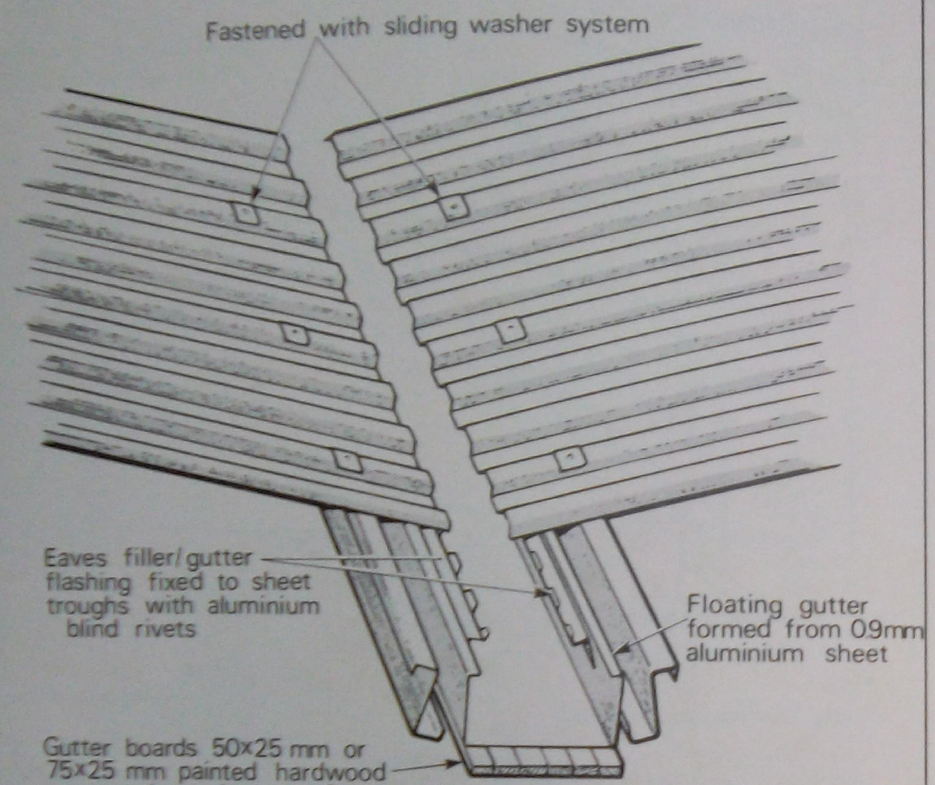
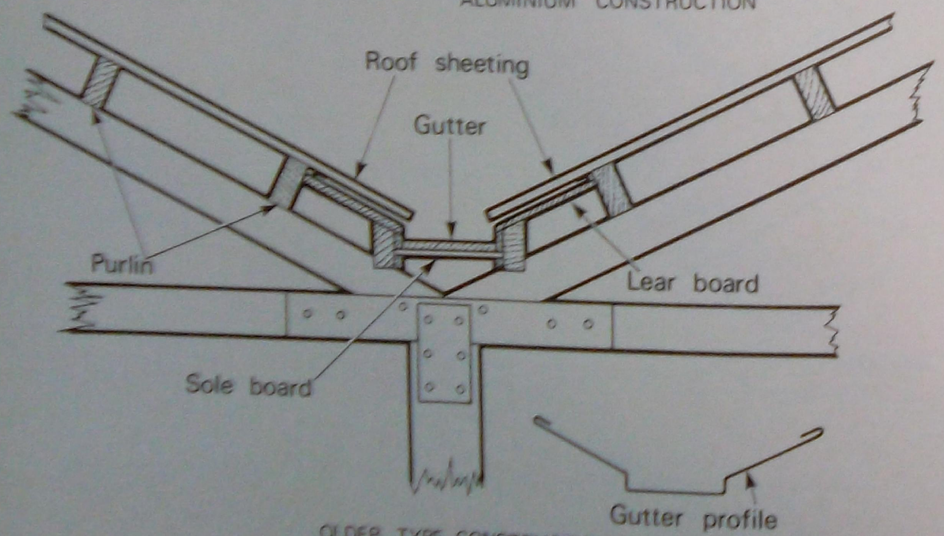
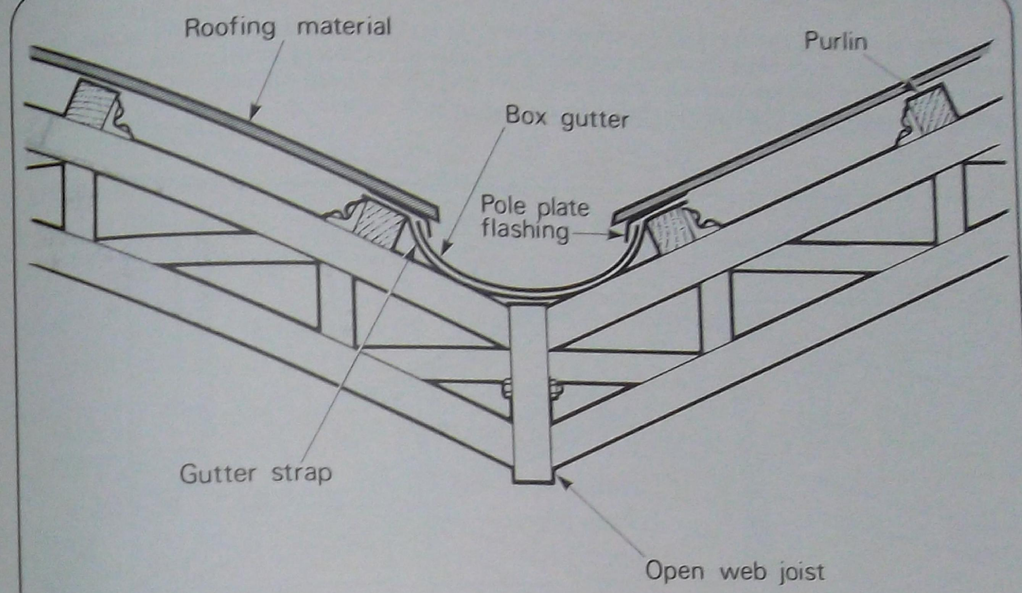


ALUMINIUM CONSTRUCTION



OLDER TYPE CONSTRUCTION

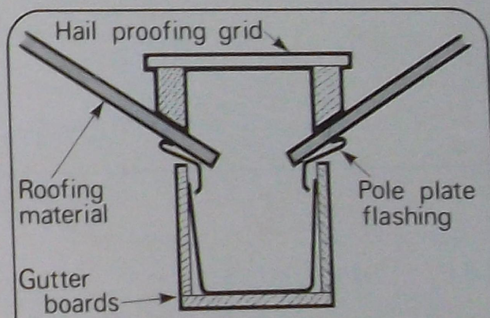
CENTRE BOX GUTTERS - INDUSTRIAL APPLICATIONS



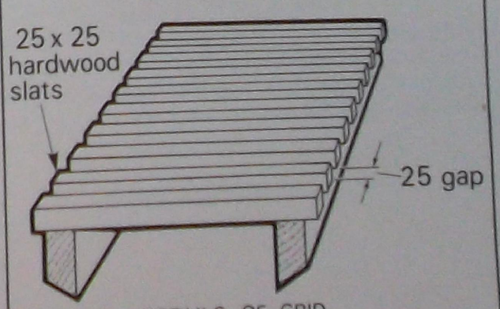
CONSTRUCTION WITH HALF-ROUND BOX GUTTER

3.2.2 Hail proofing of box gutters

This can be done by means of a jarrah framework (hail grid) as illustrated. The frame is placed on the roof above the gutter. Its purpose is to hold the hail above roof level until it has melted, thus providing thawed water with a free passage down the gutter. This hail grid also protects the gutter from accumulation of debris, birds, leaves, etc., thereby increasing the life of the gutter.



HAIL PROOFING GRID IN PLACE

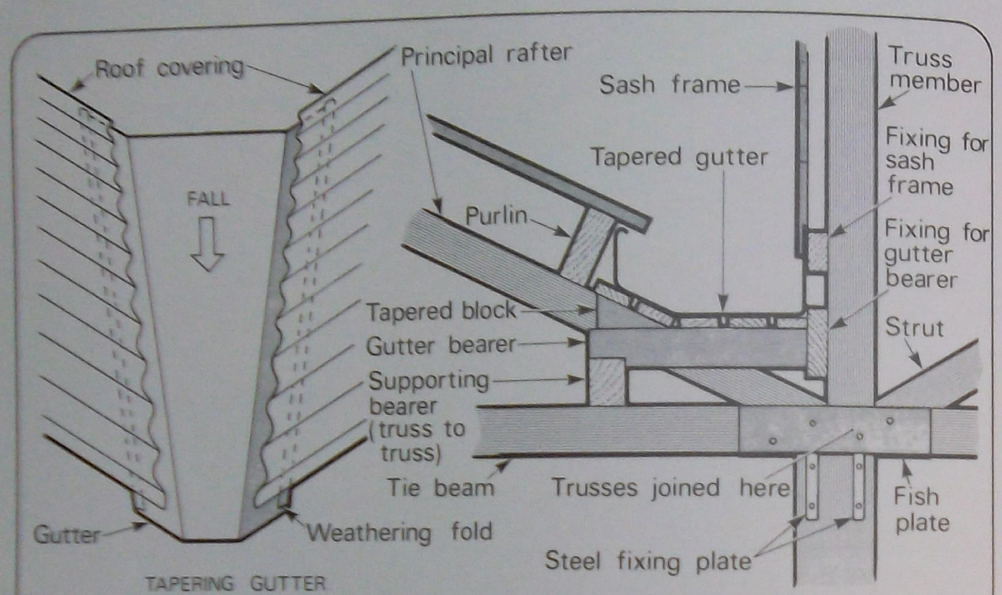


DETAILS OF GRID

HAIL PROOFING BOX GUTTERS

3.2.3 Tapering gutters

The base of tapering gutters is progressively reduced in width as it falls towards the outlet. The amount of taper given depends on the width of the roof and the degree of fall of the gutter. Tapering gutters have less capacity than box gutters and are not used on roofs with large catchment areas. The illustrations show applications of such gutters.

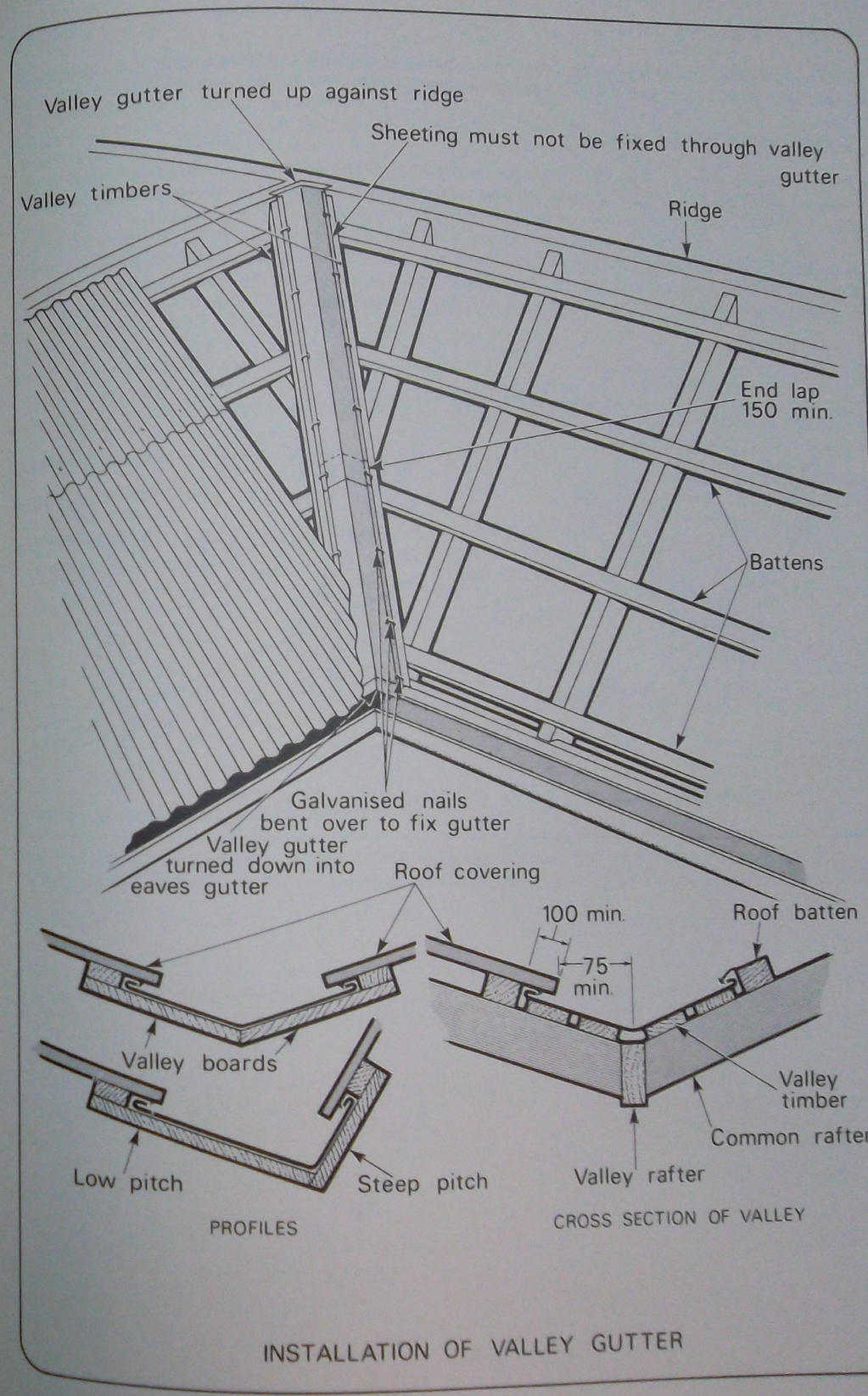


APPLICATION OF TAPERING GUTTERS

3.2.4 Valley gutters

Valley gutters are placed at a rake (or slope) in the internal angle of a composite roof and run between the ridge board and fascia gutter. The illustrations show the cross section and location of a valley gutter.

