

**GUIDELINES FOR THE
CONTROL OF WELDING
HAZARDS IN
SURFACE
MINES AND QUARRIES**



March 2008

For Review In 2010

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ACKNOWLEDGEMENT

MinEx would like to thank those who have contributed to the development and review of this guideline. Special acknowledgement is given to Department of Labour (Workplace), Mines and General Workplace Inspectorate, who have allowed their original material to be used as the basis of this publication.

1.0 INTRODUCTION

- A. Welding and gas cutting activities create a range of both well-known and subtle hazards, which can impact upon the health and safety of employees. These can have immediate consequences (e.g. electric shock) or have consequences that may surface only in the longer term (e.g. lung function changes over time).
- B. These guidelines have been prepared in order to help prevent accidents, caused by hazards created by welding and gas cutting activities associated with the extraction industry.
- C. It is recommended that in order for these guidelines to be truly effective, site-specific operating instructions should be developed and implemented and that all personnel involved in these activities are trained and deemed competent to undertake these tasks.

2.0 WELDING HAZARDS

- A. **Fires and Explosions** These are an ever-present hazard with many welding processes.
- B. **Burns** Welding causes items to become hot – creating a risk of burns and fires from hot metal and welding spatter.
- C. **Fumes** (mostly metal) generated by different welding processes may range from being of nuisance value to highly toxic. Health effects can occur very soon after exposure (e.g. exposure to cadmium fumes can be fatal within hours) or may not result until after many years. Fume control requires appropriate ventilation equipment and may require advice from a specialist.
- D. **Electric Shock** Welding processes that use electricity pose both obvious and subtle hazards of electric shock – which can be fatal. Standard precautions need to be taken when using welding equipment. Equipment selection, set-up and maintenance may require specialist advice to ensure safety.
- E. **Compressed Gases** Compressed gases in cylinders pose a number of hazards.
- F. **Hazardous Substances** Hazardous substances used during some welding processes can require highly specialized methods of control.
- G. **Toxic Gases** Toxic gases may be:
 - a. used in, or generated by, the process (e.g. acetylene, ozone, nitrogen oxides, carbon monoxide)
 - b. generated when coatings on metal surfaces are heated
 - c. generated when the arc flash and some degreasing chemicals or paints react
- H. **Suffocation** Inert gases used during welding can flood an area and lower its oxygen content, especially in confined spaces. Suffocation can result.

- I. **Radiation** Arc flash is a well known hazard of welding. Standard precautions should be used to prevent eye and skin exposure – both for the worker and for people in the vicinity. Reflecting surfaces make exposure to radiation more likely.
- J. **Heat Stress** Working for long periods in hot environments can lead to distress and in an extreme, fatal heat stroke. Specialist advice must be sought if welders work in hot environments.
- K. **Dust** Associated processes (grinding) may generate hazardous levels of dust.
- L. **Noise and Vibration** Noise and vibration levels during some welding processes can be high and should be controlled and/or appropriate hearing protection should be worn.
- M. **Manual Handling** Some welding processes may involve heavy and or repetitive handling.

3.0 TRAINING, QUALIFICATIONS AND COMPETENCY

- A. Welding involves a wide range of processes carried out in a variety of working conditions. Only workers with appropriate levels of competence and skill should do welding. They must know:
 - a. the right way to do the work
 - b. the hazards of the work
 - c. how to prevent those hazards from causing harm.
- B. Competence in welding may be shown by an appropriate qualification issued by a registered training organization (such as an industry training organisation (ITO) or Polytechnic) or relevant unit standards for welding from the National Qualifications Framework.
- C. Welders should only use equipment that they have been trained to use.
- D. Welders should be trained in the use of fire extinguishers and hot work permits, if such a system is used.

4.0 EQUIPMENT SELECTION, MAINTENANCE AND SAFETY

- A. Ensure that the right equipment has been selected for the particular welding process being carried out. Consult with the manufacturer or supplier of the equipment in order to obtain detailed directions for setting up the equipment, safe usage and maintenance.

5.0 GENERAL HEALTH AND SAFETY IN WELDING

- A. **Good Housekeeping** Good housekeeping, especially the removal of combustible materials, is essential.
- B. **Gas** If you can smell gas – don't light any gas torches or use electric welding equipment, and do not rely wholly on your sense of smell to warn you.
- C. **Eye Protection** Wear eye protection and cover bare skin. Be aware that:
 - a. arc flash can occur through the side of the eye
 - b. arc flash can cause 'sunburn' on exposed skin.

