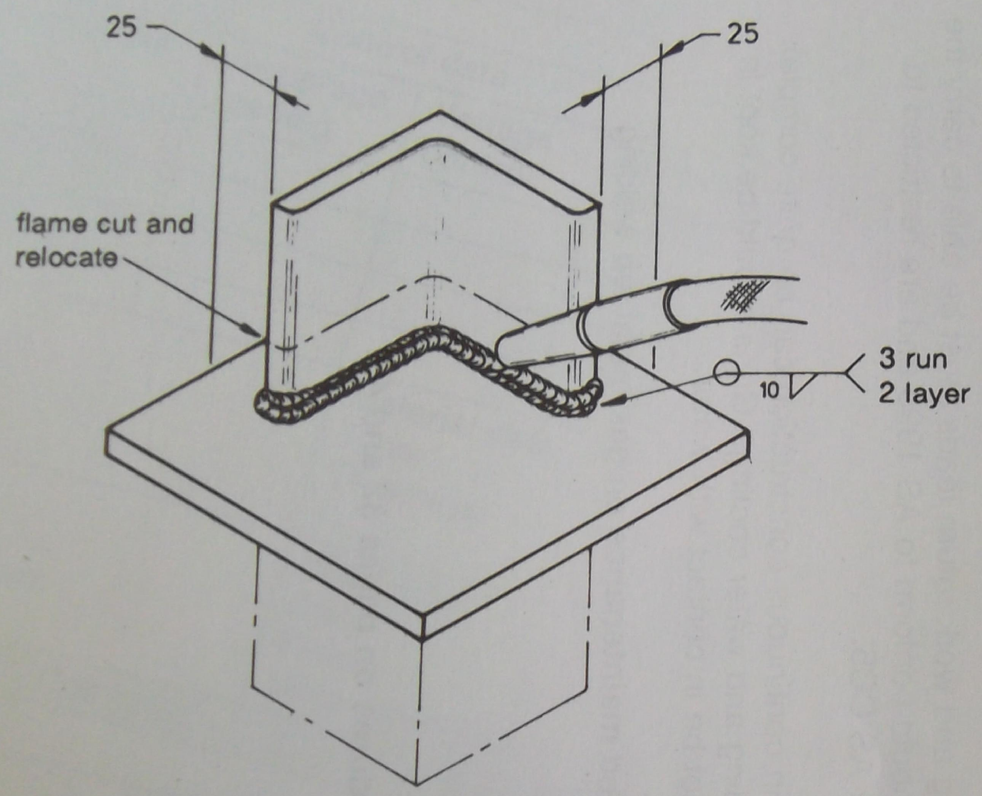
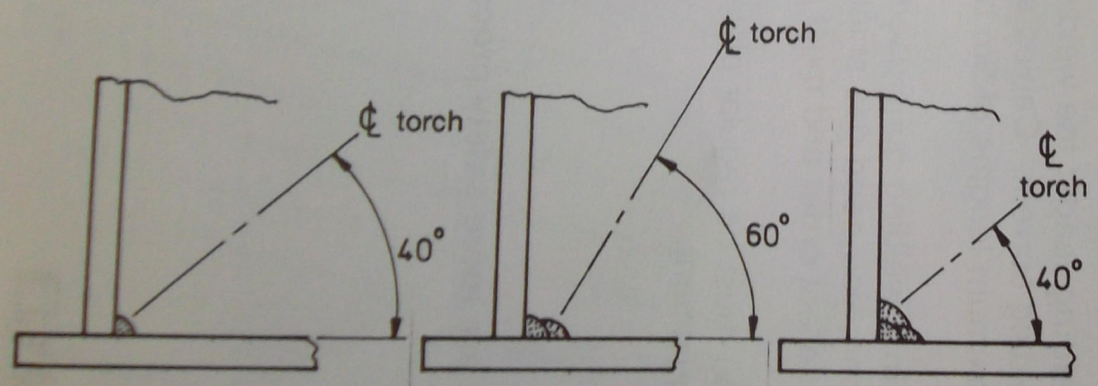
SECTION 6: FILLET WELD - ANGLE TO PLATE - HORIZONTAL





weld-layer sequence

IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE Deposit a 3 run 2 layer fillet weld using the gas metal arc welding process on angle section to plate

POSITION Horizontal

PROCEDURE Your teacher will demonstrate

METHOD

1. Assemble and tack weld the angle section to plate
2. Establish a weld procedure and finalise the first run
3. Submit the assembly for inspection
4. Using a three run, two layer technique complete the weld and submit for inspection
5. Mark out and flame cut the angle section to allow for further practice
6. Relocate the section on the opposite side of the plate and repeat the exercise
7. Evaluate your weld exercise and complete the weld procedure sheet
8. Submit your work for assessment

REQUIREMENTS

- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- a maximum of two significant weld defects per 250mm of weld length with an accumulative area of less than twice the square of the plate thickness
- weld size 10^{+2}_{-0} mm
- undercut to be no greater than 1.5mm per 50% of the weld length

MATERIAL 1 piece 150 x 10 x 150mm low carbon steel plate
1 piece 75 x 75 x 10mm ASEA

UNITS 2

ECONOMY Return unused material to the store
Cut angle and reposition to gain maximum use from material

Safety procedures for gas metal arc welding: Part 3



- *Welding machines*

Direct current machine - supply of direct current by generators (driven by electric motors, petrol or diesel engines).
Transformer/rectifier - supply of alternating and/or direct current as designed.

Arc welding machines should be manufactured and tested to AS 1966 or equivalent standard. They must show a clearly visible nameplate stating the operating conditions of the machine (eg 300 amps, 32 volts, 60% duty cycle).

Although welding machines can supply a wide range of current, they generally operate within the following ranges:

Arc Voltage 16 to 35 V
Open Circuit Voltage (OCV) 50-80V AC
Open Circuit Voltage (OCV) 115 DC

OCV is restricted by Australian Standards AS 1966, AS CC5 and AS MP17.

- **Wire feeders:** where wire feed equipment is used with continuous wire processors, it should be installed and maintained in a safe condition to the manufacturer's recommendations. Particular notice should be taken of the possibility of contact with high voltages and the need for suitable earthing.

- **Welding leads:** the welding and work return leads must be able to carry the welding current. Cables should conform to AS 1995 and are restricted to maximum lengths of 9m by AS CC5.

- **Guns:** welding guns used in continuous construction can be quite complex where you need gas shielding and water cooling. Guns should be kept in excellent order and must not be in contact with water.

- You must do regular planned **maintenance** on gas metal arc welding equipment.

There are more safety procedures on pages 32 and 48.

Section 7: Effects of gas metal arc welding variables

Task: To understand the effects of gas metal arc welding variables on welding. This section covers parts of learning outcomes 2 and 3 of the National Module Descriptor.

Why? So you can use this knowledge in a practical environment to set up and maintain ideal operating conditions for welding carbon steels.

To pass: Consists of short answer and multiple choice questions on gas metal arc welding variables. You'll be tested on this section at the end of the module.

Technical information

If you don't understand any part of this section, ask your teacher for help.

1. Variables

A variable is a change that can be made to the operating conditions of a welding process.

The variables in the gas metal arc welding process are:

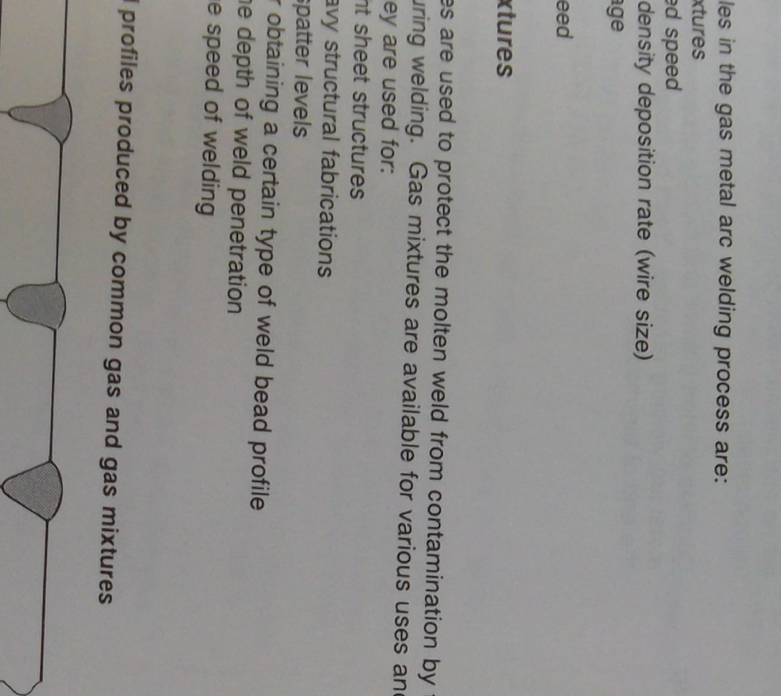
- *gas mixtures*
- *wire feed speed*
- *current density deposition rate (wire size)*
- *arc voltage*
- *stickout*
- *travel speed*

2. Gas mixtures

Shielding gases are used to protect the molten weld from contamination by the atmosphere during welding. Gas mixtures are available for various uses and conditions. They are used for:

- *welding light sheet structures*
- *welding heavy structural fabrications*
- *controlling spatter levels*
- *improving or obtaining a certain type of weld bead profile*
- *increasing the depth of weld penetration*
- *increasing the speed of welding*

Typical weld bead profiles produced by common gas and gas mixtures



Effects of shielding gases on weld bead shape
The recommended flow rates for gas mixtures for general workshop use range from 14 to 18 litres per minute.

Note: *A heater is not required for a mixture of carbon dioxide and argon.*

Characteristics and uses of gas mixtures

Gas mixture %			Characteristics	Uses
carbon dioxide	oxygen	argon		
		99.99	▪ Limited penetration with a good surface finish ▪ Not recommended for welding carbon steels	Aluminium and non-ferrous materials
5	3	92	▪ Active gas addition that produces a rapid freezing with low spatter levels for positional welding, medium penetration	Light medium steels, for example motor vehicle repair, sheetmetal fabrications, light structural work
16	2.5	81.5	▪ Produces a hot arc with deep penetration ▪ High deposition rates ▪ For welding medium to heavy steel section ▪ Medium spatter levels	Medium to heavy sections, for example heavy structural steels, earthmoving equipment and machine bases
23		77	▪ A single active gas addition ▪ Hot arc with deep penetration ▪ Medium spatter levels ▪ For welding alloyed steels	Light to heavy sections, for example chrome, molybdenum steels, quench and tempered steels
100			▪ Welding grade CO2 gives a hot arc ▪ Deep penetration ▪ Because of levels and poor contour it's used where weld finishes are not critical	Medium to heavy sections, for example all low carbon steels and carbon steels and carbon - manganese steels.

Characteristics and uses of gas mixtures

Gas mixture %			Characteristics	Uses
carbon dioxide	oxygen	argon		
		99.99	▪ Limited penetration with a good surface finish ▪ Not recommended for welding carbon steels	Aluminium and non-ferrous materials
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23		77	▪ A single active gas addition ▪ Hot arc with deep penetration ▪ Medium spatter levels ▪ For welding alloyed steels	Light to heavy sections, for example chrome, molybdenum steels, quench and tempered steels
100			▪ Welding grade CO2 gives a hot arc ▪ Deep penetration ▪ Because of levels and poor contour it's used where weld finishes are not critical.	Medium to heavy sections, for example all low carbon steels and carbon steels and carbon - manganese steels.

3. Wire feed speed

Wire feed is controlled by the wire feed unit which is part of the gas metal arc welding plant. You can adjust the wire speed to increase or reduce the feed rate to suit a particular job.

Because of the characteristics of constant potential power sources the welding current output is directly proportional to the wire feed speed (increasing the wire feed speed automatically increases the amperage).

4. Current density deposition rate

The rate of metal transfer is proportional to the current and current density.

Current density is the current per cross sectional area of the electrode wire and is expressed as amperes per mm^2. At a given current there is much higher current density with 0.9mm diameter wire than with 1.2mm diameter wire.

$$\text{Current Density} = \frac{\text{Amperage}}{\text{Cross sectional area}}$$

Wire size in mm	Cross section area mm	Current amps	Current density Amps/mm^2	Deposition rate (kg/hr)
0.9	0.636	200	$\frac{200}{0.636} = 314.46$	higher
1.2	1.130	200	$\frac{200}{1.13} = 176.99$	lower

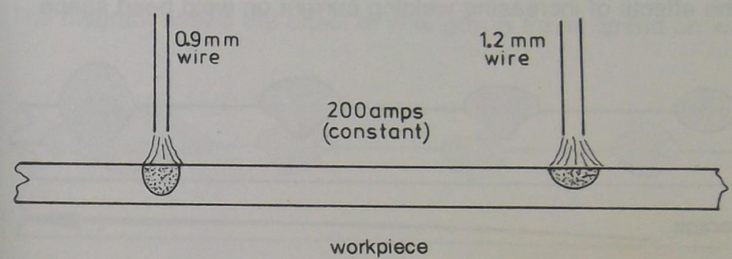
Note: The higher the current density the greater the deposition rate.

The metal deposition rate can be increased by using a thinner wire (giving a higher current density) at the same amperage
or
by using the same wire size but increasing the current.

However there are limitations on how much the current can be increased. Too much current vaporises the wire and practically no transfer takes place.

Machine capacity and duty cycles also determine the upper limit of current. High currents produce very fluid weld pools which make out of position work very difficult. Higher current density (or smaller diameter wire) also gives deeper penetration - see below.

Comparison of wire diameter to current density

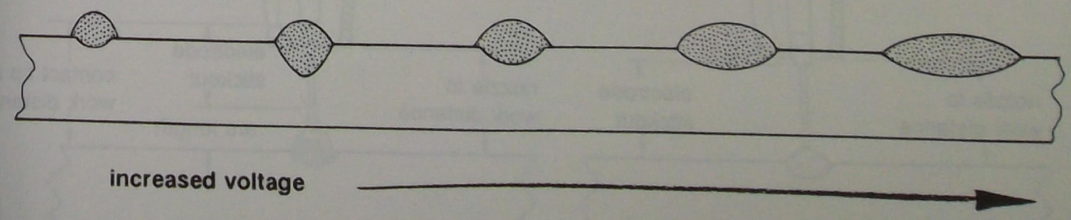


5. Arc voltage

Arc voltage controls the arc length. An increase of voltage increases the arc length and the width of arc at the work surface. It also increases the heat of the arc (if current is maintained) so there is a small increase in deposition rate, even though radiation heat losses are greater.

Increasing arc voltage:
- increases bead width
- increases arc heat
- reduces (flattens) bead height

The diagram shows the effect of arc voltage on weld bead shape and level of penetration:



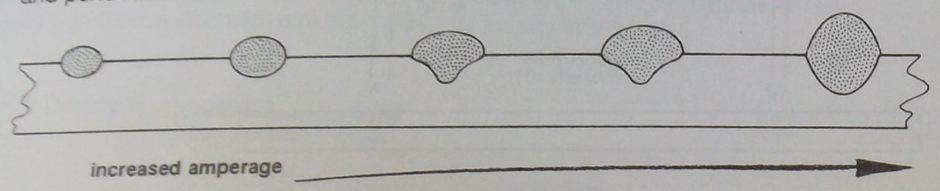
6. Welding current

Welding current is controlled by the wire feed speed. An increase in wire speed will give you:

- an increase in current
- increased penetration
- increased deposition
- increased bead size

It has only a minor effect on bead width. A change of wire size produces a change in current density for any selected current. Higher current densities (reducing wire size) give a more forceful arc and increase penetration and deposition rates.

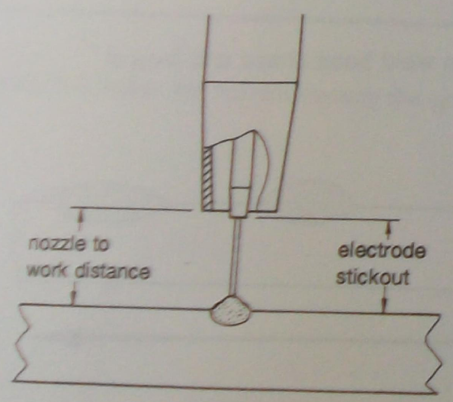
The diagram shows the effects of increasing welding current on weld bead shape and penetration:



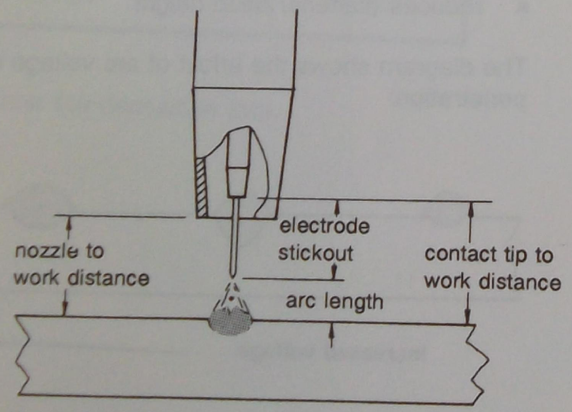
7. Stickout

Electrical stickout is the term used to describe the distance of the wire from the contact tip to the workpiece. An increase in stickout increases the preheat of the wire, reduces heat to the arc pool, slows the melting of the parent metal and decreases penetration.

Variations of stickout can be used by the operator to control the heat input to the workpiece. For example, an increase in stickout automatically reduces the heat input by lowering the current. This can be used to overcome the difficulties of bridging root gap openings from poor fit-ups.



short arc electrode stickout



spray arc electrode stickout

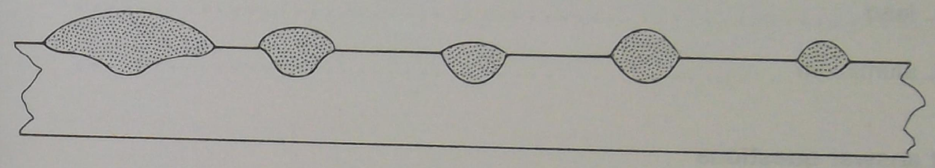
8. Travel speed

This variable contributes to the rate of heat input and amount of deposited metal per metre of weld. A smaller bead is produced as travel speed increases. At very low speeds there is a small increase in penetration, its effect reaches a maximum of some 400-500mm per minute and decreases after that.

Travel speed influences:

- bead height and width
- heat input rate/metre
- deposition rate (volume of metal)

The diagram shows the effect of changes in travel speed on weld profiles:



Review questions

These questions will help you revise what you've learnt in Section 8. The answers are on page 120.

Multiple choice question

1. *Circle the appropriate answer* **a, b, c, d.**

   Argon is the most suitable shielding gas for gas metal arc welding which of the following metals?

   a. steel

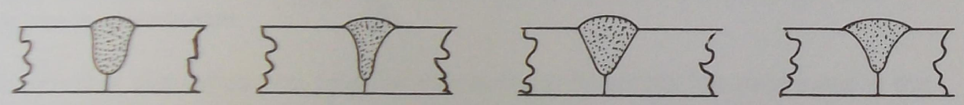
   b. cast-iron

   c. lead

   d. aluminium

Short answer questions

2. *Shielding gases have varying effects on weld bead shape and depth of penetration. In the space provided list the shielding gas used for each profile shown below:*



a. ..... b. ..... c. ..... d. .....

3. When welding with a gas metal arc what effect would increasing the electrode stickout have on the amperes (current) and volts?

   a. Current: .....

   b. Volts: .....

4. Using the following equation provide the current density for 1.0mm diameter wire.

   $$\text{Current Density} = \frac{\text{Amperage}}{\text{Cross sectional area}}$$

Wire size	Cross sectional area mm^2	Amperes	Current density
1.0	0.785	220	

5. Briefly describe the effect on the weld if the gas flow is too high:

   .....

   .....

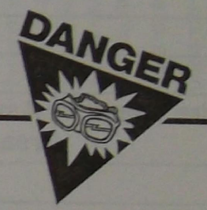
Notes

Section 8 Corner fillet - horizontal

Task: To deposit a multiple run corner fillet weld on low carbon steel plate in the horizontal position. This section covers part of learning outcome 3 of the National Module Descriptor.

Why? So you'll be able to deposit corner fillet welds on low carbon steel plate as required by industry.

To pass: You'll be expected to deposit safely a multiple run fillet weld on low carbon steel plate in the horizontal position to the requirements specified on the work sheet for this section.