Valley gutters are scribed to shape at the fascia and turned down into the fascia gutter. The top edge of the gutter is scribed and dressed to fit the shape of the ridge as shown. Each length is fixed to the timber decking with nails driven into the deck and bent over the gutter edges. The joints between lengths should have a lap of 150 mm minimum.



INSTALLATION OF VALLEY GUTTER

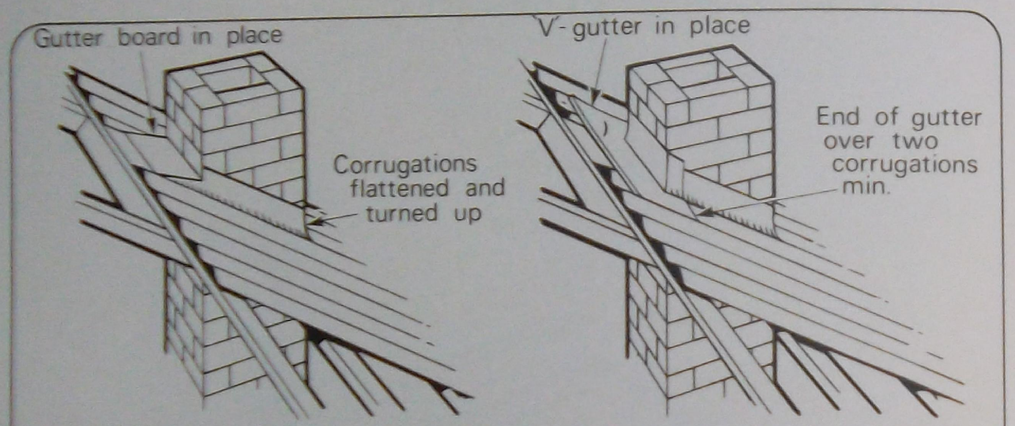
3.2.5 Chimney gutters

When a chimney intersects a roof, the junction between the roof and the chimney must be made watertight on all sides. The method used depends on the type of roofing material used.

Corrugated iron roof

The corrugated iron is cut to fit tightly against the front of the chimney. At the sides of the chimney, the corrugated iron is flattened and turned up some 50 to 75 mm, as illustrated. At the front of the chimney, the hollows of the corrugations are closed.

A galvanised steel sheet gutter, known as a chimney gutter or V-tray is made to fit at the back of the chimney. Its sides project two full corrugations past the sides of the chimney and it is finished at each corner with a gusset piece, riveted and strongly soldered.



CHIMNEY 'V'-GUTTER ON CORRUGATED IRON ROOF

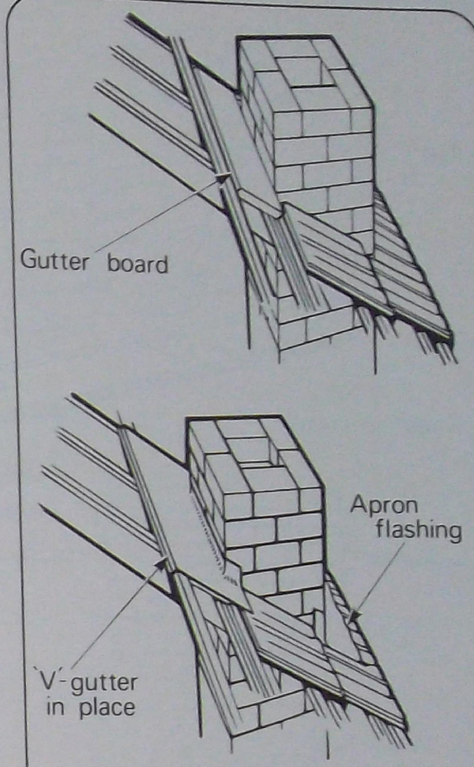
Tiled roof

On a tiled roof, the first part of the flashing to be made and fitted is the V-gutter for the back of the chimney. The gutter is made by the plumber and laid in position by the tiler when the roof is being covered. The preparation is illustrated. If lead is used it should be 1.7 mm minimum thickness and supported by gutter boards. The use of lead to make a chimney gutter would be extremely rare nowadays.

The size of the gutter varies with the position in which each course of tiles finishes. It should extend under the tiles above it by at least 150 mm and also 150 mm past the sides of the chimney. It is placed on the surface of the tiles as illustrated. If lead is used, it should be dressed down into the shape of the tiles.

Slate roof

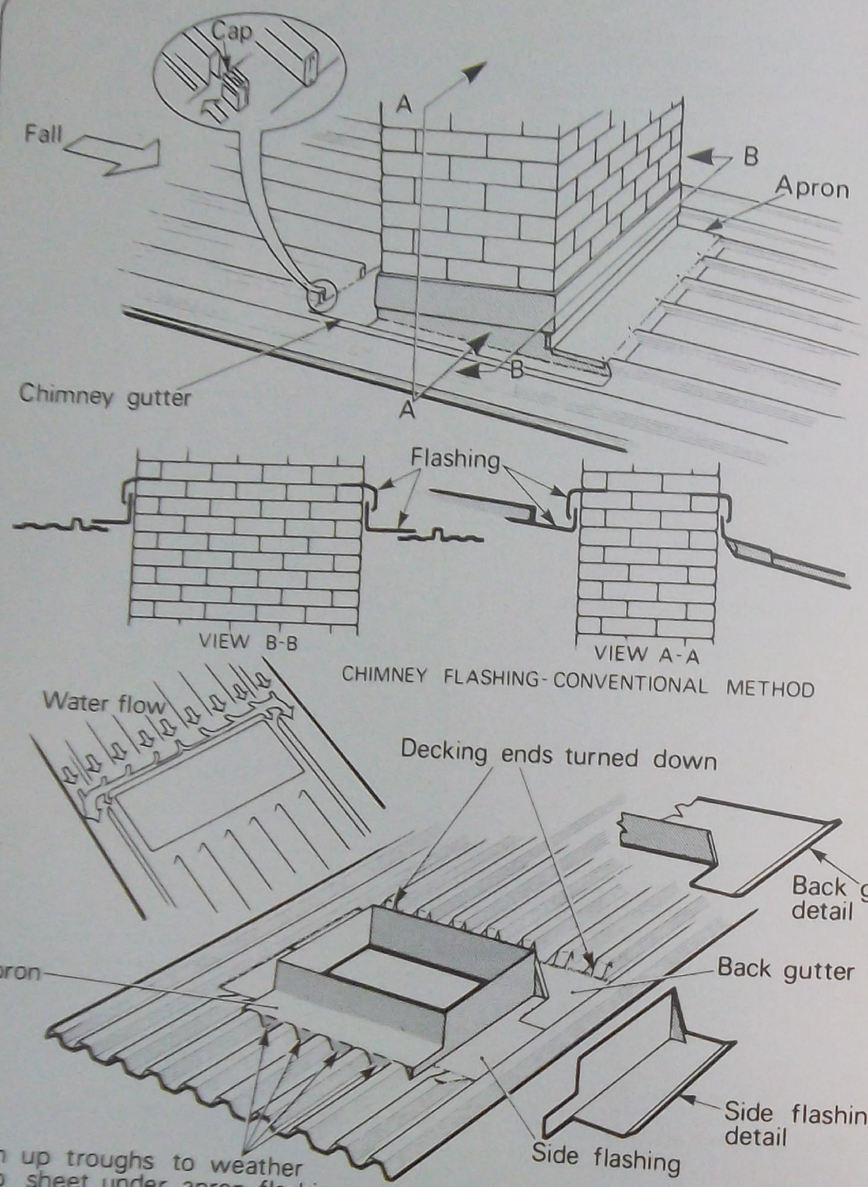
A chimney passing through a slate roof is flashed in a similar way as a tiled roof.



'V'-GUTTER ON TILED ROOF

Chimney gutters for metal roof decking

The methods illustrated are not the only methods used today. Ask your instructor or consult manufacturers' literature for other approved methods. (See page 52 for some applications).



CHIMNEY FLASHING- CONVENTIONAL METHOD

ALTERNATIVE METHOD

CHIMNEY GUTTERS AND FLASHING STEEL/ALUMINIUM ROOF DECKING

3.3 MATERIALS FOR ROOF GUTTERS

Roof gutters may be made from:

- plain galvanised steel sheet
- plain Zincalume sheet
- copper sheet
- aluminium
- asbestos cement
- stainless steel (special applications)
- PVC (and other plastic material for special applications)

3.3.1 Recommended material thicknesses

- Plain galvanised steel sheet

Recommended thickness for gutters with a girth of less than 600 mm: a minimum of 0.6 mm.

For gutters with a girth of more than 800 mm: a minimum thickness of 0.8 mm.

- Plain Zincalume sheet

The same thicknesses as for galvanised steel sheet.

- Sheet copper

The thicknesses to use would be generally the same as those of plain galvanised steel sheet for strength. Consideration must be given to cost where 0.8 mm is going to be used.

- Aluminium

The usual thicknesses used for aluminium gutters are the same as for plain galvanised steel sheet, providing the aluminium is hard or half hard sheet. However, when using soft aluminium (annealed), it is best to increase the thickness to the manufacturer's specifications.

- Asbestos cement

The manufacturers recommend that for 300 and 450 mm internal width of gutter, the asbestos cement be 9 mm thick and for 600 mm internal width, the asbestos be 12 mm thick.

- Stainless steel

As this metal is far stronger than normal galvanised steel and is virtually everlasting, the recommended thickness can be lowered to 0.5 mm.

- PVC

Usually 3 mm thick PVC sheet is used to manufacture gutters. However, some job specifications may require thicker grades, e.g. 6 mm.

NOTE:

The thicknesses quoted should be compared with the regulations laid down by the local authorities in the State or locality where it is being used. Also check with your instructor.

3.3.2 Fall in roof gutters

All roof gutters should have an even fall towards the outlet of not less than 1 in 120 or 25 mm in 3000 mm. However, if a greater fall can be achieved, the water will be discharged to the outlets more quickly and leave less debris in the gutter.

NOTE:

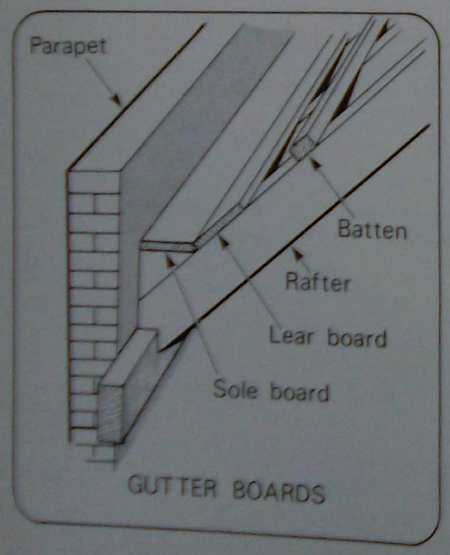
When using asbestos cement gutter, the fall may be decreased to 1 in 180. (AS CA44-1969 refers).

3.4 MAKING ROOF GUTTERS

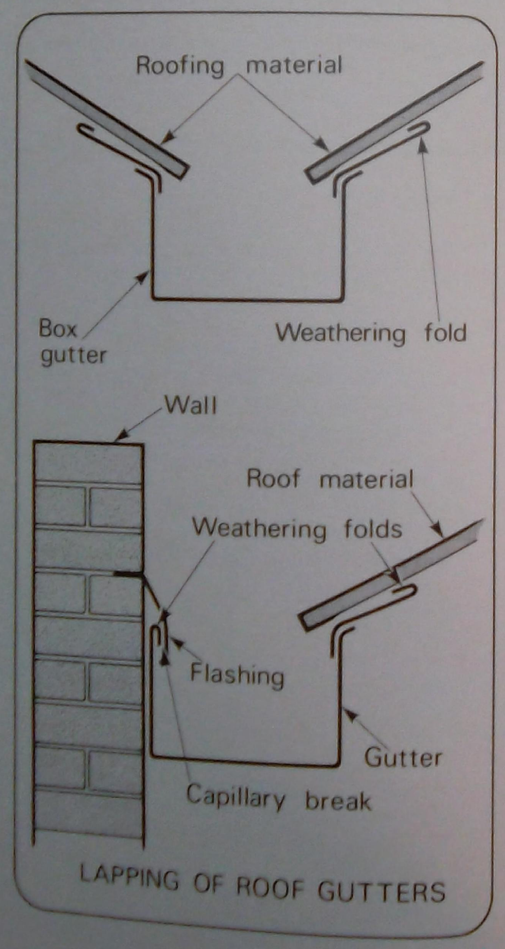
There are no stock sizes for roof gutters. The size and shape of the gutters are set out in the roof plan. The gutters are either made by the plumber or as is more usual today, they are manufactured by firms specialising in sheet metal fabrications with the aid of the latest machines and facilities.

