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Insight guide

An introduction to sheet lead weatherings

CIPHE The Chartered Institute of Plumbing and Heating Engineering

Foreword

Mike Maskrey has produced a valuable introduction to the traditional skills of sheet lead work fabrication that plumbers have executed since antiquity and may be found on all types of buildings throughout the country.

It succinctly describes those common techniques, such as the types of tools used for bossing, as well as modern welding methods and setting out geometry. The descriptions and clear illustrations of each stage of the processes will be of value to the young trainee who is able to attend a college apprenticeship to further their craft careers or to the mature entrant.

As with all professional craft skills, the correct basics learned at the outset form the foundation of good practice and future creative designs, and the inventiveness is unlimited once those skills are mastered.

This publication will provide architects, surveyors, and those associated with the building industry with a secure insight into the application of the principal sheet lead applications.

Dr Peter T J Rumley FSA
Past Master of the Worshipful Company of Plumbers

About this guide

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This document is based on the best knowledge available at the time of publication (May 2024). However, no responsibility of any kind for any injury, death, loss, damage or delay however caused resulting from the use of these recommendations can be accepted by the authors or other parties involved in its publication.

This guide is primarily intended to provide a brief insight into the design, installation, and maintenance of sheet lead weatherings. The information it contains has been compiled based on relevant authoritative publications and the experience of the authors through their careers within the plumbing industry from apprentices to tradesmen, and after obtaining further qualifications, as designers and advisors to the plumbing industry.

It is not intended to be exhaustive or definitive and it will be necessary for users of the guidance given to exercise their own professional judgement when deciding where to apply the guidance recommendations.

All of the information was correct at the time of publication.

Sheet lead weathering

Sheet lead working is one of the most ancient of all the crafts a plumber can undertake. The methods of working and shaping the lead we use and the tools we will look at have changed very little in two millennia. It is, quite simply, the traditional craft of the plumber.

The first utilisation of lead is lost in antiquity, but archaeologists have evidence of its use some 6,000 years ago in various forms. This was later extended to include roof coverings by the Normans after the Norman conquest of 1066. The word plumber is an occupational name derived from the Latin word for lead, *plumbum*. *Plumbum laborantis* means 'worker of lead'.

As a plumber, you may be asked to install flashings to a chimney or to weatherproof a soil stack or maybe even work on historical buildings such as churches and stately homes. Lead looks extremely attractive and will often outlast the building itself, but it also has its dangers.

In this guide, we will investigate the properties of sheet lead and its working characteristics. We will examine the methods of working we use to be able to cut, manipulate and weld the lead into the shape required and we will revisit the health and safety aspects of working with sheet lead.

Author, Mike Maskrey (left), working on the lead-covered cupola of Stockport Workhouse

Thank you

With thanks to my good friend Dave Sharman whose lead working craftmanship you see in the following pages.

Mike Maskrey
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Introduction

CHAPTER 1

The purpose of sheet lead weatherings

The purpose of sheet lead weatherings

The purpose of sheet lead weatherings is twofold:

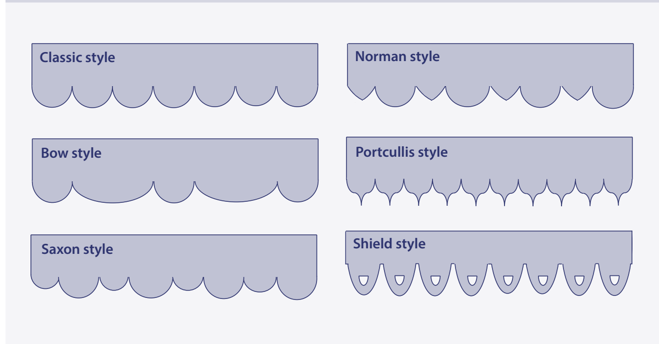
To prevent water ingress into a building — correctly prepared and installed lead flashings will protect a property from rain penetration. Typical situations where lead might be used are as follows:

- Flashings around chimney stacks, i.e., front aprons, back gutters, step and cover flashings and soakers. These will be looked at later in this chapter.
- Weatherings to soil and vent and flues where they penetrate the roof structure. Again, these will be examined later.
- Internal and external dormer windows.
- Large and small flat roof areas. Lead is the preferred material for use on high quality public buildings such as criminal courts, police stations and tax offices.
- Refurbishments of historical buildings such as cathedrals, churches, stalely homes and castles, many of which have lead roofs that require periodic maintenance, conservation or replacement.

To provide an aesthetically pleasing covering — because of weather proofing a building, many plumbers take the opportunity to show the decorative qualities of sheet lead by scalloping and shaping.

Traditional lead flat roofs

Scalloping styles



The types of sheet lead

The construction industry uses more than one type of lead sheet. The different types of sheet lead and their uses within the construction industry are as follows:

- Rolled (milled) lead sheet to BS EN 12588:2006
- Sand cast sheet lead
- Machine cast lead

Rolled (milled) lead sheet to BS EN 12588: 2006

Rolled lead sheet has been produced since the 17th century. A patent was granted to Sir Philip Howard and Francis Watson in 1670 for milling lead, primarily for supplying lead sheets for sheathing the hulls of Royal Navy ships. By the beginning of the 20th century, it was being produced in the UK where it eventually replaced sand cast lead as the choice of lead for weathering and roofing, mainly on modern buildings.

Often called milled sheet lead, rolled sheet lead is produced by rolling slabs of refined lead backwards and forwards through computerised rolling mills where the lead receives its final thickness which does not vary more than +/-5% at any given point. After the final thickness has been achieved, the lead sheet is then cut to a variety of lengths and widths and packaged ready for distribution. It is the only lead sheet produced to a British and European Standard.

BS EN 12588: 2006 Lead and lead alloys — rolled sheet lead for building purposes, specifies the thickness tolerances and chemical composition ensuring that its purity is at least 99.9% pure lead. The accuracy of the thickness of the lead ensures that, when it is fitted to a roof structure, the expansion and contraction can be accurately calculated, and the correct fixing method used.

Sheet weatherings using rolled lead sheet must be designed in accordance with ***BS 6915:2001+A1:2014 Design and construction of fully supported lead sheet roof and wall coverings. Code of practice.***

Rolled sheet lead is available in various thicknesses. These are known as codes and each code has an identifying colour, as seen in the table below.

Codes were originally derived from the weight of a square foot of sheet lead — 1 square foot of lead at 1lb weight would be lighter than 2lb per square foot, thereby had a greater thickness.

Code	Weight	Colour	Thickness	Use	Maximum length
3	14.97kg/m	Green	1.32mm	Soakers	1m
4	20.41kg/m	Blue	1.80mm	Cover flashings Lead welded aprons and weatherings Flat and pitched roofing	1.5m
5	25.40kg/m	Red	2.24mm	Cover flashings Bossed aprons and weatherings.Flat and pitched roofing	1.5m
6	30.05kg/m	Black	2.65mm	Flat and pitched roofing	1.5m
7	35.72kg/m	White	3.15mm	Flat and pitched roofing	1.5m
8	40.26kg/m	Orange	3.55mm	Flat and pitched roofing	1.5m

Sand cast lead sheet

Medieval cathedral, church and castle roofs were weathered using sand cast lead. Surviving records show that the material had an exceptional life span when correctly installed.

The traditional method of manufacture continues to be used to this day, which involves molten lead being poured across a bed of prepared sand and then skimmed to correct thickness with a strickle. It is only manufactured today by a few specialist foundries.

☞ Wirksworth

In 2021, in the town of Wirksworth in Derbyshire, the lead on the roof of the Church of St Mary's was stripped, and recast using the sand cast method and re-laid back on to the roof at a cost of over £100,000.

It is often used to replace the lead roofs of historical buildings where its 'rough grain' appearance is a necessity. The overall weight of sand cast lead is around 2.7 to 3.6kg per 300mm and this generally accounts for its longevity.

Sand cast lead has no fixed chemical composition and is not made to any British or European Standard.

Machine cast lead sheet

Machine cast lead sheet was first developed in Australia in the 1950s and was introduced into the UK in the early 1980s. Also known as DM (Direct Method) lead sheet, the process involves immersing a rotating water cooled drum into a bath of molten lead. Because the lead solidifies on the surface of the drum, the thickness of the lead is dependent upon the speed of the drum, the depth to which it is immersed in the metal and the difference in temperature between the drum and the molten lead. When the lead has solidified it is peeled off the drum as it rotates.

Machine cast lead sheet differs in both surface finish and grain structure from rolled and sand cast sheet lead. The lead surface in contact with the drum has a dimpled finish while the other side is relatively smooth in texture.

Machine cast lead sheet does not conform to the British Standards because consistency of thickness cannot be achieved although some DM lead sheet manufacturers have obtained individual British Board of Agrément Certification for their products.

CHAPTER 2

The properties of sheet lead

The properties of sheet lead

The physical and mechanical properties of lead make it one of the best roofing and weathering materials available because of its longevity. The desirable and non-desirable properties of lead that make it almost unique as a roofing material are under the following categories:

- Appearance
- Malleability
- Durability
- Corrosion resistance
- Life span
- Recyclability
- Thermal movement
- Creep
- Ductility of sheet lead
- Conductivity

Properties of sheet lead	
Desirable	**Non-desirable**
Appearance	Ductility
Malleability	Conductivity
Durability	Creep
Corrosion resistance	Coefficient of thermal expansion
Life span	
Recyclability	

The effects of rain washing off the lead patina (Photo: Mike Maskrey)

Appearance

Lead is a very dense metal that has a bluish-grey colour. It does, however, have a bright lustre of silver when freshly cut. It tarnishes slowly in moist air conditions giving the lead a dull, grey coating. This is called the patina.

When used as a roof covering lead has an attractive appearance due to its grey colour. It does, however, require treatment with patination oil as the work progresses to stop the patina being washed off during rainfall, as this leaves grey-white streaks on brickwork and roof tiles.

Introduction

Malleability

Lead is a very soft metal that has the ability to be worked into complicated shapes using hand tools and by a technique known as bossing. It can also be easily dressed to fit many types of profiled roof tiles, such Dutch pan tiles, and concrete interlocking types. Unlike other metals it can be cold worked without fatigue cracking, and it does not appreciably work harden.

COLD WORKING

Cold working is the ability of a metal to be worked and manipulated without the presence of heat. Most metals, like steel for instance, need to be heated until they glow red before they can be hammered into various shapes. Lead does not need to be heated because it is soft enough to work at much lower temperatures. It may, however, need warming in very cold weather before being worked, especially with lead Codes 7 and 8.

When a metal is cold worked, it becomes hard as the round shaped molecules of the metal are forced tightly together becoming oval and eventually almost flat. When this happens, the metal loses its ability to be cold worked and it eventually cracks. This is known as fatigue cracking or by its more common name of metal fatigue.

Work hardening in some metals, such as copper, can be avoided by periodically heating the metal until red and then quenching in water. This re-aligns the molecules of the metal and so the metal becomes soft again. This process is known as annealing.

Durability

Rolled (milled) sheet lead is resistant to atmospheric corrosion, even in very aggressive atmospheres such as coastal regions and inner-cities with high levels of air pollution. When sheet lead roof coverings are designed and installed correctly with the correct thickness of lead being used, it will provide a maintenance free weather proofing for a long period of time. The correct thickness and size of each piece of the lead will depend upon the application. In some instances, thicker lead sheet will be required if:

- The lead is being dressed into deep profiled tiles.
- The lead is likely to have frequent foot traffic.
- It is being fitted to extensive flat roof areas and gutters
- Extra rigidity is required because of wind lift.

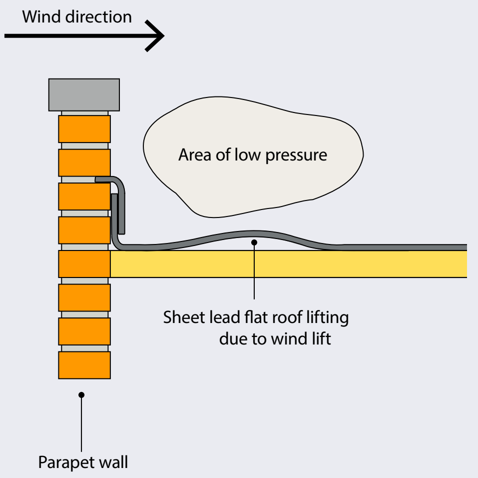
☞ Foot traffic

Many sheet lead flat roofs are designed to cope with being walked on, such as church roofs, for instance. This is known simply as 'foot traffic'.

