

Code of Practice for

Plastics pipework (thermoplastics material) —

Part 1: General principles and choice of
material

UDC 696:621.643:691.17:678.073

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Plastics pipe

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This part of this Code of Practice has been prepared by a committee convened by the Codes of Practice Committee for Building. Having been endorsed by the Council for Codes of Practice, it was published under the authority of the Executive Board on 28 September 1973

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The following BSI references relate to the work on this Code of Practice:
Committee reference BLCP/48
Draft for comment D64/14117

ISBN 0 580 07624 5

Amendments issued since publication

Amd. No.	Date of issue	Comments

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Foreword

The preparation of this Code of Practice has been authorised in order to present the details of comparative physical, chemical and mechanical properties of the various plastics pipes, to guide the selection for different applications and, consequently, to define sound practice in the fabrication and installation of such pipes.

Part 1 deals with the selection of the most suitable pipework material. Part 2 provides recommended practice in the installation of unplasticized PVC (UPVC) pipework for the conveyance of liquids under pressure and Part 3 provides similar information for polyethylene pipework.

NOTE The name “polyethylene” is now preferred to “polythene” and is used in this Code of Practice except where the latter is included in the title of a published British Standard which has not yet been revised to take account of this preference.

It is proposed to issue further parts dealing with other materials and applications, as follows.

- *Part 4: Unplasticized PVC soil pipes;*
- *Part 5: Plastics waste pipes;*
- *Part 6: Plastics drain pipes.*

This Code of Practice represents a standard of good practice and therefore takes the form of recommendations. Compliance with a British Standard does not confer immunity from relevant statutory and legal requirement.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 46, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 General

1.1 Scope

1.1.1 This part of the code deals with the selection of thermoplastics pipe systems for particular applications and with the general principles applicable to all such systems.

1.1.2 Pipes are also produced from thermosetting materials and from plasticized PVC; these however are outside the scope of this code.

1.1.3 The use of plastics pipes in services supplied from the mains of water undertakings is governed by the byelaws of the undertakings and these shall be strictly observed. They include requirements that pipes shall be located and protected so as to avoid damage by frost, and these are deemed to be satisfied if the recommendations of CP 99 are observed. Although pipes of polyethylene are not easily fractured by freezing, the flow of water may be stopped, and therefore precautions should be taken as for pipes of other materials.

NOTE The titles of British Standards referred to in this Code of Practice are listed on the inside back cover.

2 Definitions

For the purposes of this code, the following definition applies.

thermoplastics material

a plastics material capable of being softened by heating and hardened on cooling; these phenomena are repeatable

3 Materials available

The thermoplastics materials generally used for pipes and the relevant British Standards are as follows.

Unplasticized PVC

BS 3168, *Rigid PVC extrusion and moulding compounds.*

BS 3505, *Unplasticized PVC pipe for cold water services.*

BS 3506, *Unplasticized PVC pipe for industrial purposes.*

BS 4346, *Joints and fittings for use with unplasticized PVC pressure pipes.*

BS 4346-1, *Injection moulded unplasticized PVC fittings for solvent welding for use with pressure pipes, including portable water supply.*

BS 4346-2, *Mechanical joints and fittings, principally of unplasticized PVC.*

BS 4346-3, *Solvent cements and solvent welded joints¹⁾.*

BS 4346-4, *Mechanical joints other than unplasticized PVC¹⁾.*

BS 4346-5, *Fabricated fittings¹⁾.*

BS 4514, *Unplasticized PVC soil and ventilating pipe, fittings and accessories.*

BS 4576, *Unplasticized PVC rainwater goods.*

BS 4576-1, *Half-round gutters and circular pipe.*

BS 4660, *Unplasticized PVC underground drain pipe and fittings.*

Polyethylene

BS 3412, *Polythene materials for moulding and extrusion.*

Low density polyethylene

BS 1972, *Polythene pipe (Type 32) for cold water services.*

BS 1973, *Polythene pipe (Type 32) for general purposes, including chemical and food industry uses.*

High-density polyethylene

BS 3284, *Polythene pipe (Type 50) for cold water services.*

BS 3796, *Polythene pipe (Type 50) for general purposes, including chemical and food industry uses.*

¹⁾ In course of preparation.

Acrylonitrile-butadiene-styrene copolymer (ABS)

BS, *ABS pressure pipe*²⁾.

BS, *ABS fittings for use with ABS pressure pipe*²⁾.

Propylene copolymer

BS, *Propylene copolymer pressure pipe*²⁾.

NOTE The type designation (32 or 50) indicates the recommended maximum working stress for the material in bars³⁾ at 20 °C when in pipe form. This stress has been used as the basis for calculating the minimum wall thicknesses in the relevant standards.

