Section 5 – D/602/2682

Understand and carry out site preparation, and pipework fabrication techniques for domestic plumbing and heating systems
D/602/2682 - Understand and carry out site preparation, and pipework fabrication techniques for domestic plumbing and heating systems

This combination unit provides learning in a range of basic pipework competences that underpin work on plumbing and heating systems. The unit also provides an introduction to the range of work activities carried out in plumbing and heating as well as methods of checking that pipework and plumbing and heating components are leak free. On completion of the unit the learner will:

LO1. Know the types of hand and power tools used for domestic plumbing and heating work
LO2. Know the types of domestic plumbing and heating pipe work and their jointing principles
LO3. Know the general site preparation techniques for plumbing and heating work
LO4. Be able to apply general site preparation techniques for domestic plumbing and heating work
LO5. Know how to use clips and brackets to support domestic plumbing and heating pipe work and components
LO6. Be able to apply fixings and brackets to domestic plumbing and heating pipe work and components
LO7. Know the installation requirements of domestic plumbing and heating pipe work
LO8. Know the inspection and soundness testing requirements of domestic plumbing and heating pipe work
LO9. Be able to inspect and soundness test domestic plumbing and heating pipe work

Learning Outcomes highlighted in Red indicates that these are covered by practical tasks from the learner practical portfolio and will not appear in this book.
Learning Outcome 1

Know the types of hand and power tools used for domestic plumbing and heating work.
There are four Assessment Criteria in Learning Outcome 1:

**AC1.1.** State the purpose of hand and power tools used to carry out work on plumbing and heating systems.

**AC1.2.** Identify the different types of hand and power tools used to carry out work on plumbing and heating systems.

**AC1.3.** State how to safely use and maintain hand and power tools to carry out work on plumbing and heating systems.

**AC1.4.** Identify pipe work materials used in domestic plumbing and heating work.

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**AC1.1** State the purpose of hand and power tools used to carry out work on plumbing and heating systems

and

**AC1.2** Identify the different types of hand and power tools used to carry out work on plumbing and heating systems

There are many different tools that a plumber/heating engineer should have in the tool kit. Some general tools such as screwdrivers, saws and hammers, but others are specialised, such as pipe cutters, pipe benders and soldering equipment.

In AC1.1 and AC1.2, we will look at some of the more common tools and their uses, as well as investigating those tools more specific to plumbers and heating engineers.

### Hand Tools

**Flat Blade Screwdrivers**

Used with slotted screws. The blade of the screwdriver is available in many sizes and it is important to use the correct sized blade for the size of screw.
Phillips Screwdrivers

The Phillips head screw driver was designed to prevent overtightening by ‘riding out’ when the screw became tight. Largely superseded by the pozidriv screwdriver.

Pozidrive Screwdrivers

Similar in appearance to the Phillips screwdriver except that the head has an eight pointed star instead of four. This ensures a better grip in the screw head. It is not compatible with Phillips screws.

Star head Screwdrivers

Also known as Torx screwdrivers, these are seldom used except in appliances and specialist installations.

Claw hammer

These are dual purpose hammers used for driving in and extracting nails from wood. The head is made from forged steel for strength, with the handles being made from a variety of materials including steel, wood and carbon fibre.

The claw is used in conjunction with the handle to form a lever for extracting nails.
Club/Lump hammer

Designed for heavy duty hammering, such as breaking masonry and concrete. Can be used with masonry and bolster chisels.

Masonry Chisels

As the name suggests, masonry chisels (also known as cold chisels) are used with a lump/club hammer for breaking masonry and concrete. There are many different types of masonry chisels that can be used for a variety of applications. Chisel types include plugging chisel, bolster chisel and flat cold chisel. Many chisels are now supplied with hand guards to prevent hand injuries when using these tools.

Wood Chisels

There are many different types of wood chisels available. Plumbers generally use them when notching floor joists.

Care should be taken when using these tools as the blades can be extremely sharp, especially when the chisels are new. To prevent injury, always replace the blade guard after use.

Combination Pliers

These are a type of pliers used by electricians and other tradesmen primarily for gripping, twisting, bending and cutting wire and cable.

They are also known as Linemen’s Pliers.
Long nose Pliers

Also known as needle nose pliers, these are especially useful for getting into tight spaces because of their long thin jaws. They are predominantly used to bend, re-position and snip wire. Their long nose gives good control while the conveniently positioned cutting edge near the pliers' joint makes them particularly useful all-round tool.

Circlip Pliers

Many modern taps and valves have circlips keeping the head workings in place inside the tap body. Often, the only way these can be safely removed without breaking them is by the use of circlip pliers.

Made in a variety of sizes, these are a very useful addition to a plumber’s tool kit.

Water Pump Pliers

Instantly recognisable as a plumber’s general purpose tool, water pump pliers are used to grip, tighten and loosen compression fittings, unions and nuts and bolts. They are available in a range of sizes.

It is recommended to have at least two pairs in various sizes.

Mole Grips

Also known as the ‘portable vice’, mole grips provide a very secure vice-like grip. They are especially useful for holding materials in a secure position while they are permanently fixed, soldered or welded.
Spanners

Adjustable Spanner
Along with water pump pliers, the adjustable spanner is probably the most used tool in a plumber’s tool kit. It is generally used to tighten compression fittings and unions, and is particularly useful for use on chromed and gold plated fittings as the smooth jaws do not mark the plating. They can also be used to tighten nuts and bolts. A plumber’s tool kit should include 2 or 3 pairs in varying sizes.

Ring Spanner
Ring spanners are particularly useful when servicing appliances, such as gas boilers and gas fires. The ones shown in the image are ratchet type, which makes the removal of nuts and bolts much easier.

Open ended Spanner
Again, open spanners are very useful when servicing appliances.

Box Spanners
Box spanners are used to tighten taps onto sanitary appliances and kitchen sinks. Larger versions can be used to install and remove immersion heaters.

Tap Spanner
Tap spanners are used to tighten tap connectors and other compression fittings when they are installed in inaccessible places such as at the back of a bath, a washbasin or a kitchen sink. There are many different types available.
**Footprints**

Footprints are a traditional plumbers tool that are used to tighten and loosen nuts, bolts and compression fittings and unions. Care should be taken when using these as have a tendency to trap the skin on the hands and fingers if not used correctly.

**Stilson type wrenches**

Traditionally these adjustable wrenches are used by heating engineers and pipe fitters for installing and removing Low Carbon Steel pipework and fittings. However, most plumbers would also use them from time to time and so are a useful addition to a plumber’s tool kit. Various sizes are available.

**Pipe Slice**

Like the name suggests, the pipe slice is a tool for cutting copper tubes from 10mm up to 28mm. The stainless-steel cutting blade is replaceable.

For prolonged use, these tools require regular maintenance to keep the pipe rollers free from dirt and swarf.

**Wheel Pipe Cutters**

This is a general-purpose cutter for copper and stainless-steel tubes from 10mm up to 54mm sizes.

Like the pipe slice, the cutting wheels are replaceable and the pipe rollers require regular maintenance to keep them working correctly. There are many different types available.
Plastic Pipe Cutters

These simple scissor action cutters are specifically designed to cut plastic pipes with a clean burr-free edge.

Many different types are available including ratchet type cutters.

General-purpose Hand Saw

The general-purpose hand saw is extremely useful for cutting wood, plasterboard, insulation board, plastic pipe and many more materials. The saw teeth are hard point, designed to last much longer than traditional hand saws.

Hack Saw

This saw is used to cut copper tubes, plastic pipes and gutters and many types of metal including Low Carbon Steel and cast iron. They are not suitable for cutting wood.

When using a hacksaw, always ensure that the correct blade type is fitted and that the teeth are facing towards the front and that the blade tension is adequate.

Junior Hack Saw

An essential tool for cutting tubes in tight positions where access is difficult. Replace the blade regularly and always ensure the blade teeth face towards the front of the saw.
Floor board Saw

This saw is designed specifically for lifting floorboards. Not only does it have teeth along its long edge, but also on the end and partially across the top edge. This allows the floorboards to be cut whilst they are still in position.

Scissor Pipe Bending Machine

Also known as a ‘handi-bender’, this is a portable, lightweight bending machine for precision bending of copper tubes in sizes 15mm and 22mm.

Tripod Pipe Bending Machine

Similar in operation to the scissor bender, the tripod bending machine is for bending copper tubes from pipe sizes 15mm to 42mm. The main difference with this type of bending machine is that the main bending roller on the bending arm must be manually set to suit the size of pipe. If it is set too tightly against the bending guide, then throating of the copper tube will occur. Similarly, if the roller is set too loosely, then the tube will ripple on the inside face of the bend.

Internal Pipe Bending Spring

Largely obsolete since the introduction of the scissor bending machine, the internal bending spring is used to bend R250 grade copper tubes over the knee.

Always anneal the tube first before bending to prevent excessive rippling of the tube and damage to the knee.
External Pipe Bending Spring

A useful tool for bending 8mm and 10mm microbore tubing.

Spirit levels

Used for levelling appliances such as baths and washbasins, it is advisable to have two sizes of spirit level, 600mm and 1200mm.

Torpedo level

Fitted with a magnetic strip, these are ideal for levelling appliances such as boilers.

Soldering tools

Soldering and brazing torch

This blowtorch is very portable and does not require a separate hose and gas governor. It can be used for both soft soldering, silver soldering and high temperature brazing as it gives a much hotter flame, especially when used with MAPP gas. Gas usage tends to be high.

Blowtorch with separate governor and hose and separate LPG bottle

This is the traditional plumber’s soldering torch. It has a separate gas governor to control the flow of gas and a hose. The nozzles of the torch are interchangeable with various sizes being available for soldering large fittings on large size copper tubes. They are not as controllable as other blowtorches on the market.
Pipe Threading tools

Ratchet Stocks and Dies
This tool is for threading Low Carbon Steel pipes. The dies are interchangeable for different sizes of pipe. Although they can be used in situ, they are best used by fastening the pipe into a pipe vice.

Power tools

Drills

110V Power drill
There are many different sizes and types of power drill from small hand held drills to large hammer drills for drilling large holes with a core drill. Most construction power drills use the SDS system (Special Direct System) of drills and chucks as these are far more secure than those using key chucks and keyless chucks. Care should be taken with large drills as the power of the drill may cause injury to the wrist if mishandled.

110V Rotary drills
This kind of drill has a standard chuck and key. The chuck requires regular maintenance to prevent it from seizing up.

Cordless drills
There are many different cordless drills from simple screw driver drills to larger SDS drills with the power to handle core drill bits. Typical voltages are 7.2V up to 36V. They are an extremely useful tool on construction sites where a reliable 110V electricity supply is often limited.
Electric Power Saws

Circular saw
These are useful tools for lifting floorboards and notching joists. Most blades are now tungsten carbide tipped for long life. Because of the high speed that the blade rotates, they should never be used without the blade guard.

There are many different types of circular saw including cordless types.

Jig saws
Mainly used for cutting out worktops for kitchen sinks and washbasins. The blades tend to work loose and care must be exercised to ensure that the blade guards are in place before the tool is used. Many different blades are available for both wood, plastics and metals. Both 110V and cordless versions are also available.

Reciprocating saws
The reciprocating saw has few uses in the plumbing and heating trades as it is mainly used for demolition work. However, when used with a metal cutting blade it can be useful for removing old pipework etc.

Hand held electric pipe threading tool
Easy-to-use and portable, this pipe threading machine that can be used either at a pipe vice or in situ. Used for threading Low Carbon Steel pipes from ½ inch to 2 inch BSP pipe sizes.
Copper pipe socket crimping tools

These are the latest addition to the plumber’s tool kit. It is for crimping press-fit fittings on to copper tubes.

A set of jaws crimps the fitting and sealing ring to the copper tube to make a perfect, watertight joint. These are ideal where ‘hot working’ with blow torches is not allowed.

Miscellaneous and specialist tools

Hydraulic pipe bending machine

The hydraulic pipe bending machine uses the hydraulic power of oil to bend Low Carbon Steel pipe.

Frequent maintenance is essential with hydraulic bending machines and the oil level should be checked at regular intervals.

Portable pipe freezing kit (refrigerant)

Pipe freezing kits create a plug of ice to hold back water to allow maintenance and repairs to be carried out. This type uses the freezing qualities of a refrigerant gas to freeze the water.
Electric portable pipe freezing kit

The electric freezing kit relies on the vapour compression refrigeration cycle to freeze the water. Although more expensive than the refrigerant type, electric freezing kits have the advantage that they never run out of refrigerant.

Care should be taken when using any freezing kit. Gloves should be worn at all times because of the risk of frost bite.

AC1.3 State how to safely use and maintain hand and power tools to carry out work on plumbing and heating systems

When used correctly, hand tools present little or no danger to the user. Only when unsafe working practices are employed do hand tools cause harm. Accidents in the construction industry occur every year because of unsafe working practices with both hand and power tools, such as using a hammer with a loose head or lifting and lowering an electric drill by its electric flex. Many accidents involving the use of hand tools arise from:

1. Poor maintenance of tools.
2. Not wearing Personal Protective Equipment.
3. Using the wrong tool for the wrong job.
4. Using the wrong technique or using the tool outside of its safety limits.
5. Incorrect use of the tool. For example:
   a. Using a screwdriver as a chisel
6. Ignoring manufacturer’s operating instructions and health and safety guidance on the safe use of tools.

All tools can cause harm but some tools are more likely to cause injury than others. The most common tools likely to cause injury are:

- Any sharp-edged tool such as chisels, saws and knives
- Any pointed tool such as screwdrivers and bradawls.
- Hammers can cause severe hand injuries if care is not taken.
- Wrenches, pliers and grips can trap fingers.
- Pipe bending machines can cause serious hand injuries if used incorrectly or not left in a safe position after use (the bending arm should never be left in the raised position).

The safety rules to follow when using hand tools are:
1. Only use tools for the purpose they were designed for.
2. Do not use tools you are not trained to use.
3. Always replace worn or damaged tools.
4. Be careful when using sharp edged tools and always keep the blades sharp.
5. Keep moving parts oiled and free from dirt.
6. When working at height, make sure your tools are secure. Remember, a falling tool is a dangerous tool.
7. Never put sharp, pointed tools in your pocket.
8. Clean and maintain tools regularly.
9. Use appropriate PPE i.e. googles, gloves etc. when using chisels, drills and saws.

Hand tools are an important part of your job. They must be treated, cared for and used in a professional manner. By following these safety rules, many hand tool injuries can be avoided.

Use and Maintain Power tools

Power tools, like hand tools, need regular inspection and maintenance. Remember:

- Power tools should be PAT tested every 3 months.

**Do’s**
1. Inspect the tool, plug and cord before each use for signs of wear or faults.
2. Ensure that the tool is compatible with the voltage of the electrical supply.
3. Make sure the work area is clean, clear of debris and that there is plenty of light.
4. Ensure the correct method of working with power tools. Grip with both hands and take a firm standing position.
5. Store electrical tools in a secure, dry place after use.
6. Keep drill bits and blades in good order and sharp.
7. Use appropriate PPE i.e. googles, gloves and ear protection, when using power tools.
8. Always take damaged or incorrectly working tools out of service and tag them as faulty.

**Don’ts**
1. Do not lift or lower a power tool by its cord.
2. Do not drag a power tool or cable/flex across the floor.
3. Do not use power tools that are visibly damaged or working incorrectly.
4. Do not use power tools in wet conditions.
5. Never use indoor-type extension cables in outside conditions.
6. Do not change blades or drill bits with the tool plugged in. Always switch off and remove the tool from the power supply first.
7. Do not use power tools without the guards/blade covers in place.
8. Do not over – reach when working with power tools at height.
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Learning Outcome 2

Know the types of domestic plumbing and heating pipe work and their jointing principles
There are six Assessment Criteria in Learning Outcome 2:

AC2.1. Identify pipe work materials used in domestic plumbing and heating work

AC2.2. State the range of typical pipe material sizes available for use in dwellings.

