*Electric shocks: high voltage*
High voltage shocks shouldn't happen if:
- welding machines are maintained by licensed electrical tradespersons
- you never interfere with the inside parts of the welding machines.

*Symptoms of electrical shock*
Electric shock often stuns, but doesn't kill. However, when electricity passes through the body it causes muscles to contract. This can stop your heart beating. Electricity can also cause serious burns.

## Fumes

*Causes of fumes*
- The production of oxides and nitrous gases.
- Incomplete combustion or oxidation of nitrogen from the atmosphere.
- Surface coatings on steel:
  - Galvanising
  - Cadmium plating
  - Chrome plating
  - Paints and solvents (such as red oxide coated parts and degreasing solvents).
- Elements within the parent metal.
- Electrode flux coatings.

*Safety*
Welding should be carried out in well ventilated areas. When welding high fuming materials such as galvanised steel, use an exhaust fan to carry away the fumes. If an exhaust fan is not available, an approved respirator should be used to filter out the fumes.

*Dangerous fumes*
Gases, dusts and vapours are given off during welding. They can cause:
- Asphyxiation because the oxygen has been used up in the work area (common in confined spaces)
- A build up of poisonous metals in the body, such as lead, cadmium, zinc, beryllium or mercury
- Respiratory ailments from wheeziness to serious lung disorders.

## Heat

Heat is a form of energy. When a substance is heated, the molecules vibrate or move more rapidly. Heat may be generated by various means. In manual metal arc welding, it is generated by the passage of an electric current across an arc gap.

The electric arc (about 6000°C) generates the heat to melt and fuse the metal surfaces.

*Heat transfer*
Heat is transferred either by conduction or radiation.

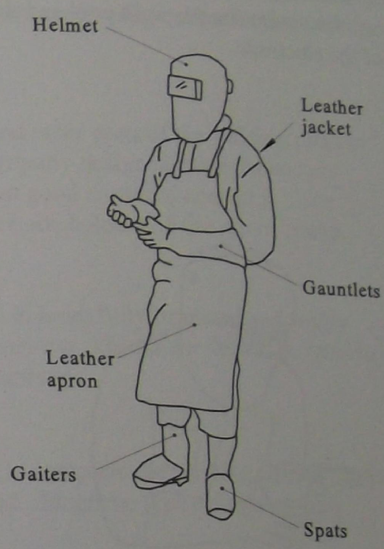


*Conduction*
Solid bodies must be in contact for heat to travel through them. Some materials conduct heat more rapidly than others. Metals are generally good conductors but, because of their different properties, some have a greater conductivity rate than others. For example, copper and aluminium are very good conductors while cast iron and stainless steel are poorer conductors.

*Radiation*
Radiation is the transfer of heat through space by wave motion. No actual contact is needed. All bodies at a higher temperature than their surroundings radiate heat. For example, the sun radiates heat energy in the form of cosmic rays and an electric radiator transfers heat through space across a room.

## Electrical safety

***Protection against hot metal, heat and arc rays***
Molten droplets have a way of getting into boots. You can avoid this by wearing proper protective clothing and footwear. When welding out of position, wear spats over your boots and under the overall's legs.



*Full protective clothing*

*Harmful rays*
The harmful rays given off from an electrical welding process are:
- ultra-violet rays
- infra-red rays.

These rays can damage the skin. *Ray burn* is like very severe sunburn; your skin reddens and then peels. If the ray burn is very severe, there may be blisters and sores. Rays can also harm the eyes causing a condition called *a flash* or *arc eye*. The first symptom of a flash is an itchy feeling in the eye. Afterwards a throbbing pain (much like sand in the eye) may stop you sleeping. There are eye drops available that can relieve the problem.

***Filter lenses***

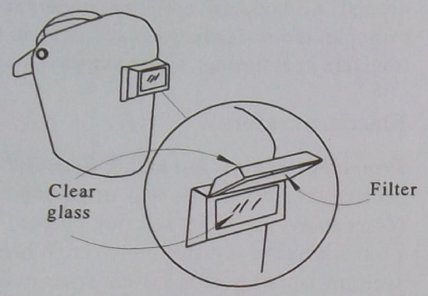
Filter lenses are specially designed glass lenses to filter out harmful rays and allow you to see what you are welding without causing damage to your eyes. Filters come in different shade numbers, according to the current range or type of welding.

***Safety***

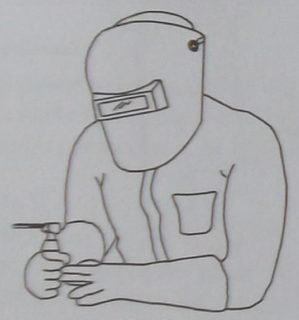
- Wear appropriate clothing to protect your eyes and skin from welding rays.
- Avoid exposure to the welding arc.

**Protective equipment**

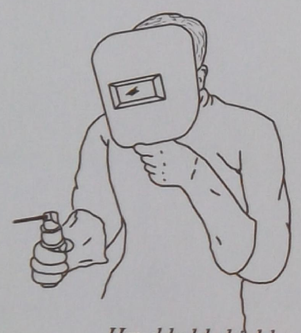
Wear a welding shield or helmet to protect yourself from arc rays, heat and the spatter from molten metal. The filter reduces the intensity of the radiation, but allows sufficient light through for you to see the weld pool and the end of the electrode.




*Helmets*



*Head shield*



*Hand held shield*

***Maintenance on welding equipment***

Before carrying out any maintenance on electrical equipment, it is important that you first switch off the power and remove the plug. If there is no plug available, lock off the machine or danger tag the isolator switch.

***Transformer***

**Never** do maintenance work inside the cabinet of a welding machine. This is the responsibility of a licensed electrician.

Operators can care for the machine by:

- keeping the case clean and dust free
- maintaining the secondary circuit in good condition
- sending the machine to a licensed electrician for any maintenance on the internal parts, the primary lead and plug.



***Machine terminals***

Keep terminals clean and tight to ensure that the current will flow freely. If you do not keep the terminals in good condition, you may get arcing and/or overheating of the terminal and lug connections. This can lead to fire or unreliable welding conditions.

***Secondary leads***

Damaged leads may cause the operator discomfort from overheating, and poor arcing characteristics. Maintain leads by:

- rolling them up after use
- making sure that the ends are fixed correctly into the electrode holder, work clamp or terminal lugs
- covering lug connections with insulation tape when necessary.

The size of the cable must suit the output of the welding power source at the maximum used duty cycle (refer to Australian Standard AS 1995 on welding cables for the cable size ratings).

***Joints***

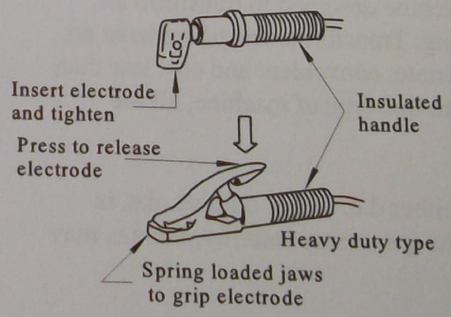
Loose joints or bad contacts cause cable, clamps and other parts of the welding plant to overheat and may give you unstable arcing. Use properly designed cable connectors when you make any joints in cables. Make sure that good electrical contact is made when you connect cables to the power source, electrode holder and the return clamp.

***Electrode holder***

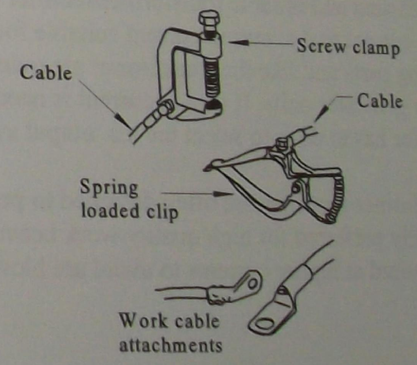
The holder should be relatively light, comfortable to hold, fully insulated and sturdy enough to withstand the wear and tear from constant use. The holder should be rated to withstand the maximum current required for the activity.

***Return clamp***

This is fastened to the work or to the workbench to complete the welding circuit. Spring pressure and screw type clamps are normally used. Magnetic type clamps are also available.




*Electrode holders*




*Cable attachments*

***Safety***
Protect yourself by wearing the following safety clothing.

- Overalls or work clothes
- Leather apron and/or coat
- Welding gloves
- Spats
- Helmet

***Machine location***
Welding machines should always be in a dry protected area and as close to the power outlet as possible.

***Protection of others***
Welding should be done in special welding bays. When this is not possible, use portable screens to shield others working in the area from the rays generated from the arc. You should also put up signs to warn people that you are welding.

## Welding machines

***Alternating current (a.c.) welding machines***
Alternating current welding machines are transformers which step down line voltage (220/240 or 415/440 volts) to provide a safe welding voltage. The welding current supplied by the secondary circuit of the transformer is set by the operator to suit the type and size of electrode.

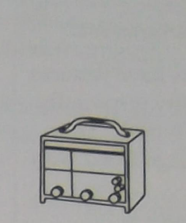
Transformer welding machines are less complex and slightly less expensive than other types.

***Direct current (d.c.) welding machines***
The direct current output may be supplied by a transformer/rectifier or a generator power source.

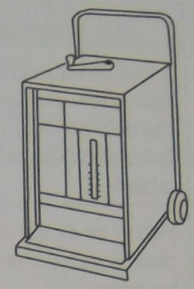
***Transformer/rectifiers***
An efficient and reliable transformer/rectifier is a machine designed to transform a.c. input current to d.c. output current suitable for welding. Transformer/rectifiers have no moving parts and like the transformer are quiet to operate, convenient and cost less than motor generater units. If an a.c. current is needed from this type of machine, all the operator has to do is to select the a.c. output switch.

Transformer/rectifiers are often designed to provide either d.c. or a.c. outputs. d.c. is normally preferred for high quality work because of its greater arc stability, but a.c. may be required at higher currents to avoid arc blow.



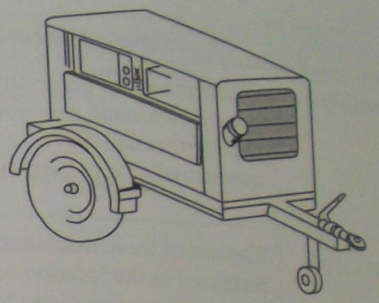


Portable light duty



Medium duty

*Arc welding power source - a.c. transformer*



*Arc welding power source - mobile engine driven d.c. generator*

| | *a.c. transformer sets* | *d.c. motor generator sets* |
|---|---|---|
| Portability | These machines generally consist of a static step-down transformer and they are considered as stationary types. | Most modern types have features that allow portability (especially the self contained types). They have an undercarriage fitted with wheels. |
| Power supply | The use of these machines is restricted to the location of the nearest alternating current power point. | Petrol or diesel engine driven machines can be used in any location. |
| Efficiency | 70-90 per cent electrically efficient. Many multi operator sets give higher efficiency. | 40-60 per cent electrically efficient but some modern types compare with alternating current efficiency. |
| Polarity | No polarity. | A choice of polarity is obtained by a simple reversal of a switch (d.c. - or d.c.+) |
| Arc blow | Unaffected. | Arc blow occurs even in normal current and is difficult to control above 300 amperes. |
| Maintenance | As there are no moving parts to be considered, maintenance costs are very low. | Revolving and wearing parts add to running costs. |
| Initial costs | Cheaper plant as less construction is involved. | More costly due to generator and motor construction. |
| Electrodes | Restricted to the use of electrodes that are suitable for alternating current only. | Suitable for all types of electrodes. |
| Running costs | Cheaper running costs due to the use of an installed power supply. | Added costs due to the use of electric motors or internal combustion engines. |
| Voltage control | Constant open circuit voltage. | A variation of open circuit voltage is possible allowing a selection of electrode type and welding technique. |
| Arc length | Limited arc length. | Greater tolerance in arc length due to the characteristics of the machine. |

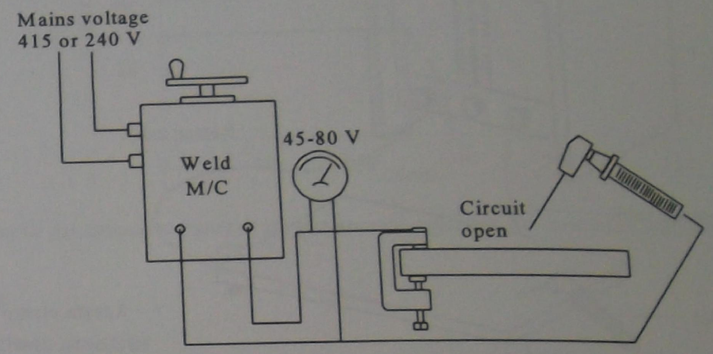


**Power source**

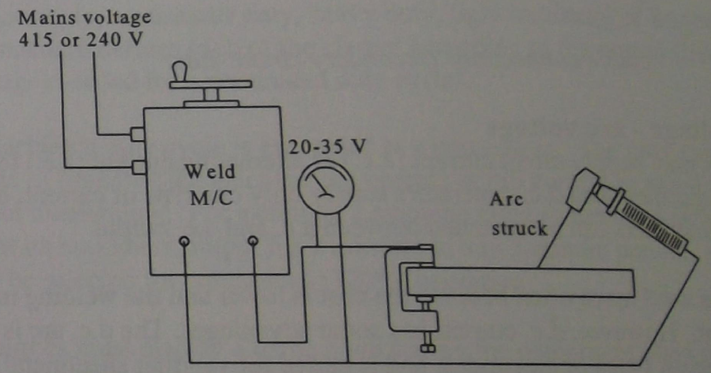
A welding source provides enough current (heat energy) to melt the electrode and the parent metal. Manual metal arc welding machines have a variable (adjustable) current output that can be set to suit the job and type of electrode.

**Power source terminals and polarity**

Electrical connections for a welding machine are illustrated below.




*Open circuit voltage (no current flowing)*



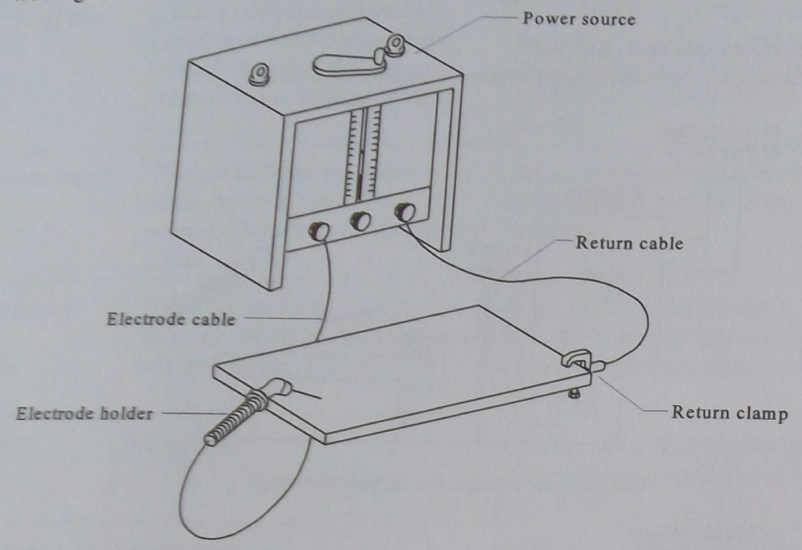

*Arc voltage (current flowing)*

Output terminals on a.c. machines are marked *electrode* and *work*.

On a d.c. machine, the terminals are marked positive (+) and negative (-) except in the case where the polarity can be changed by means of a polarity reversing switch. In such cases, the terminals are marked *electrode* and *work* with electrode terminal polarity indicated at the polarity switch.

Most electrodes designed for d.c. operate on d.c. electrode terminal positive (+) while some types of electrodes should be operated on d.c. electrode negative (-). Refer to the manufacturer's instructions for polarity selection.

***Welding cables***
A multiple-strand, insulated flexible copper or aluminium lead conducts the welding current from the power source to the work. A return cable is needed to complete the welding circuit between the work and the power source.




*Cable connections (secondary circuit side)*

## Open circuit voltage - arc voltage

Welding machines may supply direct current (d.c.) or alternating current (a.c.) to the electrode. a.c. transformers and d.c. generators supply only one type of current, but many transformer/rectifiers can be switched between a.c. and d.c. output.

a.c. power supply is used more often because the cost is lower and the welding machines are simpler in design. However, d.c. current has some advantages. The d.c. arc is much more stable with certain types of electrodes, and is suited for welding sheetmetal. Engine driven d.c. models provide welding power where there are no electrical supply lines available for example, on site work.

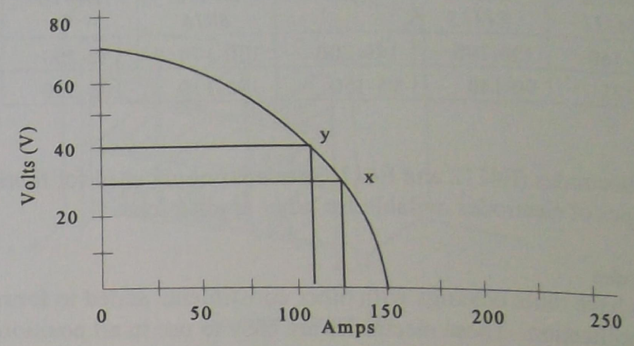
Welding machines are designed to control the current output despite variations in arc length caused by accidental or deliberate movements by the operator. For example, to control the weld pool, the operator may increase the arc length which will greatly increase the voltage across the arc and slightly decrease the welding current.

The open circuit voltage (OCV) is located and measured at the power source terminals with the machine switched on, but no welding current flowing. The OCV must be high enough to establish an arc, but not so high that there is risk of dangerous electric shock.

The welder makes the arc by striking the tip of the electrode on the work to cause a momentary short circuit. This is at the point on the graph where V=O (see below). With current flowing, the electrode is drawn away by the welder to establish the arc. The amperage and voltage for a typical arc length are shown at Point x. For a longer arc



length, there is significant increase in arc voltage and a small decrease in welding current (Point y). The welding machine is designed to avoid noticable changes in current output when the welder varies the arc length.




*Output curve for constant current power source adjusted for minimum current variation*

## Duty cycle

***Rating of power sources***
Australian Standard AS 1966 rates the output (duty cycle) of electric arc welding power sources. The machines are classified according to the type of service for which they are designed for example, continuous duty, heavy duty, light industrial or limited output cycles. The standard defines each of the classes according to the output (load current and load voltage) needed for a nominated duty cycle.

A welding machine's duty cycle is expressed as a percentage. The duty cycle indicates the percentage of time that the machine can operate at full current in any 5 minute period without overheating. For example, a machine rated as having a 60% duty cycle can be used at its maximum output for 3 minutes in any 5 minute period. A much lower current must be selected for continuous (100%) operation.

All power sources must display a name plate stating the equipment class and the rated output and duty cycle for its class (eg. 300 amps, 32 volts, 60% duty cycle). The 100% duty cycle output current must also be noted.

## Current range

***Selection of electrode size welding current***
The welding operator must follow the manufacturer's recommendations on the range of current for different types and sizes of electrodes. The following table gives some typical electrode sizes and welding currents.

**Typical current ranges for the electrode classifications**

| *Electrode diameter* | *E4110 E4111* | *E4112 E4113* | *E4814* | *E4815 4816* | *E4818* | *E4824 E4828* |
|---|---|---|---|---|---|---|
| 4.0 | 130-160 | 130-190 | 140-200 | 130-170 | 140-200 | 185-235 |
| 3.25 | 75-125 | 90-140 | 95-150 | 100-130 | 105-150 | 130-170 |

## Electrodes

General purpose electrodes (E4112 and E4113) are commonly used for fabrication. There are other types of electrodes avilable for other applications.

- ***EXX12 Electrodes***

EXX12 electrodes have rutile coatings with other constituents added to form a gaseous shield and slag modification. These electrodes are easy to use in all positions. They operate with a quiet, medium penetrating arc able to bridge gaps or misaligned sections. These electrodes are general purpose electrodes used for structural and steel sheet fabrication.

- ***EXX13 Electrodes***

EXX13 electrodes' coating is rutile, similar to the EXX12, but they produce a more fluid and removable with a very neat and flat profile. They are generally more suited to overhead and vertical welding in an upwards direction than EXX12. They have good X-ray and impact qualities.

***The effect of moisture on electrodes***

Any electrode that absorbs excessive moisture into the coating may cause one or more of the following problems.

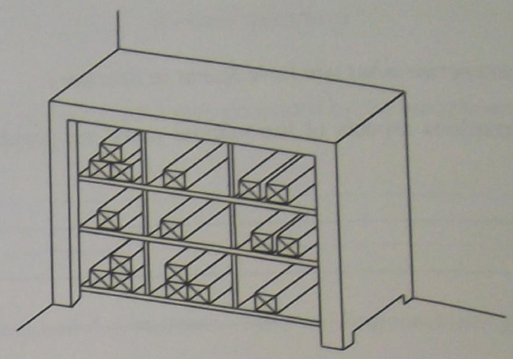
- Porosity
- Excessive spatter
- Arc instability
- Poor weld contour
- Undercut
- Difficulty in slag removal
- Cracking

***Storage***

All electrodes should be stored in their original packaging in a weather proof area on racks clear of the floor. They should be stored away from moisture, high humidity and possible damage.

Storage in an unheated room is satisfactory for a period of less than six months. For more than six months or in tropical or very wet climates, all electrodes except cellulose types (EXX10, EXX11) should be stored in a room or container heated to 15°C to 20°C room temperature, but at no time more than 40°C. Electrodes stored in hermetically sealed (airtight) boxes need not be kept in such an environment. Keep electrodes in original packets for identification purposes.





*Storing electrodes*

***Responsibility***

Welders are responsible for the care and handling of electrodes in the workplace.

***Condition***

Electrodes should kept clean and dry.

***Defective electrodes***

Do not use electrodes with damaged coatings. Discard electrodes which are wet or seek the manufacturer's advice. Do not use electrodes showing signs of rust.

***Number of electrodes***

Only remove from the packet, the number of electrodes you need for the next few hours or for the immediate job in hand. This reduces the risk of contamination and waste.

***Opening of containers***

Unseal packets of electrodes immediately before you use them.

## Review questions

*These questions will help you revise what you have learnt in Section 1.*

1. List **three** of the hazardous aspects of the manual metal arc welding (MMAW) process.

   - _____
   - _____
   - _____

2. List the effects of the hazards listed above on the human body.

   _____

   _____

   _____

   _____

3. A welding process operates for 4 minutes of a 5 minute cycle. State the duty cycle appropriate for that welding process.

   _____

4. State the welding current type (a.c. or d.c.) for the following.

   (a) A current which enables polarity selection.

   _____

   (b) The current supplied from a transformer.

   _____

   (c) The current supplied from a rectifier.

   _____

   (d) The current supplied from a generator.

