DIESEL MECHANIC

MINING QUALIFICATIONS AUTHORITY

CODE: OAW

USE WELDING EQUIPMENT

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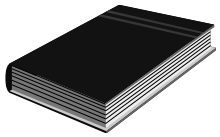
INDEX

The following elements are contained in this learning guide:



SOURCE REFERENCES

Handbook: Introduction to Gas Welding.

Pages 1, 2 and 10 to 13 of book number 2 – “Metal Arc Welding”

Display boards and sample modules.

Sample model: OAW-1

Sample model: OAW-2

Audio-visual aids

Mines Health and Safety Act and Regulations:

- Regulations 11.3.1
- 11.3.3,
- 11.3.4 and
- 11.3.5.

OBJECTIVE

You will be learning towards the outcome “Use welding equipment”. Whilst learning towards the outcome you will be required to achieve the following:

- Basic use of oxy-acetylene welding equipment.
- Safe use of arc welding equipment.

On completion of this module, the learner must be able to:

- Weld an outside corner joint with oxy – acetylene equipment.
- Weld a bead weld on a piece of material with an arc welder.

During this process you must adhere to certain specified requirements as listed in the Module.

ASSESSMENT AND EVALUATION CRITERIA

You will be assessed, when you are confident that you may achieve the outcomes as listed, to determine your competence as measured against the required criteria. This assessment will be in line with accepted best practices regarding assessment.

- A practical test will be set at the end of the module, and must be completed without using references.
- The following standards must be achieved:
    - Corner Joint
        i. The start and finish of the weld must comply with the sample model OAW-1.
        ii. The weld surface must comply with the sample model.
        iii. The angle of the joint must be within ± 2º of that required.
        iv. Blow holes must not appear in the weld.
    - Bead Weld
        i. There must not be any slag inclusions present.
        ii. The start and finish of the run must comply with sample model OAW-2.
        iii. The surface of the weld must comply with the sample model.
- All safety procedures applicable to oxy-acetylene and arc welding must be adhered to.

DICTIONARY

Acetylene : Colourless hydrocarbon gas, C_2H_2, burning with a bright flame, used especially in lighting and welding.

Pressure regulator : Device to regulate pressure in gas cylinders, and adapt it to requirements.

Backfire : Flashback which may occur in the torch of oxy-acetylene welding equipment under faulty application.

Regulate : To allow an even flow.

Weld : To join together by heat or by fusion with electric arc.

Electrode : Rod covered in flux, used for welding.

Clamp : Brace, clasp or band, usually of iron, for strengthening materials or holding things together.

Strike an arc : To complete the electrical circuit through the work piece during arc welding.

HAZARD IDENTIFICATION AND CONTROL (HIAC) FORM

OAW

USE WELDING EQUIPMENT

STEPS IN OPERATION / PROCESS	POTENTIAL ACCIDENT / INCIDENT	CONTROLS (BY RESPONSIBLE PERSON)
1. Inspect and maintain oxy- acetylene equipment.	• Burn injuries from ignition of gas leaking from regulators, damaged hoses and torch attachments.	• Ensure regulators and attachments are properly secured and leak proof. • Check hoses for damage and replace if necessary (do not repair).
	• Possible serious injury and death if flash back causes gas bottles to explode.	• Ensure flash back arresters are installed.
2. Handling and transport of oxy-acetylene equipment.	• Equipment damage due to wrong handling procedures.	• Remove regulators and other fittings that can be damaged. • Do not drag or roll bottles. • Use appropriate trolleys for transporting gas bottles.
3. Inspect and maintain arc welding equipment.	• Danger of electric shock from damaged cables and equipment.	• Inspect power supply and welding cables, electrode and earth clamp for damage and replace if necessary.
4. Use oxy-acetylene equipment.	• Danger of eye injuries and burns from hot material.	• Use appropriate PPE, e.g. correct type protective tinted goggles for gas cutting, leather aprons, leggings, gloves, safety shoes, etc. • Do not wear nylon or other easily inflammable clothing.

	• Fire hazard from ignition of combustible material.	• Do not weld or cut near combustible material or near transformers or switch gear. • Ensure that adequate and appropriate fire fighting equipment is available at the work site.
	• Possible inhalation of noxious fumes and gases resulting from cutting and welding.	• Always cut and weld in well-ventilated areas. • Wear appropriate gas masks when necessary.

NOTE: Before doing the practical work contained in this module, the learner must study the content of the above HIAC form again and then sign the statement below.

The above risks, which will be encountered in this module, are fully understood and will be controlled during the practical work.

Signature of learner: _____

Signature of Training Officer: _____

Date: _____

1. OXY-ACETYLENE WELDING

ITEM / TASK: Introduction.

DESCRIPTION:

A. In oxy-acetylene welding, oxygen and acetylene are mixed in a blowpipe (torch) and a flame hot enough to melt the metal which has to be joined, is produced. A filler rod is used to build up the body of the joint. (Fig 1)

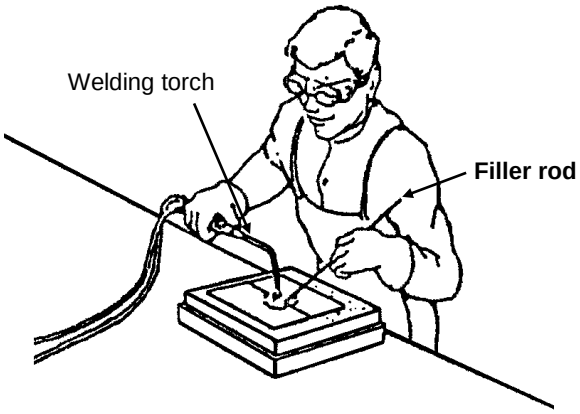


FIG 1.