AC2.3. State the acceptable methods of jointing new hot and cold water pipe to existing lead pipe work.

AC2.4. Identify the general fitting types used in dwellings.

AC2.5. State the methods of jointing pipe work used in dwellings.

AC2.6. State the methods of bending pipe work used in dwellings.

AC2.1 Identify pipe work materials used in domestic plumbing and heating work

and

AC2.2 State the range of typical pipe material sizes available for use in dwellings

Copper tubes to BSEN 1057

Copper tube is manufactured to BSEN 1057 and has been used in UK plumbing systems since the 1940s. The type of copper used is today phosphorus de-oxidised copper that has a minimum copper content of 99.9%. De-oxidised copper has a melting point of 1083°C and can be soldered, brazed and welded with ease. Between 20°C and 100°C it has a linear expansion rate 0.00000166 per °C.

Chromium coated copper tube is available where there are aesthetics considerations and plastic-coated copper...
Copper tubes can be used for hot and cold water services, central heating systems, gas installations, medical gas systems, oil systems and sanitation systems. It is available in the UK in 3 grades (see below):

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R220</td>
<td>Soft copper tube, full annealed and supplied in coils from 10m to 50m in length. It is thicker walled than other grades of copper tube. Used for underground water services (sizes 15, 22, 28mm) and micro-bore central heating systems (sizes 6, 8 and 10mm).</td>
</tr>
<tr>
<td>R250</td>
<td>The most widely used grade of copper tube for plumbing and heating applications. Supplied in straight lengths of 3m or 6m in sizes 15, 22, 28, 35, 42, 54mm. It is known as half-hard tempered.</td>
</tr>
<tr>
<td>R290</td>
<td>Hard tempered, thin walled and very unsuitable for bending. Not normally used in the UK.</td>
</tr>
</tbody>
</table>

Low Carbon Steel to BSEN 10255:2004

Not really used in domestic installations and its use should be restricted to wet central heating systems and gas installations. Low Carbon Steel is used extensively on commercial and industrial systems for specialised water systems, heating, gas, compressed air and many other specialised applications. It is often referred to as mild steel pipe. LCS is supplied in lengths up to 6m with either threaded or plain ends. It is usually painted either black or red. It can also be supplied with a galvanised coating. There are 3 grades of LCS. The grades are related to pipe wall thickness:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Colour Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>Brown</td>
<td>Seldom used except with fire suppressant sprinkler systems. The pipe wall is thin.</td>
</tr>
<tr>
<td>Medium</td>
<td>Blue</td>
<td>The most common grade used in plumbing installations.</td>
</tr>
<tr>
<td>Heavy</td>
<td>Red</td>
<td>The same as medium grade but can also be used below ground. The thickest pipe wall of all LCS grades.</td>
</tr>
</tbody>
</table>
Low Carbon Steel pipe sizes are listed in the table left:

From the table it will be seen that both metric and imperial pipe sizes have been given. While both measurements are interchangeable, they refer to the internal diameter of the pipe, the outside measurement being considerably larger. Fittings for LCS pipe are still stamped with imperial measurements and not metric, which can cause confusion.

Plastic pipework

Plastic pipe materials have transformed modern plumbing systems and greatly reduced installation times whilst increasing system efficiency with superior flowrates but just like a plumber must know their metals, a good knowledge of plastics is essential to stop mistakes being made. Using plastic pipe for systems that it is not designed for can have a detrimental effect on the system and gives plastic and undeserved bad name.

There are two types of plastic pipe:

A. Plastic pressure pipe (for hot and cold water and central heating systems)
B. Plastic sanitary pipe (for above and below ground drainage, waste pipes and gutter systems)

Plastic pressure pipe (for hot and cold water and central heating systems)

Plastic pressure pipe is plastic pipe that can be installed in high-pressure plumbing systems, such as cold water supplied from a water main. There are two types of plastic pressure pipe

- **Polyethylene** – this is used for mains cold water pipe (coloured blue) and gas pipe (coloured yellow).
  
  There are two grades:
  
  - **Medium density polyethylene (MDPE)** – often referred to as ‘alkathene’, it is manufactured to Water Standards ISO4427: 2007 for below ground use. It is light and flexible, and ideal for carrying wholesome, potable water as well as a variety of chemicals. However, it does degrade under the effects of ultra-violet light. Because of this, it should not be used for above ground installations and it is recommended that no more than 150mm of blue MDPE be exposed when it enters a dwelling. It is available in 25m, 50m and 100m coils in the following pipe sizes – 20mm, 25mm, 32mm, 50mm and 63mm.
  
  - **High Density Polyethylene (HDPE).** Used for mains cold water pipe until the mid-
Polybutylene – Produced for pressurised plumbing systems and central heating installations. Because it is flexible, it can be cabled easily through holes cut into timber joists. This ensures that fewer joints are required and the installation process decreases the installation time. It has:

1. A high temperature/pressure resistance with low noise and thermal transmission.
2. Smooth internal bore giving it better flowrate characteristics than copper tube.
3. High resistance to corrosion and scaling.

However, polybutylene is micro-porous, which allows air to be leeched through the walls of the pipe and while this is not a problem for hot and cold water supplies, central heating installations would suffer increased corrosion as a result. To counteract this, polybutylene pipe is manufactured with an impervious barrier to prevent the air from infiltrating the central heating system water. It is available in sizes 10mm, 15mm, 22mm and 28mm in straight lengths of 3m and coils of 25m, 50m and 100m lengths. The pipe sizes are compatible with copper tubes to BSEN1057 meaning standard compression fittings can be used.

Plastic sanitary pipe (for above and below ground drainage, waste pipes and gutter systems)

Modern sanitary plumbing systems utilise modern materials. This involves the use of plastics of one type or another. Plastics have an extremely smooth internal surface, which helps the flow rate when compared to more traditional materials such as cast-iron and clay pipes. There are 4 types of plastics that are used extensively in modern sanitary systems:

- **PVCu – Unplasticised Polyvinyl Chloride.** Manufactured to BS4514, PVCu pipes are used mainly for above and below ground sanitation systems, soil and vent pipes, waste pipes and overflows, push-fit and solvent weld fittings, gutter systems and rainwater pipework. Despite its good resistance to ultra-violet light, PVCu can suffer from photo-degradation and it’s coefficient of linear expansion is high. It is available in the following sizes:
  
  - 150mm and 110mm for soil pipes, vent pipes and below ground drainage systems
  - 50mm, 40mm and 32mm for waste pipes
  - 22.1mm for overflow pipes.
• **PVCmu – Modified Unplasticised Polyvinyl Chloride.** Manufactured to BS5255, PVCmu is mainly used for solvent weld waste and overflow pipes. It has better performance than other plastics at high temperature and is much more durable than PVCu. It is available in the following sizes:
  - 50mm, 40mm and 32mm for waste pipes
  - 22.1mm for overflow pipes.

• **ABS – Acrylonitrile Butadiene Styrene.** Mainly used for soil and vent pipes and mains cold water pipework. It is much tougher than PVCu, possessing good impact and mechanical strength but degrades quickly when exposed to ultraviolet light. The jointing methods and sizes are the same as PVCu.

• **Polypropylene.** One of the most widely used plastics in the plumbing industry, Polypropylene is used for waste pipes, cisterns, WC siphons and overflow pipework. Unlike the other three types of plastic, polypropylene cannot be solvent welded. Jointing is normally either push-fit or compression fittings.

**AC2.3 State the acceptable methods of jointing new hot and cold water pipe to existing lead pipe work**

Lead pipe was used extensively in plumbing for hundreds of years but as we discovered in the health and safety unit, lead is a highly toxic substance. Because of this, it’s use declined when safer alternatives, such as copper pipe, became available in the 1940s and 1950s. Finally, in 1986, it’s use was banned under the new 101 Model Water Byelaws. There are, however, still many thousands of homes and businesses still connected to a lead mains cold water supply and there will be situations where these will need to be repaired or replaced. The old practice of ‘wiping’ a lead solder joint with a moleskin wiping cloth has also been prohibited by the Water Supply (water fittings) Regulations 1999 and so alternative methods have had to be developed. There are two main lead to copper/plastic jointing alternatives:

- The leadlock compression fitting
- The Philmac Universal Transition coupling.

**The LeadLock Compression fitting**

Leadlocks are the most common fitting used to convert lead pipe to copper/polybutylene pipe. Connection is made via a rubber ‘O’ ring being compressed against the lead pipe. There are six parts to this fitting:

- **The fitting body, made of brass** – the physical connection between the copper and the lead pipes
- **A compression nut** – to hold the lead and copper pipes to the fitting body
- **A rubber sealing ring** – to make the seal to the lead pipe
- **A copper compression ring or ‘olive’** – to make the seal between the copper and the fitting body
- **A copper grab ring** – to prevent the lead from pulling out of the joint
• **A friction ring** – to prevent the tightening process from destroying the rubber sealing ring.

The most common problem with leadlocks is establishing the correct size of the lead pipe. Lead pipe was generally bought by weight as well as size. The following size/weights were common:

- 3/8” - 5lb
- 1/2” - 6lb
- 1/2” - 7lb
- 3/4” - 8lb
- 3/4” - 9lb

It is therefore, important to know the size/weight of the pipe before buying the leadlock. This was usually stamped into the outside wall of the pipe at regular intervals.

**Making a leadlock joint**

1. Firstly, the lead pipe must be as round as possible. This can sometimes prove difficult, especially when lead has been buried in floors or underground for many years. If the pipe isn’t round, the fitting may be difficult to push on to the pipe and the rubber sealing ring may not seal properly and the fitting will leak.

2. Any markings on the pipe must be removed with a file or a rasp and ensure that the end of the pipe is cut square.

3. Dis-assemble the fitting and slide the compression nut over the pipe. Follow this with the grab ring, the friction ring and finally the rubber sealing ‘O’ ring.

4. Slide the fitting onto the end of the pipe, ensuring that it travels all the way to the pipe stop in the fitting.

5. Now, slide the compression nut/grab ring/friction ring/‘O’ ring combination up to the fitting and turn in a clockwise direction until the fitting is hand tight.

6. Tighten the compression nut with an adjustable spanner. Hold the fitting body with a second spanner to stop it from turning. The compression nut will wind down compressing both the rubber ‘O’ ring to make the seal and the grab ring, which will bite slightly into the lead preventing it from blowing off when the system is pressurised with water. The friction ring will prevent over-tightening of the fitting.

7. When this is completed, the copper end of the fitting can be completed by following the method for making a compression joint, outlined later in this unit.

8. Turn on the water slowly and test the completed joint.

**Important point:** whilst leadlocks are a recognised method of making lead to copper joints, it must be
remembered that a lead/brass/copper combination may cause galvanic action (as outlined in Scientific Principles) and the lead may corrode quickly, depending on the type of water. Always seek the advice of the local water authority before using leadlocks.

The Philmac Universal Transition coupling

An alternative to the lead lock, which does not cause galvanic action, is the Philmac Universal Transition Coupling. This fitting is designed to connect many different types of pipe together using a common fitting body and a selection of different inserts to accommodate the different types of pipe available. One of the benefits of using this system is that the fitting has a greater tolerance to the lead pipe being deformed or mis-shaped and will accommodate most lead pipe sizes with a single adapter or insert. It is also much easier to dis-mantle and refit, if necessary.

Making a Philmac joint

- Ensure that the lead pipe is cut square
- Any markings on the pipe must be removed with a file or rasp
- The fitting does not need to be dis-mantled. Ensure that the locking nut is open and that 3 turns of thread are visible
- Hold the fitting next to the pipe with the pipe end against the stop flange
- Mark the pipe so that you know when the pipe is full inside the fitting
- Push the fitting on to the pipe up to the mark you have made on the pipe
- Now, using a pair of water pump pliers, tighten the compression nut. Use a second pair of water pump pliers on the fitting to prevent the whole assembly from spinning
- Ensure that the joint is fully tightened and once both ends of the fitting are complete, slowly turn on the water up to full pressure and check for leaks.

AC2.3 Identify the general fitting types used in dwellings

For a plumber to be able to their job, they must be able to identify and select the correct fitting for the installation. In AC2.3, we will investigate the jointing methods and some of the common fittings used to joint
copper pipe, mild steel pipe and plastic pipes. The fitting types shown are not extensive and manufacturer’s data sheets and fittings catalogues should be consulted.

<table>
<thead>
<tr>
<th>Fitting</th>
<th>Compression</th>
<th>Capillary End Feed</th>
<th>Capillary integral solder ring</th>
<th>Push fit</th>
<th>Press fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Couplers</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Elbows and bends</td>
<td></td>
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</tr>
<tr>
<td>Equal tees</td>
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</tr>
<tr>
<td>Reducing tees – reduced end</td>
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<tr>
<td>Reducing tees – reduced branch</td>
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<tr>
<td>Reducers</td>
<td></td>
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<tr>
<td>Stop/cap ends</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
### Tap connectors for BSEN 1057 Copper tube

<table>
<thead>
<tr>
<th>Fitting</th>
<th>Compression</th>
<th>Capillary End Feed</th>
<th>Capillary integral solder ring</th>
<th>Push fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap connector - straight</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
<tr>
<td>Tap connector - bent</td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
</tr>
</tbody>
</table>

### Manifolds and tank connectors for BSEN 1057 Copper tube

<table>
<thead>
<tr>
<th>Fitting</th>
<th>Compression</th>
<th>Capillary End Feed</th>
<th>Capillary integral solder ring</th>
<th>Push fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tank connectors</td>
<td><img src="image9.png" alt="Image" /></td>
<td><img src="image10.png" alt="Image" /></td>
<td><img src="image11.png" alt="Image" /></td>
<td><img src="image12.png" alt="Image" /></td>
</tr>
<tr>
<td>Manifolds</td>
<td><img src="image13.png" alt="Image" /></td>
<td><img src="image14.png" alt="Image" /></td>
<td><img src="image15.png" alt="Image" /></td>
<td><img src="image16.png" alt="Image" /></td>
</tr>
</tbody>
</table>

### Stopvalves, isolation valves and gate valves for BSEN 1057 Copper tube

<table>
<thead>
<tr>
<th>Fitting</th>
<th>Compression</th>
<th>Push fit</th>
<th>Capillary integral solder ring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stop taps</td>
<td><img src="image17.png" alt="Image" /></td>
<td><img src="image18.png" alt="Image" /></td>
<td><img src="image19.png" alt="Image" /></td>
</tr>
</tbody>
</table>
Whiteheart Screwed fittings

<table>
<thead>
<tr>
<th>Sockets</th>
<th>Reducers</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Sockets" /></td>
<td><img src="image" alt="Reducers" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Equal tees</th>
<th>Unions</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Equal tees" /></td>
<td><img src="image" alt="Unions" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Elbows</th>
<th>Nipples</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Elbows" /></td>
<td><img src="image" alt="Nipples" /></td>
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<table>
<thead>
<tr>
<th>Bends</th>
<th>Bushes</th>
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</thead>
<tbody>
<tr>
<td><img src="image" alt="Bends" /></td>
<td><img src="image" alt="Bushes" /></td>
</tr>
</tbody>
</table>

Fittings for BS EN 10255:2004 (formally BS1387:1985) Low Carbon Steel

- **Whiteheart fittings**: These have a rounded bead around the mouth of the fitting.
- **Blackheart fittings**: These have a square bead around the mouth of the fitting.
## M/F Elbows

