BRITISH STANDARD

BS 8010-2.3: 1988

Code of practice for

Pipelines —

Part 2: Pipelines on land: design, construction and installation —

Section 2.3 Asbestos cement

UDC 621.644:666.961 – 462

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Civil Engineering and Building Structures Standards Committee (CSB/-) to Technical Committee CSB/10, upon which the following bodies were represented:

Association of Consulting Engineers
British Compressed Gases Association
British Gas plc
British Plastics Federation
British Precast Concrete Federation Ltd.
Concrete Pipe Association
Country Landowners' Association
County Surveyors' Society
Department of Energy (Petroleum Engineering Division)
Ductile Iron Producers' Association
Electricity Supply Industry in England and Wales
Engineering Equipment and Materials Users' Association
Federation of Civil Engineering Contractors
Health and Safety Executive
Home Office
Institution of Civil Engineers
Institution of Gas Engineers
Institution of Mechanical Engineers
Institution of Water and Environmental Management
Ministry of Agriculture, Fisheries and Food
National Farmers' Union
Pipeline Industries Guild
Royal Institution of Chartered Surveyors
Society of British Gas Industries
Water Authorities' Association
Water Companies' Association
Water Research Centre

The following body was also represented in the drafting of the standard, through subcommittees and panels:

Fibre Cement Manufacturers' Association Limited

This British Standard, having been prepared under the direction of the Civil Engineering and Building Structures Standards Committee, was published under the authority of the Board of BSI and comes into effect on 28 February 1989

First published, as CP 2010-4, April 1972
First revision February 1989

The following BSI references relate to the work on this standard:
Committee reference CSB/10
Draft for comment 86/12464 DC

ISBN 0 580 16572 8

Amendments issued since publication

Amd. No.	Date of issue	Comments

Contents

Foreword

This Section of BS 8010 has been prepared under the direction of the Civil Engineering and Building Structures Standards Committee. The standard is being published in four Parts to form a complete revision of all five Parts of CP 2010 as follows:

— *Part 1: Pipelines on land: general;*

— *Part 2: Pipelines on land: design, construction and installation;*

— *Part 3: Pipelines subsea: design, construction and installation;*

— *Part 4: Pipelines on land and subsea: operation and maintenance.*

The new Part 1 (which supersedes CP 2010-1:1966) is intended to contain general information which is relevant to a variety of pipeline construction materials and a variety of transported materials. It deals with those aspects of pipeline development which affect the owner and occupier of land through which the pipeline passes.

Part 2 will be divided into several Sections which will be published as separate documents as follows:

— *Section 2.1: Ductile iron;*

— *Section 2.2: Steel (for water and associated products);*

— *Section 2.3: Asbestos cement;*

— *Section 2.4: Prestressed concrete;*

— *Section 2.5: Glass reinforced thermosetting plastics;*

— *Section 2.6: Thermoplastics;*

— *Section 2.7: Precast concrete;*

— *Section 2.8: Steel (for oil, gas and associated products).*

Each Section will contain information on the design, construction and installation of a pipeline in the particular material. These Sections will supersede the existing Parts 2, 3, 4 and 5 of CP 2010.

Part 3 will include information relevant to the design, installation and commissioning of subsea pipelines in steel and other materials.

Part 4 will contain advice on the operation and maintenance of pipelines and will probably be in sections related to conveyed material.

This Section 2.3 supersedes CP 2010-4:1972, which is withdrawn.

Appendix A describes and illustrates some typical types of joint used with asbestos cement pipe.

Appendix B gives the requirements for materials for use with potable water.

Appendix C contains the references for additional detailed information.

References are indicated in the text by numbers in square brackets.

It has been assumed in the drafting of this British Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people.

Attention is drawn to the following principal Statutes. This list is not intended to be complete and the relevant authorities should be consulted and reference made to Part 1. These Acts are supplemented by Statutory Instruments.

Acquisition of Land Act 1981

Control of Pollution Act 1974

Countryside Act 1968

Pipelines Act 1962

Public Health Acts 1936 and 1961

Requisitioned Land and War Works Act 1948

Water Acts 1945, 1948, 1973, 1975, 1981 and 1983.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 18, 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.

blank

Subsection 1. General

1 Scope

This Section of BS 8010 gives design considerations and construction and installation recommendations for asbestos cement pipelines and should be read in conjunction with BS 8010-1*.

This British Standard code of practice is not intended to replace or duplicate hydraulic, mechanical or structural design manuals.

2 Definition

For the purposes of this Section of BS 8010 the following definition applies.

pipeline

a line of pipes, of any length, without frequent branches. It does not include piping systems such as process plant piping within refineries, factories or treatment plant

3 Application

The pipelines covered by this Section of BS 8010 are generally suitable for conveying natural or potable water, slurries and sludges, sewage, trade waste and brine. When designing for the conveyance of sewage, reference should also be made to BS 8005.

