Copper Development Association

Copper for Domestic Natural Gas Installations

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Copper for Domestic Natural Gas Installations
Design and Installation

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Copper Development Association

Copper Development Association is a non-trading organisation sponsored by the copper producers and fabricators to encourage the use of copper and copper alloys and to promote their correct and efficient application. Its services, which include the provision of technical advice and information, are available to those interested in the utilisation of copper in all its aspects. The Association also provides a link between research and user industries and maintains close contact with other copper development associations throughout the world.

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Contents

Tables

Figures

1 Introduction

Copper tube and fittings manufactured in the UK make up the pipework systems that convey liquids and gases around most of the homes in the UK. Not only is copper ideally suited for the distribution of water for domestic plumbing it is ideal for the distribution of natural gas.

The information necessary to design and install a copper domestic natural gas installation can be found in a number of different documents, see Section 3. This technical publication draws together all of the relevant information from each of these sources into one comprehensive document.

The technical information that follows will enable those who design, install, service, maintain, remove or repair natural gas systems in buildings to ensure that copper domestic natural gas installations are safe, efficient and serviceable. Only those installers registered with the COUNCIL FOR REGISTERED GAS INSTALLERS, CORGI, may undertake installation, extension or repair work on gas systems and their appliances.

2 Advantages Of Using Copper

Copper tube and fittings have many advantages over other materials permitted for use in natural gas installations.

Economic

Copper tube and fittings are readily available and the fittings sizes are compatible with the tube sizes, from 6mm outside diameter up to 159mm.

They are easily jointed by soldering, brazing or compression fittings to form mechanically strong, gas tight joints.

Copper pipework can be easily prefabricated, which can reduce installation time by allowing sections of the pipework to be fabricated in the ideal conditions of the workshop.

It is possible to bend copper tube easily and accurately using either flexible springs or bending machines.

Copper pipework will last the life time of the building.

Copper is 100% recyclable.

All of the above factors lead to an easier, cleaner, less time consuming installation and lower costs.

Safety

Copper tube has been tested and shown to be reliable over many years - the same cannot be said for some of the alternatives.

There is no deterioration of properties with time due to creep (gradual deformation).

The corrosion resistance, both internal and external, of copper is excellent.

Copper tubes are not embrittled at low temperatures.

The availability of long lengths in seamless tube lead to the requirement for fewer joints and potential weak spots.

Appearance

Copper tubes are neat in appearance and have an attractive colour.

They may be easily painted to blend in with the surroundings without affecting the integrity of the tube.

In order to avoid confusion in communication between manufacturers, suppliers and users the product designation is defined in BS EN 1057 as follows:

Denomination (copper tube).

Number of European Standard (EN1057).

Material Temper.

Nominal cross section dimensions in millimetres: outside diameter x wall thickness.

Example

Copper tube conforming to BS EN 1057, temper R220 (annealed), nominal outside diameter 12mm, nominal wall thickness 1mm, shall be designated:

Copper tube - EN1057-R220 12x1.0

Copper tube manufacturers have developed their production techniques to meet the demand for high quality copper tube. Only those manufacturers whose products are certified by regular checks from BSI Inspectors have the right to use the 'Kitemark' quality assurance symbol. In addition, the UK copper tube producers quality management procedures are inspected by BSI personnel to validate their continued registration as 'firms of Assessed Capability'.

3 Standards and References

BS 6891 : 1997 Specification for installation of low pressure gas pipework of up to 28 mm (R1) in domestic premises (2nd family gas).

BS EN 1057 : 1996 Copper and copper alloys - Seamless, round copper tubes for water and gas in sanitary and heating applications.

BS EN 1254 : 1997 Copper and copper alloys - Plumbing fittings.

Part 1 Fittings with ends for capillary soldering or capillary brazing to copper tubes.

Part 2 Fittings with compression ends for use with copper tubes.

BS EN 29453 : 1994 Soft solder alloys. Chemical compositions and forms.

Gas service technology : No 3 Volume 2 : Domestic installation and servicing practice. Published by Tolley.

4 Design of the Installation

4.1 Exchange of Information and Time Schedule

The gas installation pipework should be proven to be adequate for immediate use, and probable future requirements, during the initial stages of building design and services planning. A time schedule for installing the pipework should be agreed as early as possible and any changes to the schedule should be notified to interested parties at the earliest opportunity.

Drawings should be made available showing the details of the pipework installation. These details should include the position of controls, ducts and chases and the position and sizes of all installation pipework.

All pipework which will be inaccessible when the installation is complete should be tested for soundness before finally being covered or buried.

4.2 Design Considerations

4.2.1 External Protection of Copper Pipework

Copper resists atmospheric corrosion very well, there is no corrosion of copper in a dry environment. Conditions which may cause concern are those where water, salt spray, damp, corrosive chemicals, debris or soot are present. In these situations factory finished yellow plastic coated tube should be used. Protection of joints requires special attention and PVC wrapping tape or certain paints should be applied to the joint area. Pipework which has been assembled must be tested for soundness before any additional protection against corrosion is applied on site.

Copper should not be in direct contact with other metals, such as steel, in moist environments. The copper must be insulated if the pipework is to be situated in a moist environment. Clips supporting copper pipe should be made of either copper or plastic.

The importance of using a corrosion resistant material is stressed in the Gas Safety Regulations (1994) and in BS6891 - copper fulfils the requirements of the Regulations and Standards in an excellent manner.

4.2.2 Copper Pipework In Solid Floors

When copper pipes are laid in solid floors they must be protected against failure by movement of the floor.