- D. Hot Surfaces Mark hot surfaces as such, perhaps using common chalk. Better still assume that everything is hot.
- E. First aid In addition to standard training, first-aiders in welding situations should know about the symptoms of electric shock, arc flash and the consequences of exposure to heated coatings on metals. Competency in resuscitation techniques is required, especially in association with confined space work.

6.0 FIRE AND EXPLOSION PREVENTION AND HOT WORK

- A. Prevent the ignition of combustible materials (solvents, oils, etc.) that may be near the welding process. No gas cutting or welding should be carried out near any battery charging stations.
- B. Know how to use gas equipment safely.
 - a. Oxygen under pressure can cause the spontaneous combustion of oil or grease. Keep all regulators and air hoses free of oil and grease, and avoid getting grease/oil on hands, gloves and overalls.
 - b. Use the right gases for the situation. **Never** substitute oxygen for compressed air, as it could produce an explosive atmosphere.
 - c. Acetylene and oxygen bottles should always be fitted with flashback arrestors.
 - d. In confined spaces, the risk of fuel gases (acetylene and oxygen) and air combining to ignite or explode is increased. Don't allow welding gas supply lines to lie in a confined space where they may leak.
 - e. Keep appropriate fire extinguishers and water hoses available and visible at all times, ready for immediate use. Make sure staff are trained in their use.
 - f. If a permit to work system is in place, consider the use of a Hot Work Permit, such as the example, which follows:
 - g. EXAMPLE: Permit to Work and HOT WORK PERMIT forms

7.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

- A. Standard personal protective equipment (PPE) for the variety of welding processes includes:
 - a. welding helmet with a suitable arc flash filter, not less than shade 10. (Note: a) 9 is often used by older people and b) a welding helmet does not protect against fumes.)
 - b. eye protection – and use dark clothing to avoid ultraviolet (UV) rays
 - c. flameproof overalls with long sleeves and neck fastenings
 - d. leather gauntlets
 - e. apron
 - f. respiratory protection (appropriate to the type of welding, e.g. for lead, lead-bearing materials, steel coated with lead-zinc paints, zinc or cadmium coated metals which may give off toxic fumes))
 - g. hearing protection

- B. Welding without this protection may allow bare skin to be exposed to the welding arc.
- C. Eye protection may be worn under a welding helmet for additional protection. Eye protection must be worn when using a tool such as a chipping hammer or powered grinder to prepare or deslag metal.
- D. Additional items of protective clothing/equipment should include:
 - a. a cap
 - b. neck covering (for protection from arc flash in confined spaces)
 - c. spats or leggings
 - d. steel-capped boots
 - e. welding screens

8.0 FUME AND GAS CONTROL

- A. Exposure to welding and cutting gases and fumes can result in serious health effects, including allergic reactions. Unsafe atmospheres and toxic welding gases and fumes may create a risk of discomfort, suffocation, fire and/or poisoning.
- B. Nuisance dusts can also be created while welding and cutting, which should be controlled at the source.
- C. Inert shielding gases may pose risks of oxygen depletion and therefore suffocation, especially in confined spaces.
- D. Welding in confined spaces may increase the risks associated with fumes and gas (see Part 13: Welding in Confined Spaces).
- E. Preparation of metal surfaces may cause toxic fumes or vapours to be released. Examples include:
 - a. when paints or plastic coatings are heated
 - b. if degreasing agents, oil or grease are not removed from metal surfaces
 - c. welding car parts painted with isocyanate paints.
- F. Do not rely on the sense of smell to detect any of these hazards. Some cannot be smelt at all and the sense of smell can become insensitive to those odours it can detect.
- G. Effort should be made to ensure that fumes are controlled, such as:
 - a. Use of a technology that creates less fumes
 - b. Use of local exhaust ventilation, which gather or blow away fumes and gases near the point of generation
 - c. Use dilution technology, such as extraction fans
 - d. Limiting the time of exposure to fumes
 - e. Use of personal protective equipment
 - f. Use of gas detectors