B. For all the different gas welding procedures described in this module:
   - The regulator pressure for both oxygen and acetylene must be set at 13.8kPa.
   - A size 2 nozzle must be used.
   - A 1.6mm diameter filler rod (BS1453/A1) must be used.

Note:

The correct methods of using oxy-acetylene equipment were explained in Module OA-1. If you are uncertain about these methods, you should read that module again.

ITEM / TASK: Introduction.

DESCRIPTION:

A. **The nozzle**

The number stamped on the shank of the nozzle changes with the diameter of the holes in the nozzle (Fig 2 on the next page). A bigger number means a larger hole.

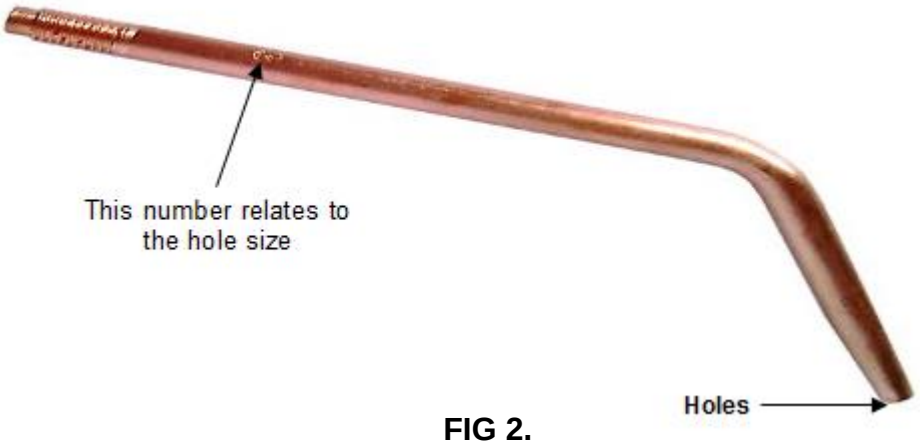


FIG 2.

B. **Lighting and adjusting the blowpipe flame**

- Select a nozzle to suit the material to be welded.
- Fit the nozzle to the blowpipe (welding torch).
- Close all the valves on the blowpipe. (Fig 3)

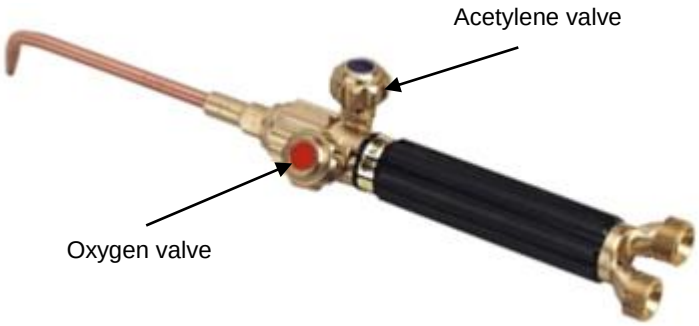


FIG 3.

- Open the valves at the cylinders very slowly for one turn of the spindle only.
- Set both regulators to the correct working pressure of 13.8kPa.
- Open the acetylene control valve on the blowpipe about three quarters of a turn.
- Wait a few seconds to flush the system with acetylene **pointing the blowpipe in a safe direction.**
- Use a spark lighter to light the acetylene. (Fig 4)

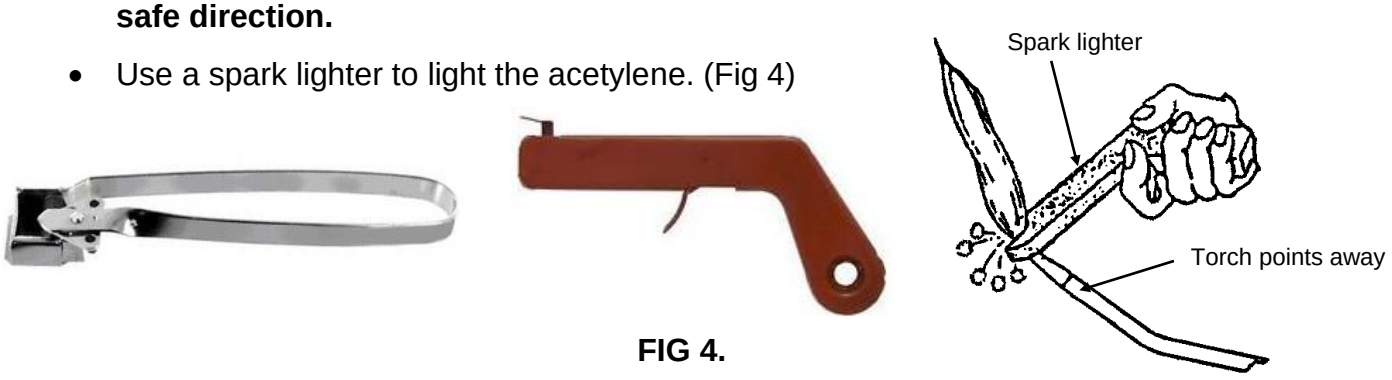


FIG 4.

- Open or close the acetylene valve until the flame burns clearly and ceases to smoke.
- Open the oxygen valve on the blowpipe slowly until the white inner cone has a rounded tip which flickers slightly.