WHAT IS WIND LIFT?

Wind lift is a condition that often occurs on sheet lead flat roofs that are bordered by a low parapet wall.

As the wind blows against the parapet wall, an area of low pressure forms behind it and immediately above the lead. The pressure underneath the sheet lead remains constant. The difference in pressure above and below the lead will often result in the lead lifting.



You can try the theory for yourself. Take a sheet of A4 paper and hold it between the finger and first thumb of each hand. Let the paper curve away from you. Now blow across the top of the paper gently but firmly and the paper will lift straight as though blown from underneath.

This is wind lift.

Corrosion resistance

Sheet lead is resistant to almost all forms of corrosion when fixed in a roofing application but some precautions must be taken against the following situations:

Unprotected sheet lead damp proof courses (DPCs) and cavity trays often corrode when in contact with moisture from cement mortar. Sheet lead DPCs and cavity trays should be painted with black bitumen paint before being fitted.

Lichen growth contains acids, which runs off when it rains and may cause holes in the sheet lead where it drips on to the lead from the tiles or slates. A sacrificial flashing can be fitted to a lead roof or gutter to prevent this. Alternatively, the lichen may be treated with fungicide.

Sheet lead must be protected when fitted to substrates made from oak as this contains acids that corrode the lead. This is usually done by the use of an underlay made from waterproof building paper.

Under certain conditions, condensation may form on the underside of the lead. It often occurs when the lead is fixed to a damp substrate. It is important to ensure that the substrate is dry before the lead is installed and that the roof is designed to reduce the risk of condensation forming.

Care must be taken against galvanic action when used in co-operation with other metals.

☞ What is a 'substrate'?

A substrate is any solid surface to which the sheet lead is applied, such as a timber flat roof or a brick wall.

Life span

It is not unusual to find lead on historic buildings that is 200 or even 300 years old. The life expectancy of lead is diminished if the wrong code of lead or the wrong sizes of lead are used.

Using the wrong sizes or code of lead can lead to premature failure due to fatigue cracking because of the thermal movement (expansion and contraction) of the lead sheet (see page 16). Using the correct bay sizes and fixing techniques, and allowing proper expansion prolongs the life of the lead sheet.

Recyclability of sheet lead

Almost 95% of the sheet lead used in the building industry today is recycled. Most of it comes from the demolition of old buildings in the form of old lead sheet and lead piping. Collection of the scrap lead is a relatively simple task. The scrap is separated into suitable containers and collected direct from the demolition site and transported to scrap collection point.

The first process involved in the recycling of lead is the initial melting at just above leads melting point of 327°C. This facilitates the removal of non-lead items and is followed by the refining stage to bring the material up to the purity of 99.9% pure lead. All scrap recovery in this way is closely monitored by Health and Environment Agencies to ensure that the recovered lead is treated safely.

The advantages of lead recycling are:

- Very high recovery rate of scrap lead
- Low energy consumption because of the low melting point of lead.
- Lead outlasts feasible alternative sheet metal roofing materials.
- Strict control of environmental issues applied to lead recycling process.

Thermal movement of lead

The coefficient of thermal expansion for lead is 0.0000297mm/m for every degree rise in temperature that the lead is subjected to. This high expansion rate means that lead sheet roofing must include regular expansion joints to allow the expansion and subsequent contraction to take place and that the sizes of sheet lead must be restricted to those recommended in BS6915.

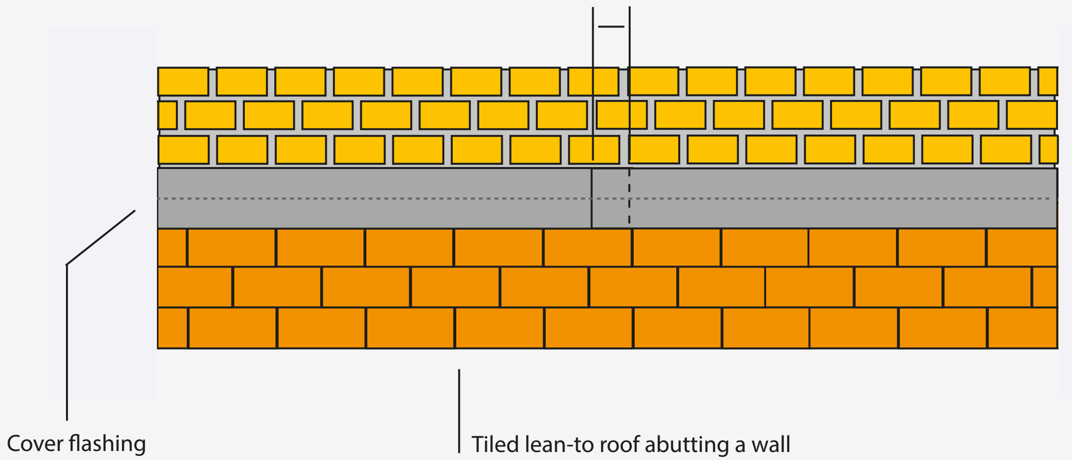
For most lead flashings, expansion joints will take the form of laps. The table on page 8 shows the code of lead, its thickness and the maximum length of sheet lead allowed before a lap joint is required.

Lap joints are used on flashings such as valley gutters and are installed so that a vertical distance of 75mm is maintained regardless of the roof pitch. This means that the steeper the pitch, the shorter the lap. Shallower roof pitches will have a longer lap. See lap chart on page page 15.

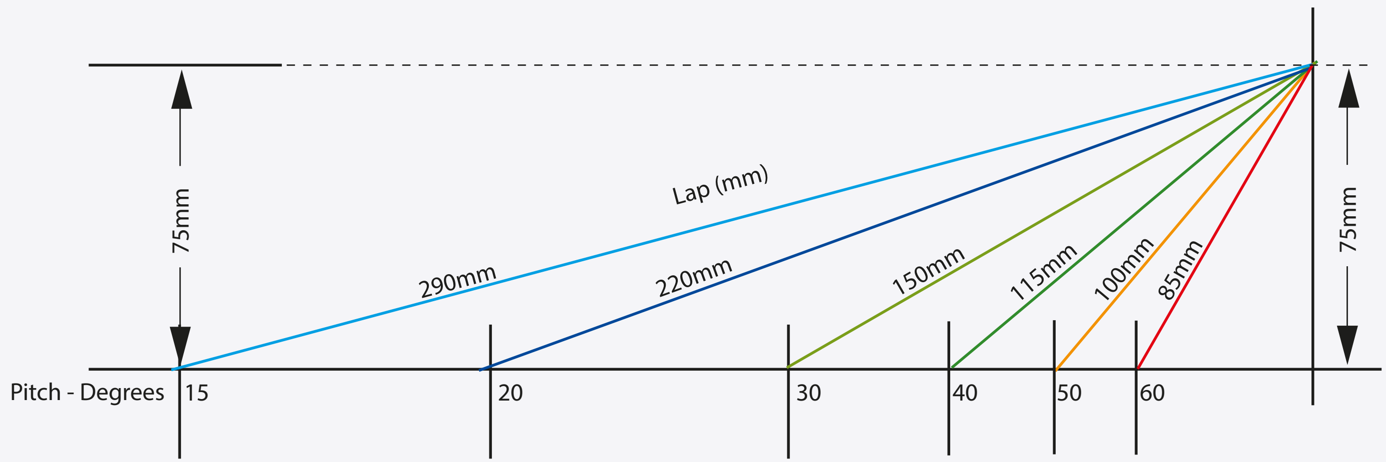
Introduction

Laps on a cover flashing

For horizontal cover flashings, a lap of at least 100mm is required

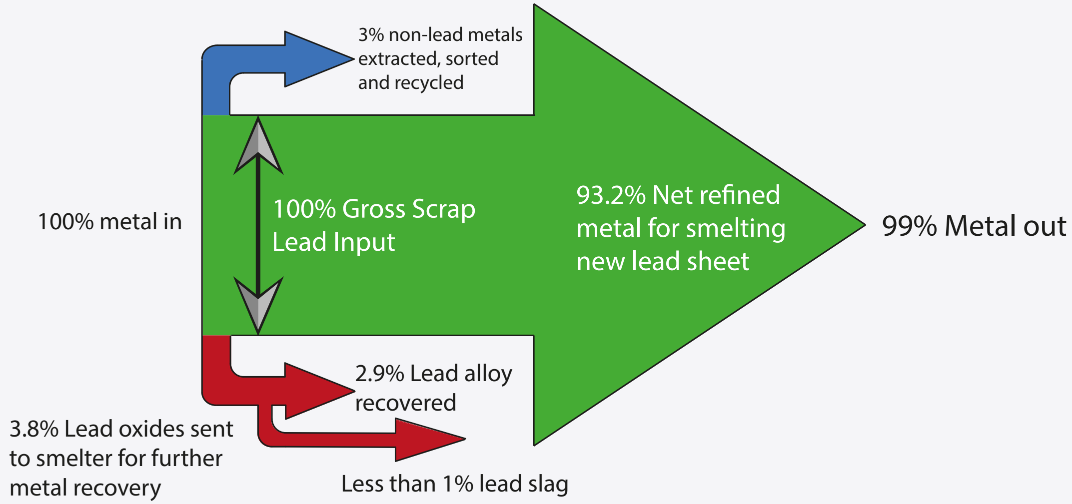


Roof pitch and laps



Introduction

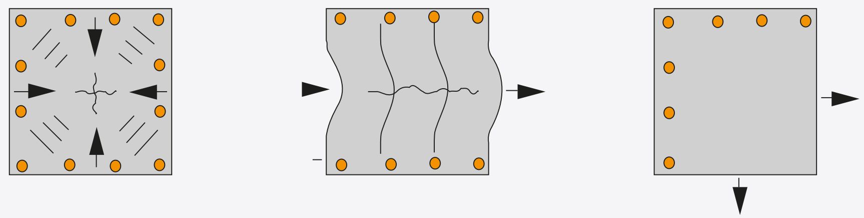
Lead recycling



Methods of preventing damage caused by expansion and contraction

When the lead gets hot in the heat of the sun, it will distort if there has been no allowance for expansion to take place. When the lead cools down, it will return to its original position. Constant expansion and contraction of sheet lead due to temperature change (thermal movement) could eventually lead to fatigue cracking if the lead is fixed incorrectly. The diagram (right) illustrates this.

Fatigue cracking in lead



Lead fixed on all sides has nowhere to expand. This means that the lead moves into the middle of the sheet, moving upwards causing buckling and possible fatigue cracking.

Lead fixed top and bottom only. This means that the lead moves in one direction. This also causes uneven expansion and possible fatigue cracking.

Lead fixed top and one side. This means that the lead can expand in all directions and fatigue cracking will not occur

It is, therefore, important that lead is fixed properly to promote even expansion and contraction without restriction. This can be achieved by the use of:

- The correct code of lead for the application
- Using the recommended sizes of lead for a given situation
- Correct jointing methods
- Adequate fixings

Creep

Sheet lead can suffer from an occurrence known as creep, especially when the lead is fixed vertically or on a steep incline. It is a term that is used to describe the effects of thermal movement. When thermal expansion takes place, on contraction the lead does not return to its original position making the lead slightly longer than it was originally. Over a long period of time, the stretching of the lead in this way can eventually lead to fatigue cracking.

Ductility of sheet lead

The ductility of a metal is its ability to deform under tensile stress and is often shown by the metals ability to be stretched into a wire without fracture. In this regard, lead is a very ductile metal and, as we have already seen, often stretches under its own weight in the form of creep and this can lead to fatigue cracking.

Conductivity

Unlike other metals, lead is a poor conductor of heat and electricity.