4 Health and Safety

The inhalation of asbestos dust can lead to asbestosis, lung cancer and mesothelioma. There is no completely safe level of exposure to asbestos dust, but the risk of disease increases with increasing exposure. Occupational exposure to asbestos dust should therefore be kept to a minimum and in any event should not exceed current control limits published by the Health and Safety Executive [1].

Asbestos cement pipes made in the UK since 1982 contain only chrysotile (white asbestos). Pressure pipes made in the UK between 1955 and 1964 and sewer pipes made in the UK between 1967 and 1970 contain some crocidolite (blue asbestos) in addition to chrysotile. Amosite (brown asbestos) replaced crocidolite in much UK manufacture of pressure pipes between 1970 and 1982, although the asbestos content of the pipes was predominantly chrysotile. The Asbestos (Prohibitions) Regulations 1985 prohibit the supply of materials and articles containing crocidolite and amosite, or the use at work of such products except those which were in use before 1 January 1986, but do not prohibit removal or disposal. Crocidolite and amosite and products containing either of them may not be used in the manufacture or repair of any other product.

NOTE The production of asbestos cement pipes in the UK ceased in 1986.

The Asbestos Regulations 1969 require that HM Factory Inspectorate be given twenty-eight days notice before work is started on any process (which includes cutting and turning) involving crocidolite in a factory (which includes water treatment works). The 1969 Regulations are due to be replaced by the Control of Asbestos at Work Regulations, currently being prepared.

The precautions to be taken when working with asbestos cement are described in HSE Guidance Notes [2] [3] [4]. Work methods should be selected which effectively prevent the spread of asbestos contamination and do not create unnecessary dust. Asbestos cement pipes should be thoroughly wetted, wherever reasonably practicable, before cutting, rasping or machining operations.

Water-flushed rotary abrasive discs are permissible for cutting pipes provided that those involved in the operation wear suitable respiratory protective equipment and impervious protective clothing (see BS 4275), [5] [6]. Other types of high-speed rotary tools should not be used. Hand saws and low speed turning and parting lathes are permissible.

Arrangements should be made for decontamination of personnel and equipment. Waste material such as off-cuts, turnings and dust containing asbestos should be disposed of in accordance with current regulations on hazardous waste. It may be necessary to place the material in impervious bags or air-tight containers, appropriately labelled, for disposal as asbestos waste.

The recommendations in this Section which relate to the integrity of pipelines have regard to the need for public safety under conditions usually encountered by asbestos cement pipelines in urban, rural and industrial areas.

5 Inspection

The integrity of a well-designed pipeline depends to a great extent upon the performance standards set for each stage of manufacture and construction, and the quality of inspection by which the achievement of those standards is controlled. The promoter of a pipeline should carefully evaluate what degree and balance of inspection, as between the manufacturer and constructor on the one hand, and the promoter and his agents on the other, will most efficiently achieve the overall level of assurance required.

The purchaser's rights of inspection of pipes and components at the factory, including some optional rights, are covered in the relevant British Standards.

Special attention should be paid to:

a) inspection before installation for possible damage particularly to the ends of each pipe and any coating (see clause **25**);

b) proper bedding to ensure that the design criteria for superimposed loading are met and that leakage is not caused by undue settlement;

c) proper jointing, anchoring and testing.

Any substandard materials or workmanship detected should be rectified or, where necessary, rejected before any further work is done.

Subsection 2. Materials and availability

6 General

All materials should be compatible with the products that are to be conveyed in the pipeline.

When used under the conditions for which they are designed, all materials, including repair materials in contact with or likely to come into contact with potable water should be incapable of permitting microbial growth. Non-metallic materials should comply with the requirements for the effect of non-metallic materials on water quality (see Appendix B).

7 Pipes

Pressure pipes should comply with BS 486. Pipes for gravity pipelines should comply with BS 3656. Pipes outside the range of sizes and classes given in these British Standards are permissible provided that they are designed in accordance with the same principles and that they are capable of withstanding agreed manufacturing tests and the tests recommended in this Section of the code.

8 Fittings and valves

8.1 Fittings

Fittings should be of asbestos cement, cast iron or steel, depending on size and design requirements. Fittings of cast iron or steel should have plain or flanged ends or a combination of both. Plain spigots should be of sufficient length and surface smoothness to accommodate the particular joint to be used. Asbestos cement fittings should be made from pipe complying with BS 486 or BS 3656 as appropriate. Cast iron fittings should be compatible with the pipe diameter and in all other respects should comply with BS 78, BS 2035 or BS 4622. Steel fittings should be compatible with the pipe diameter and in all other respects should comply with BS 534.