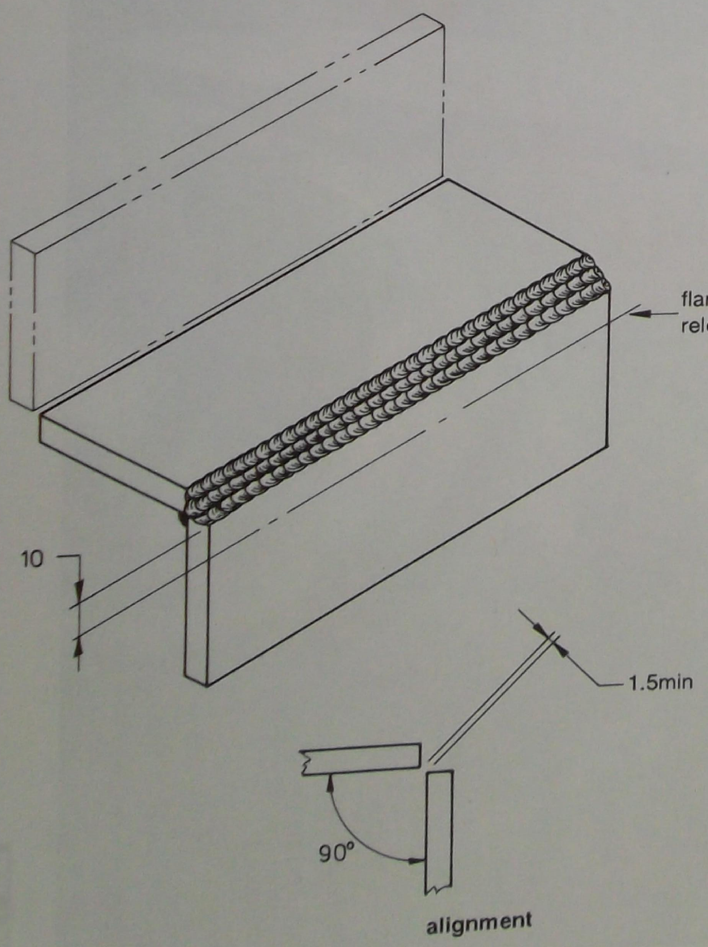
Safety

- Follow OH&S procedures in the workshop.
- Wear approved protective clothing. Don't wear clothes made from nylon material.

PROCEDURE SHEET

SECTION 8: CORNER FILLET WELD - HORIZONTAL						
Sketch						
Machine type:						
		Control data				
Run	Wire speed	Amperage reading	Voltage control	Voltage reading	Transfer mode	
1						
2						
3						
4						
Electrode wire Size Ømm: Type: Classification:			Material data Type: Thickness:			
Shielding gas Type: Flow rate: Litres/min			Weld time Start: Finish: Units completed:			
Assessment			Complies		Doesn't comply	
Alignment and assembly						
Angular distortion						
Surface finish						
Weld size						
Surface defects						
Full radius						
Undercut						
Name				Exercise No.		

SECTION 8: CORNER FILLET WELD - HORIZONTAL



IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE To deposit multiple run corner welds in the horizontal position using fillet welding techniques to the requirements below

POSITION Horizontal

PROCEDURE Your teacher will demonstrate

METHOD

1. Assemble and tack plates using a suitable spacer to maintain root gap
2. Position the plates and deposit approximately 50mm of the root run
3. Examine the bead shape and penetration before continuing the weld
4. Completely fill the remainder of the weld in a logical weld sequence
5. Seal the reverse side with a 6mm horizontal fillet weld
6. After inspection, flame cut the plate and relocate as shown
7. Evaluate your weld exercise and complete the weld procedure sheet
8. Submit your work for assessment

REQUIREMENTS

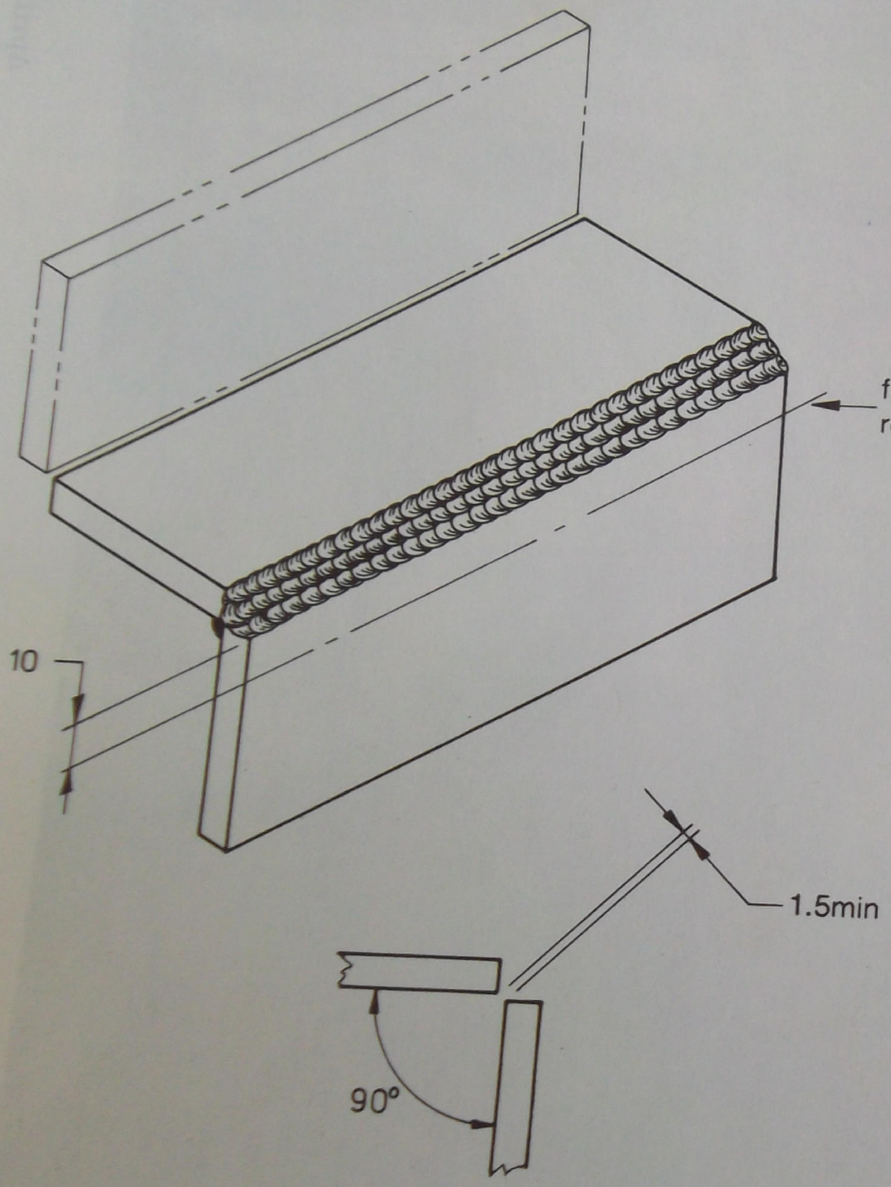
- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- a maximum of two significant weld defects per 250mm (or 225mm plate) of weld length with an accumulative area of less than twice the square of the plate thickness
- weld size 8^{+2}_{-0} mm
- undercut to be no greater than 1.5mm per 50% of the weld length

MATERIAL 2 pieces 50 x 10 x 225mm low carbon steel

UNITS 2

ECONOMY Return unused material to the store
Flame cut material for maximum use as shown

SECTION 8: CORNER FILLET WELD - HORIZONTAL



alignment

IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE To deposit multiple run corner welds in the horizontal position using fillet welding techniques to the requirements below

POSITION Horizontal

PROCEDURE Your teacher will demonstrate

METHOD

1. Assemble and tack plates using a suitable spacer to maintain root gap
2. Position the plates and deposit approximately 50mm of the root run
3. Examine the bead shape and penetration before continuing the weld
4. Completely fill the remainder of the weld in a logical weld sequence
5. Seal the reverse side with a 6mm horizontal fillet weld
6. After inspection, flame cut the plate and relocate as shown
7. Evaluate your weld exercise and complete the weld procedure sheet
8. Submit your work for assessment

REQUIREMENTS

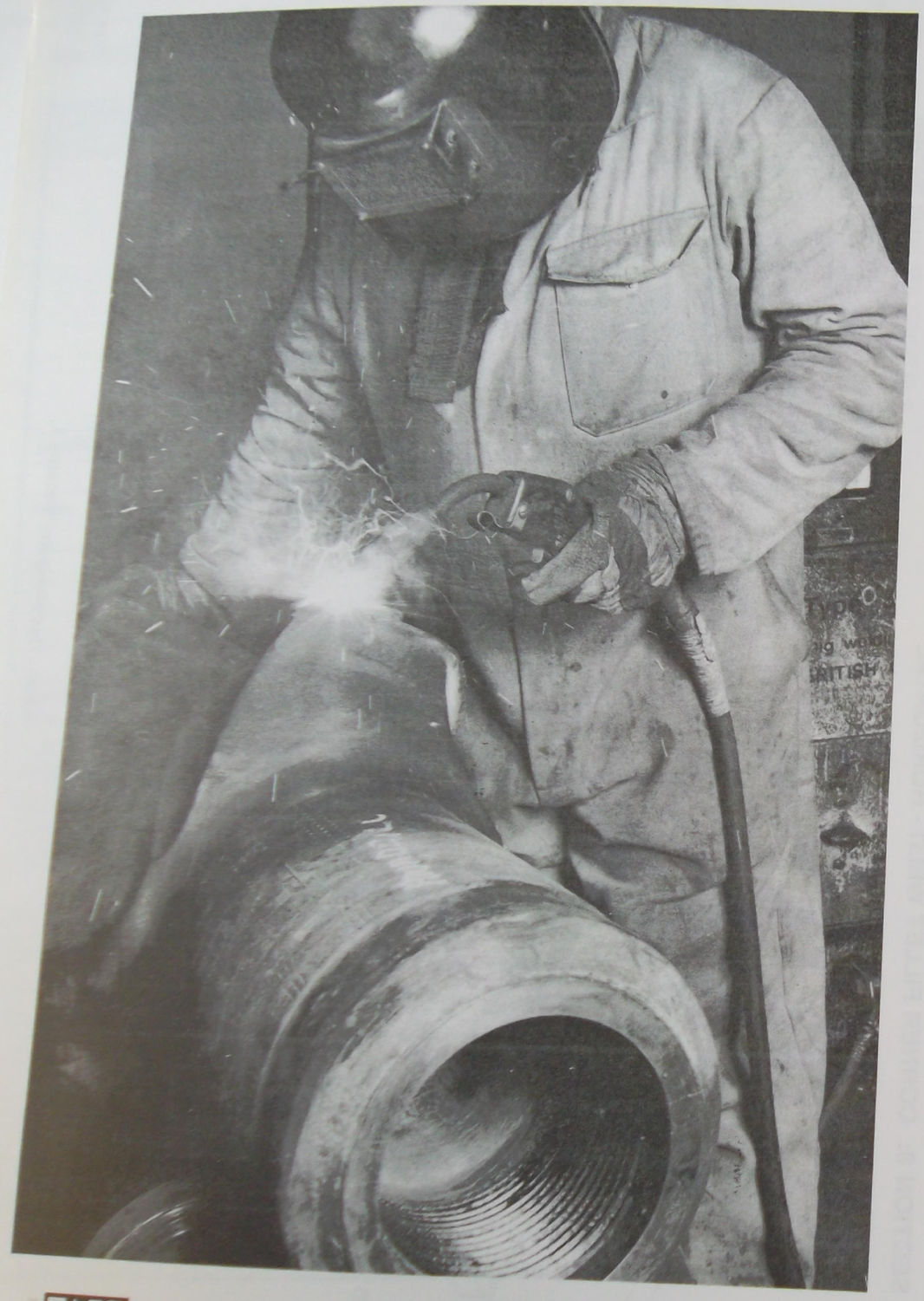
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- undercut to be no greater than 1.5mm per 50% of the weld length

MATERIAL 2 pieces 50 x 10 x 225mm low carbon steel

UNITS 2

ECONOMY Return unused material to the store
Flame cut material for maximum use as shown

An industrial use of gas metal arc welding

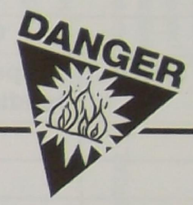


Section 9: Fillet weld - sheet steel - horizontal

Task: To deposit single run fillet welds on low carbon sheet steel in the horizontal position. This section covers part of learning outcome 3 of the National Module Descriptor.

Why? So you'll be able to deposit fillet welds on sheet steel sections as required by industry.

To pass: You'll be expected to deposit safely a single run fillet weld on low carbon sheet steel to the requirements specified on the work sheet for this section.



Safety

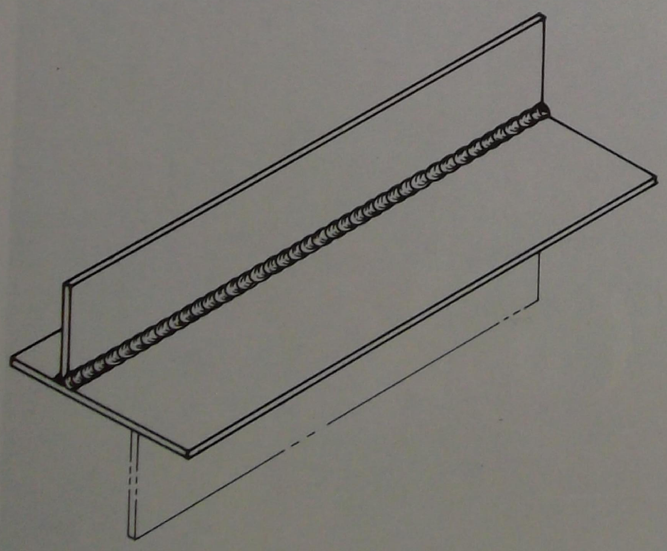
- Follow OH&S procedures in the workshop
- Don't put plastic lighters in your pockets - they can **explode**
- Clean up your area when you've finished working

PROCEDURE SHEET

SECTION 9: FILLET WELD - SHEET STEEL - HORIZONTAL						
Sketch						
Machine type:						
		Control data				
Run	Wire speed	Amperage reading	Voltage control	Voltage reading	Transfer mode	
1						
2						
3						
4						
Electrode wire Size Ømm: Type: Classification:			Material data Type: Thickness:			
Shielding gas Type: Flow rate: Litres/min:			Weld time Start: Finish: Units completed:			
Assessment		Complies		Doesn't comply		
Alignment and assembly						
Angular distortion						
Surface finish						
Weld size						
Surface defects						
Undercut						
Name			Exercise No.			

SECTION 9: FILLET WELD - SHEET STEEL - HORIZONTAL

IF IN DOUBT ASK YOUR TEACHER



OBJECTIVE To deposit single run fillet welds in the horizontal position on low carbon steel sheet to meet the requirements listed below

POSITION Horizontal

PROCEDURE Your teacher will demonstrate

METHOD

1. Wire brush the material
2. Assemble and tack sheets
3. Deposit fillet weld along the weld joint
4. Critically evaluate the weld before welding the other side
5. Add an additional sheet (side 2) and repeat the process
6. Repeat the exercise on 1.6mm and 1.2mm sheet and submit assemblies for assessment
7. Document welding parameters on your procedure sheet

REQUIREMENTS

- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- a maximum of two significant weld defects per 250mm (or 225mm sheet) of weld length with an accumulative area of less than twice the square of the sheet thickness
- weld size to equal to the sheet thickness $^{+2}_{-0}$ mm
- undercut to be no greater than 1mm per 50% of the weld length

MATERIAL

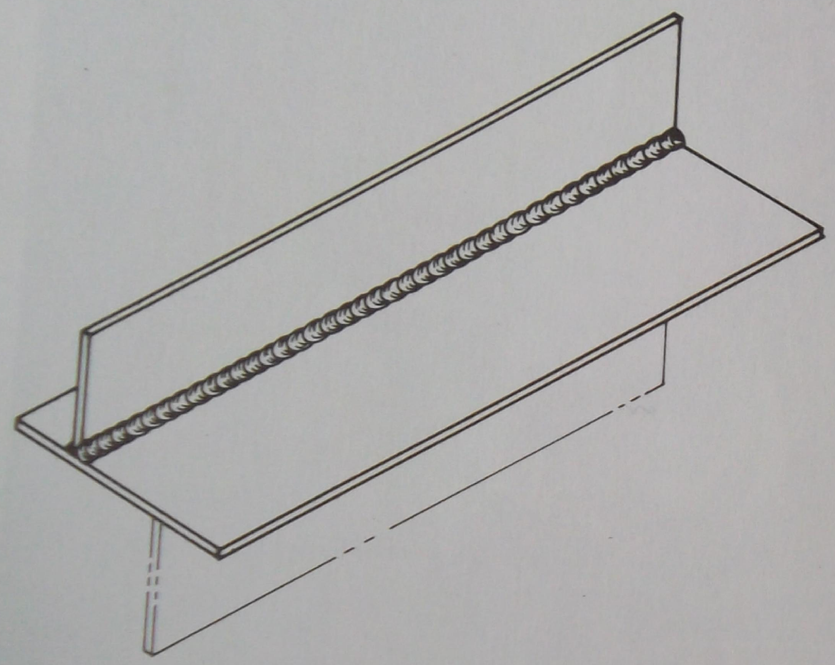
2 pieces low carbon steel 75 x 3 x 225mm sheet
2 pieces low carbon steel 25 x 3 x 225mm sheet
2 pieces low carbon steel 75 x 1.6 x 225mm sheet
2 pieces low carbon steel 25 x 1.6 x 225mm sheet
2 pieces low carbon steel 75 x 1.2 x 225mm sheet
2 pieces low carbon steel 25 x 1.2 x 225mm sheet

UNITS 2

ECONOMY Use stock fully and remember to turn cylinders off after you've finished

SECTION 9: FILLET WELD - SHEET STEEL - HORIZONTAL

IF IN DOUBT ASK YOUR TEACHER



OBJECTIVE To deposit single run fillet welds in the horizontal position on low carbon steel sheet to meet the requirements listed below

POSITION Horizontal

PROCEDURE Your teacher will demonstrate

METHOD

1. Wire brush the material
2. Assemble and tack sheets
3. Deposit fillet weld along the weld joint
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7. Document welding parameters on your procedure sheet

REQUIREMENTS

- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- a maximum of two significant weld defects per 250mm (or 225mm sheet) of weld length with an accumulative area of less than twice the square of the sheet thickness
- weld size to equal to the sheet thickness $^{+2}_{-0}$ mm
- undercut to be no greater than 1mm per 50% of the weld length

MATERIAL

2 pieces low carbon steel 75 x 3 x 225mm sheet
2 pieces low carbon steel 25 x 3 x 225mm sheet
2 pieces low carbon steel 75 x 1.6 x 225mm sheet
2 pieces low carbon steel 25 x 1.6 x 225mm sheet
2 pieces low carbon steel 75 x 1.2 x 225mm sheet
2 pieces low carbon steel 25 x 1.2 x 225mm sheet

UNITS 2

ECONOMY Use stock fully and remember to turn cylinders off after you've finished

Fillet welding using the gas metal arc welding process



Section 10: Fillet weld - sheet steel - horizontal and vertical

Task: To deposit single run fillet welds on low carbon sheet steel in the horizontal and vertical position. This section covers part of learning outcome 3 of the National Module Descriptor.

Why? So you'll be able to deposit fillet welds on sheet steel section as required by industry.

To pass: You'll be expected to deposit safely a single run fillet weld on low carbon sheet steel to the requirements specified on the work sheet for this section.

DANGER

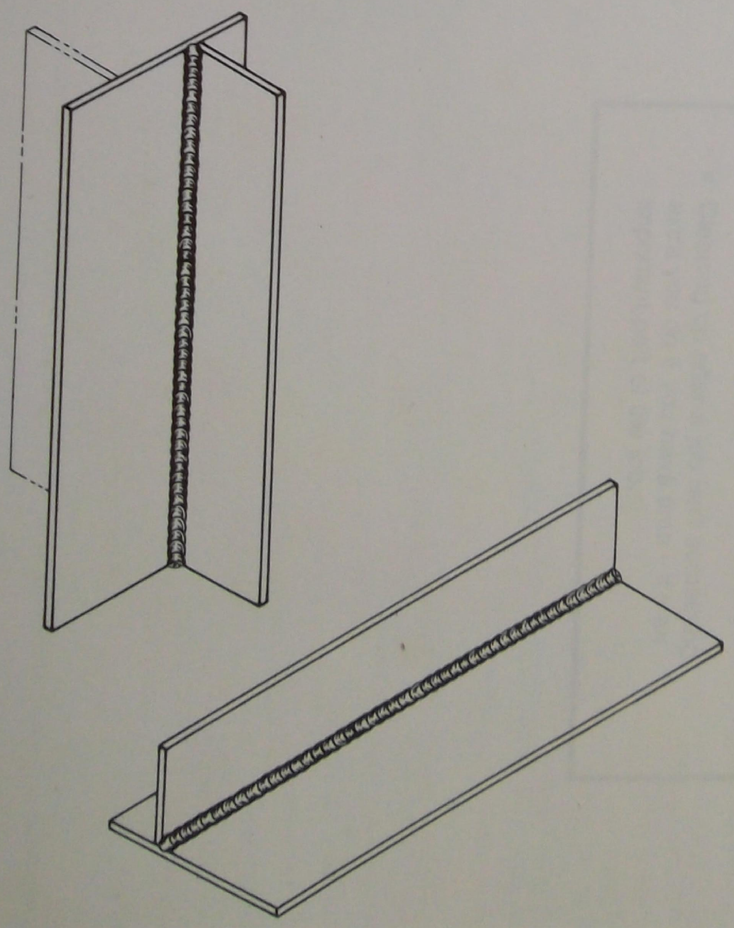
Safety

- Follow OH&S procedures at all times
- Wear correct footwear in the workshop area - no joggers
- Wear clothing made from fire-resistant fibres such as wool and cotton not from nylon material
- Don't wear clothing that has come into contact with any flammable substances such as petrol, diesel, oil or solvents.