Attention is drawn also to:

BS 3867, *Outside diameters and pressure ratings of pipes of plastics materials*.

BS 4159, *Colour markings of plastics pipes to indicate pressure ratings*.

BS 864, *Capillary and compression fittings of copper and copper alloy — Part 3 Metal fittings for polyethylene pipes*²⁾.

BS...., *Performance requirements for joints and compression fittings for use with polyethylene pipe*²⁾.

An indication of some of the physical and chemical properties of the above materials is given in Table 1. Where more detailed information is required the manufacturer should be consulted.

4 Hydraulic characteristics

4.1 The extrusion and injection moulding process by which plastics pipes and fittings are manufactured ensure that these products have very smooth, and sometimes highly polished, bores. The effect of this is to give plastics pipes excellent hydraulic characteristics, resulting in low frictional losses and high flow capacities.

4.2 Plastics pipes will not corrode in contact with water or with certain chemicals (see Table 2a and Table 2b). This property ensures that their excellent hydraulic characteristics are maintained throughout their life.

4.3 For the purposes of calculation of flow rates through plastics pipes the Colebrooke-White equation may be used, in which the value of the hydraulic roughness, K , for a plastics pipe is 0.003 mm.

When using the Hazen-Williams equation a coefficient, C , of 150 is indicated as an upper limit. Due regard should however be given to the effect of pipe diameter and water velocity and to the friction losses caused by fittings. The character of the water (or liquid) to be conveyed should also be taken into account.

Particular waters may, at certain times, give rise to slime and silt deposits which, whilst not necessarily damaging to the smooth surface of the pipe material, may in themselves increase the friction losses in pipe-lines.

4.4 Detailed frictional loss data and flow charts are available from plastics pipe manufacturers, and reference may also be made to Hydraulics Research Paper No. 2, Charts for the hydraulic design of channels and pipes, 2nd edition, 1963, HMSO.

4.5 There is not as yet a large body of data on the frictional losses caused by injection-moulded plastics fittings, but the following equation gives approximate values applicable to fittings currently available in all plastics materials.

$$E = F \times D$$

where E is the equivalent pipe length in metres

D is the pipe internal diameter in millimetres

F is the constant, as follows:

90° elbow	0.022
tee (straight through)	0.011
tee (through branch)	0.042
reduced tee (straight through)	0.022
sweep bend (90°)	0.011
angle valve	0.18
globe valve	0.36

²⁾ In course of preparation.

³⁾ 1 bar = 10⁵ Pa = 10⁵N/m².

5 Handling and storage

Detailed reference to the precautions which should be taken in handling and storing pipes of a particular plastics material will be given in the appropriate part of this code; however the following general points should be noted.

- 1) The materials are thermoplastic and therefore during prolonged storage at elevated temperature, they may distort if subjected to a crushing load or if inadequately supported.
- 2) Contact with burrs or sharp metal edges on racks, etc., should be avoided.
- 3) Pipes made from PVC and polypropylene, and to a lesser extent ABS, have a reduced impact strength when operating at low temperatures and therefore require more careful handling under these conditions.

The impact resistance of polyethylene is not appreciably affected under these conditions.

- 4) The ends of pipes should be protected from damage to avoid the risk of unsatisfactory jointing.

6 Thermal effects

6.1 The coefficients of expansion of plastics materials (see Table 1) are generally much greater than those of metals. Particular care should be taken in the design of pipework layouts above ground, or where there is considerable fluctuation in temperature, to ensure adequate allowances for expansion and contraction, e.g. by the inclusion of expansion joints or loops.

6.2 As mentioned in Section 5, some plastics materials have reduced impact strength at low temperatures and this should also be taken into account in the siting of pipework to avoid damage under these conditions.

6.3 Higher temperatures, either environmental or in the fluids conveyed, soften the materials and thus reduce the internal pressures at which the pipes may safely be used; this should be allowed for in the design of systems. In addition the existence of higher temperature service conditions will necessitate greater support for runs of pipe. Higher temperatures generally reduce the resistance of plastics to chemicals.

7 Environment

7.1 Plastics are resistant to many chemicals (see Table 2a and Table 2b) and are thus suitable for installation in aggressive soils or areas where there is a high degree of pollution of the atmosphere.

7.2 Some of the materials are degraded by exposure to direct sunlight unless their composition includes additives such as carbon black; thus natural grades of polyethylene or polypropylene are not recommended for use under these conditions.

8 Long-term behaviour under hydraulic pressure

The safe working stresses for plastics pipes are based on the results of long-term hydrostatic tests extra-polated to predict a safe working life in excess of 50 years. The type numbers in the titles of some of the British Standards listed in Section 3 indicate the safe working stress (expressed in bars) for water at 20 °C.