CHAPTER 3

The tools used when installing sheet lead

The tools used when installing sheet lead

Lead working tools fall into two categories:

- **Traditional lead working hand tools — those used to dress, boss and shape the lead**
- **Tools used during lead welding activities.**

In this part of the chapter, we will examine the tools associated with the skill of lead working.

Traditional lead working hand tools

Traditional lead working tools are those involved in dressing, bossing, and shaping. Lead working hand tools are as old as lead working itself. The tools have changed very little in hundreds of years although, today, they may well be made from polypropylene rather than wood.

Box wood, beech wood or hornbeam were the traditional materials for lead working tools primarily because they are light in weight but reasonably hard enough to take repeated blows against the lead. They require frequent maintenance and occasional coatings of linseed oil to prevent them from splitting.

Polypropylene lead working tools are generally slightly heavier than box wood but do not require the maintenance associated with beach wood or hornbeam tools.

There are many different lead working tools that we need to be able to recognise and use correctly:

The flat dresser — used to flatten, straighten, and dress the lead into the required position on the roof area. Can also be used on a work bench. It has a characteristic triangular cross section with a flat work surface.

The bending stick — not widely used now but was used extensively in the past when bossing angles in large diameter lead pipes. It has a curved appearance with a flat oval cross-section. This should not be confused with a bossing stick.

The bossing stick — similar in appearance to the flat dresser except that this tool has a large, curved underside and has an 'egg' shaped cross-section. Used to shape the lead using the 'bossing' technique. We will look at the bossing technique a little later in the chapter.

The setting-in stick — used to define the edges of sheet lead work to give an angular appearance. Generally used with a bossing mallet. It has a thin defining edge.

The chase wedge — similar in appearance to a bolster chisel, this tool is used in conjunction with a bossing mallet to define the edges of internal and external corners where the use of a setting in stick is difficult.

The lead knife — a hooked bladed knife that is used to deep score the lead sheet so that it can be precisely ripped.

The bossing mallet — generally used as a striking tool but can also be used in conjunction with a bossing stick to form internal and external corners.

Tin snips — often called shears, tin snips are used to cut the lead sheet.

The Step turner — this is used for turning down the part of the step flashings that is inserted into the brickwork.

Other tools used during sheet lead installations

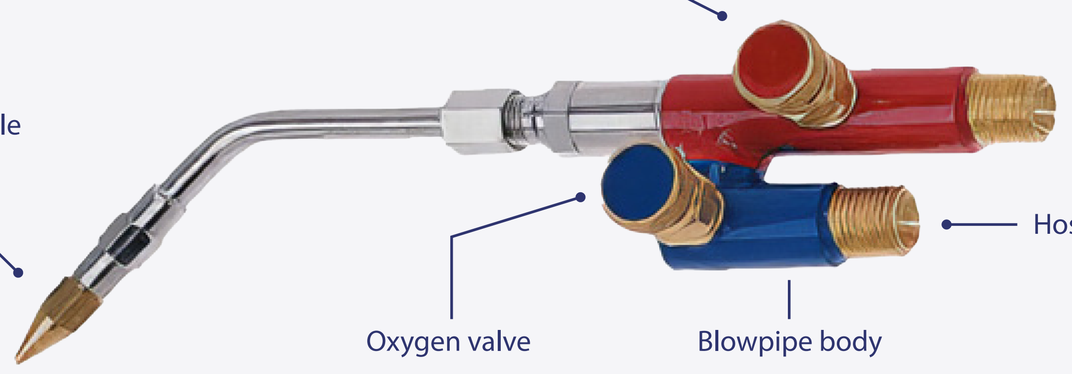
Apart from the sheet lead specific tools we have so far looked at, there are several other tools that we will use:

Joiners folding rule — this is used for marking the steps of step and cover flashings.

Club/lump hammer and plugging chisel — used in conjunction with a plugging chisel to rake out brickwork joints and to open up lead wedges that hold chimney flashings in place.

Marking pen — used to mark the lead sheet. Pencils should not be used as these score the lead, making the lead sheet susceptible to tearing.

A blow pipe



Lead welding tools

The lead welding kit consists of:

A blow pipe (above) — this is the actual lead welding tool.

Oxy-acetylene hoses — used to connect the blow pipe to the gauges and the oxy-acetylene bottles.

Two single stage gauges and governors — used to set the pressure of the gases.

Flame arrestors — these must be fitted to prevent a dangerous situation known as blowback where the flame travels backwards up the hoses into the oxy-acetylene bottles causing a fire inside the bottles.

A bottle spanner — used to tighten the gauges on to the bottles.

Lead welding nozzles — these are fitted to the blow pipe, generally a nozzle size 2 or 3 is recommended for lead welding depending on the code of lead being welded.

Shave hook — used to clean the lead by scraping.

Flat steel rule — used for accurate marking out and as an aid for cleaning the lead when used in conjunction with the shave hook.

CHAPTER 4

Sheet lead fabrication techniques

Safety when working with sheet lead

Before carrying out any sheet lead work, it is important that we first re-cap the health and safety aspects of working with lead.

REMEMBER

- Lead is very heavy — always lift with care and seek assistance if necessary.
- Do not eat, drink or smoke when handling or working near lead.
- Always wear the appropriate personal protective equipment (PPE).
- Always apply barrier cream before working with lead.
- Local fume extraction must be available when lead welding inside.
- Always wash hands thoroughly after working with lead.

Sheet lead fabrication techniques

Have you ever thought of why lead is so soft and workable at normal room temperatures? This is simply because of the low melting point of the lead. Lead melts at the relatively low temperature of 327.4°C. This means that lead will behave at room temperature in the same way as other metals do when they are heated. Consider the hardness of some of the more common metals:

- **Steel** — very hard and has a melting point of around 2000°C
- **Copper** — moderately hard and has a melting point of around a 1000°C
- **Aluminium** — moderately soft and melts at around 600°C
- **Lead** — soft and melts at around 300°C

There are three basic fabrication techniques used with sheet lead work. These are:

- **Cutting and forming**
- **Bossing**
- **Lead welding**

Details of the correct methods of fabrication and installation of lead sheet can be found in the Lead Sheet Association manual — *Rolled Sheet Lead.*

Cutting and forming

This is the simplest of all the sheet lead working techniques. It involves simply cutting the lead and bending it into the required shape. Usually used when forming step and cover flashings and soakers on the side of a chimney.

Step and cover flashing

Bossing

Bossing is a skill that developed in the Middle Ages for shaping the lead without the need to cut or weld it. It involves using tools such as the bossing stick and bossing mallet to thicken the lead by movement the lead molecules using targeted, directed blows. The lead is thickened in specific areas to allow shaping and dressing into complicated shapes. This has the effect of thinning the pre-thickened lead almost back to its original thickness but in the shape required. Where the lead has thinned out, the reduction should not be more than 25%.

Bossing can be used in many situations, such as internal and external corners, chimney front aprons and back gutters and step and cover flashings. Bossing lead requires the use of Code 5 lead and above, otherwise splitting of the lead during the bossing process is likely to occur.

There are two bossing procedures to look at:

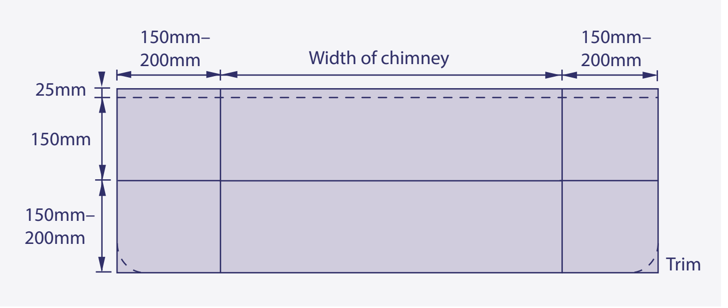
- The bossed internal corner. This is known as an abutment weathering, where the roofline butts up to a wall.
- The bossed external corner. Most commonly found on the front aprons of chimneys.

The bossed external corner

For this exercise, we will look at the development of a chimney front apron. It is probably the most common bossed lead profile.

The width of the chimney will need to be measured first. To this, we then add 150–200mm either side depending on whether the roof tiles are plain tiles or deeply profiled tiles. The width of the lead should be 150mm for the apron +150 for the up-stand +25mm for turning into the brickwork (325mm).

STEP 1 Mark out the lead using a permanent marker pen and a straight edge as shown in the diagram below and trim the corners as shown in the drawing and in the photograph below.



Step 1: Marking and trimming the lead

STEP 2

After the lead has been marked, set in the roofline pitch using a setting-in stick and a bossing mallet. Do not strike the setting-in stick too harshly as this may damage the lead sheet. Lift the up-stand of the apron to create the pitch of the roof. Then, using a bossing stick, create a wave in the lead by hitting the sheet lead upwards at the start of the corner.

Step 2: Setting the line and creating the wave

STEP 3

Using the wide rounded face of the bossing stick, drive the wave in the lead towards the end. When the wave flattens out, reform it and continue with the bossing process. By doing this the lead sheet will thin out where the wave was started and thicken up towards the end of the apron.

Step 3: Driving the wave

STEP 4

Continue to drive the wave along the lead, turning the corner when the end of the apron is reached. Turning the corner should be done using the corner of the up-stand as a pivot point. Do not boss too closely to the pivot point or a crease may begin to develop.

Step 4: Turning the corner

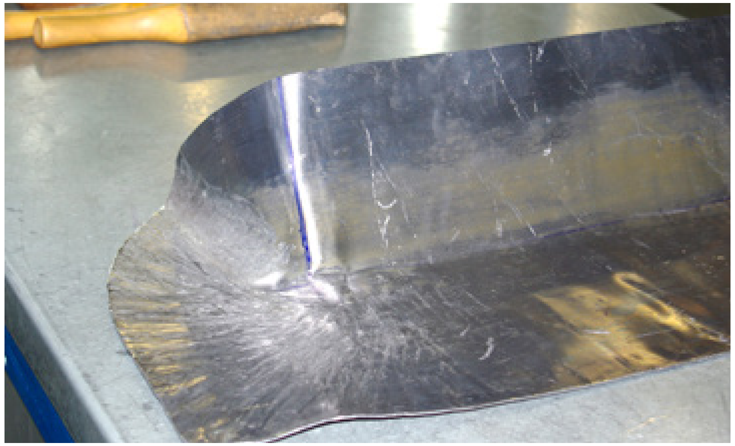
STEP 5

The corner will, by now, have begun to turn and the roof pitch will be prominent. Continue to create the wave and move the lead into the corner. This will thicken the lead at this point ready for final dressing into the roof pitch/apron intersection. Remember to periodically stop bossing and re-dress the lead back into its apron shape.

Step 5

STEP 6

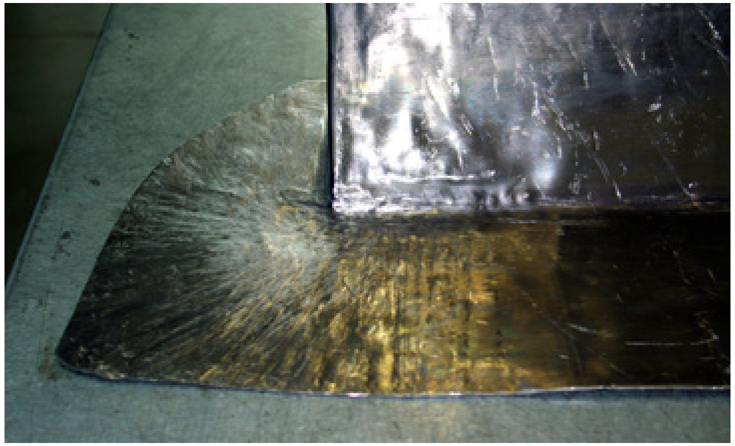
At this stage, the corner will have turned, and the lead should be thick enough to allow bossing into the corner. It is important, here, that the roof angle is maintained. This can be checked using an adjustable bevel or a joiners folding rule that has been set to the correct roof pitch or a set square as shown.



Step 6: Bossing the final corner and checking the roof angle

STEP 7

The external corner can be completed by final dressing the apron and re-defining the corners with a setting-in stick.