Most gutters are laid on gutter boards prepared by the builder, but depending on the shape, some gutters are supported by gutter brackets only. The base board is normally called the 'sole board'. The boards laid on the slope of the roof are called the 'lear boards'.

The sides of the gutter are lapped by the roofing material. If one side of the gutter abuts against a wall, flashing is fitted to lap this side. Gutters must be positioned before the roofing material is laid.



GUTTER BOARDS



LAPPING OF ROOF GUTTERS

3.4.1 Measuring roof gutters

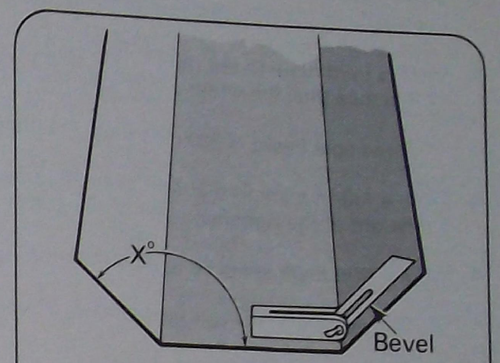
When measuring gutters, use the following procedure:

- Measure the length of the run.
  - Allow for a lap of not less than 25 mm at each joint and for any upturn or downturn to be included in the total length of the run of gutter.

NOTE:

For aluminium gutters, increase the lap to not less than 50 mm.

- Measure the width of the sole board at the beginning and at the end of the run.
- Measure the width of the lear board at the beginning and at the end of the run.
- Measure the angles included by the sole board and the lear board or where the gutter abuts a wall (usually 90°) or a vertical surface.
- Measure the height of any purlin or curb which abuts the gutter.
- Break very long runs into sections and treat each section as a separate run.
  - Treat each section in a 'stepped' gutter as a separate run.



MEASURING GUTTER ANGLES

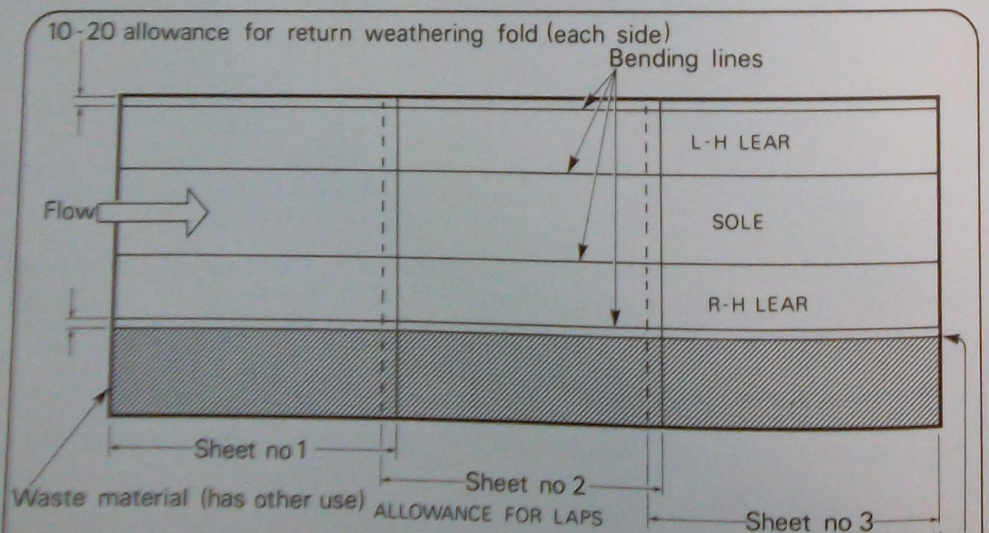
3.4.2 Setting out sheets

Modern machinery used by large firms engaged in sheet metal fabrications, is able to make gutters from a continuous roll of sheet metal. This makes it possible to produce gutters in long lengths without joins to suit specific jobs and to within the limitations of transport regulations.

However, some situations still require gutters to be made from individual sheets, whether they be galvanised steel sheet, copper, aluminium and others. To set out the sheets:

- Determine the number of sheets required to make the run.
- Number these sheets in sequence.
- Lay the sheets end to end in numerical order with the maker's brand name on the under-side.

- Make a lap of not less than 25 mm at each joint, lapping sheet number 1 over sheet number 2, number 2 over number 3 and so on in the direction of the fall.
- Make a mark of some 10 to 20 mm from the left-hand edge of sheet number 1.
  - This is to allow for a small return bend or weathering fold that will be made along the edge of the left-hand lear.
- Make a second mark to the right of the first, so that the distance between the two is equal to the height of the left-hand lear of the gutter at the beginning of the run.
- Make a third mark to the right of the second mark, so that the distance between these two is 15 mm less than the width of the sole board at the beginning of the run.
  - If the sole board is 320 mm wide, the distance between these two marks would be 305 mm.
- Make a fourth mark to the right of the third, so that the distance between these two is equal to the height of the right-hand lear of the gutter at the beginning of the run.
- Make a fifth mark some 10 to 20 mm to the right of the last mark.
  - This allows for a small return bend, or weathering fold, to be made along the right-hand lear.
- Mark a line square across the last sheet to mark the length of the run.
- Mark the end line on the last sheet in the same way as the first sheet but use measurements taken at the end of the run on the sole and lear boards, because the measurements will vary if the gutter is tapered.
- Join the opposing marks at the beginning and end of the run with chalk lines.
- Cut the sheets along the right-hand line and the end line on the last sheet.



SETTING OUT THE SHEETS

When setting out the gutter on a continuous run of metal, the procedure remains the same, but there is no need to allow for joining laps. Possibly, turn ups or turn downs at the ends will have to be marked.

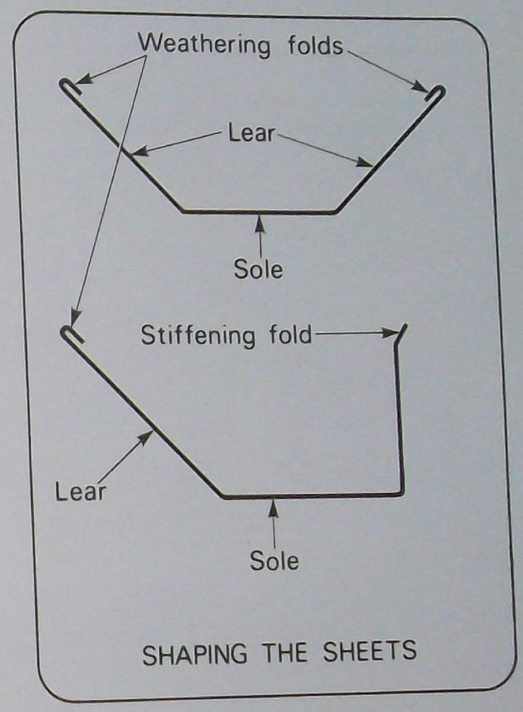
3.4.3 Shaping the sheets

Fold the marked sheets into the required gutter shape with a folding machine if the sheets are in short lengths, e.g. 1.8 m in length. For continuous long lengths, use an open ended brake press if available.

Be careful not to crack the protective coating on the sheet metal when folding by not making the folds too sharply angled, but rather with a suitable radius.

It is necessary to make a small return fold in the edge of the lear of the gutter, on the side that is to be positioned under the roofing material. This will prevent capillary attraction or wind pressure forcing water over the top edge and into the roof space.

Make a break or stiffening fold in the top edge of the gutter that will be positioned against a wall. This will stiffen the top edge of the gutter, keep it straight and positioned tightly against the wall.



SHAPING THE SHEETS

3.4.4 Aligning the gutters

Gutters may be aligned in two ways:

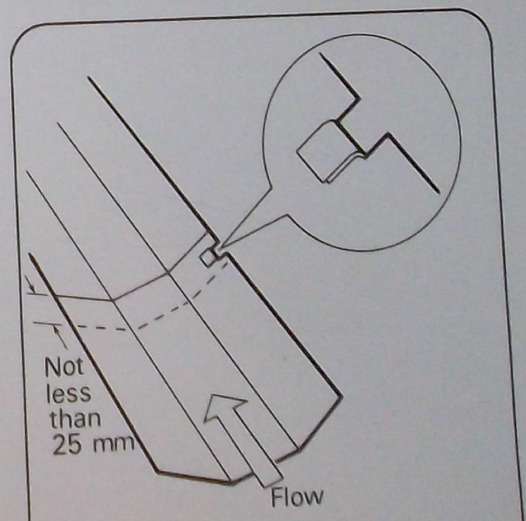
- By aligning several lengths at a time;
- By aligning two lengths at a time.

It is preferable to use the first method if space is available, because it is far quicker.

3.4.5 Aligning several lengths

To align several lengths of guttering:

- Place the lengths of guttering on a bench or on a flat floor, open end facing up.
- Lap the guttering not less than 25 mm and in the direction of the flow.
- If the guttering has no return weathering fold, make two cuts 10 to 12 mm apart in the top edge of one side of the guttering in the centre of each lap.
- Fold over the material between the cuts to form a clip.
  - If the guttering has a return weathering fold, one side of this must be flattened to allow one to fit inside the other, but do not cut out.

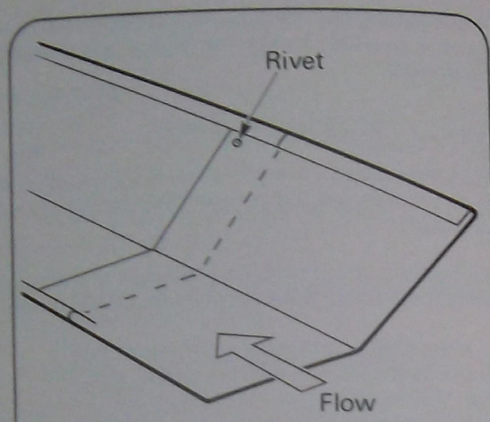


CLIPPING THE GUTTERING

— Place a single pop rivet just under the fold to hold the gutter in place. The rivet then takes the place of the clip.

- Sight along one edge of the guttering, or use a string line stretched tightly along one edge of the guttering. (See page 59).
- Adjust the lengths until the assembly is perfectly straight.
- Tack solder each joint opposite where the gutter has been clipped or pop riveted.

— If the material is unsolderable refer to section 3.4.7.

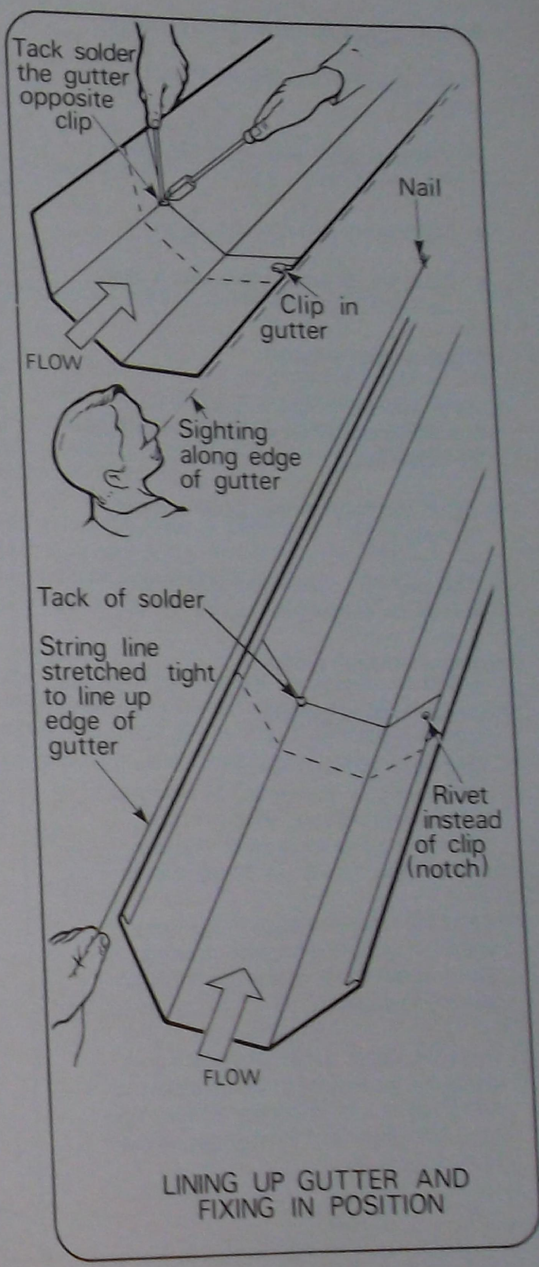


RIVETING THE GUTTERING

NOTES

3.4.6 Aligning two lengths at a time

When working space is short, two lengths of guttering may be aligned at a time. This is done in the same manner as already described. After the lengths have been joined in twos, they will have to be joined together in position on site.