NB:

This is a "neutral" flame and is the one used for welding. To refresh your memory on the various types of flames see Fig 5.

- The flame is extinguished by closing first the acetylene valve and then the oxygen valve on the blowpipe.

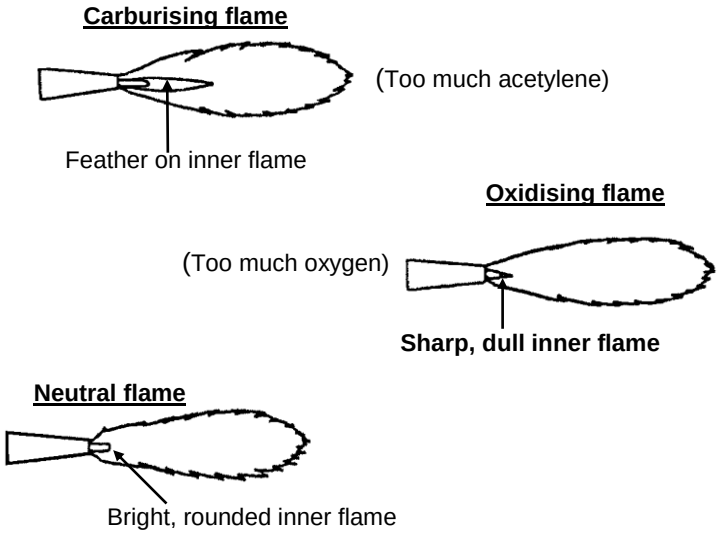
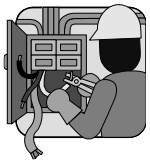


FIG 5.

DO THE PRACTICE ON THE NEXT PAGE
BEFORE CONTINUING WITH THE REST OF THE MODULE.



PRACTICE

NB:

Before you do the practice, read the safety precautions in Module OA-1 and the contents of the HIAC FORM at the beginning of this module and strictly adhere to them.

- Select a nozzle to weld a 1.6mm plate.
- Light the torch and practice producing the three types of flames.

Ask your Training Officer to check your work and if it is correct, to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

ITEM / TASK: Oxy-acetylene welding without filler material (fusion).

DESCRIPTION:

In some cases plates can be welded together by fusion, i.e. it is not always necessary to add filler metal to build up the body of the joint.

Proceed as follows:

- Select and fit the appropriate nozzle to the blowpipe.
- Place the workpiece on a firebrick and support it at one end. (Fig 6)

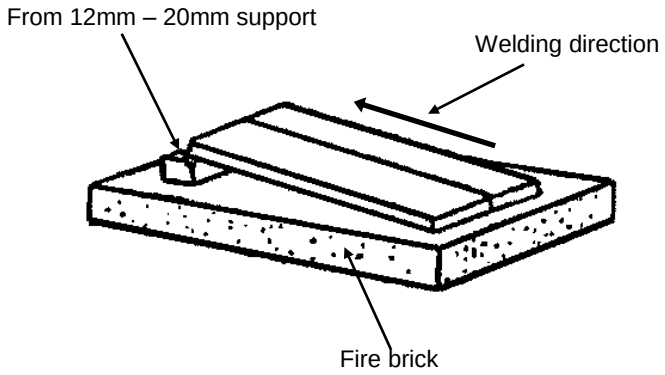


FIG 6.

NB:

The axis of the welding joint must be parallel to the operator's body. (Fig 7)

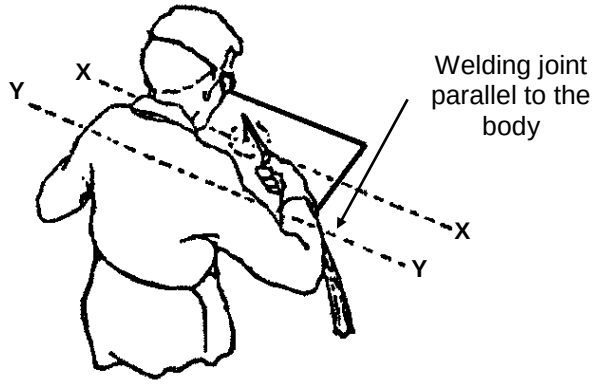


FIG 7.

- Check the regulator setting on the bottles.
- Light the torch and adjust the flame to a "neutral" setting.
- With your goggles in position, lower the blowpipe until the end of the inner cone is about 3mm above the surface of the workpiece and as near to the right-hand edge as possible. (Fig 8)

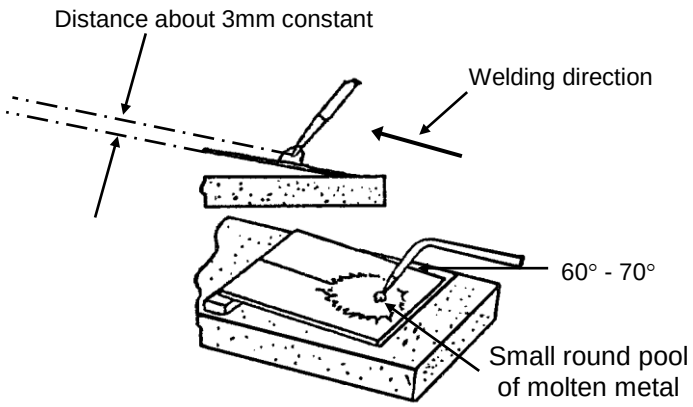


FIG 8.