PROCEDURE SHEET

SECTION 10: FILLET WELD - SHEET STEEL - HORIZONTAL AND VERTICAL						
Sketch						
Machine type:						
		Control data				
Run	Wire speed	Amperage reading	Voltage control	Voltage reading	Transfer mode	
1						
2						
3						
4						
Electrode wire Size Ømm: Type: Classification:			Material data Type: Thickness:			
Shielding gas Type: Flow rate: Litres/min:			Weld time Start: Finish: Units completed:			
Assessment		Complies		Doesn't comply		
Alignment and assembly						
Angular distortion						
Surface finish						
Weld size						
Surface defects						
Undercut						
Name		Exercise No.				

SECTION 10: FILLET WELD - SHEET STEEL - HORIZONTAL AND VERTICAL



IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE To deposit single run fillet welds on low carbon sheet steel to meet the requirements listed below

POSITION Vertical down and horizontal

PROCEDURE Your teacher will demonstrate

METHOD

1. Wire brush the material to remove surface rust and loose mill scale
2. Assemble and tack plates
3. Deposit fillet weld along the weld joint
4. Critically evaluate the weld before welding the other side
5. Add an additional sheet (side 2) and repeat the process
6. Repeat the exercise and submit assemblies for assessment
7. Complete your procedure sheet

REQUIREMENTS

- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- a maximum of two significant weld defects per 250mm (or 225mm sheet) of weld length with an accumulative area of less than twice the square of the sheet thickness
- weld size equal to the sheet thickness 3^{+2}_{-0} mm
- undercut to be no greater than 1mm per 50% of the weld length

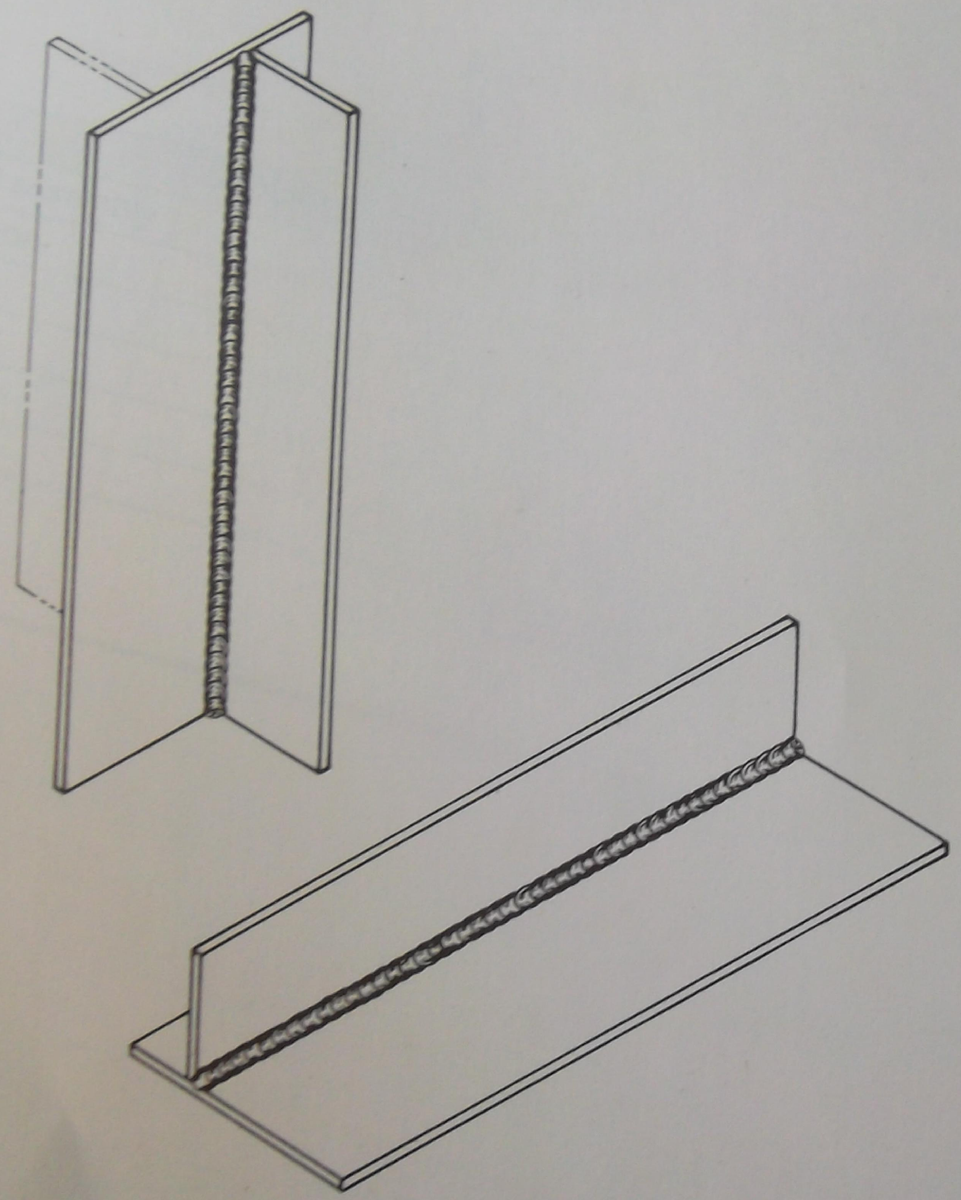
MATERIAL

2 pieces low carbon steel 75 x 3 x 225mm sheet
2 pieces low carbon steel 25 x 3 x 225mm sheet
2 pieces low carbon steel 75 x 1.6 x 225mm sheet
2 pieces low carbon steel 25 x 1.6 x 225mm sheet

UNITS 2

ECONOMY Use stock fully and remember to turn shielding gas cylinders off after you've finished

SECTION 10: FILLET WELD - SHEET STEEL - HORIZONTAL AND VERTICAL



IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE To deposit single run fillet welds on low carbon sheet steel to meet the requirements listed below

POSITION Vertical down and horizontal

PROCEDURE Your teacher will demonstrate

METHOD

1. Wire brush the material to remove surface rust and loose mill scale
2. Assemble and tack plates
3. Deposit fillet weld along the weld joint
4. Critically evaluate the weld before welding the other side
5. Add an additional sheet (side 2) and repeat the process
6. Repeat the exercise and submit assemblies for assessment
7. Complete your procedure sheet

REQUIREMENTS

- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- a maximum of two significant weld defects per 250mm (or 225mm sheet) of weld length with an accumulative area of less than twice the square of the sheet thickness
- weld size equal to the sheet thickness 3^{+2}_{-0} mm
- undercut to be no greater than 1mm per 50% of the weld length

MATERIAL

2 pieces low carbon steel 75 x 3 x 225mm sheet
2 pieces low carbon steel 25 x 3 x 225mm sheet
2 pieces low carbon steel 75 x 1.6 x 225mm sheet
2 pieces low carbon steel 25 x 1.6 x 225mm sheet

UNITS 2

ECONOMY Use stock fully and remember to turn shielding gas cylinders off after you've finished

otes

Section 11: Corner fillet - sheet steel - horizontal and vertical

Task: To deposit corner fillet welds on low carbon sheet steel in the horizontal and vertical positions. This section covers part of learning outcome 3 of the National Module Descriptor.

Why? So you'll be able to deposit fillet welds on sheet steel sections as required by industry.

To pass: You'll be expected to deposit safely single run fillet welds on low carbon sheet steel to the requirements specified on the work sheet for the section.



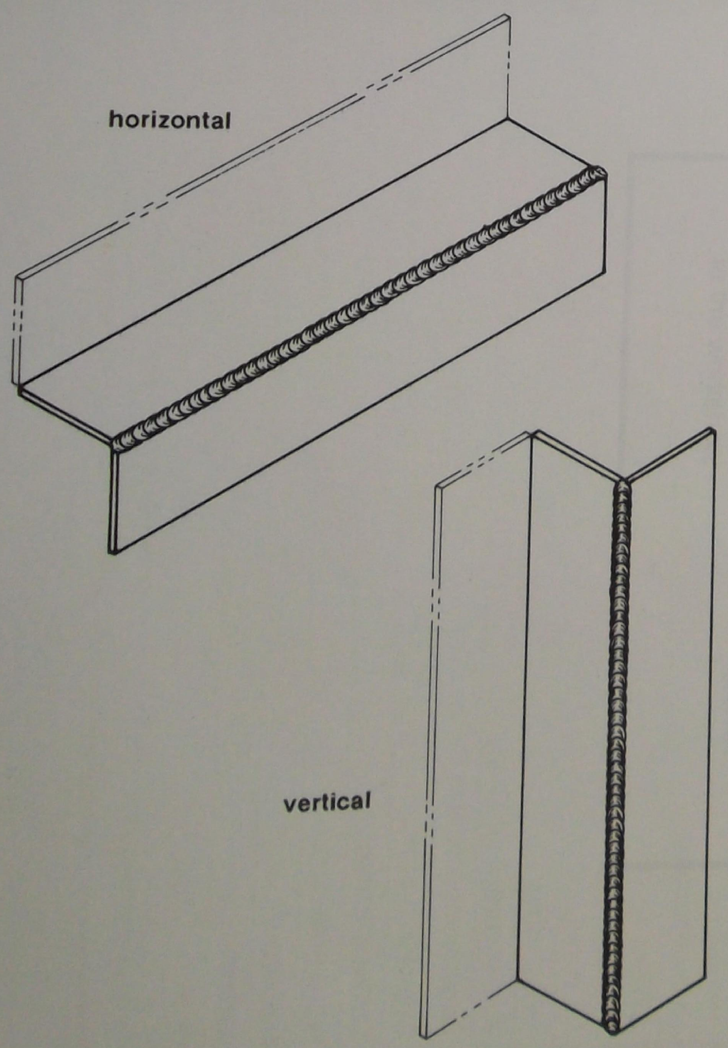
Safety

- Follow OH&S workshop procedures at all times.
- Cleaning up after a job isn't something extra you do if you have time - it's an important part of the job.

PROCEDURE SHEET

SECTION 11: CORNER FILLET - SHEET STEEL - HORIZONTAL AND VERTICAL						
Sketch						
Machine type:						
		Control data				
Run	Wire speed	Amperage reading	Voltage control	Voltage reading	Transfer mode	
1						
2						
3						
4						
Electrode wire			**Material data**			
Size Ømm:			Type:			
Type:			Thickness:			
Classification:						
Shielding gas			**Weld time**			
Type:			Start:			
Flow rate: Litres/min:			Finish:			
			Units completed:			
Assessment	Complies	Doesn't comply				
Alignment and assembly						
Angular distortion						
Surface finish						
Weld size						
Surface defects						
Undercut						
Name		Exercise No.				

SECTION 11: CORNER FILLET - SHEET STEEL - HORIZONTAL AND VERTICAL



IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE To deposit single run outside corner fillet joints to the requirements listed below

POSITION Horizontal and vertical down

PROCEDURE Your teacher will demonstrate

METHOD

1. Wire brush the material to remove surface rust and loose mill scale
2. Assemble and tack plates
3. Deposit a corner weld in the horizontal position
4. Critically evaluate the weld before repeating the exercise
5. After you achieve the reuqired standard repeat the exercise in the vertical position
6. Submit your items for assessment
7. Document welding parameters on your weld procedure sheets

REQUIREMENTS

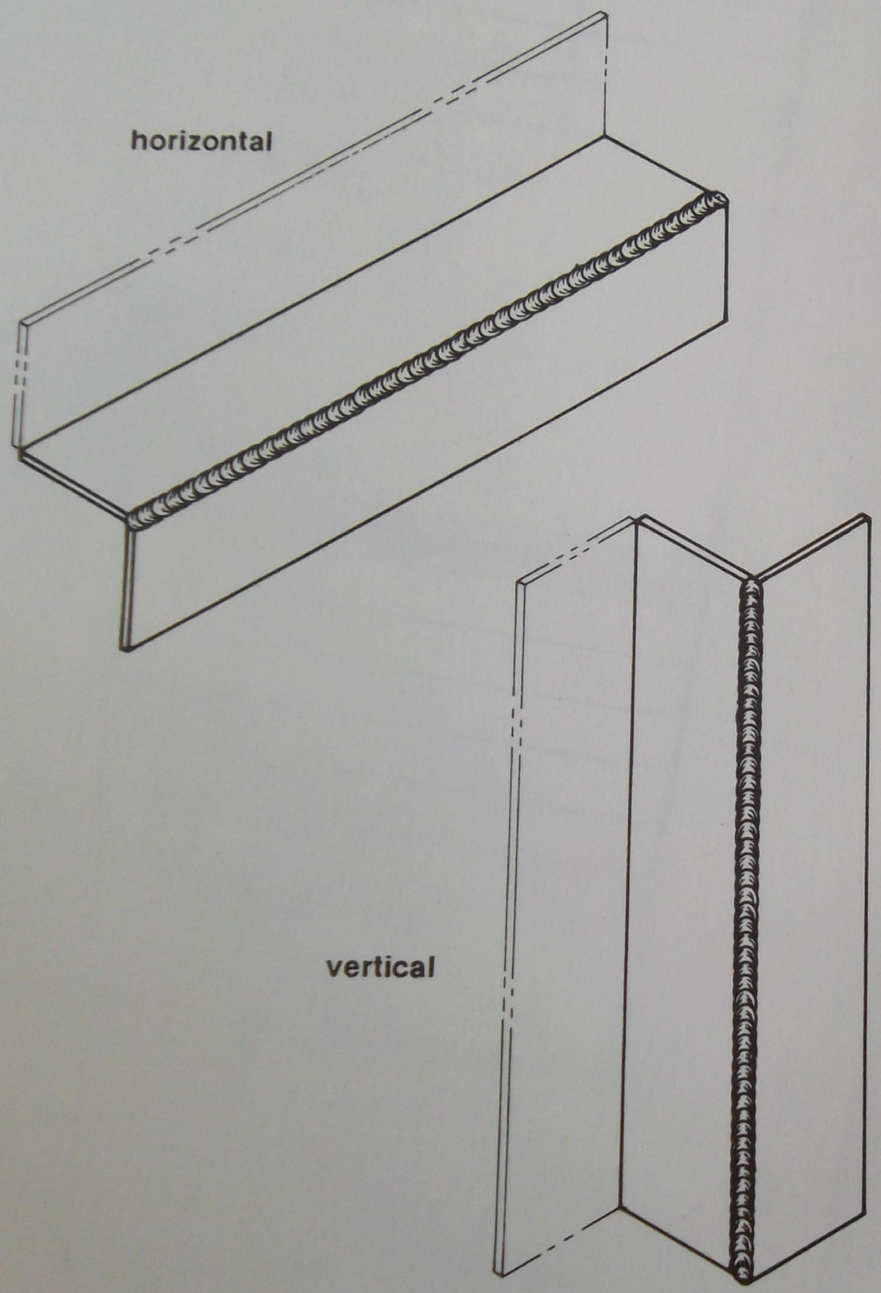
- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- a maximum of two significant weld defects per 250mm (or 225mm sheet) of weld length with an accumulative area of less than twice the square of the sheet thickness
- weld size to equal to the sheet thickness 3^{+2}_{-0} mm
- undercut to be no greater than 1mm per 50% of the weld length

MATERIAL 8 pieces low carbon steel 25 x 3 x 225mm sheet

UNITS 4

ECONOMY Fully use material and return any unused pieces to the store

SECTION 11: CORNER FILLET - SHEET STEEL - HORIZONTAL AND VERTICAL



IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE To deposit single run outside corner fillet joints to the requirements listed below

POSITION Horizontal and vertical down

PROCEDURE Your teacher will demonstrate

METHOD

1. Wire brush the material to remove surface rust and loose mill scale
2. Assemble and tack plates
3. Deposit a corner weld in the horizontal position
4. Critically evaluate the weld before repeating the exercise
5. After you achieve the reuqired standard repeat the exercise in the vertical position
6. Submit your items for assessment
7. Document welding parameters on your weld procedure sheets

REQUIREMENTS

- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- a maximum of two significant weld defects per 250mm (or 225mm sheet) of weld length with an accumulative area of less than twice the square of the sheet thickness
- weld size to equal to the sheet thickness 3^{+2}_{-0} mm
- undercut to be no greater than 1mm per 50% of the weld length

MATERIAL 8 pieces low carbon steel 25 x 3 x 225mm sheet

UNITS 4

ECONOMY Fully use material and return any unused pieces to the store

Notes

Section 12: Butt weld - sheet steel - flat

Task: To deposit single run butt welds on low carbon sheet steel in the flat position. This section covers part of leaning outcome 3 of the National Module Descriptor.

Why? So you'll be able to deposit butt welds on sheet steel sections as required by industry.

To pass: You'll be expected to deposit safely single run butt welds on low carbon sheet steel to the requirements on the work sheet for this section.



Safety

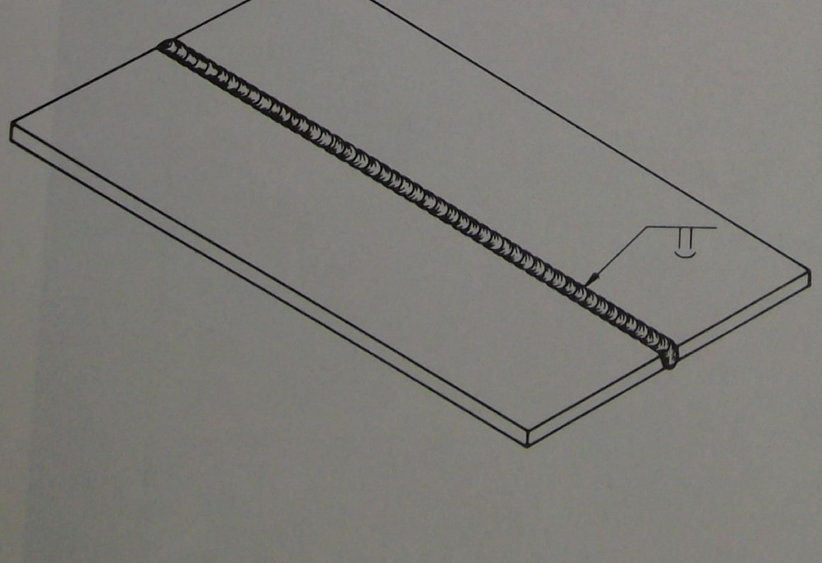
- Follow OH&S workshop procedures at all times.
- Wear approved protective clothing. Don't wear clothes made from nylon material in the workshop.