Methods used to protect copper pipes:

1. A plastic sheath set into the floor with cement mortar. No joints should be located in the sleeve.
2. Burying - Pipes which have been protected laid on top of base concrete and covered by a screed. Pipes up to 28mm may be buried and a minimum cover of 20mm must be applied. When pipes are to be buried in magnesium-oxy-chloride cement or magnesite flooring copper is the only material recommended (BS6891) and must be factory plastic coated.
3. Use of preformed ducts.
4. Use of a protective covering at least 5mm thick (BS 6891).

Copper pipes passing through solid floors must take the shortest practicable route and be enclosed in a gas tight sleeve which is normally another piece of copper tube.

It must be emphasised that copper is the best choice for gas pipes enclosed in solid floors because of its flexibility, strength and good corrosion resistance. BS 6891 does NOT ALLOW stainless steel pipes to be buried in solid floors.

4.2.3 Copper Pipework In Wooden Joisted Floors

When copper pipes are installed between joists in ceiling or roof spaces they must be correctly supported, as detailed in section 5.2.5. The supporting clips should be made from copper or plastic to avoid the risk of dissimilar metal corrosion.

When pipes are laid across the joists in ceiling or roof spaces fitted with floor boards, they shall be located in purpose made notches or circular holes. The location, size and shape of notches in joists should be as follows:

a) Notches must NOT be located at the centre of a joist supported at both ends, since this is where the maximum bending force is located. Notches must be located not more than one quarter of the span from an end support.

b) Notches must not be deeper than 15% (approx. 1/6) of the depth of the joist.

c) Notches shall not be made in joists less than 100mm high.

d) Notches must be U-shaped and of minimum possible width.

e) Notches should be positioned where possible under the centre of floorboards to avoid damage to the copper pipework from nails or water dripping on to the pipe through the joints between the floorboards. The floorboard should be marked to avoid any possible future damage from nails or screws.

4.2.4 Copper Pipework In Walls

Vertical pipework runs

For vertical pipework runs the installation pipework should, where possible, be placed in ducts which should provide easy access to the pipework. If it is impractical to provide pipework ducts and providing the wall thickness is adequate pipework may be placed in a chase.

A duct is a recess in brickwork or concrete which is purpose made. If the cross-sectional area of a duct is greater than 10,000mm2 the duct should be vented. A chase is a recess which is made after the wall has been constructed. A chase must be made vertically or horizontally, never diagonally.

Cavity walls

Installation pipework should not be placed within the cavities of cavity walls. Every pipe passing through a cavity wall should take the shortest practical route and must be sleeved.

Dry lined walls

Installation pipework installed within dry lined or timber construction walls should be run within purpose designed channels or ducts so constructed as to prevent, as far as is reasonably practicable, the transfer of gas into the cavity of a cavity wall. The pipework should be adequately secured to studding, have the minimum number of joints and be adequately protected against corrosion, e.g. factory applied polyethylene covering.

All pipework passing through a solid wall must be sleeved.

4.2.5 Copper Pipework On Wall Surface

Copper is the ideal choice of material when pipework has to be run along the wall surface. Wall mounted gas installation pipework should be readily identifiable through some form of colour coding. For the same carrying capacity copper tube has a smaller outside diameter than steel tube making copper pipework a neater and more acceptable installation. The copper pipework must be correctly clipped, using stand off pipe clips, and supported.

4.3 Copper Tube Sizing

It is important for appliances to have the correct inlet pressure to deliver the correct volume (gas rate) to fire the burners.

When a gas flows through pipework friction is generated between the gas and the tube wall. The friction causes a reduction in the pressure, a pressure loss, which affects the flow rate available at each of the outlets in the pipework. In a natural gas installation the pressure loss due to friction between the flowing gas and the tube walls will reduce the pressure available and the gas flow rate at each of the gas burning appliances on the installation.

Pressure will also be lost each time the pipework changes direction, through bends or fittings. The pressure loss through fittings can be expressed as an additional equivalent length of pipe to be added to the actual length of the run. For gas pipework up to 28mm the equivalent lengths given in Table 1 must be added to the actual pipe length.

Table 1 – Equivalent lengths of fittings and bends

Fitting	Equivalent length, m
Tee	0.5
Elbow	0.5
90° bend	0.3

In order to keep pressure losses through the pipework to a minimum consideration should be given to reducing the number of fittings used. Where changes in direction of the pipework are necessary preference should be given to tube bends, rather than elbows, providing bends are acceptable in the particular situation. The bore of any installation pipework should not be restricted by kinks, burrs, foreign matter or in any other way. Using the correct installation procedure, as described in section 5.2, will ensure that the pipework bore is not restricted in any way.

The sizes of copper tubes used for the installation are determined from the maximum gas flow rate of each of the connected appliances together with an allowance made for the maximum demand on the installation likely to occur at any one time. Allowance should also be made for appliances which may be incorporated in any future extensions to the installation.

When designing new installations or making changes to existing installations the gas consumption of existing appliances and any proposed replacement or additional appliances should be noted. The length and sizes of existing pipework and of any extension to the installation together with numbers of fittings and bends used must be noted.

The pipework should be designed so that the pressure drop between the outlet of the meter and the appliance does not exceed 1mbar at maximum flow conditions. The mains gas supply should generally use not less than 22mm diameter tube. Thought should be given for the provision for any future extensions to the installation when sizing branches from the mains supply.

The installation design process involves three stages:

1. A labelled schematic diagram of the installation showing lengths of pipework and location of appliances.
2. Identification of the consumption figures for each of the appliances connected to the pipework installation.
3. Consideration of the pressure losses in each section of pipework to determine whether each appliance will be provided with an adequate gas flow rate.

The following is a typical example of the installation design process.