- Adjust the angle of the nozzle to be at 60° - 70° to the workpiece and pointing in the direction of travel.
- As soon as local fusion (i.e. a small pool of molten metal) appears, move the blowpipe in a leftward direction.
- Synchronise the rate of travel (movement of the torch) with the progressive formation of the molten pool and avoid excess concentration of heat at any one point.

NB:

If the speed of travel is correct, the fused and solidified metal will be uniform in width. (Fig 9)

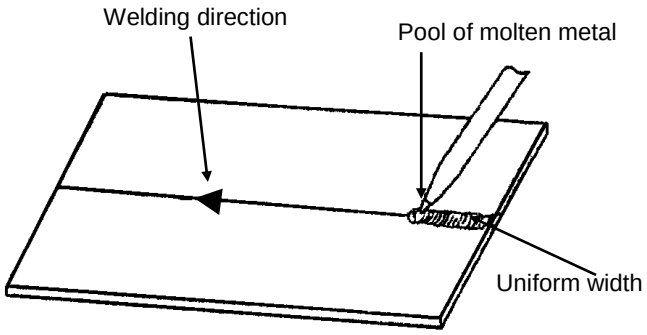


FIG 9.

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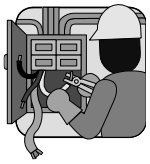

PRACTICE

Take two pieces of 1.6mm mild steel plate and practice welding the two plates together by means of fusion.

The run must be uniform in width.

Ask your Training Officer to check your work and if it is correct, to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

ITEM / TASK: Weld a straight deposit onto a flat mild steel plate.

DESCRIPTION:

- Select an appropriate nozzle and fit it to the blowpipe.
- Place the workpiece on a firebrick and support it at one end.
- Check the regulator setting on the bottles.
- Light the torch and adjust the flame to a "neutral" setting.
- With goggles in position and the blowpipe nozzle held at an angle of 60° - 70°, establish a small pool of molten metal at the right-hand edge of the sheet.

- Hold the filler rod in your left hand, **pointing it at the front edge of the molten pool** and at an angle of 30° - 40° to the surface of the sheet. (Fig 10)

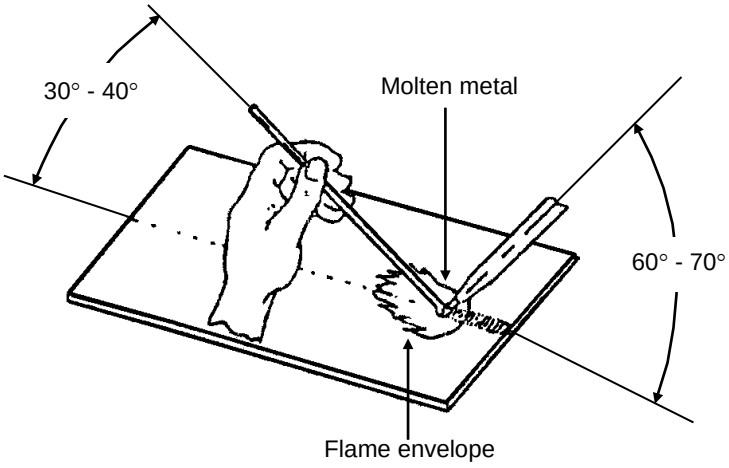

FIG 10.

- Allow the flame to melt a droplet of metal from the end of the filler rod.
- Keep the end of the filler rod within the flame envelope but not in the hot portion near the cone.
- Continue adding molten filler metal by moving the end of the filler rod repeatedly to the front edge of the molten pool and the hotter portion of the flame.
- The rate of travel leftwards should be co-ordinated with the melting of the filler rod to control the size of the bead and the extent of penetration.
- When you are near the left-hand edge of the sheet, slowly withdraw the flame.

NB:

To restart a run after you have stopped, proceed as follows:

- Initially apply the blowpipe nozzle at an 80° angle with the cone pointing on the last 3mm of weld bead deposited. (Fig 11)

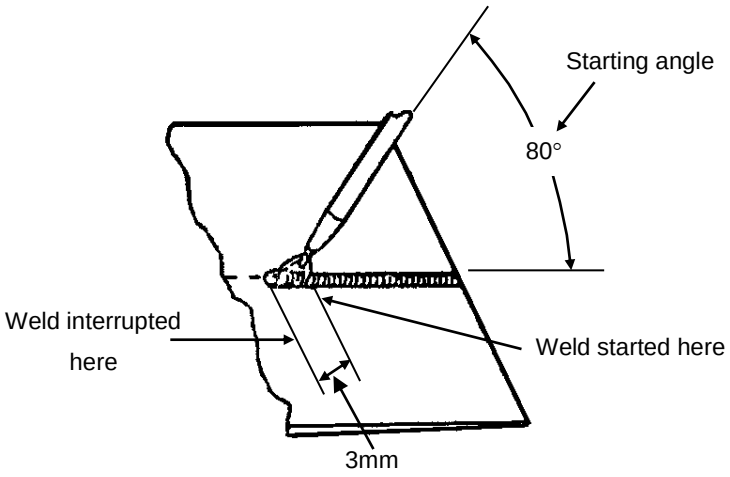

FIG 11.

- Add filler metal to the molten pool when the end of the weld bead has re-melted and proceed with the deposition at the angle of between 60° - 70°.