Step 7: Final dressing and re-defining

The bossed internal corner

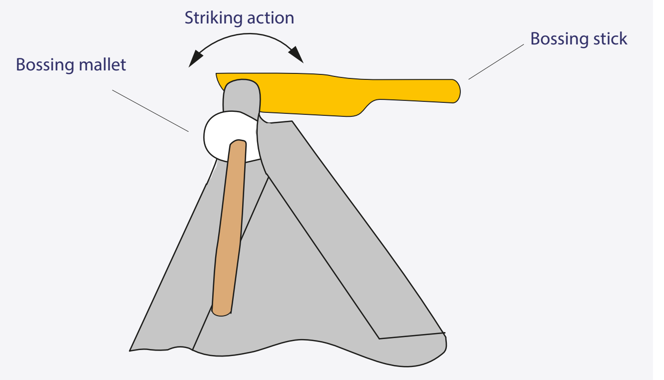
For the purposes of this exercise, we will assume that the piece of sheet lead is 600mm x 600mm, Code 5. The procedure is as follows:

STEP 1 Marking out the lead — on two sides, mark a margin of 100mm using a permanent marker pen. Use a straight edge so that the dimensions are accurate. Trim off the corner.

STEP 2 Using a setting-in stick, set-in the angles by placing the setting-in stick on the line and striking it with a bossing mallet. This fixes the up-stand position during the bossing process. Do not use too much force or the lead may be damaged. Turn the marked sides up at 90°. To ensure accuracy here, use a piece of 100 mm x 50 mm timber 600 mm in length to bend against. A slight groove can also be put into the base of the lead sheet with the bossing mallet to ensure a good, square base.

STEP 3 Grip the bossing mallet in your non-striking hand, with the thin end of the head towards the fingertips and the handle pointed downwards between the middle finger and the index finger. The mallet head should be cupped in the hand. Now, place the thin end of the mallet inside the lead between the turn-ups and into the corner. The mallet acts as a brace so that when the lead is struck with the bossing stick, the corner retains its shape while the bossing process is ongoing. The thin end of the mallet is used simply because we are attempting to make the corner as tight as possible.

The thin end of the bossing mallet used in conjunction with the bossing stick to create a tight corner



STEP 4 Using a bossing stick and working from the base of the corner, strike the lead towards you with a left-to-right-to-left motion. Some plumbers will use the thin edge of the bossing stick for this procedure as it gives a more accurate bossing action.

As you work the lead towards you, pull the bossing mallet back at the same time so that the bossing stick blows are at the thin end of the mallet at all times.

As the bossing progresses, the lead will stretch and gather surplus lead at the end. This can be periodically trimmed as necessary.

STEP 5 Always keep a check on the corner to ensure that it is square. An engineer's square can be used for this. Trim any surplus lead away with tin snips and dress the finished corner with the flat dresser.

Lead welding

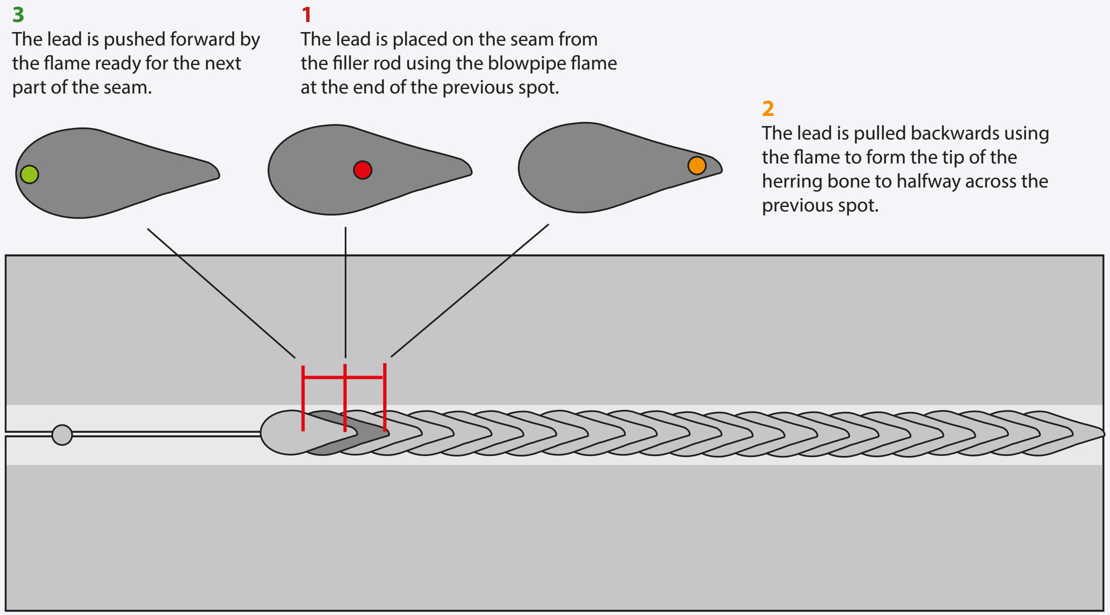
Lead welding is probably the most difficult of all the lead working techniques to master. It involves the joining of two pieces of lead by melting the free edges of the pieces of lead (the parent metal) together using a filler rod of the same metal. The correct name for the process is fusion welding. It is used as an alternative to the bossing technique for internal and external corners and flat roof applications. Lead can be horizontally and vertically welded and welded on an incline. On-site lead welding activities usually involves the use of portable lead welding equipment, the most important part of which is the blowpipe and nozzle. There are two basic welds that we will look at:

- **The butt welded seam**
- **The lap welded seam**

There are two lead welding techniques we can use — the herringbone technique and the thumbnail technique. The style of these techniques is shown in the following two images.

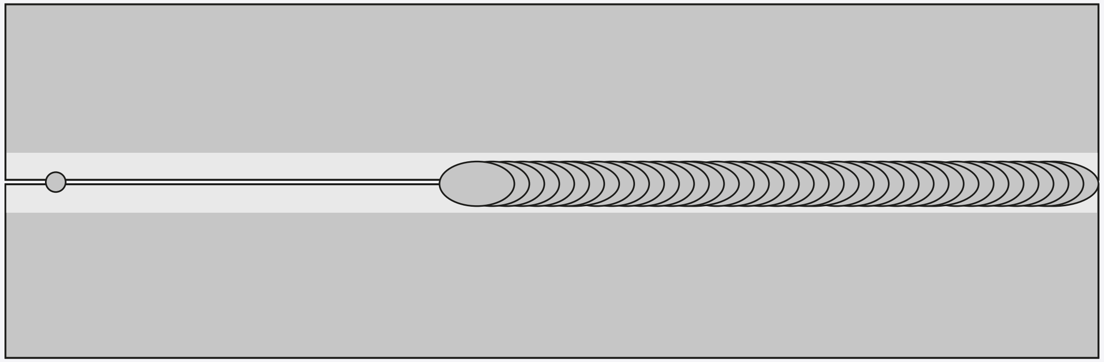
Herringbone weld

This weld pattern is called herringbone. It is the most difficult of the patterns to perfect but it is the most aesthetically pleasing.



Thumbnail weld

This weld pattern is called thumbnail. It is the easiest of the patterns to perfect and the one most used by modern plumbers because of the speed of the welding process.



The butt welded seam

The butt welded seam is the simplest of the welds and involves butting two pieces of lead together and welding directly down the seam with one continuous weld.

Introduction

The lap welded seam

The lap weld is a little more complex as it involves making two weld runs along the same joint, one on top of the other so that half of the bottom weld is visible. This is because the two pieces of lead to be joined are lapped one on top of the other.

Preparing a lead weld

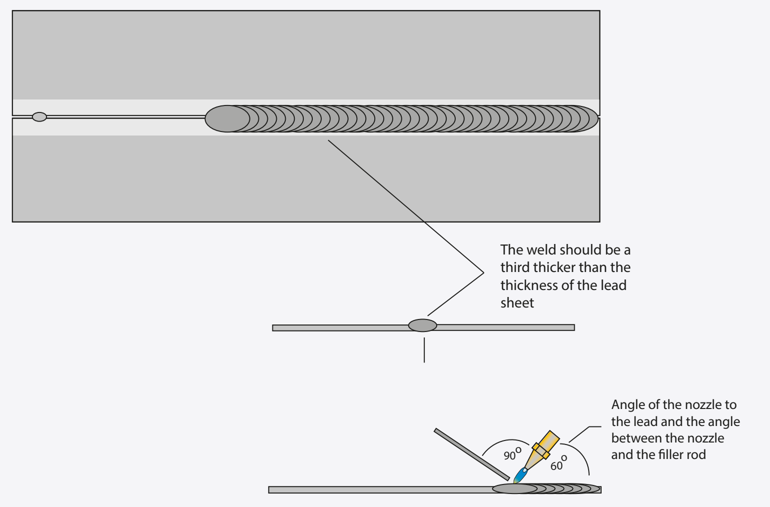
The art of good lead welding is preparation. If the weld is prepared correctly and the flame is set correctly then the weld process is much easier. There are several stages of preparation of a lead weld and with each one, it is important that we get it right.

The stages are:

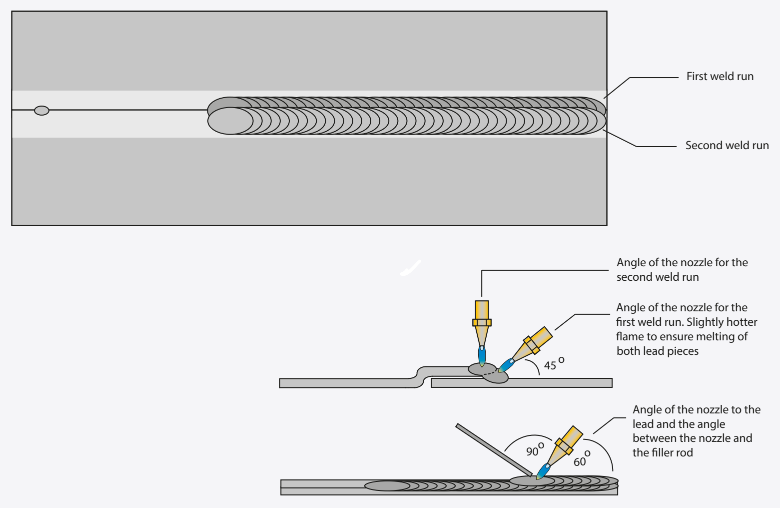
STEP 1 **Cutting the lead** — precise cutting of the lead, whether it is a practice weld, or the gusset of a lead front apron is important. Big gaps in the lead are hard to weld and use up filler rod. Always ensure any cuts are accurate.

STEP 2 **Cleaning the lead** — the edges of the lead that are to be welded need cleaning with a shave hook before they can be welded. Uncleaned lead welds with an orange-peel effect caused by the impurities in the lead (known as dross) floating on the molten lead surface, which is not pleasing to the eye.

The butt weld



The lap weld



It is a good idea to use the edge of a steel rule to run the shave hook against when cleaning the lead as this gives a nice, straight edge to the weld. The area to be cleaned should be 8–10mm wide on both sides of the weld as shown in the diagram right:

STEP 3 **Cutting the filler rod** — filler rod needs to be about 3–5mm wide. Any bigger than this will lay too much lead on to the weld, which will make it appear too wide. Too much lead is difficult to move into place with the blowpipe. A finished weld should be about 10mm in width.

