceiling or high up on a wall to extract the air in the room and draw in clean air to disperse airborne contaminants.

9.7. Personal protective equipment (PPE)

Prevent exposure to direct and reflected ultraviolet (UV) light and infrared rays by wearing protective clothing and using welding screens.

To protect against splatter when welding, wear appropriate clothing that covers arms and legs, and use suitable gloves. Wear goggles when chipping slag or wire brushing welds during preparation or finishing off work.

Specific eye protection including filters for welding operatives (to prevent arc eye) should conform to relevant British and European standards. There are standards covering impact resistance, auto-darkening welding filters and fixed filters.

10. Emergency procedure

Emergency arrangements will be incorporated within each method statement and risk assessment for the works being carried out. This will take into account the hazards, risks, existing control measures, availability of the emergency services and the type of incident which could possibly occur. In the event of an emergency the Hazardous Database must be made available for the emergency services.

For specific welding workshops, e.g. Merchiston, one workshop method statement and risk and COSHH assessment will be sufficient for all the activities in that room, rather than one assessment per activity. If however welding activities take place outside these dedicated workshops, then a separate risk assessment needs to be carried out for the location, a permit to work may also be required and details incorporated into the overall risk assessment.

Any injuries or illness will initially be treated by certificated on-campus first aiders. Where they consider the injured person requires further treatment, arrangements will be made for the injured person to promptly attend the local Accident and Emergency unit.

Care needs to be taken with any acetylene cylinders that have been involved in a fire, especially if they have not failed (i.e. ruptured or exploded) as they can still pose a risk due to the possibility of the acetylene inside starting to chemically decompose. This exothermic reaction can turn the cylinder into a time bomb which can explode hours later.

The main control features that should be followed include:

- If any cylinders are involved in a fire, they should be left in situ and cooled with water.
- A hazard zone will initially be set at 200m whilst the facts are established by the emergency services. Disruption to the local services area is likely. The reason for the 200m hazard zone is that evidence shows that fragments of cylinders can travel about 150m, zones generally need only to be maintained for one hour, instead of 24 hours, but this will be down to the Local Fire & Rescue Service to decide on timescales.
- Although a 200m exclusion zone may be imposed, it must be noted that the emergency services may decide not to fight or extinguish a fire/incident.
- If necessary, people should be evacuated from the hazard zone and prevented from entering it.
- The water cooling of acetylene cylinders should continue for one hour, followed by a further hour of monitoring to ensure any decomposition has stopped. ‘Monitoring’ consists of a ‘wet test’ (where water is sprayed on the surface of the cylinder and observed for steam or drying out quickly) and thermal imaging. The hazard zone can only be reduced after a dynamic risk assessment by the emergency services.
- Under no circumstances should cylinders be moved or vented until they have been completely cooled down.
- If there is no clear cylinder identification after a fire they will be assumed to be acetylene and treated in the same way.

11. Training

All operatives involved in operations requiring the use of welding and cutting equipment must be competent and trained in its use. They will also be instructed to their understanding in the contents of their Safe Operating Procedures and Risk Assessments for their specific work.

Similarly, any contractors working on University premises are required to ensure that their employees are competent to carry out their activities. The University will periodically monitor contractor competence records to ensure they are being maintained.

12. Health surveillance

Welding and cutting, if not properly controlled, could pose a risk to a person's health. These risks can come from inhaling minute particles in the air, through contact with hot or hazardous materials, and by exposure to high levels of vibration or noise or heat stress. It is well known that exposure to welding fume is an asthmagen.

In most cases exposure to trace quantities of many toxic or irritant substances will cause harm only if exposure occurs sufficiently frequently, however health surveillance may be appropriate even if very small or infrequent exposure to hazardous substances is known to pose a potent risk to health, such as may occur with powerful respiratory sensitizers, recognised carcinogens or used outside of a manufacturing process.

It has been recognised that various health conditions which can arise as a result of working with welding or cutting activities and therefore all University personnel involved in such activities must undergo Health Surveillance in accordance with the University's Health Surveillance Policy.

Health surveillance is a system of ongoing health checks that is used to:

- collect data to detect or evaluate health hazards
- protect employees' health by early detection of changes or disease
- evaluate control measures
- create an opportunity for training and education of employees regarding the risk of specific work-related conditions
- create an opportunity for individuals to discuss concerns about work related ill-health

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Appendix A: Monthly Checks on Respiratory Protective Equipment (RPE) form

MONTHLY CHECKS ON RESPIRATORY PROTECTIVE EQUIPMENT (RPE)											
MAKE:								MODEL:			
SERIAL No.								ISSUED TO:			
TYPE:								DATE:			
DATE:	CLEANINESS	FILTER CHECK	PRE-FILTER CHECK	FACE PIECE/SEAL	HEAD STRAPS	VALVES/SEALS		MAINTENANCE CARRIED OUT	DATE ACTION COMPLETE	FIT FOR USE Y/N?	SIGNATURE OF EMPLOYEE