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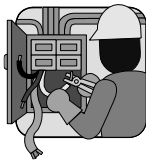

PRACTICE

Take a piece of 1.6mm mild steel plate and practice welding straight runs across the plate with a filler rod.

The run must be uniform in width across the plate.

Ask your Training Officer to check your work and if it is correct, to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

ITEM / TASK: Weld a straight deposit onto a flat plate.

DESCRIPTION:

A. Tack welding is used to maintain a gap and to align parts which have to be welded. (Fig 12)

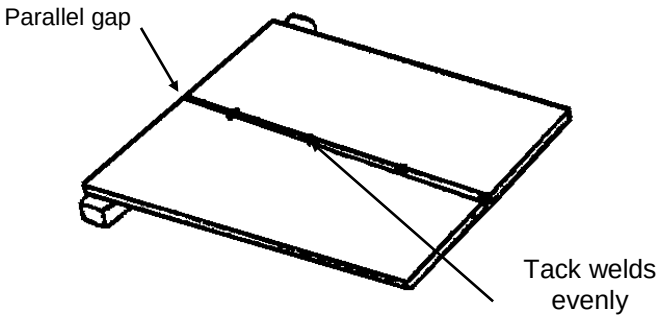

FIG 12.

B. Tack welds on sheet metal should be short in length, but must be sound and sufficient in number to prevent movement of the parts being welded.

C. The distance between tacks should be about 40mm for sheet metal up to 1.6mm thick and about 50mm for sheet metal between 1.6mm and 5.0mm thickness.

D. Use the following procedure:

- Heat a small triangular area with the blowpipe to melt the parent metal in the position where the tack weld is required.
- Add filler metal to the molten pool to make a small but sound weld and then remove the flame.
- Repeat until all the tack welds are made.

NB:

The tack welds should be on the side to be welded and in the line of the joint.

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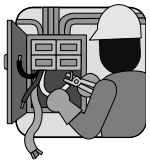

PRACTICE

1. Tack weld two pieces of 1,6mm thick mild steel plate to give an included angle of 90°. (See Fig 13)
2. Weld the joint on the outer edge by fusion. (See Fig 14)
3. Weld a straight run across one plate. (See Fig 15)

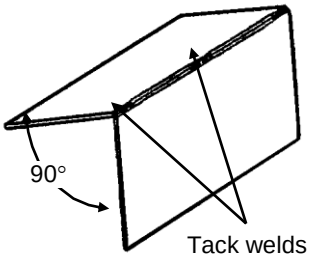

FIG 13.

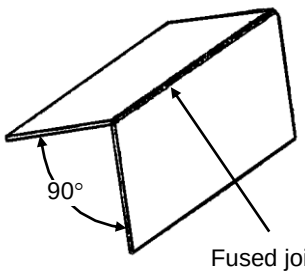

FIG 14.

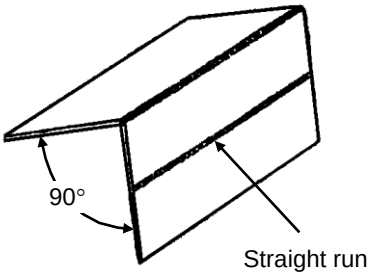

FIG 15.

Compare the appearance of your welded joint with the one on the display board and if it is correct, ask your Training Officer to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

2. ARC WELDING

ITEM / TASK: General information.

DESCRIPTION:

A. In electric arc welding the source of heat to melt the metal comes from an electric arc with a high current flow (amperes) at a low to moderate voltage between the work piece and the electrode. In effect it is a tiny, local electric furnace at the end of the electrode. See Fig 16.

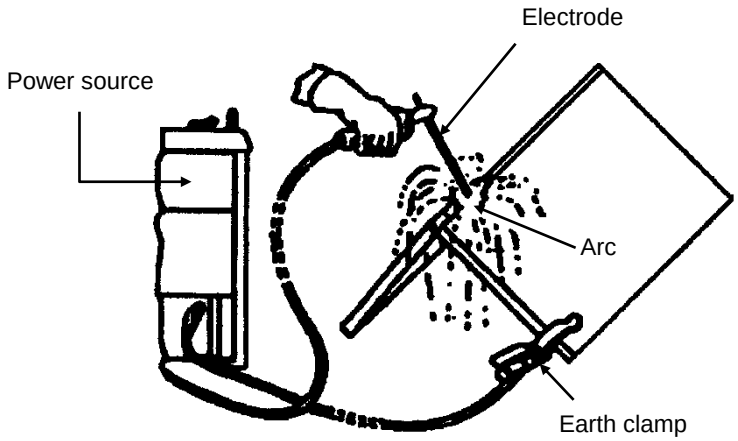

FIG 16.

B. The electric circuit is provided by equipment arranged as shown below.

i. **Welder**

- The welding current is provided by a power source called a welder.
- The most common type of welder is an inverter type.
- The output is adjustable over a wide range to suit different jobs.

FIG 17.

ii. **Electrode holder**

- The current is carried from the welder to the electrode holder by means of a flexible cable.
- The holder needs to be fully insulated. (Fig 18)

FIG 18.

iii. **Electrode**

- The current then flows through the holder to the electrode, which is gripped in the holder.
- The electrode consists of a core wire. It has a flux coating of mineral and alloy materials.
- Between 25 mm and 40 mm of the wire is left bare to provide a good electrical contact with the electrode holder.
- The gases from the flux protect the weld pool from contamination by the atmosphere.
- The melted flux coating produces slag, which helps to shape the weld bead. (Fig 19 on the following page)
- It is important to always select the right electrode for the material and position of the job.

