# UNIT 3 Common Plumbing Processes

#### Summary

In this unit, we cover the following:

- Using hand tools
- Using power tools
- Measuring
- Marking out

- Cutting
- Bending
- Jointing and
- Fixing

on a range of pipework materials, copper, low carbon steel (LCS) and plastic, used in domestic plumbing systems.

In addition to the items mentioned above, we also look at:

- Generic systems knowledge
- Associated trade skills, such as:
  - Processes for lifting flooring surfaces
  - Requirements for cutting holes and notching timber joists
  - Procedures for cutting holes through a range of materials
  - Making good.

One key feature about this unit is that we ask you to carry out some of your own research. As a plumber, finding information out for yourself is a useful skill to learn because you need to keep up-to-date with changes to regulations and new technology. It is also necessary in this unit because it would have been impossible for us to include every type of fitting or fixing that is available.

## Generic systems knowledge

#### Introduction

The purpose of this unit is to cover what we refer to as generic systems knowledge, these are areas that are 'general' or common to all the systems used in the domestic plumbing and heating industry and it will save repeating the same information during each systems unit: cold water, hot water, etc.

Generic systems knowledge covers topics such as taking basic site measurements, how to prepare work locations, use of specifications, paperwork for ordering materials, and how to deal with customers and co-workers.

We think it is important that you understand the preparation work that is required before starting a job – that is why we have put this unit first.

## Use of documentation

General documentation can include such things as:

- Health and Safety Regulations, covered earlier in the Health and Safety Unit
- Water Regulations
- Requirements of British Standard Specifications and in particular BS 6700 and BS 8000
- Building Regulations, affecting a plumber's work such as the energy efficiency of central heating boilers.

The above documents underpin much of the work that is carried out by the plumber. Other documentation includes manufacturers' instructions, site drawings, job specifications and work programmes.

#### Manufacturers' instructions

Most appliances and plumbing components are supplied with manufacturers' instructions. These provide information on the installation service and maintenance requirements and once an appliance is installed, these instructions should be left with the customer for future reference. Depending on the type of appliance or component, user instructions are also included.

#### Site drawings

Site drawings are covered in greater detail at Level 3. Building drawings provide details of how a building is going to be designed, e.g. size and shape of rooms, location of doors and windows, etc. They

#### Key point

Domestic plumbing can vary from carrying out a small maintenance job like re-washering a tap, to carrying out complete system installations on large scale new housing developments. In this book, we make reference to 'larger contracts' and we take this to mean the large scale new housing developments or refurbishments where site drawings, specifications and work programmes are likely to be used.

#### Hot tips

Throughout this book, we encourage the reader to research the internet for manufacturers' information as well as provide contact details for manufacturers' catalogues. Try to get into the habit of obtaining and reading the information as this will help to make sure you keep yourself up-to-date with new products and technology.

#### **Key point**

If for any reason, a part of the job cannot be done to the specification, you should inform your supervisor, foreman or employer immediately. This applies equally to a smaller job, e.g. boiler replacement, where a detailed specification has not been provided but a quote or estimate has been provided, but the job, for whatever reason, can no longer be done as originally planned. also show specific design details, such as floor, wall and roof construction. Building services drawings show the layout of pipework systems and the location of appliances and components, such as baths, sinks, water closets (WCs), radiators, boilers and pumps.

#### Job specifications

These usually accompany site and services drawings and details, and are mostly used on larger contracts.

#### Activity 3.1

What sort of details do you think a job specification might cover? Jot down your thoughts for inclusion in your portfolio and check out your answers at the end of this book.

Specifications form part of the contract documentation, so any alterations required to the specification should not be done by you.

#### Work programmes

If a plumber was working on a replacement bathroom suite, it is unlikely that a written work programme would have been prepared, but the plumber would have the work programme inside their head, based on an agreed start and finish date and a series of activities required in between to get the job done.

This principle is not very different on a larger contract but in this case, a contract programme will have been written out. This could consist of an overall programme for all site trades, as well as a separate programme for each trade (Figure 3.1).

#### Other documentation

Other documentation used by plumbers relates to carrying out a plumbing job from an initial customer enquiry to completing the work. Let us take a look at the procedures for a typical job, adding three extra radiators to an existing heating system, replacing the boiler and upgrading the controls.

- Customer asks a plumber for a quote
- Plumber visits the customer, measures up and estimates the materials required



Figure 3.1 Example of a programme for a domestic plumbing installation

- Plumber contacts the merchants and gets a quotation for the materials
- This enables the plumber to finalise a quote to the customer
- In our case, the customer accepts and the quotation is confirmed in writing
- The plumber orders the material from the merchants; on delivery of materials, the plumber receives a delivery note
- The work is carried out to meet the customer requirements
- The plumber receives the invoice requesting payment for the materials used, and accordingly invoices the customer for the work that has been completed
- A remittance advice (record of payment) is sometimes issued with payment
- On any job, large or small, if you are advised that the delivery of materials will be delayed or a particular item is not the one ordered, either the site foreman (so he/she is aware of potential delays) or the immediate supervisor/employer is notified.

## Preparing for plumbing installations

#### Estimating the material requirement

As a plumber qualified at S/NVQ Level 2, you are likely to do most of your estimation from site and this is done in the absence of drawings or specifications.

Again, the estimation process will depend on what job you are doing – could be working out what pipe and fittings you will need for a simple repair job to the requirement for a complete plumbing installation from scratch. On large multi-dwelling developments, the material, requirements will probably have already been worked out for you and supplied in 'packs' for each dwelling.

Where you are required to estimate the materials for a job, you will need to have a thorough understanding of what you are going to do so you can 'visualise' the installation, where you are going to install appliances, components and fittings, how you are going to run the pipework and what sizes you are going to use.

Once you have determined all this, it might be a good idea to produce a sketch of the installation with dimensions on it by taking measurements from site. This will help in working out the pipework lengths.

#### Preparation checklist

See Activity 3.2.

#### Activity 3.2

How much preparation is required will depend on the size of the job, but there are a number of things that a plumber should prepare before starting any job. Can you think what these might be? Write your answers in your portfolio and then take a look at our list at the end of this book.

## **Test yourself 3.1**

- 1. Which of the following relates to the requirements for the energy efficiency of central heating boilers?
  - a. Building Regulations
  - b. Water Regulations
  - c. British Standards Specifications
  - d. Health and Safety Regulations
- 2. Give two examples of what a job specification might cover.
- 3. What action should you take if the job cannot be done to a specification?
- 4. Fill in the gaps, selecting from the words below:
  - can be used to give a price for a \_\_\_\_\_ by a \_\_\_\_\_ or from a
  - \_\_\_\_\_. An \_\_\_\_\_ is
  - confirmation that a quotation has been

#### accepted. Once a job has been completed an \_\_\_\_\_ is sent requesting . The confirms that has been made.

#### remittance advice, invoice, job, plumber, quotations, payment, order, merchant, materials, payment

- 5. Which are the two main requirements of an installation programme?
  - a. Activity against time
  - b. Activity against speed
  - c. Time against labour
  - d. Time against materials
- 6. State three checks that you would carry out in preparation for an installation. Now check your answers at the end of the book.

## Plumbing tools Introduction

As a plumber, you will be required to:

#### Key point

Good quality tools are expensive, but worth the initial outlay. Our advice is to buy good quality tools of a well-known brand. What might seem a bargain could end up damaged or failing when most needed, simply because they are not up to the job. Cheap tools that are suitable more for the DIY market, will soon wear out under prolonged professional use. 

#### Measure

- Mark out
- Cut
- Fabricate
- Make joint and
- Fix a range of materials.

In most of the cases, this will involve the use of tools to enable you to do this.

Once you have got your tool kit, keep the tools clean and well maintained, this should ensure a long life and keep down the cost of having to regularly buy replacements.

The range of power tools used in domestic plumbing work includes:

- Cordless power drills and screwdrivers
- Power drills
- Combined cordless drills and screwdrivers
- Power saws.

The power tools illustrated in this unit have been reproduced with the kind permission of Draper Tools Ltd., whose contact details are given in the next section.

## The hand tool kit

The tools illustrated here have been reproduced with the kind permission of:

#### **Ridgid Tools**

Key point

such as tools for:

Fabrication

Jointing

Hand tools can be subdivided

Measuring and marking out

Cutting and preparation

Fixing and making good

Specialist tools.

into a number of categories,

Arden Press House Pixmore Avenue Letchworth Herts SG6 1LH Tel: 01462 485335 E-mail: sales.uk@rigid.com

#### **Draper Tools Ltd.**

Hursley Road Chandler's Ford Eastleigh Hants SO53 1YF Tel: 023 8026 6355 E-mail: sales@draper.co.uk Website: www.draper.co.uk

#### Measuring and marking out

The standard tools include:

- Spirit Level
- Folding Steel Rule
- Tape Measure.

And do not forget, you will need a pencil for marking out!