LINING UP GUTTER AND FIXING IN POSITION

3.4.7 Joining roof gutters

Join lengths of guttering on the bench in manageable lengths where possible. When joining lengths of guttering, ensure that:

- all lengths of guttering to be joined are perfectly aligned;
- the guttering is lapped in the direction of waterflow.

Joining galvanised steel sheet gutters

To join lengths of galvanised steel sheet gutters:

- Rivet all joints with a double row of rivets.
- Thoroughly sweat solder all joints.
- Clean off all excess flux with a damp cloth.

Joining copper gutters

Copper gutters should be braze welded (silver soldered) where possible. If welding is not possible:

- Rivet the joints with a double row of copper rivets.
- Thoroughly sweat solder the joints with a high tin content solder.

Joining aluminium gutters

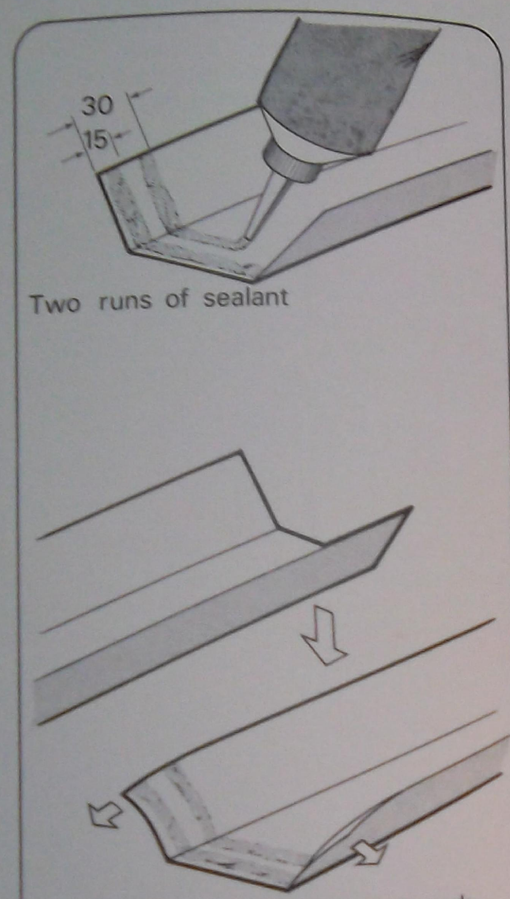
To join aluminium gutters:

- Spread two runs of sealant approximately 15 mm and 30 mm from the end of the lower section of the gutter from one edge down one lear, across the sole and up the other lear.
- Bend the front and back of the lower length of guttering slightly outwards, or the front and back of the upper length slightly inwards.
- Place the upper length of guttering inside the lower length from above and with a lap of approximately 50 mm, then bring both back and front edges of the gutter together.

NOTE:

Do not attempt to slide the lengths of guttering together. This will displace the sealing compound and may make the joint faulty.

- Drill and rivet the joint with a double row of aluminium rivets.
- Evenly spread sealant over the rivet heads to complete the joint.
- Wipe off any excess sealant.



JOINING ALUMINIUM GUTTERS

Joining Zincalume gutters

Joining of Zincalume gutters is done in exactly the same way as joining aluminium gutters.

Joining asbestos cement gutters

Joining of asbestos cement gutters is done in exactly the same way as joining asbestos cement spouting. Refer to section 2.5.6 and to AS CA44-1969.

Joining PVC gutters

The method commonly used to join PVC gutters is the hot-air welding method. The cement welding method can also be used.

As distinct from metal welding, PVC is not welded in its liquid state, but in a softened state which exists at temperatures in excess of 160°C. Fusion between the heated components is obtained by the application of pressure on the filler rod. The filler rod of 3 mm diameter is supplied either in short lengths or in continuous lengths. It is of similar material to that being welded. It can also be obtained in a double rod for ease of welding a double run of weld.

The necessary heat is provided by hot air generated in a special gas or electrically heated blowpipe. Welding is done by moving the blowpipe backwards and forwards in a stroking action, preferably in a horizontal position. Normally, air pressure of about 35 kPa is supplied to the blowpipe so that the air emerging from the nozzle is approximately 280°C, measured at a distance of about 6 mm from the nozzle.

In welding sheet, it is desirable to employ butt welds and to bevel the edges to give an included angle of 60°. The welding rod should be held almost vertically, or at right angles to the sheet; only downward pressure should be applied. The rod should not slope backwards. Charring of the work should be avoided. If this occurs, the burnt portion should be scraped off before continuing the weld.

NOTES

3.4.8 Welding PVC

The square butt weld is used on PVC of up to 3 mm in thickness where both sides can be welded and only two single runs are required.

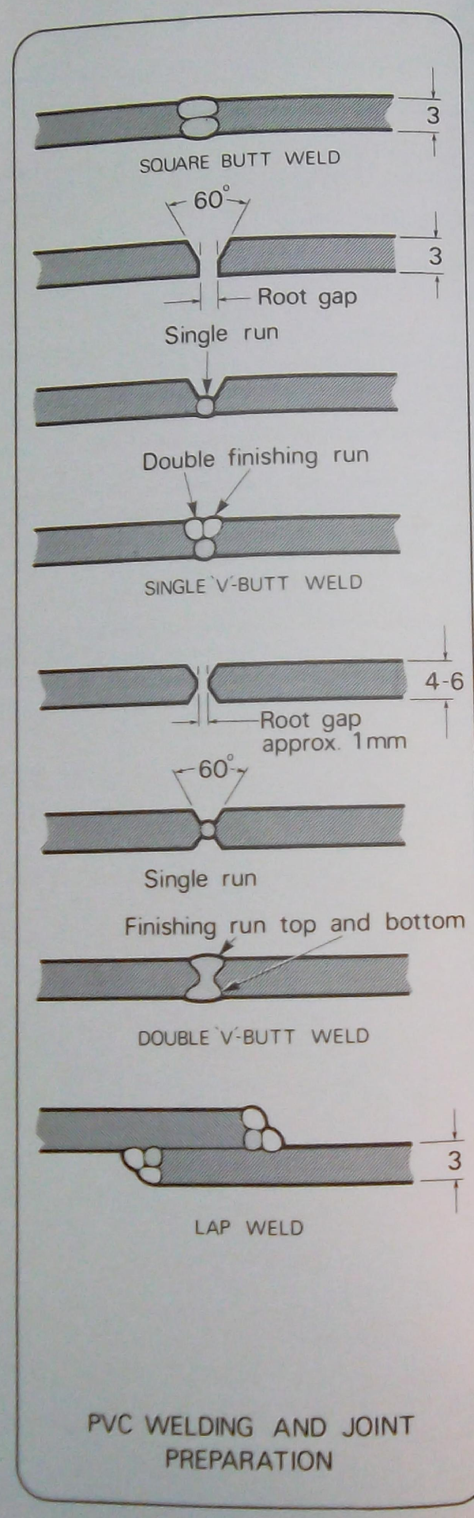
The single 'V'-butt weld is used on PVC of up to 3 mm in thickness where only one side can be welded. Three runs are required, either 3 single runs or 1 single and 1 double run.

The double 'V'-butt weld is used on PVC of 4 to 6 mm in thickness where both sides can be welded, either with 5 single runs or 1 single and 2 double runs.

The lap weld is also used on PVC of up to 3 mm thick where both sides can be welded. 6 single runs or 2 single and 2 double runs are then used.

NOTE:

Ask your instructor for further information on welding of plastics, PVC and others.



PVC WELDING AND JOINT PREPARATION

3.4.9 Cementing of PVC gutters

Most of the cements in use are based on PVC polymers, dissolved in suitable solvents. Among the cements commercially available is Tensol No. 50 cement. This can be conveniently used for cementing PVC and unplasticised PVC sheet to wood, concrete, plaster as well as to other PVC components. The technique used is to apply one coat of cement to each surface to be joined. This is allowed to dry for two minutes. A second coat is applied to each surface and the surfaces are clamped together or pressure is applied until dry. These joints have a maximum strength of approximately 10 350 kPa. This type of cement has no appreciable gap filling properties and the surfaces to be joined must therefore be a close fit.

A two-component cement, known as Tensol No. 3, is used where gap filling properties are required.

NOTE:

For further information on cementing PVC, consult your instructor or the manufacturer of the PVC gutters.

9.4.10 Joining stainless steel gutters

Various processes are used for joining stainless steel gutters:

- silver brazing
- oxy-acetylene welding
- TIG welding (tungsten inert gas)
- arc welding
- riveting, combined with a jointing compound
- riveting and soldering

Silver brazing

When using the silver brazing method (silver soldering) it is necessary to consider what grade of stainless steel is being used as there are various silver brazing alloys available for use with stainless steel. Also a silver brazing flux must be used.

The table below lists the various types of brazing rods that can be used for silver brazing stainless steel.

Grade	SBA 235	SBA 245	SBA 250	SBA 2503
Flow point	700 °C	620 °C	635 °C	685 °C
Results	Good	Good	Good	Excellent
Tip colour	Dark blue	Light blue	Light green	Light grey

SBA = Silver brazing alloy.

Comweld flux silver brazing No. 2 is generally recommended.

For further information, refer to CIG handbook: 'Hints on Gas Welding and Cutting' or to CIG: 'Gas Welding Consumables'.

Oxy-acetylene welding

If oxy-acetylene welding is used for joining the stainless steel gutter, follow the details given in the table below:

Metal	Process	Flame	Filler Rod	Flux
Stainless iron (12%-28% Cr)	Fusion weld	Strictly neutral	347 St Steel	Comweld St Steel
Stainless steel (18% Cr-8% Ni)	Fusion weld	Strictly neutral	347 St Steel	Comweld St Steel
Molybdenum	Fusion weld	Strictly neutral	316 St Steel	Comweld St Steel

For further information, consult your instructor in relation to joint preparation and the two CIG handbooks mentioned earlier.

TIG welding (Tungsten inert gas)

Tungsten inert gas-shielded electric arc welding is an extension of the electric arc welding process. It was developed for more effective welding of many metals used in industry today, especially stainless steel.

Previously, these metals required a flux to be used and problems were encountered with the removal of flux residues after welding.

The heat required for gas-tungsten arc welding is produced by an electric arc maintained between the non-consumable electrode and the part to be welded. The heated weld zone, the molten metal and the tungsten electrode are shielded from the atmosphere by a blanket of inert gas fed through the electrode holder.

A temperature of approximately 20 000 °C can be produced. The TIG torch brings heat only to the workpiece. If filler rod is required, it may be added manually as in oxy-acetylene welding or fed automatically through a special machine.

Inert gases used

Inert means inactive or deficient in active chemical properties. The shielding gas serves only to blanket the molten metal and to exclude the active oxidising properties of the surrounding air. The inert gas does not burn and it adds nothing to or takes anything away from the metal. Inert gases, like argon and helium, do not chemically react, or combine with other gases.

They are odourless, and being transparent, they permit maximum vision.

The argon shield range of gases contains gas mixtures which are formulated into broadly specific areas; some are for steel, others for stainless steel, copper, aluminium, and so on.

Argon shield gas	TIG Application
Argon shield 90T	Extremely hot arc: Suitable for steels (mild and alloy, stainless steel, nickel) where high welding speeds are required.
Argon shield 71T	Very hot arc: Suitable for steels (mild and alloy, stainless steel; also some copper alloys). Welding speed intermediate between 80T and 90T.
Argon shield 80T	Hot arc: Suitable for all metals, especially aluminium.

Stainless steel, manual welding —

Direct current — straight polarity

Metal thickness	Joint type	Tungsten electrode dia.	Filler rod dia. (if required)	Amperage	Gas	
					Type	Flow: l/min.
1.6 mm	Butt Lap Corner Fillet	1.6 mm	1.5 mm	40-60 50-70 40-60 50-70	Argon	7 7 7 7
3.2 mm	Butt Lap Corner Fillet	2.4 mm	2.4 mm	65-85 90-100 65-85 90-100	Argon	7 7 7 7

Metal preparation

The weld areas should be thoroughly cleaned. Protective paper or plastic coating is applied to many stainless steel sheets. Foreign material may cause porosity in welds. Any wire brushing should be done with a stainless steel wire brush to prevent iron pick up on the surface of the base material.

Arc welding

Arc welding is possible on stainless steel but on the thickness of material that would be used on guttering, it is not advisable to use this process, because of the tendency to burn holes in the metal. However, the range of stainless steel electrodes available from one manufacturer (CIG) is listed for information.