   _____



## Review questions

5. State the names of the harmful rays generated by the electric arc and list their effects on the human body.

   _____

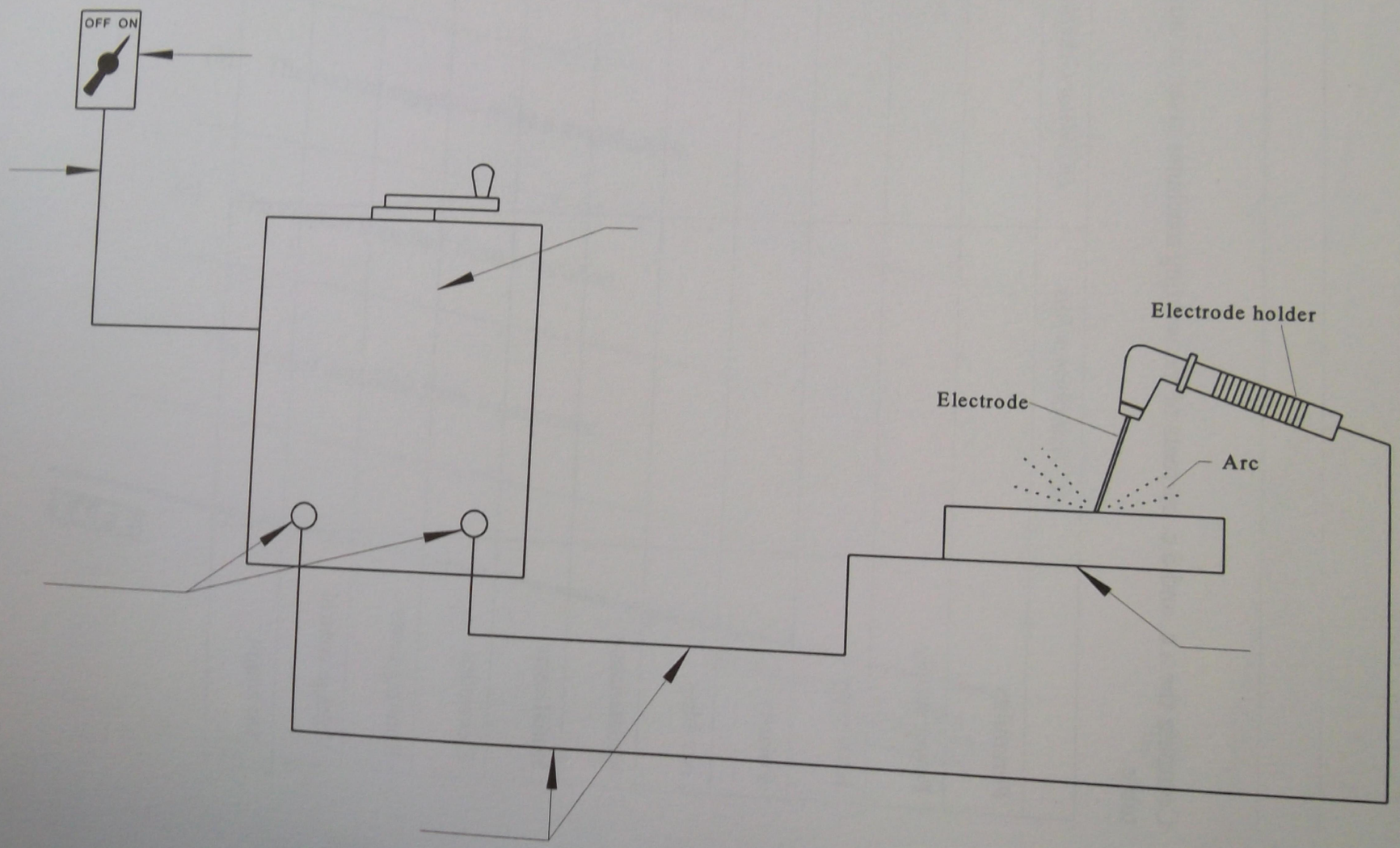
   _____

6. Compare the a.c. and d.c. currents of the welding machines given in the following table.

| | *AC Transformer Sets* | *DC Motor Generator Sets* |
|---|---|---|
| Portability | | |
| Power supply | | |
| Efficiency | | |
| Polarity | | |
| Arc blow | | |
| Maintenance | | |
| Initial costs | | |
| Electrodes | | |
| Running costs | | |
| Voltage control | | |
| Arc length | | |

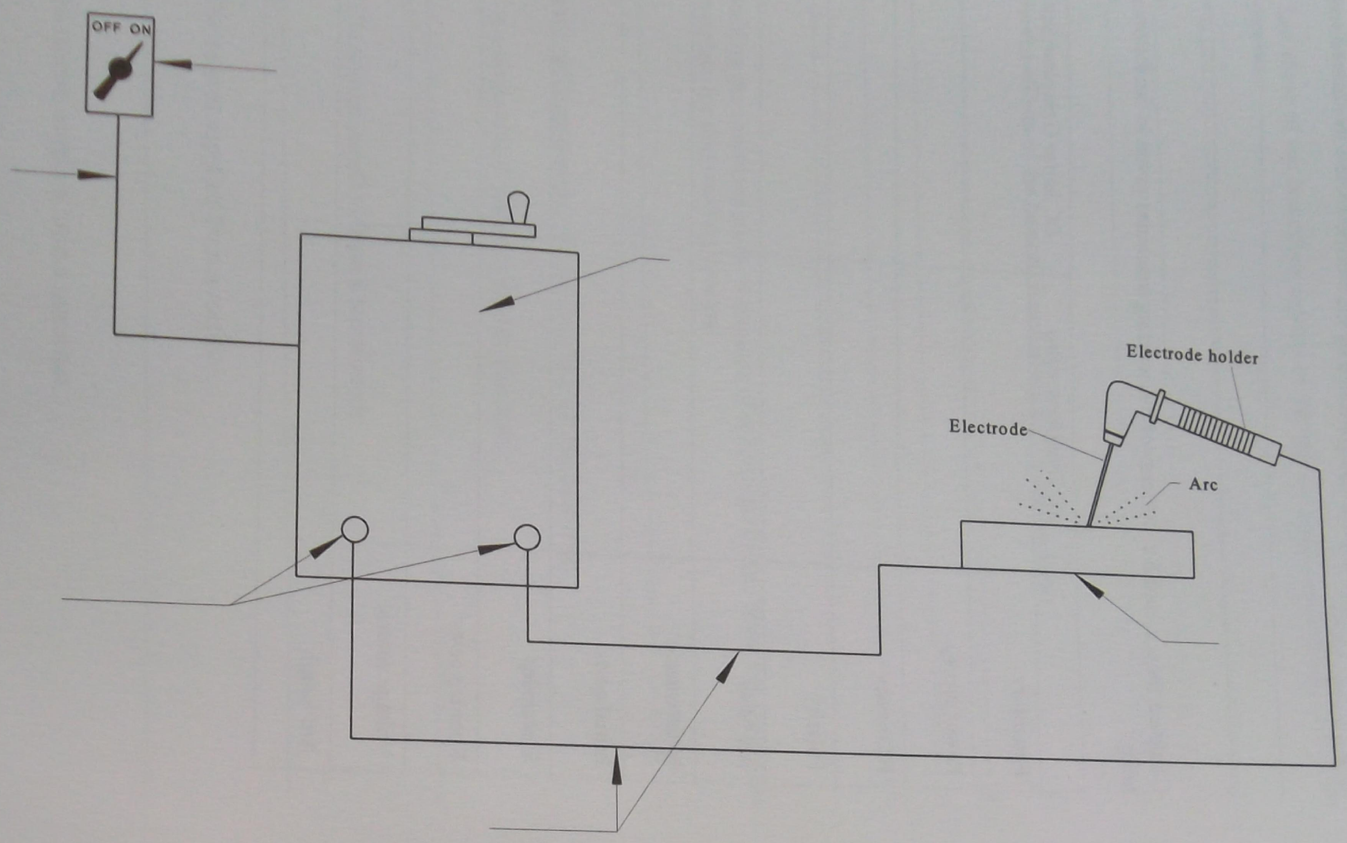
**Review questions**

7. Identify the parts of a typical welding circuit by labelling the parts on the diagram shown below.



## Review questions

7. Identify the parts of a typical welding circuit by labelling the parts on the diagram shown below.




## Review questions

8. State the name of **one** weld defect that can occur if moist electrodes are used.

_____

**Notes**



## Section 2: Pad weld shaft - rotated

| SUGGESTED DURATION | PREAMBLE |
|---|---|
| 2 hours | This section develops your knowledge and skills to build up a pad weld on low carbon steel solid round bar. |

***Objectives***

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

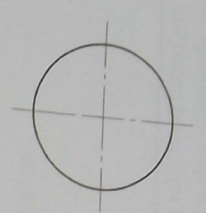
- ☐ use pad welding techniques to build up 10 mm thick low carbon steel shaft to the following requirements
  - smooth regular pad deposit 3 + 2 -1 mm high
  - a maximum of four significant surface defects with an accumulative defect area of less than 200 $mm^2$
- ☐ record the weld procedure
- ☐ follow Occupational Health & Safety workshop procedures.

***Safety***

- You must wear eye protection.
- Make sure the work is cool before touching it with your bare hands.

**Procedure sheet**
**Pad weld shaft - rotated**

Sketch welding runs on diagram.



Complete the control data table below.

| **Weld current data** | | **Electrode data** |
|---|---|---|
| Run | Run | Size |
| 1 | 7 | Type |
| 2 | 8 | |
| 3 | 9 | Brand name |
| 4 | 10 | |
| 5 | 11 | Electrode classification |
| 6 | 12 | |
| **Material data** | **Weld time** | Angles Lead Lateral |
| Type | Start | |
| Thickness | Finish | |
| | Units completed | |
| **Remarks** | **Complies** | **Does not comply** |
| Surface finish | | |
| Weld size | | |
| Surface defects | | |
| **Name** | | **Exercise Number** |



## Skill practice 1 - Pad weld shaft - rotated



IF IN DOUBT ASK THE TEACHER

*Objective* To use pad welding techniques in the workshop, to build up the surface of a shaft to the requirements given below.

*Position* Flat.

*Procedure* Demonstrated by the teacher.

*Method*

1. Draw chalk guidelines to indicate weld runs 1, 2, 3, 4.
2. Deposit the first run, then rotate the bar 180° to deposit the second run in a flat position.
3. Each run is deposited in the sequence shown to counteract distortion.
4. When the build up is complete, remove all weld spatter and present the exercise for inspection.
5. Deposit pad welds on both ends of the bar.
6. Evaluate the weld project and complete the procedure sheet.
7. Submit the weld and procedure sheet to the teacher.

*Things to note*

- Amperage setting
- Position of shaft on the bench
- Arc length
- Welding speed and uniformity of travel
- Unfilled craters
- Unremoved slag or spatter

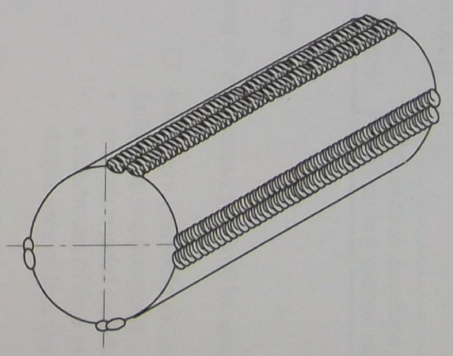
*Requirements*

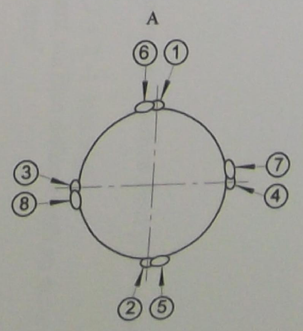
- Smooth regular contour
- Deposit height 3 + 2 -1 mm
- A maximum of four significant surface defects with an accumulative defect area of less than 200 $mm^2$

*Material unit* 1 piece ϕ50 mm low carbon steel bar 150 mm long

*Unit required* 1

*Economy* Material and consumables are expensive. Use electrodes to a stub length of 50 mm maximum.






Welding sequence
View A

## Skill practice 1 - Pad weld shaft - rotated



IF IN DOUBT ASK THE TEACHER

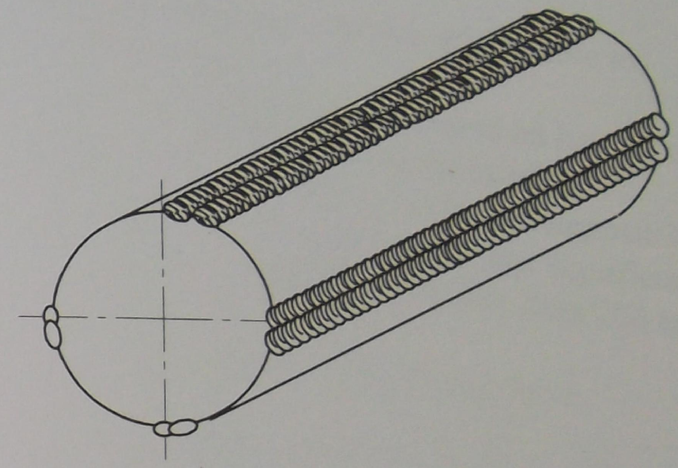
*Objective* To use pad welding techniques in the workshop, to build up the surface of a shaft to the requirements given below.

*Position* Flat.

*Procedure* Demonstrated by the teacher.

*Method*

1. Draw chalk guidelines to indicate weld runs 1, 2, 3, 4.
2. Deposit the first run, then rotate the bar 180° to deposit the second run in a flat position.
3. Each run is deposited in the sequence shown to counteract distortion.
4. When the build up is complete, remove all weld spatter and present the exercise for inspection.
5. Deposit pad welds on both ends of the bar.
6. Evaluate the weld project and complete the procedure sheet.
7. Submit the weld and procedure sheet to the teacher.



*Things to note*

- Amperage setting
- Position of shaft on the bench
- Arc length
- Welding speed and uniformity of travel
- Unfilled craters
- Unremoved slag or spatter

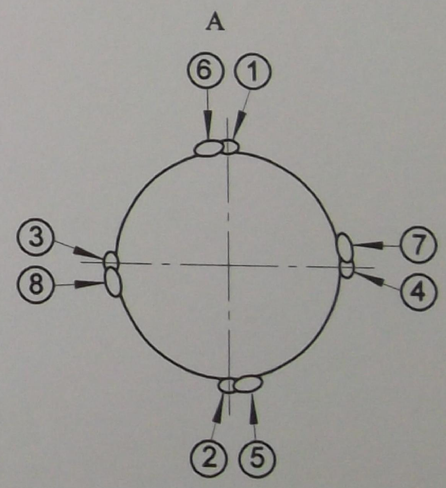
*Requirements*

- Smooth regular contour
- Deposit height 3 + 2 -1 mm
- A maximum of four significant surface defects with an accumulative defect area of less than 200 $mm^2$

*Material unit* 1 piece ϕ50 mm low carbon steel bar 150 mm long

*Unit required* 1

*Economy* Material and consumables are expensive. Use electrodes to a stub length of 50 mm maximum.




Welding sequence
View A

## Notes



## Section 3: Pad weld plate - horizontal

| SUGGESTED DURATION | PREAMBLE |
|---|---|
| 1 hour<br>30 minutes | This section develops your knowledge and skills to build up a pad weld on low carbon steel plate in the horizontal position. |

***Objectives***

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

- ☐ build up a pad weld on low 10 mm thick carbon steel plate to the following requirements
  - smooth regular pad deposit 3 + 2 -1 mm high
  - a maximum of four significant surface defects with an accumulative defect area of less than 200 $mm^2$
- ☐ record the weld procedure
- ☐ follow Occupational Health & Safety workshop procedures.

***Safety***

- You must wear eye protection.
- Wear suitable protective clothing.
- Follow correct safety procedures.

**Procedure sheet**
**Pad weld plate - horizontal**

*Sketch welding runs on diagram.*

Complete the control data table below.

| **Weld current data** | | **Electrode data** | |
|---|---|---|---|
| Run | Run | Size | |
| 1 | 7 | | |
| 2 | 8 | Type | |
| 3 | 9 | | |
| 4 | 10 | Brand name | |
| 5 | 11 | | |
| 6 | 12 | Electrode classification | |
| | | Angles Lead | Lateral |
| **Material data** | | **Weld time** | |
| Type | | Start | |
| | | Finish | |
| Thickness | | | |
| | | Units completed | |
| **Assessment** | | **Complies** | **Does not comply** |
| Surface finish | | | |
| Weld size | | | |
| Surface defects | | | |
| **Name** | | | **Exercise Number** |
| | | | |





## Skill practice 2
## Assessment event 1 (practical)
## Pad weld plate - horizontal

IF IN DOUBT ASK THE TEACHER

*Suggested time* Skill practice: 1 hour 30 minutes
Assessment: 30 minutes

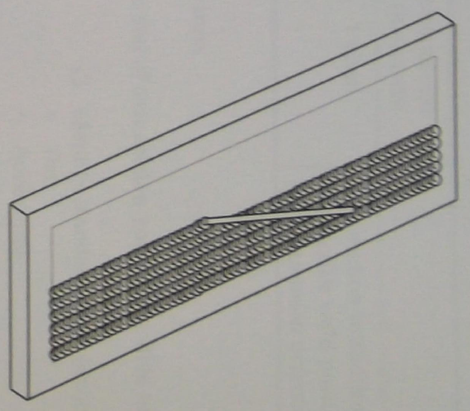
*Objective* To deposit a pad weld on low carbon steel plate to the requirements given below.

*Position* Horizontal.

*Procedure* Demonstrated by the teacher.

*Method*

1. Outline with chalk, the required rectangular shape 60 x 200 mm.
2. Position the plate on the bench in the specified position.
3. Deposit weld beads along the plate length.
4. Remove all slag from individual weld beads before depositing subsequent runs. Each run is to have a staggered stop and restart.
5. Build up the pad to the required dimensions and present the exercise for inspection.
6. Evaluate the weld project and complete the procedure sheet.
7. For assessment, repeat the pad weld to the requirements given below.

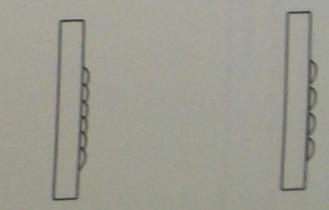


*Things to note*

- Setting of amperage and heat input
- Position of plate on the bench
- Correct method of arc striking
- Correct arc length
- Correct welding travel speed
- Correct electrode angles

*Requirements*

- Smooth regular contour
- Deposit height 3 + 2 -1 mm
- A maximum of four significant surface defects with an accumulative defect area of less than 200 $mm^2$



Correct bead placement

Incorrect bead placement

*Material unit* 1 piece low carbon steel 75 x 10 x 225 mm

*Unit required* 1

*Economy* Material and consumables are expensive. Use electrodes to a stub length of 50 mm maximum.

| DURATION | |
|---|---|
| 1 hour | This section introduces you to the technical terms that are used to describe weld positions, areas and locations of a welded [illegible] defects and their causes |



**Skill practice 2**
**Assessment event 1 (practical)**
**Pad weld plate - horizontal**

IF IN DOUBT ASK THE TEACHER

*Suggested time* Skill practice: 1 hour 30 minutes
Assessment: 30 minutes

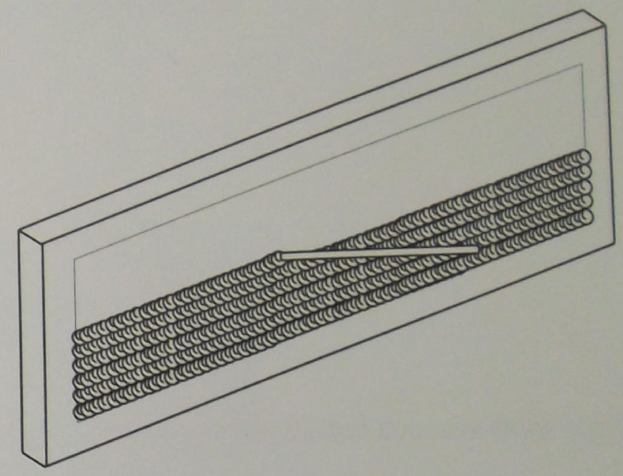
*Objective* To deposit a pad weld on low carbon steel plate to the requirements given below.

*Position* Horizontal.

*Procedure* Demonstrated by the teacher.

*Method*

1. Outline with chalk, the required rectangular shape 60 x 200 mm.
2. Position the plate on the bench in the specified position.
3. Deposit weld beads along the plate length.
4. Remove all slag from individual weld beads before depositing subsequent runs. Each run is to have a staggered stop and restart.
5. Build up the pad to the required dimensions and present the exercise for inspection.
6. Evaluate the weld project and complete the procedure sheet.
7. For assessment, repeat the pad weld to the requirements given below.

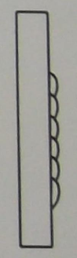


*Things to note*

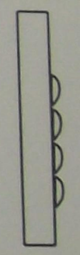
- Setting of amperage and heat input
- Position of plate on the bench
- Correct method of arc striking
- Correct arc length
- Correct welding travel speed
- Correct electrode angles

*Requirements*

- Smooth regular contour
- Deposit height 3 + 2 -1 mm
- A maximum of four significant surface defects with an accumulative defect area of less than 200 mm²



Correct bead placement



Incorrect bead placement

*Material unit* 1 piece low carbon steel 75 x 10 x 225 mm

*Unit required* 1

*Economy* Material and consumables are expensive. Use electrodes to a stub length of 50 mm maximum.

Notes



## Section 4: Fillet weld joint terminology and faults

| SUGGESTED DURATION | PREAMBLE |
|---|---|
| 1 hour | This section introduces you to the technical terms that are used to describe weld positions, areas and locations of a welded joint, common defects and their causes. |

***Objectives***

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

- ☐ identify standard weld positions
  - flat
  - horizontal
  - vertical
  - overhead
- ☐ identify typical weld joints
  - fillets
  - outside corner
  - plug and slot
- ☐ sketch and dimension mitre, convex and concave fillet welds
  - leg length
  - throat thickness
  - weld toe
- ☐ identify typical weld defects associated with fillet welds
  - under and over size welds
  - undercut
  - overroll
  - slag inclusions
  - lack of penetration
  - porosity.

***Safety***
Wear the right clothing to protect you against rays and hot metal spatter.

## Fillet welding

Fillet weld joints are the most commonly used method of joining welded structures. This type of joint does not require any preparation and is easily assembled.

Industrial uses for fillet welds include:

- structural steel work
- ship building
- earth moving equipment.

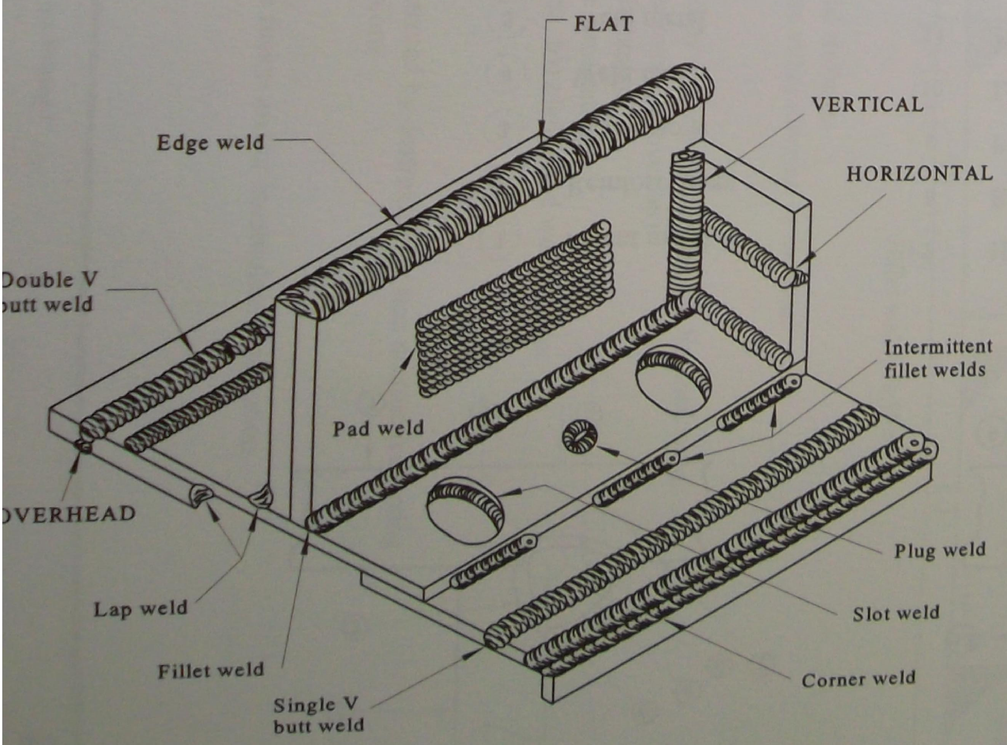
Fillet welds can be welded in any position. Welding positions and weld joint terms and definitions are included for your information.