1. Schematic diagram of the installation

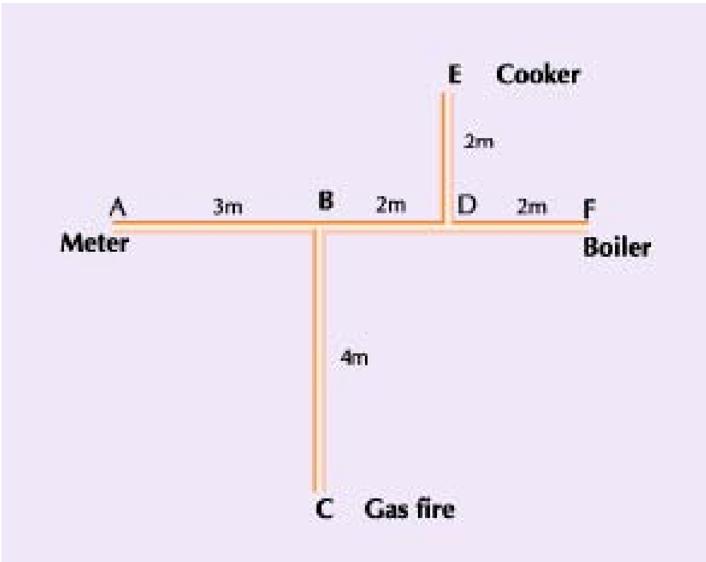

Figure 1 – Schematic diagram

2 Identification of gas consumption figures for each of the appliances connected to the installation.

Typical gas consumption figures for a number of household appliances are given in table 2.

Table 2 – Appliance gas consumption rates

Appliance	Gas consumption m3/hour
Cooker	1.0
Boiler	1.6
Gas fire	0.5

3 Determination of the pressure losses in each section of the pipework

Table 3 – Gas discharge, m^3/h, in straight horizontal opper tube with 1.0 mbar differential pressure between the ends, for gas of relative density 0.6

	Length of pipe run, m							
Size of tube	**3 m**	**6 m**	**9 m**	**12 m**	**15 m**	**20 m**	**25 m**	**30 m**
10	0.86	0.57	0.50	0.37	0.30	0.22	0.18	0.15
12	1.5	1.0	0.85	0.82	0.69	0.52	0.41	0.34
15	2.9	1.9	1.5	1.3	1.1	0.95	0.92	0.88
22	8.7	5.8	4.6	3.9	3.4	2.9	2.5	2.3
28	18	12	9.4	8.0	7.0	5.9	5.2	4.7

The information contained in Table 3 enables the pressure drop in sections of pipework to be calculated. Each section of the pipework installation is now considered in turn.

A to B

Estimated size of copper tube = 22mm

Gas flow required is for a cooker, boiler and gas fire. 1 + 1.6 + 0.5 = 3.1m^3/hour

Actual length of pipework = 3m

This pipework section includes two elbows and a tee, the equivalent length is

therefore 3 x 0.5m = 1.5m

Corrected length is therefore 3 + 1.5 = 4.5m

Reference is now made to Table 3. Look at the column headed size of copper tube and find 22mm. Now look along the row and find the longest distance that will give the correct volume of gas (3.1m^3/hour). In this instance 15 metres will supply 3.4m^3/hour of gas at 1mbar pressure drop. The pipe run from A to B is 4.5 metres so the actual pressure drop over this distance can be calculated as follows:

$$\frac{4.5}{15} = 0.3 \text{ mbar}$$

B to C

Estimated size of copper tube = 15mm

Gas flow required is for a gas fire. 0.5m^3/hour

Actual length of pipework = 4m

This pipework section includes three elbows, the equivalent length is therefore 3 x 0.5m = 1.5m

Corrected length is therefore 4 + 1.5 = 5.5m

Reference is made to Table 3. Look at the column headed size of copper tube and find 15mm. Now look along the row and find the longest distance that will give the correct volume of gas ($0.5m^3$/hour). In this instance 30m will supply $0.88m^3$/hour at 1 mbar pressure drop. The pipe run from B to C is 5.5 metres so the pressure drop is:

$$\frac{5.5}{30} = 0.2 \text{ mbar (approx.)}$$

The total pressure loss to C is 0.3 + 0.2 = 0.5mbar which is acceptable.

It indicates that a smaller pipe may be used for the pipework from B to C. Consideration should be given to changing to 12mm copper tube.

Reference is made to Table 3. Find 12mm copper tube size, the longest distance that will give the correct volume ($0.5m^3$/hour) is 20 metres.

The pressure drop from B to C is:

$$\frac{5.5}{20} = 0.30 \text{ mbar (approx.)}$$

The total pressure loss to C is 0.3 + 0.3 = 0.6mbar

This is less than 1 mbar and is therefore acceptable and 12mm copper pipe could be used from B to C.

B to D

Estimated size of copper tube = 22mm

Gas flow required is for a cooker and a boiler. 1 + 1.6 = $2.6m^3$/hour

Actual length of pipework = 2m

This pipework section includes three elbows and a tee, the equivalent length is therefore 4 x 0.5m = 2.0m

Corrected length is therefore 2 + 2 = 4m

As with above examples, reference is made to Table 3. The longest distance giving correct volume of gas is 20 metres.

Pressure drop is:

$$\frac{4}{20} = 0.2 \text{ mbar}$$

D to E

Estimated size of copper tube = 15mm

Gas flow required is for a cooker. 1.0m^3/hour

Actual length of pipework = 2m Gas flow required is for a cooker. 1.0m^3/hour

This pipework section includes two elbows, the equivalent length is therefore 2 x 0.5m = 1.0m

Corrected length is therefore 2 + 1.0 = 3.0m

Reference is made to Table 3. Longest distance giving correct volume of gas is 15 metres.