#### Cutting and preparation

This will require:

- Hacksaw Frame Straight Tin Snips
- Compact Pipe Cutter
- Trimming Knife
- File
- Wood Chisels

# UNIT

- Floorboard Saw
- Abrasive Cleaning Pads
- Cold Chisel with Guard
- Floorboard/Brick
- Bolster with Guard
- Padsaw
- Junior Hacksaw.

#### Fabrication

Bending and threading equipment is also available for use with low carbon steel (LCS) pipe. These are covered in more detail in Unit 4, tube bending, measuring and marking out. Fabrication tools include:

- Claw Hammers
- Floorboard/Nail Bar
- Club/Lump Hammer
- Copper Pipe Hand Bender
- Internal Bending
- Spring
- External Bending
- Spring.

#### Jointing

There are three considerations here (for copper) – jointing by soldering, compression fittings, and jointing using the latest push fit methods. There is also jointing of LCS using threaded fittings. Let us see what they look like in Figure 3.2.

- (a) Adjustable Basin Wrench
- (b) Adjustable Wrench
- (C) Basin Wrench
- (d) Adjustable spanner
- (e) One Hand Speed Wrench
- (f) 250 mm Waterpump Pliers
- (g) Blow Lamp-Propane Torch
- (h) Combination Pliers
- (i) Curved Jaw Locking Pliers



**Figure 3.2** Jointing tools (Reproduced with permission of Draper Tools Limited (a–f, h–j) and Ridgid Tool (g))

As you build up your tool kit over time, you may consider investing in a set of spanners.

(j) Spanners.

Fixing and making good

- 8 piece screwdriver set
- Insulated screwdriver
- Flat piece wood bits set

- 150 mm pointing trowel
- Masonry drill bits
- High speed steel drill bits.

#### Other tools

- Allen keys
- Immersion heater key
- Sink plunger
- Stop valve key
- Tool box.

#### Specialist tools

Plumbers also use tools and equipment of a more specialist nature and these should be used in accordance with manufacturers' instructions and by personnel who have been properly instructed in their use (Figure 3.3).



Figure 3.3 Pipe freezing kit (Reproduced with permission of Ridgid Tools)

In addition to the tools and equipment, you will need materials such as:

- Solder wire
- Fluxes approved for plumbing work (including those suitable for wholesome water installations)
- Jointing tape approved for plumbing work
- Jointing compound approved for plumbing work (including those suitable for wholesome water installations)
- A range of screws and nails.

#### Key point

Do not forget to make sure that solder wire used on water supply systems is 'lead free'.

#### Tool safety maintenance checklist

#### Activity 3.3

You covered tool safety briefly during the Health and Safety Unit. Using the headings that follow, make a list of bullet points outlining the key safety maintenance points, write them in your portfolio and then check it out with our list at the end of this book.

- General
- Hacksaws
- Pipe cutters
- Wood chisels
- Cold chisels
- Hammers
- Pipe grips and wrenches
- Screwdrivers.

## **Power tools**

#### Cordless power drills and screwdrivers

The cordless drills/screwdrivers are available in a range of voltages; 12, 14, 14.4 and 24 V being a few examples. Most drills are combined so they can be used as a drill and a screwdriver. They are powered by batteries (usually supplied with two) and a charger, so you can have one working and one on charge.

Figure 3.4 shows an example from a very wide range of what is available.



#### Key point

These tools are popular because you do not need to carry a transformer around, and if there is no electricity on site you do not have to revert to hand tools. The added advantage is that they can also be used as a screwdriver.

Figure 3.4 Cordless Combi hammer drill (Reproduced with permission of Draper Tools Limited)

#### Power drills

#### $110 \,\mathrm{V}$

There is a wide range of makes and models of power drills; this section is designed to show a cross section of what is available.

Typical power ratings for 110 V drills range from 620 to 1400 W. Most drills are of variable speed and some have a reversible action. Drills vary in power depending on the size of motor; this in turn has a bearing on what the drill can do.

The one shown in Figure 3.5 has a 'hammer action' which when engaged makes drilling through masonry easier. Not only does the drill rotate but it also moves fractionally backwards and forwards at high speed, giving the effect of hammering the drill into the building fabric.



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Figure 3.5 110 V hammer drill
(Reproduced with permission of
Draper Tools Limited)
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**Figure 3.6** Screwdriver drill bits

A range of bits is available for powered and cordless drills for use on metal, wood, brickwork, blockwork and concrete. Core drills are also available for drilling large diameter holes. Screwdriver bits are available in the following designs (Figure 3.6):

- These are precision made using hardened steel and are hard wearing
- The bits can be purchased individually or in sets. The type shown slot into a purpose made bit for the drill.

#### Power saws

Power saws such as circular saws are used by plumbers for taking up floorboards or sheets in order to install pipework under floors (Figure 3.7).



Figure 3.7 Example of a power saw; make sure a guard is fitted (Reproduced with permission of Draper Tools Limited)

Here is a power saw checklist:

- Power saws should run off 110 V
- Never use one without a guard
- Make sure that nails or screws are avoided when cutting with the saw. If possible, take up a board by hand to check what is beneath the area where you are going to use the saw.
- Always make the cutting depth the same depth as the floor thickness.

Jig saws can be used to take up boards, but are mostly used to cut holes in worktops or countertops to fit sinks or washbasins. Battery operated circular saws are also available, usually with an 18 V motor.

#### Power tools in general

Here are a few points to remember about power tools:

- All electric tools should be double insulated
- Always use 110 V supply
- Check that electrical cables are not damaged or worn out
- Check that plugs are not damaged
- Check for test labels to show the equipment is safe to use
- Remember to wear safety goggles when using drills and saws. These will protect your eyes from dust and any splinters of material that might fly off whilst working.

#### Key point

Why is making the cutting depth the same depth as the floor thickness a good idea? Think about what might happen if you make it deeper than the depth of the floor thickness.

#### Key point

All electrical equipment should be PAT tested in accordance with your employer's procedures. PAT tests are maintenance records of all portable electrical equipment to ensure that it is in safe working order.

#### Try this

Next time you are in a plumbing merchant's or a tool shop, make it a point to look at the range of hand and power tools that are available for plumbing work. Take time to obtain hand and power tool catalogues, and look on the internet to see what is available based on the tools listed in this unit. Prepare a list of tools you will need to include in your plumbing tool kit. [You may have some of the tools already, compare the quality and prices of the various manufacturers].

#### Cartridge-operated tools

We covered cartridge-operated tools under Health and Safety. Remember, people under the age of 18 are not allowed to use them. If over the age of 18, you must receive proper instructions on their use.

## **Test yourself 3.2**

- **1.** List a typical tool for each of the following:
  - Measuring and marking out
  - Cutting and preparation
  - Fabrication
  - Jointing
  - Fixing and making good
- 2. State the safety and maintenance requirements for:
  - Hacksaws
  - Wood chisels
  - Pipe grips and wrenches
- 3. What tools would you use for:
  - The cutting of sheet metal
  - De-burring a pipe
  - Removing a mild steel fitting from a pipe
  - Notching a floor joist
  - Removing an immersion heater

- 4. Which voltage must power drills run on?
  - a. 110 V
  - **b**. 240 V
  - **c.** 225 V
  - d. 415 V
- 5. What is a PAT test used for?
- 6. What is the minimum age that you can use cartridge-operated tools?
  - a. 18
  - **b**. 20
  - **c**. 21
  - d. There is no minimum age
- State three specific safety precautions when using a power saw
- 8. State three safety precautions when using any power tools

## Tube bending, measuring and marking out



Figure 3.8 Large radius plastic bend and fixing bracket (Reproduced with permission of Hepworth Plumbing)

#### Key point

What do you think are the advantages of bending pipe rather than using fittings?

Bending pipe rather than using fittings has the following advantages:

- They produce larger radius bends than elbow fittings and larger radius bends have less frictional resistance than fittings
- Using bends costs less than using fittings
- Long sections of pipework can be prefabricated before installation, saving time.

#### Introduction

Bending, measuring and marking out is a basic essential skill for any plumber. In this unit, we will concentrate on the bending of copper pipe, which can be done by hand (with a spring) or machine. We will also look at LCS which, in the main, is bent by hydraulic machines.

## **Bending methods**

We will concentrate here on copper and LCS pipes. Plastic pipes used in domestic plumbing systems can be bent, but the main application is restricted to small-bore polythene pipes which can be positioned into large radius 90° bends or offset by hand, and then clipped into position. There are also steel preformed 90° brackets for tighter bends, into which the pipe can be clipped (see Figure 3.8).

This image was reproduced with the kind permission of Hepworth who can be contacted on the numbers below, and you can visit their website www.hepworthplumbing.co.uk

Technical Support Tel: 01709 856 406 Fax: 01709 856 407 Literature Service Tel: 01709 856 408 Fax: 01709 856 409

## Copper tube bending

The type of copper tube suitable for bending is BS EN 1057–R250 (previously designated as BS EN 1057; Part 1 – Table X). It is termed as half hard, and is available in straight lengths.