PROCEDURE SHEET

SECTION 12: BUTT WELD - SHEET STEEL - FLAT						
Sketch						
Machine type:						
		Control data				
Run	**Wire speed**	**Amperage reading**	**Voltage control**	**Voltage reading**	**Transfer mode**
1					
2					
3					
4					
Electrode wire Size Ømm: Type: Classification:		**Material data** Type: Thickness:			
Shielding gas Type: Flow rate: Litres/min:		**Weld time** Start: Finish: Units completed:			
Assessment	**Complies**	**Doesn't comply**			
Alignment and assembly					
Angular distortion					
Surface finish					
Surface defects					
Root penetration					
Undercut					
Name		**Exercise No.**			

SECTION 12: BUTT WELD - SHEET STEEL - FLAT

IF IN DOUBT ASK YOUR TEACHER



OBJECTIVE To deposit single run butt welds on low carbon steel sheet to the requirements listed below

POSITION Flat

PROCEDURE Your teacher will demonstrate

METHOD

1. Assemble and tack weld the 3mm material to form an open square butt joint
2. Dress the tack welds before beginning the weld
3. Deposit half of the joint length before stopping to assess weld profile and penetration
4. Cut and relocate for further practice
5. After adequate practice repeat the procedure using 1.6mm and 1.2mm thick material
6. Repeat procedures
7. Evaluate the weld and document welding parameters on your procedure sheet
8. Submit your work for assessment

REQUIREMENTS

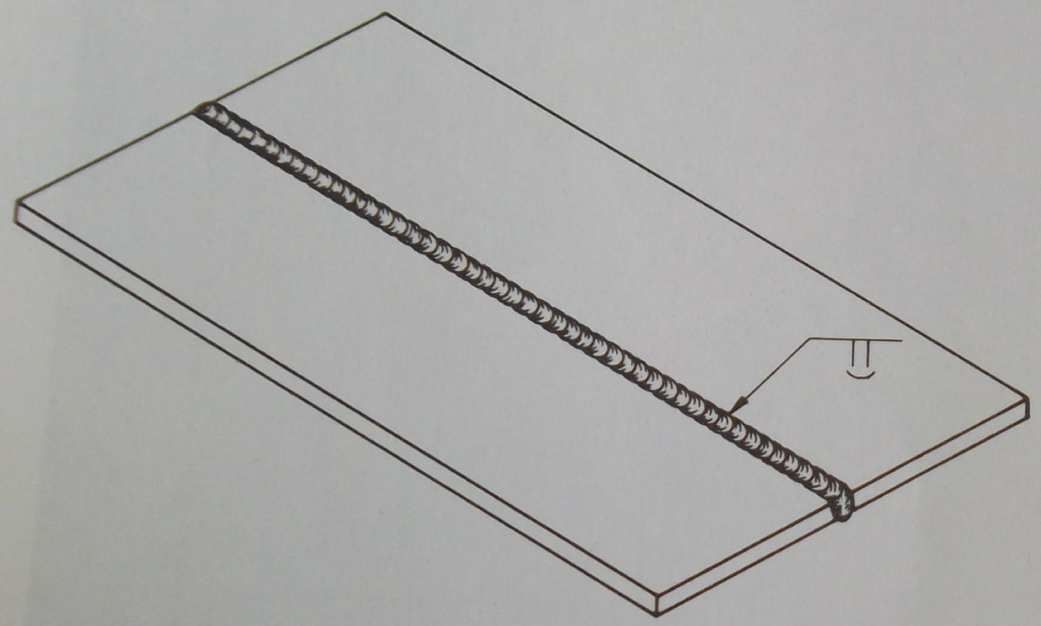
- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- root penetration to be a minimum of 20% of the weld length
- a maximum of two significant weld defects per 250mm (or 225mm sheet) of weld length with an accumulative area of less than twice the square of the sheet thickness
- undercut to be no greater than 1mm per 50% of the weld length

MATERIAL 3 pieces 50 x 3 x 225mm low carbon steel sheet
3 pieces 50 x 1.6 x 225mm low carbon steel sheet
3 pieces 50 x 1.2 x 225mm low carbon steel sheet

UNITS 2

ECONOMY Cut and relocate material for maximum use
Return all unused material to the store

SECTION 12: BUTT WELD - SHEET STEEL - FLAT



IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE	To deposit single run butt welds on low carbon steel sheet to the requirements listed below
POSITION	Flat
PROCEDURE	Your teacher will demonstrate
METHOD	1. Assemble and tack weld the 3mm material to form an open square butt joint 2. Dress the tack welds before beginning the weld 3. Deposit half of the joint length before stopping to assess weld profile and penetration 4. Cut and relocate for further practice 5. After adequate practice repeat the procedure using 1.6mm and 1.2mm thick material 6. Repeat procedures 7. Evaluate the weld and document welding parameters on your procedure sheet 8. Submit your work for assessment
REQUIREMENTS	▪ correct alignment and assembly ▪ smooth regular weld contour ▪ angular distortion 0° to 5° ▪ root penetration to be a minimum of 20% of the weld length ▪ a maximum of two significant weld defects per 250mm (or 225mm sheet) of weld length with an accumulative area of less than twice the square of the sheet thickness ▪ undercut to be no greater than 1mm per 50% of the weld length
MATERIAL	3 pieces 50 x 3 x 225mm low carbon steel sheet 3 pieces 50 x 1.6 x 225mm low carbon steel sheet 3 pieces 50 x 1.2 x 225mm low carbon steel sheet
UNITS	2
ECONOMY	Cut and relocate material for maximum use Return all unused material to the store

Welding sheet metal using the gas metal arc welding procedure



Section 13: Butt weld - sheet steel - horizontal

Task: To deposit single run butt welds on low carbon sheet steel in the horizontal position. This section covers part of learning outcome 3 of the National Module Descriptor.

Why? So you'll be able to deposit butt welds on sheet steel sections as required by industry.

To pass: You'll be expected to deposit safely single run butt welds on low carbon sheet steel to the requirements specified on the work sheet for this section.

DANGER

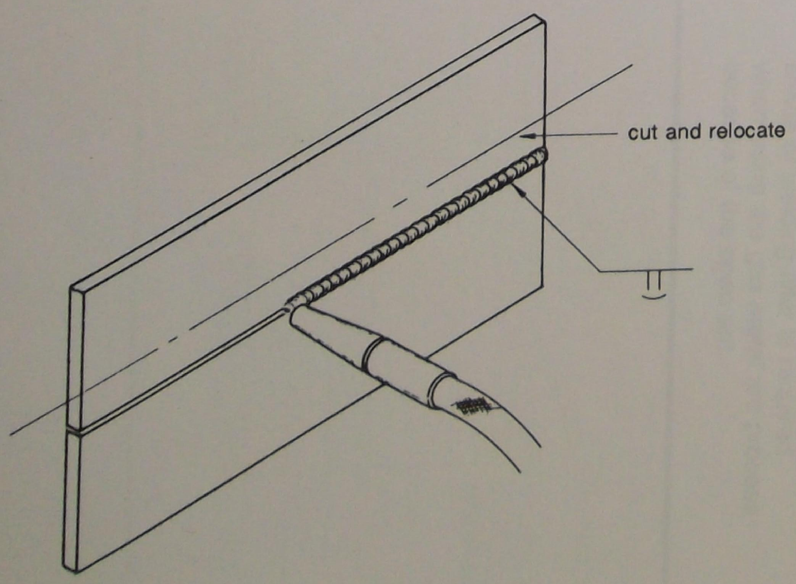
Safety

- You must follow OH&S workshop procedures - your teacher will tell you what they are.
- Be careful of small diameter wires. Their ends are sharp and may pierce your skin.
- **Weld** only on the striker plate.
- Leave the bay **clean** at the end of the session.
- **Turn off** bay power points at the end of the session.

PROCEDURE SHEET

SECTION 13: BUTT WELD - SHEET STEEL - HORIZONTAL						
Sketch						
Machine type:						
		Control data				
Run	**Wire speed**	**Amperage reading**	**Voltage control**	**Voltage reading**	**Transfer mode**	
1						
2						
3						
4						
Electrode wire			**Material data**			
Size Ømm:			Type:			
Type:			Thickness:			
Classification:						
Shielding gas			**Weld time**			
Type:			Start:			
Flow rate: Litres/min:			Finish:			
			Units completed:			
Assessment		**Complies**	**Doesn't comply**			
Alignment and assembly						
Angular distortion						
Surface finish						
Surface defects						
Root penetration						
Undercut						
Name			**Exercise No.**			

SECTION 13: BUTT WELD - SHEET STEEL - HORIZONTAL



IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE To deposit single run butt welds on low carbon steel sheet to the requirements listed below

POSITION Horizontal

PROCEDURE Your teacher will demonstrate

METHOD

1. Assemble and tack weld the 3mm material to form an open square butt joint
2. Deposit half of the joint length before stopping to assess weld profile and penetration
3. Make any procedural changes necessary and complete the weld
4. Cut and relocate for further practice
5. After adequate practice repeat the procedure using 1.6mm thick material
6. Evaluate the weld and document welding parameters on your procedure sheet
7. Submit your work for assessment

REQUIREMENTS

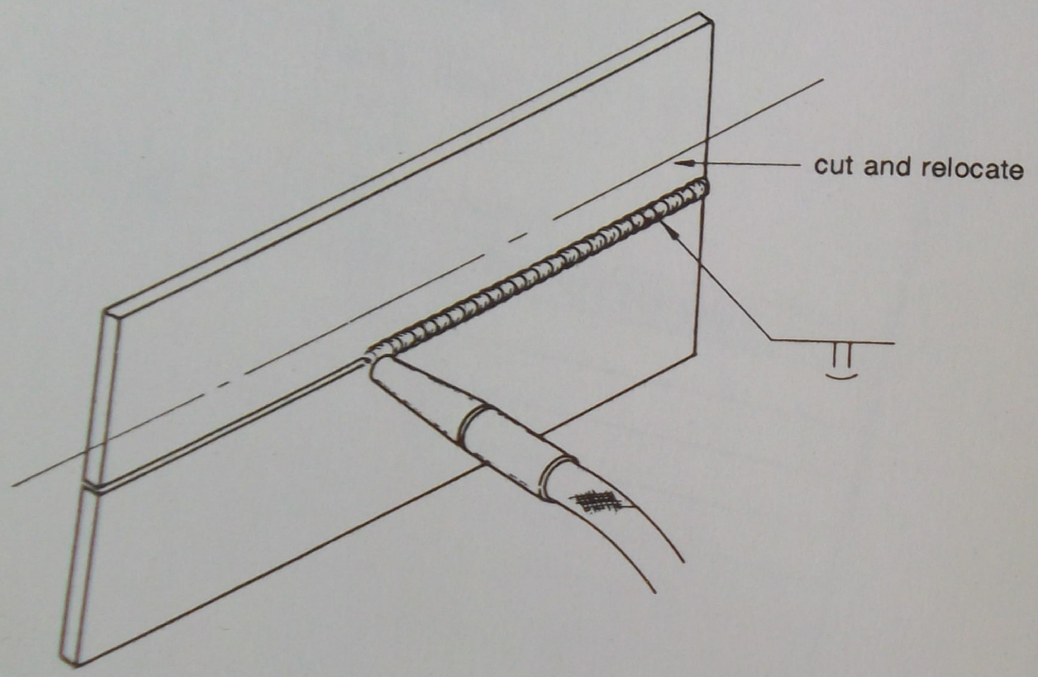
- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- root penetration to be a minimum of 20% of the weld length
- a maximum of two significant weld defects per 250mm (or 225mm sheet) of weld length with an accumulative area of less than twice the square of the sheet thickness
- undercut to be no greater than 1mm per 50% of the weld length

MATERIAL 3 pieces 50 x 3 x 225mm low carbon steel sheet
3 pieces 50 x 1.6 x 225mm low carbon steel sheet

UNITS 2

ECONOMY Cut and relocate material for maximum use.
Return all unused material to the store

SECTION 13: BUTT WELD - SHEET STEEL - HORIZONTAL



IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE To deposit single run butt welds on low carbon steel sheet to the requirements listed below

POSITION Horizontal

PROCEDURE Your teacher will demonstrate

METHOD

1. Assemble and tack weld the 3mm material to form an open square butt joint
2. Deposit half of the joint length before stopping to assess weld profile and penetration
3. Make any procedural changes necessary and complete the weld
4. Cut and relocate for further practice
5. After adequate practice repeat the procedure using 1.6mm thick material
6. Evaluate the weld and document welding parameters on your procedure sheet
7. Submit your work for assessment

REQUIREMENTS

- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- root penetration to be a minimum of 20% of the weld length
- a maximum of two significant weld defects per 250mm (or 225mm sheet) of weld length with an accumulative area of less than twice the square of the sheet thickness
- undercut to be no greater than 1mm per 50% of the weld length

MATERIAL 3 pieces 50 x 3 x 225mm low carbon steel sheet
3 pieces 50 x 1.6 x 225mm low carbon steel sheet

UNITS 2

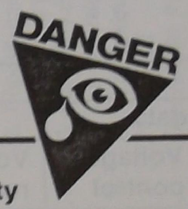
ECONOMY Cut and relocate material for maximum use.
Return all unused material to the store

Section 14: Butt weld - sheet steel - vertical

Task: To deposit single run butt welds on low carbon sheet steel in the vertical position. This section covers part of learning outcome 3 of the National Module Descriptor.

Why? So you'll be able to deposit butt welds on sheet steel sections as required by industry.

To pass: You'll be expected to deposit safely a single run butt weld on low carbon sheet steel to the requirements specified on the work sheet for this section.



Safety

- Follow OH&S workshop procedures at all times.
- Protect your skin and eyes. A darker shade of welding filter is required when using the gas metal arc process because of the open arc.

N

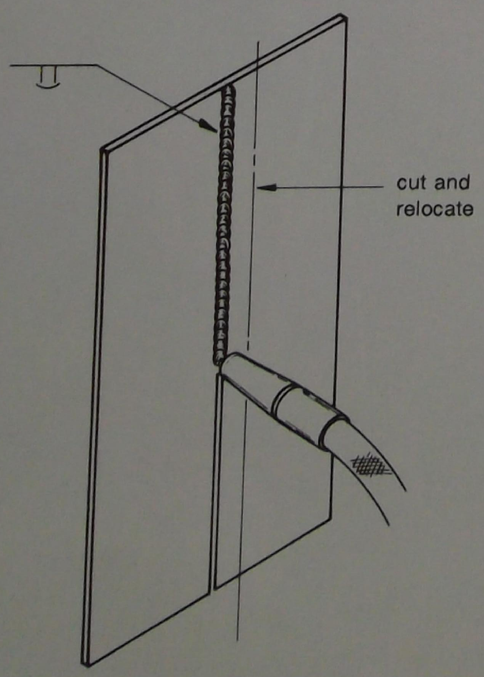
PROCEDURE SHEET

SECTION 14: BUTT WELD - SHEET STEEL - VERTICAL						
Sketch						
Machine type:						
		Control data				
Run	Wire speed	Amperage reading	Voltage control	Voltage reading	Transfer mode	
1						
2						
3						
4						
Electrode wire Size Ømm: Type: Classification:			Material data Type: Thickness:			
Shielding gas Type: Flow rate: Litres/min:			Weld time Start: Finish: Units completed:			
Assessment		Complies		Doesn't comply		
Alignment and assembly						
Angular distortion						
Surface finish						
Surface defects						
Root penetration						
Undercut						
Name		Exercise No.				

April 1991

SECTION 14: BUTT WELD - SHEET STEEL - VERTICAL

IF IN DOUBT ASK YOUR TEACHER



OBJECTIVE To deposit single run butt welds on low carbon steel sheet to the requirements listed below

POSITION Vertical down

PROCEDURE Your teacher will demonstrate

METHOD

1. Assemble and tack weld the 3mm material to form an open square butt joint
2. Deposit half of the joint length before stopping to assess weld profile and penetration
3. Make any changes necessary and complete the weld
4. Cut and relocate for further practice
5. After adequate practice repeat the procedure using 1.6mm thick material
6. Evaluate the weld and document welding parameters on your procedure sheet
7. Submit your work for assessment

REQUIREMENTS

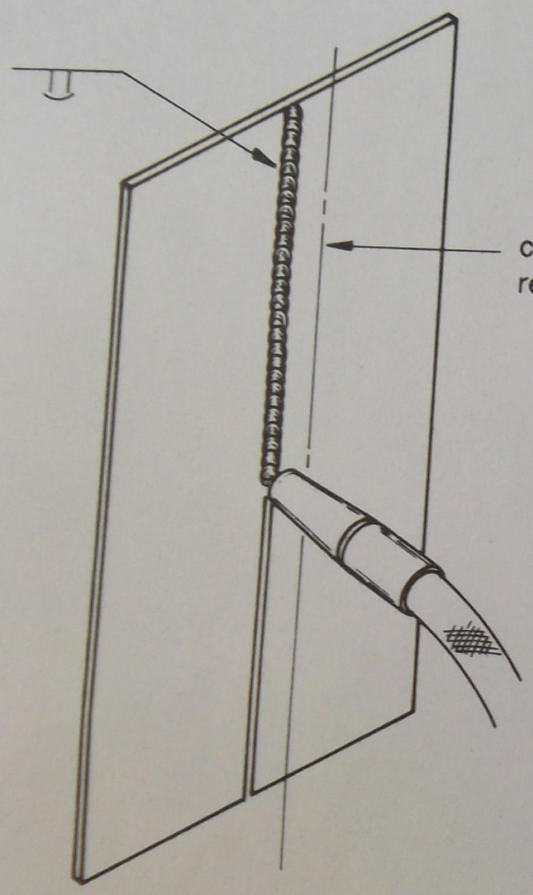
- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- root penetration to be a minimum of 20% of the weld length
- a maximum of two significant weld defects per 250mm (or 225mm sheet) of weld length with an accumulative area of less than twice the square of the sheet thickness
- undercut to be no greater than 1mm per 50% of the weld length

MATERIAL 2 pieces 50 x 3 x 225mm low carbon steel sheet
2 pieces 50 x 1.6 x 225mm low carbon steel sheet

UNITS 2

ECONOMY Cut and relocate material for maximum use
Return all unused material to the store

SECTION 14: BUTT WELD - SHEET STEEL - VERTICAL



IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE

To deposit single run butt welds on low carbon steel sheet to the requirements listed below

POSITION

Vertical down

PROCEDURE

Your teacher will demonstrate

METHOD

1. Assemble and tack weld the 3mm material to form an open square butt joint
2. Deposit half of the joint length before stopping to assess weld profile and penetration
3. Make any changes necessary and complete the weld
4. Cut and relocate for further practice
5. After adequate practice repeat the procedure using 1.6mm thick material
6. Evaluate the weld and document welding parameters on your procedure sheet
7. Submit your work for assessment

REQUIREMENTS

- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- root penetration to be a minimum of 20% of the weld length
- a maximum of two significant weld defects per 250mm (or 225mm sheet) of weld length with an accumulative area of less than twice the square of the sheet thickness
- undercut to be no greater than 1mm per 50% of the weld length

MATERIAL

2 pieces 50 x 3 x 225mm low carbon steel sheet
2 pieces 50 x 1.6 x 225mm low carbon steel sheet

UNITS

2

ECONOMY

Cut and relocate material for maximum use
Return all unused material to the store

The gas metal arc welding process
in use in the motor transport industry



Section 15: Butt weld - 6mm plate - flat

Task: To deposit multiple run butt welds on low carbon steel plate in the flat position. This section covers part of learning outcome 3 of the National Module Descriptor.

Why? So you'll be able to deposit butt welds on steel plate sections as required by industry.

To pass: Section 16 is a skill practice exercise that is not assessed as part of this module. However you should try to reach the standards specified on the work sheet for this section. You'll use the skills you learn for later exercises that are formally assessed.

DANGER

Safety

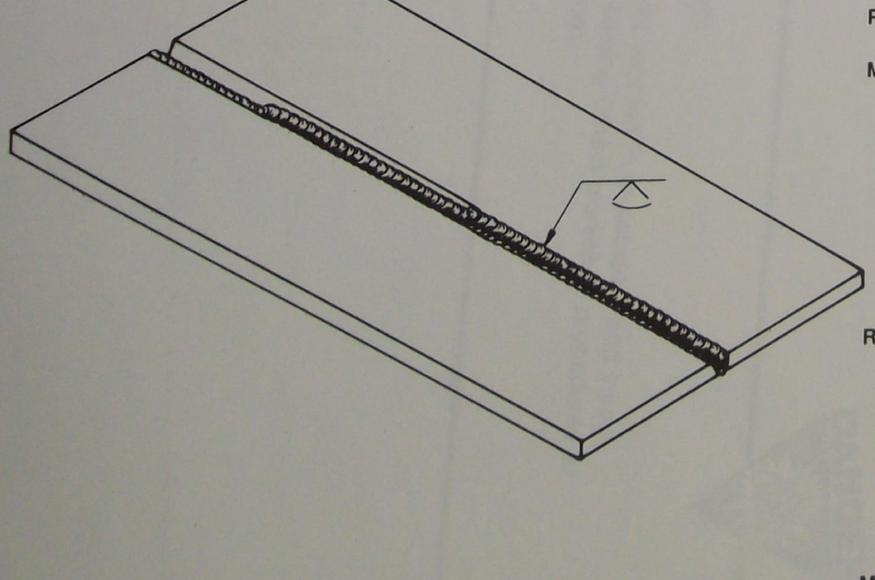
- Follow OH&S workshop procedures at all times
- Wear approved safety clothing

PROCEDURE SHEET

SECTION 15: BUTT WELD - 6MM PLATE - FLAT						
Sketch						
Machine type:						
		Control data				
Run	Wire speed	Amperage reading	Voltage control	Voltage reading	Transfer mode	
1						
2						
3						
4						
Electrode wire Size Ømm: Type: Classification:			Material data Type: Thickness:			
Shielding gas Type: Flow rate: Litres/min:			Weld time Start: Finish: Units completed:			
Assessment		Complies		Doesn't comply		
Alignment and assembly						
Angular distortion						
Surface finish						
Surface defects						
Root penetration						
Undercut						
Name				Exercise No.		