Staincraft	308L — 16
" " "	316L — 16
" " "	318 — 16
" " "	347 — 16
" " "	390Mo — 16
Heatcraft	319 — 15

NOTE:

Consult your instructor or the manufacturer for further information about arc welding of stainless steel.

Riveting with jointing compound

The same principles already discussed for other materials apply for stainless steel, but stainless steel pop rivets must be used.

3.5 FIXING ROOF GUTTERS IN POSITION

Roof gutters are held in position by clips of galvanised steel sheet, copper, aluminium, etc., depending on the gutter material. This is to prevent pressure being placed on the gutter flashing or roofing material. These clips can be made by the plumber and fixed to the gutter boards at approximately 900-1000 mm intervals.

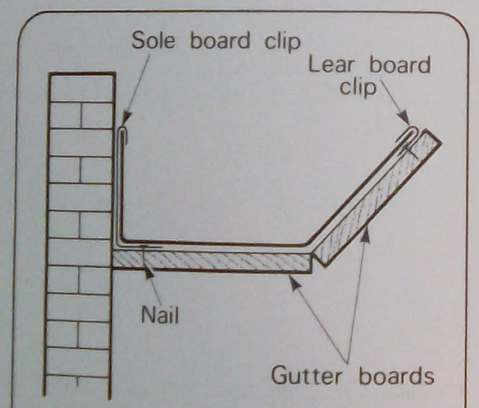
The gutters must be left loose in the clips to allow for expansion and contraction.

Clips for the lear side of the gutter are approximately 75 mm x 25 mm.

Clips for the parapet side of gutters, or for box gutters, are as long as the gutter is deep, plus 50 m.

NOTE:

Before gutters are positioned, all raking out of mortar joints for the flashing must have been completed.

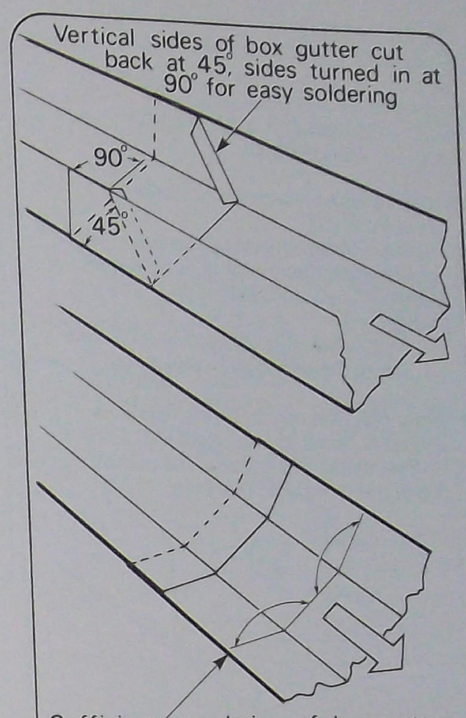


POSITIONING OF GUTTERS

3.6 SLIP JOINTS

Slip joints are made between lengths of guttering after they have been positioned on the roof. They are necessary when fixing long runs of guttering which would be unmanageable if joined on the bench.

A slip joint is made in a similar fashion to that for eaves gutters (spouting), especially when joining lengths of box gutter. The ends of the lear may not have to be cut back at 45° and folded in on the edges when making a slip joint in lear gutters, if the angle of the lear is great enough. (See section 2.8.3).

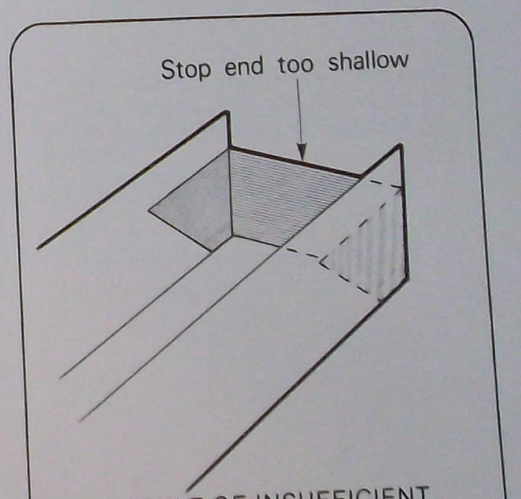


SLIP JOINTS IN GUTTERS

3.7 STOP ENDS

Allowances must be added for stop ends to be fitted when measuring for gutters.

The allowances must be slightly greater than the depth of the gutter. If insufficient allowance is made, the stop end will be too shallow and overflow could occur at the ends of gutters.

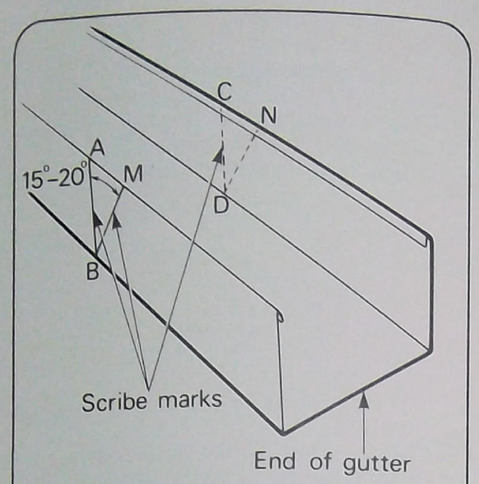


RESULT OF INSUFFICIENT ALLOWANCE FOR STOP END

3.7.1 Making a stop end for box gutters

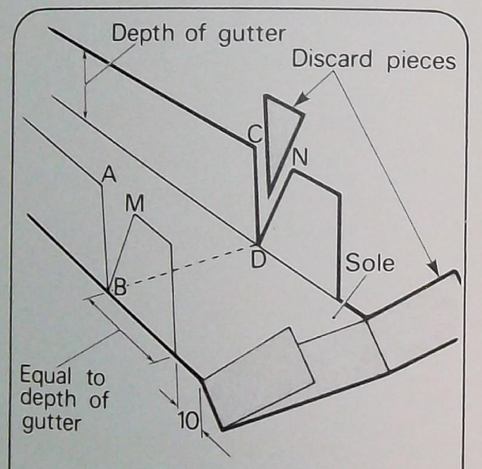
To make a stop end for a box gutter:

- Scribe a vertical line at each side of the gutter where the gutter is to be turned up (lines A-B and C-D).
  - — If possible, this should be done with the gutter temporarily positioned.
- From points B and D, scribe two lines angled at about 15°-20° from the vertical marks and towards the end of the gutter (lines B-M and D-N).



SCRIBING BOX GUTTER

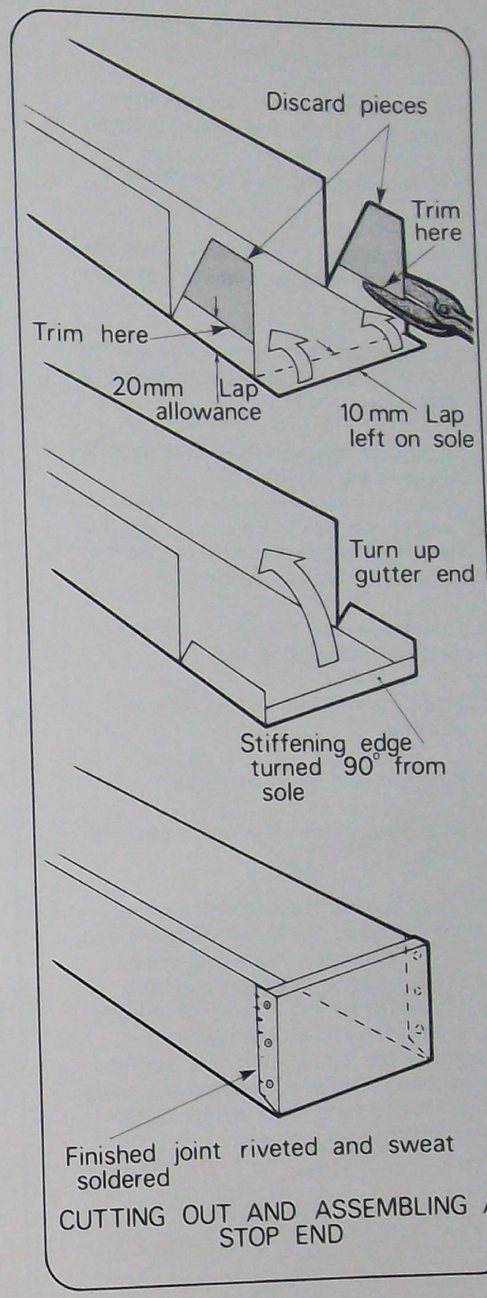
- Check that the distance from points B and D to the end of the gutter is equal to the depth of the gutter.
  - — If this distance is greater than the depth of the gutter, trim off the excess length, but leave the sole piece projecting by approximately 10 mm.
- Trim off either the top of the gutter or the weathering fold between points M and N and the end, leaving a 20 mm lap.



TRIMMING EXCESS LENGTH

- Turn the 10 mm allowance on the sole up at 90° to form a stiffening fold.
- Turn up the end of the gutter vertically.
  - — The lapping allowances should be on the inside of the gutter sides.
- Tack with solder, drill and rivet into position.
- Thoroughly sweat solder the joints.
- Remove all excess flux with a damp cloth.

Where a stop end is to be made from a piece of cut off material, a box-shaped stop end can be made to fit as shown and having 20 mm laps at the bottom and sides. The top end is then inserted, drilled, riveted and sweat soldered on all joints. A stiffening fold at the top may also be made when making the stop end piece.



CUTTING OUT AND ASSEMBLING A STOP END

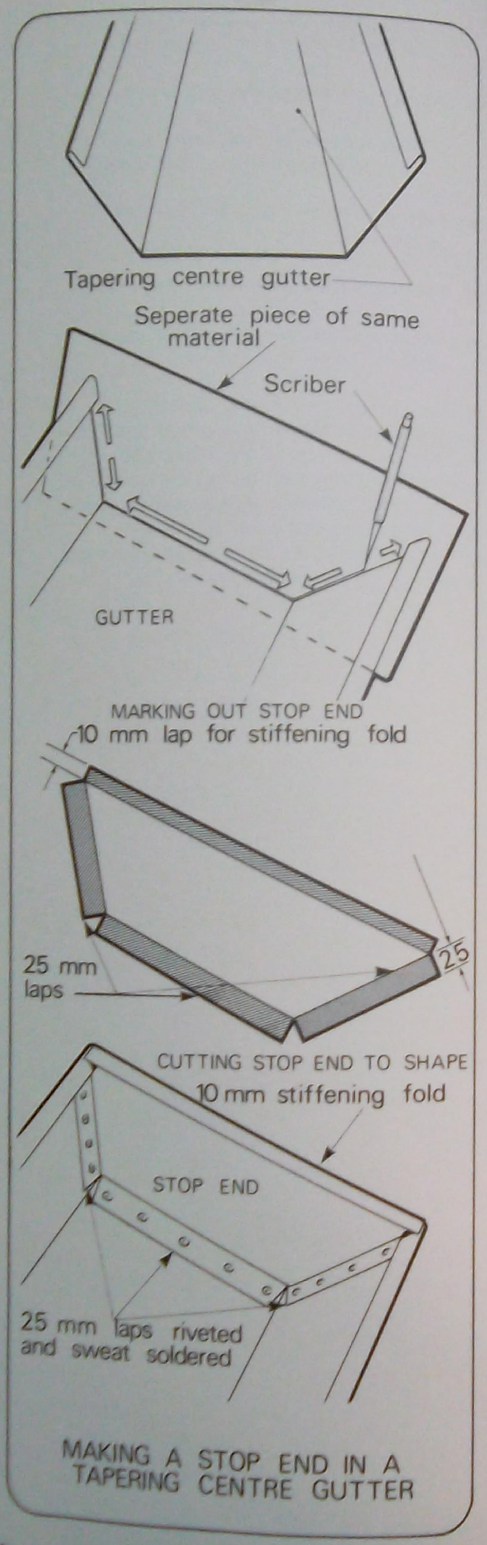
3.7.2 Making a stop end for irregular-shaped gutters

The procedure will apply for tapering gutters, lear gutters and parapet gutters.

To make a stop end for a tapering centre gutter:

- Place a piece of material, the same as the gutter material, over the end of the gutter.
  - — The material must be large enough to cover the complete profile of the gutter.
- Scribe the shape of the profile on to the piece of the material.
- Add 25 mm laps to the bottom and the two sides, plus a 10 mm lap to the top for a stiffening fold, as shown.
- Fold these laps in at 90° to the end section or loose stop end.
- Insert the stop end and secure it in position.
- Drill, rivet and sweat solder all joints.
- Remove all excess flux with a damp cloth.