Other types are BS EN 1057–R220 (previously designated as BS EN 2871; Part 1 – Table Y), this type has thick walls, and is supplied in coils. It is not usually used internally in dwellings; it is mostly used for underground services and is available with a plastic coating to protect it from corrosion.

There is also BS EN 1057–R220 (previously designated as BS EN 2871; Part 1 – Table W), supplied in coils and generally used for micro-bore heating installations.

We will explore copper tube in a bit more detail when we look at pipe jointing in the next session. The latter two are not suitable for bending by machine. R250 (Table X) copper pipe can be bent by using either:

- Hand or
- Machine.

#### Hot tips

Yorkshire Copper Tube produce an excellent 'technical guide' covering all aspects of working with copper tube. It can be downloaded as a Pdf from their website on: http://www.yorkshirecopper.com/ technical/yc\_te\_index.php

#### Key point

Spring bending methods can quickly enable high quality, accurate bends to be formed on copper tubes without wrinkling or flattening as the springs support the wall of the tube as it is being bent.

Once the necessary skills have been developed and practised, there is little difficulty bending light gauge copper tube (R250) by hand, up to a diameter of 15 mm. A 22 mm pipe can also be bent by spring methods but it is usually advisable to anneal the area forming the radius of the bend first.

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#### By hand

This is a popular method of bending pipe when carrying out maintenance and repair work and the copper pipe can be bent using either an internal or external spring. In either case you pull the bend against your (padded) knee to get the desired angle.

There is some excellent technical material available on this topic, for bending both by hand and machine. Here are some contacts where you can find further information to support your learning. We strongly recommend that you obtain as much information as you can.

## Yorkshire Copper Tube

This company produce a publication called 'Yorkshire Tube Systems technical Guide' which can be viewed on: www.yorkshirecoppertube.com

#### UK Copper Board

As well as producing a range of technical material, the UK Copper Board runs a Copper Club.

The Copper Club – a loyalty scheme set up by the UK Copper Board in May 2000 to reward supporters of Copper – is proving a great success. The club currently has over 2300 members, including a substantial number of students, and the number of members is continuing to rise!

When signing up to the Copper Club via the application form on their website new members will receive a welcome pack which includes the latest copy of their reference book 'Installation Tips', a 'Make the Right Start CD' and details of our Plumbing Advice Telephone Hotline.

In addition to the pack, members receive regular updates about the industry and the activities of the UK Copper Board.

The UK Copper Board site is at: www.ukcopperboard.co.uk and their address is:

UK Copper Board c/o Copper Development Association 5 Grovelands Business Centre Boundary Way Hemel Hempstead Hertfordshire HP2 7TE

#### Copper Development Association

The Copper Development Association provides excellent technical advice in the form of various publications, and also supports further education. Their website is at: www.cda.org.uk

# Setting out for hand bends using bending springs

It's pretty obvious that if you tried to bend a piece of copper tube without supporting the wall of the pipe, the pipe would simply collapse, leaving a totally unacceptable result. One way of preventing this is to use a bending spring.

Half-hard copper tubing R250 (formally table X) is the recommended grade for pipe bending, using either an internal or external bending spring. Hand-made bends have to be 'set out' in order to form the radius of the bend, and provide accurate measurements to a fixed point or fitting.

Hand bends should be limited to up to 22 mm diameter; some plumbers may use an internal spring for larger sizes, but this isn't recommended or indeed allowed for in BS 5431(4) (the British Standard for bending springs).

The first thing to bear in mind when setting out for a  $90^{\circ}$  bend is that there is an apparent gain of the material when the bend is formed. Take a look at Figure 3.10.

The distance from 'A' to 'C' through 'B' along the broken line is in effect the measured length of the bend, but when the bend is actually formed, its path follows the arc A to C which is a shorter distance than the measured length. In summary the gain in length is due to the measured length A-B-C being longer than the actual length A-C.



Figure 3.10

When setting out then:

- Allowances have to be made for the 'gain in material'
- The bend must be pulled in the right position in relation to the fixed point.

### Step by step to setting out

- Decide on the centre line radius of the bend, which (unless given on a drawing or specification) most practitioners usually determine as four times the diameter of the pipe (4D), although Yorkshire Copper Tube recommend five times
- The length of the pipe occupied by a 90° bend can be calculated using the formula:

$$\frac{Radius \times 2 \times 3.142}{4}$$

• Next we'll assume that a 15 mm pipe is to be bent to a radius of 4D and we need to find out how much pipe will be taken up by the bend, so:

Radius of bend is 4D, which is  $4 \times 15 = 60$  mm. Now use the formula:

$$\frac{\textit{Radius} \times 2 \times 3.142}{4}$$

So:

$$\frac{60 \times 2 \times 3.142}{4}$$

Length of bend = 94.26 mm, say 95 mm.

- The next step when making the bend is to measure and mark off the length required from a fixed point (which could be where the pipe is going to enter a fitting for example) to the centre line of the bend (see procedure indicated at Figure 3.11a)
- Then divide the calculated length of pipe by three, which in our case gives three equal measurements of approximately 32 mm
- From the original centre line, mark 32 mm forward and 64 mm back (see procedure indicated at Figure 3.11b)

- The bend is then pulled making sure that it is kept within the confines of the three 32 mm measurements, this will make sure that the centre will be the correct distance from the fixed point
- This setting out technique can also be used for offsets, but a bend of 45°/135° will only require half the length of pipe as that of a 90° bend



• You're now ready to make the bend

## Figure 3.11

Key point

Bending copper pipe using a

spring is something you can try

and practice at home. Use this

material as a guide, and have a

go at setting out and forming 90° bends. You can also try

internal spring, and start off

with 15 mm copper tube and

work up to 22 mm.

forming an offset. Use an

- It's advisable to use a template, most plumber's will use a 90° set square or similar
- Insert the spring, it may be an idea to lubricate it first using oil or grease
- Pull the bend gently around the knee to an angle slightly over 90° and then pull it back to 90° and check its accuracy against the template before removing the spring
- Forming offsets, in order to route pipe work around obstacles, is best done by making a template out of strong wire such as welding rod or similar, and then bending the pipe to match the template.

Why do you think it's necessary to overpull the bend? You don't have to write anything down here, but have a think before moving on.

Overpulling the bend and then returning to  $90^{\circ}$  will release the tension between the spring and the pipe wall and make it easier to remove the spring.

## Machine bending

This is the most common method used for bending copper tube. Bending machines can be either hand held, or free standing, and



Figure 3.12 Examples of hand held bending machines (Reproduced with permission of Ridgid Tools)





Figure 3.14 Student using a hand held bender in a centre

they work on the principle of leverage. Here are a couple of examples of bending machines.

The small hand held bender is used for pipe sizes of 15 mm and 22 mm, and is light and portable. The free-standing bender can handle pipes up to 35 mm and uses a range of sizes for the back guide and former.

It's important that the machines are set up properly. If the roller is adjusted so that it's too loose it will cause rippling on the inside of the radius of the pipe. If too tight, it will reduce the pipe diameter at the bend, an effect called throating.

Figure 3.13 Free-standing pipe benders

#### Key point

We would strongly recommend that you find out more about machine benders, try and obtain catalogues about the various items shown here, search on websites or better still visit tools shops and take a look at the equipment for yourself.



Figure 3.15 Components of a free-standing bending machine

# Setting out for pipe bends using a machine bender

Bending machines produce a much tighter bend (approximately three times pipe diameter) than is possible using a spring. This method is by far the most widely used for bending copper tubes in the UK. Here we'll look at three types of machine bends:

- 90° or square bend
- Offset
- Passover sets.

#### 90° or square bends

When forming square bends the bend can be set to either the inside of the bend and inside of the former, or outside of the bend and outside of the former; the procedures are almost identical, both methods are equally correct and will produce perfect bends. Here's what to do when setting the bend to the outside of the former:

- Mark the pipe to the required measurement using a pencil, this should be taken from the back of the bend to the fixed point
- Make sure that the pipe is pushed fully into the former and is also inserted in the stop
- Place the alloy guide over the pipe (don't use the steel version, as these are used for bending low carbon steel tubes)



Figure 3.18 Tube Position in Former

- Adjust the pressure onto the guide enough to hold the pipe in position (if adjustable type)
- The square is then placed against the mark on the pipe and adjusted until the square touches the outside of the former
- Make a final adjustment to ensure the correct bending position
- Pull the lever arm to bend the pipe slightly over the required 90° angle as this will counteract the spring back in the bend

Making a return bend, or bending the same pipe again in a different position is achieved using the same technique, only now the first bend becomes the fixed point.

**Offsets** 

You may hear offset being referred to as a double set, with an ordinary single bend being known as a set. The machine is set up in the same way as that of the  $90^{\circ}$  bend. There are a couple of variations for producing an offset, it can be produced by measurements from the site, or by producing a template, which could be made from strong wire, or drawn on the floor in chalk or on a piece of sheet timber.