- **Plugs and Caps**

## Pitcher tees

## Fittings for Plastic Pressure pipe

### All fittings Hep20

<table>
<thead>
<tr>
<th>Couplers</th>
<th>Elbows</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Equal tees</th>
<th>Reducing tees – reduced end</th>
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</table>

<table>
<thead>
<tr>
<th>Reducing tees – reduced branch</th>
<th>Reducers</th>
</tr>
</thead>
<tbody>
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</table>

<table>
<thead>
<tr>
<th>Tap connector</th>
<th>Manifolds</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

<table>
<thead>
<tr>
<th>Tank connectors</th>
<th>Service valves</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>
### Fittings for Plastic Sanitary Pipe

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>Socket</td>
<td><img src="image1" alt="Socket Soil solvent weld" /></td>
<td><img src="image2" alt="Socket Soil push fit" /></td>
<td><img src="image3" alt="Socket Waste solvent weld" /></td>
<td><img src="image4" alt="Socket Waste push fit" /></td>
<td><img src="image5" alt="Socket Waste universal" /></td>
</tr>
<tr>
<td>Knuckle bend</td>
<td><img src="image6" alt="Knuckle bend Soil solvent weld" /></td>
<td><img src="image7" alt="Knuckle bend Soil push fit" /></td>
<td><img src="image8" alt="Knuckle bend Waste solvent weld" /></td>
<td><img src="image9" alt="Knuckle bend Waste push fit" /></td>
<td><img src="image10" alt="Knuckle bend Waste universal" /></td>
</tr>
<tr>
<td>Large radius bend</td>
<td><img src="image11" alt="Large radius bend Soil solvent weld" /></td>
<td><img src="image12" alt="Large radius bend Soil push fit" /></td>
<td><img src="image13" alt="Large radius bend Waste solvent weld" /></td>
<td><img src="image14" alt="Large radius bend Waste push fit" /></td>
<td><img src="image15" alt="Large radius bend Waste universal" /></td>
</tr>
<tr>
<td>Junction (tee)</td>
<td><img src="image16" alt="Junction (tee) Soil solvent weld" /></td>
<td><img src="image17" alt="Junction (tee) Soil push fit" /></td>
<td><img src="image18" alt="Junction (tee) Waste solvent weld" /></td>
<td><img src="image19" alt="Junction (tee) Waste push fit" /></td>
<td><img src="image20" alt="Junction (tee) Waste universal" /></td>
</tr>
<tr>
<td>135° bend</td>
<td><img src="image21" alt="135° bend Soil solvent weld" /></td>
<td><img src="image22" alt="135° bend Soil push fit" /></td>
<td><img src="image23" alt="135° bend Waste solvent weld" /></td>
<td><img src="image24" alt="135° bend Waste push fit" /></td>
<td><img src="image25" alt="135° bend Waste universal" /></td>
</tr>
<tr>
<td>Reducers</td>
<td><img src="image26" alt="Reducers Soil solvent weld" /></td>
<td><img src="image27" alt="Reducers Soil push fit" /></td>
<td><img src="image28" alt="Reducers Waste solvent weld" /></td>
<td><img src="image29" alt="Reducers Waste push fit" /></td>
<td><img src="image30" alt="Reducers Waste universal" /></td>
</tr>
</tbody>
</table>

*Push fit only*
Jointing copper tubes

There are four methods of jointing copper tube used frequently in plumbing and heating systems:

a) Capillary (BSEN1254: 1998)
   a. Integral solder ring
b. End feed

b) Compression
   a. Type A – non-manipulative
   b. Type B – manipulative

c) Push-fit
d) Press-fit

Capillary fittings to BSEN1254: 1998

Capillary type fittings are heated by a blow torch. They use the principle of capillary attraction to draw the solder into the fitting as it is heated.

Integral solder ring capillary fittings

This type of fitting already contains the solder to make a watertight joint. The solder is contained in a raised section of the fitting and releases into the joint when it is heated by a blowtorch. Extra solder is not required.

End feed capillary fittings

End feed fittings require the solder to be applied by the plumber at the mouth of the fitting while the fitting is hot. It does not contain its own solder.

To successfully make a capillary fitting, the following method should be used:

a) Cut the copper tube using either pipe cutters or a hacksaw and de-burr the end.
b) Clean the inside of the fitting and the outside of the pipe using either steel wool or emery cloth.
c) Apply a suitable flux to the tube end only and insert the tube into the fitting. A slight twist of the fitting will ensure that the solder is evenly spread throughout the whole joint.
d) Apply heat to the fitting from the blowtorch and wait 10 seconds before applying any solder. End feed fittings should be fed at the mouth of the fitting. Solder ring fittings do not require this as the solder will appear at the mouth of the fitting when it has been successfully soldered. After the fitting has been heated, check that the solder has flowed around the entire fitting. Do not use excessive heat or the flux will turn black and the solder will not take to the tube.
e) While the fitting is still hot and the solder fluid, wipe any excess solder away with a cloth. Care should be taken to ensure that the fitting is not disturbed or you may cause a leak.
f) Once cooled, wipe any excess flux away with a damp cloth.
Fluxes and solders

Solders

The Water Supply (water fittings) Regulations 1999 require that only lead free solders are used when installing hot and cold water supply. There are several types of lead free solder available and most are a mixture of tin and copper. They are manufactured to BSEN29453 and are known as ‘number 23 tin based solders’ and have a melting point range of between 230°C to 240°C.

Solders that contain lead can be used on systems such as gas installations and central heating. However, there is a risk that the wrong solder will be used when installing hot and cold water systems and so its use should be avoided if possible.

Fluxes

Fluxes are necessary during the soldering process to remove any surface oxides on the copper tube and to assist with the free flow of the solder in the fitting itself. Fluxes take two forms:

- **Active flux** – known as self-cleaning flux, this flux cleans the copper tube and the fitting during soldering making pre-cleaning with an abrasive material not necessary. Some active fluxes contain hydrochloric acid, which encourages corrosion if not completely cleaned off the copper tubes after use. Active fluxes are water soluble and are therefore thoroughly washed out when the water systems are flushed through when the initial flushing of systems is carried out.

- **Traditional flux paste** – traditional flux has been used successfully to make soldered joints for many years and contains zinc chloride and amines that act as active agents. However, it is reliant on the copper tube and the fitting being totally clean. Therefore, cleaning of both the tube and the fitting is required. It is not water soluble, which means it can stay in the pipework for many years after soldering has taken place and even after flushing with cold water. Because of this, it should be used with care.

Compression fittings to BSEN1254: 1998

Compression fittings are mechanical and require spanners to tighten them to make a leak-free joint. Care should be taken to avoid overtightening as this will distort the tube and cause the fitting to leak. Again, there are two distinct types:

**Type A Non-manipulative fittings** – these fittings are called non-manipulative because the copper tube does not have to be worked or ‘manipulated’ to enable a leak free joint to be made. Made from brass or gun metal, they contain three parts:

1. The fitting body
2. The Compression nut
3. The compression ring or ‘olive’.

When the fitting is tightened, the compression nut compresses the olive on to the copper tube slightly so that the fitting does not come apart or leak when the joint is under pressure.

To make a successful Type A non-manipulative compression joint follow the steps below:

- Cut the copper tube with a pipe cutter or hacksaw and de-burr the end.
- Slip the compression nut and olive over the end of the tube and re-assemble the fitting until it is hand tight.
- Using an adjustable spanner, tighten the joint 1 ½ to 2 turns. Do not overtighten as this will deform the olive and the copper tube and may cause a leak.

Note: Manufacturer’s say that compression joints do not require any jointing paste or PTFE to make a successful joint. Jointing pastes and compounds should only be used in the event of the fitting leaking after normal assembly procedures.

Type B Manipulative fittings – These fittings are called manipulative because the end of the copper tube must be worked or manipulated before a joint can be made. The end of the copper must be flared out with a swaging tool. The fitting is comprised of the fitting body, the compression nut, a compensating ring and an adapter to allow the copper to make a leak free joint with the copper tube.

Generally, these fittings are used on R220 grade soft copper tubes for underground water service pipes.

To make a successful Type B non-manipulative compression joint follow the steps below:

- Cut the copper tube with a hacksaw and de-burr the end. Do not use a pipe cutter because these tend to reduce the internal bore of the copper making insertion of the swaging tool difficult.
- Slip the compression nut and the compensating ring over the tube.
- Insert the swaging tool into the pipe end and strike 2 or 3 times with a hammer. This will flare open the tube ready for the adapter.
- Ensuring that the adapter is in place in the fitting, locate the flared end of the copper over the adapter
and hand tighten the compression nut.

- Using an adjustable spanner, tighten the joint 1 ½ to 2 turns. Do not overtighten as this may deform copper tube and may cause a leak.

Compression Fittings are manufactured from Duplex Brass, Gun-metal or corrosion resistant (DZR) Brass and can be used on hot and cold water systems, central heating installations and gas pipework. **Brass** is an alloy made from Copper and Zinc. **Gunmetal** is a type of bronze – an alloy of copper, tin, and zinc.

**Push-fit fittings for copper tubes**

Push-fit fittings rely on a stainless-steel grab ring and a neoprene rubber seal ‘O’ ring to make a successful joint. The grab ring holds the joint together, whilst the rubber sealing ring prevents any leakage. There are a number of similar types available and all use this method of jointing. Some fitting types are de-mountable, in other words, they can be taken off the tube for re-use with the aid of a special ‘de-mounting’ tool.

<table>
<thead>
<tr>
<th>Temperature not exceeding</th>
<th>Max. Working pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>30°C</td>
<td>16 bar</td>
</tr>
<tr>
<td>65°C</td>
<td>10 bar</td>
</tr>
<tr>
<td>90°C</td>
<td>6 bar</td>
</tr>
</tbody>
</table>

Under normal working conditions, the pressures in the table (above) are applicable.

The fitting itself is made from either copper or corrosion resistant brass (DZR) and some manufacturer’s use gunmetal (also corrosion resistant).

To make a successful push-fit joint follow the steps below:

- Cut the tube with a tube cutter. The tube needs to be rounded and slightly bevelled at the end for ease of inserting it into the fitting. Do not use a hacksaw as the roughness of the tube may damage the rubber sealing ring.

- At this stage, it is better to offer the tube against the fitting and mark the fitting depth on the tube with a pencil or marker. This is so you can check to make sure that the tube is fully in the socket once the joint has been completed.

- Apply a little silicon lubricant on to the end of the fitting and push the tube fully inside the socket until resistance is felt.

- Check against the mark on the tube to ensure that the fitting is fully on the tube.
Press-fit fittings for copper tubes

Press-fit fittings are the latest fitting type for copper tubes to become available. They use a special electrical crimping tool to crimp the fitting on to the tube to ensure a water tight and secure joint. They are used widely on commercial and industrial installations, especially where hot working with a plumber’s blow torch is not allowed.

As can be seen by the photograph left, the fittings contain a rubber ‘O’ ring seal and a grab ring to ensure pipe security and water tightness. Tube sizes available range from 12mm up to 108mm.

Press-fit can be successfully used on hot and cold water installations, heating systems, chilled water installations and solar hot water systems. For gas installations, a special fitting with a yellow ‘O’ ring seal is available.

<table>
<thead>
<tr>
<th>Temperature not exceeding</th>
<th>Max. Working pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>20°C</td>
<td>16 bar</td>
</tr>
<tr>
<td>110°C</td>
<td>6 bar</td>
</tr>
</tbody>
</table>

Jointing Low Carbon Steel pipes (BS EN 10255:2004)

There are 3 methods that are used to join LCS pipes:

- Compression joints using a special compression fitting
- Welded joints. These are outside the scope of plumbing work and will not be discussed here.

Screw threaded jointing of Low Carbon Steel pipes

The screw threads on Low Carbon Steel pipes and fittings are manufactured to BSEN1025: Pipes threads where pressure-tight joints are made on the threads. Verification by means of limit gauges

Low Carbon Steel pipe is usually supplied from the manufacturer’s with threads already cut on to the ends of the pipe. Additional threads are cut using either manual stocks and dies or electric threading machines. There are two types of thread used:
Tapered threads – This is the standard thread cut on to the ends of LCS pipes and blackheart male fittings. The principle of the thread is that, because it is tapered, it tightens the further it is screwed into the fitting. However, with some fittings this can either lead to the fitting stretching or, at worst, the fitting fracturing.

Parallel threads – The parallel thread is so called because the thread is of uniform diameter along its entire length. It is used on pipe sockets and whiteheart female thread fittings.

Male (m) and female (f) threads

A male thread is an external thread found on pipes and fittings. Also sometimes referred to as a spigot. These can be tapered as shown in the left hand photograph, or parallel.

There two types of fittings for use on Low Carbon Steel pipes that use these two distinct thread types. Fittings for LCS are manufactured from malleable iron to BS EN 10242 and BS 1256.

Blackheart fittings – These have both tapered male and female threads. They are made from malleable cast iron and tend to be quite brittle. Because of this, they are susceptible to splitting if the fitting is overtightened. The fittings are marked with the letter ‘B’ and are identifiable by a square edged bead around the head of the fitting.

Whiteheart fittings – these have tapered male threads and parallel female threads. Again, they are made from malleable iron but the metal has a high ferrite content, making them much more malleable than blackheart fittings. They tend to stretch rather than fracture when overtightened, making much less susceptible to splitting. The fittings are marked with the letter ‘W’ are identifiable by a round edged bead.
around the head of the fitting.

Jointing compounds, pastes and tapes

When a fitting has been made on to a length of pipe, one and a half to two threads should be visible when the joint is completed.

There are several jointing compounds, pastes and tapes that can be used in conjunction with threaded pipes and fittings to ensure that the fittings do not leak when tested. The table below highlights the most common types of compounds available.

<table>
<thead>
<tr>
<th>Linseed oil based compounds</th>
<th>Used in conjunction with hemp on wet central heating systems and compressed air lines. <strong>Caution: Not suitable for use on natural gas installations.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsintered Polytetrafluorethylene (PTFE tape)</td>
<td>A thin, white (or yellow if used on gas) tape that can be used on almost all installations, from hot and cold water to gas installations.</td>
</tr>
<tr>
<td>PTFE based jointing compounds</td>
<td>A compound specially made for use on potable water systems. <strong>Caution: Not suitable for use on natural gas installations.</strong></td>
</tr>
<tr>
<td>Heldite jointing compound</td>
<td>A universal compound that can be used on most installation types such oil, gas, hot and cold water, central heating, compressed air lines and vacuum lines.</td>
</tr>
<tr>
<td>Manganese paste</td>
<td>Specialist compounds for use with high temperature hot water and steam installations</td>
</tr>
<tr>
<td>Graphite paste</td>
<td></td>
</tr>
<tr>
<td>Gas seal paste</td>
<td>A compound specifically made for use with natural gas and LPG installations.</td>
</tr>
</tbody>
</table>

Compression jointing of Low Carbon Steel pipes

Compression fittings for Low Carbon Steel are a fairly recent addition to the LCS jointing methods. They differ from copper compression joints in having a rubber compression ring to seal the joint rather than a brass olive.
Jointing plastic pressure pipes

There are 3 types of plastic pressure pipes used by plumbers:

- Polyethylene (PE, HDPE and MDPE)
- Cross – linked polyethylene (PE-X)
- Polybutylene (PB)

Each of these different materials can be jointed by the same techniques:

1. **Push-fit** – plastic push-fit fittings use the same method of jointing as seen earlier. The main difference here, is that, because the pipe wall is relatively soft, the pipe requires reinforcing with a stiffened pipe insert to prevent the fitting from pulling off when the water is under pressure.