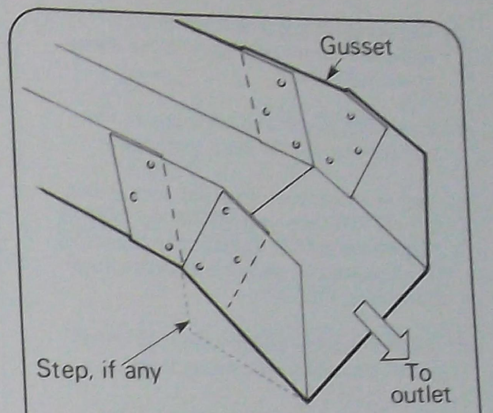
Stop ends in other metallic materials are made in the same way as far as making and cutting out are concerned, e.g. aluminium, Colourbond, copper, stainless steel and Zincalume. The joining for each of those is the same as described in the relevant sections on the joining of gutters. For PVC and asbestos cement gutters, the stop ends are pre-moulded and fitted in the manner described for joining gutters.



MAKING A STOP END IN A TAPERING CENTRE GUTTER

3.8 TURN DOWNS

Turn downs may be required at gutter outlets or where there is a step down in a run of guttering.

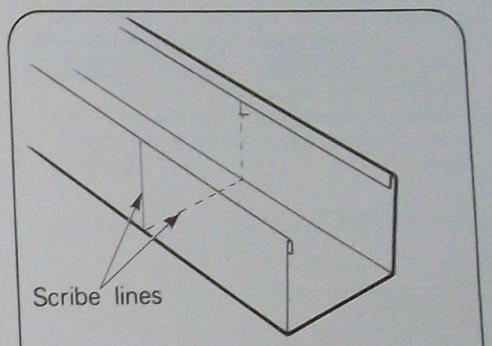


TURN DOWN

3.8.1 Making a turn down

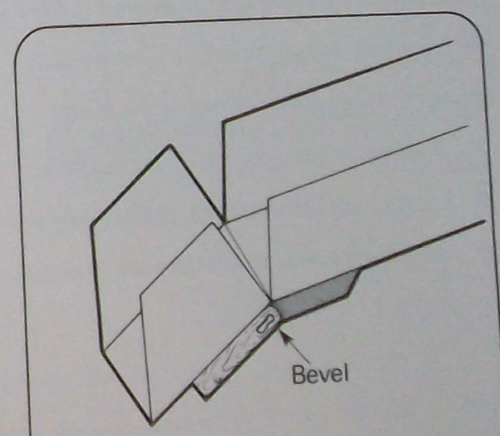
Solderable material

- Scribe vertical lines on the sides of the gutter at the points where the turn down is to be made.
- Cut along the scribe lines using a hacksaw and tin snips.



SCRIBING FOR A TURN DOWN

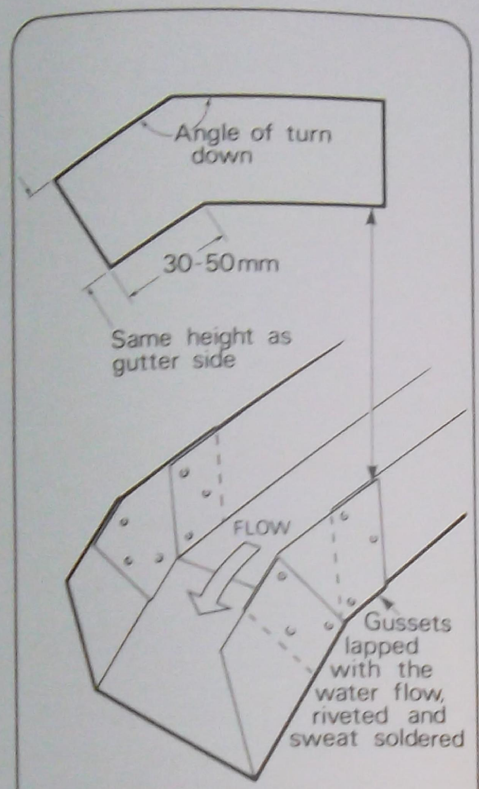
- Bend the gutter down to the required angle and check with a bevel.



CHECKING THE ANGLE OF BEND

- Cut a pair of gussets from scrap material to cover the gaps in the sides of the gutter.
- Insert the gussets to the sides of the gutters and secure them temporarily.
- Tack the gussets into place with solder, or rivet with one rivet on the top of each side of the gusset if the material is unsolderable metal, such as aluminium, Zincalume, etc.
- Check the angle again, then rivet the joints and fully sweat solder them.
- Clean off all excess flux with a damp cloth.

When making turn downs in other materials, apply similar principles to manufacture them, but refer to the sections on joining the different types of material, e.g. Zincalume, aluminium, copper, PVC, stainless steel, Colourbond. Asbestos cement turndowns would have to be moulded by the manufacturer to the correct angle.



FINISHED TURN DOWN

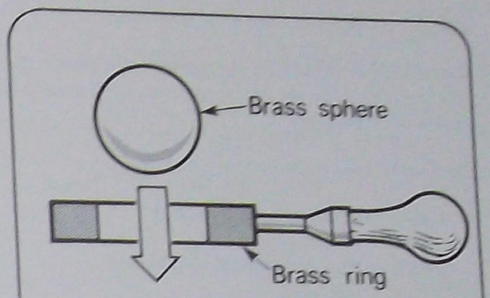
3.9 EXPANSION AND CONTRACTION

The effects of heat when applied to various substances can cause many problems. To appreciate them, one should consider the answers to the following questions:

- Do metals expand equally in all directions?
- Is the expansion of all metals the same?
- What forces are produced during expansion?
- Are the forces of expansion and contraction equal?
- Can the expansion that takes place in metals be measured?

3.9.1 Metals expand equally in all directions

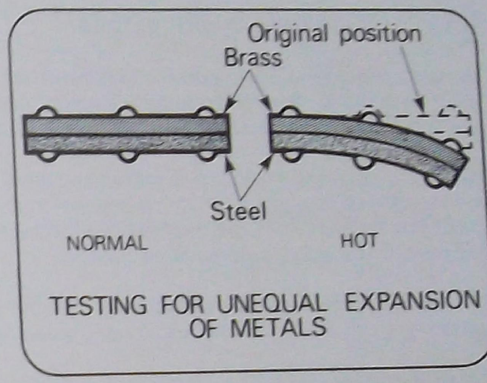
This may be proved using the apparatus shown. When both the brass sphere and the ring are at room temperature the sphere can pass through the ring with a minimum of clearance. When the sphere is heated, it expands equally in all directions and will not pass through the ring.



TESTING FOR UNIFORM EXPANSION

3.9.2 Metals do not expand equally

Careful experiments show that different metals expand at different rates. If two different metal strips are riveted or welded together to form a compound bar known as 'a bimetallic strip', the bar will bend or curl when heated because of the unequal expansion of the metals.



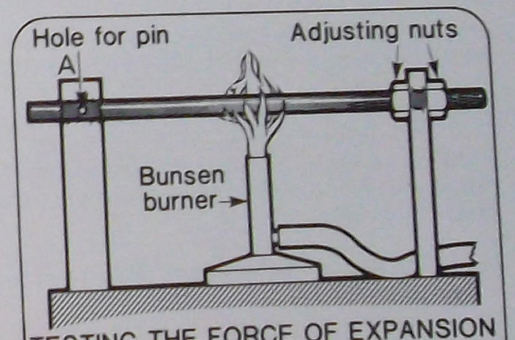
TESTING FOR UNEQUAL EXPANSION OF METALS

3.9.3 The force of expansion

In the apparatus shown, there is a metal bar, one end of which has a hole for a pin, while the other end is threaded with two nuts for adjusting the bar tightly between the supports.

A metal pin is slipped in through the support and the bar at A and the nuts are adjusted to hold the bar tightly in the clamp. The bar is then heated.

The force exerted by the expanding rod will break the pin suddenly.



TESTING THE FORCE OF EXPANSION

3.9.4 The forces of expansion and contraction are equal

If the previous experiment is carried out and the bar is re-adjusted while in the expanded position and a new pin inserted at A, it will be found that the metal pin will snap again when the bar cools and contracts.

Cast iron is the most suitable metal to use for the pins because it is brittle.

3.9.5 Measuring the expansion

Expansion of metals is measured for a particular metal by determining how much a sample of it will expand when the temperature is increased by a fixed amount. The amount of this measure is called 'a coefficient'.

There are three coefficients of expansion:

- coefficient of linear expansion
- coefficient of superficial expansion
- coefficient of cubic expansion

Linear means length, superficial means area and cubic means volume.

3.9.6 Expansion in roof gutters

Because considerable expansion and contraction takes place in long lengths of gutter, provision must be made for this. When gutters are very long, outlets should be provided at both ends and the gutter installed in lengths with expansion joints connecting these lengths.

Generally, guttering made out of galvanised steel sheet, Zincalume or copper should not exceed 20 m in length without provision for an expansion joint. When longer than 20 m in length, the gutter should be broken with expansion joints allowing not less than 25 mm on each side of the joint for expansion. The whole joint must be flashed.

The same principle applies to aluminium, but the gutter lengths should be reduced. The length of guttering made of aluminium should not exceed 12 m without provision for an expansion joint.

If stainless steel is used for guttering, it is advisable to consult with the local authorities, because the expansion of stainless steel is 50% greater than that of steel. It could well be that the distance between expansion joints has to be reduced to 10 m.

If asbestos cement gutters are installed, their length should preferably not exceed 30 m without provision for expansion joints. (See AS CA44-1969).

The expansion of PVC is approximately 6 times that of galvanised steel sheet.

It may be necessary to reduce the distance between expansion joints considerably. Consult the manufacturer in relation to the coefficient of expansion for the size, thickness and type of the PVC that is being used.

A practical rule for PVC gutters is: allow 3 mm per 3 m for every 4.5° rise in temperature.

3.9.7 Making an expansion joint

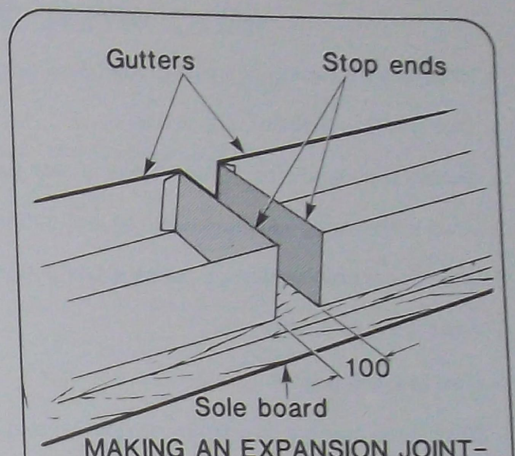
- Make and fit two stop ends in the gutter so that a gap of about 100 mm is left in the run.
- In the centre of the gap, insert a piece of timber 50 mm wide and equal in height to the gutter.
  - Dimension 'A' should not be less than 25 mm. It should be increased if the materials used in the guttering have a greater expansion rate than that of steel.
- Cap the timber insert and the stop ends with a piece of timber approximately 25 mm thick as shown.
- Cover the wooden capping piece with flashing shaped to size.

NOTE:

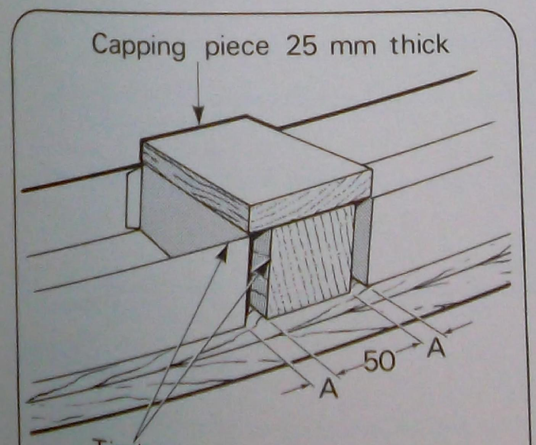
Expansion joints must be positioned so that the fall is always away from the expansion joint in both directions.

Expansion joints in other materials follow the same principles. Refer to the sections on joining, and making stop ends in the respective materials.

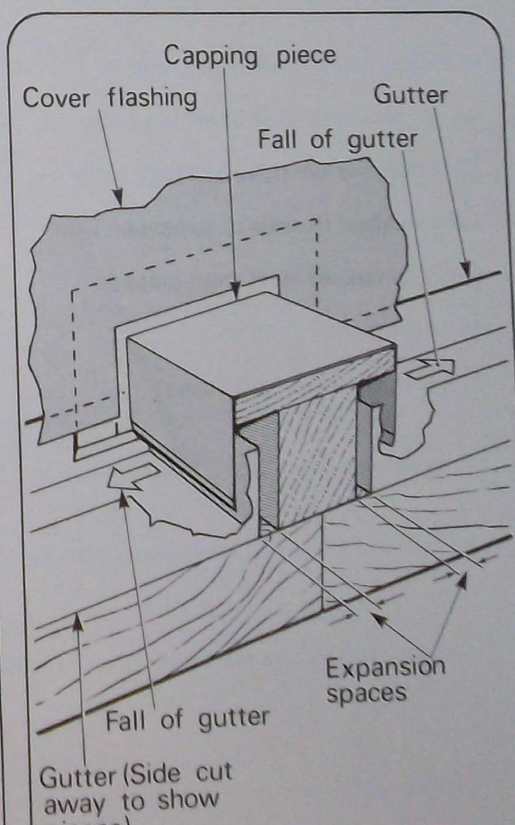
In some cases, the wooden block is omitted. Ask your instructor for details on how to make a capping piece.