TAFE

SECTION 15: BUTT WELD - 6mm PLATE - FLAT



IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE To deposit single run butt welds on 6mm low carbon steel sheet to the requirements listed below

POSITION Flat

PROCEDURE Your teacher will demonstrate

METHOD

1. Use a suitable spacer to maintain root gap before tacking plates
2. Check root gap and preset plates to counteract distortion
3. Complete half of the root run
4. Make any necessary procedural adjustments and complete the weld
5. Finish the weld joint using a logical weld sequence
6. Flame cut the assembly and reposition for further practice
7. Submit your work for assessment and complete your procedure sheet

REQUIREMENTS

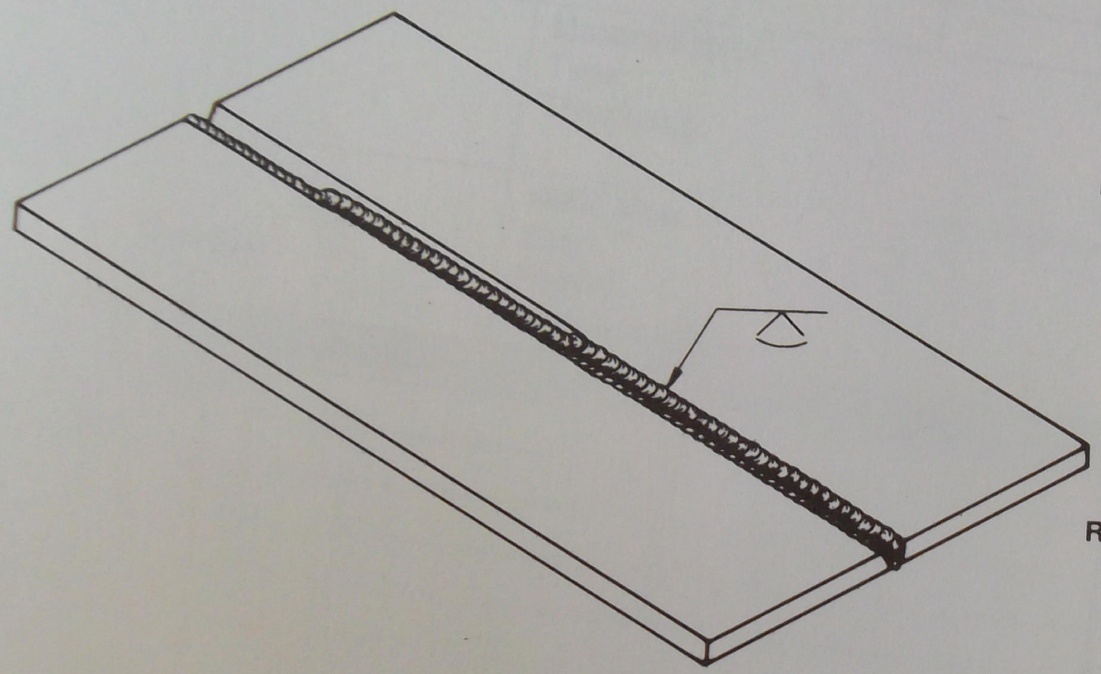
- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- root penetration to be a minimum of 20% of the weld length
- a maximum of two significant weld defects per 220mm (or 225mm plate) of weld length with an accumulative area of less than twice the square of the plate thickness
- undercut to be no greater than 1mm per 50% of the weld length

MATERIAL 2 pieces 75 x 6 x 225mm low carbon steel plate

UNITS 4

ECONOMY Return all unused material to the store

SECTION 15: BUTT WELD - 6mm PLATE - FLAT



IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE	To deposit single run butt welds on 6mm low carbon steel sheet to the requirements listed below
POSITION	Flat
PROCEDURE	Your teacher will demonstrate
METHOD	1. Use a suitable spacer to maintain root gap before tacking plates 2. Check root gap and preset plates to counteract distortion 3. Complete half of the root run 4. Make any necessary procedural adjustments and complete the weld 5. Finish the weld joint using a logical weld sequence 6. Flame cut the assembly and reposition for further practice 7. Submit your work for assessment and complete your procedure sheet
REQUIREMENTS	▪ correct alignment and assembly ▪ smooth regular weld contour ▪ angular distortion 0° to 5° ▪ root penetration to be a minimum of 20% of the weld length ▪ a maximum of two significant weld defects per 220mm (or 225mm plate) of weld length with an accumulative area of less than twice the square of the plate thickness ▪ undercut to be no greater than 1mm per 50% of the weld length
MATERIAL	2 pieces 75 x 6 x 225mm low carbon steel plate
UNITS	4
ECONOMY	Return all unused material to the store

Notes

Section 16: Butt weld - rolled steel section - flat

Task: To deposit multiple run butt welds on low carbon steel rolled structural section in the flat position. This section covers part of learning outcome 3 of the National Module Descriptor.

Why? So you'll be able to deposit butt welds on rolled steel sections as required by industry.

To pass: You'll be expected to deposit safely a multiple run butt weld on a low carbon steel angle section to the requirements specified on the work sheet for this section.



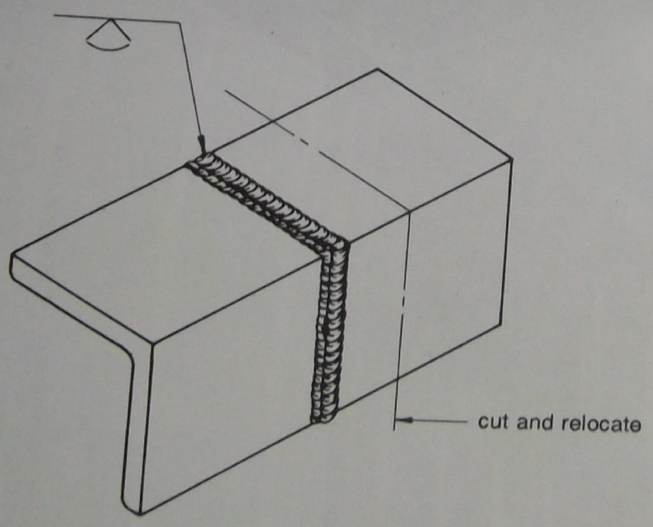
Safety

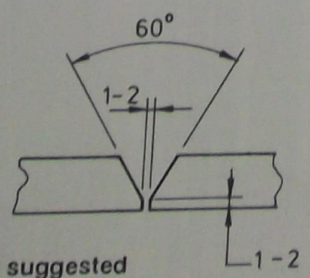
Protect yourself from accident and injury by following OH&S workshop procedures at all times.

PROCEDURE SHEET

SECTION 16: BUTT WELD - ROLLED STEEL SECTION - FLAT						
Sketch						
Machine type:						
		Control data				
Run	Wire speed	Amperage reading	Voltage control	Voltage reading	Transfer mode	
1						
2						
3						
4						
Electrode wire Size Ømm: Type: Classification:			Material data Type: Thickness:			
Shielding gas Type: Flow rate: Litres/min:			Weld time Start: Finish: Units completed:			
Assessment		Complies		Doesn't comply		
Alignment and assembly						
Angular distortion						
Surface finish						
Surface defects						
Root penetration						
Undercut						
Name		Exercise No.				

SECTION 16: BUTT WELD - ROLLED STEEL - FLAT





suggested
edge preparation

IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE To prepare, assemble and deposit multiple run butt welds on low carbon steel rolled sections to the requirements listed below

POSITION Flat

PROCEDURE Your teacher will demonstrate

METHOD

1. Flame cut and dress angle edge preparation as illustrated
2. Assemble, align and tack weld angle sections
3. Fully weld the first side of the angle
4. Complete the butt weld in the flat position
5. Evaluate the weld exercise and complete the procedure sheet
6. Submit your work for assessment
7. Document welding parameters on your weld procedure sheet

REQUIREMENTS

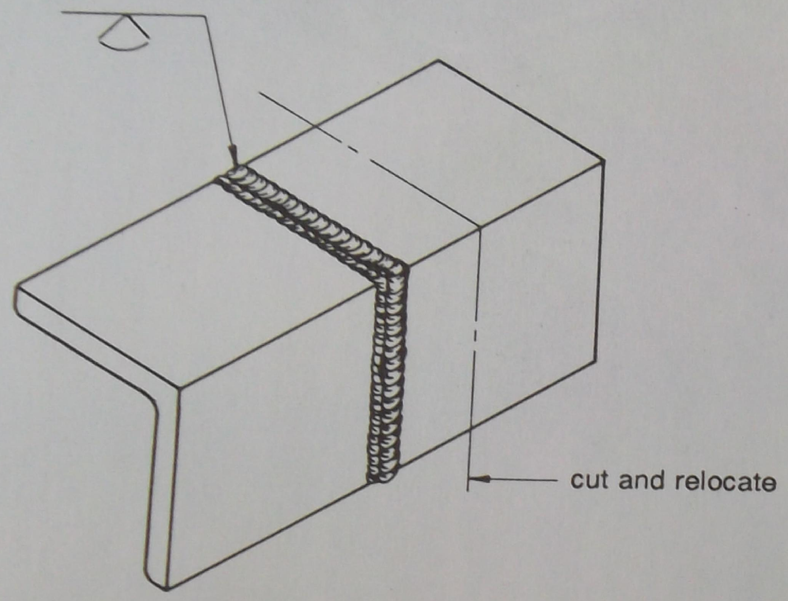
- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- root penetration to be a minimum of 20% of the weld length
- a maximum of two significant weld defects per 250mm (or 225mm material) of weld length with an accumulative area of less than twice the square of the material thickness
- undercut to be no greater than 1.5mm per 50% of the weld length

MATERIAL 2 pieces 75 x 75 x 10mm 75mm long ASEA

UNITS 2

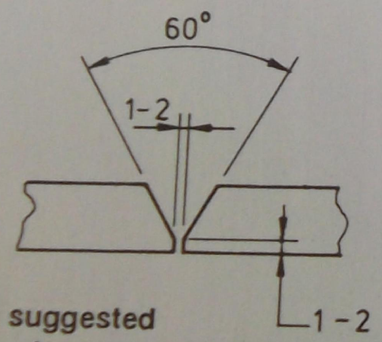
ECONOMY Return all unused material to the store

SECTION 16: BUTT WELD - ROLLED STEEL - FLAT



IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE	To prepare, assemble and deposit multiple run butt welds on low carbon steel rolled sections to the requirements listed below
POSITION	Flat
PROCEDURE	Your teacher will demonstrate
METHOD	1. Flame cut and dress angle edge preparation as illustrated 2. Assemble, align and tack weld angle sections 3. Fully weld the first side of the angle 4. Complete the butt weld in the flat position 5. Evaluate the weld exercise and complete the procedure sheet 6. Submit your work for assessment 7. Document welding parameters on your weld procedure sheet
REQUIREMENTS	▪ correct alignment and assembly ▪ smooth regular weld contour ▪ angular distortion 0° to 5° ▪ root penetration to be a minimum of 20% of the weld length ▪ a maximum of two significant weld defects per 250mm (or 225mm material) of weld length with an accumulative area of less than twice the square of the material thickness ▪ undercut to be no greater than 1.5mm per 50% of the weld length
MATERIAL	2 pieces 75 x 75 x 10mm 75mm long ASEA
UNITS	2
ECONOMY	Return all unused material to the store



suggested edge preparation

The gas metal arc welding process
in use on sheet steel



Section 17: Butt weld - 6mm plate - horizontal

Task: To deposit a single multiple run V butt weld on low carbon steel plate in the horizontal position. This section covers part of learning outcome 3 of the National Module Descriptor.

Why? So you'll be able to deposit butt welds on steel plate sections as required by industry.

To pass: You'll be expected to deposit safely a multiple run butt weld on low carbon steel plate sections to the requirements specified on the work sheet for this section.

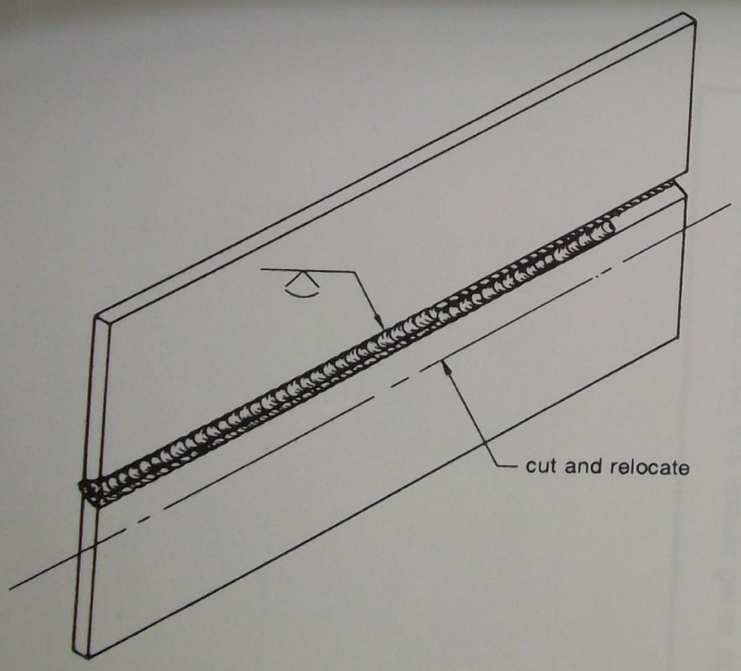
DANGER

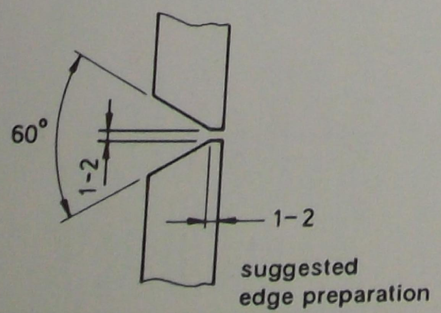
Safety

- Follow OH&S procedures at all times.
- Make sure you wear approved protective clothing.

PROCEDURE SHEET

SECTION 17: BUTT WELD - 6MM PLATE - HORIZONTAL						
Sketch						
Machine type:						
		Control data				
Run	**Wire speed**	**Amperage reading**	**Voltage control**	**Voltage reading**	**Transfer mode**	
1						
2						
3						
4						
Electrode wire *Size Ømm:* *Type:* *Classification:*			**Material data** *Type:* *Thickness:*			
Shielding gas *Type:* *Flow rate:* Litres/min:			**Weld time** *Start:* *Finish:* *Units completed:*			
Assessment		**Complies**		**Doesn't comply**		
Alignment and assembly						
Angular distortion						
Surface finish						
Surface defects						
Root penetration						
Undercut						
Name				**Exercise No.**		





suggested edge preparation

IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE To deposit multiple run butt welds on 6mm low carbon steel plate to the requirements listed below

POSITION Horizontal

PROCEDURE Your teachers will demonstrate

METHOD

1. Use a suitable spacer to maintain root gap before tacking plates
2. Check root gap and preset plates to counteract distortion
3. Complete half of the root run and inspect
4. Make any necessary procedural adjustments and complete the weld
5. Finish the weld joint using a logical weld sequence
6. Flame cut the assembly and reposition for further practice
7. Submit your work for assessment and complete your procedure sheet

REQUIREMENTS

- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- root penetration to be a minimum of 20% of the weld length
- a maximum of two significant weld defects per 250mm (or 225mm sheet) of weld length with an accumulative area of less than twice the square of the sheet thickness
- undercut to be no greater than 1.5mm per 50% of the weld length

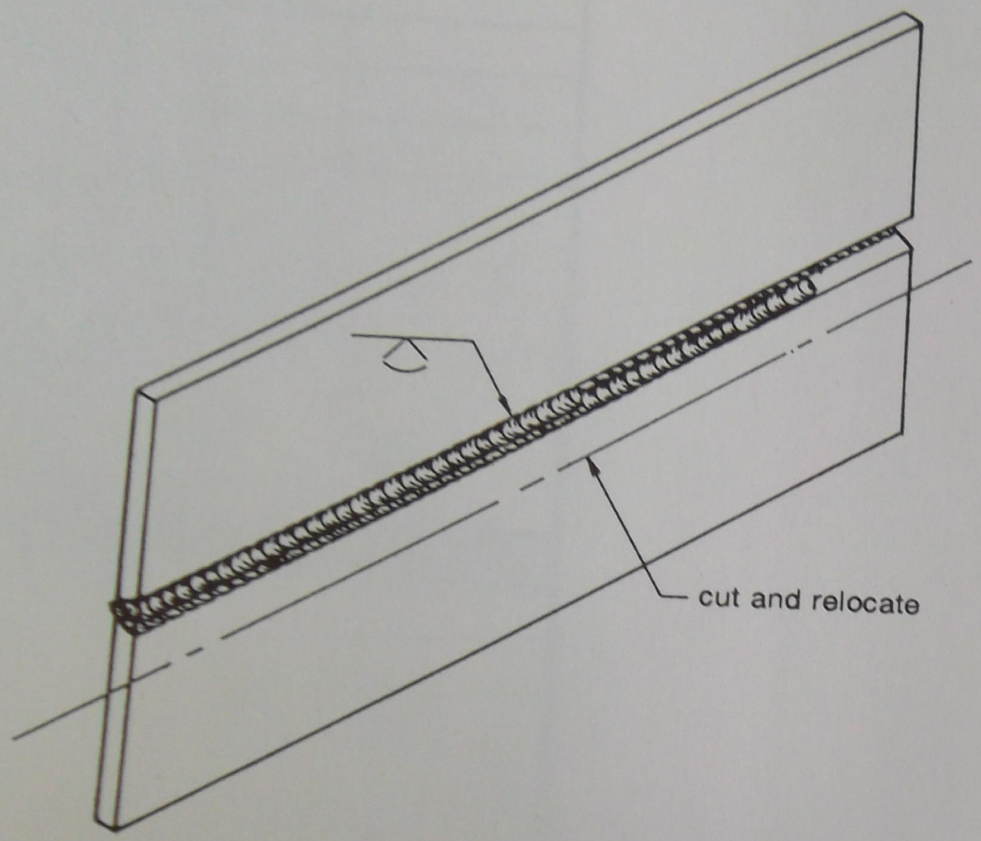
MATERIAL 2 pieces 75 x 6 x 225mm low carbon steel plate

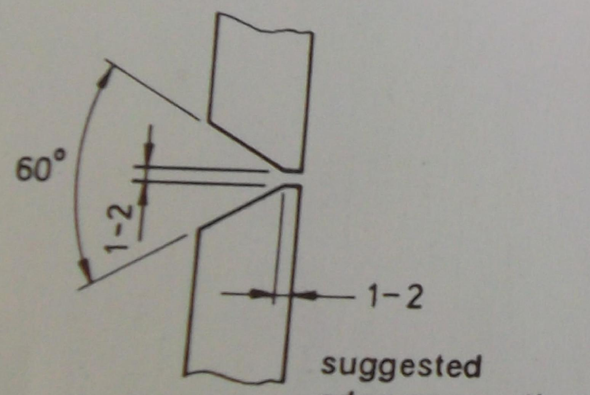
UNITS 4

ECONOMY Return all unused material to the store

on the work sheet for this section.

SECTION 17: BUTT WELD - 6mm PLATE - HORIZONTAL





suggested
edge preparation

IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE To deposit multiple run butt welds on 6mm low carbon steel plate to the requirements listed below

POSITION Horizontal

PROCEDURE Your teachers will demonstrate

METHOD

1. Use a suitable spacer to maintain root gap before tacking plates
2. Check root gap and preset plates to counteract distortion
3. Complete half of the root run and inspect
4. Make any necessary procedural adjustments and complete the weld
5. Finish the weld joint using a logical weld sequence
6. Flame cut the assembly and reposition for further practice
7. Submit your work for assessment and complete your procedure sheet

REQUIREMENTS

- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- root penetration to be a minimum of 20% of the weld length
- a maximum of two significant weld defects per 250mm (or 225mm sheet) of weld length with an accumulative area of less than twice the square of the sheet thickness
- undercut to be no greater than 1.5mm per 50% of the weld length

MATERIAL 2 pieces 75 x 6 x 225mm low carbon steel plate

UNITS 4

ECONOMY Return all unused material to the store

Notes

Section 18: Butt weld - 6mm plate - vertical

Task: To deposit multiple run single V butt welds on low carbon steel plate in the vertical position. This section covers part of learning outcome 3 of the National Module Descriptor.

Why? So you'll be able to deposit butt welds on steel plate sections in the vertical position as required by industry.

To pass: You'll be expected to deposit safely a multiple run butt weld on low carbon steel plate sections to the requirements specified on the work sheet for this section.



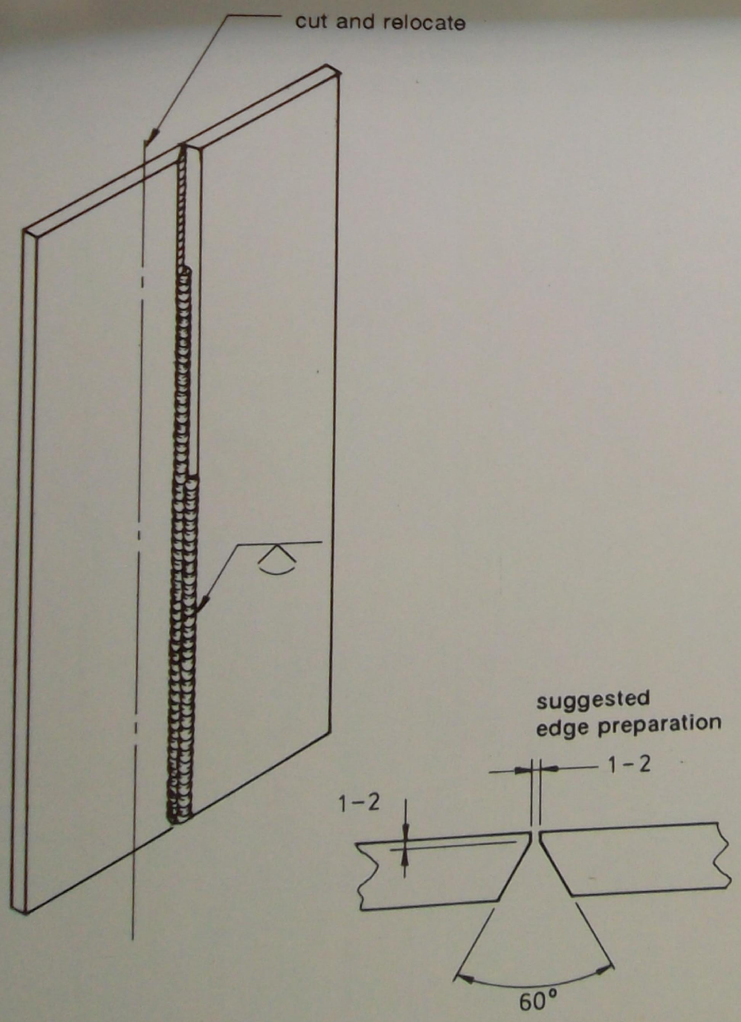
Safety

- Follow OH&S workshop procedures at all times.
- Make sure your work area is clean and tidy.
- Only use approved anti-spatter gel or spray.