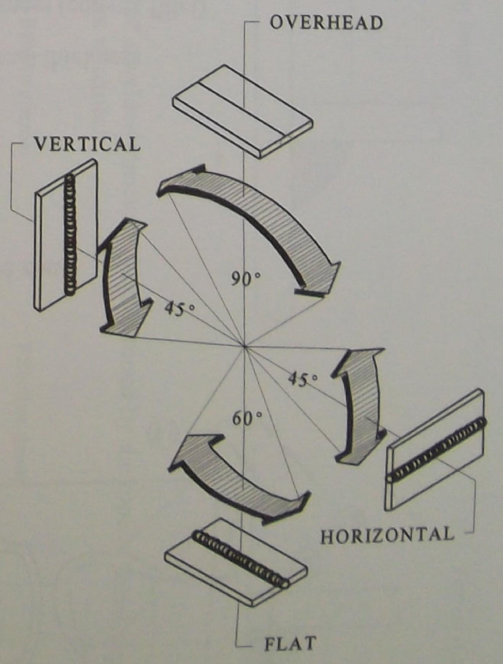




## Fillet weld joint terminology and faults

### Types and positions of welds




*Note:* The angles shown are those through which the joint may be tilted before it is considered to have changed position.

welded in any position. Welding

ded for you

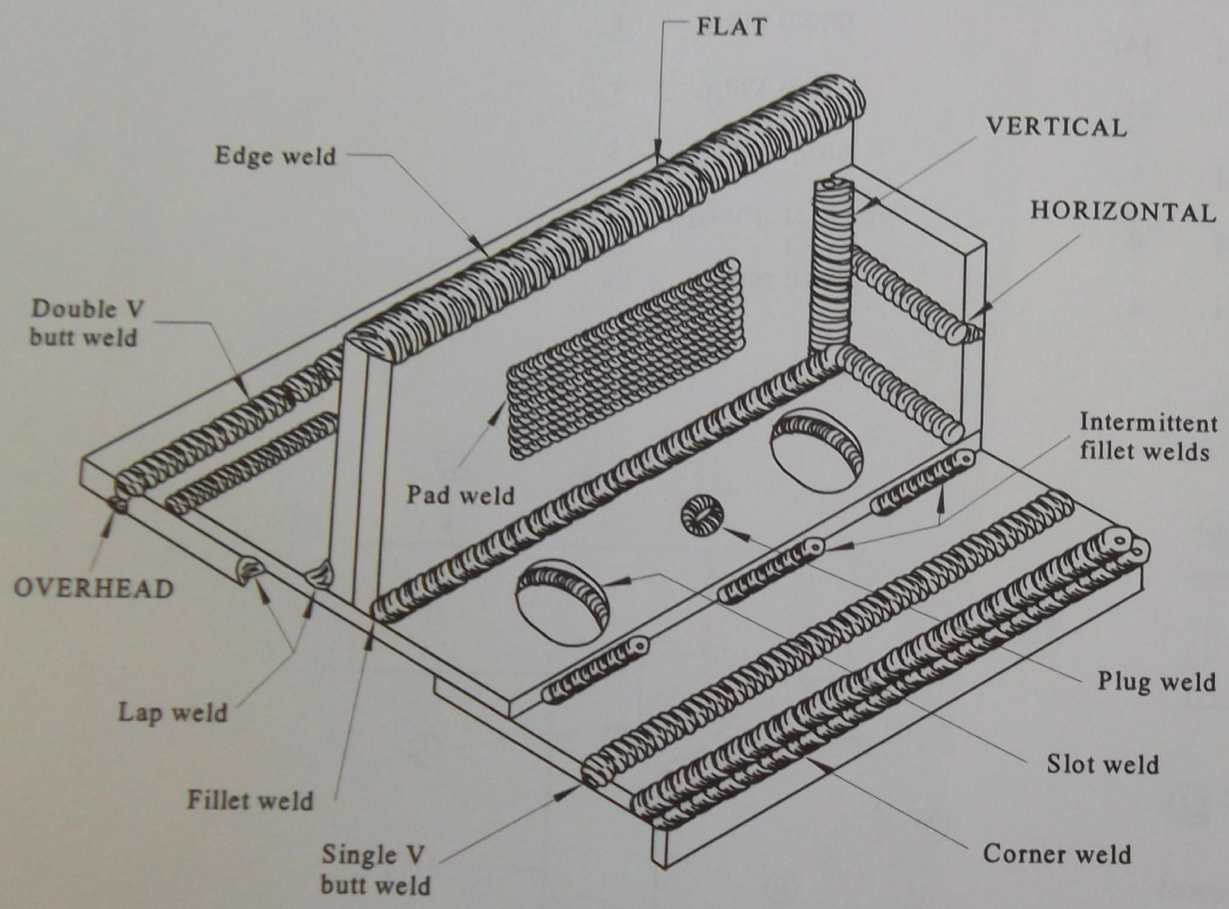
(a) Leg length

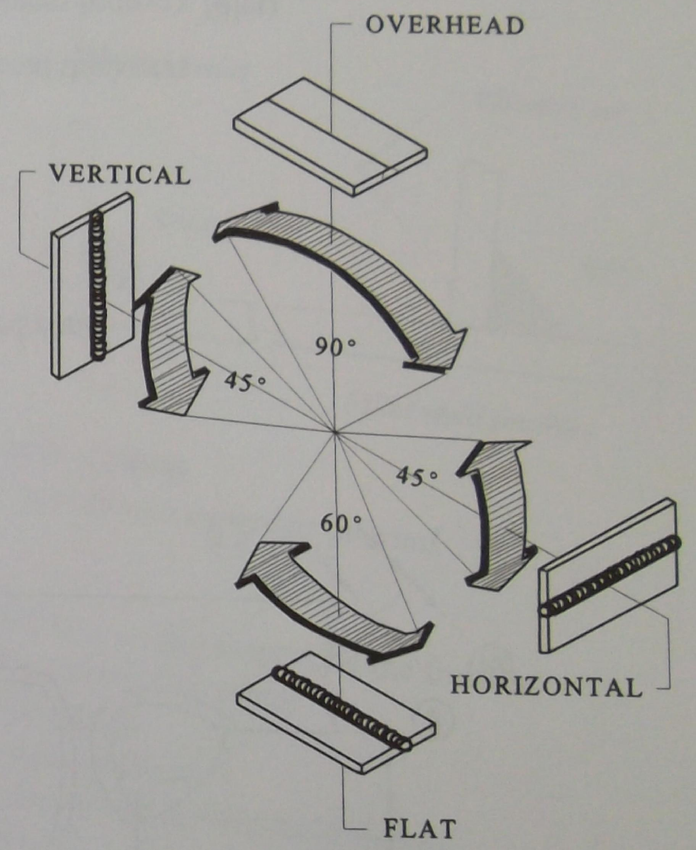
(b) Throat thick



## Fillet weld joint terminology and faults

### Types and positions of welds

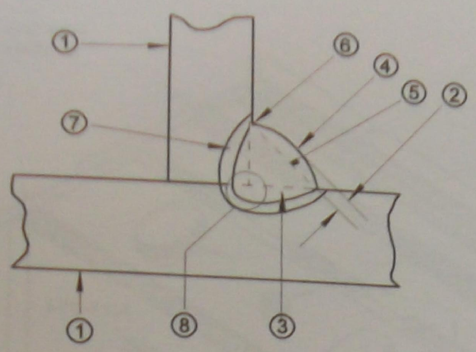


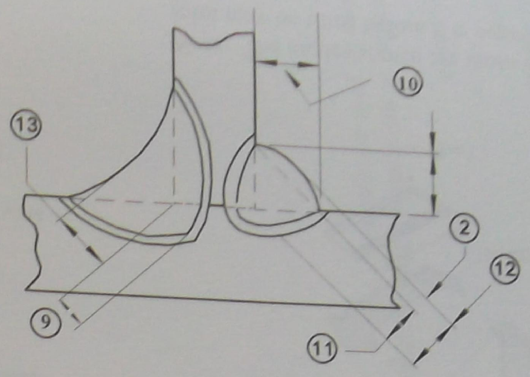




*Note:* The angles shown are those through which the joint may be tilted before it is considered to have changed position.

## Components of a fillet weld



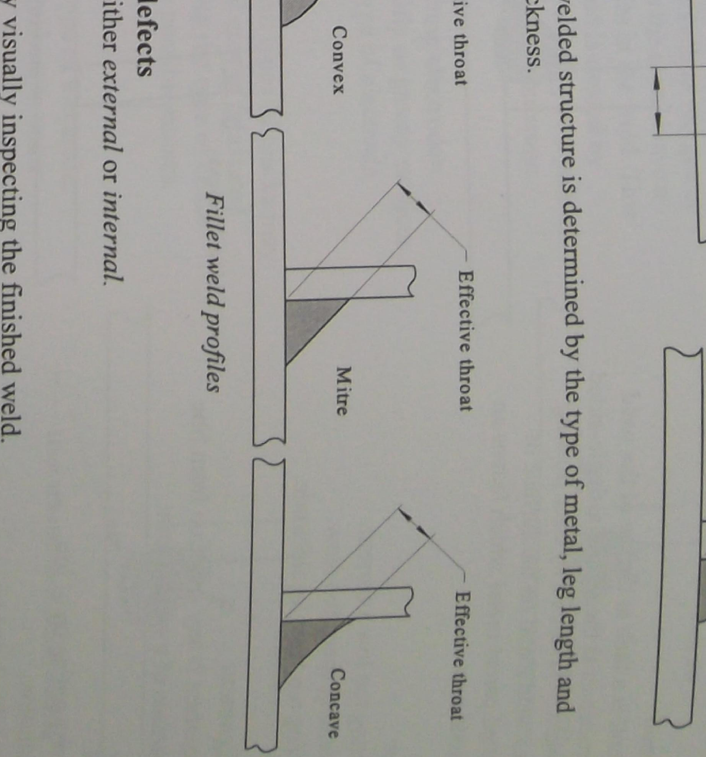



1. Parent metal
2. Reinforcement
3. Fusion zone
4. Weld face
5. Weld metal
6. Toe
7. Heat affected zone
8. Root
9. Penetration
10. Leg length
11. Nominal throat thickness
12. Throat thickness (convex fillet)
13. Throat thickness (concave fillet)

**Fillet weld dimensions**
The size of a fillet weld is determined by the following dimensions. These can be measured with a fillet gauge.

(a) *Leg length* (b) *Throat thickness*



The strength of a welded structure is determined by the type of metal, leg length and effective throat thickness.




*Fillet weld profiles*

**Common weld defects**
Weld defects are either *external* or *internal*.

***External***
Can be detected by visually inspecting the finished weld.

- Undercut or overroll (overlap)
- Plate misalignment
- Incomplete penetration
- Weld craters, blowholes and weld spatter
- Weld size

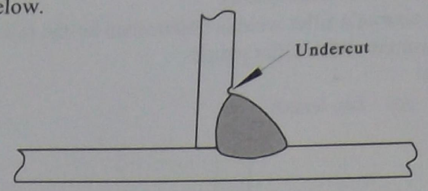
***Internal***
Can only be detected by destructive or non destructive testing

- Slag inclusions
- Porosity
- Cracks
- Incomplete fusion and/or incomplete penetration

The most common weld defects are given below.

***Undercut***

Undercut is a reduction in a cross-section which weakens the joint and creates a slag trap.

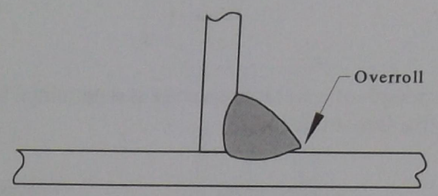



*Causes*

- Using the wrong electrode angle.
- Excessive welding current.
- Incorrect operating technique.

***Overroll***

Overroll is a fault at the toe of the weld or sometimes at the root in a single-sided butt weld. It is caused by over flowing molten weld metal on the surface of unmelted parent metal which leaves an unwelded area.

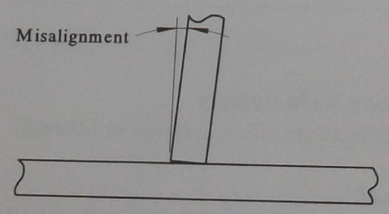



*Causes*

- Using too low a current.
- Welding speed too slow.
- Using too large an electrode.

***Misalignment***

Misalignment is any variation from line or dimension of a welded joint.

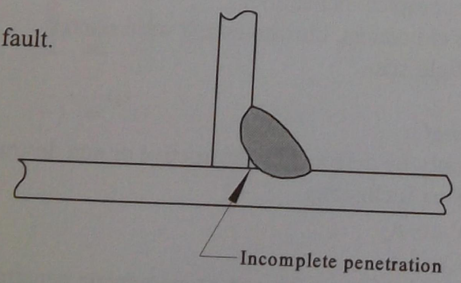



*Causes*

- Faulty setting up of job.
- Distortion.
- Lack of tack welds.

***Incomplete penetration***

Incomplete penetration can be classified as being either an internal or external weld fault. Incomplete penetration is the failure of the weld metal to fill and fuse the root of the joint.



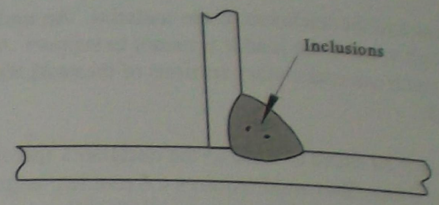

*Causes*

- Faulty preparation of work.
- Using too low a welding current.
- Poor operating technique.



***Slag inclusions***

Slag inclusions are non-metallic particles trapped in the weld metal. They can weaken the weld joint.

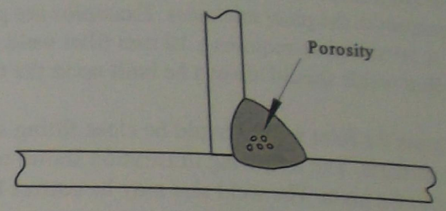



*Causes*

- Not removing slag from previous runs.
- Using too low a current.
- Using too long an arc length.

***Porosity***

Gaseous substances such as oxygen or nitrogen, trapped in the metal leave a cluster of small holes in the weld. This is called porosity and is caused by damp electrodes or welding over painted surfaces, oil or other contaminants.

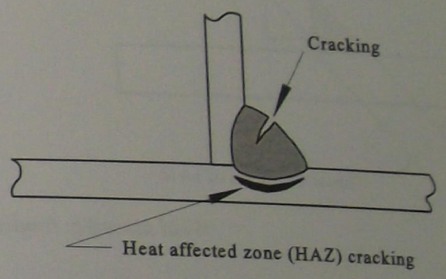



*Causes*

- Using wet or damp electrodes.
- Welding over oily or greasy surfaces.
- Using wrong type of electrode.

***Cracking***

A variety of different types of cracks may occur in the welded area of fabricated products. Identifying the type of crack helps to isolate the possible causes.

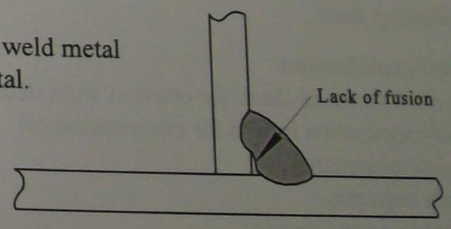



*Causes*

- Using wrong type of electrode.
- Not applying preheat to crack sensitive steel.
- Using damp or wet electrodes.
- Welding over oil, grease or a plated metal surface.

***Lack of fusion***

Lack of fusion is incomplete fusion between weld metal and weld metal or weld metal and parent metal.




*Causes*

- Not enough amperage.
- Incorrect joint preparation.
- Incorrect welding technique.

***Undersize and oversize welds***

Welded joints are calculated to carry loads safely. The size and type of weld depends on

its use and the thickness of the material. An undersized weld might not be strong enough to carry the load it is meant to support. A weld that is reinforced (over welded) too much can make other sections of the work too rigid and cause them to crack or break.

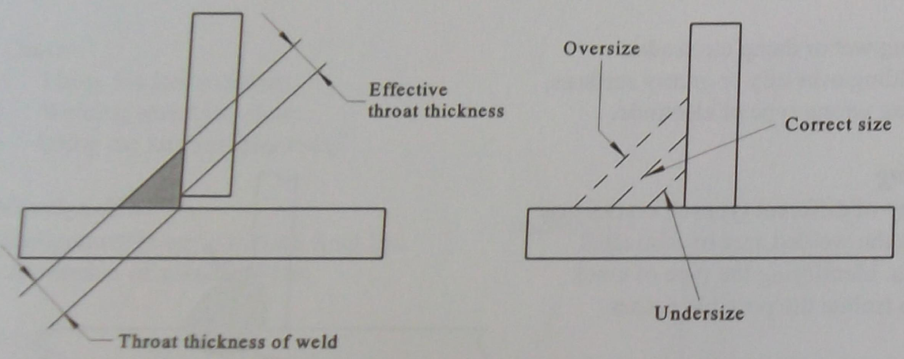
You will be asked to weld to the designer's specification. Examples are given below.

- A 6 mm fillet weld requires a 6 mm leg length and a 4.2 mm throat thickness.
- A butt weld requires an even or slightly convex curved surface.

Weld sizes may not be given for all jobs. If no weld size is specified, deposit the weld in proportion to the plate thickness. Examples are given below.

- A 10 mm plate requires a 10 mm fillet weld.
- Butt welds should always be built up to the thickness of the parent metal.

The parts for fillet welds should be close fitting so that there is complete fusion of the joint surfaces. The following illustration shows what happens when there's a gap between the parts. The weld size may be correct but the throat thickness is too small.




*Weld assembly (undersized weld)*

*Causes of incorrect weld size or profile*

- Incorrect weld sequence (under or overwelding).
- Poor fit-up.

## Workshop tests

### *Visual examination*

You can do a visual check for external weld defects such as overroll and undercut.
Visual examination is used for examination of:

- plate preparation
- run sequence
- weld size and profile.

### *Fillet break*

A fillet break shows fusion, penetration, and inclusions or porosity.



## Summary of weld defects and how to fix them

### *Plate preparation*

Make the following checks.

- Correct edge preparation
- Clean/smooth surfaces
- Correct plate alignment

### *Weld procedure*

Make the following checks.

- Correct electrode
- Correct current (amperage)
- Correct speed of travel
- Correct arc length
- Correct operation (welder)

### *Electrode condition*

Check for damp or damaged electrodes.

### *Interrun cleaning*

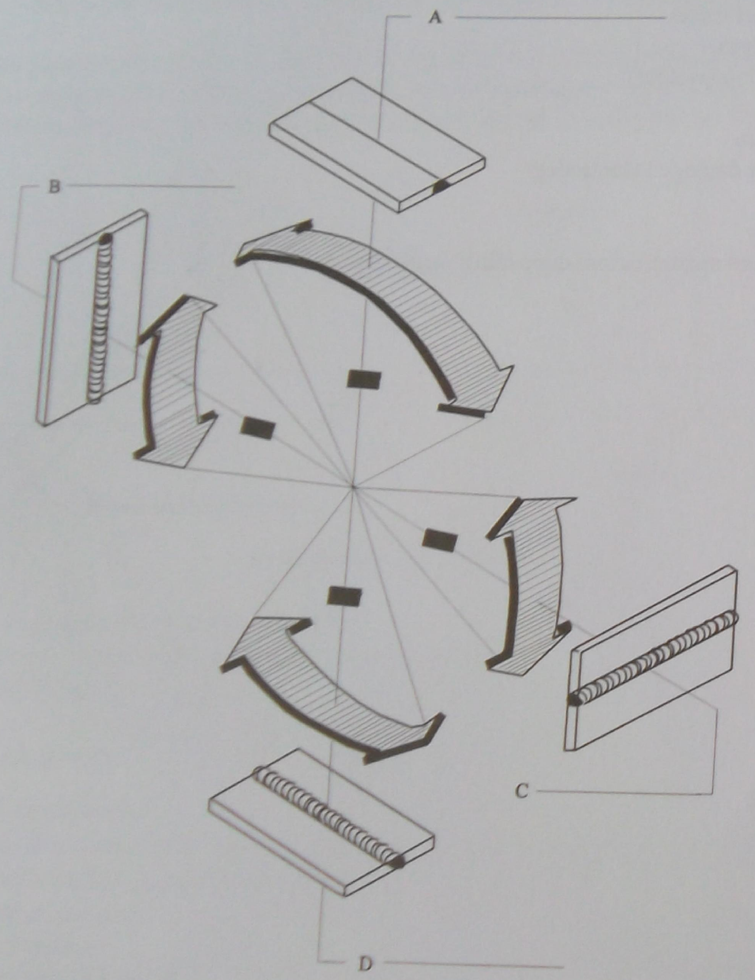
Remove all slag and spatter before depositing the next pass.

## Review questions

*These questions will help you revise what you have learnt in Section 4.*

1. Identify the weld positions by writing their names in the spaces provided on the diagram shown below.

   *Note* The angles shown are those through which the joint may be tilted before it is considered to have changed position.

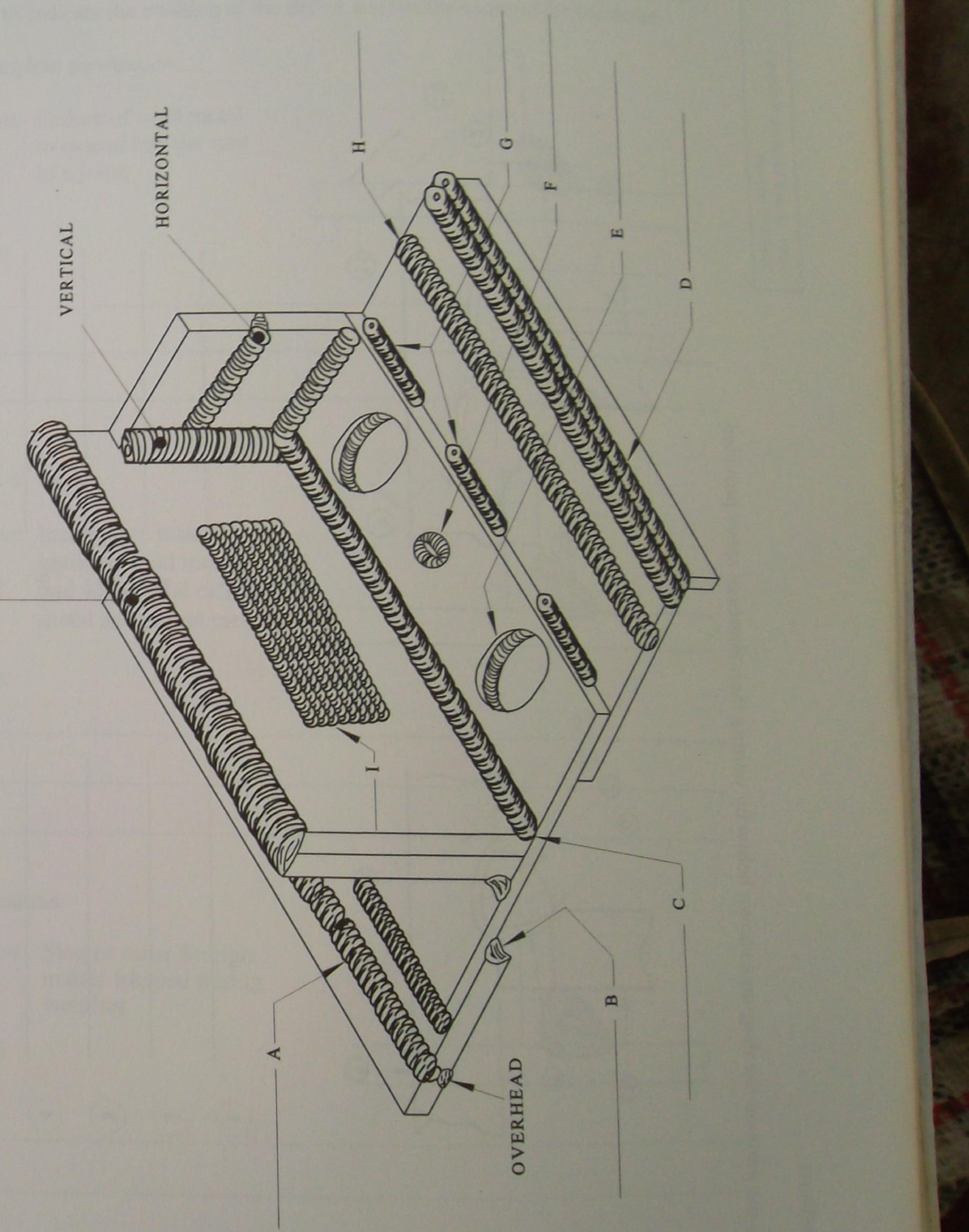






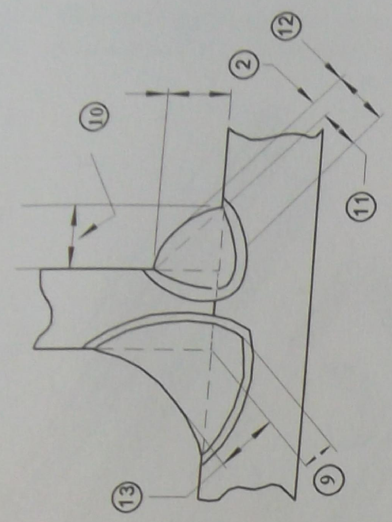

## Review questions

2. Identify the positions and types of welds by writing their names in the spaces provided on the diagram shown below.

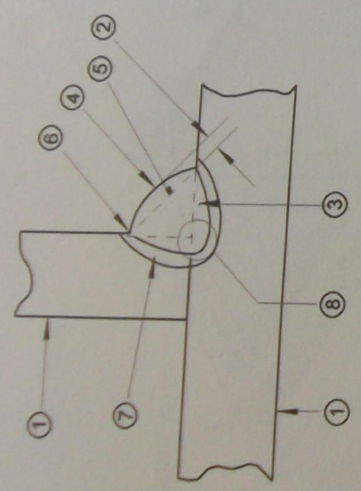


**Review questions**

3. Identify the parts on the diagrams shown below by writing their names in space provided.




7 8 9 10 11 12 13



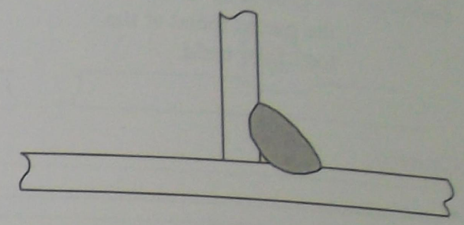

1 2 3 4 5 6

**Review questions**

4. Shown below are diagrams of weld defects. For each defect, draw an arrow on the diagram to indicate the position of the defect and list the cause(s) for the defect.