MAKING AN EXPANSION JOINT– PLACING AND ALIGNING GUTTERS



PLACING THE TIMBERS



FINISHED GUTTER EXPANSION JOINT

REVISION QUESTIONS

1. What is the function of a roof gutter?
2. Describe four types of roof gutter.
3. Sketch and name four profile shapes of roof gutter.
4. What is the usual minimum width of roof gutters?
5. What is the main difference between box gutters and tapering centre gutters?
6. What is a sole board?
7. What is a tear board?
8. What is the purpose of a return weathering fold on the edges of gutters?
9. Why should copper gutters be silver brazed?
10. How are lengths of gutters, made of the following materials, joined?
    (a) Galvanised steel sheet
    (b) Zincalume
    (c) PVC
11. Describe how to make a stop end in:
    (a) A galvanised steel sheet box gutter
    (b) An aluminium tapering centre gutter
12. Describe how to make an expansion joint:
    (a) In galvanised steel sheet gutters
    (b) In aluminium gutters
    (c) When are these joints used?

NOTES FOR THE INSTRUCTOR

In these Training Manuals the term 'instructor' refers to any person who may train or be directly responsible for training individuals.

For example, the task of instructing may be the sole or shared responsibility of:

—skilled tradespeople

—leading hands

—supervisors

—instructors

—apprentice trainers

—managers

INITIAL PLANNING

A Analyse:

- The training requirements of a newcomer, considering that the person:
    —may have no previous experience in the subject;
    —will need to do productive work as soon as possible.
- What the trainee must learn about:
    —the tools to be used for the subject;
    —the terminology involved in the subject;
    —basic working methods.
- What will be the first productive work you will be able to give the trainee.

B Decide:

- Whether your trainees need information to supplement that given in this manual.
- Whether or when additional training material or exercises will be required to improve on the skill gained.
- Which other Basic Training Manuals the trainee should use during training.

C Plan:

The explanations, demonstrations and the practice required by the trainee, preferably on an individual basis, if numbers allow.

USING THE MANUAL

It may be of assistance to the trainee to arrange for short periods of learning followed by short periods of practice in applying the knowledge gained.

To maintain interest, it will be useful to relate, as much as possible, the material treated in this manual with actual practical applications in the field.

PRACTICAL EXERCISES AND PROJECTS

There may be areas and tasks in actual situations where the developing skills of the trainee can be put to effective productive use at any stage during the period spent learning the subject. Such possibility should be carefully considered and used to the full for the trainee's benefit as well as that of the firm.

Give the trainee as many opportunities as possible to use the whole range of hand tools on suitable small jobs to quickly acquire the manual dexterity required.

Small projects and exercises to suit particular work situations may be devised, but they must take into consideration the limits of skill and knowledge of the trainee.

Whatever form of exercise is used to develop practical skill, it must be carefully planned. A suggested course of instruction is:

- Prepare the working area, the materials and the hand tools to be used.
- Make the aim of the project clear to the trainee.
- State how you intend to assess the proficiency of the trainee.
- Stress key points in the project, paying particular attention to safety precautions.
- Explain clearly and thoroughly any new steps in the project.
- Check that the trainee can use the hand tools correctly.
- Assess the finished project, record the results and discuss with the trainee your appraisal of the performance.
- If you are satisfied with the performance, direct the trainee to the next exercise or project.

TRAINING RECORDS

Simple training records will help in planning systematic training.

Record:

- the parts of the manual learnt by the trainee;
- your assessment of the general skills developed;
- the practical exercises undertaken and completed.

Use your record to measure the trainee's performance and to assess his readiness for undertaking actual operations.

Draw up a simple record card to suit your needs.

Using records helps to pinpoint the trainee's strengths and weaknesses. They ensure that training in essential skills is not missed. Training records can be used to help co-ordinate on-the-job training and technical school learning. Where trainees have to serve a probationary period, records assist when the trainee's progress is being assessed.

PUBLICATIONS IN BASIC TRAINING MANUALS — ROOF PLUMBING

Title	
12-1	Introduction and Downpipes
12-2	Spouting and Guttering
12-3	Deck Fixing and Materials
12-4	Decking Flashing
12-5	Calculations and Water Storage
12-6	Stormwater Drainage

OTHER PUBLICATIONS IN BASIC TRAINING MANUALS
(Available at date of printing)

FITTING SERIES	10 MANUALS
WORKSHOP SAFETY	1 MANUAL
PRACTICAL GEOMETRY	3 MANUALS
LATHE WORK	7 MANUALS
SHAPING AND SLOTTING	3 MANUALS
GRINDING	3 MANUALS
MILLING	4 MANUALS
ARC WELDING	4 MANUALS
SOLDERING	1 MANUAL
SANITARY PLUMBING	4 MANUALS
WATER SUPPLY	4 MANUALS
ROOF PLUMBING	6 MANUALS
BRICKLAYING	2 MANUALS
CARPENTRY AND JOINERY	14 MANUALS (MORE IN PREPARATION)
PAINTING AND DECORATING	9 MANUALS (MORE IN PREPARATION)
ELECTRICAL	13 MANUALS
MOTOR VEHICLES	10 MANUALS (MORE IN PREPARATION)
PANEL BEATING	2 MANUALS (MORE IN PREPARATION)
FURNITURE REMOVAL	4 MANUALS
TIMBER TECHNOLOGY	1 MANUAL
SHEET METAL	(2 MANUALS IN PREPARATION)

Information is available at your local Department of Employment, Education and Training Regional Offices.

These manuals are available from Commonwealth Government Bookshops.

Mail orders to: Mail Order Sales, Australian Government Publishing Service, P.O. Box 84, CANBERRA, A.C.T. 2601.

BASIC TRAINING MANUAL

10–1

SANITARY PLUMBING

Introduction

NATIONAL BUILDING AND CONSTRUCTION
INDUSTRY TRAINING COUNCIL

DEPARTMENT OF EMPLOYMENT, EDUCATION AND TRAINING

BASIC TRAINING MANUAL

10-1

SANITARY PLUMBING

Introduction

Australian Government Publishing Service
Canberra

This manual was produced as the result of the need to update existing manuals in line with the revised National Plumbing Code and to have comprehensive manuals on the aspects of plumbing available for trainees in the trade.

The topics of this manual were compiled by Mr. R. Verity of RMIT in consultation with a working panel appointed by the National Building and Construction Industry Training Council who have approved this publication on behalf of the National Training Council.

The panel consisted of:

Mr. J. Rutherford	— (Chairman) Plumbers and Gasfitters Employees' Union.
Mr. L. Fraser	— Technical and Further Education.
Mr. R. Kelly	— Lecturer — State College of Victoria (Hawthorn), seconded from the Technical Division, Department of Education (Vic.).
Mr. J. Park	— Melbourne and Metropolitan Board of Works.
Mr. A. Quick	— Quick Contracting Pty Ltd, representing employers.
Mr. J. R. M. Jentzema	— Department of Employment, Education and Training.

The manual was prepared by the Training Publication Unit of the Department of Employment, Education and Training.

The advice and valuable contributions given to the successful production of this publication by the panel are gratefully acknowledged.

EDITOR: Mr. J. R. M. Jentzema

First published 1975
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CONTENTS

PREFACE

This manual forms part of a series on basic plumbing skills, specifically designed as practical training aids for apprentices in this trade.

It is based on a general syllabus content that exists for courses in the plumbing trades.

Each manual is self-contained and is intended as an instructional guide in on- or off-the-job training situations. It may be used by instructors, or by trainees for self-teaching and private study purposes.

The aim of the manual is to help the trainee to develop a particular skill to the stage where it can be applied productively on the job.

Ideally the manual should be used as part of a course of instruction involving:

- demonstrations of practical skills by instructors, experienced tradespeople or operators;
- planned and supervised practice in handling the tools or machines involved;
- instruction in related theory and workshop technology.

Some notes for the instructor to assist him or her in planning systematic training on the job are included.

The manuals, or the topics they cover, may be used in any order convenient to the learning needs of the trainee.

As much as was possible to ascertain, most of the important fields have been covered. In special circumstances, it is expected that instructors and trainers will provide trainees with the specific additional information to comply with any local conditions which are at variance with the contents of this manual, where this may be the case.

INSTRUCTIONS TO TRAINEE

This manual is a teaching aid to help you develop skills you need in your job. It is best used on the job where you can handle the tools and use the equipment.

You should follow the directions given by the person training you. To reach the required standard of skill, you must pay particular attention to your instructors' explanations and demonstrations. Supervised and individual practice is essential.

Practice means making repeated efforts to improve your level of skill. Study is making an effort to learn. Every advance in skill depends on study and practice. You will make most progress by co-operating actively in the training arranged for you.

When you are told to study all or part of this manual, try and use a definite plan of study. The following plan is effective.

SURVEY: Read quickly through the headings as you turn the pages. Glance at the drawings. Get an overall view before you read.

QUESTION: Ask yourself: What do I know? What do I need to know? How will this manual help me to learn?

READ: Read right through each section carefully. Be thorough, but do not dawdle. Reading quickly will help you concentrate.

DO: Use all your senses in learning. Getting the 'feel' of any tool of equipment is essential in learning to use it. Follow the directions given to you.

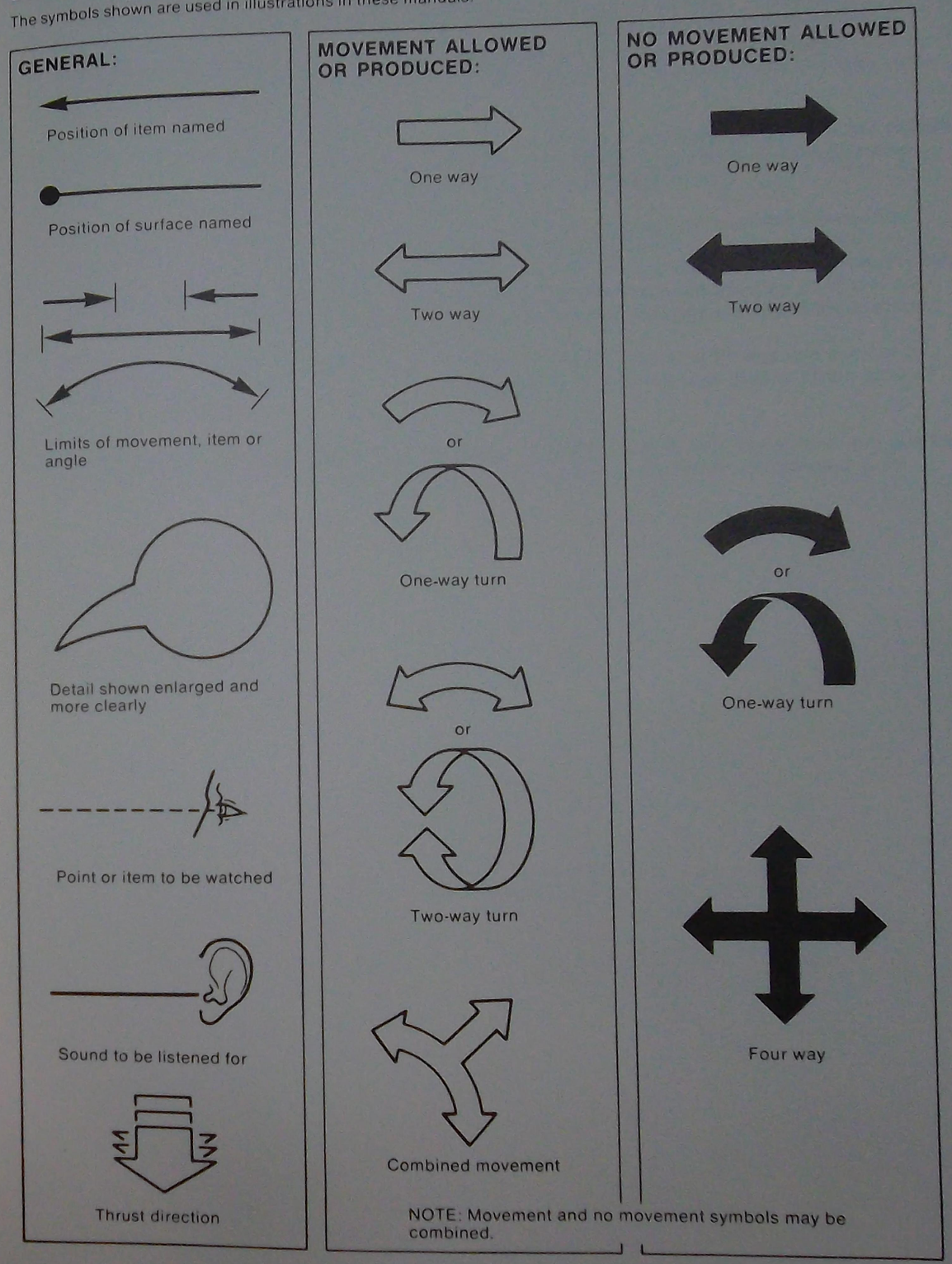
REVIEW: Shut the manual. Try to remember the main points of the section. Check to make sure that you are right. Revise points on which you are doubtful; often if necessary.

