MEM05 Metal and Engineering
Training Package

MEM05020C
Perform advanced welding using gas tungsten arc welding process (steel edition)

Learner guide

Version 2

Training and Education Support
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Electrical safety
Welding operators commencing study of this advanced welding unit must be familiar with the dangers and risks associated with working with electrical welding equipment. Summarising the causes and effects of electric shock include the following:

Electric shock - low voltage
Electric shocks are possible on the secondary (low voltage) side of the welding circuit. They may be caused by:

- Working on wet floors - a shock may be felt when contact is made with machine parts, torch, filler rod or return clamp. Always stand on insulated mats or wooden boards to reduce the risk
- Always wear dry leather gloves or gauntlets
- Working in a very humid climate or rainy weather - Keep torch, filler rods, leads and gloves dry at all times.

Electric shocks - high voltage
High voltage shocks can be avoided by:

- Having power sources checked and tested on a regular basis by licensed electrical repairers
- Operators **never** interfering with internal electrical components of a welding power source.

Symptoms of electrical shock
The severity of an electric shock can range from a “tingling” sensation, muscle spasms, burns, or in extreme cases, death. When electricity passes through the body, particularly through the arms or legs it causes muscles to contract. When the heart is in this current path it can stop it beating.

Factors which affect the severity of an electric shock include:

- The open circuit voltage (OCV) of the power source
- Whether the power source supply is alternating (a.c.) or direct current (d.c.)
- The amount of moisture generated from perspiration, humidity or other source
- How well the operator is insulated from the torch, filler rod and the workpiece
- The parts of the body in contact with the work and/or the torch or filler rod. Current flow from hand to hand or hand to foot via the torso (heart) are the most dangerous
- Susceptibility of the victim to shock which is influenced by a persons general health and wellbeing as well as other factors.

Voltage reduction device

VRD's are usually rendered inactive when using GTAW, however safety investigations into workplace fatalities associated with welding have resulted in a tightening of safety requirements when performing on-site welding. One outcome is that manufacturers of welding plant are now incorporating voltage reduction devices (VRD) technology into their welding plant.

VRD safety devices are fitted into power sources to ***eliminate the risk of electrocution from the secondary welding circuit***. When a VRD is fitted to a power source it reduces the maximum uploaded open circuit voltage across the output terminals of the machine to a safe level of approximately 12 volts.

When a load of low resistance is applied to the welding circuit, the VRD will sense this change and activate the welding machine to allow welding to commence.

It is recommended that welding machines are fitted with VRD technology where operators are required to work in a hazardous or **category C** environment (refer to AS1674.2:2007 for more details). Such an environment would include:

- Confined spaces
- Humid environments
- Wet areas
- Conditions where operators may perspire excessively.

Note: Where existing machines do not have this facility it is recommended that they be replaced or retro-fitted to conform.

High Frequency

The GTAW process uses a high frequency (HF) to start the arc. Although it will not give a shock it can give the operator a fright or scare which can cause an injury such as a fall when welding at heights or in a confined space. For example, if an operator is not wearing gloves or the gloves are in poor condition, a stray HF spark can cause a skin burn.

For this reason it is important that welding leads carrying a HF are regularly inspected to ensure they are in good repair. Damaged leads, due to heat burn or cuts will allow the HF to leak from inside the insulated lead.

High frequency causes a corona discharge which can slowly deteriorate or break down the rubber insulation around the power lead. Neoprene sheathing fitted to some leads resist this breakdown effect.

Weld fume

Welding fumes consist of:

- Particulate fume, the part you can see

  and

- Gaseous fume, the invisible part you usually smell

Particulate fume is formed from vaporisation of the welding consumable and parent metal.

Although GTAW produces less visible fume than other arc welding processes, gaseous fumes are still present. The intense ultraviolet (UV) light emitted by the GTAW process reacts with oxygen in the surrounding atmosphere to form toxic ozone (O_3).

Ozone is formed during welding by the ultraviolet light reacting with the surrounding oxygen in a similar way that ozone is created during lightning strikes or atmospheric storms. Although ozone is harmful to the human body, good ventilation around the welding area should prevent any harm to operators.

High ozone exposure levels are produced particularly when welding aluminium and aluminium alloys.

A summary of fume generation sources include:

- Elements within the parent metal and filler rod
- The production of toxic gases such as ozone
- Incomplete combustion or oxidation of nitrogen from the atmosphere
- Surface coatings on steel such as:
  - Galvanising
  - Cadmium plating
  - Chrome plating
  - Paints and solvents (e.g. red oxide, coated parts and degreasing solvents).

Effects of gases, dusts and vapours

Depending on the exposure time and volume of fume, breathing in gases, dust and vapours may cause:

- Ailments from irritation of the respiratory tract to serious lung disorders
- An acute flu-like illness often referred to as "metal fume fever"
- Asphyxiation due to oxygen depletion in the work area such as in a confined space or area where there is restricted air flow
- A build-up of poisonous metals in the body from elements within the parent metal, surface coatings or welding consumables.

Fume exposure levels and measurements are norrmally determined by the Work, Heath and Safety (WHS) Act 2011 and the WHS Regulations, authorities and other government statutory bodies. Their purpose is to advise and ensure fabrication companies take steps to limit the concentration of welding fumes in the breathing zone of the operator.