PROCEDURE SHEET

SECTION 18: BUTT WELD - 6MM PLATE - VERTICAL						
Sketch						
Machine type:						
		Control data				
Run	Wire speed	Amperage reading	Voltage control	Voltage reading	Transfer mode	
1						
2						
3						
4						
Electrode wire			**Material data**			
Size Ømm:			Type:			
Type:			Thickness:			
Classification:						
Shielding gas			**Weld time**			
Type:			Start:			
Flow rate: Litres/min:			Finish:			
			Units completed:			

Assessment	Complies	Doesn't comply
Alignment and assembly		
Angular distortion		
Surface finish		
Surface defects		
Root penetration		
Undercut		
Name	Exercise No.	



IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE To deposit multiple run butt welds on 6mm low carbon steel plate to the requirements listed below

POSITION Vertical up

PROCEDURE Your teacher will demonstrate

METHOD

1. Use a suitable spacer to maintain root gap before tacking plates
2. Check root gap and preset plates to counteract distortion
3. Complete half of the root run and inspect
4. Make any necessary procedural adjustments and complete the weld
5. Finish the weld joint using a logical weld sequence
6. Flame cut the assembly and reposition for further practice
7. Document welding parameters on your procedure sheet

REQUIREMENTS

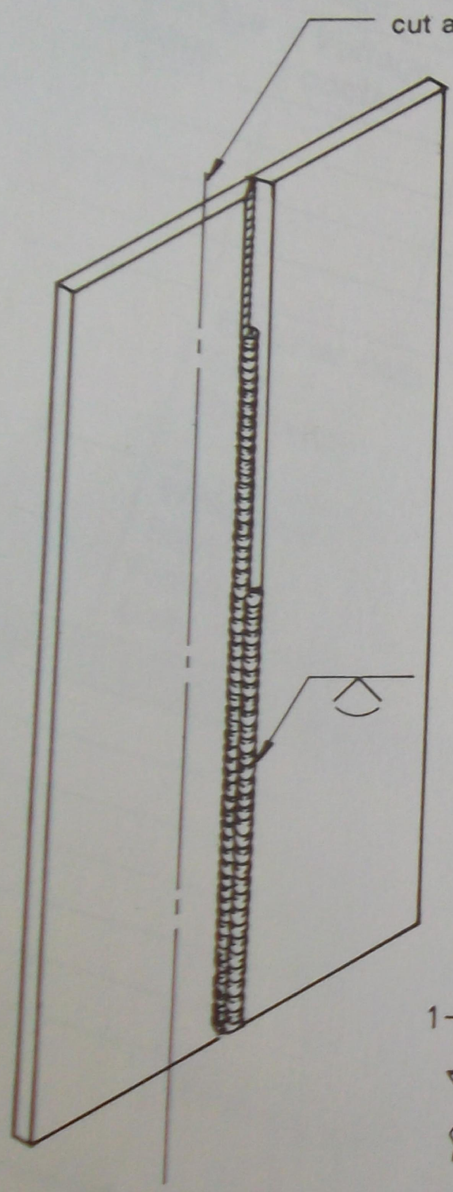
- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- root penetration to be a minimum of 20% of the weld length
- a maximum of two significant weld defects per 250mm (or 225mm sheet) of weld length with an accumulative area of less than twice the square of the sheet thickness
- undercut to be no greater than 1mm per 50% of the weld length

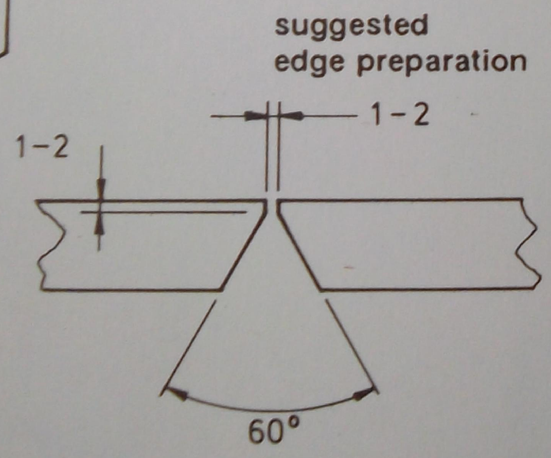
MATERIAL 2 pieces 75 x 6 x 225mm low carbon steel plate

UNITS 4

ECONOMY Return all unused material to the store

SECTION 18: BUTT WELD - 6mm PLATE - VERTICAL





IF IN DOUBT ASK YOUR TEACHER

OBJECTIVE To deposit multiple run butt welds on 6mm low carbon steel plate to the requirements listed below

POSITION Vertical up

PROCEDURE Your teacher will demonstrate

METHOD

1. Use a suitable spacer to maintain root gap before tacking plates
2. Check root gap and preset plates to counteract distortion
3. Complete half of the root run and inspect
4. Make any necessary procedural adjustments and complete the weld
5. Finish the weld joint using a logical weld sequence
6. Flame cut the assembly and reposition for further practice
7. Document welding parameters on your procedure sheet

REQUIREMENTS

- correct alignment and assembly
- smooth regular weld contour
- angular distortion 0° to 5°
- root penetration to be a minimum of 20% of the weld length
- a maximum of two significant weld defects per 250mm (or 225mm sheet) of weld length with an accumulative area of less than twice the square of the sheet thickness
- undercut to be no greater than 1mm per 50% of the weld length

MATERIAL 2 pieces 75 x 6 x 225mm low carbon steel plate

UNITS 4

ECONOMY Return all unused material to the store

otes

Section 19: Gas metal arc spot welding theory

Task: To develop an understanding of the theoretical aspects of the gas metal arc spot welding process.

Why? To use your knowledge in a workshop environment to spot weld safely and competently.

To pass: You'll be expected to answer a series of questions on this topic at the end of this module.

TAFE

Technical information

1. Spot welding

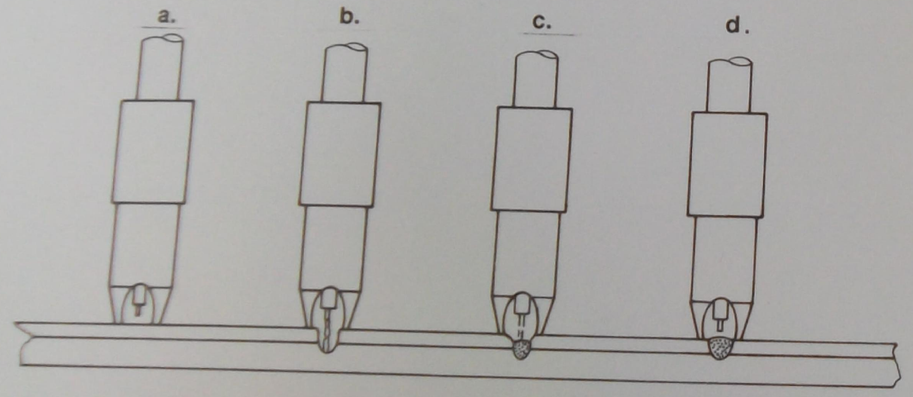
Gas metal arc welding is used to make high quality arc spot welds with either standard or specialised equipment. The process is used on awkward spaces and in cases where you mustn't damage the other side of the surface being welded. It's an excellent process for auto body repair.

Gas metal arc spot welds are produced from only one side of the joint. The weld starts on the surface of one material and burns through to the other material. Fusion between the sections leaves a small nugget on the metal surface.

Advantages:

- Welds can be made between thin and thick materials
- The weld can be made when you have access to only one side of the material's surface
- The weld can be made when there is paint on the interfacing surfaces
- The arc spot weld can also be used to assemble parts for welding at a later time.

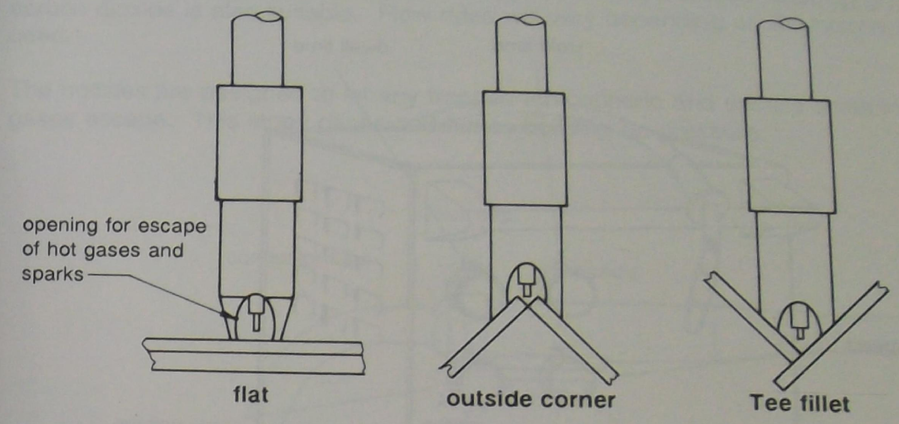
Typical sequence of operation



There are four steps in the gas metal arc spot weld sequence:

a. the arc starts
b. a hole is burnt through the first plate
c. the hole is filled with weld metal
d. the wire feed stops and the arc burns the wire back.

Specially designed nozzles provide flash protection, part alignment, and arc alignment.



A timing device controls the weld and burn back time. You must set the amperage, voltage, and length of welding time correctly to make a weld. The burn back time is a short period at the end of the weld when the wire feed stops but the current doesn't. The wire is burned back so it doesn't stick onto the weld.

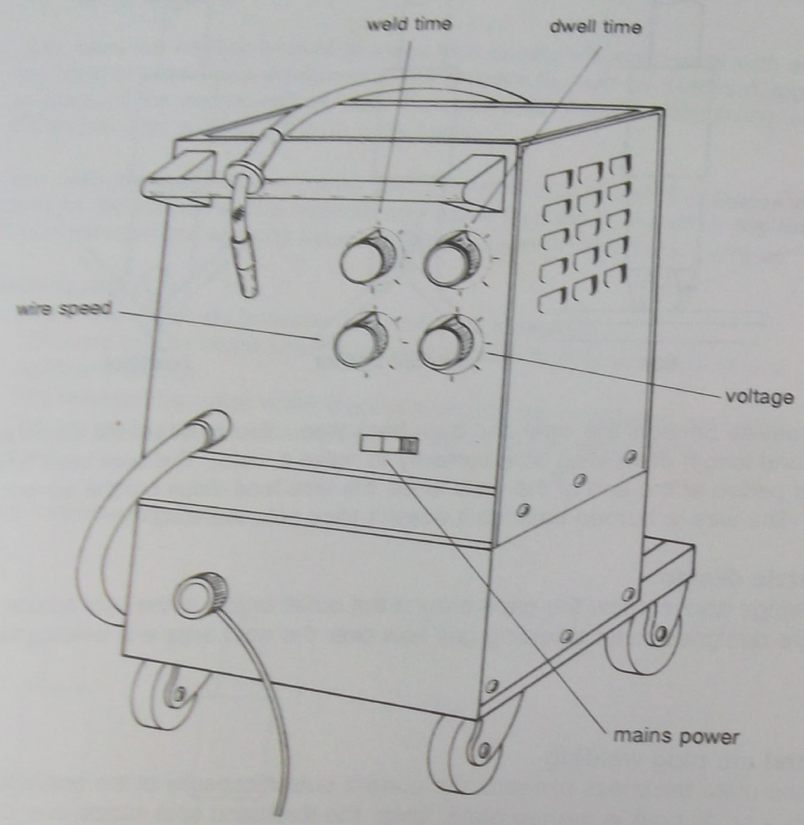
Spot nozzle design

The drawings above show the gaps around the outlet orifice of the spot nozzle. These are designed to let shielding gas flow over the weld area and welding fumes escape.

Gas metal arc plug welding

Where top plate thickness exceeds the current output capacity of the machine, drill or punch a small hole in the top plate, lower the torch and spot nozzle over the hole and spot weld as normal.

2. Equipment for gas metal arc spot welding



Voltage: A multi position switch for selecting the required welding voltage.

Wire speed: A variable control for selecting the wire speed and welding current.

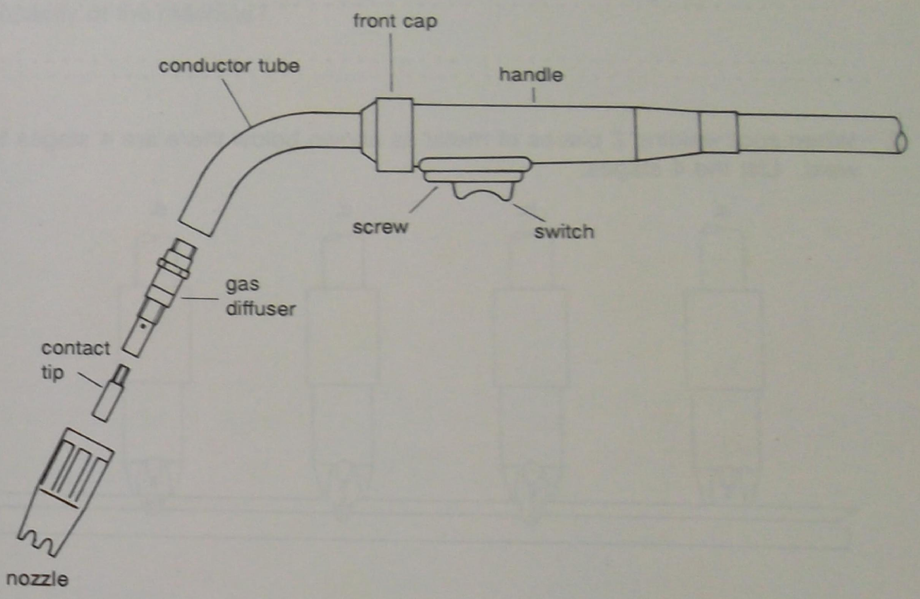
Weld time: The weld time control determines the duration of the weld time when **spot** or **stitch** welding. Make sure this control is in the **off** position for continuous welding.

Dwell time: The dwell time control adjusts the weld **off** time when **stitch** or **interval** welding. Make sure this control is in the **off** position for continuous welding.

3. Shielding gases

Gas mixtures such as argon/carbon dioxide are normally used but welding grade carbon dioxide is also suitable. Flow rates will vary depending on the nozzle being used.

The nozzles are designed to let any trapped atmospheric and excess shielding gases escape. This stops gases and fumes building up pressure.



4. Recommended spot welding procedure

Steps

1. Select the most appropriate spot welding nozzle for the torch and the job.
2. Fit the correct diameter consumable wire.
3. Select voltage setting.
4. Set wire feed to achieve current conditions.
5. Set weld time to appropriate arc on time.
6. Trial weld and increase or decrease voltage, wire feed and time to get the penetration and bead shape you want.

Review questions

These questions will help you revise what you've learnt in Section 19. The answers are on page 120.

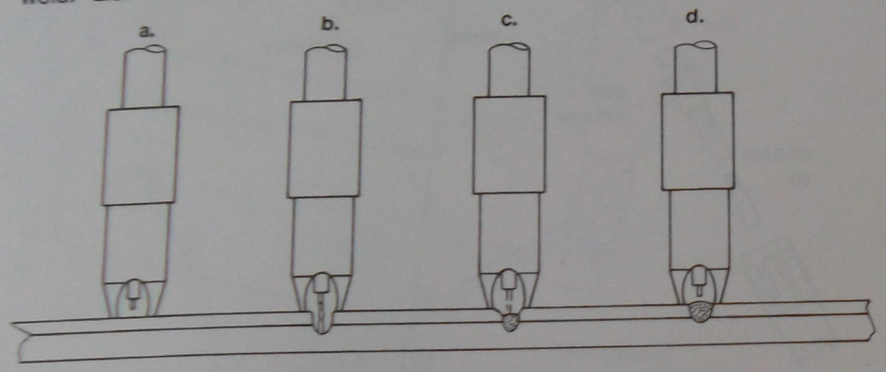
Short answer questions

1. Briefly describe the gas metal arc spot welding process:

   .....

   .....

2. When spot welding 2 pieces of metal as shown below there are 4 stages to the weld. List the 4 stages:



   a. .....

   b. .....

   c. .....

   d. .....

3. Spot welding nozzles are a special design - they have openings at the end. Briefly explain the reason for the openings:

   .....

   .....

4. Generally the power source/wire feed unit has 4 function control knobs. List the functions of these knobs:

   a. ..... b. .....

   b. ..... c. .....

5. What can be done about the problem of the top plate being too thick for the capacity of the machine?

   .....

   .....

Notes

Answers to review questions

Section 1: Gas metal arc operating principles

1. a. power
   b. wire feed unit
   c. wire rolls
   d. regulator
   e. flow meter
   f. gas cylinder
   g. gas shielding
   h. contact tip

2. (in any order)

   a. short arc
   b. globular
   c. spray arc

3. spray arc

4. To break down the high cylinder pressure to a safe operating pressure.

5. globular

6. increase the electrode stickout

7. The electrode would get poor current pickup, there would be reduced penetration and the electrode would wander in the arc.

8. a. To help prevent rust which would introduce oxides into the weld and to give better current pick-up.

   b. i. silicon
      ii. manganese

9. Operates the wire feed motor to feed the wire through the torch and contact without inducing current into the electrode.

Section 3: Fillet and butt weld definitions and defects

1. a. parent metal
   b. toe
   c. weld face
   d. penetration or fusion zone
   e. root
   f. weld metal
   g. reinforcement
   h. heat affected zone (HAZ)

2. a. porosity
   b. undercut
   c. lack of penetration
   d. spatter
   e. lack of fusion
   f. overroll

3. mitre

4. a. overhead
   b. horizontal
   c. flat
   d. vertical

Section 7: Effects of gas metal arc welding variables

1. aluminium

2. a. CO_2 (carbon dioxide)
   b. Ar/CO_2(argon/carbon dioxide)
   c. Ar/CO_2/0_2 (argon/carbon dioxide/oxygen)
   d. Argon

3. a. current would decrease
   b. volts would be increased

4. current density = 280.25

5. It becomes turbulent and the gas could mix with the atmosphere and contaminate the weld making it porous.

Section 19: Gas metal arc spot welding theory

1. The spot weld starts on the top surface and burns through to the lower surface. There is fusion between the two surfaces and a small nugget is left on the top surface.

2. a. The arc starts
   b. A hole is burned through the top plate
   c. The hole is filled with weld metal
   d. The wire feed stops and the arc burns the wire back

3. Allows the shielding gas to flow over the weld area and hot gases, fumes and sparks to escape.

4. a. voltage
   b. wire feed speed
   c. weld time
   d. dwell time

5. Drill or punch a hole.

Notes

Words you need to know

ASEA	Australian Standard Equal Angle
burn back:	fusing of the wire electrode to the contact tip
CO_2	carbon dioxide gas
contact tip:	a short tube fitted to a GMAW gun to pass electrical current onto the wire
current density:	the current for a given filler wire diameter
deposition rate	the weight of metal deposited in a unit of time
duty cycle:	percentage of time, for a test period during which power supply can be operated at its rated output without overloading
dwell time:	the period of time the nozzle remains on the job after welding to protect the cooling weld
flowmeter:	a gas flow measuring device connected to the regulator to adjust operating flow rates
globular transfer:	metal transfer which takes places as globules of a diameter larger than that of the electrode
GMAW:	gas metal arc welding
inching:	automatically feeding the wire electrode without welding
inert gas:	shielding gas consisting of argon or helium or a mixture of the two
liner:	supply conduit that the wire electrode feeds through
rectifier:	a power source developed to supply direct current (DC) for welding from an alternating (AC) mains power supply
short arc transfer:	metal transfer in which fused particles of wire electrode are detached in rapid succession during the repeated short circuiting contacts the weld pool

Words you need to know

spatter the metal particles which are expelled during welding on to the surface of the parent metal or a weld and which do not form a part of the weld

spray transfer: metal transfer which takes place as a rapidly projected stream of droplets of a diameter no larger than that of the wire electrode

stickout: the length the wire electrode projecting past the contact tip during welding

variables: operating conditions such as volts, wire speed, travel speed gas flow rate, that are adjustable before and during welding

weld time: total time involved between the start and finish of welding current during the making of one weld

TAFE NSW

Module Resource Manual

NF01

Manual Metal Arc Welding 1

Student Workbook

Third Edition

Manufacturing &
Engineering
Educational Services
Consortium

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1997

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Notes

Student organiser

This chart provides you with an overall picture of the content of this module. Use it as a guide as you work through each section.