(a) Incomplete penetration.

*Definition:* Failure of weld metal to extend into the root of a joint.

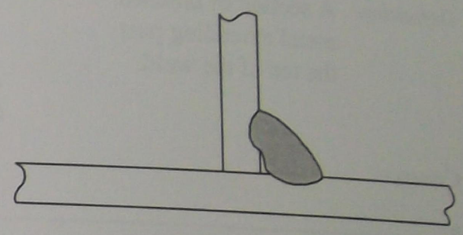


*Cause(s):*

- _____
- _____
- _____

(b) Lack of fusion.

*Definition*: Incomplete fusion between weld metal and weld metal or weld metal and parent metal.

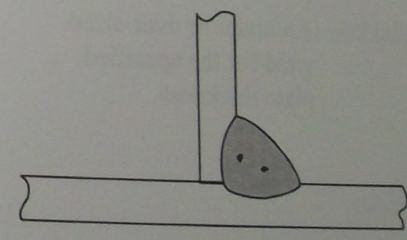


*Cause(s):*

- _____
- _____
- _____

(c) Inclusions.

*Definition:* Slag or other foreign matter trapped during welding.

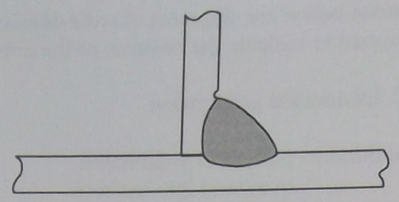


*Cause(s):*

- _____
- _____
- _____

(d) Undercut.

*Definition:* A groove or channel in the parent metal at the toe of the weld.

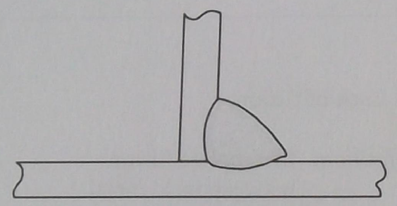


*Cause(s):*

- _____
- _____
- _____

(e) Overroll.

*Definition:* A section of unfused metal extending past the toe of the weld.

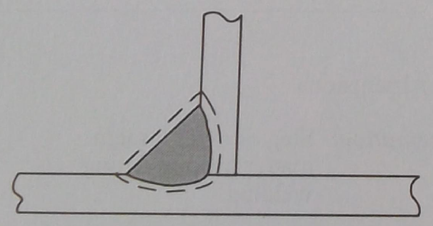


*Cause(s):*

- _____
- _____
- _____
- _____

(f) Incorrect weld size or profile.

*Definition:* An under or over-sized weld for the specified plate thickness.



*Cause(s):*

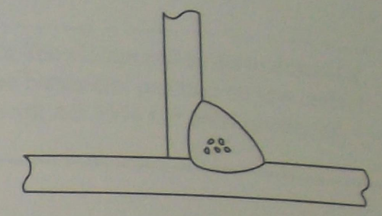
- _____
- _____
- _____





(g) Porosity.

*Definition:* A group of gas holes in the weld metal.



*Cause(s):*

- _____
- _____
- _____

**Notes**



## Section 5: Fillet weld - single run - horizontal

| SUGGESTED DURATION | PREAMBLE |
|---|---|
| 1 hour<br>30 minutes | This section develops your knowledge and skills to deposit a single run fillet weld in the horizontal position on low carbon steel plate in accordance with AS 1554 GP weld quality or equivalent. |

**Objectives**

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

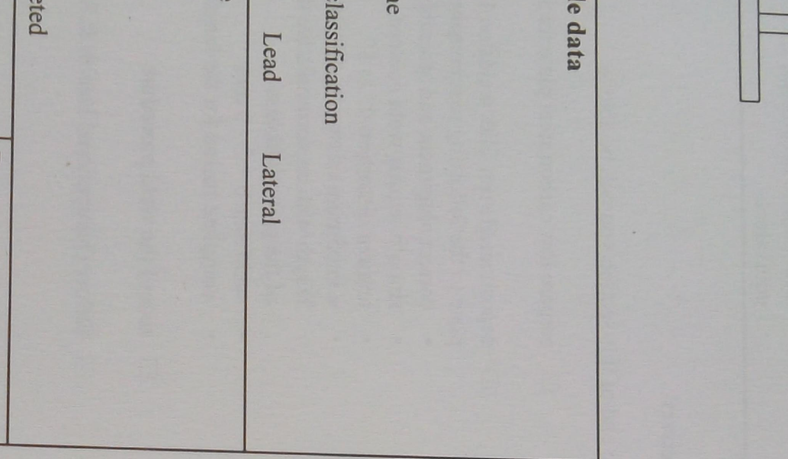
- ☐ prepare low carbon steel plate for fillet welding
- ☐ deposit single run fillet welds on 1.6 to 10 mm thick low carbon steel plate to the following requirements
  - correct alignment and assembly
  - smooth regular weld contour
  - angular distortion 0° to 5°
  - a maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
  - weld size 6 + 2 - 0 mm
  - complete fusion for the length of the weld joint
- ☐ record the weld procedure
- ☐ follow Occupational Health & Safety workshop procedures.

***Safety***

- You must wear eye protection.
- Make sure that the centre of the press ram and the highest point of the exercise are in line when breaking welds.

**Procedure sheet**
**Fillet weld - single run - horizontal**

Sketch welding runs on diagram.



Complete the control data table below.

| **Weld current data** | | **Electrode data** |
|---|---|---|
| Run | Run | Size |
| 1 | 7 | |
| 2 | 8 | Type |
| 3 | 9 | |
| 4 | 10 | Brand name |
| 5 | 11 | |
| 6 | 12 | Electrode classification |
| | | Angles Lead Lateral |
| **Material data** | **Weld time** | |
| Type | Start | |
| Thickness | Finish | |
| | Units completed | |
| **Remarks** | **Complies** | **Does not comply** |
| Alignment and assembly | | |
| Angular distortion | | |
| Surface finish | | |
| Weld size | | |
| Surface defects | | |
| Complete fusion | | |
| **Name** | | **Exercise Number** |
| | | |





**Skill practice 3**
**Fillet weld - single run - horizontal**

IF IN DOUBT ASK THE TEACHER

*Objective* To deposit a 6 mm fillet weld to the requirements given below.

*Position* Horizontal.

*Procedure* Demonstrated by the teacher.

*Method*

1. Wire brush the material to remove surface rust and loose scale.
2. Tack both ends of the plate to ensure metal to metal contact.
3. Complete approximately half the weld, stop, remove slag, restart and finish the weld.
4. Remove all slag and spatter and submit the exercise for visual inspection.
5. Break the weld and resubmit the exercise for internal inspection.
6. Relocate the plates for further practice using all edges as shown.
7. Evaluate the weld exercise and complete the procedure sheet.
8. Submit your work to the teacher.

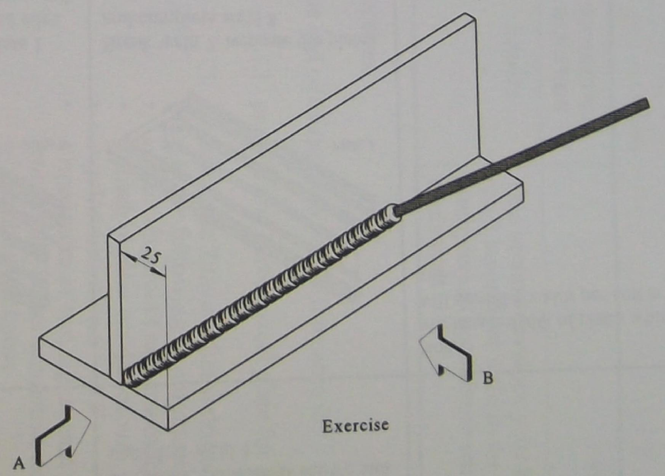
*Requirements*

- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° to 5°
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size 6 + 2 -1 mm
- Complete fusion for the length of the weld joint

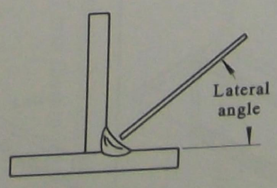
*Material unit* 2 pieces low carbon steel 75 x 10 x 225 mm

*Unit required* 1

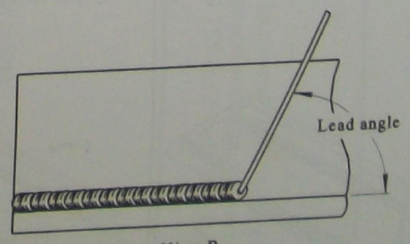
*Economy* Consumables and materials are expensive. Relocate plates as shown for maximum use.




Exercise




View A




View B

## Skill practice 3
## Fillet weld - single run - horizontal

IF IN DOUBT ASK THE TEACHER

*Objective* To deposit a 6 mm fillet weld to the requirements given below.

*Position* Horizontal.

*Procedure* Demonstrated by the teacher.

*Method*

1. Wire brush the material to remove surface rust and loose scale.
2. Tack both ends of the plate to ensure metal to metal contact.
3. Complete approximately half the weld, stop, remove slag, restart and finish the weld.
4. Remove all slag and spatter and submit the exercise for visual inspection.
5. Break the weld and resubmit the exercise for internal inspection.
6. Relocate the plates for further practice using all edges as shown.
7. Evaluate the weld exercise and complete the procedure sheet.
8. Submit your work to the teacher.

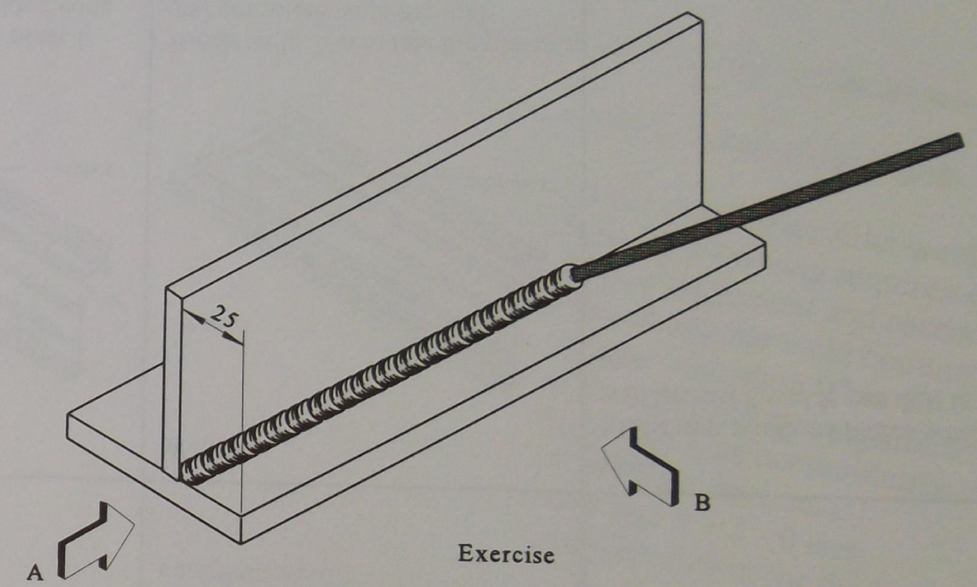
*Requirements*

- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° to 5°
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size 6 + 2 -1 mm
- Complete fusion for the length of the weld joint

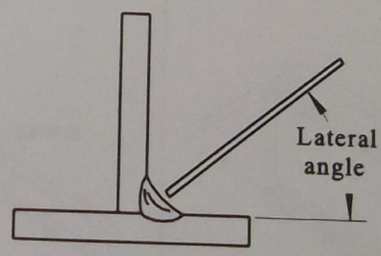
*Material unit* 2 pieces low carbon steel 75 x 10 x 225 mm

*Unit required* 1

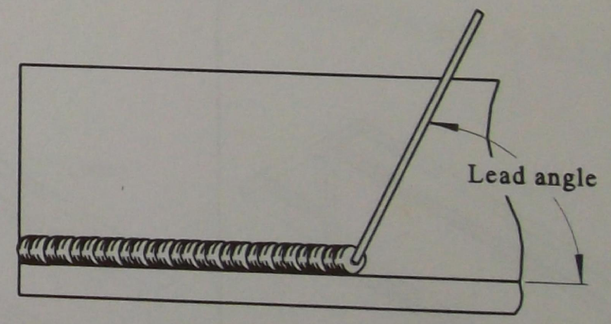
*Economy* Consumables and materials are expensive. Relocate plates as shown for maximum use.




Exercise

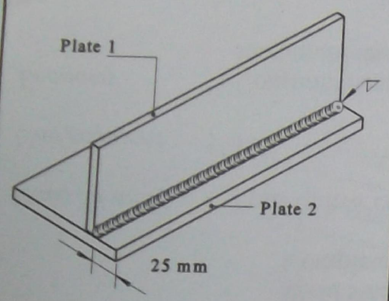
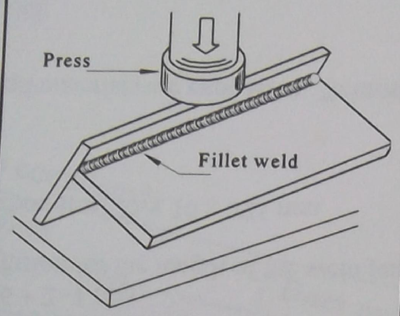
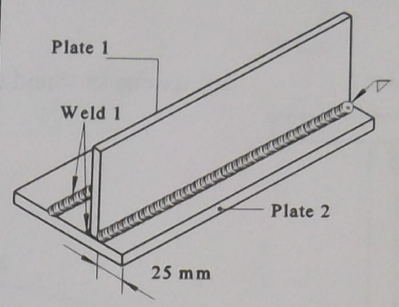
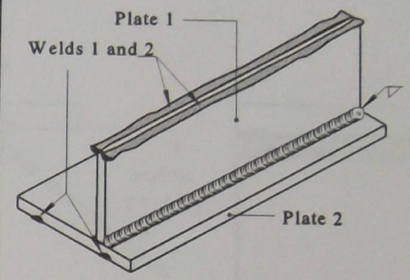
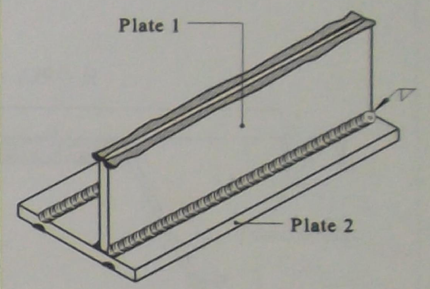
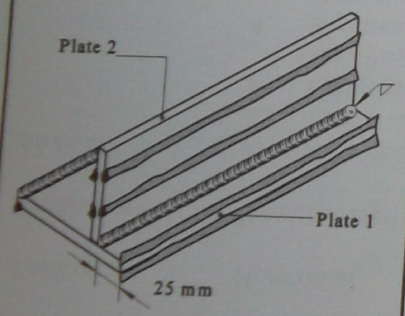
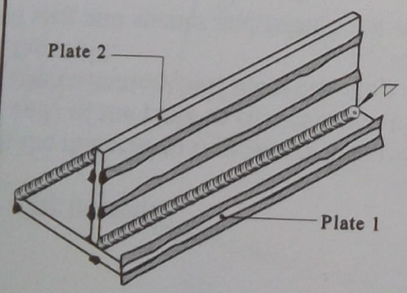
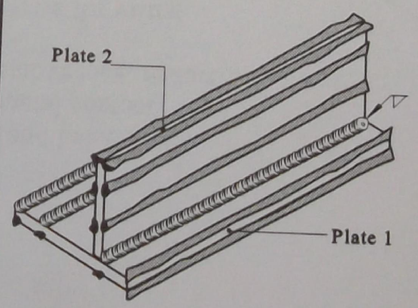
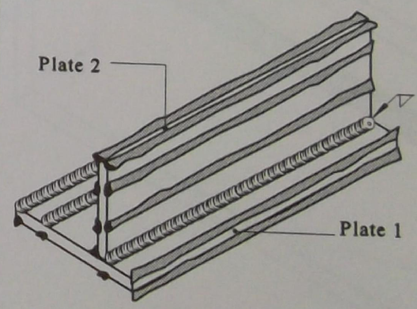



View A

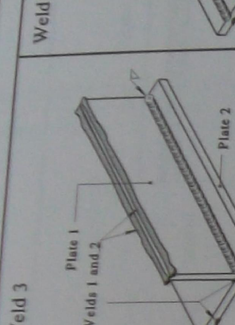
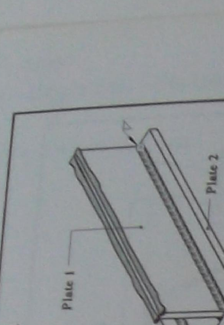
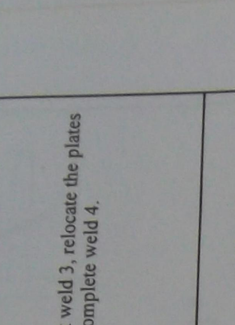
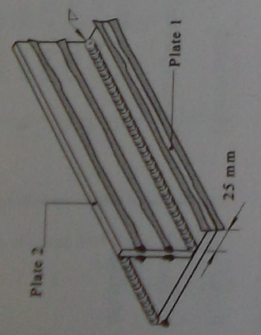
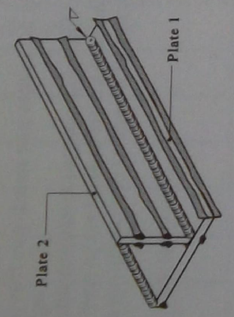
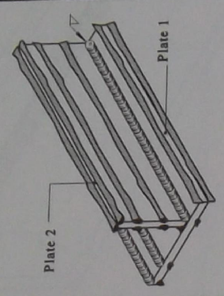



View B

## Suggested sequence of plate positions (to obtain 8 fillet welds from one material unit)

| | | | | |
|---|---|---|---|---|
| Weld 1<br>  <br><br>Locate plates as shown and complete weld number 1. Inspect visually for surface defects such as undercut, poor weld profile and surface porosity. | Fillet break test<br>  <br><br>Break the weld in a suitable press as shown. When broken, check for penetration in the corner of the joint. | Weld 2<br>  <br><br>After examining the break relocate the plates and complete weld 2. | Weld 3<br>  <br><br>Break weld 2 and turn plate 2 over. Using the unwelded edge of Plate 1, relocate as shown and complete weld 3. | Weld 4<br>  <br><br>Break weld 3, relocate the plates and complete weld 4. |
| Weld 5<br>  <br><br>Break weld 4. Place plate 1 in a flat position, then locate plate 2 vertically on plate 1 as shown, and complete weld 5. | Weld 6<br>  <br><br>Break weld 5, relocate the plates and complete weld 6. | Weld 7<br>  <br><br>Break weld 6 and turn plate 1 over. Using the unwelded edge of plate 2, relocate as shown and complete weld 7. | Weld 8<br>  <br><br>Break weld 7, relocate the plates and complete weld 8. | Note<br>Minimum width of plates which will permit 8 welds per unit is 75 mm. |

**Suggested sequence of plate positions (to obtain 8 fillet welds from one material unit)**

| | | |
|---|---|---|
| **Weld 1**<br>  <br>Locate plates as shown and complete weld number 1. Inspect visually for surface defects such as undercut, poor weld profile and surface porosity. | **Fillet break test**<br>  <br>Break the weld in a suitable press as shown. When broken, check for penetration in the corner of the joint. | **Weld 2**<br>  <br>After examining the break relocate the plates and complete weld 2. |
| **Weld 5**<br>  <br>Break weld 4. Place plate 1 in a flat position, then locate plate 2 vertically on plate 1 as shown, and complete weld 5. | **Weld 6**<br>  <br>Break weld 5, relocate the plates and complete weld 6. | **Weld 7**<br><br>Break weld 6 and turn plate 1 over. Using the unwelded edge of plate 2, relocate as shown and complete weld 7. |
| **Weld 3**<br><br>Break weld 2 and turn plate 2 over. Using the unwelded edge of Plate 1, relocate as shown and complete weld 3. | **Weld 4**<br><br>Break weld 3, relocate the plates and complete weld 4. | **Weld 8**<br>  <br>Break weld 7, relocate the plates and complete weld 8. |

Note
Minimum width of plates which will permit 8 welds per unit is 75 mm.

## Section 6: Fillet weld - 3 run 2 layer - horizontal

| SUGGESTED DURATION | PREAMBLE |
|---|---|
| 3 hours | This section develops your knowledge and skills to deposit a 3 run 2 layer fillet weld in the horizontal position on low carbon steel plate in accordance with AS 1554 GP weld standard or equivalent. |

***Objectives***

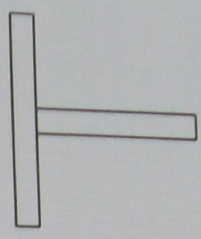
At the end of this section you will be able to:

- ☐ prepare low carbon steel plate for fillet welding
- ☐ deposit 3 run 2 layer fillet welds on 1.6 to 10 mm thick low carbon steel plate to the following requirements
  - correct alignment and assembly
  - smooth regular weld contour
  - angular distortion 0° to 5°
  - a maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
  - weld size 8 + 2 - 0 mm
  - complete fusion for the length of the weld joint
- ☐ record the weld procedure
- ☐ follow Occupational Health & Safety workshop procedures.

***Safety*** Always follow the approved sequence when fracturing fillet joints under a press.

**ure sheet**
**eld - horizontal**

elding runs on diagram.



he control data table below.

| rent data | Electrode data |
|---|---|
| Run | Size |
| 7 | |
| 8 | Type |
| 9 | |
| 10 | Brand name |
| 11 | |
| 12 | Electrode classification |
| Angles Lead Lateral | |
| **a** | **Weld time** |
| | Start |
| | Finish |
| | Units completed |
| **Complies** | **Does not comply** |
| assembly | |
| on | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | **Exercise Number** |



**practice 4**
**weld - 3 run 2 layer - horizontal**

DOUBT ASK THE TEACHER

*ive* To use the fillet welding technique necessary to deposit an 8 mm three run, two layer fillet weld to meet the requirements given below.

*on* Horizontal.

*lure* Demonstrated by the teacher.

*d*

1. Wire brush or grind the weld fusion faces to remove the rust and mill scale.
2. Tack both ends of the plate ensuring metal to metal contact with no gap. Tack only on the ends or side to be welded.
3. Complete approximately half the first run, stop, remove slag, and examine the weld profile.
4. Finish the run and subsequent runs using the sequence illustrated with at least one staggered stop and start per run.
5. Submit the exercise for visual inspection then fracture the weld and resubmit it for internal inspection.
6. Relocate the plates for further practice using all edges as shown.
7. Evaluate the weld exercise and complete the procedure sheet.
8. Submit your work to the teacher.

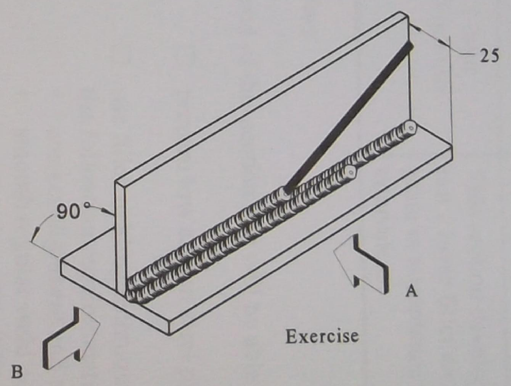
*ements*

- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° to 5°
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size 8 + 2 - 1 mm
- Complete fusion for the length of the weld joint

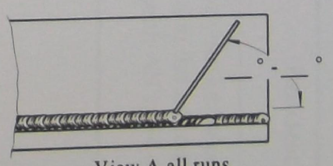
*ial unit* 2 pieces low carbon steel 75 x 10 x 225 mm

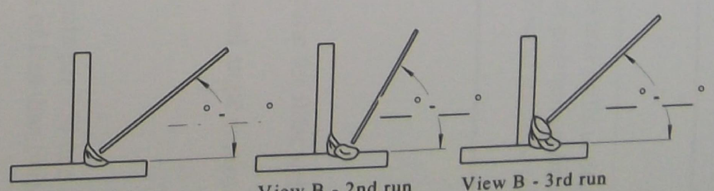
*required* 2

*omny* Use all electrodes to a maximum stub length of 50 mm and return unused material to the Store.