   ![Polyethylene](image1)
   ![Cross-linked polyethylene](image2)
   ![Polybutylene](image3)

   **Polyethylene**  **Cross-linked polyethylene**  **Polybutylene**
   (speedfit)         (Hep₂O)

   **Push-fit fittings for plastic pressure pipe**

2. **Compression for MDPE pipe** – compression fittings for MDPE come in 2 different styles:
   a. **Compression fittings made from brass** – these are specifically made to fit the diameters of MDPE pipe. The method of installation is the same as the compression fittings mentioned earlier but with one exception. The pipe requires a copper or nylon insert to be placed inside the pipe to strengthen the pipe wall. Because these are used on underground water supplies, they are made from corrosion resistant brass or gunmetal.

   ![MDPE Compression brass](image4)

   **A brass stoptap for MDPE pipe**

   b. **Compression fittings made from plastic (philmac)** – these are designed so that any kind of pipe from MDPE, HDPE, copper etc. can be joined to other different pipework materials. The pipe fitting remains the same but each different pipe material has a different colour coded insert.
Using compression fittings on PE-X and PB

Both PE-X (speedfit) and PB (Hep2O) are manufactured to standard copper tube sizes (10mm, 15mm, 22mm). This means that standard compression fittings for copper tubes to BS EN 1254 can be used to joint them provided a pipe insert is used inside the pipe to support the pipe wall. The method of use and installation is the same as for copper tubes.

Jointing plastic soil and waste pipes

There are 3 basic methods of jointing soil and waste pipes. These methods depend on the pipe material. They are:

1. Solvent weld – for PVCu and ABS soil and waste pipes
2. Push-fit:
   a. for PVCu waste pipes
   b. for polypropylene waste pipes
3. Compression – a universal fitting to connect pipework of differing materials.

Solvent weld – for PVCu and ABS soil and waste pipes

Solvent weld fittings use a solvent cement that literally melts the surface of the plastic and fuses the fitting and the pipe together. Care should be taken when using solvent weld adhesive as the fumes given off can be overpowering. It is recommended that its use should only be restricted to outside or a well-ventilated room.

To make a solvent weld joint on PVCu, muPVC and ABS, the following procedure should be followed:

1. Cut the pipe with either a hacksaw or a multi-purpose saw and remove the burr from the inside and outside of the pipe with a file
2. Wipe the dirt and manufacturer’s oils off the pipe with a clean, soft cloth
3. Clean the inside of the socket and the outside of the pipe with the correct solvent cleaner
4. Apply the solvent weld cement to the inside of the socket first, and then to the outside of the pipe. This will allow more time to make the joint as the cement cures much quicker when exposed to air.
5. Insert the pipe into the socket and slowly twist it into place. The twisting action allows for an even spread of cement throughout the socket.
6. Wipe off any excess cement with a clean, dry cloth.

After completion, the joint must be left up to 24 hours before testing can begin.
Push-fit – for PVCu and ABS soil pipes

Push-fit joints are probably the most common jointing method for soil and vent pipes. The fittings have a single neoprene chamfered rubber sealing ring in them which allows for easy jointing. There are two points to remember when making push-fit joints:

1. Always chamfer the pipe before you try to push the fitting and the pipe together
2. Always use a silicon lubricant to help ease the pipe into the socket. Do not be tempted to use washing up liquid or similar soap because as this dries out, the joint will seize up and movement will be restricted. Also, soap eventually corrodes the rubber seal and so the joint may leak in the future.

To make a push-fit joint on PVCu, muPVC and ABS, the following procedure should be followed:

1. Cut the pipe with either a hacksaw or a multi-purpose saw and remove the burr from the inside and outside of the pipe with a file
2. Chamfer the end of the pipe to about 45° with a rasp or a file
3. Wipe the dirt and manufacturer’s oils off the pipe with a clean, soft cloth
4. Apply a little silicon lubricant grease to the end of the pipe and to the rubber seal inside the fitting
5. Push the pipe all the way into the socket
6. Withdraw the pipe 10mm. This will allow for expansion of the pipe. Pipes must be supported by a pipe clip or bracket to ensure that the fitting/pipe does not slip.

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Push-fit soil fitting | Silicon spray lubricant | Push-fit fitting for Polypropylene waste pipe systems

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Push-fit – for Polypropylene waste pipes

Polypropylene waste pipe fittings are push-fit containing a single neoprene rubber ring seal. It cannot be solvent welded as polypropylene is unaffected by the solvents used in solvent weld cement.

To make a push-fit joint on polypropylene, the following procedure should be followed:

1. Cut the pipe with either a hacksaw or a multi-purpose saw and remove the burr from the inside and outside of the pipe with a file
2. Chamfer the end of the pipe to about 45° with a rasp or a file
3. Wipe the dirt and manufacturer’s oils off the pipe with a clean, soft cloth
4. Apply a little silicon lubricant grease to the end of the pipe and to the rubber seal inside the fitting
5. Push the pipe all the way into the socket

A note about solvent weld and push-fit waste pipes and fittings – push-fit and solvent weld fittings are not compatible with each other. They have different outside diameters and the fittings will only fit their recommended pipe.

**AC2.6 State the methods of bending pipe work used in dwellings.**

In this next section, we will look at the methods we can use to bend the different types of pipe.

**Bending copper tube**

Bending copper tube is a skill that becomes easier with practice. The art to good pipe bending is knowing the limitations of the bending machine you are using, whether that machine is a scissor bender, tripod bender or spring.

**Using a bending machine**

Using a bending machine is an economical way of installing copper pipes as each bend we produce saves time and money on fittings purchasing, preparation and completion. Where lots of changes of direction must be performed, these can be completed by bending the pipe much more precisely and much neater than by using fittings. The end result is a professional looking installation with less leakage potential.

Both the scissor bender (also known as the handibender) and the tripod bender use the same technique to bend the pipe. The following methods can be performed on either of these two machines easily and to the same degree of accuracy.

As you work through the different bends, it will become apparent that the accuracy of the bends relies upon determining the bending point and the position of the tube in the machine. Accurate templates and marking of the tube are also vitally important if an acceptable degree of accuracy is to be obtained.

These notes assume that you will be performing most your bends on a scissor bending machine.

**90° Bends**

There are two ways of performing a 90° Bend:

- 90° bend from a fixed point
- 90° bend using a short piece of tube
90° bend from a fixed point

Required bend

Fixed point

Measured length

4 diameters back

start of the bend mark on the bending former

Tube stop

Bending point

Back guide

Former

Position tube in machine so that the bending point is at a tangent to the edge of the former

Bend to 90
90° bend using a short piece of tube

90° bends from a fixed point using a scrap piece of tube

1. Measured length
2. Guide
3. Position of finished bend
4. Former

Fixed point

Required bend
Sets and offset bends – 45° sets

1. Measured length

2. Place a mark at the centre of the bend and place a second mark to make a cross.

3. Place the centre of the X mark against the bending former.

4. Finished bend
Sets and offset bends – offsets

1. To find the correct offset angle, the size of the offset should be deduced from 600mm and a 600mm folding rule opened to the measurement, i.e. offset 100mm: 600 - 100 = 500mm

2. Bend tube to the angle set by the folding rule

3. Remove tube from machine and mark for the second bend measuring from inside edge of tube using a straight edge bending mark

4. Re-position tube in the machine so that mark forms a tangent to the former

5. Re-position the rule to give the correct angle for the second bend

6. Re-position tube in the machine so that mark forms a tangent
Passover bends

1. Fixed point of the obstruction
   - The bending mark for the first bend is determined by adding 1/4 of the diameter of the obstruction to the measurement from the fixed point to the centre of the obstruction.
   - Add 1/4 of the obstruction.

2. Fixed point of the obstruction
   - To find the correct angle for first bend, multiply the diameter of the obstruction by 1 and close the tube by the amount (2x) of the bending mark. Touch the bending mark and the centre of the angle align.

3. Making sure that the bend shows the obstruction place, a straight edge over the tube and mark the bending marks on both sides.

4. Position tube in machine so that the bending mark touches the former edge.

5. Bend until the top and in line with the far mark.

6. Reverse tube in former and position and repeat until the top edges are in line.
Partial Passover bends

1. Close a folding rule down to the passover measurement to obtain the angle for the first bend.

2. Bend tube to the angle required by the folding rule.

3. Close folding rule down to twice the passover measurement to obtain the angle for the second bend.

4. Mark for the second bend by measuring from the inside edge of tube.

5. Re-position tube in the machine so that mark forms a tangent to the former.
Bends in two planes

Two 90 bends

Required measurement
centre to centre
inside to back

A centre to centre measurement should be marked inside to back to obtain the bending point

Finished bend

Former
90°
90°

Plane of second bend

Sight from back of machine to check angle of first bend before pulling second bend

Bend to 90
Rippling or throating of Tube in Machine Made Bends

Bending machines are designed to produce a bend with a diameter of 4 x the diameter of the tube. So, for instance, a 90° bend on 15mm tube will have a centre radius of 60mm. The bending former on the machine supports the tube through the bending process at its throat and sides, whilst the bending guide supports the top of the tube. When bending takes place, two actions occur simultaneously:

1. The outside of the bend is subjected to stretching

2. The inside of the bend (called the throat) is subjected to crushing.

The bend is dependent on the bending guide being placed in the correct position and the correct pressure being applied from the bending roller, through the bending guide to the tube. If this pressure is incorrect, or the guide is positioned incorrectly, then, again two outcomes could be possible:

3. Too much pressure will result in the tube ‘throating’ excessively. In other words, the bend will show signs of crushing deformation on its throat.

4. Not enough pressure will result in the tube rippling along its throat.

Look at the drawing left. The top drawing shows that the bending roller on the bending machine has not been tightened sufficiently. Both the roller and the guide are too far forward. This will result in the tube rippling on its throat. The slack roller is indicated in the bottom drawing. When the bending arm is placed in the correct upright position, a gap appears between the roller and the guide, indicating that the roller isn’t tight enough. For the bend to be performed correctly in this instance, the roller must be tightened.

The rollers on tripod and bench bending machines can be adjusted successfully. With scissor benders,
however, the rippling effect occurs over time as the machine is used. This is because the bending former is made from aluminium, which, being a soft, light metal, stretches with use. Because the roller is fixed, it cannot be re-adjusted and so rippling occurs. As a temporary measure, a thin strip of metal the thickness of a hacksaw blade can be placed on the top of the bending guide to close the gap between the roller and the guide. Usually, though, it’s an indication that the bender has come to the end of its useful life.

Using a bending spring

Bending springs are used to support the wall of the pipe during the bending process. Springs are available to suit copper tube grades R220 and R250, so it’s important that the correct size of spring is used as these two grades of copper have different wall thicknesses.

The bending radius with spring bends, at 5 diameters of tube, is slightly larger than for machine made bends but 4d can be achieved comfortably.

The big advantage with spring bending is that the radius of the bend can be varied as it is not fixed by a bending former. This allows centre to centre measurements to be continued around bends. See the drawing left.

Setting out 90° spring bends

On R250 grade copper tube, spring bends should be limited to 15mm and 22mm as bending over this size is not only difficult but can also damage the knee. The point to remember is that the tube will appear to ‘gain’ length when it is bent. If wastage of tube is to be avoided, then we must calculate the actual length of the bend.

1. Decide on bend radius. Yorkshire Copper Tube recommend 5D. Any radius can be determined by a drawing a template first.

   The length of the pipe taken up by a 90° bend can be calculated using the formula:

   \[ \text{Radius} \times 2 \times \pi \times (3.142) \]

2. Assuming that a 15mm pipe is to be bent to a radius of 5D, to find out how much pipe will be taken up by the bend:
Radius of bend is $5D = 5 \times 15 = 75\text{mm}$.

Using the formula:

$$\frac{75 \times 2 \times 3.14}{4} = 117.8\text{mm rounded to 120mm}$$

Length of bend $= 120\text{mm}$

3. Mark off the required distance from the end of the tube to the centre-line of the bend (the end-to-centre measurement)

4. Divide the calculated length of tube by three (for 15mm tube this will be three equal measurements of 40 mm)

5. From the original measurement, mark 40mm forward and 80mm back

6. The bend can then be pulled between the second and third marks ensuring that it is kept within the three 40mm measurements, this will keep the centre of the bend the correct distance from the fixed point.
Setting out offset spring bends

1. Measure the length of the tubing.
2. Measure back 2 diameters.
3. Measure forward 1 diameter.
4. Anneal the copper tube between the second and third marks to soften the tube so that rippling and creasing does not occur.

5. Offset required
6. First mark on the centre line of the tube
7. Back 1/2 a tube diameter
8. Second bending point

Figure 3: Bending point for offsets
Bending Low Carbon Steel

There are two common methods of bending Low Carbon Steel pipe:

1. **By hydraulic bending machine.** Hydraulic bending machines use hydraulic oil in a pressurised cylinder to exert enough force to bend the steel pipe via a bending former. Unlike copper bending machines, LCS bending machines do not need a bending guide as the pipe can withstand the effects of bending. This prevents problems such as rippling occurring. The LCS pipe tends to spring back a little when a bend has been formed and so it is recommended to overbend the bends slightly as the pipe will spring back into its correct position once the pressure on the pipe has been released. This method generally known as cold bending.

2. **By using heat.** This is mainly used on industrial installations and involves the use of oxy/acetylene torches to heat the steel pipe enough to allow bending to take place by hand. This method generally known as hot bending.

The following bends are performed using the cold bending method in a hydraulic bending machine.

**Bending a 90° bend using a hydraulic bending machine**

1. Measure the distance required and mark a line on the pipe to the centre line of the required bend.

2. From this mark, measure back towards the pipe end or fixed point 1 diameter of the internal bore of the pipe to point A.
3. Place point A at the centre of the bending former on the bending machine. The centre point will be marked on the bending former.

4. Pump the handle of the bending machine until an angle of $90^\circ + 5^\circ$ (this allows for the pipe springing back) has been achieved. Always stand to the side of the machine. DO NOT stand in front of it whilst bending is being performed.

Bending an offset bend using a hydraulic bending machine

1. Mark a line at the first bend onto the pipe

2. Place pipe in machine on that line. Do not make any deduction. The measured distance mark goes on the centre of the former. The measurement $A$ is from the fixed end of the pipe to the centre of the set

3. Bend the pipe to the offset angle (usually $30^\circ$ or $45^\circ$) and check the angle using a template or a set
4. Release the pipe from the bending machine and place a straight edge against the back of the pipe. Measure the required offset distance and mark bending point B.

5. Place the pipe back into the machine and line up point B with the centre of the former. Make sure that the first bend is pointed away from the machine. Bend the second bend and check with the template or set square.

**Bending a Passover bend using a hydraulic bending machine**

1. Mark on the tube the position of the initial bend at the centre of the obstacle. Now, go forward of that mark \( \frac{3}{4} \) of the obstacle diameter e.g. if the obstacle is a pipe of 35mm diameter then:

   \[ 35 \div 4 = 8.75\text{mm or 10mm rounded up} \]

Now mark the pipe 10mm past the fixed end point. This is where the initial pipe bend will be made.
1. Find the correct angle to allow clearance of the obstacle by multiplying the diameter of the obstacle (if it’s a pipe) by 3 and then deducting this distance from a 600mm rule and opening a 600mm folding rule at this distance e.g. if the obstacle is a pipe of 35mm diameter then:

\[
\begin{align*}
35 \times 3 &= 105 \\
600 - 105 &= 495
\end{align*}
\]

So, the folding rule will need to be opened to a distance of 105mm, creating the bending angle.