Further factors of safety should be imposed where a pipe will be used under onerous conditions.

9 Inspection

Pipes and fittings should be examined before acceptance and before installation for the presence of visual imperfections. Other tests may also be carried out as required, but attention is drawn to the fact that pipes and fittings complying with the requirements of the British Standards listed in Section 3 may be available marked under the BSI certification mark scheme.

10 Installation

10.1 The coefficient of thermal expansion of most thermoplastics pipes is about 5 to 12 times that of traditional metal pipes, and proper provision should therefore be made for the effect of thermal movement.

10.2 Between anchors for suspended pipes the supports should not grip or distort the pipe but should allow the repeated longitudinal movement due to temperature changes to take place freely without risk of abrasion. They should be of adequate area; line or point contact with the pipe should be avoided. It is particularly important to observe the recommendations regarding the spacing of supports that are given in subsequent parts of this Code dealing with specific materials. Heavy components such as metal valves or filters should be individually supported, and anchored against thrust and torque.

10.3 Some types of joint (i.e. “positive” joints) are capable of withstanding the end thrust resulting from internal fluid pressure, whilst in the case of “telescopic” joints an external anchorage is generally necessary at each end of the pipeline, at valves, and at all changes of direction. When positive joints are used provision should be made for the free movement of the pipe between points of anchorage. It should be remembered that any side connections into the line, except at the point of anchorage, will be subjected to lateral movement and that their supports should therefore be placed a sufficient distance away from the branch connection or bend to ensure that excessive lateral bending does not occur. Where there is any risk of temperature movement causing excessive stress at branches, bends, valves or other fittings, the movement should be absorbed by means of expansion loops, telescopic joints or bellows type expansion units.

10.4 Plastics pipes should not be painted in such a way as to disguise their character, e.g. when the contents are dangerous. A dangerous situation may arise, if, some years after installation, the painted system is assumed to be metal and is used as a load bearing support or as an electrical conductor (see **17.1**).

10.5 If plastics pipes are to be installed in the proximity of pipes carrying hot fluids care should be taken to ensure that there is adequate spacing or insulation between the hot surfaces and the plastics pipe.

10.6 Plastics pipes and fittings have more than sufficient strength to withstand the treatment normally encountered during and after installation, but it is important to note that they are usually less robust than their metal counterparts. Particular care should be taken under low temperature conditions. Attention is drawn to Sections **5** and **6**.

10.7 Due to their light weight, plastics pipe and fittings may be prefabricated into large assemblies prior to final installation and can still be easily handled without need of heavy equipment. Such prefabricated assemblies should, however, be accurately made as forcing or twisting the assembly out of its natural shape to compensate for inaccuracies can cause severe stresses and eventual failure.

10.8 The use of plastics pipes in services connected to the mains of water undertakings is governed by the byelaws of the undertakings and these shall be strictly observed. They include requirements that pipes shall be located and protected so as to avoid damage by frost, and these are “deemed to be satisfied” if the recommendations of CP 99 are observed. Attention is drawn to CP 2010-1 concerning the installation of pipelines in land.

11 Jointing methods

11.1 A wide variety of jointing methods is available for plastics pipes. Some methods are only applicable to certain materials, and therefore the recommendations on jointing for each material, given in other parts of this code, should be studied with care.

11.2 Certain materials (e.g. PVC and ABS) in small sizes may be jointed easily and quickly by solvent welding techniques, which form a “cold weld” as strong as the pipe, but this becomes less easy in nominal sizes much greater than 6.

11.3 Other materials (e.g. polyethylene and polypropylene) are so chemically inert that appropriate solvents are not available for them. In these cases mechanical jointing or thermofusion (hot welding techniques) have to be used.

11.4 Thermofusion techniques for jointing pipe systems should be carried out only by highly skilled operatives, as this is an operation demanding considerable training. Unskilled application of this process can produce joints that are visually adequate, but which contain stresses resulting in brittle areas and eventual failure.

11.5 With all types of plastics pipes many varieties of mechanical joints may be used, i.e. flanged joints, rubber ring joints of several types, metal and plastics compression ring joints, and joints with combinations of these principles. Care should be exercised in the choice of mechanical joints, as some are not designed to withstand the end loads of a pressurized system, and special anchorage arrangements may be necessary. Environmental considerations applying to the choice of pipe should also apply to the choice of appliances and fittings and of the jointing techniques.

11.6 Detailed information regarding the types of joint which can be used with each type of plastics pipe is given in subsequent parts of this code dealing with specific materials.

When metal fittings are used in conjunction with plastics pipe, it may be necessary to protect them suitably against corrosion, as otherwise many of the benefits of using plastics pipe may be lost.