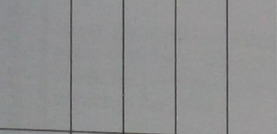
Exercise


- View A all runs


View B - 1st run
View B - 2nd run
View B - 3rd run

***Procedure sheet***
***Fillet weld - horizontal***

*Sketch welding runs on diagram.*



*Complete the control data table below.*

| **Weld current data** | | **Electrode data** | |
|---|---|---|---|
| Run | Run | Size | |
| 1 | 7 | | |
| 2 | 8 | Type | |
| 3 | 9 | | |
| 4 | 10 | Brand name | |
| 5 | 11 | | |
| 6 | 12 | Electrode classification | |
| | | Angles Lead | Lateral |
| **Material data** | **Weld time** | | |
| Type | Start | | |
| Thickness | Finish | | |
| | Units completed | | |
| **Remarks** | **Complies** | **Does not comply** | |
| Alignment and assembly | | | |
| Angular distortion | | | |
| Surface finish | | | |
| Weld size | | | |
| Surface defects | | | |
| Complete fusion | | | |
| **Name** | | **Exercise Number** | |



## Skill practice 4
## Fillet weld - 3 run 2 layer - horizontal



IF IN DOUBT ASK THE TEACHER

*Objective* To use the fillet welding technique necessary to deposit an 8 mm three run, two layer fillet weld to meet the requirements given below.

*Position* Horizontal.

*Procedure* Demonstrated by the teacher.

*Method*

1. Wire brush or grind the weld fusion faces to remove the rust and mill scale.
2. Tack both ends of the plate ensuring metal to metal contact with no gap. Tack only on the ends or side to be welded.
3. Complete approximately half the first run, stop, remove slag, and examine the weld profile.
4. Finish the run and subsequent runs using the sequence illustrated with at least one staggered stop and start per run.
5. Submit the exercise for visual inspection then fracture the weld and resubmit it for internal inspection.
6. Relocate the plates for further practice using all edges as shown.
7. Evaluate the weld exercise and complete the procedure sheet.
8. Submit your work to the teacher.

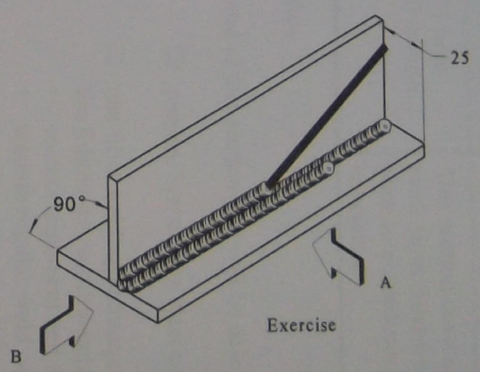
*Requirements*

- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° to 5°
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size 8 + 2 - 1 mm
- Complete fusion for the length of the weld joint

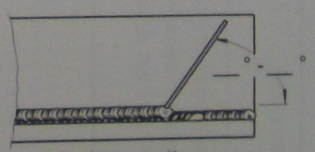
*Material unit* 2 pieces low carbon steel 75 x 10 x 225 mm

*Unit required* 2

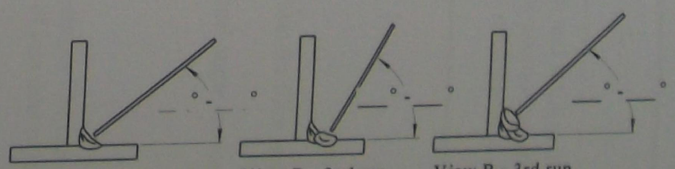
*Economy* Use all electrodes to a maximum stub length of 50 mm and return unused material to the Store.




Exercise



- View A all runs



View B - 1st run View B - 2nd run View B - 3rd run

## Skill practice 4
## Fillet weld - 3 run 2 layer - horizontal

IF IN DOUBT ASK THE TEACHER

*Objective* To use the fillet welding technique necessary to deposit an 8 mm three run, two layer fillet weld to meet the requirements given below.

*Position* Horizontal.

*Procedure* Demonstrated by the teacher.

*Method*

1. Wire brush or grind the weld fusion faces to remove the rust and mill scale.
2. Tack both ends of the plate ensuring metal to metal contact with no gap. Tack only on the ends or side to be welded.
3. Complete approximately half the first run, stop, remove slag, and examine the weld profile.
4. Finish the run and subsequent runs using the sequence illustrated with at least one staggered stop and start per run.
5. Submit the exercise for visual inspection then fracture the weld and resubmit it for internal inspection.
6. Relocate the plates for further practice using all edges as shown.
7. Evaluate the weld exercise and complete the procedure sheet.
8. Submit your work to the teacher.

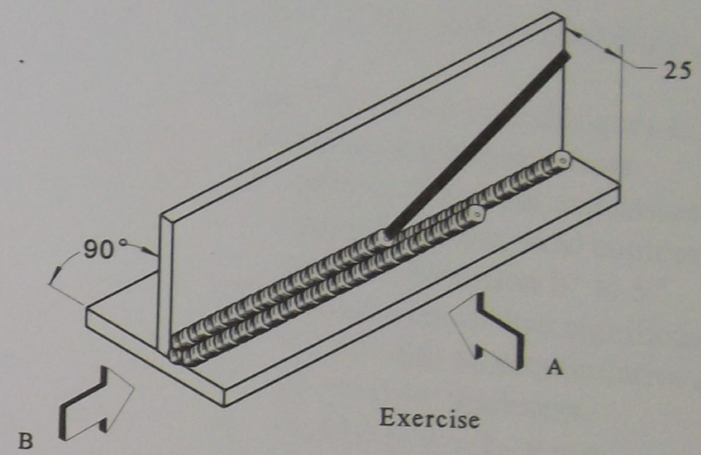
*Requirements*

- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° to 5°
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size 8 + 2 - 1 mm
- Complete fusion for the length of the weld joint

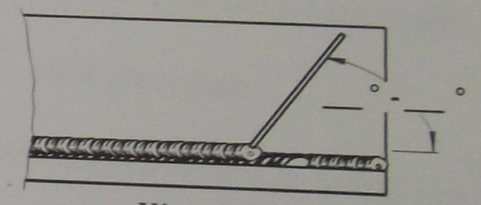
*Material unit* 2 pieces low carbon steel 75 x 10 x 225 mm

*Unit required* 2

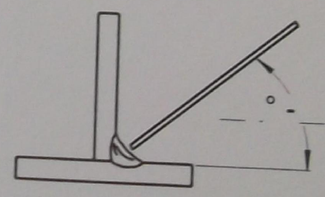
*Economy* Use all electrodes to a maximum stub length of 50 mm and return unused material to the Store.



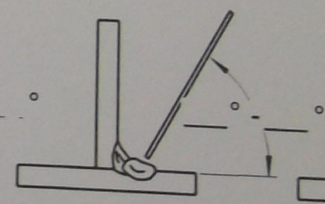

Exercise



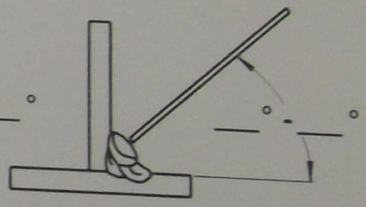
- View A all runs



View B - 1st run



View B - 2nd run



View B - 3rd run

**Notes**



## Section 7: Fillet weld - angle to plate - horizontal

| SUGGESTED DURATION | PREAMBLE |
|---|---|
| 1 hour<br>40 minutes | This section develops your knowledge and skills to deposit a 3 run 2 layer fillet weld in the horizontal position on an angle to plate in accordance with AS 1544 GP weld standard or equivalent. |

***Objectives***

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

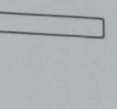
- ☐ prepare low carbon steel plate and angle section for fillet welding
- ☐ use fillet welding techniques to join rolled steel angle sections to plate to the following requirements
  - correct alignment and assembly
  - smooth regular weld contour
  - angular distortion 0° to 5°
  - a maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
  - weld size 8 + 2 - 0 mm
  - complete fusion for the length of the weld joint
- ☐ record the weld procedure
- ☐ follow Occupational Health & Safety workshop procedures.

***Safety***

- Always wear non-flammable clothing, goggles and footwear when oxy-fuel gas cutting.

***Procedure sheet***
***Fillet weld - angle to plate - horizontal***

*Sketch welding runs on diagram.*



*Complete the control data table below.*

| **Weld current data** | | **Electrode data** | |
|---|---|---|---|
| Run | Run | Size | |
| 1 | 7 | | |
| 2 | 8 | Type | |
| 3 | 9 | | |
| 4 | 10 | Brand name | |
| 5 | 11 | | |
| 6 | 12 | Electrode classification | |
| | | Angles Lead | Lateral |
| **Material data** | **Weld time** | | |
| Type | Start | | |
| Thickness | Finish | | |
| | Units completed | | |
| **Assessment** | **Complies** | **Does not comply** | |
| Alignment and assembly | | | |
| Amgular distortion | | | |
| Surface finish | | | |
| Weld size | | | |
| Surface defects | | | |
| Complete fusion | | | |
| **Name** | | **Exercise Number** | |



**Skill practice 5**
**Assessment event 2 (practical)**
**Fillet weld - angle to plate - horizontal**



## IF IN DOUBT ASK THE TEACHER

*Suggested time* Skill practice: 1 hour 40 minutes
Assessment: 20 minutes

*Objective* To fillet weld a structural angle section to a plate to the requirements given below.

*Position* Plate horizontal, and angle vertical.

*Procedure* Demonstrated by the teacher.

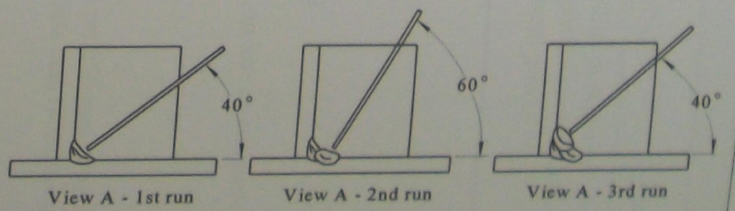
*Method*

1. Wire brush or grind the fusion faces to remove rust or scale.
2. Assemble and tack weld the angle section to the plate.
3. Complete approximately half of the first run, stop and examine the weld profile.
4. Complete the first weld run.
5. Complete the second and third runs and submit for inspection.
6. Flame cut and relocate the angle section for further practice.
7. Evaluate the weld exercise and complete the procedure sheet.
8. For assessment, repeat the fillet weld to the requirements given below.
9. Submit your weld and procedure sheet to the teacher




*Requirements*

- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° to 5°
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size 8 + 2 - 1 mm
- Complete fusion for the length of the weld joint




*Material unit* 1 piece 150 x 10 x 150 mm low carbon steel
1 piece 75 x 75 x 10 ASEA 75 mm long

*Unit required* 1

*Economy* Use material to the maximum by flame cutting and rewelding for further practice as illustrated.

**Skill practice 5**
**Assessment event 2 (practical)**
**Fillet weld - angle to plate - horizontal**

## IF IN DOUBT ASK THE TEACHER

*Suggested time* Skill practice: 1 hour 40 minutes
Assessment: 20 minutes

*Objective* To fillet weld a structural angle section to a plate to the requirements given below.

*Position* Plate horizontal, and angle vertical.

*Procedure* Demonstrated by the teacher.

*Method*

1. Wire brush or grind the fusion faces to remove rust or scale.
2. Assemble and tack weld the angle section to the plate.
3. Complete approximately half of the first run, stop and examine the weld profile.
4. Complete the first weld run.
5. Complete the second and third runs and submit for inspection.
6. Flame cut and relocate the angle section for further practice.
7. Evaluate the weld exercise and complete the procedure sheet.
8. For assessment, repeat the fillet weld to the requirements given below.
9. Submit your weld and procedure sheet to the teacher

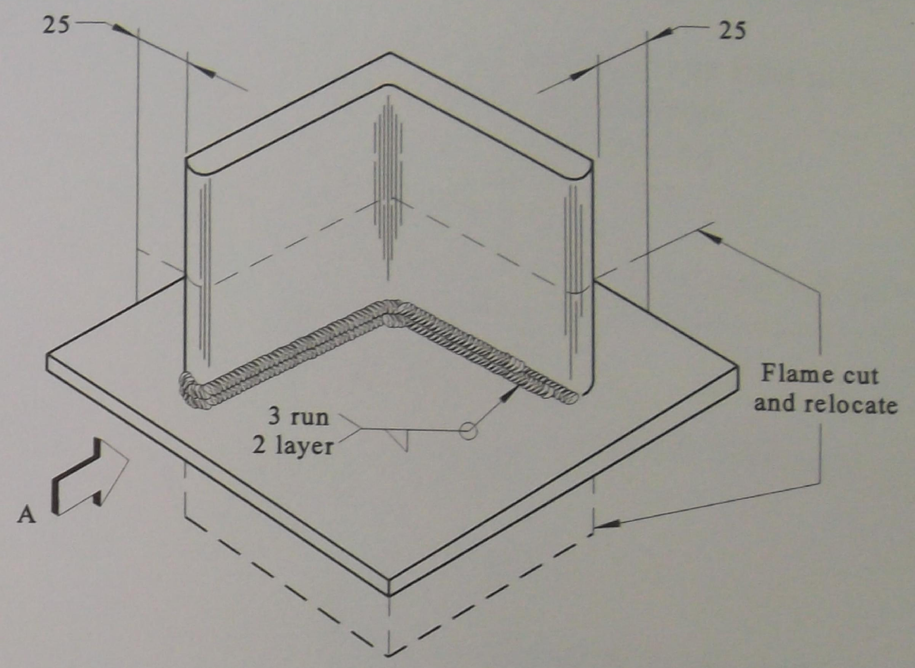
*Requirements*

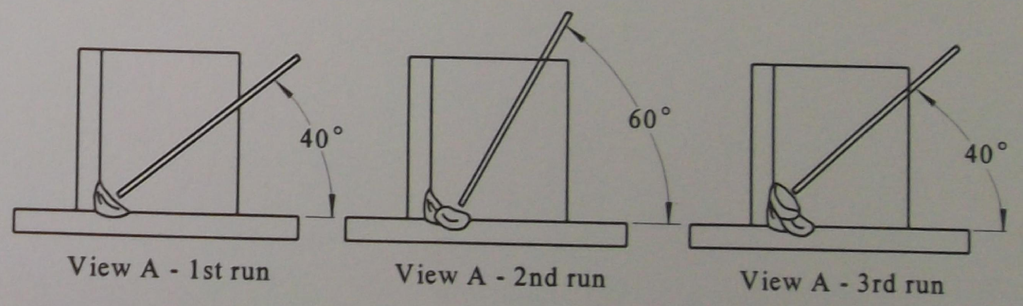
- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° to 5°
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size 8 + 2 - 1 mm
- Complete fusion for the length of the weld joint

*Material unit* 1 piece 150 x 10 x 150 mm low carbon steel
1 piece 75 x 75 x 10 ASEA 75 mm long

*Unit required* 1

*Economy* Use material to the maximum by flame cutting and rewelding for further practice as illustrated.



**Notes**



## Section 8: Corner fillet weld - horizontal

| SUGGESTED DURATION | PREAMBLE |
|---|---|
| 1 hour<br>40 minutes | This section develops your knowledge and skills to deposit a multiple corner fillet weld in the horizontal position low carbon steel plate in accordance with AS 1554 GP weld quality or equivalent. |

***Objectives***

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

- ☐ prepare low carbon steel plate for fillet welding
- ☐ deposit multiple run outside corner fillet welds on low carbon steel plate to meet the following requirements
  - correct alignment and assembly
  - smooth regular weld contour
  - angular distortion 0° to 5°
  - a maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
  - weld size 8 + 2 - 0 mm
  - complete fusion for the length of the weld joint
  - Full radius weld
- ☐ record the weld procedures
- ☐ follow Occupational Health & Safety workshop procedures.

> ***Safety***
> Always wear safety glasses when chipping slag deposits away from the weld.

**Procedure sheet**
**Corner fillet weld - horizontal**

Sketch welding runs on diagram.

Complete the control data table below.

| **Weld current data** | | **Electrode data** | |
|---|---|---|---|
| Run | Run | Size | |
| 1 | 7 | | |
| 2 | 8 | Type | |
| 3 | 9 | | |
| 4 | 10 | Brand name | |
| 5 | 11 | | |
| 6 | 12 | Electrode classification | |
| **Material data** | | **Weld time** | |
| | | Angles | Lead / Lateral |
| Type | | Start | |
| Thickness | | Finish | |
| | | Units completed | |
| **Assessment** | | **Complies** | **Does not comply** |
| Alignment and assembly | | | |
| Angular distortion | | | |
| Surface finish | | | |
| Weld size | | | |
| Surface defects | | | |
| Complete fusion | | | |
| **Name** | | | **Exercise Number** |





**Skill practice 6**
**Assessment event 3 (practical)**
**Corner fillet weld - horizontal**

IF IN DOUBT ASK THE TEACHER

*Suggested time* Skill practice: 1 hour 40 minutes
Assessment: 20 minutes

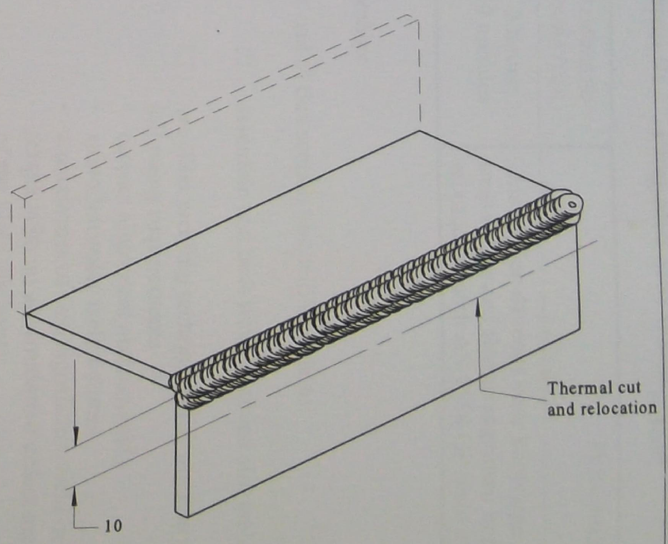
Objective To deposit a multiple run corner weld in the horizontal position using fillet welding techniques to the requirements given below.

*Position* Horizontal.

*Procedure* Demonstrated by the teacher.

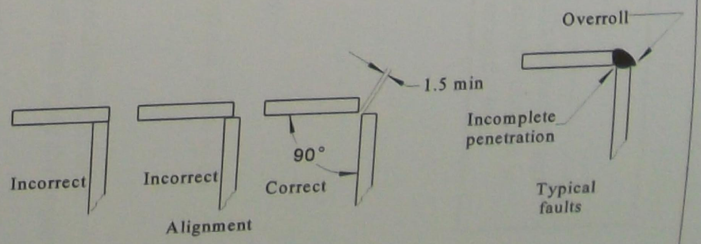
*Method*

1. Assemble and tack plates using a suitable spacer to maintain root gap.
2. Position the plates and deposit approximately 50 mm of the root run.
3. Examine the bead shape and penetration before continuing the weld.
4. Completely fill the remainder of the weld using 3.2 diameter electrodes and a logical weld sequence.
5. Seal the reverse side with a 6 mm horizontal vertical fillet weld.
6. Add the additional plates as required and repeat steps 1 to 5.
7. Evaluate the weld exercise and complete the procedure sheet.
8. For assessment, repeat the corner fillet weld to the requirements given below.
9. Submit your weld and procedure sheet to the teacher.




*Requirements*

- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° to 5°
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size 8 + 2 - 1 mm
- Complete fusion for the length of the weld joint
- Full radius weld




*Material units* 2 pieces 50 x 10 x 225 mm low carbon steel

*Units required* 2

*Economy* Maximise the use of electrodes and return all unused material to the store.

## Skill practice 6
## Assessment event 3 (practical)
## Corner fillet weld - horizontal

IF IN DOUBT ASK THE TEACHER

*Suggested time* Skill practice: 1 hour 40 minutes
Assessment: 20 minutes

Objective To deposit a multiple run corner weld in the horizontal position using fillet welding techniques to the requirements given below.

*Position* Horizontal.

*Procedure* Demonstrated by the teacher.

*Method*

1. Assemble and tack plates using a suitable spacer to maintain root gap.
2. Position the plates and deposit approximately 50 mm of the root run.
3. Examine the bead shape and penetration before continuing the weld.
4. Completely fill the remainder of the weld using 3.2 diameter electrodes and a logical weld sequence.
5. Seal the reverse side with a 6 mm horizontal vertical fillet weld.
6. Add the additional plates as required and repeat steps 1 to 5.
7. Evaluate the weld exercise and complete the procedure sheet.
8. For assessment, repeat the corner fillet weld to the requirements given below.
9. Submit your weld and procedure sheet to the teacher.

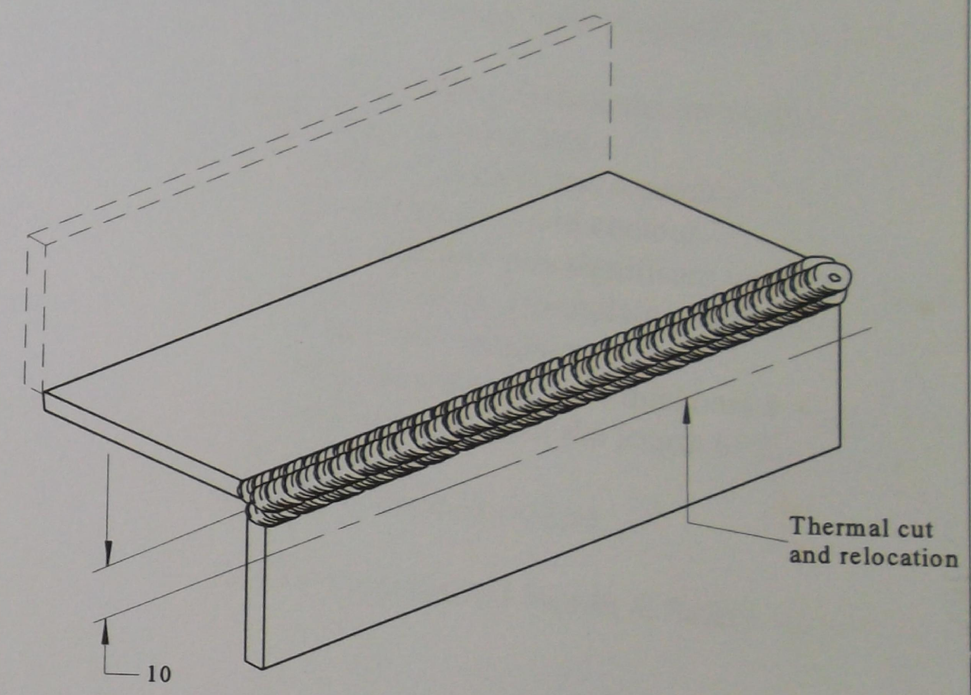
*Requirements*

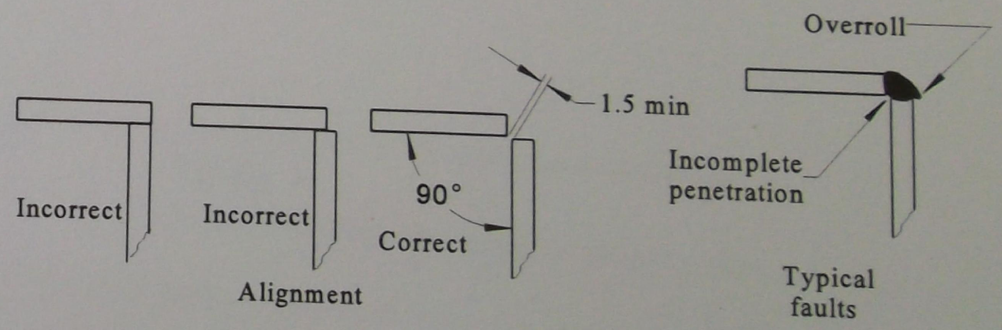
- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° to 5°
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size 8 + 2 - 1 mm
- Complete fusion for the length of the weld joint
- Full radius weld

*Material units* 2 pieces 50 x 10 x 225 mm low carbon steel

*Units required* 2

*Economy* Maximise the use of electrodes and return all unused material to the store.



Notes



## Section 9: Plug and slot welds

| SUGGESTED DURATION | PREAMBLE |
|---|---|
| 3 hours<br>30 minutes | This section deveops your knowlege and skills to prepare and weld a plug and slot arrangement in the horizontal position in accordance with AS 1554 GP weld quality or equivalent. |

***Objectives***

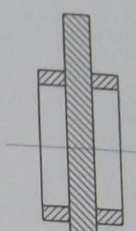
At the end of this section you will be able to:

- ☐ assemble and tack weld plug and slot weld joints
- ☐ use fillet welding techniques for welding plug and slot joints to the following requirements
  - correct alignment and assembly
  - smooth regular weld contour
  - a maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
  - weld size equal to plate thickness 8 + 2 - 0 mm
  - complete fusion for the length of the weld joint
- ☐ record the weld procedure
- ☐ follow Occupational Health & Safety workshop procedures.

> ***Safety***
> Always shield your work to protect others around you from arc flashes.