On completion of a measured period of time, a number is calculated to reflect an 8-hour time weighted average (TWA) of the fume concentration in the operator's breathing zone, measured in milligrams of particulates per cubic metre of air.

Other terms used to measure and tabulate fume concentration include:

- Threshold limit value (TLV)
- Permissible exposure limits (PEL)
- Short-term exposure limits (STEL)

Analysis of weld fume content, concentration and exposure levels are used by consumable manufacturers to produce detailed safety information known as Material Safety Data Sheets (MSDS). See *MEM05052A Apply safe welding practices* for more details on MSDS. MSDS's provide Responsible Officers and operators with advice on exposure limits and suggested safety measures to limit inhalation of fumes.

In summary, methods used to ensure air quality is safe to inhale during welding include:

- Keeping your head out of the fume column rising from the weld zone
- Using forced ventilation and respirators when welding harmful fume producing metals such as stainless steel, nickel, nickel alloys, copper or coated metal surfaces such as galvanised or cadmium coated steels
- Using a forced fume extraction system if welding is to be done in a confined space or area where there is restricted air movement
- Respirators must be worn to filter out toxins if natural or forced ventilation is inadequate or the material and/or consumables are likely to generate dangerous fumes
- Limit exposure time to weld fumes (PEL and STEL), such as those documented on material safety data sheets (MSDS) for welding consumables
- Workshops that have high roofs, large doorways and windows allow a natural movement of air to dilute and remove welding fumes making it safe to carryout general welding work.

NOTE: Respirators must be suitable for welding applications and manufactured in accordance with Australian Standard guidelines.

Hot metal, heat and arc rays
You can avoid the effects of these hazards by simply wearing approved protective clothing, footwear and personal protective euqipment (PPE).

Harmful rays
The harmful rays given off from a GTAW arc are:

- Ultraviolet rays (UV)
- Infra red rays (IR).

The arc rays emitted from the GTAW process are particularly concentrated due to its open arc characteristics. Arc rays can quickly burn unprotected skin; this effect is known in industry as ray burn.

Ray burn results in a condition similar to severe sunburn; your skin reddens and then peels. If the burn is severe, blisters and sores may result. Intense UV is capable of penetrating through inadequate, badly damaged or worn clothing, therefore closely woven material designed for welding should be worn at all times.

Arc rays can also harm the eyes causing a condition called "flash" which can result in personal discomfort. The intense ultraviolet light absorbed by the eye causes a superficial and painful keratitis, a dryness and inflammation of the cornea. Symptoms tend to occur several hours after exposure and typically resolve spontaneously within 36 hours. The sensation has been described as "having sand in your eyes".

To protect others working nearby from these harmful rays, it is strongly recommended that portable screens be erected or located around the welding area. Other workers should wear safety glasses which will further reduce the risk of being affected by welding flash.

Grinding tungsten electrodes

Serious injuries have resulted due to incorrect use of bench grinders when preparing tungsten electrodes. Correct instruction and training must be provided before using a grinder to prepare electrodes. It is important read and understand the operating requirements documentd on, or close to the machine. If in doubt seek advice from your supervisor or responsible workplace officer.

Electrodes should be ground by gripping the tungsten firmly in one hand and rotating it with the other. Light pressure should be applied against the abrasive wheel while at the same time moving it across the full face of the wheel until the end of the tungsten forms the recommended profile. Alternatively, specially designed tungsten grinding tools are avilable for this purpose, see topic 3 GTAW consumables for more details.

When grinding tungsten electrodes you must take the following safety precautions:

- Inspect the condition of wheel before use, if it is damaged, worn or running erratically isolate the machine and report the matter immediately to the supervisor or responsible officer
- Always wear safety glasses and ensure guards are in place
- Never wear gloves
- Ensure the clearance between the tool rest and grinding wheel is no greater than 1 mm
- Ensure there is adequate ventilation.

Grinding technique

Note: Inhaling particles of thorium can be extremely dangerous. An approved exhaust system MUST be used when grinding thoriated alloyed electrodes.

Operator wearing appropriate PPE

Review Questions

These questions have been included to help you revise what you have learnt in *Topic 1: GTAW safety.*

Q1. List **two** (2) possible causes of electric shock from the secondary (low voltage) side of the welding circuit.

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Q2. State **four** (4) factors that can affect the severity of an electric shock.

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Q3. Explain why precautions should be taken when using a high frequency.

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Q4. List **three** (3) typical hazardous or category C environments which increase the risk of electric shock.

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Q5. List **four** (4) causes of weld fume.

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Q6. Briefly describe the possible effects of weld fume on welding operators.

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Q7. State **four** (4) precautions operators can take to ensure air is safe to breathe during welding.

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Q8. List **three** (3) safety measures that must be followed when grinding tungsten electrodes.

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True / False questions *(circle the correct response)*

Q9. Particulate fumes are visible to the welding operator.

True False

Q10. Ultraviolet radiation can cause high frequency shocks.

True False

Q11. An exhaust system must be used when grinding thorium tungsten electrodes.

True False