12 Bending

12.1 All pipes made from thermoplastics materials have the property of softening under the influence of heat and of hardening on subsequent cooling. This property of the material is employed to fabricate the more severe bends; this is done by heating the pipe to softening point, then bending it to the desired radius. Care should be exercised during this operation as an extremely tight radius may seriously reduce the thickness on the outer wall due to stretching, thus restricting the working pressure of the whole installation. For details of the recommended bend radii for a specific material, reference should be made to the relevant parts of this code relating to that material.

12.2 The hot bending of plastics pipes requires controlled heating conditions, and whilst emergencies may demand fabrications of bends in the field, this practice is not to be recommended; any such bends should be regarded as a temporary expedient only. Bends of the correct radii, together with factory made specials are normally available from manufacturers and suppliers of plastics pipe and fittings or are made by the user in his own workshop.

13 Connections

Detailed recommendations on connection of plastics pipes to pipes of other material and to branch off pipes are given in subsequent parts of this code dealing with specific materials.

14 Identification

Plastics pipes are generally identified by means of stamped and coloured marks repeated at frequent intervals along their length. These marks give the manufacturer's identity, the size and class of pipe and the relevant British Standard. Plastics pipes are generally known by the nominal size. The outside diameter is specified for each nominal size and wall thickness varies according to the maximum pressure rating.

Attention is drawn to:

BS 1710, *Identification of pipelines*.

BS 4159, *Colour marking of plastics pipes to indicate pressure ratings*.

BS . . . ⁴⁾, *Recommendations for the identification of buried plastics pipes and cables*.

15 Laying buried pipes

15.1 General principles

The external loads imposed on a pipe of brittle material such as vitrified clay, concrete, asbestos cement or cast iron are supported mainly by virtue of the resistance of the pipe to circumferential bending. However, a plastics pipe, because it is able to deform to a considerable degree without fracture, is able to derive additional supporting strength from the lateral restraint afforded by the passive resistance of the fill material at the sides of the pipe, which opposes any increase of the horizontal diameter of the pipe. For the lighter gauges of plastics pipe this lateral support is of prime importance in enabling the pipe to carry the external loads without excessive deformation (flattening) and it is thus important when laying such pipe that adequate precautions be taken to ensure that the lateral support is effective. Because of its softer nature it is also necessary to ensure with plastics pipe that sharp objects such as large flints do not bear directly on it.

The flexible nature of plastics pipe enables it to accommodate more readily than pipe of brittle material any axial deformations resulting from ground movements or from differential settlement of structures to which the pipe line is connected.

⁴⁾ In course of preparation.

Buried pipes are not normally subjected to large temperature variations, and in such cases when positive joints are used the temperature movement can usually be taken up as elastic strain in the pipe. However, there may be an exceptionally large change of temperature immediately after backfilling, or on filling the pipe with liquid, as for example, when work is being carried out in hot sunshine. Trouble from this cause may be minimized by deferring final connexion at any fixed points until the majority of the line has been covered with backfill. Where a non-positive joint is used (e.g. at a valve) in an otherwise positively jointed line it should be remembered that temperature movement will tend to accumulate at that point. Care should be taken to ensure that movement does not exceed the maximum telescopic movement afforded by the joint. Because of the low relative density of plastics pipes their readiness to float when empty in waterlogged ground is much more obvious. Therefore such pipes require more substantial earth loading immediately after laying than that required by the heavier materials. Attention is drawn to **1.1.3** concerning plastics pipes supplied for the mains of water undertakings.

15.2 Trench preparation

Since pipes up to nominal size 6 can be jointed on the surface and subsequently “snaked” into the trench, it is not necessary to dig jointing holes and wide trenches in which men can work. Advantage may also be taken of the lightness, flexibility and smoothness of plastics pipes by adopting the economical mole ploughing technique.

The trench should not be opened too far in advance of pipe laying and should be backfilled as soon as possible. The width of the trench at the crown of the pipe should be as narrow as is practicable but not less than the outside diameter of the pipe plus 300 mm to allow proper compaction of the sidefill. Above the crown of the pipe the trench may be of any convenient width.

In uniform, relatively soft, fine-grained soils free from large flints or stones or other hard objects, and where the bottom can readily be brought to an even finish providing a uniform support for the pipes over their length it may be permissible, more especially with class C (see BS 3867) or heavier gauge pipes, to lay them directly on the trimmed bottom of the trench. In other cases the trench should be excavated to a depth below the bottom of the pipe sufficient to allow for the necessary thickness of selected bedding material.

15.3 Bedding and sidefilling

The care required with the bedding and sidefilling depends to some extent on the wall thickness of the pipe employed. The following relates particularly to pipe thinner than class C, and to pipes of nominal size 3 and above.