• The first bend or set on the pipe is made in the required position which will have been marked on the pipe



Figure 3.19 Angle of the first set

- The angle of the first bend is usually 45°, but this is not essential. However, where the angle is critical, it can be taken from the actual job using a bevel, and then the bevel angles are used to produce a template
- As before, the bends are made from the back of the former, and the pipe is adjusted in the machine, holding a slight pressure on the lever to hold the pipe in place
- A straight edge is positioned against the outside of the former and parallel with the pipe





- The pipe in the machine is adjusted until the required measurement for the offset has been achieved. Alternatively, if using a template, when the first bend has been pulled it is removed from the machine, placed on the template, and marked off in the position of the second bend
- The second bend is now pulled by applying pressure to the lever arm and bending the pipe until the pipe legs are parallel.



Figure 3.21 Completed offset

#### Pass-over bends

These are used to clear other obstacles such as other pipes, and can be either pass-over offsets (see Figure 3.22) or crank pass-over bends (see Figure 3.23).

The measurements for a pass-over bend are taken in the same way as an ordinary offset. The angle of the first pull will be governed by the size of the obstacle it has to 'pass over'. It is to be made sure that the first bend is not too sharp or it will be difficult when pulling the offset bend (Figure 3.24).





Dotted line indicates tube after bending. i.e. until in line with straight edge

A straight edge is placed over the bend at the distance of the obstacle and the pipe is marked. These will be the back of the finished offsets as shown in Figure 3.25.

The pipe is then returned to the machine, and when the first mark lines up with the former, the first pipe is turned around in the machine; the second mark is lined up in the former and pulled to complete the pass-over.

## Low carbon steel (LCS) pipe bending

In domestic plumbing applications, steel pipes are bent using a hydraulic pipe bender.

#### Use of hydraulic machines

Hydraulic machines are needed to bend LCS tubes. This is due to the strength of the material, and the thickness of the pipe. Because

Figure 3.25

#### Key point

We make every effort to explain how to bend copper pipe in these pages, but the best way to learn is by practice. Follow this information carefully, particularly when working on site. of this you do not need to fully support the pipe with a back guard, as with copper pipe.

Hydraulic bending machines are used to form all bends, including  $90^{\circ}$  and offsets.

The hydraulic mechanism is usually oil based, and because liquids are incompressible, once under pressure it can exert considerable force on the pipe.

A typical hydraulic press bender in use is shown in Figure 3.26.

Setting out the offset:

- Mark off the required measurement for the first set onto the pipe
- Place pipe in machine, but do not make any deduction
- The measurement X mm is from the fixed end of the pipe to the centre of the set
- Pull the first set to the required angle
- Take the pipe from the machine and place a straight edge against the back of the tube. Mark the measurement of the offset as point A.
- Replace the tube back in the machine and line the mark up with the centre of the former. Pull the second set and check against the wire template. Again, allow a 5° over pull to allow for it to spring back.



Figure 3.26 Hydraulic press bender



(b)



(a)

Figure 3.29 Low carbon steel offset

for making the first bend



## Pipework material and jointing processes

#### Introduction

In domestic plumbing installations, the main pipework materials you will work with will be:

- Copper
- Low carbon steel and malleable iron fittings
- Plastic.

Pipes, fittings and jointing materials acceptable for water regulation purposes are listed in the Water Regulations Advisory Scheme (WRAS) Water Fittings and Materials Directory.

A WRAS symbol shows that a product has been tested for approval and is listed in the Directory. Further information can be obtained from www.wras.co.uk.

## Copper tube and fittings

#### Copper tube development

The first recorded use of copper for conveying water goes back to a conduit that has been dated back to 2,750 B.C., discovered at Abusir in Egypt. Copper water pipes and cisterns were also widely used by the Romans and good examples of copper plumbing can still be seen at the archaeological site of Herculaneum, Italy, which was uniquely preserved by the eruption of Vesuvius in 79 A.D.

Historically copper tubing was expensive and only installed in prestige buildings. It was not until the development of modern types of fittings in the 1930s, which led to the introduction of light gauge copper tubes, that copper plumbing systems became highly competitive with other materials. In 1996 the latest specification for copper tubes, EN 1057, was adopted across Europe.

In the UK this specification was published as BS EN 1057:1996, 'Copper and copper alloys – Seamless, round copper tubes for water and gas in sanitary and heating applications'. It replaced the previously familiar standard BS 2871 Part 1: 1971, 'Copper and Copper Alloys Tubes – Copper tubes for water, gas and sanitation'.

In drawing up this standard, the opportunity was taken to rationalise tube sizes across Europe. At first glance the changes to the BS 2871 Part 1 standard must have seemed quite extensive and the available options confusing.

Yorkshire Copper Tube simplified this process by branding their products as Yorkex, Kuterlon and Minibore in line with Tables X, Y and W in BS 2871 Part 1. Under BS EN 1057, temper condition (material strength) is designated with an 'R' number, the higher the number indicating a stronger material. Tables 3.1–3.5 show the relationship of the current Yorkshire range with BS EN 1057 and BS 2871 Part 1. These tables have been reproduced with the kind permission of Yorkshire Copper Tube.

Soft condition is denoted R220, half hard R250 and hard R290. Because of the variety of sizes, both diameter and thickness should be specified when ordering to BS EN 1057. For example, when ordering half hard copper tube with an outside diameter of 15 mm and a thickness of 0.7 mm (formerly 15 mm in BS 2871 Part 1 Table X tubing) the official designation is EN  $1057 - R250 - 15 \times 0.7$  mm. More simply, it can be ordered as 15 mm Yorkex.

BS EN 1057 - R250 half hard straight lengths are also available in chromium plate. They are used where pipework is exposed to the eye, and an attractive finish is required.

#### Key point

- R250 (Table X) is widely used for domestic installations but should not be used underground
- R220 (Table Y) is used for external underground installations, and can be supplied in either a blue or green (water service) or yellow (gas) plastic coating
- R220 (Table W), like Table Y, is fully annealed and is used for microbore heating

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Yorkex – Half Hard Range				
Size mm (od × wall)	EN 1057 Designation	BS 2871 Part 1 Designation		
6 imes 0.6	6 imes0.6 mm — R250	6 mm Table X		
8 imes 0.6	8 imes 0.6 mm $-$ R250	8 mm Table X		
10 × 0.6	10  imes 0.6  mm - R250	10 mm Table X		
12  imes 0.6	12  imes 0.6  mm - R250	12 mm Table X		
15  imes 0.7	15  imes 0.7  mm - R250	15 mm Table X		
22  imes 0.9	22  imes 0.9  mm - R250	22 mm Table X		
28  imes 0.9	28 imes 0.9mm-R250	28 mm Table X		
35 × 1.2	35 imes1.2mm-R250	35 mm Table X		
42 × 1.2	$42 \times 1.2 \text{mm} - \text{R250}$	42 mm Table X		
54 × 1.2	54  imes 1.2  mm - R250	54 mm Table X		

#### Table 3.2

	Yorkex – Hard Range	
Size mm (od × wall)	EN 1057 Designation	BS 2871 Part 1 Designation
35 × 1.0	35 imes 1.0 mm $-$ R290	New size
35 × 1.2	35 imes1.2mm-R290	33 mm Table X
42 × 1.0	42 imes1.0mm-R290	New size
42 × 1.2	42 imes1.2 mm — R290	42 mm Table X
54 × 1.0	54 imes1.0mm-R290	New size
54 × 1.2	54 imes1.2 mm $-$ R290	54 mm Table X
66.7 × 1.2	66.7  imes 1.2  mm - R290	66.7 mm Table X
76.1 × 1.2	76.1  imes 1.2  mm - R290	76.1 mm Table X
108  imes 1.5	108 imes1.5mm-R290	108 mm Table X
133 × 1.5	133  imes 1.5  mm - R290	133 mm Table X
159 × 2.0	159 imes 2.0mm-R290	159 mm Table X

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Kuterion – Straight Tube Range				
Size mm (od × wall)	EN 1057 Designation	BS 2871 Part 1 Designation		
6 × 0.8	6 imes 0.8 mm $-$ R250	6 mm Table Y		
8 × 0.8	8 imes 0.8 mm $-$ R250	8 mm Table Y		
10 × 0.8	10 imes 0.8mm-R250	10 mm Table Y		
12 × 0.8	12 imes 0.8mm-R250	12 mm Table Y		
15 × 1.0	15 × 1.0 mm - R250	15 mm Table Y		
22 × 1.2	22 × 1.2 mm - R250	22 mm Table Y		
28 × 1.2	28 × 1.2 mm - R250	28 mm Table Y		
35 × 1.5	35 × 1.5 mm - R290	35 mm Table Y		
42 × 1.5	42 × 1.5 mm - R290	42 mm Table Y		
54 × 2.0	54 imes2.0mm-R290	54 mm Table Y		
66.7 × 2.0	66.7 × 2.0 mm - R290	66.7 mm Table Y		
76.1 × 2.0	76.1 × 2.0 mm - R290	76.1 mm Table Y		
108  imes 2.5	108 imes 2.5mm-R290	108 mm Table Y		