One way of fixing important instructions in your mind is to repeat them over and over.

Careful study of and practice in the various trade skills treated in this manual will help you develop them to work safely and productively.

SYMBOLS

The symbols shown are used in illustrations in these manuals.



1 INTRODUCTION

This manual is one in a series dealing with sanitary plumbing and drainage. A manual of this nature can only deal with basic principles and their proper application as laid down in the Australian Model Plumbing Code — Sanitary and Drainage. Due to a variety of factors, differences in application occur, depending on local customs and statutory rules evolved over a period to suit local conditions.

Until, on a national level, final agreements are reached between all States, differences will remain for some time in the way certain work is carried out. Hopefully, these manuals will contribute towards the attainment of nationally recognised practices and applications.

Meanwhile, it will be necessary for both trainee and instructor to supplement the information contained in these manuals with that necessary to carry out the work in accordance with the requirements approved by local authorities. Because of the serious hazards to the community that could result from faulty drainage and plumbing, only approved materials must be used and only first class craftsmanship can be accepted in the installation of drainage and plumbing systems.

All drainage (sewerage) pipes and fittings, together with most plumbing fittings, are subject to inspection and approval by the local Sewerage Authority to ensure a high quality of the product and the workmanship.

Drainage fittings will usually bear some indication, by mark or stamp, that the pattern and quality of the fitting are approved by the Sewerage Authority for use in plumbing and drainage work.

Items for use in these applications are, in the main, manufactured to strict standards laid down in the appropriate Australian Standards.

2 SANITARY PLUMBING

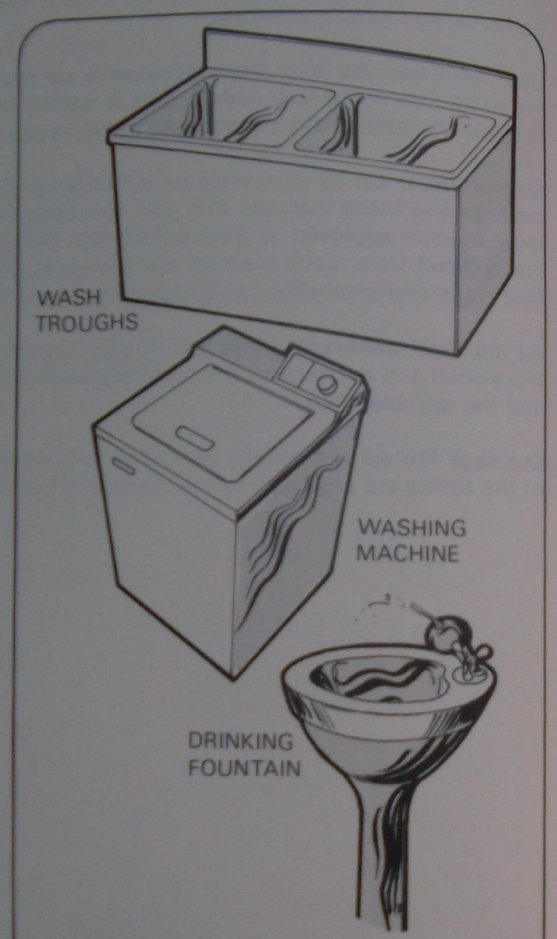
Sanitary plumbing is a branch of plumbing dealing specifically with the installation, repair and replacement of the following types of fixtures:

- waste water fixtures
- ablutionary fixtures
- greasy water fixtures
- soil fixtures

2.1 WASTE WATER FIXTURES

The first three fixtures listed are generally classed as waste water fixtures, but they can be divided into three different classes.

A waste water fixture is any fixture, other than a soil fixture. The first classification of waste water fixtures refers to those that are used for the handling of dirty, non-greasy water. They are installed in laundries and workshops. Wash troughs, clothes washing machines, cleaners' sinks, drinking fountains, dental units and bains-marie come into this category.



WASTE WATER FIXTURES

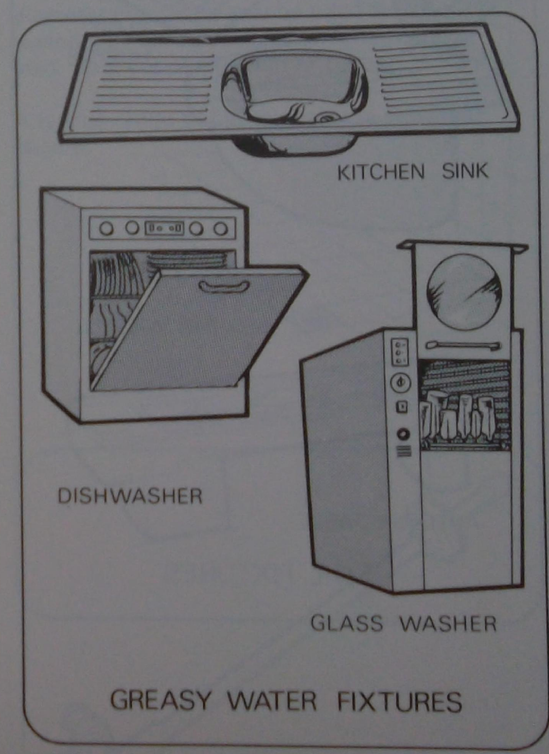
2.2 ABLUTIONARY FIXTURES

The second classification refers to those waste water fixtures used for washing the human body.

They are usually located in domestic bathrooms and in office or industrial washrooms. Baths, basins, showers, shower baths, ablution troughs, foot baths, bidets, circular wash fountains come into this category.

2.3 GREASY WATER FIXTURES

This third classification of waste water fixtures is for those used for greasy water operations. They include kitchen sinks, dishwashers and in some cases, glass-washing machines.

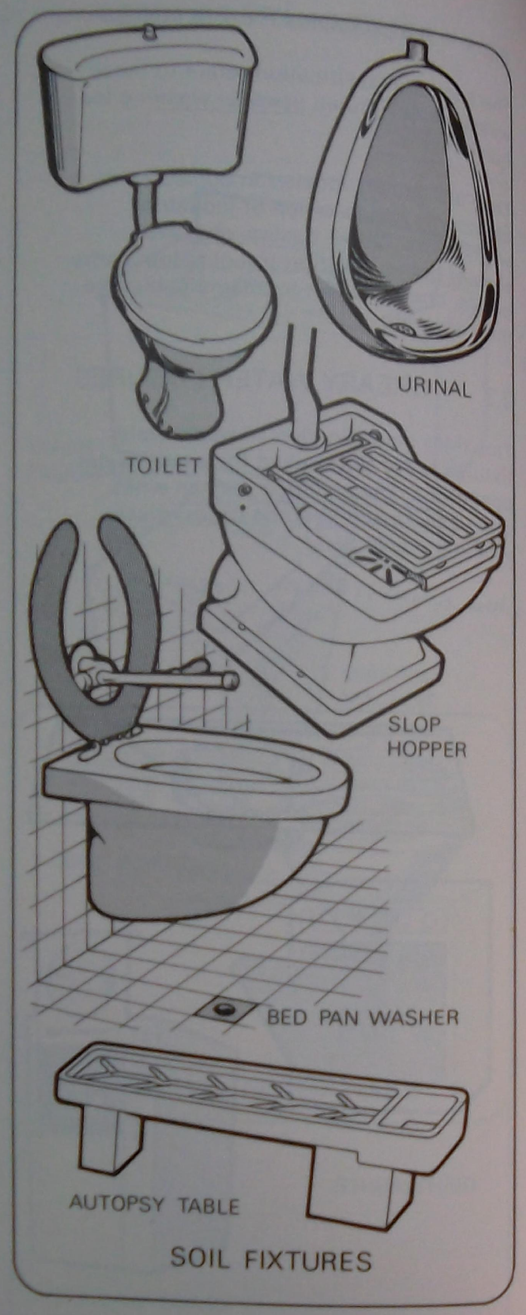


GREASY WATER FIXTURES

ABLUTIONARY FIXTURES

2.4 SOIL FIXTURES

Soil fixtures are used for the disposal of human waste. The fixtures in this category are water-closet pan, urinal, slop hopper, autopsy table, bed-pan washer and sanitary napkin disposal unit.



SOIL FIXTURES

3 TOOLS FOR SANITARY PLUMBING

The installation of sanitary fixtures requires skill in using a wide range of tools to perform operations on a variety of materials. The tools may be classified as follows:

- measuring, setting and levelling tools.
- cutting tools
- percussive and driving tools
- gripping tools
- forming tools
- joining tools
- digging and laying tools

3.1 MEASURING, SETTING AND LEVELLING TOOLS

Tools in this category are used for laying out the work and for setting the fixtures accurately in place.

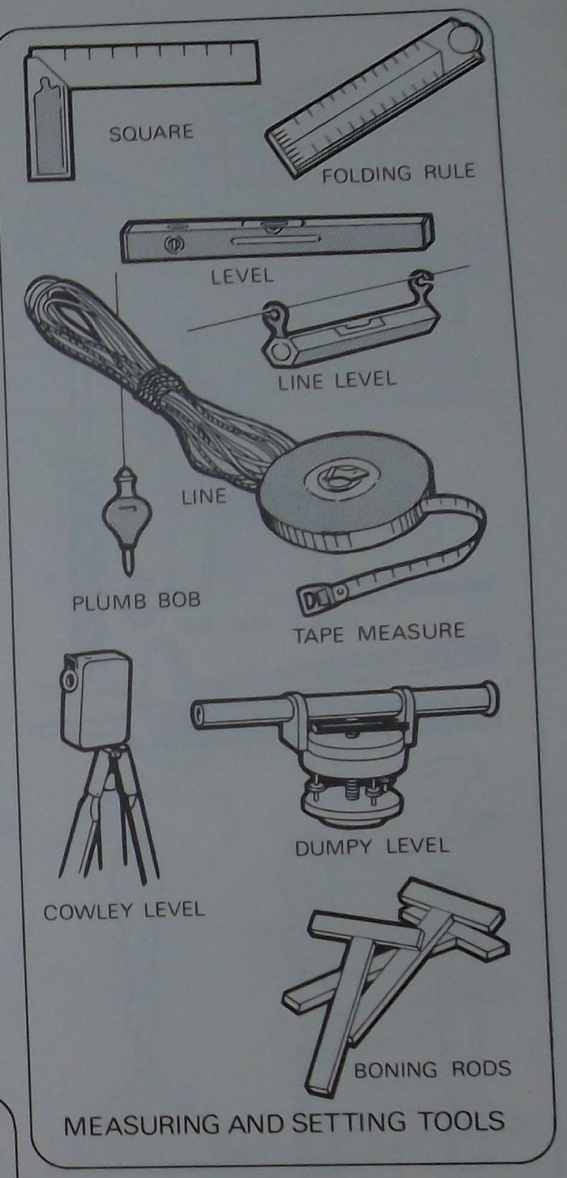
The plumber will need a rule, a steel tape, string or nylon lines, levels (spirit, Dumpy and Cowley), plumb bob and a square.

3.2 CUTTING TOOLS

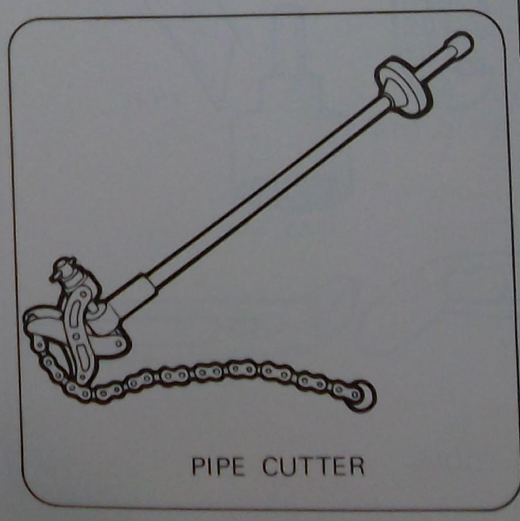
The installation of sanitary fixtures involves the cutting or drilling of timber, sheet metal, metal pipes, earthenware pipes and fittings, steel plate, plastic pipes and fittings and fibrous reinforced cement. Some of the tools used with these materials are hacksaws, wood saws, power saws, tinsnips, circular hole saws, scrapers, cold chisels, wood chisels, drill bits, files, pipe cutters, brace and bits.

Washer cutters are special, adjustable-diameter bits. They may be used to cut washers of various sizes from sheet metal, lead, zinc, copper, leather or rubber.

A typical range of cutting tools is shown at page 6.



MEASURING AND SETTING TOOLS


PIPE CUTTER

Pipe cutters are used for cutting galvanised wrought and black iron pipe. They are available in a variety of sizes and designs.