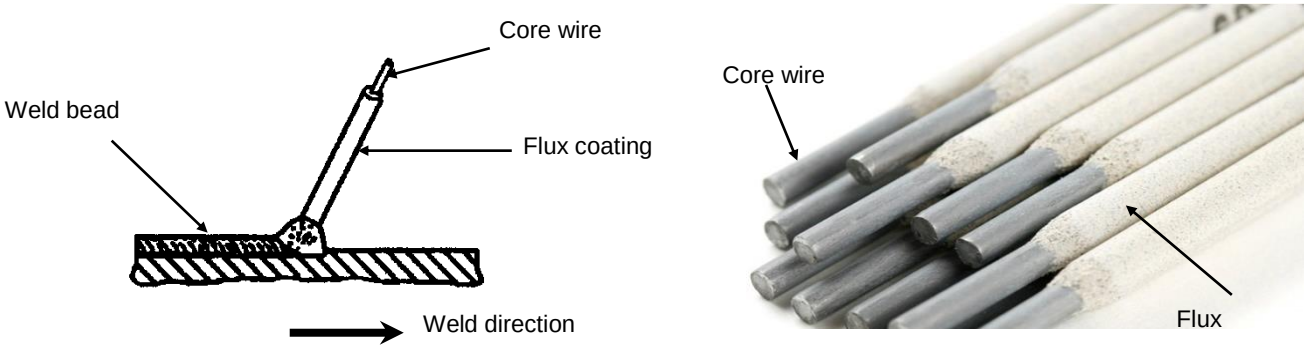

FIG 19.

iv. **Earth clamp**

- From the electrode the current flows through the workpiece to the earth clamp, which can be mounted directly onto the workpiece or onto the metal worktable. (Fig 20 – Screw clamp and Fig 21 – Spring clamp)

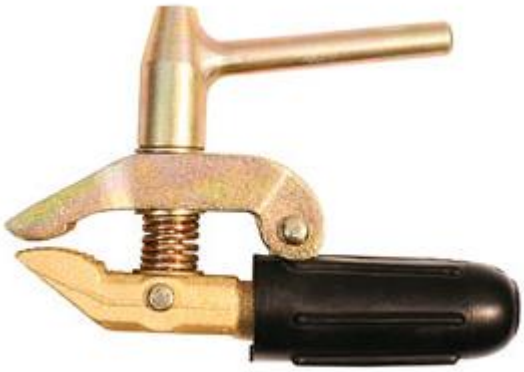

FIG 20.

FIG 21.

- To complete the circuit the current then flows from the earth clamp through a flexible cable back to the power source. (Fig 22)

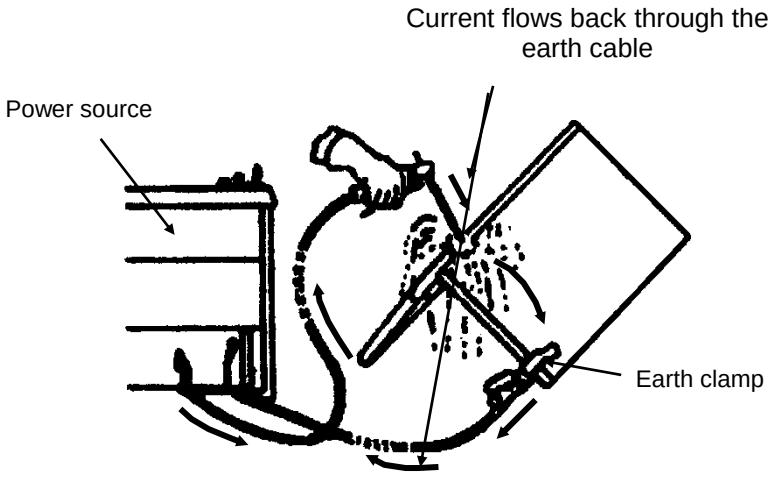

FIG 22.

ITEM / TASK: Selecting an electrode.

DESCRIPTION:

A. The size of the electrode used varies according to the thickness of the material to be welded. See table 1 below.

Recommended Electrode Diameter	
Material selection	**Electrode**
Less than 5mm	3,15mm
5mm to under 8mm	4,00mm
8mm and over	5,00mm

ITEM / TASK: Selecting the current.

DESCRIPTION:

A. The current is selected according to the size of the electrode.
See table 2 below.

Recommended Current	
Electrode size	**Range (Ampere)**
2,00mm	35 – 55
2,50mm	75 - 100
3,15mm	90 – 135
4,00mm	130 – 180
5,00mm	170 - 230

B. The 3.15 mm, 4.00 mm and 5.00 mm electrodes are those most commonly used.

DO THE PRACTICE ON THE NEXT PAGE
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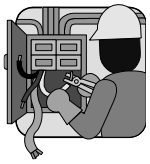


PRACTICE

- Use Tables 1 and 2 to select the appropriate size of electrode and the current range for welding the following plates:
    i. 4mm thickness
    ii. 6mm thickness
    iii. 9mm thickness

- By manipulating the levers of the welding machine, select the above ampere ranges on the machine.

Ask your Training Officer to check your work and if it is correct, to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

ITEM / TASK: Precautions when welding.

DESCRIPTION:

NB: The precautions necessary are simple but essential if the welding is to be done safely and effectively.