No	*Section*	*Suggested time*
1	Introduction to welding and theory cutting processes	2 hrs 30 mins
2	Brazing theory	1 hr
3	Brazing Skill practice 1 Assessment event 1 (practical)	 1 hr 45 mins 15 mins
4	Braze welding theory	1 hr
5	Braze welding Skill practice 2 Assessment event 2 (practical)	 1 hr 45 mins 15 mins
6	Oxyacetylene welding theory	1 hr 30 mins
7	Oxyacetylene welding - beads on sheet Skill practice 3	 1 hr 30 mins
8	Oxyacetylene welding - outside corner Skill practice 4	 1 hr 30 mins
9	Oxyacetylene welding - fillet weld Skill practice 5 Assessment event 3 (practical)	 1 hr 15 mins 15 mins
10	Flame cutting theory	1 hr 30 mins
11	Flame cutting and heating Skill practice 6 Skill practice 7 Assessment event 4 (practical) Skill practice 8 Assessment event 5 (practical) Assessment event 6 (practical)	 1 hr 45 mins 15 mins 15 mins 15 mins 30 mins
12	Flame gouging theory	30 mins
13	Flame gouging Skill practice 9 Assessment event 7 (practical)	 45 mins 15 mins
14	Manual metal arc welding theory	1 hr 30 mins
15	Manual metal arc welding - beads on plate Skill practice 10	1 hr
16	Manual metal arc welding - pad weld Skill practice 11	1 hr 30 mins

No	*Section*	*Suggested time*
17	Manual metal arc welding - fillet weld Skill practice 12 Assessment event 8 (practical)	 1 hr 45 mins 15 mins
18	Gas metal arc welding theory	1 hr 30 mins
19	Gas metal arc welding - beads on plate Skill practice 13	 1 hr
20	Gas metal arc welding - pad weld Skill practice 14	 1 hr 30 mins
21	Gas metal arc welding - fillet weld Skill practice 15 Assessment event 9 (practical)	 1 hr 45 mins 15 mins
22	Hazardous locations and situations Assessment event 10 (theory)	2 hrs 30 mins 1 hr

Assessment

☐ To pass this module you must show competency in relation to the underpinning knowledge (theory), as well as demonstrate that you can safety carry out basic welding, heating, flame cutting and gouging tasks.

☐ The assessment scheme for this module comprises seven practical tests and one theory test.

The practical tests included in this workbook are based on material covered in the following module sections.

Section 3 Brazing
Section 5 Braze welding
Section 9 Oxyacetylene welding - fillet weld
Section 11 Flame cutting and heating
Section 13 Flame gouging
Section 17 Manual metal arc welding - fillet weld
Section 21 Gas metal arc welding - fillet weld

The theory test included in this workbook is based on material covered in the following module sections.

Section 1 Introduction to welding and thermal cutting processes
Section 2 Brazing theory
Section 4 Braze welding theory
Section 6 Oxyacetylene welding theory
Section 10 Flame cutting theory
Section 12 Flame gouging theory
Section 14 Manual metal arc welding theory
Section 18 Gas metal arc welding theory
Section 22 Hazardous locations and situations

☐ A complete assessment schedule will be supplied to you by your teacher, before you start this module.

MODULE SECTIONS

Section 1: Introduction to welding and thermal cutting processes

SUGGESTED DURATION	PREAMBLE
2 hours 30 minutes	This section provides an overview of the welding and thermal cutting processes used in the fabrication industry.

Objectives

At the end of this section you will be able to:

- ☐ recognise a range welding and thermal cutting processes
  - manual metal arc welding (MMAW)
  - gas metal arc welding (GMAW)
  - oxyacetylene welding (OAW)
  - gas tungsten arc welding (GTAW)
  - submerged arc welding (SAW)
  - resistance welding
  - fuel gas cutting
  - plasma cutting

- ☐ state typical industrial applications for welding and thermal cutting processes
  - light fabrication
  - heavy fabrication
  - general engineering
  - vehicle industry
  - building industry.

Introduction to welding and thermal cutting processes

Welding is a process that uses heat to join a range of materials. In the metal industry welding and thermal cutting processes are applied to a diverse range of material shapes and thickness. For example, these processes are used in the construction of steel frames for multistory buildings and motor vehicle bodies.

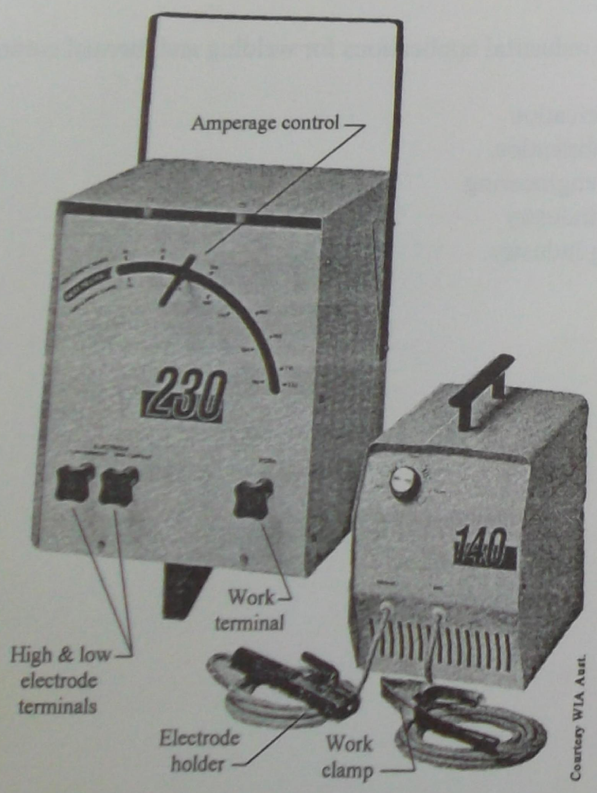
There are a variety of welding and thermal cutting processes available. Each has its own practical uses, advantages and limitations. Following are brief descriptions of common welding and thermal cutting processes used in the fabrication, engineering and related metal industries.

Manual metal arc welding (MMAW)

The process
Manual metal arc welding is an electric arc welding process.

An arc is struck on the job with a flux covered electrode. The heat of the arc melts the electrode and the parts which form the weld joint. Fumes from the electrode flux coating shield the weld area from the atmosphere as the flux melts to form a protective slag coating.

Uses
Manual metal arc welding is used in all general fabrication and pressure vessel industries.



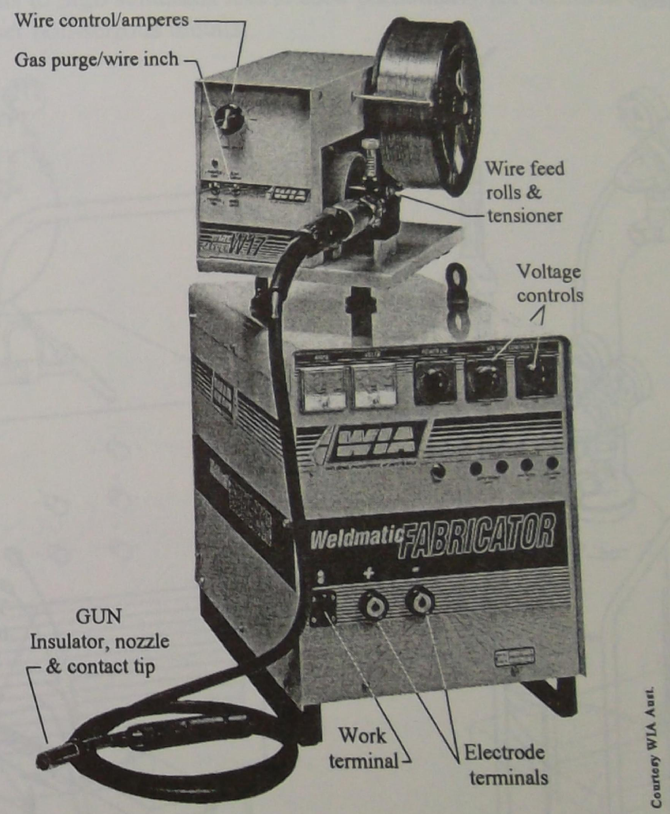
Manual metal arc welding equipment

Gas metal arc welding (GMAW)

The process
An arc is struck between the work and a continuous wire electrode fed through a torch which is supplied with a shielding gas.

Gas metal arc welding is usually a semi-automatic process but it can easily be made automatic which saves labour and consumables. It's important to use the right filler wire and shielding gas. You can weld a wide range of steels and non-ferrous metals by this method.

Uses
This versatile process is used in all light and heavy fabrication industries including the motor vehicle industry. This process is becoming more popular and in many cases is replacing manual metal arc welding.



Gas metal arc welding equipment

Introduction to welding and thermal cutting processes

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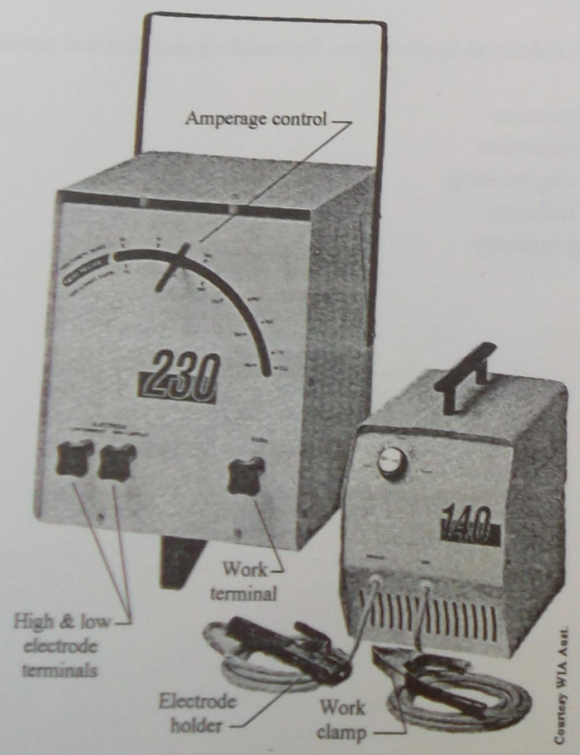
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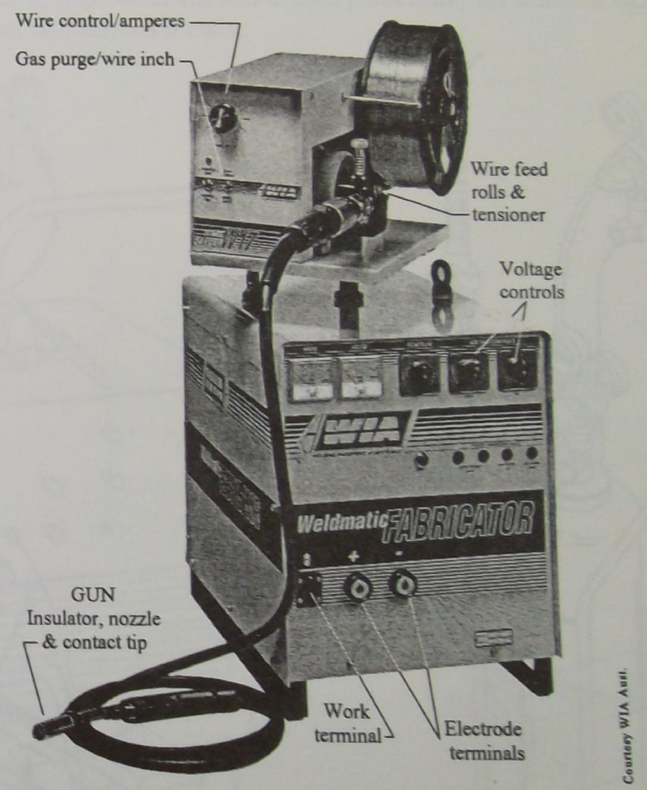
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Gas metal arc welding equipment

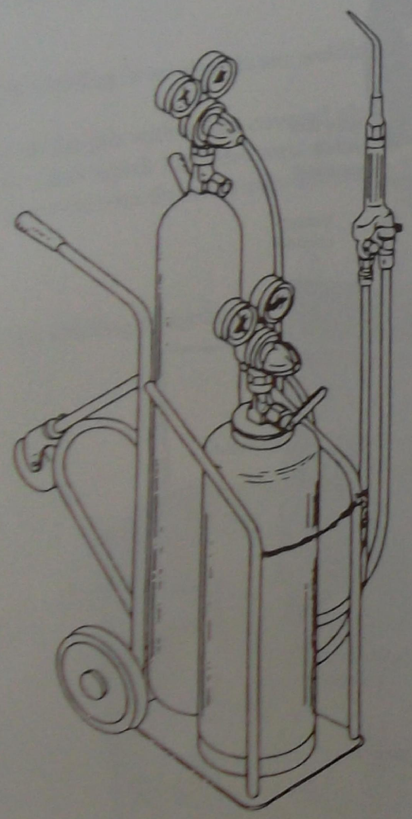
Oxyacetylene welding (OAW)

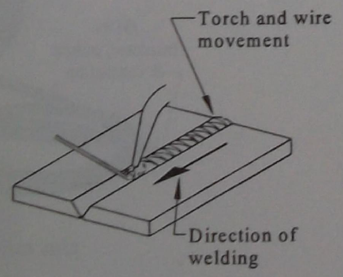
The process
The oxyacetylene welding process uses the heat from a gas flame to fuse or bond the parts together. This is called combustion.

Oxyacetylene welding is a manual skill which needs to be practised. It can be done with or without filler metal and can be used on materials of thin to medium thickness. You can't weld thicker metals economically by this method.

On the plus side, oxyacetylene equipment is fairly cheap and you can move it easily to where welding, brazing and heating are needed. However the process is slow and can sometimes cause more distortion in the metals being welded because of the greater heat.

Uses
Oxyacetylene welding is used in general engineering and in the light fabrication and vehicle industries.





Oxyacetylene welding (OAW)

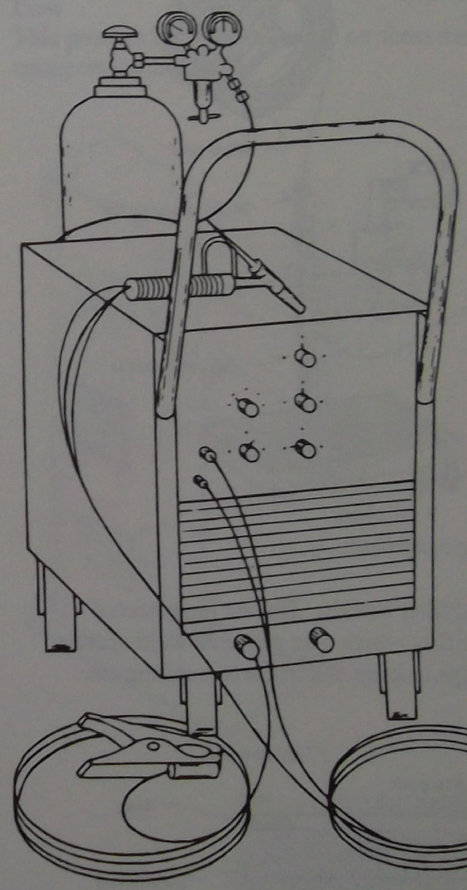
Gas tungsten arc welding (GTAW)

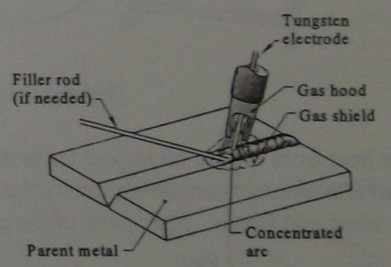
The process
Gas tungsten arc welding is a fusion process. The heat is generated by an electric arc between a tungsten electrode and the work rather than by a flame.

The tungsten electrode is used to carry the current which produces the arc and is not consumed to form part of the weld. A hand held filler rod can be used to supply additional weld metal.

Argon is the inert gas most commonly used in Australia as the shielding medium to protect the weld from contamination by nitrogen and oxygen in the atmosphere. An inert gas will not combine with other elements.

Uses
The gas tungsten arc process is used mainly in light fabrication and general engineering. It welds most metals to high standards and is used particularly for stainless steel, aluminium and other non-ferrous metals.





Gas tungsten welding equipment

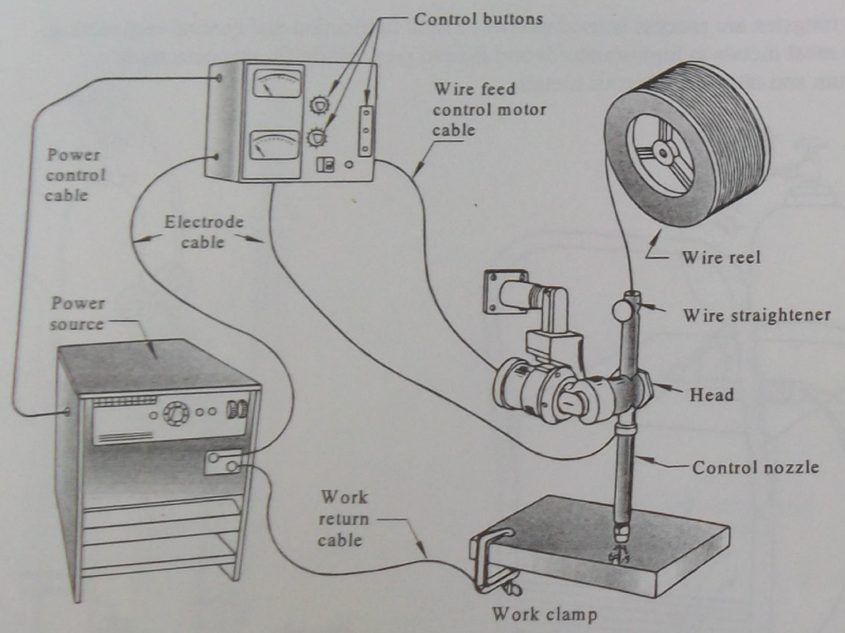
Submerged arc welding (SAW)

The process

Submerged arc welding uses a bare metal wire electrode. The arc is protected by a separate supply of loose flux. Some of this flux melts and forms a slag-cover over the weld. During welding the bare metal wire electrode is fed automatically into the blanket of flux. There are minimum fumes, no visible arcing and the equipment is easy to use.

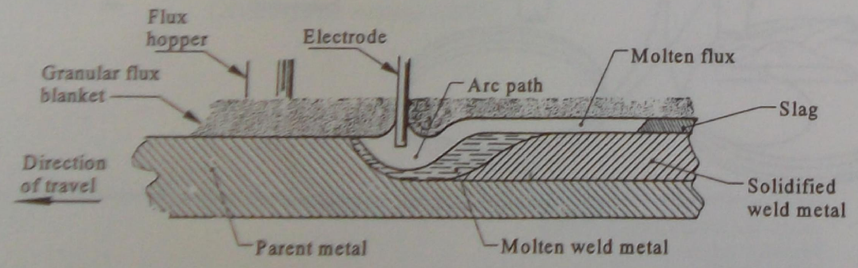
Uses

Submerged arc welding is popular in the heavy metal fabrication industry because it gives welds of high quality. It is used to make pipes, pressure vessels, boilers, road and railroad tankers and other structures that require welding in a straight and continuous line.



Submerged arc welding equipment

The heat from the arc melts and fuses the base and filler metals. The arc is protected from atmospheric contamination by the blanket of flux which also prevents weld spatter, arc noise and fumes. The speed of the process helps to keep distortion to a minimum.



Resistance welding

Spot welding process

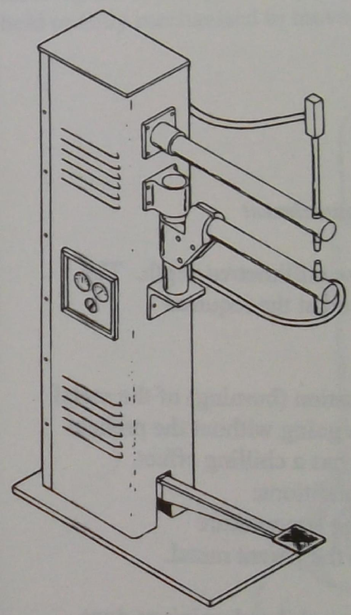
The spot welding process uses the heat resulting from resistance to an electric current passing through the metals being joined.