#### Table 3.4

Minibore – Coil Range				
Size mm (od × wall)	EN 1057 Designation	BS 2871 Part 1 Designation		
6 imes 0.6	6 imes 0.6 mm $-$ R220	6 mm Table W		
8 × 0.6	8 imes 0.6 mm $-$ R220	8 mm Table W		
10 × 0.7	10  imes 0.7  mm - R220	10 mm Table W		

#### Table 3.5

Kuterion – Coil Range					
Size mm (od × wall)	EN 1057 Designation	BS 2871 Part 1 Designation			
12 × 0.8	12  imes 0.8  mm - R220	12 mm Table Y coil			
15 × 1.0	15 imes1.0mm-R220	15 mm Table Y coil			
22 × 1.2	22  imes 1.2  mm - R220	22 mm Table Y coil			
18 × 1.2	18  imes 1.2  mm - R220	28 mm Table Y coil			

#### **Key point**

Where might you see chromiumplated pipework on a domestic plumbing installation? Probably the most likely place you would find chrome-plated pipe used is for exposed pipework runs to stand alone gas fires; other examples would be instantaneous showers in bath or shower rooms.

## Methods of jointing copper tube

This falls under three main headings:

- Compression joints
- Soldered joints
- Push fit joints.

#### Compression joints

Can be subdivided into:

- Manipulative
- Non-manipulative.

The term manipulative, as used here, means to work or form the end of the tube.

Manipulative joint (Type B)

Figure 3.30 below shows a typical manipulative fitting.

Type B or manipulative fittings are used with soft copper tube and require the plumber to flare the tube end before the joint is assembled. An adaptor fits between the end of the pipe and fitting as shown. Type B compression fittings can be used to join pipes above or below ground.

Non-manipulative joint (Type A)

Figures 3.31(a)–(d) are reproduced with the kind permission of Pegler Limited. Tel: 01302 560560; Website: www.pegler.co.uk



Figure 3.30 Manipulative joint

#### Key point

What do you think is the difference between these types of solder jointing methods? The difference between the two jointing methods, between the two fittings is that: the solder ring fitting already contains solder in the raised ring within the fitting (integral). When the fitting is heated up, the solder melts (at between 180 and 230°C) and the solder is drawn into the fitting by capillary attraction. It is the same principle for the end feed fitting, but this time the solder is end fed separately from a spool of wire solder.

The following diagrams (Figures 3.31(a)-(d)) show the basic steps required to form a non-manipulative type A joint.

Type A, or non-manipulative fittings enable the plumber to make a compression joint without carrying out any work on the tube ends other than ensuring that they are clean and cut squarely. Type A compression fittings can be used to join pipes above ground only.

A range of brass, gunmetal, cz-resistant to dezincification, and chromium-plated brass, fitting designs, compatible with pipe sizes, are available.

#### Soldered capillary joints

Soldered joints can be classified as soft soldered, on which we will concentrate here, and hard soldered, such as silver and silver alloys, which is not a domestic application (Figure 3.32).

Soft soldered joints are made using two types of fittings:

- Integral solder ring
- End feed solder.









(c)



(b)



(d)





End feed solder fitting

Figure 3.32 Solder fittings

Solder ring fitting

#### The jointing process

Diagrams in Figure 3.33 are reproduced with the kind permission of Yorkshire Fittings Ltd.

Tel: 0113 270 1104 Website: www.yorkshirefittings.co.uk/

Figure 3.33 shows the jointing of an integral solder ring fitting.

- Clean and de-burr the pipe
- Clean the fitting
- Apply the flux
- Apply heat until you see the solder appear.

There are a number of fluxes on the market that are heat activated. This means a cleaning action takes place during the heating process, so you do not have to pre-clean the pipe end or fitting. When using these fluxes, you should make sure they are nonacidic, non-toxic and WRAS-approved for use on hot and cold pipework installations.

#### Push fit joints for copper pipes

A number of types of push fit joints are available for use on hot and cold water supplies. Here is a typical example, illustration supplied by Hepworth from their Hep2O range (Figure 3.34).

They are made from plastic. A grab ring is used to lock the pipe in place and a neoprene 'O' ring makes it water-tight. The fittings are





Figure 3.33 Reproduced with permission of Yorkshire Fittings Ltd

Figure 3.34 Reproduced with permission of Hepworth Plumbing



(a)







(b)



(d)

Figure 3.35 (a) Cut tube to length, (b) Clean and de-burr the pipe, (c) Insert ring to end of pipe, (d) Check pipe depth, (e) Fully push fitting into place, (f) Complete joint (Reproduced with permission of Hepworth Plumbing)





quite bulky, so do not look too aesthetically pleasing in exposed locations.

How to make the joint? (See Figure 3.35).

#### Copper to copper push fit systems

Yorkshire Fittings produce copper to copper push fit fittings (also available in stainless steel and for use on barrier pipe). The trade name is Tectite, and the fittings work on the same principle as the 'grab ring'.



Example of a Tectite push fit tee fitting.

Yorkshire Fittings produce a range of press fit fittings known as the XPress system. The jointing procedure works on the principle of exerting pressure from a press fit tool around the end of a fitting which encompasses a purpose made 'o' ring, thus forming a perfect seal.

Ensuring that the tube is fully inserted into the fitting, the jaws of the press-fit tool are placed around the collar of the fitting, which contains a butyl or EPDM 'O' ring (the XPress Gas range contains NBR 'O' rings). With the jaws at a 90° angle to the fitting, the press-fit tool is activated and the jaws compress the 'O' ring tightly onto the tube creating a strong and reliable joint.

Example of a XPress push fit reducing tee fitting.



## Key point

Yorkshire Fittings produce catalogues explaining about Tectile and XPress fittings, including jointing techniques. Try to obtain copies of these catalogues to see how it's done.

Images reproduced with the kind permission of Yorkshire Fittings contact www.yorkshirefittings.co.uk

Figure 3.37

#### **Key point**

. . . . . . . .

Key point

by the grade.

Black painted LCS must only be used on wet heating systems, oil and gas supply pipework. It must not be used on cold and hot water supplies. Why do you think this is so?

Nominal bore means that it is

not the actual bore of the pipe

as this will vary depending on the thickness of the pipe wall, which in turn will be determined

## *Low carbon steel (LCS) pipe and fittings*

Often referred to as mild steel, low carbon steel pipe is supplied in three grades:

- Light which is identified by the colour code brown
- Medium colour code blue
- Heavy colour code red.

It can be supplied either in a painted black finish, or with galvanised coating.

Generally speaking, light-grade tube is not used on plumbing pipework. You are most likely to work on medium-grade pipes, and occasionally heavy grade.

Medium and heavy grades are available in 6 m lengths, ranging from 6 to 150 mm diameter, specified as nominal bore.

#### Methods of jointing

For domestic installations, there are two main jointing methods:

- Threaded joints
- Compression joints.

#### Threaded joints

This is shown in Figure 3.38.

Jointing LCS pipe can be done by cutting threads into the end of the LCS pipe to give a British Standard Pipe Thread (BSPT), then jointing them together with a range of female threaded fittings



**Figure 3.38** (a) Section through a male/female union (b) Section through union connection showing pipework UNIT

#### Try this

You will cover pipe threading using stocks and dies and pipe jointing as part of your practical training at your college or centre. When you have completed this exercise write up a report of what you did. Include in the report:

- Tools and equipment used
- Materials and fittings
- Safety precautions
- How you tackled the job step-by-step including how you made the joint.

Discuss the report with your tutor.

made from steel or malleable iron (Figure 3.39). The threads are cut using stocks and dies; the stocks being the body and handle of the tool, the dies being the actual cutter.

#### Use of pipe threading machine

Pipe threading machines, like the one shown here (or even smaller portable versions) provide a quicker and easier method of forming threads for LCS pipes. The machine is an 'all in one' combined pipe cutter, de-burring reamer, also comprising stock head and dies (Figure 3.40).

#### Threaded pipe fittings for LCS

As mentioned earlier, these can be made of steel or malleable iron. Steel fittings can withstand higher pressure, but are more expensive than malleable iron. They are manufactured to BS 1740 for steel and BS 1256 for malleable iron.





**Figure 3.39** (a) Head gear (b) Ratchet threader (Reproduced with permission of Ridgid Tool)







**Figure 3.40** Pipe threading machine (Reproduced with permission of Ridgid Tool)

Figure 3.41 Compression fitting

#### Key point

Due to the way in which screwed joints are made and installed (rotated in the pipe), it is sometimes difficult to remove or assemble lengths of pipework. Where this is the case, a union connector like the one shown in Figures 3.38(a) and 3.38(b) which allows the pipework joint to be 'broken', should be used. Malleable iron fittings are adequate for domestic installations and, again like copper tube fittings, there is a wide range available.