Pressure drop is:

$$\frac{3}{15} = 0.2 \text{ mbar}$$

The Total pressure drop to E is 0.3 + 0.2 + 0.2 = 0.7mbar which is acceptable.

D to F

Estimated size of copper tube = 15mm

Gas flow required is for a boiler. 1.6 m^3/hour

Actual length of pipework = 2m

This pipework section includes two elbows, the equivalent length is therefore 2 x 0.5m = 1.0m

Corrected length is therefore 2 + 1.0 = 3.0m

Reference is made to Table 3. The longest distance giving correct volume of gas is 6 metres.

Pressure drop is:

$$\frac{3}{6} = 0.5 \text{ mbar}$$

The total pressure drop to F is 0.3 + 0.2 + 0.5 = 1.0mbar which is acceptable.

The above example shows a correctly designed installation - at no location was the maximum permitted pressure drop exceeded.

However, if we consider the situation when a NEW combi boiler is installed with a gas consumption of 2.2m^3/hour.

Consider D to F

Estimated size of copper tube = 15mm

Gas flow required is for a new boiler 2.2m3/hour

Actual length of pipework = 2m

This pipework section includes two elbows, the equivalent length is therefore 2 x 0.5m = 1.0m

Corrected length is therefore 2 + 1.0 = 3.0m

Reference is made to Table 3. Longest distance giving correct volume of gas is 3 metres.

Pressure drop is:

$$\frac{3}{3} = 1 \text{ mbar}$$

Total pressure drop to F is 0.3 + 0.2 + 1 = 1.5mbar. The maximum recommended pressure drop has been exceeded. Consideration should be given to re-sizing the tube from D to F. The section of pipe from D to F may be replaced with 22mm.

Reference is made to Table 3. Longest distance giving correct volume of gas is 30 metres.

Pressure drop is:

$$\frac{3}{30} = 0.1 \text{ mbar}$$

The total pressure drop to F is 0.3 + 0.2 + 0.1 = 0.6mbar which is acceptable.

5 Installation

5.1 Materials

5.1.1 Copper Tube

Copper tube to BS EN 1057: 1996 is specified for use in domestic natural gas installations. BS EN 1057 has replaced the copper tube standard BS 2871 Part 1. Mechanical properties of copper tube are given in Appendix A.

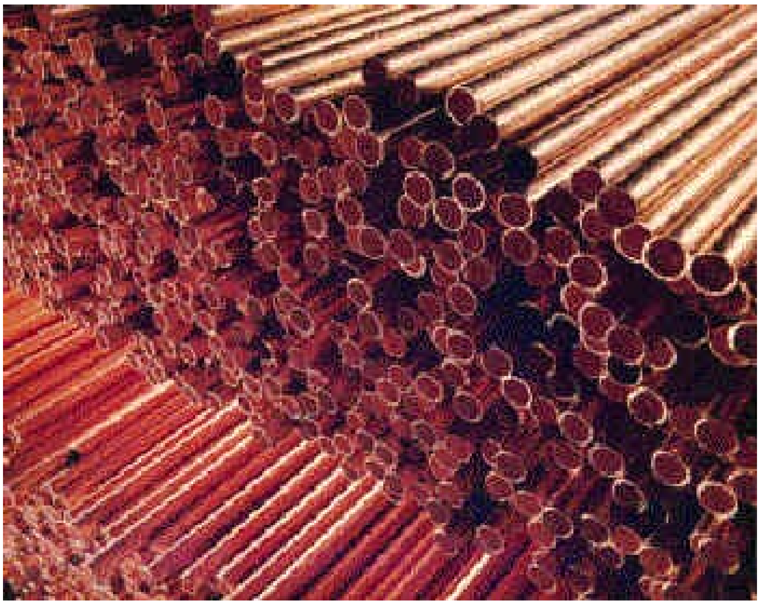

Figure 2 – Copper tube

Tables 4, 5, 6 and 7 give the old tube designation according to BS 2871 Part 1 and the new designation according to BS EN 1057.

Table 4 – BS EN 1057 – R250 (BS 2871 Part 1 Table X half hard straight lengths)

Diameter	OD x wall thickness, mm
6mm	6 x 0.6
8mm	8 x 0.6
10mm	10 x 0.6
12mm	12 x 0.6
15mm	15 x 0.7
22mm	22 x 0.9
28mm	28 x 0.9

Table 5 – BS EN 1057 – R250 (BS 2871: Part 1 Table Y harlf hard straight lengths)

Diameter	OD x wall thickness, mm
6mm	6 x 0.8
8mm	8 x 0.8
10mm	10 x 0.8
12mm	12 x 0.8
15mm	15 x 1.0
22mm	22 x 1.2
28mm	28 x 1.2

Table 6 – BS EN 1057 – R250 (BS 2871: Part 1 Table Y soft coils)

Diameter	OD x wall thickness, mm
6mm	6 x 0.8
8mm	8 x 0.8
10mm	10 x 0.8
12mm	12 x 0.8
15mm	15 x 1.0
22mm	22 x 1.2
28mm	28 x 1.2

Table 7 - BS EN 1057 – R220 (BS 2871: Part 1 Table W soft coils)

Diameter	OD x wall thickness, mm
6mm	6 x 0.6
8mm	8 x 0.6
10mm	10 x 0.7

5.1.2 Copper And Copper Alloy Fittings

Fittings for use in joining copper tube are specified in BS EN 1254 Parts 1 and 2. Fittings for capillary soldering and brazing are specified in Part 1 and compression fittings are specified in Part 2. Fittings are normally designated by either the manufacturer's catalogue number or by the common term, e.g. tee, elbow.