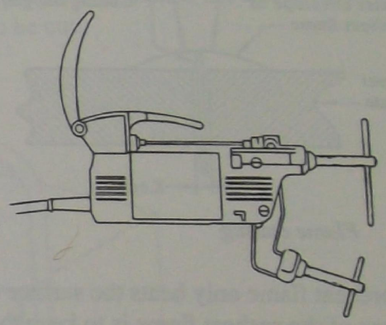
The spot welding machine produces a small round weld, called a weld nugget, to join two overlapping pieces of metal. The materials to be welded are clamped together between two copper alloy electrodes and a current is passed between the electrodes, for a controlled time. The current heats the metals at their junctions and they are joined by the force of the electrodes being squeezed together.

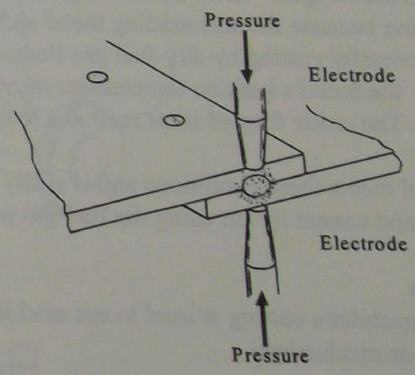
Spot welding may be used on materials from 0.025 mm to 6 mm thick but most spot welding is done with materials of less than 3 mm thickness.

Uses

This process is commonly used on sheet metal in the light fabrication, vehicle and transport industries.







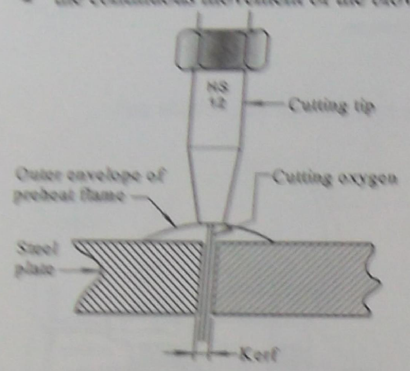
Spot welding equipment

Fuel gas cutting

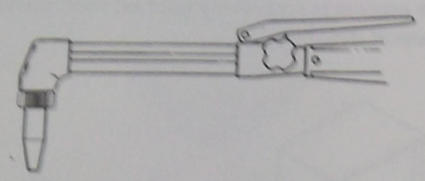
Chemistry of oxy-fuel gas cutting

The oxy-fuel gas cutting process depends on the chemical reaction of heated iron or steel coming in contact with pure oxygen. The reaction is called oxidisation.

Process
The cutting process involves:
- heating the steel to its ignition temperature (815˚C)
- oxidisation of the steel in the path of the oxygen jet
- removal of the slag by pressure from the oxygen stream
- the continuous movement of the blowpipe.



Flame cutting



Cutting attachment

The preheat flame only heats the surface of the metal to a few millimetres depth. The purpose of the preheat flame is to keep the surface of the metal at the required temperature (ignition point 815ºC).

The remaining thickness of the metal is heated by the combustion (burning) of the metal and the oxygen. There isn't enough heat to keep the reaction going without the preheat flame because the surrounding metal and the cutting oxygen has a chilling effect.
Successful cutting by oxy-fuel gas flames depends on two conditions:
- the metal's ignition temperature must be below its melting temperature
- The oxide formed must melt at a lower temperature than the parent metal.

Steel meets these conditions and is easily cut with this process whilst aluminium does not and cannot be cut using the fuel gas process.

Uses
Oxyacetylene cutting is used to cut steel in all industries. The machine can be hand-held or mechanised.

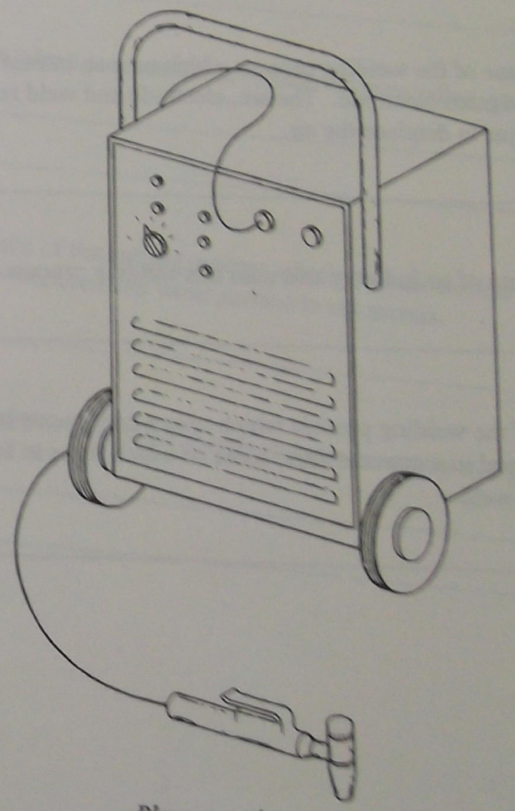
Plasma cutting

The process
The plasma cutting process is more versatile than the oxy-fuel gas cutting process and will cut non-ferrous and ferrous metals. It uses an electric current to ionise the gas to cut the metal, rather than a flame and oxygen to oxidise the metal.

In a plasma torch, the electric arc is made by:
- the tungsten electrode and the nozzle of the torch **OR**
- the tungsten electrode and the surface of the work.

Plasma cutting equipment
Plasma cutting is a thermal process used on all metals that can be melted by a hot plasma arc. Some of these metals are stainless steel, aluminium, cast iron, alloy steels and low carbon steel. Plasma cutting is good for a wide range of shapes which includes straight lines, bevel preparations and profiles.

Uses
Both light and heavy industry use the plasma cutting process. The units are either hand-held or fully mechanised to move around the shape to be cut.



Plasma cutting equipment

Review questions

These questions will help you revise what you've learnt in Section 1.

1. State a reason why a flux is used on manual metal arc welding electrodes.

_____

_____

2. List the type of electrode used in metal arc welding process.

_____

_____

3. State the name of the gases used in the OAW process.

_____

_____

4 (a) State the name of the welding process which uses an intense arc between the work and tungsten electrode. The arc, electrode and weld zone are protected by an inert gas to displace the air.

_____

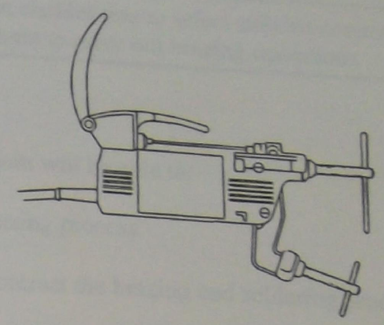
(b) State the name of an industry that uses this welding process.

_____

5. State the name of the welding process which uses a continuous bare metal electrode enveloped in a granular flux, some of which fuses to form a removable slag covering the weld.

_____

6. (a) State the name of the welding process that uses the machine shown below.



_____

(b) State the names of **two** industries which use this process.

- _____
- _____

7. Give the reason why a pre-heat flame is used when oxy-fuel gas cutting.

_____

_____

8 (a) State the name of the cutting process which uses an electric arc created between the torch and the work surface to cut metals.

_____

(b) State the names of **two** of the metals that can be cut by this process.

- _____
- _____

Section 2: Brazing theory

SUGGESTED DURATION	PREAMBLE
1 hour	This section enables you to select suitable consumables, joint types and equipment to carry out brazing operations.

Objectives

At the end of this section you will be able to:

- ☐ describe the brazing process
- ☐ compare and contrast the brazing and soldering processes in terms of:
  - appearance
  - strength
  - cost
  - applications
- ☐ list the equipment and consumables required for brazing
  - welding plant
  - flux
  - filler material
- ☐ state the metals suitable for brazing
  - ferrous
  - non-ferrous
- ☐ list common industrial uses for brazing
  - copper fittings
  - electrical connections
- ☐ list the hazards of the brazing process
  - heat
  - poisons (flux solvents)
- ☐ list the safety equipment required for the brazing process
  - eye
  - body
  - ventilation
  - respiratory.

Brazing process

Brazing is more like soldering than welding. Capillary action draws the molten filler metal between two close fitting surfaces and joins them. Lap joints and prepared fillet joints similar to soldering are recommended.

Brazing is much stronger and more expensive than soft soldering and is done at temperatures above 450°C.

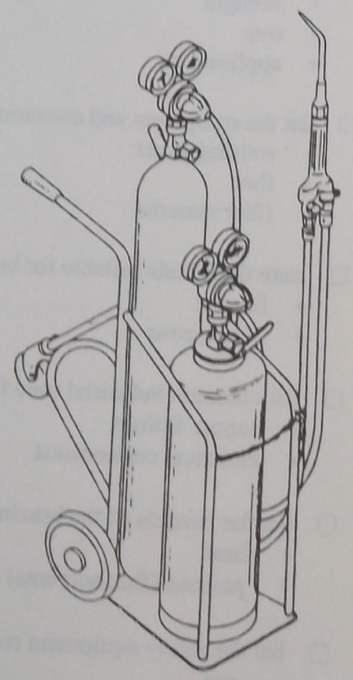
Silver brazing
Silver brazing is also called silver soldering and is used for joining steel, copper, bronze and brass.

For silver brazing you need a filler metal made of silver and copper alloy and a commercially prepared flux. Silver brazing alloy melts at a lower temperature than other alloys used for brazing.

Common heating gas mixtures

- *Oxygen and acetylene*
  This type of flame is suitable for most torch brazing. The equipment is portable and quite cheap. The flame heat can be controlled over a wide temperature range.

- *Oxygen and LP gas*
  Both industrial and hand held units are available. Hand held units are ideal for small and difficult to reach areas.



Portable oxyacetylene welding plant suitable for braze welding

Safety

Hoses should be checked regularly for gas leaks.

Brazing fluxes
Fluxes are used for most brazing operations for the following reasons.
- To assist the filler alloy to flow freely
- To clean the surfaces to be joined
- To prevent oxides forming while brazing

Fluxes are available in a number of forms. The most common fluxes are powder, liquid or paste. Manufacturers' information leaflets will help you to select the most suitable flux for a particular job.

Safety

- You must have adequate ventilation when brazing. This is particularly important when the flux contains fluorides or when the brazing alloy contains cadmium.

- Don't let flux contact your skin.

Brazing alloys
Brazing alloys are available in many combinations. You must choose the most suitable alloy.

Points to think about when choosing the most suitable alloy.
- Mechanical strength of the joint
- Materials involved
- Finish required
- Cost
- Your level of skill
- Colour of joint - matching the workpieces if required

Filler metals come in three main groups.
- Copper base alloys
- Silver base alloys
- Phoshorus copper based alloy

Silver alloys are free flowing. They can enter small openings and provide strong neat looking joints.

Brazing

Brazing is
metal betw
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Brazing is
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Metals suitable for brazing
Most ferrous and non-ferrous metals used in industry can be joined with either copper or silver alloys. You can braze metals that are not alike, eg. copper to steel.

Examples of metals commonly brazed are given below.
- Steel - most grades and alloys
- Copper
- Stainless steel
- Brass

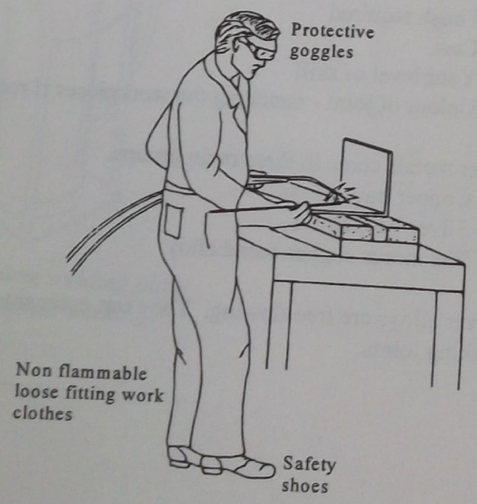
Industrial uses of brazing
Brazing is commonly used for:
- electrical connections
- copper pipes and fittings
- furniture
- auto fittings
- plumbing (phoshorus copper based alloy).

Hazards of brazing

Ventilation
Fluxing agents contain toxic (poisonous) chemicals and it's important that adequate ventilation is maintained throughout the brazing operation.

Flux
Avoid flux contacting your skin.

Chemicals
Be very careful when using acids. Always wear protective clothing, gloves and goggles when working with chemicals and make sure you're in a well ventilated area. These precautions are for your safety. Don't take risks.



Protective clothing

Safety

Hoses sh

Review questions

These questions will help you revise what you've learnt in Section 2.

1. List the safety equipment you need for brazing. Use the following headings as a guide.

   Eyes

   _____

   _____

   Body

   _____

   _____

   Ventilation

   _____

   _____

2. List **three** of the metals which can be joined by the brazing process.
   - _____
   - _____

3. State the name of **two** common heating gas mixtures used for brazing.
   - _____
   - _____

4. State a weld joint recommended for brazing.

   _____

   _____

Review questions

5. Compare brazing to soldering by ticking the appropriate box for the following.

	Greater than soldering	Less than soldering
☐ Strength	☐	☐
☐ Cost	☐	☐
☐ Temperature	☐	☐

Section 3: Brazing

SUGGESTED DURATION	PREAMBLE
1 hour 45 minutes	This section enables you to use the brazing process to safely join copper and copper alloys.

Objectives

At the end of this section you will be able to:

- ☐ use the brazing process to bond copper and galvanised sheet in the horizontal position to the following requirements
  - neat and adequate fluxing of the surfaces to be bonded
  - correct alignment and assembly
  - penetration and bonding for the length of the joint
  - adequate but not excessive addition of filler rod
- ☐ record the brazing procedure
- ☐ follow Occupational Health & Safety workshop procedures.

Safety

- Follow all Occupational Health & Safety workshop procedures.
- Keep flux away from your eyes, mouth and skin.
- Avoid breathing welding fumes.
- Wash your hands thoroughly when you've finished your exercise.

Procedure sheet
Brazing

Sketch	
Gas data	**Consumables data**
Regulator	Filler type
Pressure O_2 C_2H_2	Filler size
Flame type	Flux
Weld tip size	
Material data	**Solder time**
Type	Start
Thickness	Finish
	Units completed

Assessment		**Complies**	**Does not comply**
Alignment	copper		
	brass		
Penetration	copper		
	brass		
Surface finish	copper		
	brass		
Name		**Exercise Number**	

Skill practice 1
Assessment event 1 (practical)
Brazing

IF IN DOUBT ASK YOUR TEACHER

Suggested time Skill practice: 1 hour 45 minutes
Assessment: 15 minutes

Objective To bond materials by brazing (copper/silver alloy) to the requirements given below.

Position As illustrated.

Procedure Before beginning the exercise, you must attend a demonstration by your teacher.

Method

1. Straighten the copper material and remove oxides from the bonding surfaces with a wire brush or abrasive cloth.
2. Apply flux to both bonding surfaces and assemble members.
3. Heat plates evenly with the outer envelope of a soft flame.
4. When the flux indicates correct temperature, apply the brazing alloy allowing sufficient filler material to just penetrate the joint.
5. Take the assembly to be inspected by your teacher.
6. Repeat the exercise on brass and record the information on the procedure sheet.
7. Remove flux by wire brushing the effected areas in hot water.
8. For assessment, repeat the brazing to the requirements given below.

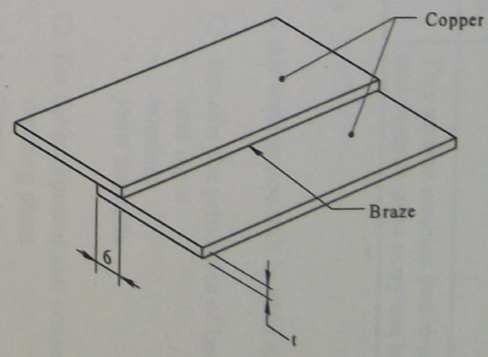
Requirements

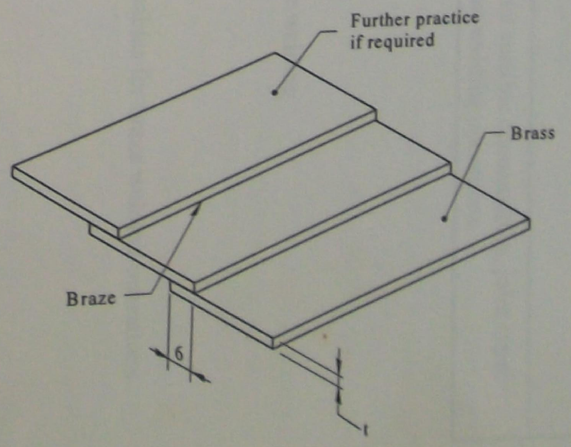
- Correct alignment with penetration for the length of the joint
- Minimum filler metal addition with adequate fluxing

Material unit 2 pieces copper 30 x 1.6 x 50 mm
2 pieces brass 30 x 1.6 x 50 mm

Unit required 1

Economy Return all unused material to the store.





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Skill practice 1
Assessment event 1 (practical)
Brazing

IF IN DOUBT ASK YOUR TEACHER

Suggested time Skill practice: 1 hour 45 minutes
Assessment: 15 minutes

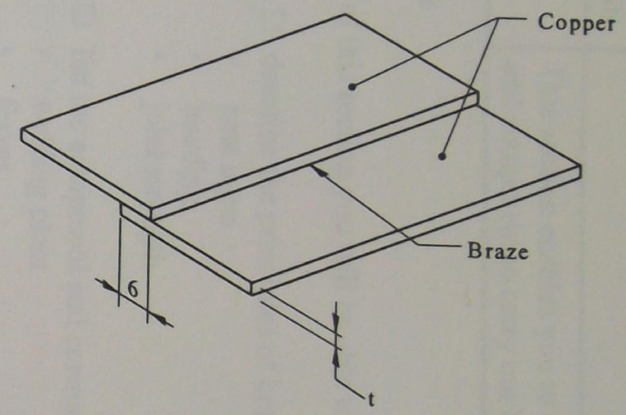
Objective To bond materials by brazing (copper/silver alloy) to the requirements given below.

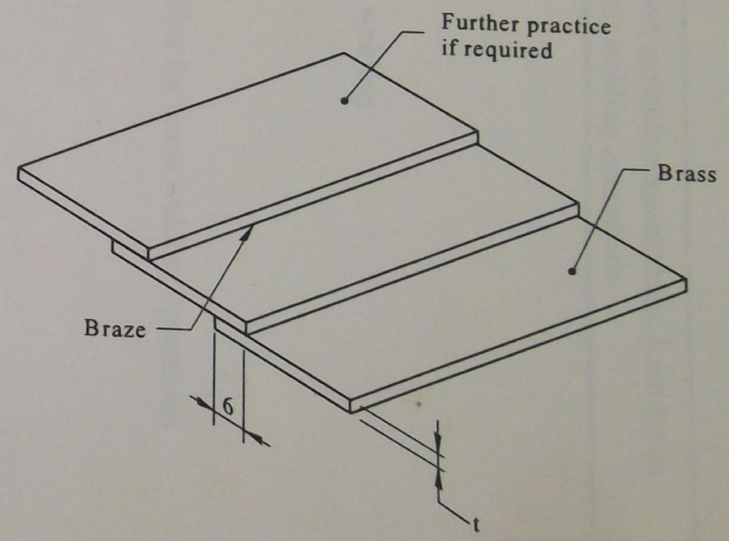
Position As illustrated.

Procedure Before beginning the exercise, you must attend a demonstration by your teacher.

Method

1. Straighten the copper material and remove oxides from the bonding surfaces with a wire brush or abrasive cloth.
2. Apply flux to both bonding surfaces and assemble members.
3. Heat plates evenly with the outer envelope of a soft flame.
4. When the flux indicates correct temperature, apply the brazing alloy allowing sufficient filler material to just penetrate the joint.
5. Take the assembly to be inspected by your teacher.
6. Repeat the exercise on brass and record the information on the procedure sheet.
7. Remove flux by wire brushing the effected areas in hot water.
8. For assessment, repeat the brazing to the requirements given below.





Requirements
- Correct alignment with penetration for the length of the joint
- Minimum filler metal addition with adequate fluxing

Material unit 2 pieces copper 30 x 1.6 x 50 mm
2 pieces brass 30 x 1.6 x 50 mm

Unit required 1

Economy Return all unused material to the store.

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Notes

6.

Section 4: Braze welding theory

SUGGESTED DURATION	PREAMBLE
1 hour	This section enables you to select suitable consumables, joint types and equipment to carry out braze welding operations.

Objectives

At the end of this section you will be able to:

- ☐ describe the principles of braze welding
  - heat input
  - bonding
  - joint strength
- ☐ list the equipment and consumables for braze welding operations
  - welding plant
  - fluxes
  - filler materials
- ☐ state the metals suitable for braze welding
  - steel
  - cast iron
  - copper
- ☐ list common industrial uses for brazing welding
  - maintenance repairs
  - tanks
  - furniture
- ☐ list the hazards of the brazing welding process
  - heat
  - poisons (fluxes)
- ☐ list the safety equipment for the brazing welding process
  - eye
  - body
  - respiratory
- ☐ outline the technique for braze welding low carbon steel
  - flame adjustments
  - flux application
  - welding technique.