2. Place the pipe in the machine ensuring that the bend mark (not the fixed end point) is in the centre of the former. Bend the pipe taking care not to over bend.

3. Making sure that the bend clears the obstacle, place a straight edge over the bend and mark both sides. Now, complete a cross on the marks that correspond to the centreline of the pipe. These are the bending marks for the completing return bends.

4. Position the pipe in the machine so that the cross falls in the centre of the former. Care is needed here to make sure that the bend is not twisted in the machine. Bend the return bend taking care to check for pipe twisting and the correct return angle.

5. Now, turn the bend around and follow the same procedure again to complete the cross over.

### Bending plastic pressure pipe (polybutylene and cross-linked polyethylene)

Plastic pressure pipe can be bent by hand without the use of a bending machine. However, to prevent pipe distortion, it is recommended that cold forming bend fixtures of the type shown left should be used wherever possible. Cold forming bend fixtures are metal braces that hold the pipe at 90°. It is also possible to brace the bend by the use of pipe clips positioned to ensure the correct bend radius as shown in the table.

<table>
<thead>
<tr>
<th>Diameter of pipe - mm</th>
<th>10</th>
<th>15</th>
<th>22</th>
<th>28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radius dimension A - mm</td>
<td>80*</td>
<td>120*</td>
<td>160*</td>
<td>224*</td>
</tr>
</tbody>
</table>

*can vary depending on the manufacturer of the pipe
Learning Outcome 3

Know the general site preparation techniques for plumbing and heating work

There are eight Assessment Criteria in Learning Outcome 3:
AC3.1. Define the typical range of activities to be carried out when working on plumbing and heating systems

AC3.2. State what information should be passed on to the customer when carrying out work on domestic pipework systems.

AC3.3. Identify how to check for pre-existing damage to the building fabric or customer property before the work commences.

AC3.4. Identify how to protect the building fabric or customer property before the work commences.

AC3.5. Identify the method of storing tools, equipment and materials when working in new buildings and existing dwellings.

AC3.6. Identify the range of hand and power tools required to complete work on domestic pipework systems.

AC3.7. State the checks to be carried out on tools and equipment to ensure that they work correctly and are correctly calibrated.

AC3.8. State the work methods for preparing building construction features for installation work.

AC3.1 Define the typical range of activities to be carried out when working on plumbing and heating systems

Plumbing systems require designing, planning, installation and commissioning.

a. Designing and selecting materials and equipment – this involves calculation of flowrates, heat losses from the building fabric, capacities of cisterns and pipe sizes. It also includes planning the installation with regard to the positioning and selection of components and appliances.

b. Preparing work sites - The preparatory work we perform before we can begin the installation is as important as the installation itself. More often than not, good prep work ensures that the installation is trouble free. Preparatory work includes removing furniture, lifting carpets and floorboards, removal of old equipment and pipework and protecting the customers property. As with all good installations, consulting the right documents is an important aspect of the job.

- Statutory regulations – these are vital because they state clearly what we can and cannot do. All regulations are enforceable in a court of law:
  - The Water Supply (water fittings) Regulations – important in the installation of bathrooms, kitchens, wet rooms, shower rooms, utility rooms, underground water services, water metering and backflow protection.
  - The Gas (installation and use) Regulations – should be consulted when preparing to install wet central heating, boiler replacements, gas fires, gas cookers and all domestic gas pipework.
  - The Building Regulations – important when structural alterations become part of the installation, such as conversions of garages into flats and bedsits, loft conversions etc.
The IET Regulations – where any plumber’s work involves the planning, installation or alteration of electrical work, these should be consulted to ensure compliance with the law and the safety of the customer.

- Industry standards – the British Standards take the form of recommendations. By ensuring that the installation meets the requirements of the British Standards, the installation will meet the strict requirements of the regulations.

- Manufacturer technical instructions – no one knows the equipment better than the people that designed and built it. Again, by following manufacturer’s preparation and installation requirements, the installation will not only meet the Regulations, but will also ensure that the manufacturer’s guarantee is valid and in force.

- Building plans – these show the intended position of the equipment and appliances. Some building layouts also show the position of any existing services and pipe work etc.

- Specifications – these not only state what equipment is being installed, but, often the make of the equipment and, often, the British Standard also. A specification should not be altered without the permission of the customer or the Architect.

c. Installing systems and components – this should be conducted with care and professionalism. Always follow the manufacturer’s instructions when installing equipment and appliances and always consult the British Standards and Regulations when necessary.

d. Maintaining and dealing with faults on systems and components – once the system has been installed, maintenance is the key to keeping it in good working order. Maintaining systems prolongs the systems life, encourages early diagnosis of potential problems and prevents breakdowns. If a component should fail, always use the manufacturer’s instructions for a proper diagnosis of the fault.

e. Decommissioning systems and components – temporary and permanent – this is where a system is either permanently or temporarily taken out of service.

f. Soundness testing systems and components – once the installation is complete, soundness testing will determine if there any leaks on the system. Different pipework materials have different testing regimes and the Regulations and British Standards, as well as the manufacturer’s instructions, should be consulted before testing begins.

g. Commissioning systems and components – when the system has been installed and tested, then commissioning can begin. Commissioning is where the components and appliances are ‘set up’ for everyday use. It is also where we find if our design calculations are correct. Flow rates, temperatures and component operation must all be checked to ensure that they meet the specification, design and customer satisfaction.
AC3.2 State what information should be passed on to the customer when carrying out work on domestic pipework systems.

Many customer complaints centre around the lack of information given to them regarding the installation of their new bathroom or central heating system etc. In almost all cases, this is down to poor customer liaison and by following a few simple rules, can be avoided. Before the installation begins:

✔ Make sure that the customer is completely in agreement on what day and time the job is going to start. Agree a start time and stick to it. Early morning starts are not always welcome as families need to prepare their day in privacy without having to worry about their routine being placed into chaos by the arrival and disruption of a working plumber.

✔ Point out any carpets and furniture that will need to be removed from the area that you will be working in and ask the customer to remove them. It may be that the customer is happy for you to remove them but the customer must be given the opportunity to remove their possessions first. This is especially important with carpets and floor coverings as old carpets can fray easily and have been the cause of many customer/plumber disputes in the past.

✔ Agree the position of appliances and equipment BEFORE you install them. It may be that the wall where a radiator is going to be installed is needed for a piece of furniture etc. This is especially important when exposed pipework cannot be avoided as customers do not like to see pipework, no matter how neat it is.

✔ Keep the customer informed about any problems that you come across, especially if there is an added cost involved. Non-agreed extras can come as a shock and, if they have not been agreed in writing beforehand, there is no legal requirement for the customer to agree to payment.

✔ Keep the customer informed when services – gas, water, electricity – are going to be turned off, or appliances, such as WCs are going to be decommissioned and removed. Always ensure the customer has enough water in the short term and, if working on central heating systems during the winter, try to ensure that they have other forms of heat, such as fan heaters etc.

AC3.3 Identify how to check for pre-existing damage to the building fabric or customer property before the work commences.

Before work commences, it is advisable to liaise with the customer to identify any existing damage to the property both internally and externally. Although a time-consuming task, this will ensure that there are no misunderstandings later as the job progresses. Before discussing this with the customer, make sure that you are aware of the problems before hand and make written notes. Check for:

- Internal damage to walls and wall coverings, including marks and dents on walls, loose, torn and missing wall coverings, damaged skirting boards, architraves and doors. Cracked or broken window panes etc.
• Visible damage to carpets, furniture, personal possessions and appliances such as cookers, washing machines, tumble dryers, fridges and freezers, tables and chairs etc.
• Damaged visible wiring and existing plumbing
• External wall damage to brickwork, rendering, guttering, rainwater pipework, facia boards and soffits.
• Damage to any vehicles, cars, motor bikes etc. This is especially important if some of the work is to be done externally.

Also point out:

• Loose and creaky floorboards, badly fitting internal doors etc.
• Existing holes in brickwork both internally and externally.
• Missing roof and ridge tiles (if working outside).

This may seem a little excessive, but often the customer is unaware of these issues and when they are suddenly discovered, it is all too easy to put the blame on the last person to work on/in the property. REMEMBER! It is easy to ask the customer to move or remove something that may be in danger of being damaged because of the work activity. For example, car paintwork can be damaged by brick dust and debris as a result of installing a boiler flue or new soil stack. These situations need to be avoided as claims on company public liability insurance can be costly when the premium has to be paid after such a claim.

**AC3.4 Identify how to protect the building fabric or customer property before the work commences**

**Use of dust sheets**

Ensure that you cover with suitably clean dust sheets all furniture, fixtures, fittings and carpets that cannot be removed in the areas where you are working, including halls, stairs and landings etc.

**Protection from flame damage**

When using soldering equipment, always ensure that you protect the customers property and decoration by the use of a heat mat or flame retarding gel. Never point the nozzle of the blow torch directly at walls or skirting boards as this creates a lot of heat/fire damage.

**Use of walking boards – lawns/flower beds**

When working outside, always ensure that the customers lawns and flower beds are protected by boarding, especially in areas where ladders and tower scaffolds are to be erected, to prevent damage by access equipment and tools.

**Application of packaging to protect components during partially completed works**

Where equipment has only been partially installed, it is a good idea to use the packaging that the equipment
came in to protect it during the installation process. This is especially critical with bathroom and kitchen equipment that can become easily damaged during installation.

**Circumstances in which furniture, breakable items and carpets need to be removed from the work area**

Any carpets that have to be removed should be rolled up and stored in a safe place. Removed furniture should be placed in a room where there is no work activity and they should be suitably covered over. Liaising with the customer is a good idea when this is being done so that removed furniture and carpets are not placed in areas where they will cause a nuisance or inconvenience.

**Circumstances in which damage to vehicles may occur**

When working outside, always ask the customer to move their vehicles to prevent falling masonry, tools and materials from damaging them.

**AC3.5 Identify the method of storing tools, equipment and materials when working in new buildings and existing dwellings**

The storage of tools and materials is an important part of planning any installation. Tools left on site or in a customer’s care overnight are often not insured unless it can be proven that they were securely locked away. Plumbers often have £1000s worth of tools that are expensive to replace if they are stolen. More often than not, stolen tools are never recovered and the cost of replacement can be a shock to the bank account, which is often doubled if the insurance company refuse to pay for the replacements. By following some simple rules, these disrupting occurrences can be prevented:

1. Lock all tools and materials in a secure lock-up or site cabin when they are not being used
2. Return all unused materials to the stores and make sure they are signed back in.
3. Ensure that fragile materials, such as WCs, washbasins etc are kept in a safe area of the stores and ensure they are not stacked too high. They can also be covered for extra protection.
4. Ensure tools are kept away from materials. It is usual to keep tools to the front of the stores to prevent damage to fragile items.
5. If working for a private customer, agree a place where the materials can be stored and ensure they do not disrupt the normal family activities.
6. Keep all delivery advice notes in a file so that a check can be made on the stock held against stock used.
7. Protect partially installed appliances such as washbasins, WCs and baths, from damage.

**AC3.6 Identify the range of hand and power tools required to complete work on domestic pipework systems**

A full range of hand tools and power tools that a plumber may use was identified in LO1, AC1.1 of this unit.
AC3.7 State the checks to be carried out on tools and equipment to ensure that they work correctly and are correctly calibrated.

Tools and equipment are expensive items and should be kept in good condition for a prolonged working life. Before use, always check them for damage and loose parts. Ensure that any working parts are suitably checked and working and oiled if necessary. Check hammers for loose heads. Electrical tools should be checked to ensure:

- Blades and cutting edges are secure and set to the correct depth for cutting
- Safety guards are in place
- The tool casing, cable and plug are not damaged in any way
- Drill chucks are oiled and working correctly

A full list of hand and electrical tool safety checks can be found in LO1, AC1.3 of this Unit.

AC3.8 State the work methods for preparing building construction features for installation work

Preparing the work area

Much of the work we do in private dwellings will involve installing pipework under floors and in/through walls. These are skills that, to some degree, we learn on the job. However, there are tried and tested methods to do this work and certain unwritten rules that will help save time and damage to the customer’s property.

Lifting and removing floorboards

There are two methods we can use to lift and remove floor boards:

- Lifting floorboards using electrical tools
- Lifting floorboards using hand tools

Lifting floorboards using electrical tools

Before attempting to lift floorboards ensure that you have the correct tools available:

- A circular saw (110V or cordless)
- A sharp bolster chisel
- A nail punch
- A claw hammer
- A pencil
To lift floorboards using power tools

1. Decide which boards you need to remove and number them. This will help in laying them when you have finished.

2. Locate the joists where the boards are to be cut. This can be done easily by looking for a row of nails that hold the board to the joist.

3. Mark across the centre of the joists position on the board. This is where you are going to cut the boards.

4. Using a nail punch, punch the nails in the boards being removed below the surface of the board and into the joist below.

5. Set the depth of cut on the circular saw to just above the maximum depth of the floorboard. This will ensure that any pipework or cables below the boards are not damaged in any way. Now carefully cut across the boards that are being lifted with the circular saw.

6. If the boards are tongued and grooved types, run down the tongue on both sides of the board. This will ensure that the board is removed without splintering or damage.

7. Using the bolster chisel, carefully prise up the board. There should be no resistance and the board should come up cleanly and without damage.

Lifting floorboards using hand tools

Before attempting to lift floorboards ensure that you have the correct tools available:
• A sharp floorboard saw
• A sharp bolster chisel
• A nail punch
• A claw hammer
• A pencil

To lift floorboards using hand tools

1. Follow points 1 to 4 of the previous method

2. Carefully cut through the tongue of the floorboard with the floorboard saw. Alternatively, carefully drive the bolster chisel through the tongue with a claw hammer.

3. Now carefully cut across the boards that are being lifted with the floorboard saw.

4. Using the bolster chisel, carefully prise up the board. There should be no resistance and the board should come up cleanly and without damage.

Lifting chipboard flooring using power tools

Chipboard flooring is very different to traditional floorboards. It is laid in 2m x 0.6m sheets that are glued at the tongue and groove and often they are also glued to the joist. They are very susceptible to movement and quite often break when they are being removed. Chipboard flooring needs support at every edge and so, if part of the board is lifted, it will require support noggins to be installed before the board is re-laid. Lifting chipboard is best done using power tools.

To lift chipboard flooring using power tools

1. Decide which boards you need to remove and mark them with a pencil. There is no need to mark the joists as the long joint in the chipboard indicates where these are. You only need to mark the area of board to be lifted as shown in the drawing left.

2. Using a nail punch, punch any nail heads below the surface of the board and into the joist below

3. Set the depth of cut on the circular saw to just above the maximum depth of the chipboard. This will ensure that any pipework or cables below the boards are not damaged in any way. Now carefully cut across the marks, on the boards that are being lifted, with the circular saw.
4. Using the bolster chisel, carefully prise up the board. There should be no resistance and the board should come up cleanly and without damage providing it has not been glued to the joist.

5. When replacing the board, the edges need to be supported by wooden noggins. This can be done as shown in the drawing left:

### Notching and drilling joists

Joists need to be notched or drilled to accommodate the pipework and fittings below the floor. These operations should be carried out properly and with extreme care if weakening of the joists and structural damage is to be avoided. The structural integrity of the joist must in no way be compromised. Notches that are too deep or incorrectly positioned and holes that are too large or too close together can weaken a joist to the point where its use as a load bearing structural support capability is diminished significantly.