Compression coupling being used

#### Compression joints

There are a number of manufacturers' designs for compression joints.

Here is a typical example (Figure 3.41).

The fitting is designed to enable steel pipes to be joined without threading. Made of malleable iron, they use locking rings and seals which are tightened onto the pipe. They can be used on water and gas supplies, and although more expensive than threaded joints, they do save time on installation.

## Plastic tube and fittings

Plastic pipes and fittings fall into a number of categories: Polythene, Propylene (pp) and Polyethylene (MDPE), all of which are by-products of polymerisation of ethers:

- BS 4991: Propylene copolymer for pressure pipe should not be used in installations where the working temperature exceeds 20°C
- BS 6572: Blue polythene pipes up to a nominal size of 63 mm for below ground supply of wholesome water
- BS 6730: Black polythene pipes up to a nominal size of 63 mm for above ground supply of wholesome water.

Other plastic pipes used for hot and cold water installation, wastes and overflows are:

- BS 7291 Part 1: polybutylene (PB) pipes (10–35 mm)
- BS 7291 Part 3: Cross-linked polyethylene (PE-X) pipes (10–35 mm)
- BS 7291 Part 4: Chlorinated polyvinyl; (PVC-C) pipes (12–63 mm) and unplasticised polyvinyl (UPVC)
- ABS Acrylonitrile butadiene styrene No British standard is available for the material and it is not suitable for use on hot water services.

Before we go into pipe jointing in further detail, here is an overview of typical jointing methods for plastic pipes (Figure 3.42).

#### Jointing methods

Fusion welding: Polythene and polypropylene (MDPE and PP). The jointing process requires the use of special equipment and fittings and is mainly used on water and gas distribution main installations. So, we will not go into it in further detail here.

(				
Types of plastic	Mechanical joints	Solvent welding	Fusion welding	Push fit 'O' ring Discharge pipes/ overflows only
Polythene	~	×	$\checkmark$	×
Polyethylene	<ul> <li>✓</li> </ul>	×	×	×
Polypropylene	$\checkmark$	×	$\checkmark$	$\checkmark$
PVC-U	$\checkmark$	$\checkmark$	×	$\checkmark$
ABS	✓	$\checkmark$	×	× )

## Key point

The black colouring is actually added to prevent the ultraviolet rays from the sun degrading and hardening the pipe, causing it to crack, and to prevent the transmission of light, protecting the water quality in wholesome water pipes – from the growth of microorganisms, e.g. Legionella.



Mechanical jointing:

This applies to the jointing of:

- Polythene/Polyethylene pipework
- ABS, PVC-U and PVC-C.

Polythene/Polyethylene pipe. It is used for underground water mains, and is identified by its blue colouring. It can also be found on internal cold water services, and is coloured black.

The joints are made using metallic or plastic (e.g. polypropylene) compression fittings. The jointing process involves:

- Cutting the pipe to the required length
- De-burring the pipe inside and out
- Sliding the cap nut and compression ring onto the pipe and inserting the approved liner into the pipe
- Making sure the pipe is fully inserted into the fitting and hand tightened
- Completing the tightening process using adjustable grips or spanners.

ABS, PVC-U and PVC-C. Solvent-welded jointing is used to join ABS, PVC-U and PVC-C pipe materials using approved solvent cement. The cement temporarily dissolves the surface of the pipe and fitting, causing two surfaces to fuse together. It is used for joints on soil and vent systems, waste pipes, overflows, and some cold water pressure pipe installations.

Here is a section (Figure 3.43) through a typical solvent-welded joint used on a waste system.

Push fit joints – used on domestic and heating overflow pipework. These are used mostly on PVC-U and PVC-C overflow pipework applications. The pipe is cut to length, making sure it is square and de-burred. The outside edge of the pipe is chamfered to give it a leading edge to make it easier when pushing it into the fitting.

Push fit connectors:

These are termed as flexible push fit plumbing systems for 'use only' on hot and cold water installations and central heating circuits. A number of manufacturers produce pipe and fittings for these systems, and the fittings can be used either on plastic or copper. Plastic pipes are available in various diameters ranging from 10 to 22 mm and in lengths of 3 m and 6 m, or in coils of 25, 50 and 100 m.

#### Key point

Inserting the approved liner into the pipe stops the plastic pipe from squashing when the nut is tightened onto the body of the fitting and pressure is applied by the compression ring.



Figure 3.43 Section through solvent-welded joint

#### Key point

Hepworth produce an 'Installer Guide' for their Hep<sub>2</sub>o products, (details are given at the end of this unit). They also produce self-adhesive metal tape, which, when applied to their plastic pipe, enables them to be detected when installed in walls.

. . . . . . . . . . . . . . . . . .

Many flexible push fit plumbing systems are manufactured from polybutylene (this is part of the polyolefin family of plastics) and allow the permeation of oxygen through the pipe wall. Therefore, polybutylene pipe is also available with a protective barrier wall to prevent occurrence of permeation, this is appropriately named 'barrier pipe'.

Barrier pipes should ideally be used in vented and sealed heating systems, reducing the risk of system corrosion, especially instances where an inhibiter is not used. Barrier pipe conforms to the requirements of BS 7291 Parts 1 and 2. The type of fitting used is the same as in Figure 3.34.

#### How to make the joint

The instructions are as follows and as shown in Figure 3.44.



(a)



(b)





(d)

## Jointing different metals

Fittings that are designed to join copper to plastic are available. These are of mechanical type and are available in either metallic or plastic finish. Fittings for jointing copper to LCS are also available.

Lead pipework is no longer allowed for new installations, but it may be necessary to join onto an existing supply in order to extend

**Figure 3.44** (a) Cut pipe to length and de-burr (b) Insert approved support liner (c) Position push fit fitting (d) Complete the joint (Reproduced with permission of Hepworth Plumbing) a system where a customer cannot afford to replace long runs of lead pipework, or where the joint is at the end of an underground service pipe.

There are various types of fittings available in the market for jointing plastic to lead, for below ground use, and lead to copper. These fittings should be WRAS-approved products.

Here are some examples, as shown in Figure 3.45.



#### Figure 3.45 Adaptor fittings

#### Key point

. . . . . . .

Make sure you include these activities in your portfolio and discuss your findings with your tutor.

#### Try this

There is a vast range of different types of fittings used for joining copper, low carbon steel and plastic pipes. We strongly recommend that you get hold of manufacturers' fitting catalogues so that you can see what is available in the market. Use the contact details that are included in this unit. Once you have obtained the catalogues, have a look at the next activities.

#### Try this

Figure 3.46 shows a number of sections from an installation drawing for a domestic dwelling. You are required to produce a fitting schedule for each. Using this support material and manufacturers' catalogues you are required to specify a suitable plastic material for the underground service pipework from the external stop valve to the internal stop tap and drain valve, and then for the rising main to the cistern. Include pipe sizes and fittings.



#### Try this

This installation is to be in copper (Figure 3.47). Here you need to:

- **1.** Specify the grade of copper to be used
- 2. Specify the type of jointing method to be used and why
- **3**. Using this support text and manufacturers' catalogues produce a fitting schedule only for the pipework installation. Include the crossover.



#### Try this

This heating installation is to be in LCS (Figure 3.48).

- 1. Specify the grade of LCS to be used
- 2. Using this support material and manufacturers' catalogues, produce a fitting schedule only for the pipework installation. Include the crossover.



## **Test yourself 3.4**

- 1. What are the three main materials used for new domestic plumbing installations?
- 2. From the list below, tick two answers which you think are correct.

The two main types of material used for fittings to joint LCS are:

- Steel
- Stainless steel

- Copper
- Malleable iron
- You have been asked to make a joint at a given length of LCS tube to an elbow.
   Describe how you would tackle the job, including tools and equipment used. Oh, you do not have access to a powered threading machine.

## Fixing devices, pipe supports and brackets

#### Introduction

In this section, we will take a look at the various types of fixing devices, such as screws and plugs. Different types of clips and brackets are used for securing the pipework, so that it looks neat, and is kept in the position it should be. Fixings should also provide sufficient support to the pipework or fittings so that they withstand possible accidental damages from people treading on it, children pulling at it and so on.

As a plumber you will be required to fix the pipework, sanitary appliances, boilers and radiators to various surfaces. You will also need to know how to refit boards and access traps in timber floors.

#### Try this

We expect you to do some additional work in this section. There are so many types of fixings, supports and brackets that you need to obtain manufacturers' catalogues to find out information for yourself.

## Fixing devices

These include:

- Brass wood screws
- Self-tapping screws
- Turn threaded wood screws
- Steel countersunk screws
- Chipboard screws
- Mirror screws
- Plastic wall plugs
- Plastic board fixings
- Cavity fixings
- Nails
- Corrosion-resistant (plated) screws.