Figure 3 – Copper and copper alloy fittings

5.1.3 Solders And Fluxes

Soft soldering utilises filler metals with melting points at temperatures up to 450°C. Filler metals are specified in BS EN 29453:1994 - Soft solder alloys - Chemical compositions and forms. Solders for use with copper tube and fittings generally melt within the temperature range 180°C to 250°C. Alloy numbers 11 and 12, with melting temperatures of 183°C to 190°C, are recommended for use in gas installations. Alloy number 13 can be used but the joint needs to be heated up by about a further 20°C.

Fluxes are used in the jointing process for three main reasons. To:

1. help to remove oxides from the joint area.
2. exclude air from the joint area, preventing oxidation.
3. assist the flow of solder into the joint gap.

All fluxes have some corrosive action and the outside of the joint should be cleaned with a damp cloth as soon as the joint has set.

5.2 Installation Procedure

Copper tube to BS EN 1057 can be joined with the use of capillary fittings to BS EN 1254 Part 1 using solders specified in BS EN 29453 or compression fittings to BS EN 1254 Part 2.

5.2.1 Soldered Joints

Soldered joints can be made simply and easily. A technically correct joint will be made by following the procedure given below.

Cut the copper tube to the required length using tube cutters, or a fine tooth hacksaw, ensuring that the tube ends are square and remain round in section. Figure 4.

Figure 4 – Cutting tube

Figure 5 – De-burring tube end

- Remove the external and internal burrs using a file or sharp knife. Figure 5.

Annealed tube, R220, may require re-rounding following the cutting operation.

Match up the tube and the fitting to ensure that they are a good fit and that there are no defects which may prevent the capillary flow of solder.

Ensure that the tube and fittings are free from grease and dirt by abrading the joint area with a cleaning pad. It is important for a successful joint that all oxides are removed from the joint area on both the socket and the tube end. Figure 6 and Figure 7.

Figure 6 – Cleaning the tube end

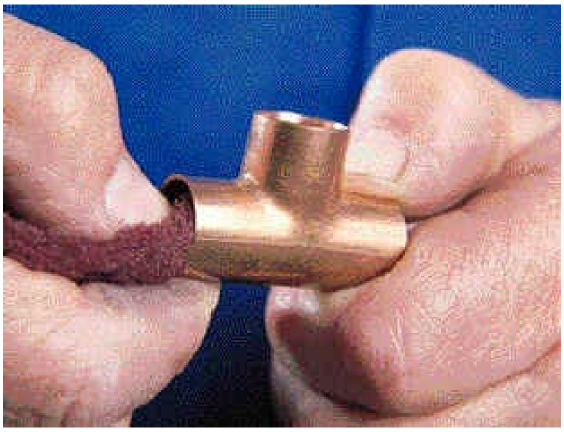

Figure 7 – Cleaning the fitting

Figure 8 – Applying flux to the tube end

Figure 9 – Assembling the joint

Apply a thin coating of flux to the tube end which will form part of the joint area. Figure 8.

Ensure that the tube end is pushed fully home into the socket. Twist the assembly to spread the flux over the jointing area. Care should be taken not to apply too much flux which can be wasteful and messy and that excess flux does not get pushed into the fitting during the assembly. Figure 9.

It is very important to ensure that the assembly is held securely so that movement cannot take place during soldering and whilst the joint is cooling. Any excess flux should be wiped off as soon as the joint is cool enough to handle safely.

The heat required to make the joint is applied to the fitting. As the heat is applied the temperature of the joint assembly rises and the flux begins to spit indicating that the joint is reaching the soldering temperature. If the heat is too fierce then the flux will be burnt off and this will prevent the solder from flowing into the capillary gap. If the heat is insufficient then the solder will not be fully molten and the solder will not fully penetrate the joint.

The heat is applied steadily to ensure an even temperature distribution around the joint area. A heat reflective material or heat resistant pad can be used at the back of the joint to assist an even heat distribution and to protect the adjacent combustible material.

With integral solder ring fittings the joint is complete when a ring of solder appears all around the mouth of the fitting. Figure 10.

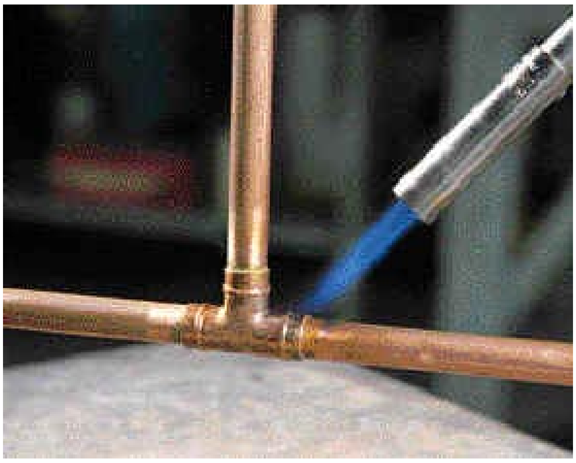

Figure 10 – Heating the joint, integral solder ring fitting

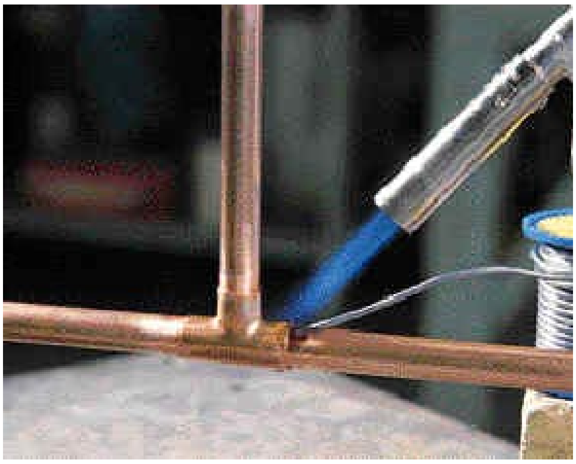

Figure 11 – Heating the joint, end-feed fitting

If end-feed fittings are being made up the solder is touched against the edge of the joint and if it begins to melt the required temperature has been reached and enough solder to fill the capillary gap is allowed to flow. The solder is melted through contact with the tube and fitting and not through direct contact with the heating flame. Figure 11.