Clay is unsuitable as a bedding or sidefilling material. Some other soils as excavated from the trench, such as free-draining coarse sand, gravel, loam and soils of a friable nature and of an adequate compaction fraction to provide support for the pipe may be suitable. Tests for the suitability of materials are described in Appendix A. Soils such as hard chalk which break up when wetted should not be used.

If the material excavated from the trench is unsuitable, then granular material should be imported. The most suitable is gravel or broken stones from 10 to 5 mm in size since it requires little compaction, but coarse sand, or sand and gravel, or gravel from 20 mm and less in size as it comes from the quarry is acceptable provided it complies with the test requirements described in Appendix A. An excess of fine particles makes the material more difficult to compact when damp.

The thickness of bedding under the barrel of the pipe should be a minimum of 100 mm. In very wet or soft conditions or where the trench bottom is very irregular it may be necessary to increase this thickness.

The bedding should be properly compacted to provide a uniform bed for the pipe. Bricks or other hard material should not be placed under the pipe for temporary support.

After the pipes have been laid and tested further material should be placed around the pipe and compacted in 75 mm layers up to a level at least 100 mm above the top of the pipe. Any trench sheeting should be partially withdrawn to enable the sidefill to be firmly compacted between the sides of the pipe and the soil sides of the trench.

15.4 Backfilling

The material excavated from the trench may be used for the remainder of the backfilling, except that special consideration of its suitability may be necessary where the risk of surface subsidence is a consideration, as for example under a road. It should be compacted, in 300 mm layers, or in compliance with any special requirements of local or other authorities. Heavy mechanical compactors should not be used until the fill has reached a depth of at least 300 mm above the top of the pipe.

With less than 450 mm of cover elsewhere than under roads, concrete slabs on a cushion of filling material above the pipe should be used as a protection against picks etc. At shallow depths under roads special consideration should be given to all the engineering factors involved, such as the class of road, its construction, the class of pipe being laid, and the proximity of other services.

Pipes above natural ground level which are subsequently to be covered with fill should preferably not be laid until the deposition and compaction of the fill has proceeded, up to a height of about 1 metre above the level of the top of the pipe. A trench should then be cut in the fill and the pipes laid in it in the manner described above.

15.5 Pipe laying without trenches

Mole ploughing is a method of pipe laying which eliminates the need for conventional trenching. Ground conditions impose considerable influence on the viability of employing the mole ploughing technique and it is, therefore, essential to carry out a preliminary ground survey before deciding to use it. Conditions that should be avoided are rocks, flints, tree-roots, existing buried cables and pipelines, etc. Although little difficulty would be encountered with gently undulating ground, a violently irregular surface would not be suitable. Investigation of sub-soil conditions may be carried out by piercing the ground, at intervals, to the depth at which the pipe will be laid.

The mole plough is a piece of equipment that cuts turf and sub-soil, at the same time forming an underground channel into which the pipe may be pulled.

In suitable soil, plastics pipe can be pulled into position underground behind a mole plough. Pipes up to at least nominal size 18 have been laid this way. Slit trenches have to be dug for the start and finish of each length pulled in, the length of the slit trenches depending on the flexibility of the pipe. The mole should be followed by an expander, the diameter of which is at least 75 mm greater than the diameter of the pipe which is connected to it. This method of pipe laying is best carried out in relatively firm clay where the mole channel can be expected to stand up at least for the length of time required to pull the pipe in.

If there is insufficient clay for the mole channel to be self-supporting, it will collapse behind the mole and the friction generated on the sides of the pipe will be such that the pipe may be stretched and thereby weakened, sometimes to the point of destruction. In such cases a cable-laying machine may be used. With this machine the pipe is not laid out behind the mole and pulled in by it but, instead, it is laid out in front of the machine, the pipe passing over the machine and down through a wider slit behind the mole blade and into the channel. By this method the pipe is not dragged through the soil but is merely placed into position by the cable layer.

For smaller diameter pipes the mole plough can be coupled direct to a tractor but mole ploughs for larger pipes, or cable laying machines are best pulled by a winch.

16 Testing

16.1 After the completion of an installation, it is essential that all pipework, fittings and appliances be inspected and tested hydraulically to ensure the safety and efficiency of the system, except that pipes for gases may be tested pneumatically (attention is drawn to CP 331-1). If the installation is a large one it may be tested in sections of suitable length.

16.2 Before the commencement of any testing, the system should be visually inspected to ensure that the recommendations for the correct installation procedure have been complied with, and that the pipeline together with appliances, valves and fittings are supported in the prescribed manner.

16.3 Whilst the testing pressure may vary depending upon the type and duty of the system, this should normally be one and a half times the maximum working pressure at the point of maximum stress.