A. All electrical connections must be sound. If not, they will overheat and the arc will fluctuate.
B. All insulated components must be in good condition and a proper earth must be used.
C. An electrode holder of adequate amperage rating must always be used for the work to be done.
D. Protect your eyes from intense visible light and ultra-violet and infrared emissions of the arc by **always using a hand or head screen**. (Fig 23 and 24)

FIG 23.

FIG 24.

- A head screen may be used if you need both hands free. (Fig 24)
- The glass filters out the rays and reduces the light to a comfortable working level.
- There is a variety of suitably tinted glasses available which gives the correct protection while still allowing the work to be seen.
- The screen also protects the face and throat from artificial sunburn, sparks and heat from the work.

IMPORTANT:

DO NOT USE oxy-acetylene welding or cutting goggles when using arc-welding equipment.

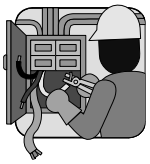
E. A variety of protective clothing is available. You must choose the outfit most suitable for each job.

ITEM / TASK: Safety thoughts.

DESCRIPTION	POTENTIAL HAZARD
A. Leads and cables should be kept clear of passageways.	• Injury to persons.
B. Keep fire extinguishing equipment handy when welding.	• Fire may cause injury to persons, loss of life and damage to equipment.
C. Repair or replace defective cables immediately.	• May cause electric shock.
D. Never strike an arc on any gas cylinder as it may explode.	• An explosion may cause serious injury to persons.
E. Never watch the arc except through lenses of the correct shade.	• May cause temporary loss of eye function.
F. Never use oxygen for venting containers.	• An explosion may cause injury to persons.
G. Keep primary terminals and live parts effectively covered.	• It may cause electric shock.
H. In confined spaces, adequate ventilation and constant observation are essential. It is dangerous to use oxy-acetylene and arc welding equipment in working places that are poorly ventilated.	• A shortage of oxygen may cause suffocation.
I. It is **extremely dangerous** to cut or weld cadmium and zinc plated (galvanised) components where there is inadequate ventilation because toxic vapours are produced. Because it is difficult to identify these materials, extra care must be taken.	• Inhalation of noxious gases.

NB:

ALWAYS CHECK THAT THERE IS SUFFICIENT FRESH AIR BEFORE USING CUTTING OR WELDING EQUIPMENT.



ITEM / TASK: Procedure for striking the arc.

DESCRIPTION:

A. Ensure that the electrical contact between the plate and the bench is good.
B. Select an electrode.
C. Select a suitable current range on the machine.
D. Insert the electrode in the electrode holder.
E. Switch on the machine.
F. With the welding screen in position, lower the electrode until the striking end touches the plate. Use an action similar to that of gently striking a match. (Fig 25)

FIG 25.

FIG 26.

G. Point the electrode downwards and away from the body at an angle of 65° - 75° to the plate surface. (Fig 26)
    - The contact of the electrode end with the plate closes the electrical circuit and the current flows.
H. Immediately withdraw the electrode a slight distance from the plate to establish the welding arc. (Fig 26)

NB:

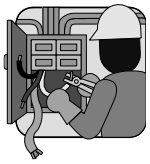
The distance between the plate surface and the electrode end must be approximately 3 mm.

I. Break the arc by withdrawing the electrode end from the plate.

DO THE PRACTICE ON THE NEXT PAGE

BEFORE CONTINUING WITH THE REST OF THE MODULE.

PRACTICE



NB:

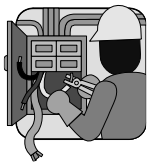
It is extremely dangerous to cut or weld cadmium and zinc plated (galvanised) components where there is inadequate ventilation because toxic vapours are produced. Extra care must be taken when identifying these materials.

ALWAYS CHECK THAT THERE IS SUFFICIENT FRESH AIR BEFORE USING CUTTING OR WELDING EQUIPMENT.

- Use any scrap metal and practice establishing an arc.

If you experience any difficulties, ask your Training Officer for a demonstration. When you have mastered this skill, ask your Training Officer to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :



ITEM / TASK: Make a welding run.

DESCRIPTION:

Although you will be taught to carry out a complete welding run, you will only be required to "tack"

A. Select an electrode.
B. Select the current range.
C. Establish the arc at the left-hand edge.
D. As the metal melts from the electrode it will become shorter. Move the electrode holder progressively toward the plate to maintain the arc and the 3 mm gap between the end of the electrode and the surface of the weld pool.

NB:

The electrode must be held at an angle of 65° - 75° to the plate surface.

E. Combine the above action with a progressive movement along the plate.
F. Aim to synchronise these movements to produce a bead of deposited metal on the surface of the plate. Avoid producing a large pool of molten metal in one spot.
G. Watch the arc length and keep it as constant as possible.
H. Keep an even rate of travel to ensure an even deposit.
I. Remove the scale with a chipping hammer.
J. If the correct arc length has been maintained, the run will be as shown in Fig 27.

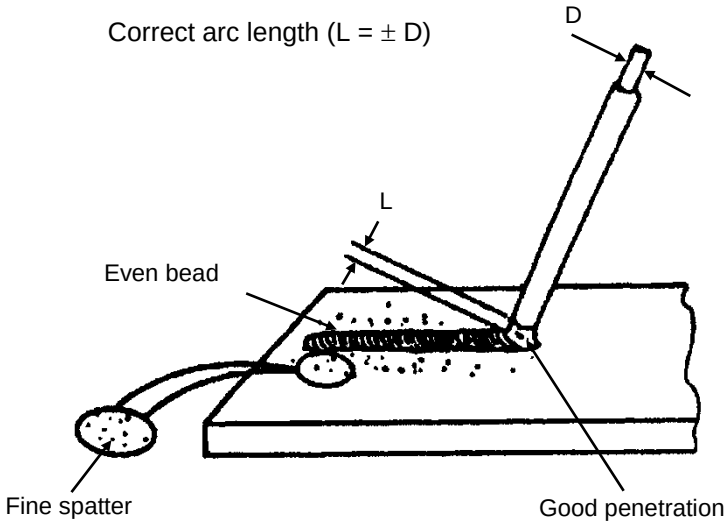


FIG 27.