When the capillary gap is full the joint is complete and allowed to cool down. At this stage it is important that the joint assembly is not disturbed or moved. When the joint has cooled sufficiently the excess flux is removed using a damp cloth. Figure 12.

Figure 12 – Removal of excess flux

Capillary joints must be visually inspected immediately after completion to ensure that a ring of solder is present all around the mouth of the fitting.

5.2.2 Brazing

The procedure for forming a brazed joint is similar to that for soldered joints. The filler metal used has a melting point above 450°C but below the melting temperature of copper. Brazing is more suited to those applications where high strength of joint is required, as in high temperature, high pressure and heavy duty installations. Soft solder fluxes are not suitable for use in forming brazed joints. Filler metals are of the copper-silver-zinc or copper-phosphorus-silver types.

5.2.3 Compression Joints

There are two types of compression fittings, Type A and Type B, as defined in BS EN 1254 - 2. Compression joints should not be used on pipework which is to be buried or hidden, e.g. underfloor, it is essential that they be accessible so that they may be checked for tightness.

Type A is defined as a fitting that requires no preparation of the tube end other than that they be cut square and de-burred. The joint is made by the compression of a ring onto the outside of the tube. The fittings are supplied with either an internal shoulder or stop against which an inserted tube will abut. Type A fittings are permitted for use in above ground applications. These fittings are suitable for use with all grades of copper tube to BS EN 1057 however, caution should be exercised when jointing annealed, R220, copper tube. Fittings of 18mm and larger will require an internal support when jointing annealed tube and for sizes less than 18mm the manufacturers advice should be sought.

Type B fittings are defined as fittings that require the end of the tube to be manipulated and which are made by compressing the manipulated portion of the tube against the face of the body of the fitting or against a loose ring within the fitting. Type B fittings are for jointing half-hard, R250, and annealed, R220, copper tube only.

Both Type A and Type B compression fittings are designed to be free from internal fins or other irregularities that may restrict the free flow of gas and also to minimise the resistance to flow of gas through the fitting. A compression ring is tightened onto the outside of the tube to compress the circumference slightly and is squeezed into the shaped socket of the fitting to seal the joint.

5.2.4 Bending Of Copper Tube

Copper tubes to BS EN 1057 can be easily formed into bends using the recommended techniques described below. In general the bending radius should be between 3 times and 4 times the OD of the tube. Table 8 reproduces information given in BS EN 1057.

Flexible bending springs

Bending springs can be used and are suitable for use with copper tubes up to 22mm outside diameter. Only relatively easy bends should be attempted.

Portable bending machines

Small hand held bending machines are available for tubes up to 22mm OD. Free standing or bench mounted machines are suitable for the larger tubes used in natural gas distribution installations.

Bending machines work on the principle that the tube is bent between matched formers and back guides which support the outside diameter of the tube, eliminating the risk of collapse of the tube wall. It is of critical importance to apply the pressure required to bend the tube in the correct position on the tube. This point of application of pressure must be maintained at an optimum distance in front of the point of support on the former, the distance is dependent upon the size and temper of the tube. If the distance between the pressure point and the tube wall support point is too small excessive throating of the bend will occur. If the distance is too great, corrugations will appear in the inner radius of the bend and flattening of the outside radius of the bend will occur. To ensure perfect bends every time it is recommended that adjustable bending machines are employed as these permit the pressure on the back guide to be adjusted.

Table 8 – Minimum radius of curvature

Tube Size,OD, mm	**Minimum bending radius, mm**	
	Internal radius	**Neutral axis radius**
6	27	30
8	31	35
10	35	40
12	39	45
14	43	50
15	48	55
16	52	60
18	61	70

5.2.5 Pipework Hangers And Supports

All pipework should be adequately supported by clips at suitable intervals. Clips should be spaced according to Table 9.

Table 9 – Hanger spacing for copper tube to BS EN 1057

Size ofTube, mm	For vertical runs, m	For horizontal runs, m
12	2.0	1.5
15	2.0	1.5
22	2.5	2.0
28	2.5	2.0

5.3 Safety Precautions

Great care must be taken when carrying out repairs or extending existing pipework. It is necessary to set out general safety guidelines to work within in order to avoid the dangerous situation which may develop when working with gas installations. A mixture of gas and air may be explosive and therefore very dangerous. Care should also be exercised when installing new pipework.

5.3.1 General Safety Precautions

1. Whilst installation work is in progress care should be taken to prevent the ingress of dirt and other foreign matter into the pipework.
2. Care should be taken not to cause damage to any drain, sewer or other pipework during the installation process.
3. When work is in progress on copper pipework already connected to a meter, the meter should be temporarily bonded, (see 5.4.2), before being disconnected and both the open ends of the copper pipework sealed with metallic fittings. All open ends of the pipework should be plugged or capped before the work is left unattended.
4. When working with naked flames, e.g. a blow lamp, on pipework that has contained gas it is essential that the gas supply to that part of the pipework be isolated and disconnected.
5. Naked flames should be kept away from open ends of pipework.
6. No person shall smoke in the area.
7. Potentially explosive mixtures of gas and air should be purged from the copper pipework prior to using tools such as a blow torch.
8. Ducts should be adequately ventilated to prevent a potential explosive mixture of gas and air forming.