16.4 Pressure should be applied either by a manually operated hand pump or by a power driven pump. Pressure gauges should be correctly positioned and closely observed to ensure that at no time is the test pressure exceeded. The system should be slowly and carefully filled with water, care being taken to avoid all surging pressures of water hammer. Air vents should be open at all high points so that air may be expelled from the system during filling.

16.5 When the system has been fully charged with water and all air displaced from the line, air vents should be closed and the line initially inspected for seepage at joints and the firmness of support under load. Pressure may then be applied until the required test level is obtained.

16.6 With the test pump stopped, the required pressure should be maintained without loss for a period of one hour, or for such shorter time as agreed between supplier and purchaser. Any defects revealed by such tests should be made good and the test repeated until a satisfactory result is obtained.

16.7 A further test should be made of the entire system at normal service operating pressure. Valves and appliances should be tested for ease of operation and correct working.

16.8 Buried pipes should be tested before backfilling is completed. Where pipelines contain couplings which permit the pipe to slip, it is essential that consideration be given to restraint of the line before pressure is applied. Partial backfilling, leaving joints exposed for inspection, is usually found to be satisfactory, although for some high pressure applications additional bracing particularly at changes of direction may be found necessary.

16.9 In special cases where hydraulic tests are not practical pneumatic tests may be substituted, but this should not be attempted without consultation with the supplier of the pipe.

16.10 For soil and waste pipe installations, the test procedure laid down in CP 304 should be followed.

16.11 For underground drainage systems (except pumping mains) the test procedure laid down in CP 301 should be followed.

Pumping mains should be subjected to a test pressure at least $1\frac{1}{2}$ times the line pressure, with a maximum pressure as agreed with the pipe manufacturer.

16.12 For pipes for water supply, the test procedure laid down in CP 310 should be followed.

17 Limitations

17.1 *Plastics are not conductors of electricity and no attempt should, therefore, be made to use pipework constructed from the materials referred to in this code as a means of earthing electrical equipment; similarly their contents cannot be thawed by electrical techniques using the pipe as the conductor. In addition, due to the combustibility of some plastics materials, a flame should not be used for thawing.*

17.2 In common with all other pipelines, provision should be made for emptying pipes in exposed positions above ground or shallow buried pipes if they are not otherwise protected against frost damage. For water pipes the relevant byelaws shall be complied with.

17.3 Because of the high resistivity of plastics pipes, attention is drawn to the need for caution in the use of the pipes where static electricity may be an important consideration, e.g. in mines.

18 Pipes for water

18.1 General

Plastics pipes are suitable for conveying water and have certain advantages over metal pipes, due particularly to their resistance to corrosion, light weight, ease of jointing, and a degree of flexibility. For potable waters, British Standards have been published covering plastics pipes manufactured from low-density and high-density polyethylene (BS 1972 and BS 3284) and unplasticized PVC (BS 3505).

Plastics pipes are not, at present, recommended for use in hot water systems.

18.2 PVC

Unplasticized PVC is a stronger and more rigid material than polyethylene and it is therefore practicable to manufacture larger bore pipes for the higher pressure applications. The jointing of these pipes is simple as the material can be successfully solvent cemented and a comprehensive range of fittings for solvent cementing to pipe is now readily available. The pipes can also be heat softened to permit the post-forming of spigot and socket joints on the pipe ends and the manufacture of bends. This manipulation normally requires skilled operatives and should not be carried out in the field by unskilled labour. Ring seal push fit joints and other methods of jointing, which are equally suitable are given in detail in Part 2 of this code.

The usual frost precautions should be taken where water pipes of PVC are laid in exposed conditions (see CP 99). Unplasticized PVC is sufficiently impermeable to coal gas to permit its use in contaminated ground.

PVC water mains up to at least nominal size 18 have also been successfully laid by the mole ploughing technique where ground conditions are suitable. When trenching is necessary, pipes up to nominal size 6 may be positively jointed and tested on the surface and subsequently snaked down into trenches. Trench widths should be at least 300 mm more than pipe diameter so that the backfill can be adequately compacted each side of the pipe. For this purpose, a positive joint is one designed to prevent longitudinal movement of the pipe. In addition to use as mains and service pipes, fabricated assemblies of PVC pipes and fittings cemented together are suitable for cold water distribution system in buildings.

18.3 Polyethylene

Both low-density and high-density polyethylenes have a high degree of flexibility and this permits manufacture of long length coils of pipe from these materials. The low-density material has a relatively low tensile strength and pressure pipes made from it are therefore generally restricted to those of smaller bore. High-density polyethylene is a rather stiffer and stronger material and, consequently, larger bore pipes (up to nominal size 12) are a practicable proposition although at present, principally due to the jointing problems with the larger sizes, it is more widely used as service pipes up to about nominal size 2.