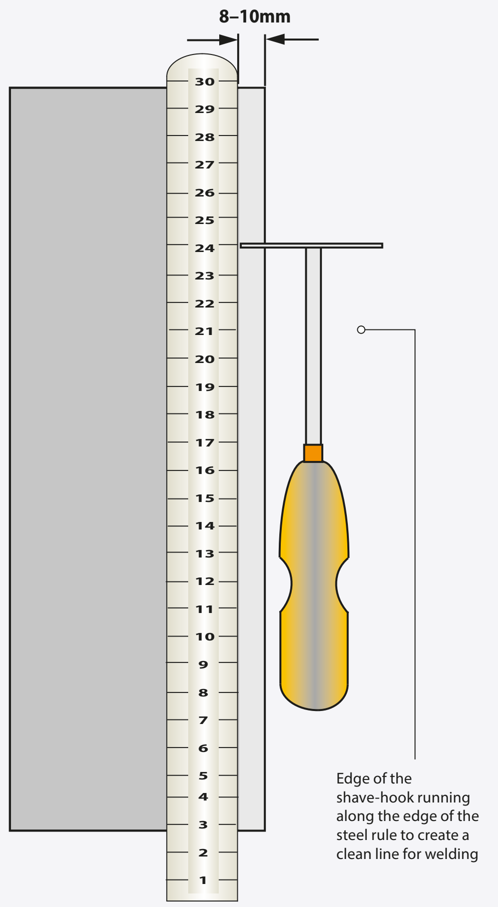
STEP 4 **Cleaning the filler rod** — as with the weld itself, do not forget to clean the filler rod. It is just as important as a clean weld area.

STEP 5 **Setting up the lead welding equipment** — Before lead welding can take place, the gas pressures n both the oxygen and acetylene must be set. The pressure on both gauges must be constant at 0.14bar (2psi). The procedure for this is as follows:

- *Ensure that the correct sized nozzle is fitted to the blowpipe. This should be a size 2 or 3 depending on the code of lead being welded.*
- *Turn on the oxygen at the control valve to the bottle half a turn.*
- *Turn on the oxygen at the blowpipe and adjust the governor to 0.14bar (2psi). Turn off the oxygen valve at the blowpipe.*
- *Follow the same procedure for the acetylene.*

STEP 6 **Make sure you have the correct PPE available** including a full face mask. A full mask is preferable to safety goggles because it protects all of the face from lead splatters.

Cleaning the lead



Now let's look at the welding procedure itself.

The lead welding procedure

Now the weld is prepared, the blowpipe can be lit:

STEP 1 Turn on the acetylene at the blowpipe first by turning the valve quarter of a turn and light with the spark igniter. The initial flame should be between 50mm and 75mm long.

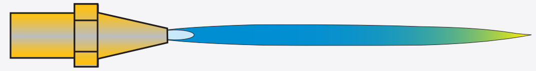
STEP 2 Turn on the oxygen and add a little at a time. The flame picture will begin to change colour and shape from yellow, through white and finally blue.

STEP 3 Setting the flame — a good flame leads to a good weld. The flame must be hot enough to melt the lead in a controlled manner without being too hot. To achieve this, it must have the right balance of acetylene to oxygen. There are three types of flame but only one of these is suitable for lead welding:

- ***The neutral flame*** *— the correct oxygen to acetylene ratio. The flame picture is a stable long blue flame with a slightly yellow tip and a bright blue inner cone. The inner cone has a rounded tip. This is a good lead welding flame.*
- ***The carburising flame*** *— Too much acetylene. This is an unstable yellow flame that may release particles of black acetylene soot. Unsuitable for lead welding.*
- ***The oxydising flame*** *— Too much oxygen. This flame is too hot for welding and may even melt holes in the lead. It is recognised by being a two-tone blue flame of long thin appearance. The inner cone is pointed with a violet hue. Unsuitable for welding.*

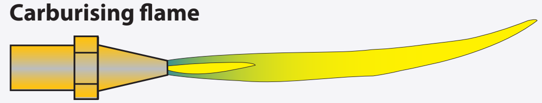
The flame

Neutral flame



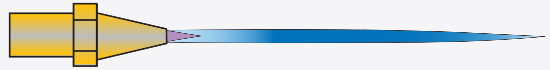
Neutral Flame. Stable with a blue colour and a slightly yellow tip. Bright blue inner cone with a rounded tip which is the hottest part of the flame. Correct ratio of Acetylene and Oxygen.

Carburising flame



Carburising flame. Bright yellow, unstable flame. Lightly visible yellow inner flame. Excess Acetylene and not enough Oxygen.

Oxidising flame



Oxydising flame. Long pointed two-tone blue flame with a pointed, violet coloured inner cone. Excess Oxygen and not enough Acetylene. This flame is too hot for lead welding.

STEP 4 Observe the pressure gauges. They should be reading identical pressures with steady flow of gas.

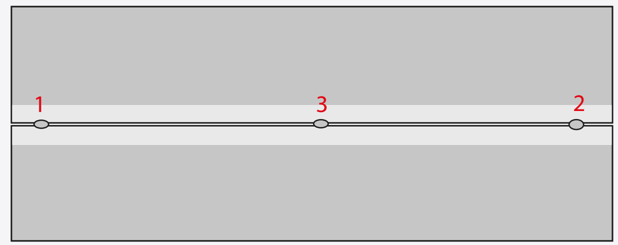
When the correct flame has been set, continue with the weld.

STEP 5 Tack the weld. This holds the weld together during the welding process and stops the weld from opening as the weld progresses. When the weld has been tacked, dress it down. The lead expands locally when it is heated by the blowpipe and will rise slightly causing a hollow point under the lead. This could turn into a hole as the weld progresses if the lead has no support underneath it.

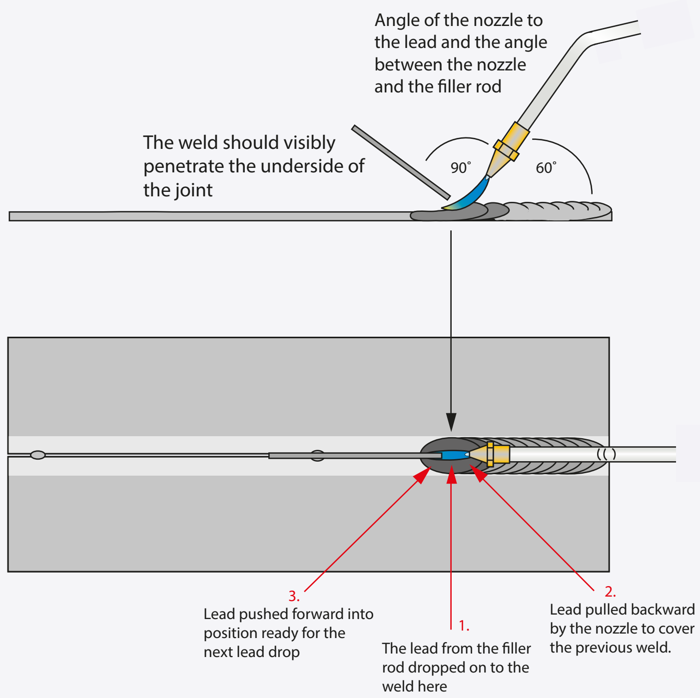
STEP 6 The weld can now be started by creating a pool of molten lead at the beginning of the weld and introducing the filler rod:

- *Hold the blowpipe at 60° to the lead and introduce the flame. Within a moment or two, a small silver pool of molten lead will appear.*
- *Put the filler rod in the direct path of the flame, ensuring that the angle between the blowpipe and the filler rod is approximately 90°. A drop of lead will fall into the molten pool.*
- *Move the droplet of lead first backwards to cover the weld and then forwards to create the position of the next lead droplet as shown in the diagram below.*
- *Continue this process along the length of the weld.*
- *Remember to dress the lead periodically in front of the weld.*

Step 1: Tacking the lead



Step 2: The lead welding process



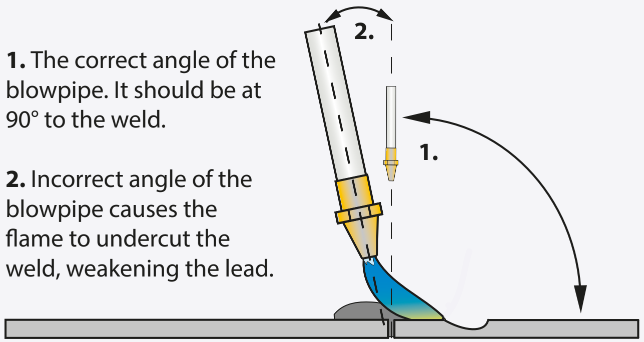
Undercutting

Undercutting of the lead occurs when the angle of the blowpipe is incorrect. To produce a successful weld, the blowpipe must be held at 90° to the lead as it travels down the length of the weld. Any variation will cause the flame to deflect to one side, melting the lead sheet in a non-weld position. This has the effect of weakening the lead, making it susceptible to fatigue cracking.

Undercutting

1. The correct angle of the blowpipe. It should be at 90° to the weld.

2. Incorrect angle of the blowpipe causes the flame to undercut the weld, weakening the lead.



Lead welded external and internal corners

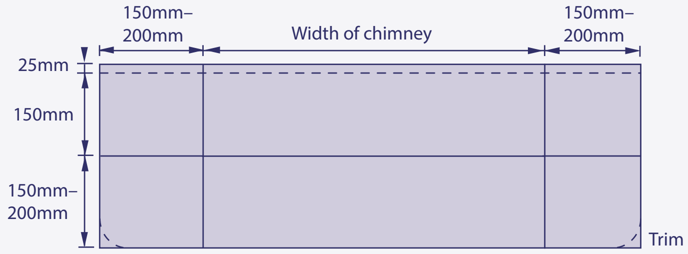
As with the bossing techniques we looked at earlier, external and internal corners can also be lead welded. Here we will look at these two simple corners.

The lead welded external corner

Used mainly on chimney front aprons, the external corner uses the butt welded joint. The procedure for setting out the joint is as follows:

STEP 1 Mark the lead the same as for the bossed apron using a marker pen and a steel rule. The measurements are shown in the diagram below:

Marking out the lead welded apron



STEP 2

Set the roof angle by lifting the lead along the horizontal line to the required roof pitch and cut the horizontal line to the edge of the chimney represented by the vertical line.

Cutting the line

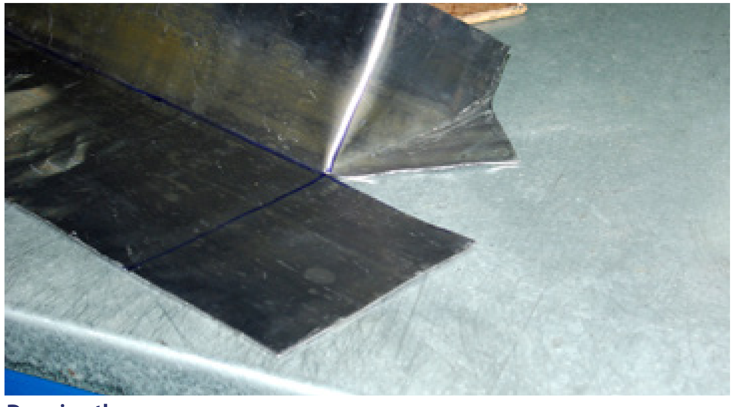
STEP 3

Whilst maintaining the roof pitch, bend the chimney line at 90° and make a second crease in line with the apron.

Bending the chimney line

STEP 4

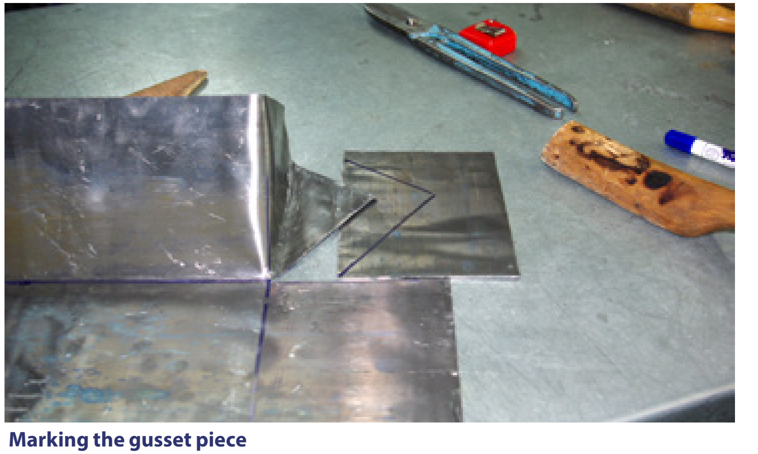
Dress the apron ready for the gusset piece.