5.3.2 Electrical Safety

1. Care should be taken not to damage any electrical conductor when installing copper pipework.
2. Copper gas installation pipes should not be buried in floors where electrical underfloor heating is installed, unless it has been physically and permanently disconnected.
3. When installation pipes are not separated by electrical insulating material they should be spaced at least 150mm away from electricity meters and associated excess current control or fuse boxes and at least 25mm (preferably 50mm) away from electricity supply and distribution cables and other metallic services. If this spacing is impracticable the copper pipe should be PVC wrapped or a panel of insulating material interposed.

5.3.3 Meters And Emergency Controls

It is required practice (Gas Safety Regulations and BS6891) to fit an emergency control (cock or valve) when a gas service is installed.

The emergency control may be fitted either:

a) to the inlet of the primary meter (see BS6400),

b) to the installation pipe where it enters the building, where the meter is sited 6m or further away from the building, or

c) inside individual flats served by a large single or multiple meter installation located in a remote communal area.

Every emergency control shall be:

a) labelled or marked to show its open (on) and closed (off) positions.

b) fitted in an accessible position.

c) easy to operate.

d) fitted with a suitable handle which is securely attached, or other permanent means of operation.

Where an emergency control is installed which is not part of a primary meter installation, a prominently displayed notice on or near the control bearing the words "Gas Emergency Control" is required.

The notice needs to tell the consumer:

1. to shut off the supply of gas if there should be a gas escape in the premises or dwelling.
2. the name of the emergency gas service and its emergency telephone number.
3. if gas continues to escape, to immediately notify the suppliers emergency gas service.
4. not to re-open the control until remedial action has been taken by a competent person to prevent gas escaping again.
5. the date the notice was first displayed.

The notice should be suitably resistant to weather damage if it is in the open air and should be updated if there is a change of gas supplier.

5.4 Electrical Insulation of Pipework and Electrical Bonding

5.4.1 Cross Bonding

Cross bonding is the connection between the consumer's earth point and the gas installation pipework. The conductor to be connected to the earth terminal should be of a size laid down in the 16th edition of Regulations for Electrical Installations (the Wiring Regulations) 1981 published by the Institution of Electrical Engineers. Note: A competent electrician should be consulted before any cross bonding is undertaken.

The purpose of cross bonding is to create a zone within the dwelling, including the area occupied by the gas installation pipework, that is at earth potential. It does not involve connecting electrical power to gas pipes.

If cross bonding is required for the installation the person responsible for the premises should be notified in writing by the pipework installer.

The cross bonding connection should be clamped on to the gas pipework at the outlet of the meter. The clamp should be positioned as near to the meter as possible and in any case not more than 600mm from it.

The installation of gas pipework into new premises and the first time installation of gas pipework into existing premises will both require cross bonding.

5.4.2 Temporary Bonding

A temporary continuity bond to the appropriate standard is required when disconnecting and reconnecting pipework, e.g. when carrying out repairs or extensions to the existing installation, where the production of a spark could cause a hazard, whether or not permanent cross bonding has been established.

The temporary bond must comprise of at least 1.2m of single core insulated flexible cable or equivalent of at least 250V rating. The cable should have a cross sectional area of not less than 4mm2 and be of multi-strand construction with each strand having a maximum diameter of 0.31mm, generally in accordance with BS6004 or BS6007, with a robust clip or clamp firmly attached at each end.

In order to clamp a temporary continuity bond to the pipework it is first necessary to isolate the electrical connections of associated gas appliances from the mains supply. The bond is then clipped or clamped to each side of the union, fittings or complete section that is to be removed or connected, ensuring that good metallic contact is made. The bond is then left in position until after the work is completed. It should only be removed when it is known that the pipework cross bonding is effective for the new sections of pipework.

6 Testing For Soundness

Testing and purging of pipes is covered in the Gas Safety Regulations 1994 and the following test procedure is detailed in BS6891.

6.1 Test Procedure

1. Where appliances are connected to the installation pipework being tested check that all operating taps and pilots are turned off.
2. If testing an existing system, i.e. one with a meter connected, a pressure test for 'let by' must be carried out prior to a full system pressure test. If, with the emergency valve shut off, gas is still being passed, 'let by', into the system the gas supplier must be informed immediately and the valve repaired or replaced.
3. For a full system pressure test connect a pressure gauge to the system, either to a suitable pressure test point, e.g. where the installation is already connected to a gas supply; or to one branch of a T-piece which is valved on the other branch for air to be pumped into the installation.
4. Slowly raise the pressure to 20mbar (with gas or air as appropriate) and turn off making sure that the test pressure does not exceed 25mbar. Pressures in excess of 25mbar may cause the meter governor to lock up and give misleading test results.
5. Allow one minute for temperature stabilisation. If a pressure rise is observed either the temperature of the system is rising, in which case the temperature has not stabilised, or the means of isolation from the pressurising source, e.g. meter control/emergency valve, is leaking in which case the gas supplier must be informed immediately.
6. Record any pressure loss during the following two minutes and check that there is no smell of gas.
7. On completion of a satisfactory test, either plug or seal the ends of the pipework or, where a meter is available, purge the pipework as described in section 7 and test all purge and pressure testing points using leak detector fluids. Then test any connected appliances for safe operation, if unsafe appliances should be labelled 'Do not use'.