Polyethylene pipes are immune to corrosive environments likely to be encountered either from the water flowing through the pipes or from the ground in which they are laid. In order to avoid freezing during very cold weather, pipes carrying water should be buried to a minimum depth of 0.75 m. Although the freezing of water inside the pipe is unlikely to damage the pipe, it will result in interruption of supply, and subsequent leakage from joints may occur. The only water service applications for which they are not recommended are in those places where the ground is liable to be contaminated with coal gas which might cause detectable tainting of water due to the aromatic constituents of the gas permeating through the polyethylene walls.

Polyethylene pipes are suitable for water distribution on farms, market gardens, golf courses, etc., and as service pipes to domestic dwellings. They can be laid in long continuous lengths using mole ploughing techniques, thus eliminating the need for trenching and backfilling while surface runs and distribution systems in farm buildings, etc., can be made without difficulty provided that adequate support and protection against mechanical damage can be arranged.

18.4 Polypropylene

Satisfactory water pipes and fittings are also manufactured from polypropylene. Pipes of this material are usually jointed by thermofusion welding.

18.5 ABS

Satisfactory water pipes and fittings are also manufactured from acrylonitrile-butadiene-styrene (ABS). Pipes of this material may be jointed by methods similar to those used for PVC pipes.

19 Pipes for soil, waste, rainwater and trade effluents (above ground)

19.1 Pipes made from a number of thermoplastics materials are suitable for the conveyance of soil, waste, rainwater and trade effluents. These include PVC, polyethylene, polypropylene and ABS.

The advantages of these materials are their high resistance to corrosion and their ease of handling and jointing.

NOTE For soil and waste systems, attention is drawn to the recommendations for designing and installations contained in CP 304.

19.2 Unplasticized PVC is the most commonly used plastics material for the manufacture of soil and rainwater pipes for use above ground. Jointing may be accomplished either by solvent welding, in which case expansion joints should be incorporated in the system, or by a rubber ring seal joint.

Many manufacturers of pipe for these applications offer an adequate range of fittings and accessories; care should be taken that fittings suitable for the particular pipe and jointing system employed are used, as not all are interchangeable.

19.3 Polyethylene pipes, both high and low density, are suitable for certain applications, being used mainly for small diameter waste pipes and laboratory waste installations. Jointing may be accomplished by welding techniques or by mechanical means. Provision should be made in any installation for movement due to thermal expansion. Polyethylene has a greater impact resistance than PVC but it is essential that adequate support be given to pipework.

19.4 ABS pipes can also be used in much the same way as PVC. They are suitable for conveying trade effluents at higher temperatures than PVC.

19.5 Polypropylene pipes can be used in the same way as polyethylene but are suitable for conveying trade effluents at higher temperatures.

19.6 For use with trade effluents the advice of the pipe manufacturer on suitable grades of material should be asked.

20 Pipes for gases

20.1 Gaseous fuels

Pipes made from any of the plastics materials listed in Section 3 are not liable to attack from methane and other aliphatic hydrocarbon gases, and such pipes are, therefore, suitable for conveying these gases *below ground*. Polyethylene pipe intended for conveying these gases should have a density greater than 0.930 g/ml. These plastics materials, however, will burn and it is essential to comply with fire regulations.

Unplasticized PVC pipes are used for conveying below ground town gas whose aromatic hydrocarbon content is not high enough to cause softening of the pipe. If such a pipe be softened temporarily in this way, it will recover its strength when a more suitable gas of lower aromatic content is admitted.

20.2 Industrial gases

Pipes made from the plastics materials listed in Section 3 are suitable for conveying non-explosive, non-flammable industrial gases above and below ground, provided:

- 1) they are chemically resistant to the gas, and
- 2) they are capable of withstanding the temperatures and pressures involved.

Sudden surge pressures and vacuum conditions should be avoided as should exposure to external damage.

21 Pipes for food and drink other than water

21.1 Plastics pipes may be used for conveying food and drink other than water provided their physical and chemical properties are satisfactory for the specific application. Care should be taken to use only pipes that do not cause contamination or adulteration of the food or drink through the extraction of harmful constituents from the pipe.

21.2 Reference should be made to the relevant Food and Drugs Legislation; the British Plastics Federation publication "Plastics for food contact applications" (reference 45/3) gives information on the suitability from this aspect of a plastics material for a given application.

21.3 Sterilization of pipe systems with steam should not be used without prior consultation with the manufacturer.

22 Pipes for general industrial applications (excluding gases)

22.1 In addition to the specific applications previously mentioned there are many other applications for which plastics pipes have been found suitable; these include:

- chemical processing (see Table 2a and Table 2b);
- food processing;
- mineral and vegetable oils;
- ship's services, above and below deck;
- pneumatic conveyance of dry solids;
- conveyance of slurries.