Look at the drawing below:

To find out where notches can be made in a joist:

1. Measure the span of the joist from wall to wall
2. Multiply the span measurement by 0.07. This will give a measurement equal to 7% of the span.
3. Measure from the wall the 7% measurement and mark it on the joist. No notches must be made within this mark.
4. Now, multiply the span measurement again by 0.25. This measurement is equal to 25% of the joists span.
5. Measure from the end of the joist again and mark the 25% distance and mark it on the joist.
6. All notches must be within the 7% and 25% marks.

**Notch position**

In calculation form:

\[
\text{Length of span of the joist} = 5m \\
7\text{% of the span} = 5 \times 0.07 = 0.35 = 350\text{mm}
\]
25% of the span = 5 \times 0.25 = 1.25 = 1.25m

Therefore, any notches made in the joist must start 350mm from the beginning of the joist span and must finish 1.25m from it. This gives 900mm in which to make the notches and can be done from both ends on a 5m joist.

Notches must not exceed 12.5% (or \(\frac{1}{8}\)) of the depth of the joist. So, if a joist measured 300mm in depth, then the depth of the notches must be no more than:

\[
\text{Depth of the joist} = 300
\]

12.5% of the depth = 0.125 = 300 \times 0.125 = 37.5mm

Drilling or cutting holes in joists follows a similar procedure. Holes must only be drilled within an area that begins at a distance equal to 25% of the span measured from the end of the joist and ends at a point equal to 40% of the span. The hole size must not be greater than 25% of the depth of the joist when measured from the centre line. Circular holes must be at least 3 diameters of the hole size apart measured centre to centre. Look at the drawing below:

In calculation form:

\[
\text{Length of span of the joist} = 5m
\]

25% of the span = 5 \times 0.25 = 1.25m

40% of the span = 5 \times 0.4 = 2m

In this example, holes can be cut or drilled in the joist providing that they fall within a 750mm area that starts 1.25 m from the end of the joist and finish no more than 2m away from the same end. Again, this can be done at both ends, so 2 sets of holes can be drilled if required.

To calculate the hole size:

\[
\text{Depth of the joist} = 300mm
\]
25% of the depth = 300 x 0.25 = 75mm

This measurement must be equidistant either side of the centre line of the joist.

**Note:** No holes must be drilled in a joist within 100mm of a notch.

**Cutting chases in walls**

Cutting chases in walls is sometimes necessary to conceal pipework, cables and the like, especially if the customer has requested that there be no visible pipework after the installation is completed. Inevitably, this will involve the use of an angle grinder fitted with an appropriate stone or concrete/masonry grinding wheel to cut the outline of the chase into the wall before removing the unwanted brickwork with a bolster chisel and lump/club hammer. This needs careful consideration as there are potentially serious health and safety implications:

- Always wear the correct PPE for this operation. This will include the use of
  - Appropriate eye protection to guard against flying chips of masonry and dust. Full goggles should be used as safety glasses do not offer adequate all-round eye protection
  - Gloves to protect the hands,
  - Overalls, and;
  - A good quality dust mask. Masonry dust can do serious harm to the lungs if breathed in. A respirator type dust mask of the type shown in the image would be appropriate.

- Always check the angle grinder beforehand. Make sure that:
  - The grinder has a current PAT certificate and is in good condition.
  - The correct cutting wheel is in fitted.
  - The wheel is secure and the wheel guard is in place.

It is important to remember that grinding out chases in walls creates a huge amount of both surface and airborne dust and undertaking grinding in rooms that contain furniture and carpets is not advisable. However, if this is unavoidable, sheeting down all carpets/furniture must be carried out. Ensure that there are no interconnecting doors open that will allow the dust to spread to other rooms and if possible, open a window to let air in and some of the dust out. Chases in walls must not exceed:

- Horizontal chases no deeper than \( \frac{1}{6} \) of the wall thickness
- Vertical chases no deeper than \( \frac{1}{3} \) of the wall thickness.

**A note about hot and cold water pipes** – the Water Supply (water fittings) Regulations 1999 state that no
pipe shall be buried in any wall, floor or ceiling unless the pipework is accessible. Obviously, if a pipe is going
to be buried in a wall, then the question of access becomes of paramount importance. If in doubt, advice
should be sought from the Water Regulations Advisory Service (WRAS).

Making good the building fabric

During any installation, there will be times when the building fabric will need to be altered, whether it’s a
simple task, such as drilling holes, or breaking out brickwork to fit a boiler flue. Whatever the reason, making
good after the installation is an important aspect of our work, and unless it’s stipulated otherwise in the
contract of work, any holes, chases or plaster patching will need to be completed by you, the plumber.
Making good involves having a few basic skills that we would normally associate with other trades such as a
brick layer or a plasterer.

- **Making good to brickwork** – holes made by drills and masonry bits can be filled with a 4:1 mixture
  of sand and cement mortar (4 parts sand to 1 part cement) mixed to a fairly stiff consistency. Larger
  holes may need the replacement of bricks. New bricks will need to match the existing bricks. The wall
  should be neatly pointed up using a pointing trowel and brushed over with a soft brush.

- **Patching plaster work** – the type of plaster to be used in the repair will depend on the type of wall
  that is being repaired. Plasterboard walls require a board finish type plaster, whilst masonry walls
  will require a good multi-finish plaster. The two types of finish are quite different. Board finish is
  harder to skim to a smooth finish because it dries quickly. The art to plastering is have a clean, smooth
  trowel and plenty of water for the smoothing or ‘skimming’ process.

Finally, after making good wall surfaces, ensure that all waste materials are cleared away and the area
cleaned thoroughly.
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- An invaluable point of reference for qualified engineers
Learning Outcome 5
Know how to use clips and brackets to support domestic plumbing and heating pipework and components
AC5.1 State how to measure and mark out for fixings to pipework and plumbing and heating components

Each different pipework material has different requirements for fixing and clipping. The distances between clips and brackets often reflect the type of pipework material that is being installed. For example, when installing clips for Low Carbon steel, the distances between the clips will be greater than for those for, stay, polybutylene pressure pipe. This is simply because the steel is much stronger and less likely to be damaged or sag between the pipe clips than the polybutylene.

In AC4.1, we will investigate each of the different pipework materials and their clipping distances in line with the British Standards and manufacturer’s data.

Clipping distances for copper tubes

Below is a table showing the clipping distances of the common sizes of copper tubes:

<table>
<thead>
<tr>
<th>Tube size</th>
<th>Horizontal distance between the clips</th>
<th>Vertical distance between the clips</th>
</tr>
</thead>
<tbody>
<tr>
<td>10mm</td>
<td>0.8m</td>
<td>1.2m</td>
</tr>
<tr>
<td>15mm</td>
<td>1.2m</td>
<td>1.8m</td>
</tr>
<tr>
<td>22mm</td>
<td>1.8m</td>
<td>2.4m</td>
</tr>
<tr>
<td>28mm</td>
<td>1.8m</td>
<td>2.4m</td>
</tr>
<tr>
<td>35mm</td>
<td>2.4m</td>
<td>3.0m</td>
</tr>
<tr>
<td>42mm</td>
<td>2.4m</td>
<td>3.0m</td>
</tr>
<tr>
<td>54mm</td>
<td>2.7m</td>
<td>3.0m</td>
</tr>
</tbody>
</table>

It will be seen that the vertical and horizontal clipping distances are quite different. The distance between vertical clips is greater than for horizontal clips. This is because when fixed horizontally, pipework is more likely to sag than if the pipework was fixed vertically. For this reason, horizontal clipping distances are reduced to take into account the semi-rigid nature of copper tubes.

The correct clipping of copper tubes is essential as clipping prevents noise, vibration, excessive movement and water hammer. Fittings failure is also less likely to occur if the pipework is protected from excessive movement. Clipping also helps to guard against accidental and intentional pipework damage.

Copper tube is easily jointed and bent and can produce installations that not only look good but are economical both in terms of copper tube usage and installation costs. Careful planning of pipework routes,
use of pre-fabrication techniques and installation techniques that are sympathetic to the building in terms of visible, well-clipped pipework ensure that the installation performs to the design criteria.

**Clipping distances for Low Carbon Steel Pipes**

The clipping distances for low carbon steel are listed in the table.

<table>
<thead>
<tr>
<th>Pipe size</th>
<th>Horizontal</th>
<th>Vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td>½&quot;</td>
<td>1.8m</td>
<td>2.4m</td>
</tr>
<tr>
<td>¾&quot;</td>
<td>2.4m</td>
<td>3m</td>
</tr>
<tr>
<td>1&quot;</td>
<td>2.4m</td>
<td>3m</td>
</tr>
<tr>
<td>1 ¼&quot;</td>
<td>2.7m</td>
<td>3m</td>
</tr>
<tr>
<td>1 ½&quot;</td>
<td>3m</td>
<td>3.6m</td>
</tr>
<tr>
<td>2&quot;</td>
<td>3m</td>
<td>3.6m</td>
</tr>
</tbody>
</table>

As with copper tubes, the vertical and horizontal clipping distances differ. In all cases, the distances are much greater for LCS and this reflects the rigid nature of the pipe. The clips and brackets used need to be robust as they will need to carry the weight of the pipe. The types of clips and brackets for LCS are limited and will be discussed later in the unit.

**Clip distances for PVCu soil and waste pipes**

Clipping distances for PVCu soil and waste pipes are listed in the table below:

<table>
<thead>
<tr>
<th>Clipping distances for PVCu pipes</th>
<th>Maximum support distance</th>
<th>Maximum distance between expansion joints</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vertical</td>
<td>Horizontal</td>
</tr>
<tr>
<td><strong>Pipe size - soil</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>82mm</td>
<td>2m</td>
<td>0.9m</td>
</tr>
<tr>
<td>110mm</td>
<td>2m</td>
<td>1m</td>
</tr>
<tr>
<td>160mm</td>
<td>2m</td>
<td>1m</td>
</tr>
<tr>
<td><strong>Pipe size – waste</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32mm</td>
<td>1.2m</td>
<td>0.5m</td>
</tr>
<tr>
<td>40mm</td>
<td>1.2m</td>
<td>0.5m</td>
</tr>
<tr>
<td>50mm</td>
<td>1.2m</td>
<td>0.9m</td>
</tr>
</tbody>
</table>

When we install plastic pipework, the use of the manufacturer’s recommended clipping distances becomes a necessity, especially in multi-storey buildings where care must be taken to ensure the provision of expansion and thermal movement. Plastic is light and easily broken if mistreated and, if installed in direct sunlight, will sag as the pipe becomes warm. PVCu pipes cannot be bent in any way because of its brittleness. The manufacturer’s place great importance on the clipping of PVCu pipes to ensure that the system remains efficient and reliable once installed.

**Clip distances for Polypropylene push-fit waste pipes**

Clipping distances for polypropylene push-fit waste pipes are listed in the table below:
Polypropylene, although more robust than PVCu, starts to soften at around 70°C and, if it is not clipped correctly, will sag between the clips. Waste pipe manufacturer’s recommend that the waste pipe should be clipped at every change of direction, close to the fittings to support the fitting and to prevent sagging.

Like PVCu, polypropylene has a high rate of expansion and so should be clipped at 2m intervals between any expansion joints.

### Clipping and supports for Polybutylene and Cross-linked Polyethylene pipe

Plastic pressure pipe is extremely flexible and can sag between clips if not clipped to the manufacturer’s instructions. Cross-linked Polyethylene is slightly more rigid than polybutylene and can be difficult to straighten out, especially when installed directly from the coil. This tendency to coil back up again can cause problems if it is not clipped correctly, which can put excess pressure on joints and changes of direction. The clipping distances are shown in the table below:

<table>
<thead>
<tr>
<th>Clipping distances for Polybutylene pipes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe diameter mm</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>22</td>
</tr>
<tr>
<td>28</td>
</tr>
</tbody>
</table>

Plastic pressure pipe can be run successfully through joists under floors without clipping, provided it is adequately supported and provided that:

1. The pipe does not form part of an open vent to a hot water or central heating system where the pipe is likely to become hot
2. The pipe is not part of a distribution system or circuit where poor pipe alignment may affect the venting of air
3. Any hot water pipe is not likely to come into contact with cold water pipework
4. Where there is no risk of the pipe coming into contact with abrasive or sharp edges.

### Select and fix clips and brackets appropriate to the system pipework and the industry recommended spacing

The type of brackets and clips that we use on an installation are chosen depending on the following requirements:
• The type of pipework material being installed. This could be copper tubes, LCS pipes or plastic pressure pipe. Copper and plastic are more likely to be used in domestic installations, which simplifies the choice of pipe clips.
• The type of building, whether it is domestic or industrial/commercial.
• Whether the pipework is to be:
  o Surface mounted, fixed to internal or external walls.
  o Fixed below ground or in roof spaces
  o Installed in pipe boxings or ducts
  o Hung from ceilings.

Copper tubes

Domestic properties are probably the easiest installation to select brackets and clips for. In most cases, where the pipework is visible, the pipework will be copper tube and will be fixed to the wall using surface mounted clips that are screwed directly to the wall surface. Wall mounted clips are generally made of white polypropylene and are available in several forms to suit different installation situations:

• Single clips, with or without a securing clip over to keep the pipe in place.
• Double clips, particularly useful when 2 pipes need to be installed side by side (hot and cold pipework or central heating flow and return)
• Interlocking clips. These are used to create banks of multiple pipes of differing sizes. They ensure that pipe centres are maintained along the entire pipework run, maintaining neatness.

Care should be exercised when installing plastic clips in external situations because, over time, direct sunlight affects and breaks down the plastic structure and this is likely to lead to failure of the clips, meaning that the pipework will be unsupported and vulnerable to damage. For outside situations, brass schoolboard clips offer a greater, longer lasting solution.

In all cases, the clip centres and distances should be maintained as specified in section 4.1. bends, elbows and changes of direction should be supported as near to the bend as practicable.

Clipping copper tubes in commercial/industrial installations

In most cases, plastic clips do not offer the strength required for pipework installed in commercial and industrial buildings. In these situations, the pipework is often subjected to severe knocks and strains. More robust options are available in all situations:

• Pipework fixed to walls both internally and externally can be completed using 1 of 2 options:
  o Brass schoolboard clips, either strip brass or cast brass type offer a good, sturdy method of wall mounting copper pipework.
  o Brass munsen rings and backplates, although slightly more expensive, offer the best protection for copper pipework when fixed to walls.
• Pipework that is to be installed at high level can be completed using:
- Munsen rings used with either 10mm tapped rod and backplates or direct fixing anchor bolts, or;
- Unistrut type channel, where multiple runs can be installed without the need for many ceiling fixings.

**Plastic pressure pipe**

Where plastic pressure pipe is to be installed, strict control of the clip distances mentioned for plastic pressure pipe in section 4.1, should be maintained if damage to the pipework is to be avoided. Because of the soft, flexible nature of plastic pipe, sagging is likely, which puts greater pressure on joints and fixings. Plastic pipe has the advantage that it can be ‘cabled’ through joists in continuous, unbroken lengths, making installation easier. However, plastic pipe also expands much more than copper exacerbating the problem of sagging. In general, it’s accepted practice that, if plastic pipe is installed, any visible pipework will be converted to copper for aesthetic reasons.

**Low Carbon Steel**

The big advantage with LCS is that it is very rigid. However, it is also very heavy, so any type of bracket or clip needs to be robust enough to carry the weight of the pipework. Brackets for LCS are very limited to just 3 different types:

- Malleable iron school board clips,
- Munsen rings with either back plates or direct anchoring, or;
- Munsen rings in conjunction with unistrut

In the majority of industrial installations, the pipework is hung at high level. Modern unistrut systems are ideal for this because many runs of pipework can be installed with the minimum of anchorages. This also allows pipework of different materials, and even electrical supplies, to be run almost side by side saving space and installation time. Double munsen rings add another advantage allowing pipes to be placed one above the other, thus making better use of the space available. Again, the pipework spacings mentioned in **section 4.1 for LCS pipe** should be adhered to.