6.2 New Pipework

1. Every installation not connected to the gas supply shall be tested for soundness in accordance with the above procedure upon completion and prior to the installation of, or connection to, the primary meter.
2. Where no appliances are connected to the pipework or where appliances are connected but are isolated there shall be no pressure loss during the two minute test period specified above.
3. Where appliances are connected but the operating taps and pilots turned off, the pressure loss values shall not exceed those given in Table 10 and there shall be no smell of gas.

Table 10 - Maximum permissible pressure drop during a 2 min. test period for existing gas installations

Meter Designation		**Maximum permissible pressure loss**	
Case Reference	**Capacity/Revolution**		
	ft^3	**mbar**	**in w.g.**
U6 (DO5 or DO7)	0.071	4.0	1.6
P1	0.1	2.5	1.0
P2	0.2	1.5	0.6
P4	0.4	0.5	0.2

Notes

The permissible pressure losses relate to average lengths of pipework in domestic installations.

The majority of domestic gas meters are of the U6 type, however these are being replaced by the electronic Ultrasonic (E6) meter which has the same rated capacity as the U6.

6.3 Extensions to Installations Connected to a Gas Supply

Where the extension work constitutes a major change to the installation the new pipework should be tested separately, in accordance with the test procedure described in section 6.1 and 6.2, before connecting it to the installation. Only if the new pipework is acceptable should it be connected to the existing installation. The whole installation should then be pressure tested.

7 Purging

Purging is the removal of all air from the copper pipework by means of passing gas through the pipework from the meter to prevent an explosive gas/air mixture forming. Purging should be carried out on all new, repaired and extended pipework after satisfactory completion of the soundness test and following connection to the gas supply.

If it is necessary to paint or coat joints this should be done after soundness testing and purging. If pipework is not to be put into immediate use after purging it should be sealed off at every outlet with an appropriate fitting.

If, during the purging operation, it is discovered that there is either a leaking joint in the pipework or a loose connection to a gas burning appliance the joint or connector should be re-made or tightened and then re-tested for gas tightness. Every seal made after the purging operation has been carried out should be tested for gas tightness.

Purging shall be effected by passing a volume of gas not less than five times the capacity per revolution of the meter mechanism, see Table 10. All installation pipes shall be purged commencing at the point(s) furthest from the meter.

Volume required for purging a U6 meter

= 5 x 0.071 = 0.355 ft^3

= 10 dm^3 = 0.01 m^3

Volume required for purging a E6 meter

= 10dm^3

NOTE: 1 m^3 = 35.3 ft^3

1 dm^3 = $10^{-3} m^3$

For small pipework installations with pipe sizes not exceeding 28mm it is generally acceptable to purge the meter and pipework together into the building providing that:

a) ventilation is adequate.

b) no inadvertent operation of any electric switch occurs.

c) no smoking is allowed or naked lights are present.

Both testing for soundness and purging are requirements of BS6891 and the Gas Safety Regulations 1994.

8 Sulphidation

It is estimated that there are approximately 18,000,000 copper natural gas installations in Great Britain. The Association of District Councils (ADC) survey looking into the potential problem of sulphidation suggests that approximately 21,000 properties in Great Britain may be affected by sulphidation to some extent, 0.12% of domestic copper natural gas installations. In the most severely affected areas of the country, where the concentration of hydrogen sulphide, H_2S, in the gas supply is high, the ADC data indicates that approximately 0.7% of the properties may be affected.

Hydrogen sulphide is a naturally occurring impurity in natural gas, the concentration of H_2S in any gas supply depends on the field from which the gas is taken and the treatment given to the gas before distribution. The permitted maximum concentration of H_2S in gas is 5 mg/m^3, as described in the Gas Regulations 1972. In the past concentrations of H_2S have been of the order of 0.5 mg/m^3. Recent years have seen an increase in the concentration of H_2S in the gas supply in a small number of areas within Great Britain. It is thought that there is a H_2S concentration level above which sulphidation will take place, this level has yet to be determined but it appears to be around 1.5 mg/m^3, or higher.

Hydrogen sulphide can affect domestic gas burning appliances through either the gradual corroding of components or by the production of copper sulphide deposits. The copper sulphide deposits flake off from the pipework and are carried through the system until they reach the gas burning appliances where, if the burner nozzles are small, they can cause a blockage.

The rate of production of copper sulphide is dependent upon a number of factors including:

- concentration of H_2S in the gas supply.
- flow rate of the gas.
- temperature of the copper pipework.

- oxygen concentration in the gas supply.
- amount of water vapour in the pipework.

Further investigations into sulphidation and concentrations of H_2S in natural gas supplies are currently being carried out.

Appendix A

Mechanical properties and chemical composition of copper tube to BS EN 1057

Mechanical properties of copper tube.

Copper tube is produced to stringent European Standards with guaranteed mechanical and physical properties. Copper tube is manufactured to BS EN 1057:1996

Copper and copper alloys - Seamless, round copper tubes for water and gas in sanitary and heating applications. (This replaces BS 2871:Part 1:1971).

Table A1 – Mechanical properties of copper tube

Material temper		Nominal outside diameter d, mm		Tensile strength R_m,MPa	Elongation A %	Hardness, indicative
Designation in accordance with EN 1173	Common term	min.	max.	min.	min.	HV_5
R220	annealed	6	54	220	40	(40 to 70)
R250	half hard	6	66.7	250	30	(75 to 100)
R250	half hard	6	159	250	20	(75 to 100)
R290	hard	6	267	290	3	(min. 100)

NOTE 1: Hardness figures are given for guidance only.

Chemical composition of copper tube and fittings.

The copper used is phosphorus deoxidised copper, designated Cu-DHP or CW024A, and has the following chemical composition:

copper (+ silver) 99.9%

phosphorus 0.015 to 0.040%

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