22.2 The principles defined in Section 18, 19 and 21, are often relevant to industrial installations that are designed for continuous or intermittent flows of liquids or the hydraulic or pneumatic transportation of solids.

22.3 The temperature and nature of the liquids or solids to be transported affects the selection of the type of pipe to be used and the manufacturer's advice should be obtained before selecting a pipe to be used in a particular application.

22.4 Manufacturers should be consulted before using plastics pipes for the hydraulic or pneumatic transportation of solids in view of the special problems associated with abrasion, static electricity, maximum and minimum permissible velocities and consequent pipe sizing.

Table 1 — Physical properties of plastics pipe materials

Property	Units	Unplasticized PVC	Low-density polyethylene (see Note 1)	High-density polyethylene (see Note 1)	Modified (high impact) PVC	ABS	Nylon	Polypropylene
Relative density	—	1.35–1.46	0.915–0.930	0.935–0.960	1.34–1.40	1.04–1.07	1.08–1.14	0.90–0.91
Tensile strength at 23 °C	MPa	450–600	110–140	190–295	385–480	350–550	600–840	325–385
Long term stress rating	MPa	98–123	32	50	60–80	75	100–160	50
Izod impact strength at 23 °C (see Note 3)	Joules per 12.7 mm width of specimen	0.25–1.3	(see Note 2)	0.8–1.3	2.7–5.4	0.8–2.4	0.25–0.8	0.54–1.07
Softening point (see Note 4)	°C	75–82	80–100	110–130	73–83	93–105	210–250	130–150
Coefficient of linear thermal expansion	K ⁻¹	$5-6 \times 10^{-5}$	$17-28 \times 10^{-5}$	$12-16 \times 10^{-5}$	$5-10 \times 10^{-5}$	$7-11 \times 10^{-5}$	$10-15 \times 10^{-5}$	11×10^{-5} at 20 °C 17×10^{-5} at 80 °C
Thermal conductivity	W/(m K) (see Note 5)	1.9×10^{-3}	3.3×10^{-3}	5.3×10^{-3}	2.5×10^{-3}	2.5×10^{-3}	$2.1-3.4 \times 10^{-3}$	1.5×10^{-3}
Volume resistivity	ohm/m	$>10^{12}$	$>10^{15}$	$>10^{14}$	$>10^{12}$	$10^{11}-10^{14}$	$10^{10}-10^{12}$	$10^{14}-10^{15}$
NOTE 1 Attention is drawn to Section 3, in which there is a list of the relevant British Standards that cover the grades of polyethylene to which these definitions relate.								
NOTE 2 Not applicable, ductile material								
NOTE 3 Determined by Method 306A of BS 2782.								
NOTE 4 Determined by Method 102J of BS 2782.								
NOTE 5 $1 \text{ W/(m K)} = 0.859 \text{ kcal m/(m}^2 \text{ h } ^\circ\text{C)} = 0.577 \text{ 8 Btu ft/(ft}^2 \text{ h } ^\circ\text{F)}$.								

Introduction to the tables of chemical resistance

The resistance of plastics pipe materials to a wide range of chemicals is listed in the following tables. The chemical names used in the tables are wherever possible in accordance with the recommendations contained in BS 2474; other chemical names commonly used are frequently included as well with a cross-reference to the preferred name. The symbols used in the tables are as follows.

S — Satisfactory.

U — Unsatisfactory. So rated because of decomposition, solution, swelling, loss of ductility, etc., of the samples tested.

D — Some attack or absorption. The material may be considered for use when alternative materials are unsatisfactory, and where limited life is acceptable. When plastics are to be used with such chemicals, full scale trials under realistic conditions are particularly necessary.

E — Environmental stress cracking hazard. Polyethylenes are subject to this phenomenon if used with certain chemicals, which although chemically inactive produce stress cracks.

* — Predicted results. In order to cover as wide a range of named chemicals as possible, the resistance of plastics to some chemicals has been predicted from its resistance to other chemicals which have similar composition.

† — Attention is drawn to Section 21.

It should be noted that the denotations of the plastics materials listed in the following tables are generic rather than specific, and that since their compositions are variable within certain limits their chemical resistance may also vary. Moreover the tables do not cover all combinations of circumstance under which chemical attack may occur. For these reasons therefore it is emphasized that the tables have been compiled solely as a general guide. It is recommended that when it is desired to use pipe of these materials for other than established uses, engineers should consult with the pipe manufacturers.

The term “high impact PVC” refers to PVC modified by the addition of such materials as ABS, chlorinated polyethylene and certain other acrylic materials. Generally, the chemical resistance of these modified materials is similar to, although lower than, those quoted for unplasticized PVC; it is however recommended that engineers should consult with pipe manufacturers regarding the chemical resistance of any specific materials before use.