---

*Using unistrut*

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Author: BPEC Ltd. Editor: BPEC Ltd. Design: BPEC Ltd
AC5.2 Identify the range of general fixing devices

Fixing devices can be classified into five groups:

- Nails, both masonry and timber
- Screws
- Heavy duty fixings
- Lightweight and plaster board fixing
- Chemical fixings

Nails, both masonry and timber

| Masonry nails | - used for making fixings to masonry surfaces. Manufactured from hardened zinc |
| Floor brads | - used to fasten floorboards in older properties. These are 50mm long. |
| Galvanised clout nails | - for fixing slates and roof tiles |
| Round bright wire nails | - used generally for carcass joinery work where appearance is not important. |
| Oval bright wire nails | - Suitable for joinery work where appearance is important. The head is lost when driven into the timber with a nail punch. |

The table above shows just some of the many hundreds of different nail types that are available. It is not necessary to know ALL nail types but the ones shown here are the ones that you are more likely to come across.

Nails are described by the size of the head and by their length. So, a 40mm long galvanised clout nail with a 2.65mm head may be described as a 40 x 2.65 clout nail. All nails are sold by their weight in kilograms (kg).

Screws

| Slotted head Countersunk Screw | - Not often used. Mainly joinery applications. The head sinks flush or a little below the wood surface. |
Cross Head/Pozi Drive Screw (Countersunk). Used for general work but unlike the counter sunk screw, it needs a pozidrive head screwdriver, which does not slip out of the screw head. A general purpose screw.

Round Head Screw. Used for fixing copper saddle clips.

Spider/star head screw. Designed to give a much more positive drive into the fixing without the risk of slipping.

Mirror Screw. Used for fixing mirrors and bathroom fittings such as bath panels. The chromed cap screws into the screw head to hide the screw.

Chip Board Screw. Used for securing chipboard and Medium Density Fibreboard (MDF). Various types of heads are available.

Screws can be made from a variety of metals including steel, stainless steel and brass. A range of head types is also available. They are often coated with a protective coating to prevent corrosion. Screws are specified by the length of the screw in mm and the gauge. Below is a screw chart showing the standard gauges and lengths:

<table>
<thead>
<tr>
<th>Gauge</th>
<th>Metric equivalent</th>
<th>Pilot hole</th>
<th>Clearance hole</th>
<th>Masonry plug colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2.5mm</td>
<td>1.0mm</td>
<td>3.0mm</td>
<td>Yellow</td>
</tr>
<tr>
<td>4</td>
<td>3.0mm</td>
<td>1.5mm</td>
<td>3.5mm</td>
<td>Yellow</td>
</tr>
<tr>
<td>6</td>
<td>3.5mm</td>
<td>2.0mm</td>
<td>4.0mm</td>
<td>Red</td>
</tr>
<tr>
<td>8</td>
<td>4.0mm</td>
<td>2.5mm</td>
<td>4.5mm</td>
<td>Red/Brown</td>
</tr>
<tr>
<td>10</td>
<td>5.0mm</td>
<td>3.0mm</td>
<td>5.5mm</td>
<td>Brown</td>
</tr>
<tr>
<td>12</td>
<td>5.5mm</td>
<td>3.5mm</td>
<td>6.0mm</td>
<td>Brown</td>
</tr>
<tr>
<td>14</td>
<td>6.5mm</td>
<td>4.0mm</td>
<td>7.0mm</td>
<td>Blue</td>
</tr>
</tbody>
</table>

for plumbing installations, the most common sizes range from 15mm x 6 for fixing saddle clips to 50mm x 10 for hanging radiators.
Plastic wall plugs

Plastic wall plugs are a tried and tested method of fixing radiators, sanitary appliances and many other components securely to wall surfaces such as brick, stone and concrete. They are available in many different sizes to accommodate the many sizes of screws available. Each plug size is colour coded to a specific drill bit size so that, once drilled, the plug fits perfectly in readiness of the screw.

Using plastic wall plugs

1. First, carefully mark the hole to be drilled.
2. Choose the correct sized masonry bit for the plastic wall plug.
3. Using an electric drill or battery drill, carefully drill the hole to the correct depth. Remember to pay attention to all health and safety requirements. Wear the correct PPE at all times and check the drill before use.
4. Insert the wall plug to slightly below wall surface.
5. Insert the screw and carefully tighten until resistance is felt.

AC5.3 Identify the range of specialist fixing devices

Heavy duty fixings

There are a number of heavy duty fixings that plumbers use from time to time. These are:

- Coach screws
- Fischer bolts

**Coach screws.** These usually come with purpose made wall plugs. They are used for fixing heavy fixings such as mounting boilers. Can be tightened with a spanner but some have pozidrive screw heads.
**Fischer bolts** – these are also known as a heavy-duty expansion anchors. They are easy to use with good load-carrying capacity and can be used in all masonry and concrete types for fixing heavy appliances and large diameter pipework.

---

### Plaster board and light structure fixings

Plasterboard, because of its lightweight nature, is notoriously difficult to fix to. Most plasterboard walls will not take the weight of a substantial appliance, such as a boiler. However, some components such as radiators can be hung without fear of them coming off the wall. In all situations, a proper plasterboard fixing, used correctly, will suffice. The common plasterboard fixings are shown below:

<table>
<thead>
<tr>
<th>Fixing Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collapsing cavity fixings</td>
<td>A good, strong plaster board fixing. Used to hang sanitary ware, radiators and many other types of appliances.</td>
</tr>
<tr>
<td>Self-drill plaster board fixings</td>
<td>Used to hang small appliances and radiators. The body of the fixing is self-drilling and is screwed directly into the plaster board, without the need to drill a hole first.</td>
</tr>
<tr>
<td>Spring loaded toggle bolts</td>
<td>Also known as butterfly bolts. Suitable for hanging radiators and other small appliances.</td>
</tr>
</tbody>
</table>

*Figure 7: Plaster board fixings*

### Unistrut pipe hanging system

The unistrut system is ideal on commercial and industrial installations where banks of pipes are to be hung in straight lines.
Unistrut uses a galvanised steel channel that can be fixed to the ceiling with pipes hung from it or with pipework fixed directly to the unistrut

Unistrut can be used with all pipes and tubes across all pipe sizes.

**Chemical Resin fixing methods**

Chemical or resin anchors are used to bond steel studs, bolts and other anchorages directly into the substrate, usually brick or concrete. They are ideally suited to high loads and normally result in a bond far stronger than the substrate itself. They are ideal for use in substrates of low compressive strength such as thermalite blocks.

Chemical fixings are a relatively new method of securely fixing pipes and appliances to walls, floors and ceilings. There are a number available:

1. **Polystyrene resin** – used instead of rawlpugs, rawlbolts and anchors, polystyrene resin is used to fill a pre-drilled hole. Once filled, the tapped rod is inserted into the hole and the resin allowed to cure. This provides a good bonding in stone, concrete, brick and blockwork.

2. **Vinylester resin** – uses are similar to polystyrene resin. It is an injection resin for the bonding of studs, sockets and fixings into concrete and masonry substrates.

**AC5.4 Identify clip and bracket types for domestic plumbing and heating work**

There are many different types of clips, brackets and fixings for pipes and tubes. Some will be familiar to you, others maybe not so. In this section, we will look at the various pipework materials and the brackets and clips we can use to make them secure.

**Clips and brackets for copper tubes and plastic pressure pipe**

<table>
<thead>
<tr>
<th>Copper Saddle clips</th>
<th>Generally used when fixing pipework to skirting boards. Not suitable for fixing pipework to plastered walls or masonry, stone or concrete.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nail-on clips</td>
<td>Useful for fixing pipework under floors against wooden joists. Caution should be exercised as pipework expansion can loosen the clips making the pipework susceptible to sagging.</td>
</tr>
</tbody>
</table>
Interlocking clips

Ideal when banks of pipework are to be installed. The clips simply slide together meaning runs of different sized pipework can be fixed easily and quickly.

Single plastic clips

The standard clip for most pipework installations. Can be used with copper or plastic pressure pipework.

Double plastic clips

Excellent for use on heating installations or hot and cold pipework when more than one pipework run is required.

Strip brass school board clips

Usually used where the pipework fixing needs to be a little more robust, such as schools, commercial buildings and industrial installations.

Cast brass school board clips

Munsen rings

Munsen rings and backplates provide a very robust fixing for copper pipework. Munsen rings can be combined with 10mm tapped rod and backplates for when pipework is to be hung from the ceiling or with unistrut channel type fixings.

Back plate

Clips and brackets for low carbon steel pipe

Low Carbon Steel, by its nature, is very heavy. Because of this any clips or brackets need to be very robust to be able to carry the weight of the pipework. There are two types of clip that are readily available for fixing Low Carbon Steel:
School board clips are a very robust bracket for single pipework runs. Care must be exercised when these are being installed as they can bend if they are mis-treated.

Munsen rings for 10mm tapped rod and Malleable iron backplates

Again, munsen rings with backplates are the bracket of choice when undertaking heavy industrial installations. Munsen rings can also be used with rawbolt anchors when being hung from concrete structures and ceilings. Double munsen rings are also available for multiple pipework runs.

Clips and brackets for plastic Soil and Waste pipes

**Soil and vent pipe clips**

110mm Plastic saddle clips

Both of these pipe clips are suitable for fixing 110mm soil and vent pipes. The top pipe clip is more suited to domestic installations. The bottom bracket is used where the installation needs to be tough enough to withstand knocks.

110mm Galvanised metal pipe clip

**Waste pipe clips**

32mm, 40mm and 50mm Plastic saddle clips

A simple plastic band suitable for clipping 32mm, 40mm, 50mm waste pipes in most installation situations.
Learning Outcome 7

Know the installation requirements of domestic plumbing and heating pipework
There are two Assessment Criteria in Learning Outcome 7:

**AC7.1.** Identify the methods of installing domestic plumbing and heating pipework

**AC7.2.** Identify how to select pipework materials and fittings from instructions including plans and drawings

---

**AC7.1 Identify the methods of installing domestic plumbing and heating pipework**

The installation of pipework, whether it is for hot water, cold water, central heating or sanitation, needs careful thought. It is a fact that not all pipework we install can be hidden and there will be occasions when surface mounted pipework will need to be used because of the constraints of the building or the requirements of the regulations. This being the case, surface mounted pipework will need to be as unobtrusive and as neat as possible. A pipe that is not level or plumb is an eyesore. It is, therefore, of great importance, that we think about where and how we are going to position our pipes beforehand.

**Surface mounted pipework**

Planning is the key to good surface mounted pipework. It should, if possible, take the shortest route. This is not only important from a visual point of view, but also in respect of the design. Flow rates and pressures can be adversely affected by large numbers of bends and elbows.

Marking out for pipework, especially in occupied premises, should be kept to a minimum to avoid defacing the customer’s decorating. Use a pencil rather than pen or markers. Carpets and furnishings should be well protected with dust sheets and coverings.

The selection of clipping method for the surface mounted pipework requires careful thought. The question to be asked is, where is the pipework being installed? Think about the following:

- Pipework mounted to skirting boards would look too bulky if stand-off type clips, such as plastic clips, were used. Instead, consider the use of copper saddle clips that lie flat to the timber. When the pipework is painted, it would not look as unsightly as a pipe that is standing away from the timber skirting boards.

- Try to hide surface mounted pipework in the corners of rooms where they may be successfully boxed in. Once decorated, these tend to blend into the wall a little and become less noticeable.

- If a number of pipes are to be installed in the same location, arrange them in banks using interlocking clips. Not only does this require less drilling and screwing but also keeps the pipework runs parallel across the entire run. This is particularly useful when installing pipework in airing cupboards, boiler room and roof spaces where long lengths of pipework may be placed in the same direction.
Consider the type of building. Whilst plastic clips and saddle clips are useful in domestic properties, they would not stand up to the everyday knocks of life in, say, a factory or a supermarket. Similarly, large bulky clipping methods usually used in commercial buildings would look out of place in a home.

Concealed pipework

Installation of pipework often means that most of the pipework be concealed out of sight. When first fixing takes place, this is where the majority of the pipes would be hidden from view under the floors or buried in studded walls and sometimes even placed behind the dot and dab plasterboard on the inside of external walls.

Whilst the idea of concealed pipework means that the walls of the property are ‘pipework free’, we also have to take into account the requirements of regulations and British Standards with regard to concealed pipework. Consider this from the Water Supply (water fittings) Regulations 1999:

Schedule 2, Regulation 7 states:

7. (1) **No water fitting shall be embedded in any wall or solid floor.**

(2) No fitting which is designed to be operated or maintained, whether manually or electronically, or which consists of a joint, shall be a concealed water fitting.

This means that if we cannot install the pipe behind the wall without joints, then the pipe should not be installed in the wall and we should consider surface mounted pipework. Why is this? Simply, every joint is a potential leak. Even if no leaks are found during testing, that doesn’t mean that the joint won’t leak in the future. Leaks in walls are notoriously difficult to find because water can travel some distance before it emerges into view. These are points that should be considered at the planning stage.

Sleeving pipework

Sleeving pipework through masonry and concrete walls is essential to prevent the masonry/concrete wall from having an adverse effect on the pipework. Sleeving a pipe has several functions:

- It prevents the pipework from coming into contact with the wall surface, thereby preventing abrasion, and corrosion from the effects of the masonry or concrete materials.

- It allows for thermal movement.

- It prevents damage from building movement due to subsidence etc.

The sleeve should be at least one pipe size larger than the pipe being passed through the wall and should be sealed on the inside and outside with an approved silicon sealant to prevent the ingress of rain/snow etc. and insects/vermin. Where sleeves are carrying gas pipework, the sleeve should only be sealed on the INSIDE of the property. The external end of the sleeve should be left open.
Fire stopping pipework installations

Pipework that passes between floors must be fire stopped to prevent the spread of fire. This can be done in two ways:

- By the use of an intumescent collar, or;
- By the use of intumescent sealant.

The photograph (left) shows an intumescent collar, which is placed around the pipework as it passes through a floor. Should a fire occur, the heat from the fire causes the bonded material inside the collar to expand, completely sealing the space around the pipe preventing the spread of fire, smoke and hot gases to other areas. This helps to:

1. Contain the fire in the room where it started
2. Maintain escape routes
3. Reduce the damage caused by the fire and reduce the effects of smoke.

Intumescent sealant works in the same way but is injected into the space around the pipe.

Measure, mark and cut pipework materials for Installation

There are many methods used when installing plumbing systems. Each plumber will have their own way of installing pipework, setting out, marking out and fabrication. In many cases, pipework may even be prefabricated before it arrives on site to be installed. Many plumbing systems and components are now supplied ‘pre-plumbed’ making the plumber’s job that much easier.
Prefabrication of pipework

Prefabrication takes place on large housing contracts where many of the same type of buildings are being constructed or where a large block of identical apartments is being built. Pre-fabrication of bends, fittings and pipework has the advantage of saving time and can be of benefit where ‘hot working’ with blow torches is forbidden.

Prefabrication off-site means that the measurements for the pipework can be taken from either on-site or taken from the working drawings. Often, it’s much better to work from measurements taken on site because plans and drawings can sometimes change and the actual building be slightly different from that drawn. Whichever way is chosen, the pipework is measured, marked, cut, formed and jointed in the workshop and then transported to site for installation.