9.0 ELECTRICAL SAFETY

A. Equipment Electrical Safety

- a. Ensure equipment is constructed to the relevant standards. Seek the advice of the equipment supplier or an appropriately qualified specialist when purchasing and/or installing welding equipment
- b. ensure the equipment has the correct current capacity
- c. provide an isolating switch
- d. where a flammable gas or solvent is present, an electrical spark might cause an explosion, so welding should not occur
- e. use a welding machine with an automatic cut-out to ensure the duty cycle cannot be exceeded
- f. check that the welding machine frame has been earthed, paying particular attention to any earth connections
- g. inspect equipment regularly. Do not use equipment with frayed or cracked leads, cables, connectors or fittings or broken switches and cover plates. Do not allow them to be used while waiting for repairs. Leads need to be tested and tagged
- h. select an appropriate rod holder. Check the electrical safety of the rod holder or welding hand piece regularly – maintain or replace hand-piece as required
- i. use the shortest possible leads and ensure they are capable of carrying the required current safely
- j. use a residual current device (RCD) when using hand-held power tools
- k. use appropriately-rated powerboards rather than double adaptors or piggyback plugs

B. Safe Use of Equipment

- a. if any equipment becomes wet, disconnect primary power and allow to dry
- b. be aware of welding where water may be present (showers, kitchens, surface/ground water, etc.)
- c. perform work on a dry, insulated floor, especially in confined spaces
- d. never twist or knot a lead, bend it sharply, tack it to a wall or drape it over your body
- e. dry your hands before welding. If you get sweaty, dry off, take a break and use a wooden duckboard to insulate yourself. Change clothes if necessary.
- f. take extreme care so as to not place one's body in such a position so as to complete a path for the passage of an electric circuit
- g. disconnect electrical equipment immediately after use
- h. pull on the plug, not the lead, to unplug equipment
- i. use welding gloves – keep them and any protective clothing dry. Don't work in the rain. Don't hold electrodes under the armpits.

- C. If you use a petrol-diesel motor generator to power a welding set, be aware that carbon monoxide can kill quickly. Do not use in confined spaces.

10.0 SAFE USE OF WELDING AND CUTTING GASES AND EQUIPMENT

A. Storage of Gas Bottles

- a. cylinders should be correctly labeled, properly secured against falls and stored upright, in a well ventilated area
- b. cylinders should be returned to safe storage after use, ensuring that valves are tightly closed
- c. acetylene gas cylinders and oxygen cylinders should be stored separately
- d. gas cylinders should be kept away from combustible materials, oils or grease, electrical apparatus and any source of heat
- e. gas cylinders should be regularly examined for signs of defects, rusting or leakage
- f. empty cylinders should be managed as if they were full.

B. Handling of Gas Bottles

- a. Never lift a cylinder by the valve cap or guard
- b. Leave valve protection caps/guards in place when cylinders are not in use
- c. Keep cylinder valve outlets clean and free from contaminants, particularly oil and water
- d. Do not use cylinders as rollers or supports or for any other purpose than to contain the gas supplied
- e. Do not subject cylinders to abnormal mechanical shock that may damage their valves or safety devices
- f. Never attempt to repair or modify cylinder valves or safety relief devices. Damaged valves or thread should be tagged and reported immediately to the manager.
- g. Cylinders should be secured when being transported or used

C. Integrity of Other Welding/Gas Cutting Equipment Connected to Gas Cylinders

- a. flashback arrestors must be fitted to acetylene and oxygen bottles and also to hand piece
- b. the integrity of the equipment fitted to gas cylinders should be inspected routinely
- c. cylinders, cylinder valves, couplings, regulators, hoses and apparatus should be kept free of oily or greasy substances
- d. red should be used to identify acetylene (and other fuel gas) hoses, blue for oxygen hoses, and black for inert gas and air hoses
- e. copper piping should not be used with acetylene
- f. if a metal inert gas (MIG) or tungsten inert gas (TIG) welding process is used, check hoses and fittings for leaks.