#### Try this

The range of fixing devices is vast, and too detailed to describe fully here. You should try to get hold of a hardware catalogue so you can have a look at the range for yourself. Try www.screwfix.com

#### Key point

The condition of the wall you are fixing it to might not be very good, so you might have to use longer screws and thicker gauge. Trial, error and experience are the factors here!

#### Screws

Screws are specified in length in inches or millimetres, and gauge. A few examples used in domestic plumbing installations include:

- 3/4'' (20 mm) × No8 for fixing saddle clips
- 1¾ 10sb to b2 (50 mm) to 2½ (65 mm) 12s for fixing radiator brackets.

This is only a rough guide and you often have to make a decision about the appropriate length and gauge for a particular situation.

Brass, alloy or zinc-plated screws are used internally where they may be affected by the moisture. This could be in situations where they are fitted close to boilers and towel rail radiators. They are also used externally for soil and vent stack installations, gutter and rainwater systems. Self-tapping screws are required when fixing into sheet metal.

Steel countersunk screws are used for general tasks, such as fixing clips and radiator brackets.

#### Try this

Here are a few screw types in Figure 3.49. Can you state what they are? Use catalogues to find out.



#### Plastic wall plugs

These come in a range of gauges that are appropriate to the gauge of the screw. They are colour-coded for ease of selection.





#### Selecting the drill, plug and screw

Here is a helpful chart (Figure 3.50). Figure 3.51 gives the details of the fixing operation using plug and screw.

Screw size (gauge)	Drill size (mm)	Plug colour code
6–8	5	Yellow
8–10	6	Red
10–14	7–8	Brown
14–18	10	Blue

Figure 3.50 Screw size, drill size and plug colour code



Figure 3.51 Fixing operation using plug and screw

#### Plaster board fittings

Several types are available from the manufacturers. In the case of the spring toggle, a hole is drilled in the plaster board, big enough to take the toggle when folded. This is inserted through the hole and once through to the space behind the board, the toggle is pushed open by the spring.

The rubber nut fixing works on the principle of drawing the nut mounted in the rubber towards the screw head. As it tightens, the rubber is squashed to form a flange to the back of the board (see Figure 3.52).

#### Metal plaster board fixing

A cavity fixing works on the same principle as rubber nut fixing, but here the aluminium body is 'squashed' to form the flange. With an all metal plaster board fixing, a small pilot hole is drilled into the plaster board and the complete fixing is screwed into the plaster board (Figure 3.53). The screw is then removed leaving a fixing point similar to a wall plug.



Figure 3.52 Spring toggle and rubber nut fixing





(b)

Figure 3.53 (a) Metal plaster board and (b) Cavity fixing

#### Other fixings

The fixings described so far should be adequate for your day-today work.

There will be occasions, however, where you may be fixing a heavy appliance, or where the fixing surface is in a poor condition. Fixings of this type would include:

- Coach screws
- Wall bolts.

#### Nails

A plumber will use a range of nails, particularly on maintenance, repair and refurbishment work.

#### Activity 3.4

What type of jobs do you think a plumber might require the use of nails

Please check out the answer given at the end of this book.

#### Try this

Again, use manufacturers' catalogues to see what clips and brackets are available.

#### Try this

Once you have completed these questions, mark the answers yourself. Not all the answers are in the text, so you may have to find out from the manufacturers' catalogues! This is a good revision exercise. Check your answers with your tutor.

## **Clips and brackets**

It is likely that the bulk of your work will take place in domestic dwellings. In this case, the use of copper or plastic clips is adequate for supporting copper and plastic pipework. Like fixings, there is a range of clips available for this purpose.

However, there may be times when you may have to work in buildings other than domestic dwellings. This could include schools, hospitals or small industrial units, in which case the clips or brackets need to be strong and robust.

Table 3.6 shows recommended spacings for internal pipework fixings.

#### Table 3.6

Pipe	e size	size Copper pipe Steel size		size	Plastic pipe		
(mm)	(in)	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
15	1/2	1.2	1.8	1.8	2.4	0.6	1.2
22	3/4	1.8	2.4	2.4	3.0	0.7	1.4
28	1	1.8	2.4	2.4	3.0	0.8	1.5
35	11/4	2.4	3.0	2.7	3.0	0.8	1.7
42	11/2	2.4	3.0	3.0	3.6	0.9	1.8
54	2	2.7	3.0	3.0	3.6	1.0	2.1

## **Test yourself 3.5**

- 1. List four common types of fixings used in plumbing installations.
- How are screws specified tick the answer which you think is correct:
  - a. Length and gauge
  - b. Length and width
  - c. Width and gauge
  - d. Strength and gauge
- 3. Where would you be most likely to use a brass or alloy or zinc-plated screw?
- 4. What type of screw would be used to fix a radiator bracket to a concrete block wall? Tick the answer which you think is correct:
  - a. Steel countersunk
  - b. Self-tapping
  - c. Mirror screw
  - d. Chipboard screw
- 5. State three types of fixings suitable for plaster board stud partitioning.

## Associated trade skills

#### **Key point**

Always remember that whether you are cutting through floorboards or chopping through walls there may be existing water or gas pipes or electrical cables lurking to give you a nasty shock. Take care when doing this type of work, and where possible, try to determine if services already exist. This can be done using pipe and cable tracing equipment. Experienced plumbers can usually work out if a pipe or cable may be present by the proximity of the work to appliances, components and fittings.

#### **Key point**

You can locate the joist by finding the floorboard nails.

#### Introduction

Throughout this book, we have made reference as to how the work of a plumber can vary considerably from working on small repair jobs in people's homes to working on large multidwelling housing developments. On the larger type of developments, most of the associated building work will be carried out by the relevant trades, e.g. preparing the fabric of the building to run pipework. But on some jobs you may have to do the work yourself.

Hence, you will need to learn some additional skills to carry out your work effectively. You will need to run pipes under timber floors, which will involve notching joists.

In existing properties, gaining access to work under the floor will mean lifting floor surfaces, so you will need to know how to do that. Often, both on new work and maintenance work, you will be required to cut or drill holes in brickwork, blockwork, concrete and timber.

## Lifting floor surfaces

#### Lifting a length of floorboard to run the pipework through joists using hand tools

This usually involves lifting a single length of floorboard. If it is a full length one, it will be easier because you will not have to cut across the board. Here is what you have to do:

- Using the hammer and sharp bolster, carefully cut the tongue and groove joint down on either side of the floorboard. A pad saw could also be used for this purpose
- Nails should be punched down to enable the board to be removed
- Alternatively you may use a nail bar, sometimes called a wrecking bar or draw bar, to carefully prize up the floor-board and nails
- Once the board is partially lifted, if it is pushed down slightly, the nail heads will be revealed, allowing their removal with the claw hammer
- If you need to lift only part of the board, you will have to make one, possibly two cuts across a joist, so that when the board goes back it has a firm fixing point; if you cannot locate a joist you will have to insert timber cleats

• The cross-cuts on the floorboard can be made using an extremely sharp wood chisel or a purpose made floorboard saw.

#### Lifting floorboards using power tools

This is done using a circular saw.

The saw can be used to cut down the full length of the tongue and groove on each side of the board. The cross-cut is made, again over the joist, making sure that the blade does not hit the nails. Setting the saw blade at a slight angle will help to avoid hitting the nails.

#### Cutting traps in floorboards

This uses similar methods like removing a single floorboard, either using hand or power tools. It is just that there are more boards to cut, although in shorter lengths in order to make an access point to a section of pipe or component such as a central heating pump.

#### Replacing floorboards and traps

The floorboard lengths and traps should be screwed back into position to make future inspection or maintenance easier, this should be done using countersunk wood screws. When refixed over the pipework, the board surface should be marked accordingly, e.g. water, heating or gas pipework.

Where it has not been possible to find a joist to refit the board or trap, cleats must be used to support the board end. The following illustration (Figure 3.54) shows a trap or board replacement over joists and using cleats.



### Key point

Do not forget the information we provided earlier in the unit about the safe use of power tools.

Figure 3.54 Trap or board replacement over joists and using cleats

#### Removing and replacing chipboard

This is a more difficult job than floorboards, as it is laid in wider sheets. The best way to remove it is by using a circular saw – as for floorboards, the same rules apply. If a power supply is not available, a section of board can be cut using a floorboard saw. Here is what you have to do:

- The section of the board to be removed needs to be marked out across the board so that you have the guidelines to follow for the cut
- If a pad saw is used to make the cut, it is helpful to drill holes in each corner of the area to be lifted in order to start the cutting process
- Using this method would mean replacing the section removed with a new piece of chipboard.



Figure 3.55 Typical pipe guard

#### Replacing the chipboard

Like the floorboards, the chipboard should be screwed back in position.

#### Use of pipe guards

As we mentioned earlier, the position of the piperuns under the floors should be marked. A more effective way of protecting the pipes, which pass through the joists, is the use of pipe guards. Figure 3.55 shows a typical example.