Fabricating pipework to clear obstacles

Working on site will also involve pre-fabrication of pipework. Precise measurements, cutting, bending and jointing will all take place to suit the obstacles that we come across. Consider the drawing:

By using the correct setting and marking out procedures, and using the correct bending methods, it is possible to bend the pipe from fitting 7, through bends 1 to 6 and up to fitting 8, out of a single piece of copper tube.

When marking out the tube for one-piece bending, there are several pieces of information that we need to know:

1. The size of the tube
2. The ‘X’ dimension of any fittings required. In this case 2 end feed capillary elbows.
3. The distance from the wall to the centre of the clip
4. The dimensions of the space where the tube will finally rest
5. The pipe gain of the machine-made bends.

Look at the drawing. The pipe is going to be installed around a concrete nib, located in a small space. The overall dimension is:

1100mm or 1.1m wide, 600mm deep, with a raised nib measuring 500mm wide by 450mm deep. There are:

- 6 machine-made bends, 4 internal and 2 external, and;
• 2 endfeed capillary elbows.

We can assume that:

• The tube size is 15mm copper
• The ‘X’ dimension of a 15mm endfeed elbow is 12mm as shown by the drawing
• The distance from the wall to the centre of the clip is 15mm
• The pipe gain of a machine made bend is 1.5 times the pipe diameter. Therefore, pipe gain is 22.5mm. rounded down to 22mm.

Method

Total up the amount of pipe needed.

From elbow 7 to bend 1 the distance is 600mm and because pipe clips are fitted inside and outside of the space, the distance is not altered. There is an endfeed elbow at elbow 7 and this has a 12mm ‘X’ dimension, which we need to deduct:

\[ 600 - 12 = 588\text{mm} \]

So, from **elbow 7 to bend 1** - the first machine **bend 1** can be marked **588mm** from the end of the pipe.

From **bend 1 to bend 2** is 400mm centre to centre of pipe. From this we need to deduct 2 clip distances totalling 30mm. \[ 400\text{mm} - 30\text{mm} = 370\text{mm} \] (this is the measurement after the deduction of 2 clips to the centre). Bend 2 can be marked at this distance.

From **bend 2 to bend 3**, the distance is **300mm** and since there are clips on the front of the nib, this is the distance we use.

**Bend 3 to bend 4** carries the tube around opposing sides of the nib and because the clip centre is 15mm we add \[ 2 \times 15 = 30\text{mm} \] to the overall nib size. Therefore, \[ 300 + 30\text{mm} = 330\text{mm} \].

**Bend 4 to bend 5** is the same as bends 2 to bends 3, as the two dimensions are identical. **300mm**.

**Bends 5 to bend 6** are identical as from **bend 1 to bend 2**, so the same dimension can be used. \[ 400\text{mm} - 30\text{mm} = 370\text{mm} \]. Mark the bend at this distance.

From **bend 6 to elbow 8** is identical as from **elbow 7 to bend 1**. Therefore, \[ 600 - 12 = 588\text{mm} \]

There are 6 machine made bends on the tube, so pipe gain is as follows: \[ 6 \times 22\text{mm} = 132\text{mm} \]. this will need to be deducted once the measurements have been added together:
588 + 370 + 300 + 330 + 300 + 370 + 588 = 2846mm

Now deduct the pipe gain:

2846 − 132 = 2714mm or 2.714m

So, to complete the installation in a single piece, without joints, we would need 2.714m of 15mm tube.

In-situ working

When working in customer’s properties, at some point the need to work on an existing installation will occur. This can be challenging, especially in older properties where we might encounter pipework of a different size or material. Over the years, there have been many different materials used for plumbing, such as copper, lead, stainless steel and plastic and many of these have sizes and jointing techniques that are uncommon to us. Problems occur when connections must be made to old pipework of imperial size that differ from the metric sizes now in use. Fortunately, for many of these pipe sizes, converters to metric sizes exist. In-situ work includes:

- Cutting in isolation valves, tees and branches to existing pipework
- Capping or plugging off existing pipework
- Removing and replacing old bath, WC pans, washbasin and sink taps,
- Replacing cold water cisterns
- Work on existing central heating systems and pipework.

7.2 Identify how to select pipework materials and fittings from instructions including plans and drawings

Select pipework materials and fittings from instructions

On some occasions, the materials and fittings we use on an installation will be dictated by the component or equipment installation instructions. Gas boilers, for example, specify that copper should be used to connect to the boiler and that plastic pipe should not be connected to within 1m – 1.5m of the boiler itself. It is important that we follow these instructions otherwise the manufacturer’s guarantee may be invalidated.

Select pipework materials and fittings from specifications, drawings and plans

Often, materials and fittings for a contract are selected by either the designing engineer or even sometimes the customer. In these cases, a specification would tell us materials to be used, their sizes and often, which make of fitting to use.

Working drawings give an insight into the layout of the building. From these, the routes of the pipework can be planned and a materials list taken. On large contracts, the designer may well have produced a full working
Installing pipework

Installing pipework falls into 2 distinct categories:

1. **First fix** – This is when all of the main runs of pipework are installed – the hot and cold water, central heating, gas and main soil and vent stacks – before any internal floors/ceilings are laid. At this stage, it’s important to follow the rules regarding drilling and notching of joists mentioned earlier in the unit. Also at this stage, any pipework that is to be concealed behind plasterboard walls are fixed into place. Installed pipework should be capped to prevent debris from entering the fixed pipework. Pipes in walls should be clearly marked and plastic pipework covered with a metallic tape to ensure that it can be found by cable and pipe sensing equipment. A soundness test should be performed at first fix stage to ensure that there are no leaks prior to floor and ceilings being installed.

2. **Second fix** – after the internal work – plastering, doors, skirting boards and architraves – then the second fix can begin. Second fix is where all appliances, boilers, radiators, bathroom and kitchen equipment etc are installed. Any exposed pipework must be clipped in line with the specifications mentioned earlier in the unit. Manufacturer’s installation instructions regarding pipework, fittings and materials must be followed. It should be remembered that a good second fix can only take place if the first fix was correct, since the second fix continues the pipework that has previously been installed at first fix stage.

First/second fix in occupied properties

First fixing and second fixing in occupied properties takes on an even greater importance because of the customers property and possessions. All exposed pipework should be agreed beforehand and this should be neatly installed and clipped to specification. The position of the radiators and boiler should be discussed and agreed upon before installation takes place. Any floorboards removed should be replaced as soon as possible. Disruption to the customer should be kept to an absolute minimum at all times. Connections to existing pipework should be left until all other work has been completed to keep the disruption to water, gas and electrical services to a minimum.

**BS8000-0:2014: Workmanship on construction sites. Introduction and general principles** should be followed.

Joint pipework to specifications

Using the jointing techniques that you will learn as you work through this unit takes time to perfect. Knowing which joint can be used and where, often comes with experience of working within the plumbing industry. There are, however, certain points that you should be aware of if mistakes are to be prevented. These can be seen as a series of do’s and don’ts:
<table>
<thead>
<tr>
<th>Do's</th>
<th>Don’ts</th>
</tr>
</thead>
<tbody>
<tr>
<td>When soldering capillary fittings in properties, ensure that the</td>
<td>Don’t take risks when soldering fittings. Consult the company risk</td>
</tr>
<tr>
<td>risk of fire is kept to a minimum.</td>
<td>assessment.</td>
</tr>
<tr>
<td>Always carry a powder fire extinguisher when soldering takes place.</td>
<td></td>
</tr>
<tr>
<td>Remember to protect the customer’s wall paper and decorations when</td>
<td>Don’t put the flame of a blow torch directly on to a decorated wall.</td>
</tr>
<tr>
<td>soldering fittings. Use either a heat proof mat or cooling gel</td>
<td>You will ruin the paper. Be aware of combustible items at all times.</td>
</tr>
<tr>
<td>around the area to be soldered.</td>
<td></td>
</tr>
<tr>
<td>Always check soldered fittings to ensure that the solder has</td>
<td>Don’t leave making soldered joints until last. Solder them as you</td>
</tr>
<tr>
<td>flowed all around the joint.</td>
<td>work.</td>
</tr>
<tr>
<td>Always tighten compression fittings as you are working.</td>
<td>Don’t leave tightening compression fittings until the last minute.</td>
</tr>
<tr>
<td>Ensure that the correct type of compression fitting is being used.</td>
<td>Don’t use type A compression fittings below ground. They are likely to</td>
</tr>
<tr>
<td>Ensure that all push-fit joints are correctly made on both copper</td>
<td>fail on soft copper installations.</td>
</tr>
<tr>
<td>and plastic pressure pipe.</td>
<td>Don’t forget to use pipe inserts when making plastic push fit pressure</td>
</tr>
<tr>
<td>When installing soil and waste pipes, ensure you follow the</td>
<td>joint.</td>
</tr>
<tr>
<td>manufacturer’s instructions with regard to expansion gaps.</td>
<td>Don’t make solvent weld joints in confined spaces. Make sure the area</td>
</tr>
<tr>
<td>Ensure that correct clipping distances is taking place across all</td>
<td>is well ventilated at all times.</td>
</tr>
<tr>
<td>pipe work types and sizes.</td>
<td>Don’t leave pipes unclipped. They will sag and eventually fail.</td>
</tr>
<tr>
<td>Ensure that you follow good health and safety practices at all</td>
<td>Don’t put yourself at risk with regard to health and safety. If you</td>
</tr>
<tr>
<td>times. If you are in doubt, ask your supervisor.</td>
<td>are in doubt, ask your supervisor.</td>
</tr>
</tbody>
</table>
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Learning Outcome 9

Know the inspection and soundness testing requirements of domestic plumbing and heating pipework
AC9.1 Identify the requirements of, and carry out a visual inspection of pipework to confirm that it is ready to be filled with water

Filling any system with water is the time when we see if the system is watertight. Pressure testing confirms the water tightness ready for the next stage of bringing the system into operation. Before these operations can take place, a visual inspection of the system should be made to confirm that the installation is correct and meets the required standards:

- Check that all open ends have been capped and/or all valves have been isolated.
- Check all visible joints to ensure that they have been properly made. Check that capillary joints have been wiped clean of any excess flux as this can cause corrosion in later life.
- Check that enough pipe clips have been installed and that the pipework is secure.
- Check that tap connectors and radiator valves are tight and that any radiator air release valves are turned off.
- Ensure that any automatic air valves are open.

AC9.2 State how to carry out a soundness test on domestic plumbing and heating pipework

The type of testing procedure will depend on the pipe work material used. Hot and cold water systems testing is detailed in BSEN806 pts 2 and 4, central heating systems testing is detailed in BSEN14336:2004 Heating systems in buildings — Installation and commissioning of water based heating systems. Above ground sanitation systems should be tested in accordance with Document H of the Building Regulations.

The recommendations of BSEN806 Pts 2 and 4

For many years the recommendations of BS6700 and the Water Supply (water fittings) Regulations 1999\(^1\) stated that a hot/cold water system should be tested at 1.5 times the maximum operating pressure of the system. However, since the introduction of BSEN806, the test pressures for hot and cold water systems has been updated and is no longer as straightforward as it once was.

---

\(^1\) Schedule 2 of the Water Supply (water fittings) Regulations 1999 currently recommends 1.5 times normal operating pressure. It has NOT been updated to reflect the Recommendations in BSEN806 pt 4
Calculating the test pressure

**BSEN806 pt 1** gives a definition of the Maximum Design Pressure or MDP of a system. It states that the MDP is:

‘the maximum hydrostatic pressure at which the potable water installation is designed to work.’

**BSEN806 pt 2**, clause 3.4.2 states that:

‘To ensure adequate strength, all components of the system shall be designed to meet the test pressure requirements of the local and national laws and regulations. The test pressure shall be at least 1.5 times the allowable Maximum Operating Pressure.’

So, the maximum design pressure as stated in BSEN806 pt 1 is:

\[
\text{Max. Operating Pressure} \times 1.5 = \text{Max. Design Pressure (MDP)}
\]

**BSEN806 pt 4**, which covers the installation and commissioning of hot and cold water systems, identifies in clauses 6.1.2 and 6.1.3 that the test pressure shall be:

\[
\text{MDP} \times 1.1
\]

Or:

\[
\text{MOP} \times 1.65
\]

How does this work in practice?

If a system is designed to operate at a Maximum Operating Pressure of 2 bar pressure, then?

\[
2 \text{ bar (MOP)} \times 1.5 = 3 \text{ bar (MDP)}
\]

\[
3 \text{ bar (MDP)} \times 1.1 = 3.3 \text{ bar (test pressure)}
\]

Or

\[
2 \text{ bar (MOP)} \times 1.65 = 3.3 \text{ bar (test pressure)}
\]

This results in a test pressure that is slightly higher than that required by the Water Supply (water fittings) Regulations 1999 in Schedule 2, Paragraph 5 (1.5 x MOP).

The testing procedures

**BSEN806** Part 4 states that there are 3 systems for testing pipework and these testing procedures are determined by the material from which the pipework is made. The testing procedures are classed as:

a) Test A
b) Test B
c) Test C

The table below illustrates which pipe material is associated with each of the tests:
Table taken from BSEN806 Part 4 page 20

<table>
<thead>
<tr>
<th>Type of material</th>
<th>Hydrostatic test procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear elastic materials (i.e. metals)</td>
<td></td>
</tr>
<tr>
<td>Elastic materials (PVC-U, PVC-C, etc.) and multi-layer materials</td>
<td>Test procedure A</td>
</tr>
<tr>
<td>Visco-elastic materials (i.e. PP, PE, PEX, PA, PB, etc.) with DN/OD &lt; 63mm</td>
<td></td>
</tr>
<tr>
<td>Visco-elastic materials with DN/OD &gt; 63mm (i.e. PP, PE, PEX, PA, PB, etc.)</td>
<td>Test procedure B or C</td>
</tr>
<tr>
<td>Combined system with DN/OD &lt; 63mm (metals and plastics)</td>
<td>Test procedure A</td>
</tr>
<tr>
<td>Combined systems with DN/OD &gt; 63mm (metals and plastics)</td>
<td>Test procedure B or C</td>
</tr>
</tbody>
</table>

Test A requirements page 21, BSEN806 pt 4

The system should be filled with water and all air vented to atmosphere. All outlet valves and vents should be sealed once the air is removed. Apply the test pressure calculated (equal to 1.1 times MDP) for a period of 10 minutes. The test pressure must stay constant for 10 minutes. If there is any pressure loss, the system must be maintained at the test pressure until all leaks have been found. The test is shown in graph form right.

Test B requirements page 21, BSEN806 pt 4

The system should be filled with water and all air vented to atmosphere. All outlet valves and vents should be sealed once the air is removed. Apply the test pressure calculated (equal to 1.1 times MDP) for a period of 30 minutes. Inspect the system to identify any leaks.

Reduce the pressure by bleeding water from the system until the pressure reads 0.5 times the test pressure.

The pressure must remain constant for a period of 30 minutes after pressure reduction. Check the system visually for leaks. If, after the pressure has been reduced there is a further pressure drop, there is a leak on the system. The test pressure must be maintained while the leak is identified. Again, the test is shown in graph form.
The system should be filled with water and all air vented to atmosphere. All outlet valves and vents should be sealed once the air is removed. Apply the test pressure calculated (equal to 1.1 times MDP) for a period of 30 minutes. Inspect the system to identify any leaks.

Note the pressure after a period of 30 mins and recheck for leaks.

Note the pressure after a further 30 mins. If the pressure drop is less than 0.06 MPa or 0.6 bar, the system can be considered to be sound. Continue the test without further pumping.

Continue the test for a further 120 minutes (2 hours). If the pressure drops more than 0.02 MPa or 0.2 bar in this time, then this would indicate that the system has a leak. Maintain the pressure and identify the leak.
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