Dressing the apron

STEP 5

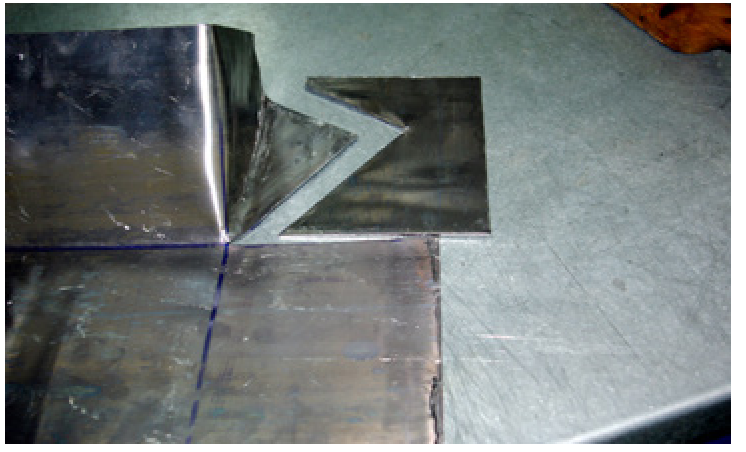
Cut a fresh piece of lead big enough to fill the gusset and place it underneath the apron. Mark the gusset on the new piece of lead.



Marking the gusset piece

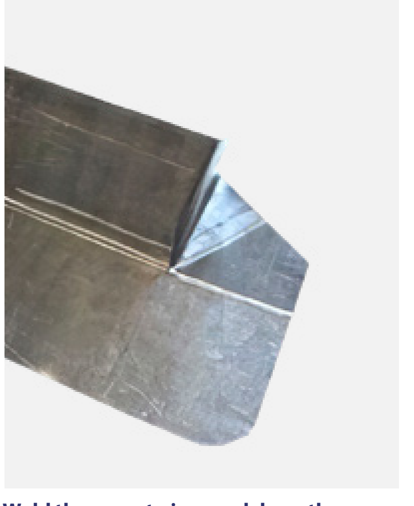
STEP 6 Cut the gusset piece and check to ensure a good fit with the on the apron.

STEP 7 Clean the weld with a shave hook and weld the gusset piece, dress the apron and trim

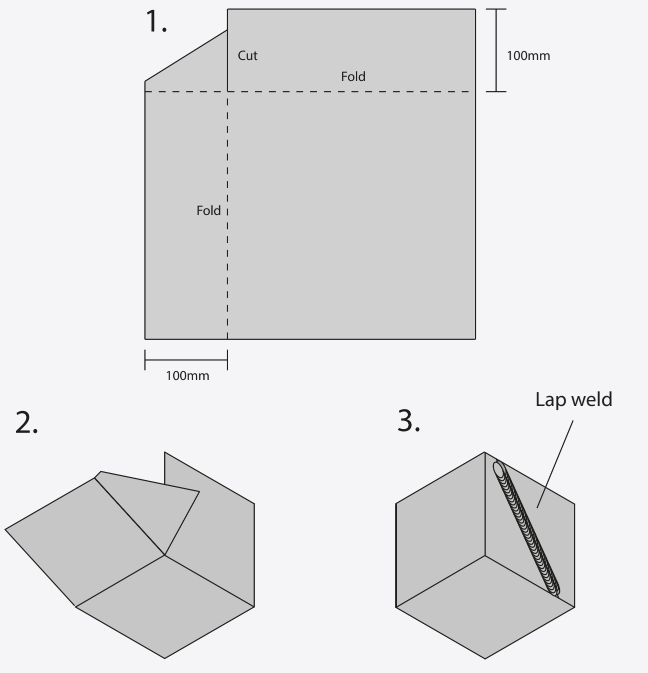

Cut the gusset piece

The lead welded internal corner

This involves cutting and folding as shown in the diagram and a lap weld to complete the corner. The fabrication process is as follows:


Weld the gusset piece and dress the apron

Marking out the lead welded internal corner



STEP 1 Mark out the corner using a marker pen and a steel rule and cut the angle as shown in point 1 of the diagram.

STEP 2 Fold the corner as shown in point 2, ensuring that the sides are at 90° to the base of the lead.

STEP 3 Clean the weld with a shave hook and weld the lead with a lap joint as shown in point 3.

Safety when using portable lead welding equipment

REMEMBER

- Oxygen and acetylene bottles should be stored separately in a well ventilated compound.
- Full bottles should be stores away from empty bottle.
- Empty bottles should be marked 'M/T'.
- All gas cylinders should be stored in the upright position on a firm level base and should be tied to prevent falling.
- Oxygen must be kept away from any grease or oil as this produces spontaneous combustion.
- Acetylene must be kept away from any copper materials as this produces an explosive mixture.
- Always handle bottles with extreme care. Do not drop or roll gas cylinders and bottles.
- Always check the condition of the hoses before use to ensure they are in a good safe condition.
- Always fit flash back arresters to both oxygen and acetylene hoses before use.
- Always have firefighting equipment near when carrying out lead welding activities.
- Always turn off the bottles after use and purge any gas left in the hoses.

CHAPTER 5

Simple lead flashings

Simple lead flashings

Simple lead flashing that are to be found on all types of buildings include:

- Lead slate
- Abutment flashings:
  - *Step flashing with soakers.*
  - *Step and cover flashings*
  - *Single step with soakers*
- Valley gutters:
  - *Open valley gutters*
  - *Secret valley gutters*
- Chimney flashings:
  - *Front apron*
  - *Back gutter*
  - *Step flashings with soakers*
  - *Step and cover flashings*

Lead slate

Where a pipe or a flue penetrates a roofline, the gaps around the pipe will require weatherproofing. For most domestic properties this is most likely to be a 110mm soil pipe. This is done by the use of a lead slate.

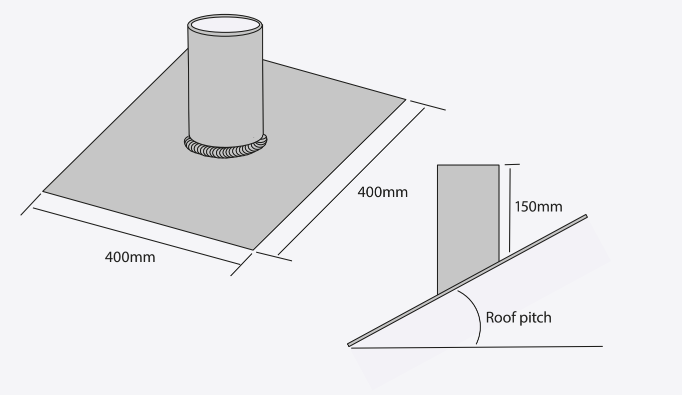
There are two pieces of information we require to produce a good lead slate:

- The size of the pipe
- The pitch of the roof

A lead slate is made from two sections of lead:

- The base — for a 110mm lead slate, the base should be 400mm x 400mm, Code 4 lead.
- The up-stand — also manufactured from Code 4 lead and designed to fit the roof pitch and the size of pipe.

A lead slate



Development of a lead slate

STEP 1 Determine the circumference of the pipe that the slate is to fit using the equation 2πr. For instance, if the diameter of the pipe is 110mm, then the calculation is as follows:

$$2\pi r = (2 \times 3.142\ (\pi)) \times 55 = 345.62mm.$$

Now divide by this by 16. This divides the circumference into 16 equal parts:

$$345.62 \div 16 = 21.60.$$

This measurement will need to be increased as there will be no movement in the slate to allow it to be fitted over the pipe. It will be far too tight, so:

$$16 \times 22 = 352mm.$$

Round this up to 22mm and multiply by 16.

The extra 7mm will allow clearance for the pipe to go inside the slate easily.

STEP 2 Determine the radius of the lead slate by transposing 2πr using the new circumference of 352mm:

$$352 \div (2 \times 3.142) = 56mm.$$

STEP 3 Draw a circle with a radius of 56mm and divide the circumference into 16 equal parts, each measuring 22mm.

STEP 4 Immediately above the circle, draw the angle of the roof pitch as shown in the diagram.

STEP 5 At each marked point on the circle, draw a line vertically upwards until each one meets the roof pitch line and number the points on the circle 0 to 8 starting on the right with 0 to 8 on the left.

STEP 6 From point 8 on the roof pitch line, mark a horizontal line that extends at least the diameter of the pipe + the circumference measurement. Add 30mm to ensure the template will be clear of the pipe. Line measurement = 112 + 352 + 30 = 494mm.

STEP 7 From the right hand side of the horizontal line, measure the circumference measurement of 352 and mark the 16 divisions as shown. Now, number them starting on the right with 8 to 0 to 8.

STEP 8 Now repeat the previous procedure for the 0 line and number 8 to 0 to 8.

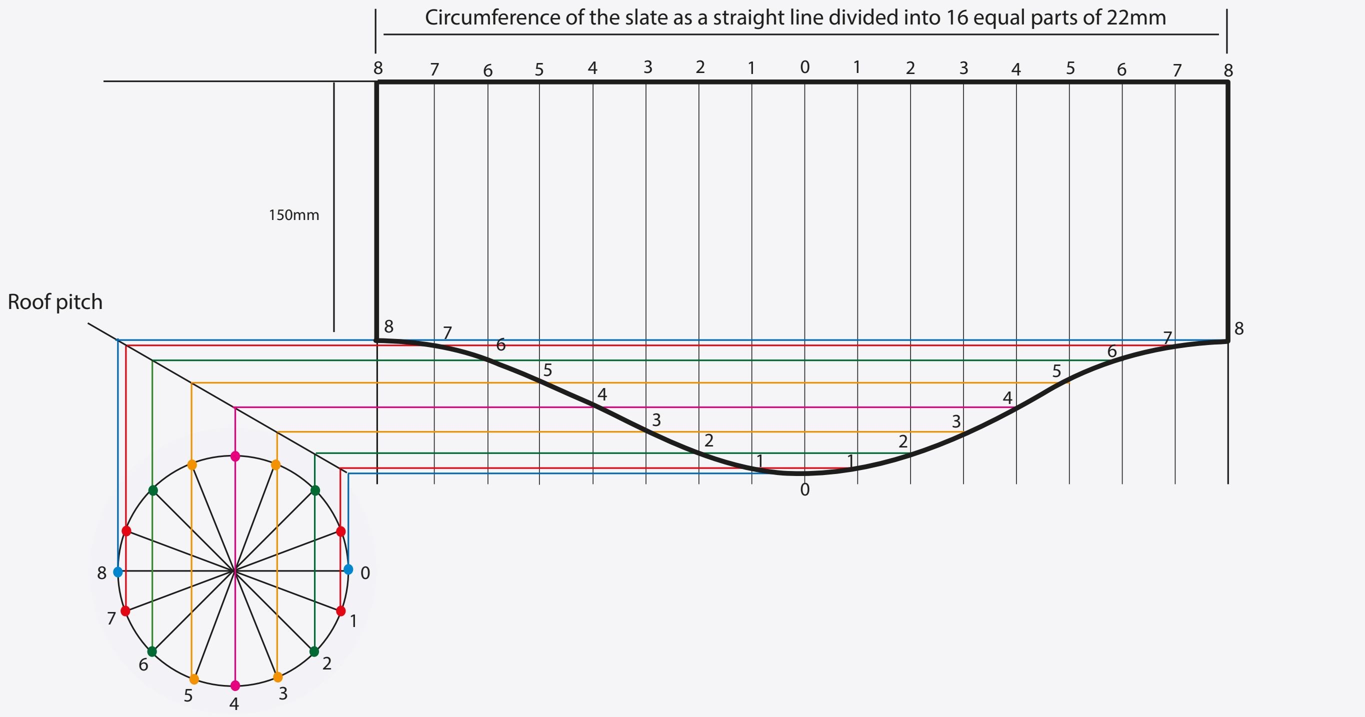
STEP 9 Draw vertical lines from the 8 line to meet the 0 line at all 16 points as shown on page 45.

STEP 10 Now draw each point on the circle up to the roof pitch line and across. Apart from 0, each number will appear twice, once at the left hand side and once on the right.