***Procedure sheet***
***Plug and/or slot welds***

*Sketch welding runs on diagram.*



Complete the control data table below.

| **Weld current data** | | **Electrode data** | |
|---|---|---|---|
| Run | Run | Size | |
| 1 | 7 | Type | |
| 2 | 8 | | |
| 3 | 9 | Brand name | |
| 4 | 10 | | |
| 5 | 11 | Electrode classification | |
| 6 | 12 | | |
| | | Angles Lead | Lateral |
| **Material data** | | **Weld time** | |
| Type | | Start | |
| Thickness | | Finish | |
| | | Units completed | |
| **Assessment** | | **Complies** | **Does not comply** |
| Alignment and assembly | | | |
| Angular distortion | | | |
| Surface finish | | | |
| Weld size | | | |
| Surface defects | | | |
| Complete fusion | | | |
| **Name** | | | **Exercise Number** |





**Skill practice 7**
**Assessment event 4 (practical)**
**Plug and slot welds**

IF IN DOUBT ASK THE TEACHER

*Suggested time* Skill practice: 3 hours 30 minutes
Assessment: 30 minutes

*Objective* To weld plug and slot joints to the requirements given below.

*Position* Horizontal.

*Procedure* Demonstrated by the teacher.

*Method*

1. Position the plates and tack weld as illustrated.
2. Complete the welds on Side 1 and present the assembly for comment.
3. After critical evaluation, repeat the procedure on Side 2.
4. Complete the procedure sheet.
5. For assessment, repeat the plug and slot weld(s) to the requirements given below.
6. Submit the weld(s) and procedure sheet to the teacher.

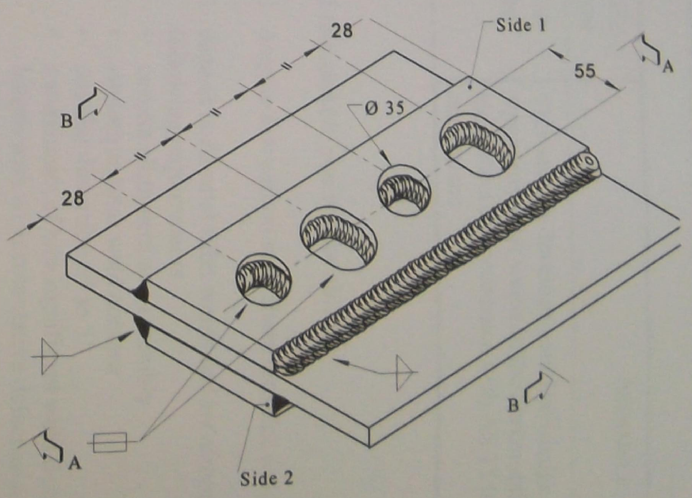
*Requirements*

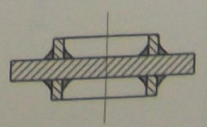
- Correct alignment and assembly
- Smooth regular contour
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size 8 + 2 - 1 mm
- Complete fusion for the length of the weld joint

*Material unit* 1 piece 150 x 10 x 225 mm low carbon steel
2 pieces 75 x 10 x 225 mm low carbon steel

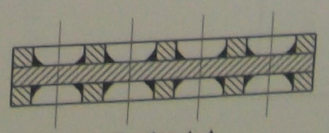
*Unit required* 1

*Economy* Position plates accurately. Return all unused material to the store.



Section B-B



Section A-A

## Skill practice 7
## Assessment event 4 (practical)
## Plug and slot welds

IF IN DOUBT ASK THE TEACHER

*Suggested time* Skill practice: 3 hours 30 minutes
Assessment: 30 minutes

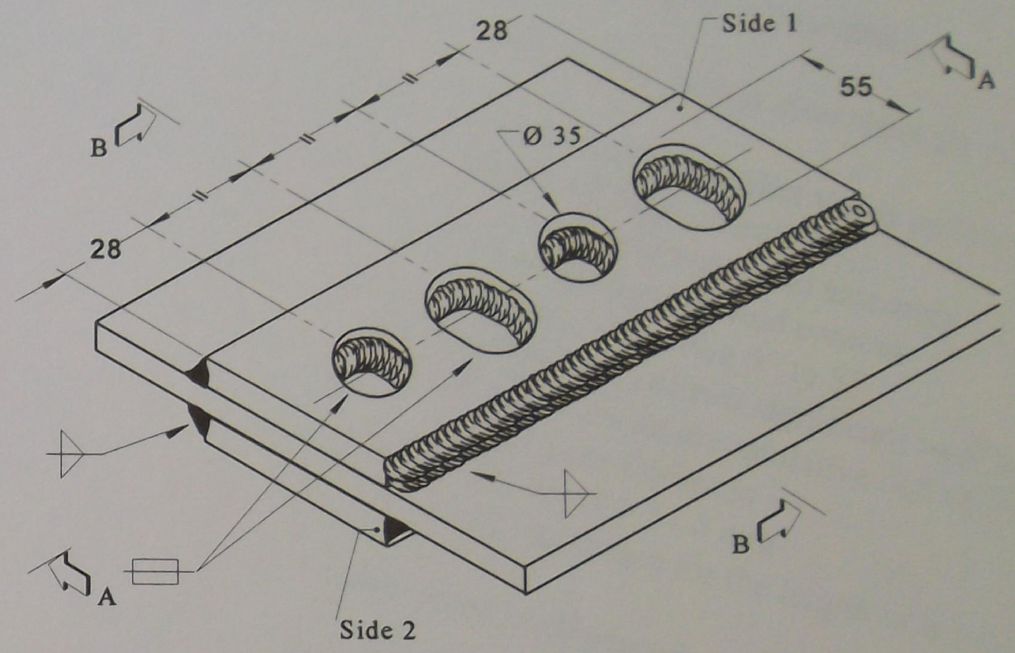
*Objective* To weld plug and slot joints to the requirements given below.

*Position* Horizontal.

*Procedure* Demonstrated by the teacher.

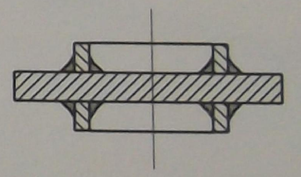
*Method*

1. Position the plates and tack weld as illustrated.
2. Complete the welds on Side 1 and present the assembly for comment.
3. After critical evaluation, repeat the procedure on Side 2.
4. Complete the procedure sheet.
5. For assessment, repeat the plug and slot weld(s) to the requirements given below.
6. Submit the weld(s) and procedure sheet to the teacher.

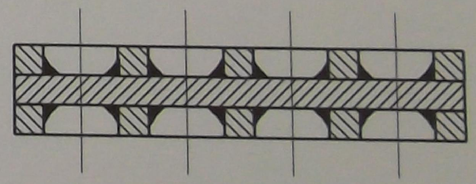



*Requirements*

- Correct alignment and assembly
- Smooth regular contour
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size 8 + 2 - 1 mm
- Complete fusion for the length of the weld joint



Section B-B



Section A-A

*Material unit* 1 piece 150 x 10 x 225 mm low carbon steel
2 pieces 75 x 10 x 225 mm low carbon steel

*Unit required* 1

*Economy* Position plates accurately. Return all unused material to the store.

## Notes



## Section 10: Fillet weld - steel sheet - horizontal

| SUGGESTED DURATION | PREAMBLE |
|---|---|
| 1 hour 40 minutes | This section develops your knowledge and skills to deposit single run fillet welds in the horizontal position on low carbon steel sheet in accordance with AS 1554 GP weld quality or equivalent. |

***Objectives***

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

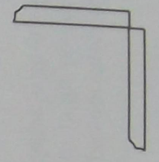
- ☐ prepare low carbon steel sheet for fillet welding
- ☐ deposit horizontal fillet welds on low carbon steel plate to meet the following requirements
  - correct alignment and assembly
  - smooth regular weld contour
  - angular distortion 0° to 5°
  - a maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
  - weld size 8 + 2 - 0 mm
  - complete fusion for the length of the weld joint
- ☐ record the weld procedures
- ☐ follow Occupational Health & Safety workshop procedures.

***Safety***

- Always use tongs to position tacked and welded work.
- Never leave hot work unattended in the workshop.

**Procedure sheet**
**Fillet weld steel sheet - horizontal**

Sketch welding runs on diagram.



Complete the control data table below.

| **Weld current data** | | **Electrode data** |
|---|---|---|
| Run | Run | Size |
| 1 | 7 | |
| 2 | 8 | Type |
| 3 | 9 | |
| 4 | 10 | Brand name |
| 5 | 11 | |
| 6 | 12 | Electrode classification |
| | | Angles Lead Lateral |
| **Material data** | | **Weld time** |
| Type | | Start |
| Thickness | | Finish |
| | | Units completed |
| **Assessment** | | **Complies** **Does not comply** |
| Alignment and assembly | | |
| Angular distortion | | |
| Surface finish | | |
| Weld size | | |
| Surface defects | | |
| Complete fusion | | |
| **Name** | | **Exercise Number** |



**Skill practice 8**
**Assessment event 5 (practical)**
**Fillet weld - steel sheet - horizontal**



IF IN DOUBT ASK THE TEACHER

*Siggested time* Skill practice: 1 hour 40 minutes
Assessment: 20 minutes

*Objective* To weld 3 mm sheet assembled in the corner and fillet positions to the requirements given below.

*Position* Horizontal.

*Procedure* Demonstrated by the teacher. Students must attend this demonstration before beginning the exercise.

*Method*
1. Clean, assemble and tack weld at three locations for each joint.
2. Use E4112 electrodes and stop each run at least once.
3. Weld both sides of the horizontal fillet.
4. Weld both sides of the lap joint.
5. Weld the corner joint.
6. Repeat steps 1 to 5 with E4113 electrodes.
7. Evaluate the weld project and complete the procedure sheet.
8. For assessment, repeat the fillet weld to the requirements given below.
9. Submit the weld and procedure sheet to the teacher.

*Requirements*
- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° to 5°
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size to equal the sheet thickness + 2 - 1 mm
- Complete fusion for the length of the weld joint

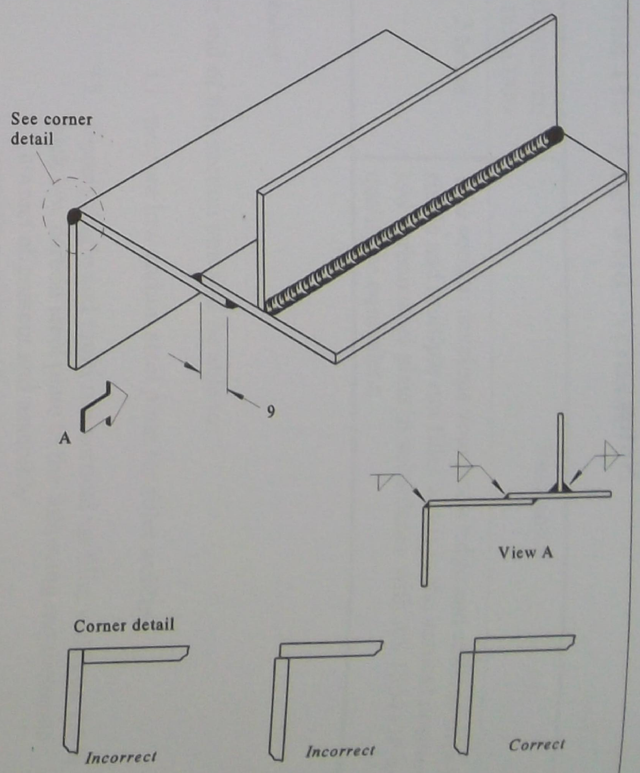
*Points to watch*
- Distortion tack at regular intervals
- Assembly and `fit up' of corner joint

*Material unit* 4 pieces low carbon steel 50 x 3 x 225 mm

*Unit required* 3

*Electrodes* ϕ2.5 mm and 3 mm E4112 and E4113

*Economy* Materials and consumables are expensive. Use electrodes to a maximum total length of 50 mm.



## Skill practice 8
## Assessment event 5 (practical)
## Fillet weld - steel sheet - horizontal



IF IN DOUBT ASK THE TEACHER

*Siggested time* Skill practice: 1 hour 40 minutes
Assessment: 20 minutes

*Objective* To weld 3 mm sheet assembled in the corner and fillet positions to the requirements given below.

*Position* Horizontal.

*Procedure* Demonstrated by the teacher. Students must attend this demonstration before beginning the exercise.

*Method*

1. Clean, assemble and tack weld at three locations for each joint.
2. Use E4112 electrodes and stop each run at least once.
3. Weld both sides of the horizontal fillet.
4. Weld both sides of the lap joint.
5. Weld the corner joint.
6. Repeat steps 1 to 5 with E4113 electrodes.
7. Evaluate the weld project and complete the procedure sheet.
8. For assessment, repeat the fillet weld to the requirements given below.
9. Submit the weld and procedure sheet to the teacher.

*Requirements*

- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° to 5°
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size to equal the sheet thickness + 2 - 1 mm
- Complete fusion for the length of the weld joint

*Points to watch*

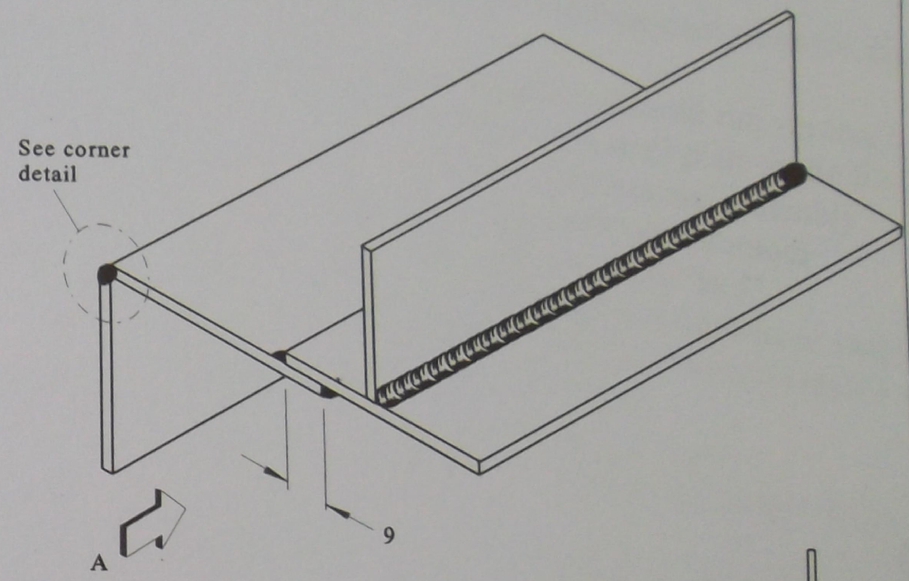
- Distortion tack at regular intervals
- Assembly and `fit up' of corner joint

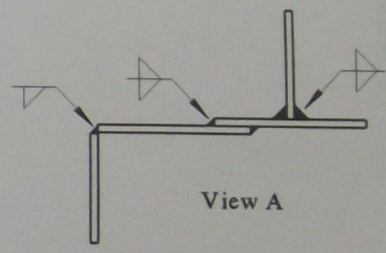
*Material unit* 4 pieces low carbon steel 50 x 3 x 225 mm

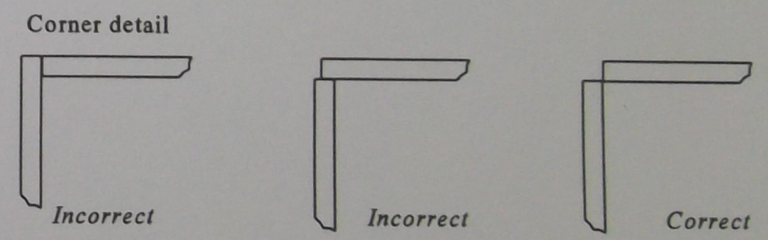
*Unit required* 3

*Electrodes* ϕ2.5 mm and 3 mm E4112 and E4113

*Economy* Materials and consumables are expensive. Use electrodes to a maximum total length of 50 mm.



**Notes**



## Section 11: Fillet weld - vertical

| SUGGESTED DURATION | PREAMBLE |
|---|---|
| 2 hours | This section develops your knowledge and skills to deposit single and multiple run fillet welds in the vertical position on low carbon steel plate in accordance with AS 1554 GP weld quality or equivalent. |

***Objectives***

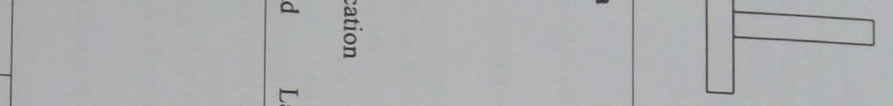
At the end of this section you will be able to:

- ☐ prepare low carbon steel plate for fillet welding
- ☐ deposit single and multi run vertical up fillet welds on 1.6 to 10 mm thick low carbon steel plate to the following requirements
  - correct alignment and assembly
  - smooth regular weld contour
  - angular distortion 0 ˚to 5˚
  - a maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area less than twice the square of the plate thickness
  - weld size 10 + 2 -1 mm
  - complete fusion for the length of the weld joint
- ☐ record the weld procedure
- ☐ follow Occupational Health & Safety workshop procedures.

***Safety***
Make sure that out of position exercises are firmly secured.

**Procedure sheet**
***Fillet weld - vertical***

Sketch welding runs on diagram.



Complete the control data table below.

| **Weld current data** | | **Electrode data** | |
|---|---|---|---|
| Run | Run | Size | |
| 1 | 7 | | |
| 2 | 8 | Type | |
| 3 | 9 | | |
| 4 | 10 | Brand name | |
| 5 | 11 | | |
| 6 | 12 | Electrode classification | |
| | | Angles Lead | Lateral |
| **Material data** | | **Weld time** | |
| Type | | Start | |
| Thickness | | Finish | |
| | | Units completed | |
| **Remarks** | | **Complies** | **Does not comply** |
| Alignment and assembly | | | |
| Angular distortion | | | |
| Surface finish | | | |
| Weld size | | | |
| Surface defects | | | |
| Complete fusion | | | |
| **Name** | | | **Exercise Number** |



**Skill practice 9**
**Fillet weld - vertical**



IF IN DOUBT ASK THE TEACHER

*Objective* To fillet weld low carbon steel plate to the requirements given below.

*Position* Vertical.

*Procedure* Demonstrated by the teacher.

*Method*

1. Clean weld zone of rust and mill scale.
2. Assemble and tack weld plates ensuring metal to metal contact.
3. Deposit approximately 50 mm of the first run and examine the bead profile.
4. Make any necessary procedural adjustements and complete the weld for the single run 6 mm fillet.
5. Fracture the joint and reposition for further practice.
6. After adequate practice and proficiency is achieved deposit a two run two layer fillet weld to achieve a 10 mm fillet size.
7. Evaluate the weld project and complete the procedure sheet.
8. Submit your weld and procedure sheet to the teacher.

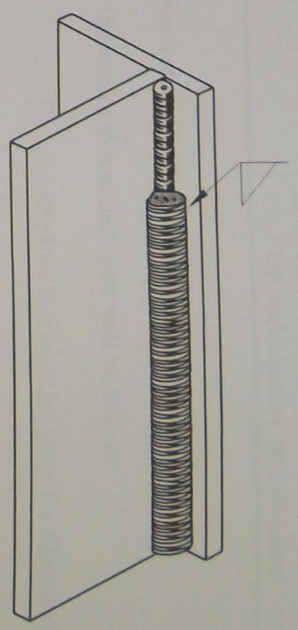
*Requirements*

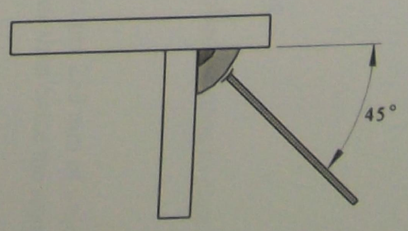
- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° to 5°
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size 10 + 2 -1 mm
- Complete fusion for the length of the weld joint.

*Material unit* 2 pieces low carbon steel 70 x 10 x 225 mm

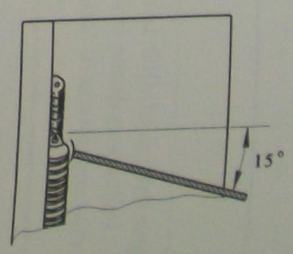
*Unit required* 2

*Economy* Break welds and relocate plates for maximum use. Return all unused material to the store.

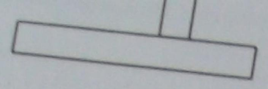





Top view




Front view



lete the control data table below.

| current data | | Electrode data |
|---|---|---|
| Run | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |
| 11 | | |
| 12 | | |
| | Ele | |
| | Ang | |
| ta | Wel | |
| | Start | |
| | Finish | |
| | Units o | |
| | Compl | |
| sembly | | |

| SUGGESTED DURATION | PREAMBLE |
|---|---|
| 1 hour 40 minutes | This section develops your knowle and multiple run fillet |

teel



**Skill practice 9**
**Fillet weld - vertical**

IF IN DOUBT ASK THE TEACHER

*Objective* To fillet weld low carbon steel plate to the requirements given below.

*Position* Vertical.

*Procedure* Demonstrated by the teacher.

*Method*

1. Clean weld zone of rust and mill scale.
2. Assemble and tack weld plates ensuring metal to metal contact.
3. Deposit approximately 50 mm of the first run and examine the bead profile.
4. Make any necessary procedural adjustements and complete the weld for the single run 6 mm fillet.
5. Fracture the joint and reposition for further practice.
6. After adequate practice and proficiency is achieved deposit a two run two layer fillet weld to achieve a 10 mm fillet size.
7. Evaluate the weld project and complete the procedure sheet.
8. Submit your weld and procedure sheet to the teacher.

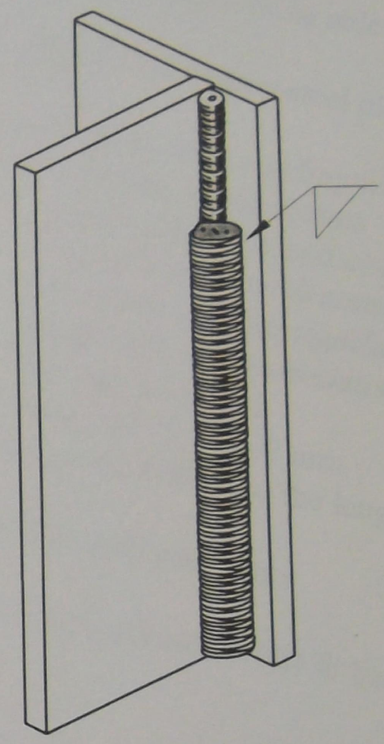
*Requirements*

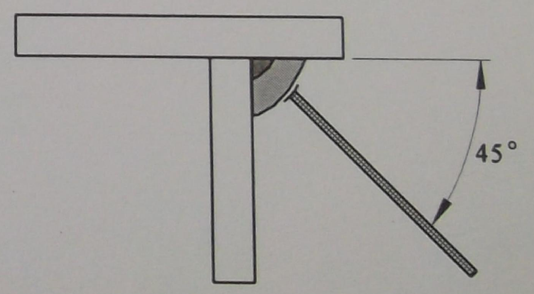
- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° to 5°
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size 10 + 2 -1 mm
- Complete fusion for the length of the weld joint.

*Material unit* 2 pieces low carbon steel 70 x 10 x 225 mm

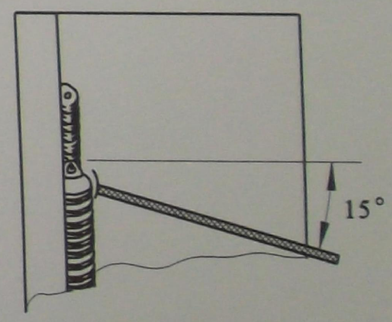
*Unit required* 2

*Economy* Break welds and relocate plates for maximum use. Return all unused material to the store.






Top view




Front view

Notes

## Section 12: Fillet weld - rolled section to plate - vertical

| SUGGESTED DURATION | PREAMBLE |
|---|---|
| 1 hour<br>40 minutes | This section develops your knowledge and skills to deposit single and multiple run fillet welds in the vertical position on rolled structural sections to low carbon steel plate in accordance with AS 1554 GP weld quality or equivalent. |

***Objectives***

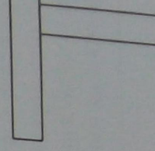
At the end of this section you will be able to:

- ☐ prepare low carbon steel plate for fillet welding
- ☐ use vertical fillet welding techniques to join rolled sections to plate to the following requirements
  - correct alignment and assembly
  - smooth regular weld contour
  - a maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area less than twice the square of the plate thickness
  - weld size 10 + 2 - 2 mm
  - complete fusion for the length of the weld joint
- ☐ record the weld procedure
- ☐ follow Occupational Health & Safety workshop procedures.

***Safety***
Wear approved eye protection and safety clothing.

**Fillet weld - rolled section to plate - vertical**

Sketch welding runs on diagram.