K. If the arc is too long, it will be deposited noisily and erratically. Large globules of metal will be ejected and excessive spatter will result. (Fig 28)

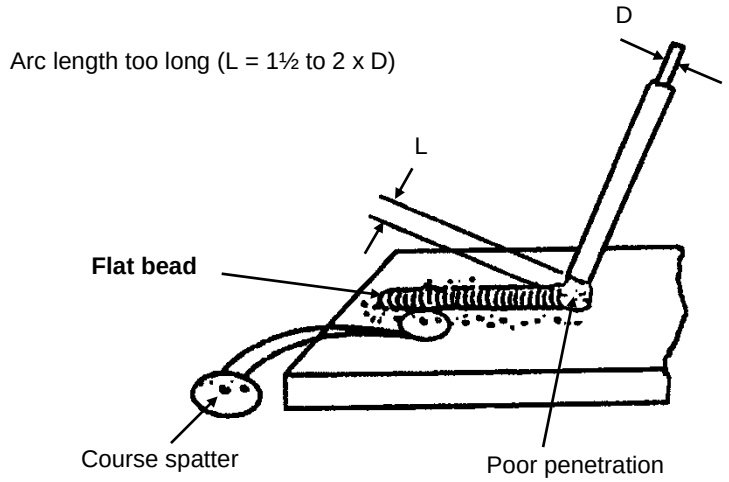


FIG 28.

L. If the arc is too short it will be difficult to maintain the arc and the electrode end may become “frozen” (stuck) in the weld pool. (Fig 29)

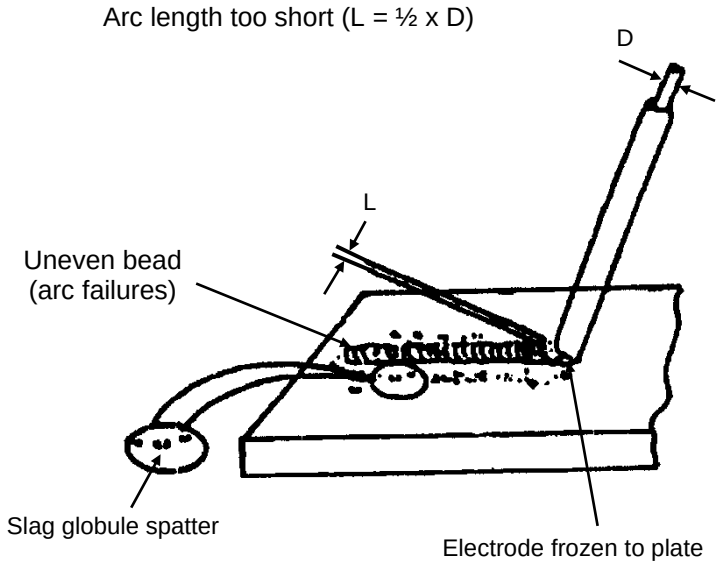
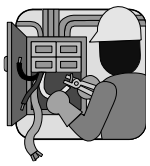


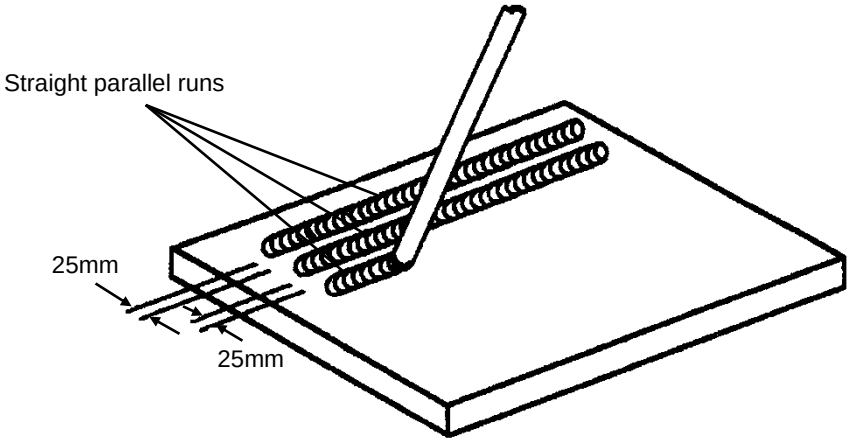
FIG 29.

DO THE PRACTICE ON THE NEXT PAGE BEFORE ATTEMPTING THE ASSESSMENT FOR THE MODULE.



PRACTICE

Practice making straight runs across the length of the plate and parallel with the side of the plate. Leave 25 mm spaces between the runs.



NB:

- The runs must have fine ripples and the bead must have a uniform width throughout.
- Only fine spatter is allowed.
- Compare your work with the model on the display board.

Ask your Training Officer to check your work and if it is correct, to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

REMEMBER ALWAYS WORK SAFE

Once you have passed the entire practices, you are now at liberty to request a Formative Assessment from your Assessor.