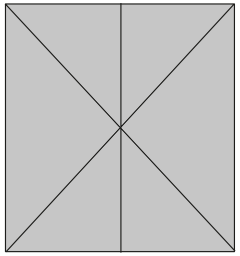
STEP 11 With points 8 to 0 and 0 to 8 marked, draw the curve line freehand.

STEP 12 Measure up from the 8 line 150mm and complete the template as shown in the diagram. We can now use this template to make the lead slate.

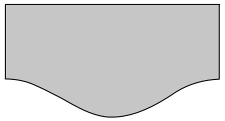
Development of a lead slate



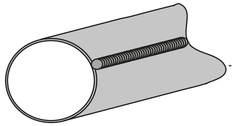
Fabrication of a lead slate



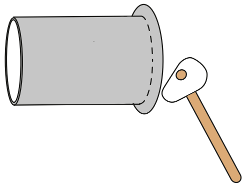
STEP 1 Cut a piece of Code 4 lead sheet 400mm x 400mm. Mark the lead as shown. This will allow the up-stand to be centred on the base and the weld on the up-stand to be in the correct position.



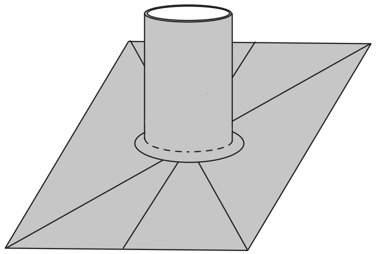
STEP 2 Mark out the outline of the Up-stand template previously developed on to a piece of Code 4 lead sheet



STEP 3 Roll the lead around the pipe to form the up-stand and clean either side of the joint. Using a wooded support, weld the lead into a pipe shape using a butt weld.



STEP 4 Boss a 25mm flange around the bottom edge of the up-stand using a bossing mallet.



STEP 5 Place the up-stand on the base and centre using the cross marks as a guide. Ensure that the upstand weld is in line with the centre line. Weld the upstand to the base using a lap weld. Cut the hole for the pipe with a pair of tin snips.

Abutment flashings

Where a raking (pitched) roof butts up to a wall, this is called an abutment. The joint between the tiles of the roof and the wall will need to be weathered to ensure that rain does not penetrate the dwelling or the space below the roof. For double lap natural slates and plain clay roof tiles (often called rosemary tiles) this will involve the use of a step flashing (often called a stepped side flashing) and soakers. For single lap, concrete interlocking roof tiles, a step and cover flashing should be used.

Horizontal and raking abutment flashings should extend over the tiles for at least 150mm. This should be increased to 200mm where flat single lap interlocking tiles are used, especially in exposed positions. A secret gutter with a step flashing can be used as an alternative.

Code 3 lead sheet is only suitable for soakers and Code 4 is the minimum thickness to use for all other flashings. The setting-out and fabrication of the steps is the same for both flashings with soakers and for step and cover flashings over single-lap tiling. These will be discussed later in the chapter.

Abutment flashings — step flashing and soakers

Soakers

Soakers are small pieces of Code 3 lead that weatherproof the wall/roof joint at every tile. They are easy to form using a flat dresser and tinsnips. The width of the soaker is always the same: 100mm across the tile + 75mm upstand — 175mm.

The length of the soaker will depend on the length of the tile, the lap given to each row of tiles during the roof construction and the gauge of the tiles (distance between the roof laths, These are the battens that the tiles are fixed to). The table below shows the dimensions, lap and gauge of common clay tiles:

Clay plain tiles					
Tile name	Size	Min. roof pitch	Max. roof pitch	Min. lap	Max. gauge
Rosemary	265 x 165	40°	Vertical	65	100
Cheslyn	265 x 165	40°	Vertical	65	100

The table shows that for a rosemary tile, the lap is 65mm and the gauge is 100mm. The calculation to determine the length of soaker is:

Gauge + Lap + 25mm

So, for rosemary tiles, the soaker length would be:

100 + 65 + 25 = 190mm

and the width would be: ***175mm.***

The total number of soakers required for an installation would, obviously, depend upon the number of rows of tiles. Each soaker should be marked and formed as shown in the diagram below.

To calculate the number of soakers required, simply divide length of the step flashing required by the gauge of the tile.

For example, if the gauge of the tile is 200mm and the length of step flashing required is 2.4m, then:

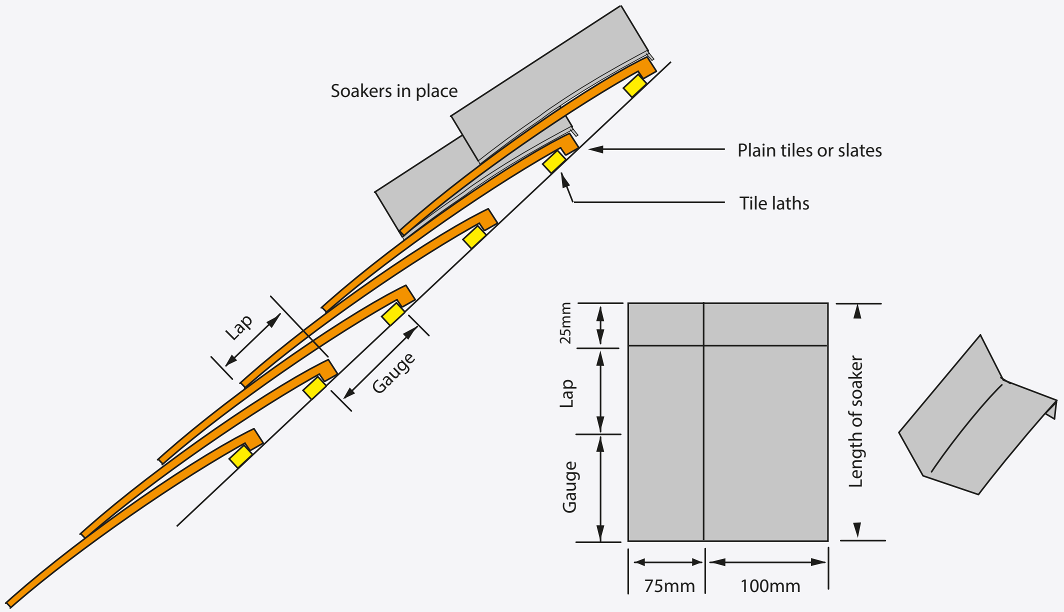
2400mm ÷ 200mm = 12

So, a step flashing 2.4m long, with a gauge of 200mm will require 12 soakers.

Each tile at the abutment will have its own soaker and these should be placed with the soaker on top of the tile with the upstand against the wall as shown. The 25mm turn-down holds the soaker in place. The next tile is then placed on top of the soaker and so on.

When all soakers are in place, the step flashing can then be fabricated.

Development of soakers



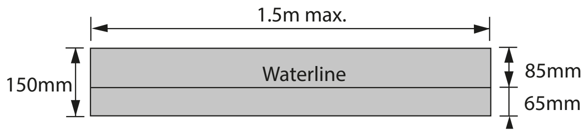
Calculation for soaker: Gauge + lap + 25mm = length of soaker

Step flashing

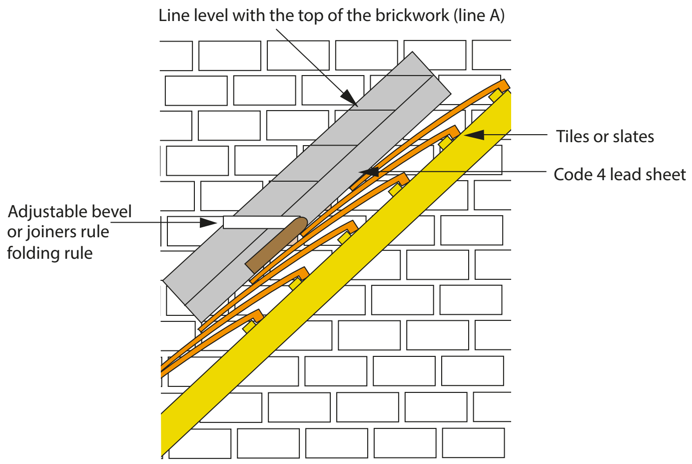
The job of the step flashing is to cover the gap left at the back of the soakers. It is fabricated as a step in line with the brickwork mortar joints as they rise up the roof. The maximum length of any step flashing is 1.5m and it should begin at the lowest part of the roofline, rising up the roof with the next step flashing overlapping the previous by 75mm measured vertically.

The width of the step flashing is 150mm, this allows for a water line of 65mm and steps of 85mm. The lead sheet should be marked as shown in the diagram. The procedure for fabricating a step flashing is as follows:

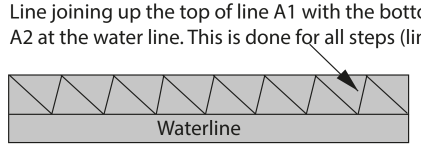
STEP 1 Cut a piece of 150mm wide Code 4 lead 1.5m in length and mark a 65mm waterline.



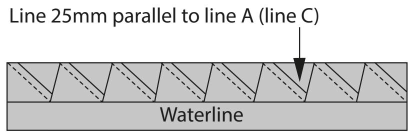
STEP 2 Place the lead on the roof so that it is resting on the edge of the tiles as shown. Start at the bottom of the roof and work upwards. If the step flashing is the first piece, allow 75mm to turn around the corner. Now mark all of the brickwork joints covered by the flashing. Mark the lead at the top of the brick and carry the line across to the waterline. This is easier if an adjustable bevel or joiners folding rule is used set at the correct angle. This is shown on the diagram as line 'A'. Alternatively, a steel rule may be used. Accuracy is the key here. If the marks are accurate then the step flashing will fit perfectly.



STEP 3 The next step is to join the beginning of line 'A' at every brick with the water line so that it touches the 'A' line below it at the water line (see drawing). These are the steps of the step flashing that will be on show. It is shown as line 'B'.

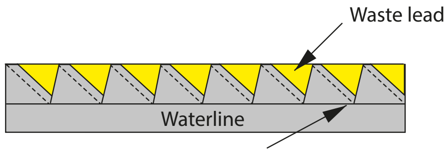


STEP 4 The step flashing should allow a 25mm for turning into the brickwork. This is shown as line 'C' and can be marked parallel to line 'A' at every step.



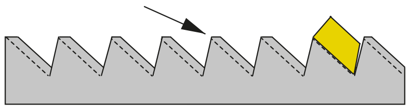
STEP 5

Using tin snips, carefully cut down every line 'B' to the water line and cut line 'C' until the scrap piece of lead falls away. Save the scrap lead as this can be used to make the lead wedges that will hold the flashing in place once it is completed.



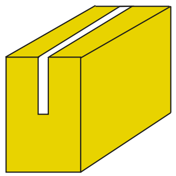
STEP 6

Bend the turn-in line 'A' at 90° to the step flashing. This can be done by using a step turner or a flat dresser. A step turner can be easily made by cutting a piece of 75mm x 40mm piece of planed timber 200mm long and cutting a grove large enough for the thickness of Code 3 lead down the centre.



STEP 7

The flashing can now be installed and fixed using lead wedges. We will take a closer look at wedges and other fixings for lead a little later in the chapter.



Step and cover flashings

These are designed to weather the joint created by contoured concrete interlocking single lap tiles when placed against an abutment wall. Examples of contoured tiles are shown below.

Example of interlocking tiles

Visually, these are very similar to step flashings with soakers, the difference being that they continue partially over the first line of tiles. There are no soakers.

The method of forming the steps is exactly the same as previously shown. The difference here is that there is an extra 170mm of sheet lead, which is turned over the tiles and dressed over the tile profile. Care must be shown or there is a risk that tiles will be broken during the dressing process. The steps should be fixed with wedges at every step.

Single step flashings

Single step flashings are usually used where the dwelling is built from stone and the wall may contain blocks of unequal size and shape. In these situations, a normal step flashing would be almost impossible to install so individual steps are fitted which can be cut according to the size of the stone. Each step should overlap the previous step by a minimum of 50mm.

Valley gutters

A valley gutter is installed at the internal intersection between the two pitched roofs.