*Complete the control data table below.*

| | | | |
|---|---|---|---|
| **Weld current data** | | | **Electrode data** |
| Run | Run | | Size |
| 1 | 7 | | Type |
| 2 | 8 | | Brand name |
| 3 | 9 | | Electrode classification |
| 4 | 10 | | |
| 5 | 11 | | |
| 6 | 12 | | |
| **Material data** | | **Weld time** | |
| Type | | Start | |
| Thickness | | Finish | |
| | | Units completed | |
| **Assessment** | | **Complies** | **Does not comply** |
| Alignment and assembly | | | |
| Surface finish | | | |
| Weld size | | | |
| Surface defects | | | |
| Complete fusion | | | |
| **Name** | | | **Exercise Number** |
| | | | |



**Skill practice 10**
**Assessment event 6 (practical)**
**Fillet weld - rolled section to plate - vertical**



IF IN DOUBT ASK THE TEACHER

*Suggested time* Skill practice: 1 hour 40 minutes
Assessment: 20 minutes

*Objective* To apply manual metal arc welding techniques to join rolled steel section to plate to the requirements given below.

*Position* Vertical.

*Procedure* Demonstrated by the teacher.

*Method*

1. Assemble and tack weld the UB section to plate.
2. Establish a weld procedure and rotate UB and plate to ensure weld is in the vertical position.
3. Complete the fillet weld.
4. Flame cut the UB section to allow for further practice.
5. Relocate the section and repeat steps 1 to 4.
6. Evaluate the weld project and complete the procedure sheet.
7. For assessment, repeat the fillet weld to the requirements given below.
8. Submit your work and procedure sheet to the teacher.

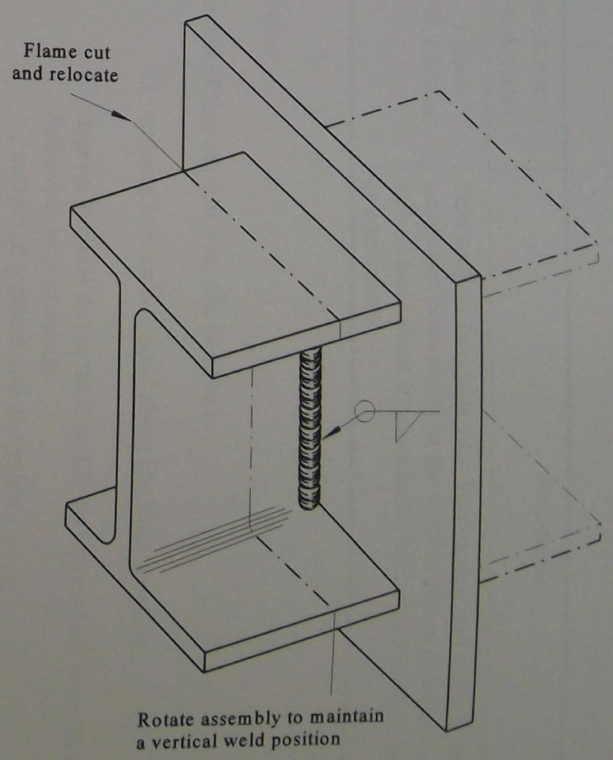
*equirements*

- Correct alignment and assembly
- Smooth regular contour
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size 10 + 2 -1 mm
- Complete fusion for the length of the weld joint

*aterial unit* 1 piece 200 x 10 x 250 mm low carbon steel
1 piece 200 x 29.8 UB x 75 mm long

*nit required* 1

*onomy* Return unused material to the store.



## Skill practice 10
## Assessment event 6 (practical)
## Fillet weld - rolled section to plate - vertical

IF IN DOUBT ASK THE TEACHER

*Suggested time* Skill practice: 1 hour 40 minutes
Assessment: 20 minutes

*Objective* To apply manual metal arc welding techniques to join rolled steel section to plate to the requirements given below.

*Position* Vertical.

*Procedure* Demonstrated by the teacher.

*Method*

1. Assemble and tack weld the UB section to plate.
2. Establish a weld procedure and rotate UB and plate to ensure weld is in the vertical position.
3. Complete the fillet weld.
4. Flame cut the UB section to allow for further practice.
5. Relocate the section and repeat steps 1 to 4.
6. Evaluate the weld project and complete the procedure sheet.
7. For assessment, repeat the fillet weld to the requirements given below.
8. Submit your work and procedure sheet to the teacher.

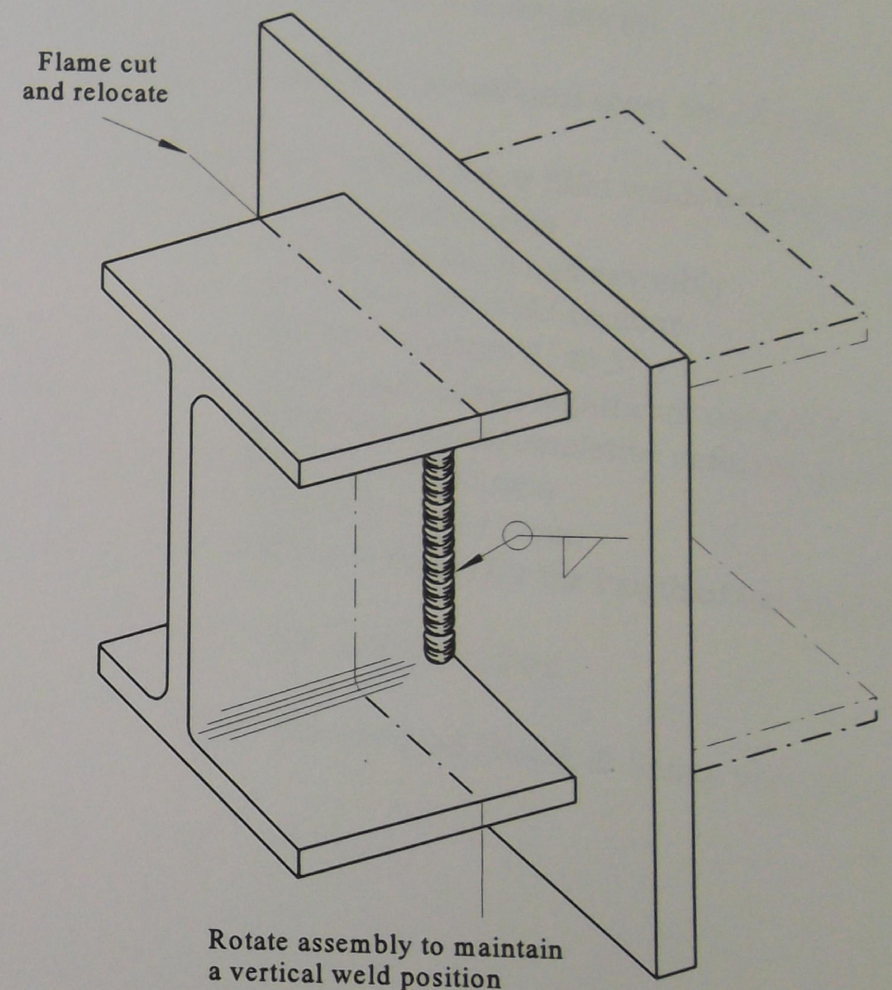
*Requirements*

- Correct alignment and assembly
- Smooth regular contour
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size 10 + 2 -1 mm
- Complete fusion for the length of the weld joint

*Material unit* 1 piece 200 x 10 x 250 mm low carbon steel
1 piece 200 x 29.8 UB x 75 mm long

*Unit required* 1

*Economy* Return unused material to the store.



**Notes**



## Section 13: Fillet weld - steel sheet - vertical

| SUGGESTED DURATION | PREAMBLE |
|---|---|
| 1 hour<br>40 minutes | This section develops your knowledge and skills to deposit single run fillet welds in the vertical down direction on low carbon steel sheet in accordance with AS 1554 GP weld quality or equivalent. |

***Objectives***

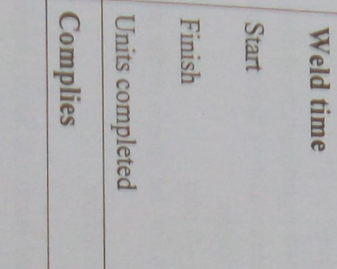
At the end of this section you will be able to:

- ☐ prepare low carbon steel sheet for fillet welding
- ☐ deposit vertical down fillet welds on low carbon steel sheet to the following requirements
  - correct alignment and assembly
  - smooth regular weld contour
  - angular distortion 0° to 5°
  - a maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the sheet thickness
  - weld size 3 + 2 - 0 mm
  - complete fusion for the length of the weld joint
- ☐ record the weld procedure
- ☐ follow Occupational Health & Safety workshop procedures.

***Safety***
Remember hot sparks can be more of a hazard when welding out of position. Keep away from falling sparks and wear appropriate safety clothing.

**Fillet weld - steel sheet - vertical**

Sketch welding runs on diagram.



Complete the control data table below.

| | | | |
|---|---|---|---|
| **Weld current data** | | **Electrode data** | |
| Run | Run | Size | |
| 1 | 7 | Type | |
| 2 | 8 | | |
| 3 | 9 | Brand name | |
| 4 | 10 | | |
| 5 | 11 | Electrode classification | |
| 6 | 12 | | |
| | | Angles Lead | Lateral |
| **Material data** | | **Weld time** | |
| Type | | Start | |
| Thickness | | Finish | |
| | | Units completed | |
| **Assessment** | | **Complies** | **Does not comply** |
| Alignment and assembly | | | |
| Surface finish | | | |
| Weld size | | | |
| Surface defects | | | |
| Complete fusion | | | |
| **Name** | | | **Exercise Number** |
| | | | |



**Skill practice 11**
**Assessment event 7 (practical)**
**Fillet weld - steel sheet - vertical**



IF IN DOUBT ASK THE TEACHER

*Suggest time* Skill practice: 1 hour 40 minutes
Assessment: 20 minutes

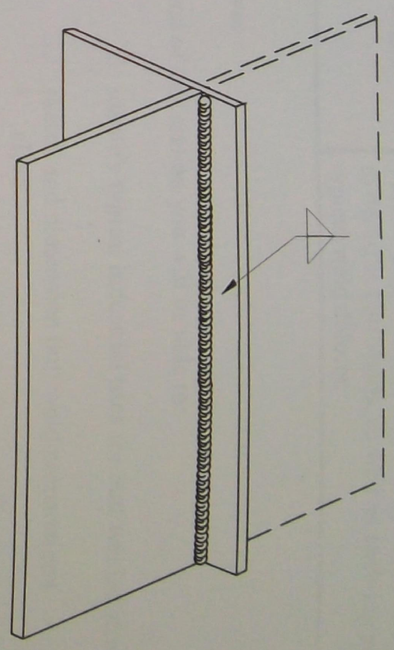
*Objective* To fillet weld low carbon steel sheet to the requirements given below.

*Position* Vertical.

*Procedure* Demonstrated by the teacher.

*Method*

1. Assemble and tack weld 1.6 and 3 mm thick material ensuring metal to metal contact.
2. Deposit approximtely 50 mm of the weld run and examine the bead profile.
3. Make necessary procedural adjustments before completing the weld.
4 Complete a second weld on the opposite side of the plate.
5. Add a second sheet and repeat the weld.
6. Repeat the weld with 1.6 mm thick material.
7. Evaluate the weld project and complete the procedure sheet.
8. For assessment, repeat the fillet weld to the requirements given below.
9. Submit your weld(s) and procedure sheet to the teacher.



*Requirements*

- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° - 5°
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size 3 + 2 -1 mm
- Complete fusion for the length of the weld joint

*Material unit* 3 pieces low carbon steel 50 x 3 x 250 mm
3 pieces low carbon steel 50 x 1.6 x 250 mm

*Unit required* 4

*Economy* Maximise the use of electrodes and return all material to the store.

# Skill practice 11
# Assessment event 7 (practical)
# Fillet weld - steel sheet - vertical

IF IN DOUBT ASK THE TEACHER

*Suggest time* Skill practice: 1 hour 40 minutes
Assessment: 20 minutes

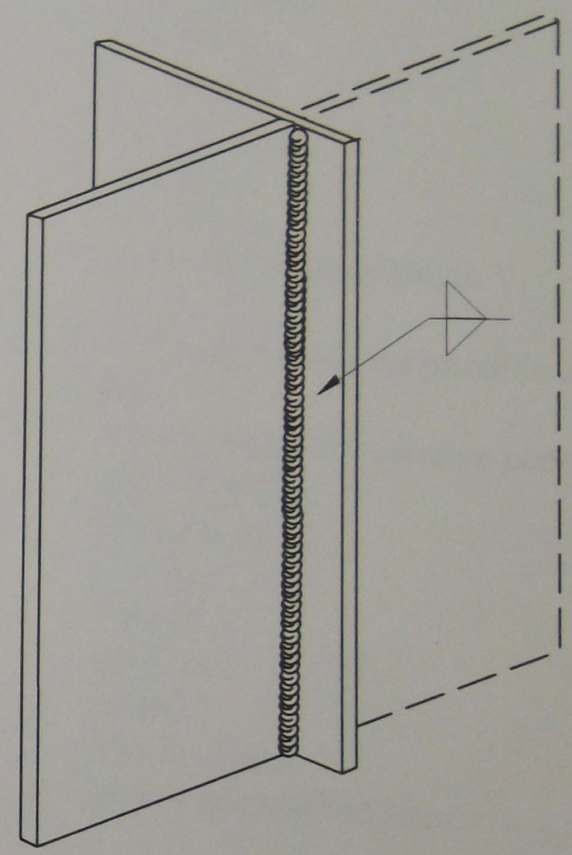
*Objective* To fillet weld low carbon steel sheet to the requirements given below.

*Position* Vertical.

*Procedure* Demonstrated by the teacher.

*Method*

1. Assemble and tack weld 1.6 and 3 mm thick material ensuring metal to metal contact.
2. Deposit approximtely 50 mm of the weld run and examine the bead profile.
3. Make necessary procedural adjustments before completing the weld.
4 Complete a second weld on the opposite side of the plate.
5. Add a second sheet and repeat the weld.
6. Repeat the weld with 1.6 mm thick material.
7. Evaluate the weld project and complete the procedure sheet.
8. For assessment, repeat the fillet weld to the requirements given below.
9. Submit your weld(s) and procedure sheet to the teacher.



*Requirements*

- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° - 5°
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness
- Weld size 3 + 2 -1 mm
- Complete fusion for the length of the weld joint

*Material unit* 3 pieces low carbon steel 50 x 3 x 250 mm
3 pieces low carbon steel 50 x 1.6 x 250 mm

*Unit required* 4

*Economy* Maximise the use of electrodes and return all material to the store.

## Section 14: Butt weld joint terminology and faults

| SUGGESTED DURATION | PREAMBLE |
|---|---|
| 1 hour | This section introduces you to the technical terms that are used to describe butt welds, as well as enabling you to identify typical weld defects. |

***Objectives***

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

- ☐ identify typical industrial uses for butt welded structures
- ☐ sketch and dimension butt weld preparations
  - close
  - open square
  - single V
  - double V
  - single bevel
  - single U
  - double U
  - uneven thickness single V
- ☐ identify and discuss the possible cause and correction of typical weld defects
  - incomplete and excessive penetration
  - lack of fusion
  - slag inclusion
  - porosity
  - cracking
  - undercut
  - overroll
  - misalignment
  - incompletely filled joint.

***Safety***

- Wear the proper clothing to protect your skin and eyes.
- Do not take short cuts or risks.

## Butt weld joint terminology and faults

### Butt welds

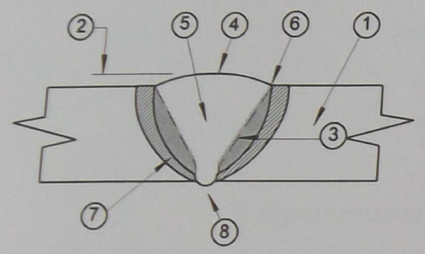
Butt welds are used to join metal products such as sheet, plate, rolled and pressed sections. This type of joint has the advantage of giving great strength without changing the profile of the structure.

Industrial uses for butt welds include:

- boiler and pressure vessel construction
- ship building
- earth moving equipment
- aircraft and submarines.

Butt weld joints can be designed for full penetration welding to give maximum strength, or for partial penetration welding, in places where the strength of the joint is not so important.

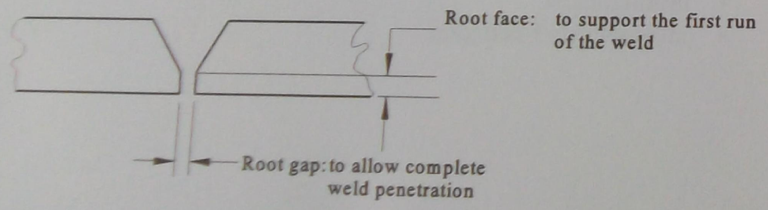
### Weld components




1. Parent metal
2. Reinforcement
3. Fusion zone
4. Weld face
5. Weld metal
6. Toe
7. Heat affected zone (HAZ)
8. Root penetration

### Weld preparation

Joint edges have to be prepared before plates are welded together. Joint or edge preparation is essential for complete fusion and penetration.



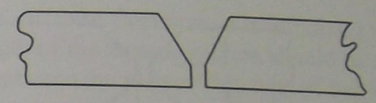

*Single V butt weld*



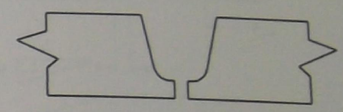
| *Weld preparations* | |
|---|---|
| On thick plate | Use double V or U preparations.<br>Less weld = less heat = less distortion. |
| U preparations | Less weld metal than V preparations but are more difficult to prepare. |
| V preparations | Usually done by flame cutting or machining. |
| Single butt welds | Back gouge and deposit a backing run for maximum strength. |
| Double butts welds and multi-fillet welds | Need to balance joint to minimise distortion. |

### Plate thickness

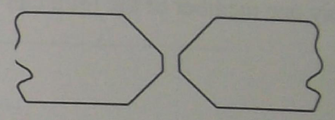
Single V butt - plate to 12 mm thick.



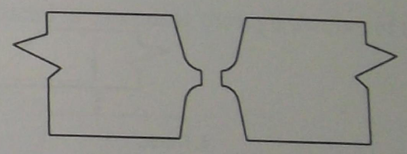
Single U butt - plate to 25 mm thick.



Double V butt - plate to 38 mm thick.



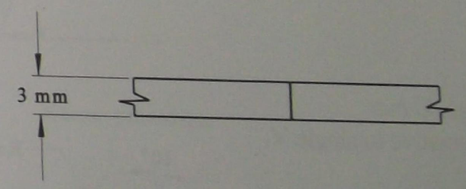
Double U butt - plate over 25 mm thick.



### Preparation types

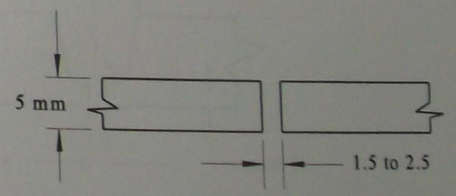
*Close butt joint*

- Edges do not need preparing. They are placed close together and single or double welded.
- Suitable for sheet up to 3 mm thick.

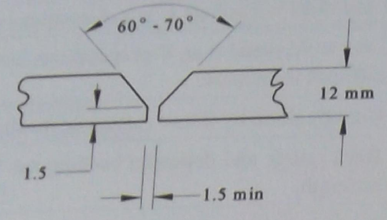



*Open butt joint*

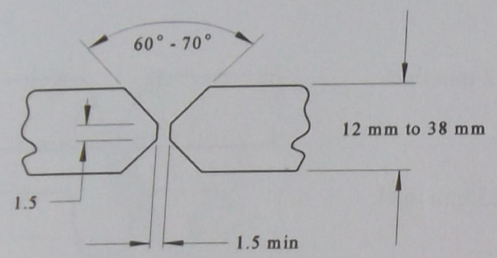
- Edges do not need preparing. They are separated slightly to allow fusion of the full thickness of material.
- Suitable for material up to 5 mm thick.



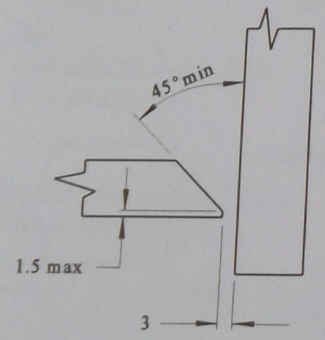
*Single V butt joint*
Commonly used on material up to 12 mm thick.



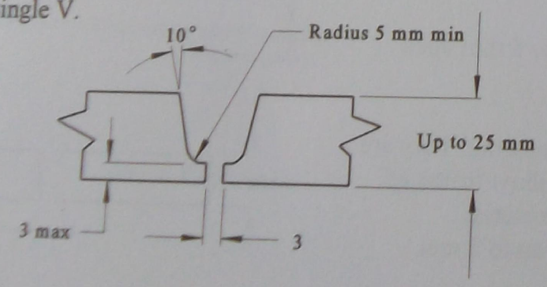

*Double V butt joint*
Used on plate 12 mm to 38 mm in thickness where both sides are welded.




*Single bevel butt joint*
Used when only one member of the joint can be prepared as in the case of a T joint.

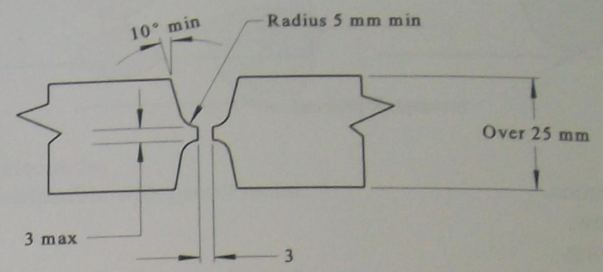



*Single U butt*
Alternative to single V.

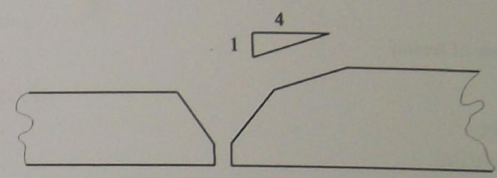





*Double U butt*
Used on material more than 25 mm thick and where welding can be done from both sides.

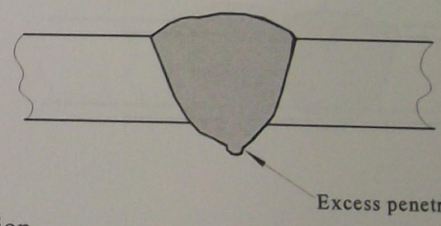



*Uneven section butt joint*
When you need to butt weld two sections of different thickness, it is important to taper the thicker one to match the other. The length of the tapered section should be at least three times the difference in the thickness between the plates. This type of butt weld is used to join dished ends in pressure vessels construction.



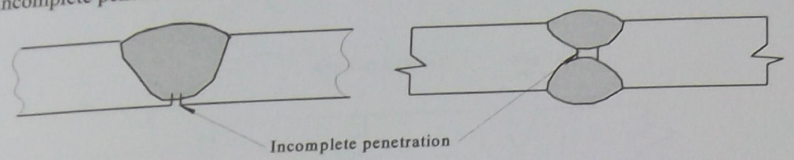

**Weld defects**

***Excess penetration***
Excess penetration is when too much weld metal is extending through the root of the weld.



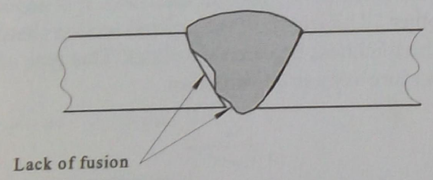

*Causes*
- Incorrect preparation.
- Amperage too high.
- Incorrect welding technique.

***Incomplete penetration***
Incomplete penetration is the failure of weld metal to extend into the root of a joint.



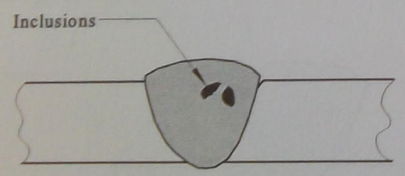

*Causes*
- Incorrect preparation.
- Amperage too low.
- Arc length too long.

***Lack of fusion***
Lack of fusion is incomplete fusion between weld metal and weld metal or weld metal and parent metal.




*Causes*
- Not enough amperage.
- Incorrect joint preparation.
- Incorrect welding technique.

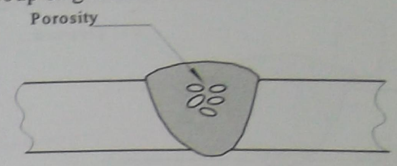
***Inclusions***
Inclusions occur when slag or other foreign matter is trapped during welding.




*Causes*
- Faulty joint preparation.
- Not enough amperage.
- Poor cleaning of prior runs.