#### Timber joists

It is inevitable that a joist will have to be drilled or notched to permit piperuns under timber floors. The preferred method would be to drill the joist in the centre of its depth as this is the point of least stress. In practice, apart from when using plastic hot and cold water supply pipe, it tends to be impractical.

The main point to remember, for either notches or holes, is that the joist is not weakened. This also applies to the distance from the wall where the joist is notched or drilled.

Think about the consequences for the customer of having joists that have been significantly weakened.

The Building Regulations set out the requirement for notching or drilling joists.



Which Building Regulation covers the notching and drilling of joists?

Check out the Building Regulations at www.odpm.gov.uk and then check your answer with the one at the end of the unit.

Building Regulations in practice



Worked out example

For a joist 200 mm deep and 2.5 m long, any notch must have a maximum depth of D  $\div$  8. So the depth of the notch is 200  $\div$  8 = 25 mm. The minimum length is 7 × 2500  $\div$  100 = 175 mm. The maximum length is L  $\div$  4 from its bearing, so maximum length of 2500  $\div$  4 = 625 mm.

The joists are normally cut using a hand or floorboard saw. They are cut to the required depth and width, and the timber notch is removed using a hammer and a sharp wood chisel.

The width of the notch should be large enough to give freedom of movement, in order to allow expansion and contraction, particularly for hot water supply pipework.





## Cutting holes in the building fabric

Again, you can use hand or power tools for cutting the holes. This time we will start with power tools. The selection of a drill will depend on the job at hand. Drills are available with various watt ratings, e.g. 500, 850 and 1400 W and have varying specifications for the different materials as shown in Table 3.7.

#### Table 3.7

	500 W	850 W	1400 W
Brick/block (mm)	30	42	152
Concrete (mm)	24	30	120
Steel (mm)	13	13	13
Wood (mm)	32	32	30

#### Key point

A core drill has the advantage over hand tools in providing a much neater finish to the job, and means less 'making good'.

#### Key point

All pipes that pass through wall structures must be sleeved, with an approved material. The drill bits used will be designed for a specific task and will be purpose made for brick, block, concrete, steel or wood. The diamond core drill will use either diamond- or tungsten-tipped bits.

Core drills are excellent for drilling through brickwork, blockwork or concrete where you need to pass a large diameter pipe, or flue pipework.

#### Wood bits or wood boring bits

These come in the following sizes: 12, 16, 18, 20, 22 and 25 mm and are useful for drilling holes in joists, or other timber constructions for the passage of pipes.

#### Hole saws

These come in the following sizes: 19, 22, 29, 38, 44 and 57 mm. These are handy while drilling through kitchen units in order to pass installation pipework or waste pipes through the side or back of cabinets. (They are also used to drill holes in plastic cold water storage cisterns.)

#### Making good

This will involve making good to brickwork, blockwork and concrete. For most jobs, a mortar mixture of 4 parts sand to 1 part cement will be adequate for jointing any brickwork joints disturbed whilst doing the job, and for making good the gap around the pipe penetration.

Mastic sealant, clear, or close to the colour of the pipework can be used as an alternative.

## Test yourself 3.6

- 1. What are the two main types of wooden floor surfaces?
- 2. A timber joist measures 200 mm deep by 4 m long. What is the maximum depth of the notch?
- 3. What is the minimum and maximum distance from the wall that the above joist can be notched?

## **Check your learning Unit 3**

#### Time available to complete answering all questions: 30 minutes

Please tick the answer that you think is correct.

- If a central heating system cannot be installed as per the client's original specification, what should a plumber's first action be?
  - a. Advise their immediate supervisor or employer about the problem
  - b. Obtain the client's verbal agreement to carry out the alterations
  - c. Obtain the client's written agreement to carry out the alterations
  - d. Proceed when the client's Quantity Surveyor issues a variation order
- Where can guidance on drilling of timber floor joists to accommodate water systems pipework be found?
  - a. Water Bylaws
  - b. Construction Regulations

- c. Building Regulations
- d. Water Regulations
- 3. What should be in place when working on uncovered first floor joists?
  - a. Lay duck boards over the joists
  - b. Knee pads and safety glove protection
  - c. Safety harnesses
  - d. Scaffold beneath the joists
- 4. What PPE would a plumber require when working in a roof space insulated with mineral wool?

(Continued)

- a. Extension lamp
- b. Fire extinguisher
- c. Respirator
- d. Safety mask

#### **Check your learning Unit 3** (Continued) 5. What is the statutory requirement for **10**. What action should a plumber take cutting the depth of notches in timber if a fault on a gas meter is suspected? floor joists, where D = Depth? a. Advise the customer a. ½ th D b. Repair the fault b. ½ th D c. Contact the gas supplier **c.** ¼ th D d. Turn off the supply d. 1/10 th D 11. When jointing copper tube, the purpose of the grab ring on a 6. What information should be left with push-fit plastic fitting is to: the customer after installation of a new a. Prevent the pipe damaging the boiler? '0' ring a. DIY servicing information b. Ensure the pipe is locked in b. Boiler installation template place c. Material delivery note c. Ensure the fitting is watertight d. User instructions d. Prevent the pipe from flattening 7. What is provided with materials to 12. Sleeves must be provided when a confirm the number and type of items pipe: delivered? a. Is located in the roof space a. Materials schedule b. Comes into contact with lead b. Materials invoice c. Passes through a brick wall c. Deliverv advice note d. Is laid in timber floor joists d. Copy of the order **13**. For what type of fitting would the 8. On a large multidwelling building application of solder wire during the site the progress of other trades jointing process be required? can be checked by referring to the: Integral ring a. a. Bill of Quantities **b.** Capillary b. Work programme c. Type A c. Materials schedule d. Type B d. Site plan What grade of copper tube is best 9. Upon delivery of sanitary ware to the suited to being bent using an internal site, the plumber should first check bending spring? if it is: a. X (R250) a. Adequately protected b. Y (R220/250) **b.** Water regulation approved **c**. Z c. The correct specification d. W d. Free from damage/defects

## Check your learning Unit 3 (Continued)

- **15.** What piece of equipment would be the most appropriate for bending 20 mm low carbon steel pipe?
  - a. External bending spring
  - b. Stand bender
  - c. Hydraulic press bender
  - d. Internal bending spring
- **16.** On which tool is 'mushrooming' most likely to occur?
  - a. Wood chisel
  - b. Screw driver
  - c. Cold chisel
  - d. Claw hammer
- 17. What document would be needed when maintaining a water softener?
  - a. Maintenance schedule
  - **b.** Installation programme
  - c. Manufactures' catalogue
  - d. Manufacturers' instructions
- **18.** What type of document would be used to plan the work activities on a long-term maintenance contract?
  - a. Bill of Quantities
  - b. Programme

- c. Materials schedule
- d. Installation plan
- 19. On a job to replace a bathroom suite in a one bathroom occupied dwelling, which of the following should a plumber install first in order to minimise disruption to the customer?
  - a. Bidet
  - b. WC suite
  - c. Shower tray
  - d. Bath
- 20. What information should be issued to a customer upon completion of a long-term planned maintenance contract?
  - a. Bill of Quantities
  - b. Material invoices
  - c. Maintenance records
  - d. Maintenance programme

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## Sources of Information

We have included references to information sources at the relevant points in the text; here are some additional contacts that may be helpful.

 Pegler Limited St Catherine's Avenue Doncaster South Yorkshire DN4 8DF Tel: 01302 560560

Website:www.pegler.co.uk

- Yorkshire Fittings Head Office PO Box 66 Leeds LS10 1NA Tel: 0113 270 1104 e-mail: info@yorkshirefittings.co.uk Website:www.yorkshirefittings.co.uk
- Copper Development Association Grovelands Business Centre Boundary Way Hemel Hempstead Herts HP2 7TE United Kingdom Tel: 01442 275700 e-mail: helpline@copperdev.co.uk Website:www.cda.org.uk (CDA provides some excellent general information on copper tube)
- Hepworth Plumbing Products Head Office Edlington Lane Edlington Doncaster DN12 1BY Tel: 01709 856400 Website:www.hepworthplumbing.co.uk

- Screwfix Screwfix Direct FREEPOST Yeovil BA22 8BF Tel: 0500 41 41 41 e-mail: online@screwfix.com Website:www.screwfix.com
- Draper Tools Ltd Hursley Road Chandler's Ford Eastleigh Hants SO53 1YF Tel: 023 8026 6355 e-mail: sales@draper.co.uk Website:www.draper.co.uk
- Ridgid Tool Arden Place House Prixmore Avenue Letchworth Herts SG6 1LH Tel: 01462 485335 e-mail: sales.uk@ridgid.com
- Water Regulations Advisory Scheme Fern Close
   Pen-Y-Fan Industrial Estate
   Oakdale
   Gwent
   NP11 3EH
   Tel: 01495 248454
   e-mail: info@wras.co.uk
   Website:www.wras.co.uk

You may also find the following websites useful: www.piping.georgfischer.com, www.plumbworld.co.uk