D. Operators should know:

- a. the correct assembly procedures for attaching equipment to gas cylinders

- b. the correct procedures and materials used for leak testing
- c. the correct procedures for lighting gas torches and shutting them off
- d. the signs of a flashback, what to do in response, how to check if damage has occurred to equipment and the actions necessary if it has occurred
- e. never to crack a fuel gas cylinder valve near a source of ignition
- f. before a regulator is removed, to close the valve and release gas from it
- g. NOT to use the oxygen cylinder to dust off clothing
- h. NOT to use the oxygen to 'sweeten' the atmosphere.
- i. The use of LPG should be avoided in holes and trenches, where it can pool at a low level.
- j. To inspect hoses and hose connections for safe location and any defects before use
- k. To inspect torch for any signs of damage or leaks before use

11.0 METAL PREPARATION

- A. The methods used to prepare metals for welding pose a series of specific hazards, each of which requires control.
 - a. Abrasive Blasting This poses hazards to the eyes, lungs and hearing through noise, vibration and dust creation. Abrasive blasting needs to be carried out in a well ventilated area.
 - b. Mechanical Preparation Power tools (grinders and nibblers) can pose hazards of eye injury, vibration injury and electric shock.
 - c. Use of Degreasing Chemicals There may be exposure to the solvent vapour or to its decomposition products. Solvent vapours may be flammable and explosive. Skin contact can result in occupational dermatitis.
 - d. Cleaning with Caustic or Acid Solutions These can pose hazards of contact with the solution or its corrosive and/or irritant fumes.
 - e. Contaminated Surfaces When coatings on metals are heated it should be assumed that decomposition products are toxic.

12.0 WELDING IN CONFINED SPACES

- B. A confined space is: Any enclosed or partially enclosed space that:
 - a. Is at atmospheric pressure during entry
 - b. Is not intended or designed primarily as a place of work

And

- c. May have restricted means of entry and exit and:
- d. May have an atmosphere which contains potentially harmful levels of contaminants
- e. Does not have a safe oxygen level
- f. Contains loose material that may result in engulfment

C. Key elements of safe welding in confined spaces include the following.

- a. Access and Emergency Rescue
 - i. A person trained in first aid (including resuscitation techniques) is to act as an observer and must be stationed outside the space.
 - ii. Safe access is required and pre-planned emergency rescue (including a safety belt or lifeline) must be assured through the use of suitable emergency equipment.
- b. Ventilation
 - i. Ventilation for welders in confined spaces is of clear importance. Local exhaust ventilation will be needed. Don't enter a confined space unless you are sure the atmosphere is safe. Consider use of an oxygen meter.
- c. Atmosphere Testing. The atmosphere in a confined space may become rapidly depleted in oxygen content.
 - i. Check with a monitoring device before entry. As welding proceeds, inert gases may rapidly displace oxygen – check the atmosphere with a continuous monitor located near the welder's breathing zone.
 - ii. Check for toxic or explosive atmospheres, if appropriate.
- d. Arc flash
 - i. Reflected arc flash in a confined space may affect bare skin (e.g. the back of the neck).
- e. Fire Protection
 - i. Where flammable material cannot be adequately protected, the area must be sprayed with water while work is in progress. Consider having a fire watch.
 - ii. Molten metal, slag and sparks must be prevented from falling onto flammable materials, e.g. conveyors, polyurethane screens, linatex linings, etc.
 - iii. Cylinders should be above cutting point so that sparks, slag, and molten material cannot fall on hoses or onto fusible plugs.
- f. Heat Stress Confined spaces may be hot because of solar load (if outside), or may become hot during the pre-heating of metals.
 - i. Take precautions to prevent heat affecting the worker.
 - ii. Cool air is one option but may not provide sufficient protection against radiant heat from hot surfaces.
 - iii. limit the welder's working time.
- g. Permit to Work
 - i. Welding in a confined space should be subject to a permit to work.

13.0 HOT METALS SPARKS

- A. Hot metal sparks are a constant hazard in many welding processes. Essential safety measures are to ensure:

- a. good housekeeping
- b. training in the selection and use of fire-fighting equipment
- c. prevention of sparks, slag entering clothing/boots through the use of flame-resistant personal protective equipment.

15.0 RADIATION (ULTRAVIOLET, INFRARED AND LASERS)

- A. Hazards of ultraviolet radiation from arc flash can affect both the eyes and skin and are covered elsewhere in this booklet. The skin has its own warning mechanism for thermal radiation but the eyes do not. When exposed to heat, the eyes should be protected.

16.0 MONITORING

- A. Environmental Monitoring
 - a. This may be required to assess the level of exposure to welding fumes, to monitor exposure to gases such as ozone or nitrogen oxides produced during certain welding processes or to monitor oxygen content or the build up of explosive gases in confined spaces.
- B. Personal Health Monitoring
 - a. This must be carried out, with the person's informed consent, if they are faced with a significant hazard. Hearing, vision and lung function testing are typically monitored in welders.