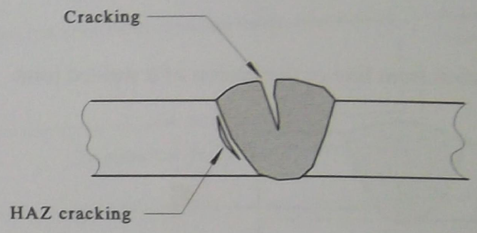


***Porosity***
Porosity refers to a group of gas holes in the weld metal.



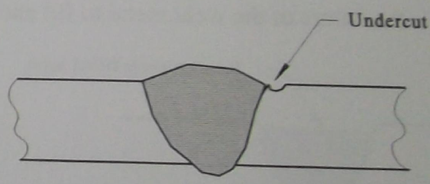

*Causes*
- Damp or old electrodes.
- Electrode incompatible with parent metal.

***Cracking***
Cracking refers to discontinuities produced from tearing of the weld metal or plate.




*Causes*
- Insufficient weld deposit.
- Insufficient pre-heat.
- Incorrect electrode.

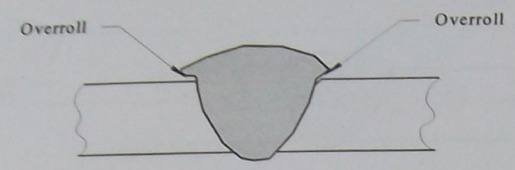
***Undercut***
Undercut is a groove or channel in the parent metal at the toe of the weld.




*Causes*
- Too much current.
- Welding too fast.
- Incorrect welding technique.

***Overroll***

Overroll is a section of unfused metal extending past the toe of the weld.

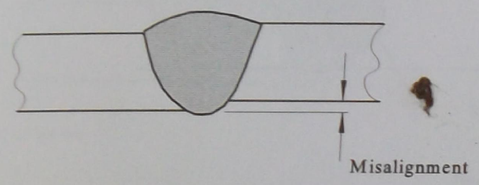



*Causes*

- Electrode too large.
- Welding speed too slow.
- Incorrect electrode angle.

***Misalignment***

Misalignment refers to any variation from line or dimension of a welded joint.

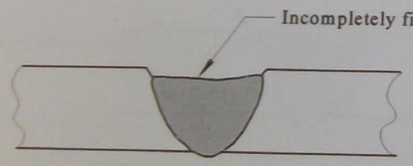



*Causes*

- Incorrect weld procedure.
- Careless preparation.
- Too few tack welds.

***Incompletely filled joint***

An incompletely filled joint is the failure of the weld metal to fill and fuse the top of the joint.




*Cause*

- Not enough weld metal.

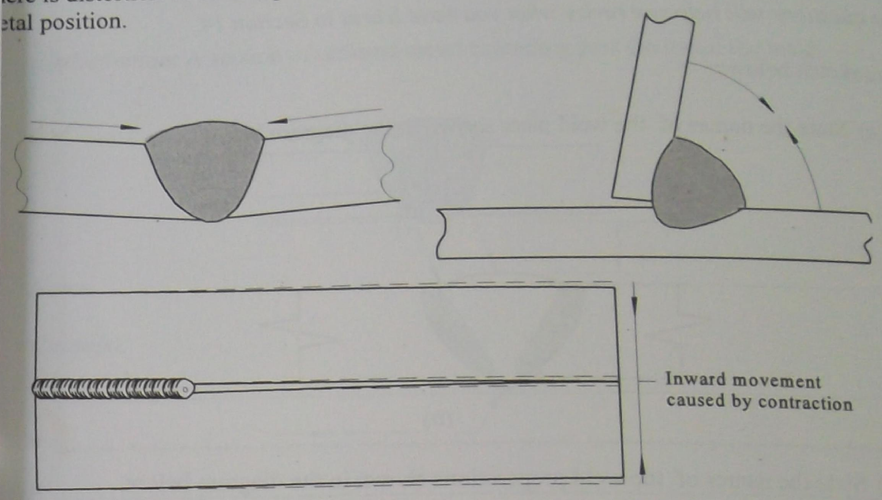
**The principle of expansion and contraction in a metal**

Metals expand when heated and contract when cooled. For example, a piece of low carbon steel if not restrained in any way, will increase its dimensions in all directions for every degree Celsius the temperature rises. On cooling, the steel will return to its original size.

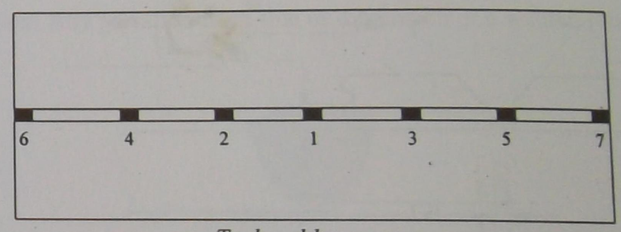


***ngular distortion***

here is distortion when unequal contractional forces cause angular change in the parent etal position.




*Transverse distortion by butt weld*



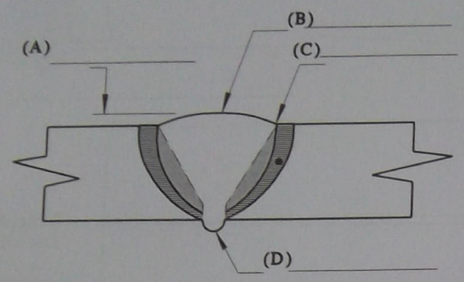

*Tack weld sequence*

## Review questions

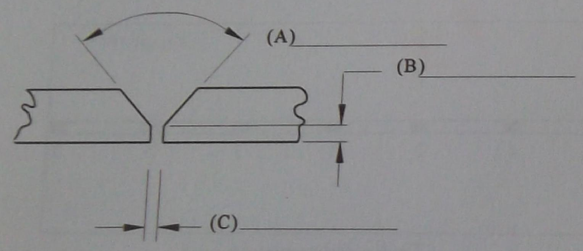
*These questions will help you revise what you have learnt in Section 14.*

On the sketch below:

1. (a) State the names of the weld parts shown in the diagram below.

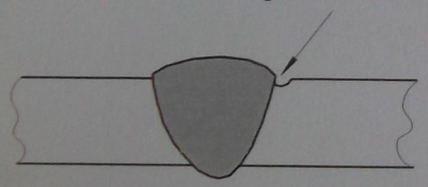



(b) State the names of the weld preparations shown in the diagram below.




2. State the name of the following butt weld external defects and list the cause(s) of each.

(a) *Definition:* A groove or channel in the parent metal at the toe of the weld.



*Name:* _____

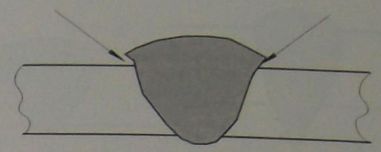
*Cause(s):*

- _____
- _____
- _____



## Review questions

(b) *Definition*: A section of unfused metal extending past the toe of the weld.

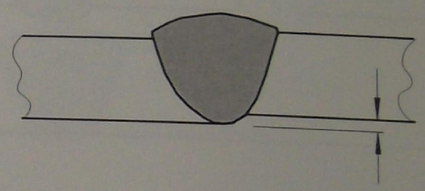


*Name:* _____

*Cause(s):*

- _____
- _____
- _____

(c) *Definition*: Any variation from line or dimension of a welded joint.



*Name:* _____

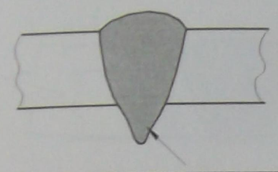
*Cause(s):*

- _____
- _____
- _____

These questions will help

## Review questions

(d) *Definition*: Too much weld metal extending through the root of the weld.

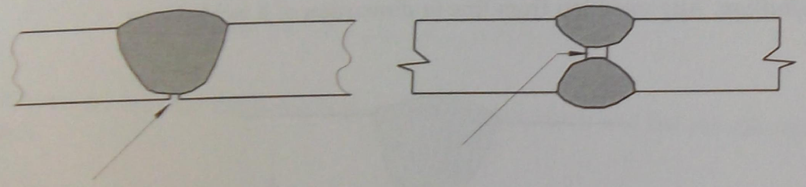


*Name:* _____

*Cause(s):*

- _____
- _____
- _____

(e) *Definition*: Failure of weld metal to extend into the root of a joint.



*Name:* _____

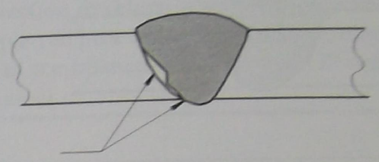
*Cause(s):*

- _____
- _____
- _____





(f) *Definition*: Incomplete fusion between weld metal and weld metal or weld metal and parent metal.

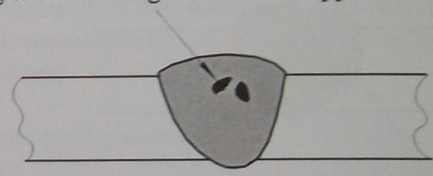


*Name:* _____

*Cause(s):*

- _____
- _____
- _____

(g) *Definition*: Slag or other foregin matter is trapped during welding.



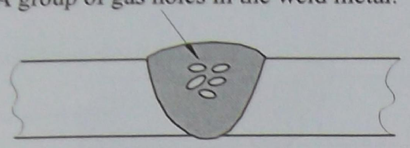
*Name:* _____

*Cause(s):*

- _____
- _____
- _____

## Review questions

(h) *Definition*: A group of gas holes in the weld metal.

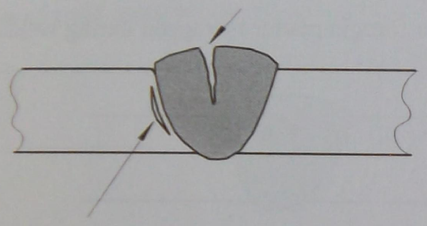


*Name:* _____

*Cause(s):*

- _____
- _____
- _____

(i) *Definition*: Discontinuities from tearing of the weld metal or plate.



*Name:* _____

*Cause(s):*

- _____
- _____
- _____



## Section 15: Butt weld - 6 mm low carbon steel - flat

| SUGGESTED DURATION | PREAMBLE |
|---|---|
| 2 hours | This section develops your knowledge and skills to deposit multiple run butt welds in the flat position on low carbon steel plate in accordance with AS 1554 GP weld quality or equivalent. |

***Objectives***

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

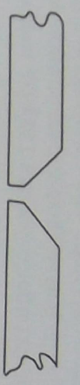
- ☐ prepare low carbon steel plate for butt welding
- ☐ butt weld 6 to 10 mm thick low carbon steel plate to the following requirements
  - correct alignment and assembly
  - smooth regular weld contour
  - angular distortion 0° to 5°
  - weld penetration for a minimum of 20% of the weld length
  - A maximum of two significant weld defects per weld length with an accumulative defect area of less than the square of the plate thickness
- ☐ record the weld procedure
- ☐ follow Occupational Health & Safety workshop procedures.

***Safety***

- You must wear safety glasses.
- Wear suitable protective clothing.

***Procedure sheet***
***Butt weld - 6 mm low carbon - flat***

*Sketch welding runs on diagram.*



*Complete the control data table below.*

| **Weld current data** | | **Electrode data** | |
|---|---|---|---|
| Run | Run | Size | |
| 1 | 7 | | |
| 2 | 8 | Type | |
| 3 | 9 | | |
| 4 | 10 | Brand name | |
| 5 | 11 | | |
| 6 | 12 | Electrode classification | |
| | | Angles Lead | Lateral |
| **Material data** | | **Weld time** | |
| Type | | Start | |
| Thickness | | Finish | |
| | | Units completed | |
| **Remarks** | | **Complies** | **Does not comply** |
| Alignment and assembly | | | |
| Angular distortion | | | |
| Surface finish | | | |
| Weld size | | | |
| Surface defects | | | |
| Root penetration | | | |
| **Name** | | | **Exercise Number** |





## Skill practice 12
## Butt weld - 6 mm low carbon steel - flat

IF IN DOUBT ASK THE TEACHER

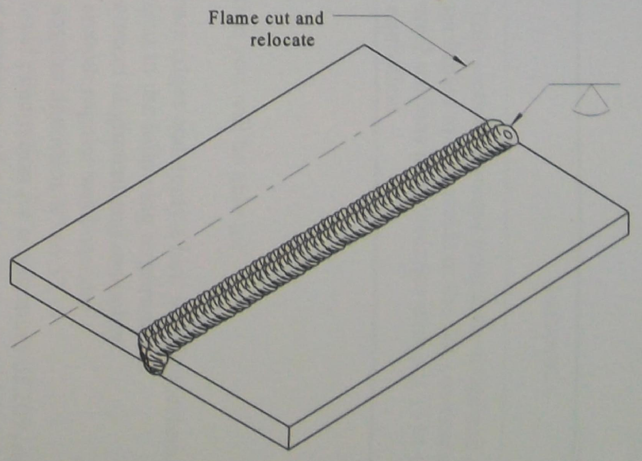
*Objective* To produce multi run butt welds to the requirements given below.

*Position* Flat.

*Procedure* Demonstrated by the teacher.

*Method*

1. Use a suitable spacer to maintain root gap and tack plates together.
2. Check root gap and preset to allow for weld contraction.
3. Deposit approximately 50 mm of the first run and examine the bead profile and penetration.
4. Make any procedural adjustments and complete the weld.
5. Repeat the exercise.
6. Evaluate the weld exercise and complete the procedure sheet.
7. Submit your work to the teacher.




*Requirements*

- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° to 5°
- Weld penetration for a minimum of 20% of the weld length
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness

*Material unit* 2 pieces 75 x 6 x 300 mm 35° bevel low carbon steel

*Units required* 4

*Economy* Return all unused material to the store. Use the electrode classification specified.

# Skill practice 12
# Butt weld - 6 mm low carbon steel - flat

IF IN DOUBT ASK THE TEACHER

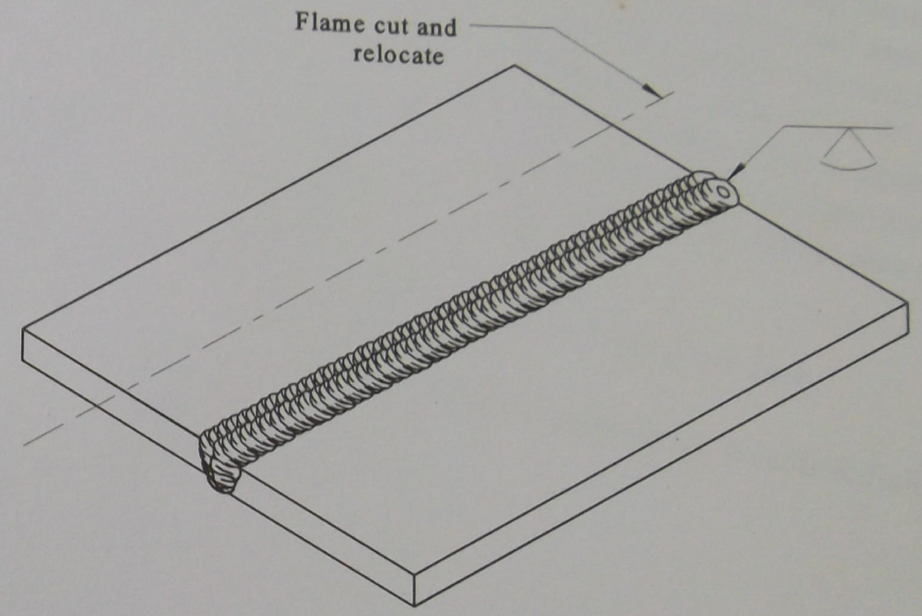
*Objective* To produce multi run butt welds to the requirements given below.

*Position* Flat.

*Procedure* Demonstrated by the teacher.

*Method*

1. Use a suitable spacer to maintain root gap and tack plates together.
2. Check root gap and preset to allow for weld contraction.
3. Deposit approximately 50 mm of the first run and examine the bead profile and penetration.
4. Make any procedural adjustments and complete the weld.
5. Repeat the exercise.
6. Evaluate the weld exercise and complete the procedure sheet.
7. Submit your work to the teacher.




*Requirements*

- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° to 5°
- Weld penetration for a minimum of 20% of the weld length
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness

*Material unit* 2 pieces 75 x 6 x 300 mm 35° bevel low carbon steel

*Units required* 4

*Economy* Return all unused material to the store. Use the electrode classification specified.

**Notes**



## Section 16: Butt weld - rolled steel section - flat

| SUGGESTED DURATION | PREAMBLE |
|---|---|
| 2 hours<br>40 minutes | This section develops your knowledge and skills to deposit multiple run butt welds in the flat position on rolled low carbon steel sections in accordance with AS 1554 GP weld quality or equivalent. |

***Objectives***

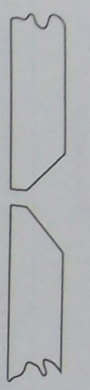
At the end of this section you will be able to:

- ☐ prepare edges and apply a butt welding technique to join rolled sections to the following requirements
  - correct alignment and assembly
  - smooth regular weld contour
  - angular distortion 0° to 5°
  - weld penetration for a minimum of 20% of the weld length
  - a maximum of two significant weld defects per weld length with an accumulative defect area of less than the square of the plate thickness
- ☐ record the weld procedure.
- ☐ follow Occupational Health & Safety workshop procedures.

***Safety***

- You must wear eye protection.
- Use approved workshop practices and work safely.

*Sketch welding runs on diagram.*



*Complete the control data table below.*

| **Weld current data** | | **Electrode data** |
|---|---|---|
| Run | Run | Size |
| 1 | 7 | |
| 2 | 8 | Type |
| 3 | 9 | |
| 4 | 10 | Brand name |
| 5 | 11 | |
| 6 | 12 | Electrode classification |
| **Material data** | **Weld time** | Angles Lead Lateral |
| Type | Start | |
| Thickness | Finish | |
| | Units completed | |
| **Assessment** | **Complies** | **Does not comply** |
| Alignment and assembly | | |
| Angular distortion | | |
| Surface finish | | |
| Weld size | | |
| Surface defects | | |
| Root penetration | | |
| **Name** | | **Exercise Number** |
| | | |



**Skill practice 13**
**Assessment event 8 (practical)**
**Butt weld - rolled steel sections - flat**



IF IN DOUBT ASK THE TEACHER

*Suggesteed time* Skill practice: 2 hours 40 minutes
Assessment: 20 minutes

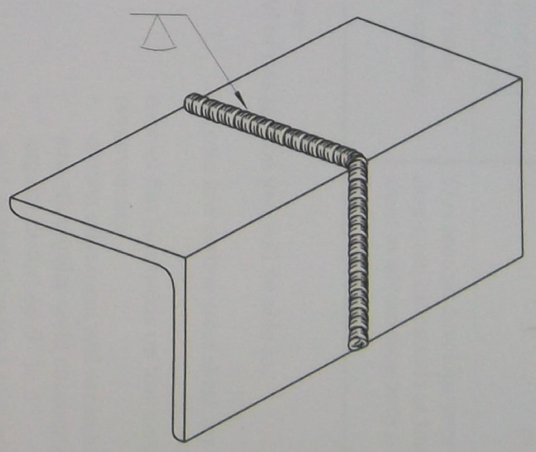
*Objective* To apply butt welding techniques to the joining of the angle sections to the requirements given below.

*Position* Flat.

*Procedure* Demonstrated by the teacher.

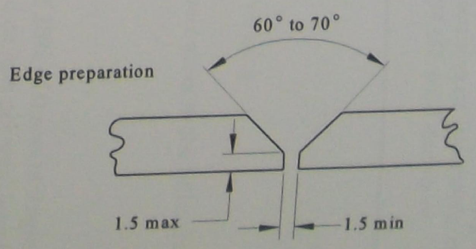
*Method*

1. Flame cut and dress angle edge preparation as illustrated.
2. Assemble align and tack weld angle sections.
3. Fully weld the first angle abutment with ϕ3.2 mm E4113 electrodes ensuring full penetration.
4. Butt second angle section and repeat steps 1 to 3.
5. Evaluate the weld exercise and complete the procedure sheet.
6. For assessment, repeat the butt weld to the requirements given below.
7. Submit your weld and procedure sheet to the teacher.



*Requirements*

- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° to 5°
- Weld penetration for a minimum of 20% of the weld length
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness




*Material unit* 4 pieces
75 x 75 x 10 ASEA x 75

*Unit required* 1

*Economy* Return all unused material to the store. Use electrode to a stub length of 50 mm.

Complete the control data table below.

| Weld current data | | Electrode data |
|---|---|---|
| Run | Run | Size |
| 1 | 7 | |
| 2 | 8 | |

| |
|---|
| 10 minutes |

single run butt welds in the flat pos
sheet in accordance with AS 1554
equivalent.

***Objectives***

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



**Skill practice 13**
**Assessment event 8 (practical)**
**Butt weld - rolled steel sections - flat**

IF IN DOUBT ASK THE TEACHER

*Suggesteed time* Skill practice: 2 hours 40 minutes
Assessment: 20 minutes

*Objective* To apply butt welding techniques to the joining of the angle sections to the requirements given below.

*Position* Flat.

*Procedure* Demonstrated by the teacher.

*Method*

1. Flame cut and dress angle edge preparation as illustrated.
2. Assemble align and tack weld angle sections.
3. Fully weld the first angle abutment with ϕ3.2 mm E4113 electrodes ensuring full penetration.
4. Butt second angle section and repeat steps 1 to 3.
5. Evaluate the weld exercise and complete the procedure sheet.
6. For assessment, repeat the butt weld to the requirements given below.
7. Submit your weld and procedure sheet to the teacher.

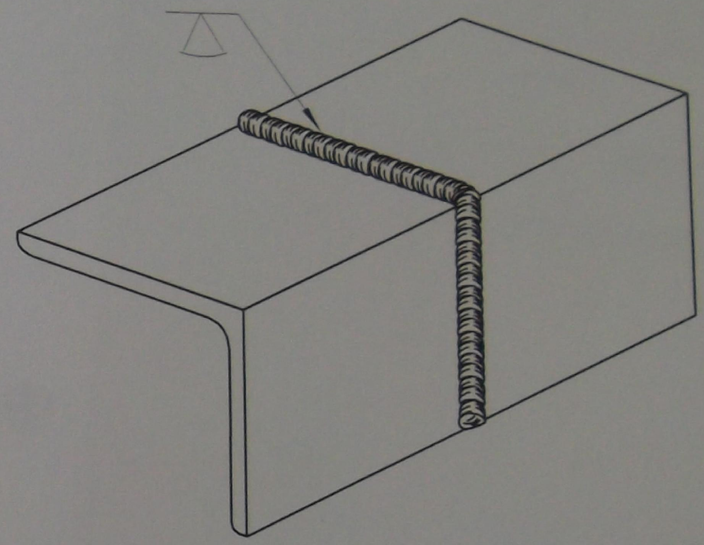
*Requirements*

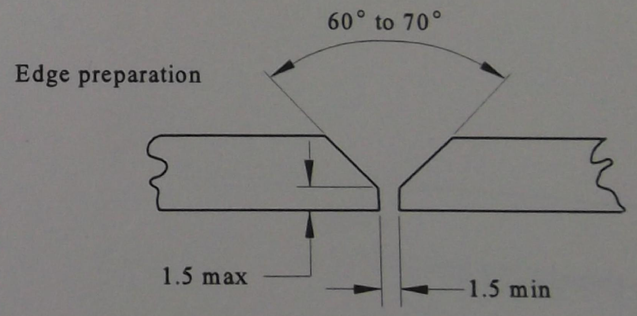
- Correct alignment and assembly
- Smooth regular contour
- Angular distortion 0° to 5°
- Weld penetration for a minimum of 20% of the weld length
- A maximum of two significant weld defects per 250 mm of weld length with an accumulative defect area of less than twice the square of the plate thickness

*Material unit* 4 pieces
75 x 75 x 10 ASEA x 75

*Unit required* 1

*Economy* Return all unused material to the store. Use electrode to a stub length of 50 mm.





**Notes**



## Section 17: Butt weld - steel sheet - flat

| SUGGESTED DURATION | PREAMBLE |
|---|---|
| 1 hour<br>10 minutes | This section develops your knowledge and skills to deposit single run butt welds in the flat position on low carbon steel sheet in accordance with AS 1554 GP weld quality or equivalent. |

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

- ☐ prepare low carbon steel sheet for butt welding
- ☐ deposit flat butt welds on low carbon steel sheet to the following requirements
  - correct alignment and assembly
  - smooth regular weld contour
  - angular distortion 0° to 5°
  - weld penetration for a minimum of 20% of the weld length
  - a maximum of two significant weld defects per weld length with an accumulative defect area of less than the square of the sheet thickness
- ☐ record the weld procedure
- ☐ follow Occupational Health & Safety workshop procedures.

***Safety***
Always keep your hands clear of cutting edges when shearing thin materials.