There are two basic types:

- **The open valley gutter** — this is probably the most common method of forming a valley gutter between two slated or tiled pitched roofs. Tilting fillets are installed to support the roof tiles so that the distance between the two tiled roofs will give a distance of 125mm. An allowance of 25mm for tile overhang of the tilting fillets should be made.

  The lead should be Code 4 and around 600mm wide with pieces of 1.5m in length. The laps should be 75mm when measured vertically. The valley should be started at the lowest point, laid into the valley and dressed over the tilting fillets and nailed with copper nails at the fillets every 150mm.

- **Secret valley gutter** — similar in construction to the open valley, the main difference being that the edge of the tiles is only 25mm apart and the lead lining is 500mm instead of 600mm. The narrow opening of the gutter means that it is not easily seen, and this is considered more aesthetically pleasing than the open valley. It does, however, have several disadvantages:

  – *Access for repairs and maintenance is a problem.*

  – *Secret valley gutters tend to block with leaves very quickly.*

  – *Cleaning the gutter is difficult.*

Chimney flashings

The type of chimney weathering set will depend on the type of tiles fitted to the roof. In this part of the chapter, we will look at the type of chimney weatherings for use with:

- Double lap plain clay roof tiles and natural slates.
- Single lap contoured and flat concrete interlocking roof tiles.

Chimney flashings used with double lap, plain clay tiles or natural slates

A chimney weathering set where the roof is double lap plain clay tiles or natural slates, the weathering set will contain the following flashings:

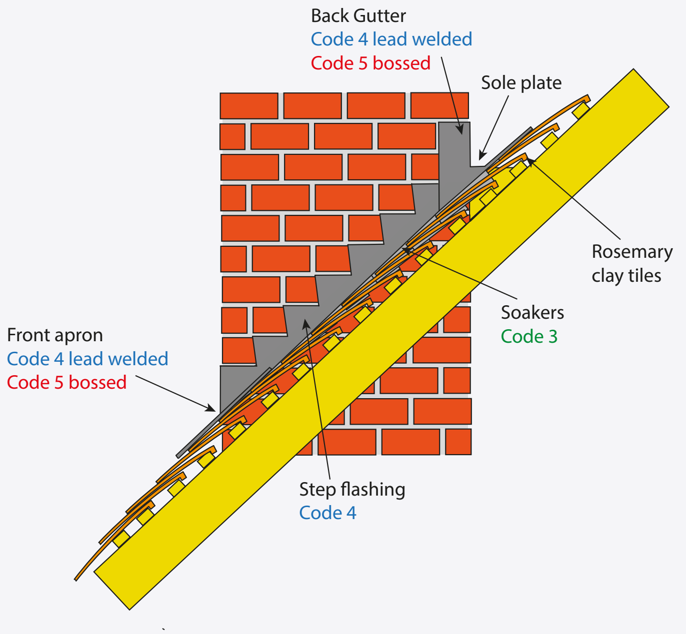
- **Front apron** — as we have already seen, this can be lead welded from Code 4 sheet lead or bossed from Code 5. The front apron is the first flashing to be fitted to the chimney.

- **Soakers and step flashing** — soakers made from Code 3 lead sheet and the step flashing from Code 4 lead sheet. The setting out of the soakers and flashing was covered earlier. The first soaker is placed on the top of the first tile lapped over the front apron. A soaker is required at every subsequent tile at the abutment to the chimney. An allowance of 100mm should be made at the lowest part of the step flashing for turning around the front apron.

- **Back gutter** — this flashing is the last major part of the chimney weathering set. It is used to weatherproof the back of the chimney. Its layout and dimensions are shown below. Like the valley gutter, a tilting fillet is fitted to support the tiles.

  The back gutter can be fabricated and lead welded form Code 4 sheet lead or bossed using Code 5 sheet lead. Bossing a back gutter is a tricky operation and should only be attempted by experienced plumbers.

Chimney weatherings



Chimney flashings used with single lap concrete interlocking tiles

The major difference with this type of tile is the use of a step and cover flashings at the abutment rather than the use of step flashings with soakers. Both front apron and back gutter remain the same. The step and cover flashing can be lead welded where the flashing turns around the front apron. This requires the use of Code 4 lead sheet. Where the flashing is to be bossed with an external corner, Code 5 lead should be used.

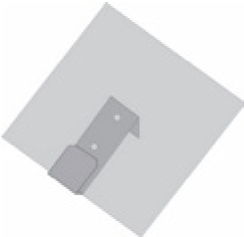
Fixings for sheet lead

Fixings for sheet lead are used to hold the lead in position and to prevent wind lift. Many lead fixings fail because the fixing position is unsuitable for the exposure to the weather that the sheet lead is likely to encounter. Also, lead tends to drop because of its weight and so regular spacing and the correct type of fixing is important. There are several methods of fixing that can be used with lead sheet. These are:

- **Nails** — copper or stainless steel clout nails should be used with *barbed shanks* to prevent the nail from pulling out under the weight of the lead. Galvanised steel clout nails should not be used.

> **What is a barbed shanked nail?**
>
> *A barbed shanked nail has grooves cut into the shank. This makes the nail difficult to pull out once it has been driven into the wood. Barbed shanked copper nails are ideal for simple fixing of lead sheet.*

- **Screws** — brass or stainless steel screws in conjunction with stainless steel washers. Stainless steel screws and washers should be used when the brickwork joints are larger than 18mm.
- **Clips** — these are strips of metal that are fixed underneath the lead and then bent over to secure the lead in position. Clips should be spaced at 300mm to 500mm intervals depending on the exposure. They can be made from several different metals:
- **Lead sheet** — only suitable for sheltered exposure where the risk of strong winds are minimal.
- **Copper strip** — tinned copper strip 50mm wide is much more rigid than lead strip especially in exposed positions. A minimum thickness of 0.6mm copper strip is recommended.



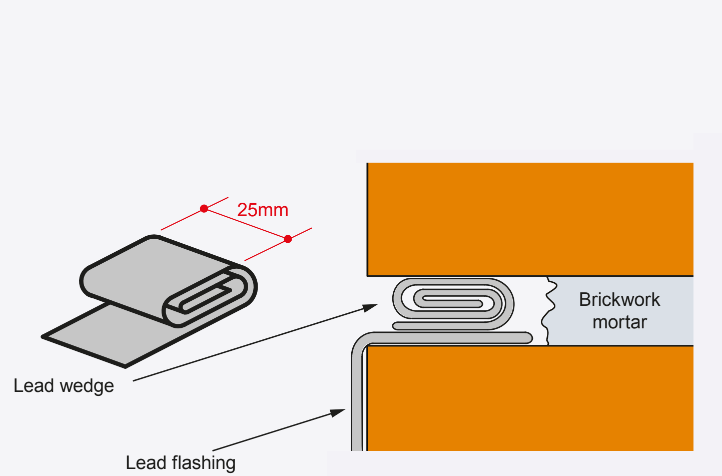
- **Stainless steel strip** — 0.4mm stainless steel is recommended for use as clips for lead sheet.

Tinned copper?

The redness of copper would be noticeable on any sheet lead installation. Tinned copper simply means that the copper strip has been cleaned and had a coating of solder applied to give it a lead-lookalike effect making it less noticeable when used with sheet lead.

- **Lead wedges** — made from scrap lead, these are small lead strips that are rolled, flattened at one end and then driven into the brick work joint with a hammer and a plugging chisel. The mortar joint can then be either re-pointed with sand and cement mortar or lead silicon sealant.
- **Borra fixing clips** — this is a simple spring clip made from stainless steel that takes the place of lead wedges when fixing lead sheet into brickwork joints. Using the clip will securely fasten the lead flashing in place in accordance to BS6915, which recommends that fixings are placed at 450mm maximum centres.

Lead wedges



REMEMBER

Almost all lead work installation is carried out at high level, so access to the work area, such as chimneys, should be carefully considered. A tower scaffold should be used wherever possible, with a dedicated chimney scaffold used to gain access to the work area. The following points should be followed:

- Protect the customers' property at all times. Walk boards should be used where garden access is required and always ask the customer to move any vehicles that may be in danger of being damaged.
- Always report any additional problems to the customer that may be found whilst working at high level such as broken or missing roof tiles.
- Always carry a fire extinguisher when lead welding on or near a roof. A 'Hot Works Permit' may be required on many properties, especially historic buildings.
- Be aware of the rules when working at height.
- Do not attempt to lift rolls of lead by yourself. This should be done using mechanical lifting apparatus if available. If not, a two man left method should be used.

Preparation and installation of sheet lead

The installation of sheet lead should be carried out in a relatively clean area, free from debris. When dressing out the lead prior to fabrication, the area should be thoroughly swept to ensure there is nothing below the sheet that could puncture the lead.

The work area should be prepared before the installation takes place. This will include:

- Removing any old, existing lead before installation takes place.
- Listed Building Consent (LBC) is required for the removal of lead, in all its forms, from designated heritage assets. It is a criminal offense to remove such fabric under the under the Planning (Listed Buildings and Conservation Areas) Act 1990 without LBC.
- Raking out any brickwork joints to a depth of 30mm where the lead is to be fitted such as on abutment flashings. This can be done using a 110V angle grinder (wearing the appropriate PPE which will include goggles and face mask) or a plugging chisel and club/lump hammer.
- Ensuring that there are no sharp edges or raised nail heads in back gutter boards and valley gutter boards. These could puncture the lead.
- Keep a clean working area at all times.

When installing the lead:

- The lead sheet should be installed working from the bottom upwards so that the upper piece overlaps the lower.
- Laps in horizontal pieces should be at least 100mm and pitched laps should be to the recommended distances according to the angle of the pitch.
- Clips and fixings must be installed to BS6915 and according to the exposure of the flashing.

When the lead has been installed, seal any joints in the mortar using lead specific high-performance silicone-based sealant. This has been specially formulated for use with lead sheet flashings for pointing between lead and brickwork or masonry. Lead silicone sealant:

- Provides a long term, flexible joint.
- Avoids the problems of pointing with wet mortar, particularly in hot or frosty conditions.
- Is quicker, cleaner and easier to use than cement mortar.
- Is Lead Sheet Association recommended.

On completion, all lead work should be treated with patination oil before being tested with water where possible to ensure that are no leaks.

Patination oil

Patination oil is a white spirit based liquid that provides a protective coating against the formation of a grey/white patina of lead oxide on the leads surface. Without patination oil, the patina washes off during normal rainfall forming unsightly white streaks on brickwork and roof tiles. Patination oil provides a clean metallic surface removing any light oxidisation when applied correctly.

Patination oil should be applied in one direction only using a soft cloth and should be completed at the end of every day to avoid discolouration of the lead overnight.

Maintenance of sheet lead

Lead, when installed correctly, should require very little maintenance. It should, however, be periodically checked to ensure that:

- Cap flashings and step flashings are correctly in place and that the cement mortar is not cracked, loose or missing.
- Fixings and clips are in place and holding the lead properly.
- Soakers on abutment flashings have not slipped.
- There are no signs of water penetration, such as daylight showing in a roof space where the front apron has lifted due to wind lift.
- Any re-fixing of lead components is completed with in accordance with the British Standard recommendations.
- Repairs are tested with water from a watering can or hosepipe to ensure that there are no leaks.

CHAPTER 6

Conclusion and acknowledgements

Conclusion

Working with sheet lead is one of the most complex of all the skills to undertake as we develop our knowledge and understanding of plumbing leadwork. It is true to say that most lead roof work is now completed by specialist companies who deal with nothing else but specialist lead roofing from new buildings to renovation of historic buildings. It is important to remember, however, that lead roof work traditional decorative leadwork and the fabrication of lead pipes, gutters and rainwater heads is the most traditional part of a plumber's repertoire and that these ancient skills may still needed for conservation work as well as new housing developments.

This guide has been but a brief insight into sheet leadwork installations, the beginning of a much larger skill that deserves careful consideration as career direction. To discover more about sheet lead and the methods of installation, visit the Lead Sheet Training Academy at **leadsheet.co.uk**

Right: The 13th Century Chapter House roof of Southwell Minster in Nottinghamshire. A six-sided sandcast lead roof, that looks double thanks to the herringbone roof design. Re-roofed during renovations in ca.1879

Acknowledgements

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