NOTE For non-standard fittings, refer to **8.4**.

8.2 Valves

Valves should comply with an appropriate British Standard, the principal ones being:

BS 5150 Specification for cast iron wedge and double disc gate valves for general purposes

BS 5151 Specification for cast iron gate (parallel slide) valves for general purposes

BS 5152 Specification for cast iron globe and globe stop and check valves for general purposes

BS 5153 Specification for cast iron check valves for general purposes

BS 5155 Specification for butterfly valves

BS 5163 Specification for predominately key-operated cast iron gate valves for waterworks purposes

8.3 Air valves

Air valves should be selected to be suitable for the duty required.

NOTE Automatic air valves are available for the release or admission of large volumes of air during emptying and filling, or for the release of small volumes accumulated during service. Special designs are available for the release of large volumes at high velocities, and for combined large and small-volume duties.

8.4 Fittings and valves not complying with British Standards

Fittings and valves outside the range of sizes, or differing in type or not complying with the recommended British Standards are permissible, provided that they have at least equal strength and tightness and are capable of withstanding the test requirements of the appropriate specifications and the tests recommended in this Section of BS 8010.

9 Flanges

Flanges should comply with BS 10 or BS 4504.

10 Bolts, nuts and washers

Bolts and nuts should comply with BS 916, BS 1769 or BS 4190. Washers should comply with BS 4320.

11 Joint rings

Elastomeric joint rings should comply with BS 2494.

The section of a joint ring which is likely to come into contact with potable water, and joint ring lubricants, should be incapable of permitting bacterial growth and should comply with Appendix B. Joint rings should be resistant to attack by the contents of the pipeline.

Temperature limitations apply to the use of both natural and synthetic rubbers. These will vary with the type of material used and the design of joints. The manufacturer's advice should be sought if the likely temperature is below 0 °C or above 50 °C for mechanical joints or above 60 °C for push-in joints. Joint rings should be protected from unnecessary exposure to the effects of ultra-violet light and ozone.

12 Flange gaskets

The dimensions of gaskets for flanges PN10, PN16, PN25 and PN40 should comply with BS 4865.

Subsection 3. Design considerations

13 General

Pipelines should be designed to balance the demands of economic durability and of safety, against the physical characteristics of the pipeline and its service conditions. Service conditions include:

a) maximum and minimum internal pressures (including those due to surge), external loads and internal and external temperatures;

b) the extent of chemical and physical reaction between the material carried and the materials of pipes and joints;

c) the nature of the material carried, and the consequences of escape;

d) the nature of the soil and the likelihood of subsidence;

e) the presence of water and/or contaminants in the soil around the pipe;

f) any other condition which might affect the pipeline.

Economics and safety are also affected by the location of the pipeline, e.g. in open country or in built-up areas.

The British Standards for pipes and fittings incorporate factors of safety appropriate to normal conditions. The structural strength of the pipeline should be made adequate to withstand the worst combination of external load and internal pressure, except that it is not normally necessary to provide for the simultaneous effects of impact allowances for vehicles and increase of internal pressure due to surge.

14 Access to the pipeline

The design should take full account of the pipeline route and layout and ensure that adequate access is available to all parts of the pipeline. In large diameter pipes, internal access should be provided at suitable intervals for inspection, maintenance and removal of obstructions and consideration should be given to the need to provide a safe working environment at all times. Where the use of scraping or swabbing equipment is contemplated, provision for insertion and extraction and the removal of debris should be made at suitable locations.

15 Hydraulic design

Hydraulic design should be based upon one of the standard formulae, e.g. Colebrook-White or Hazen-Williams.

NOTE Design tables and charts based upon the Colebrook-White formula have been produced by the Hydraulics Research Station (see Appendix C, [7] [8]).

16 Structural design

16.1 External loading

In the United Kingdom, asbestos cement pipes are traditionally regarded as rigid. The method based on the work of Marston, Spangler and others [9] [10] should normally be used to determine the class of pipe and type of bedding necessary to resist external loads from backfill, traffic, etc. Alternatively, reference may be made to ISO 2785.

Where the structural design requires a limited width of trench and/or a particular standard of backfill, these requirements should be explicit in the contract specification and drawn to the attention of the installer and those involved in inspection during installation. The contract specification should detail the steps to be taken if the design assumptions cannot be fulfilled in the light of unexpected site conditions.

16.2 Internal pressure

The design pressure should be taken as the greater of:

a) the maximum sustained operating pressure excluding surge;

b) the maximum static pressure.

Pipes and fittings of asbestos cement should be selected so that the following criteria are met.

1) The design pressure does not exceed 50 % of the works hydraulic test pressure specified in BS 486.

2) The maximum instantaneous pressure, including that due to surge, does not exceed 60 % of the works hydraulic test pressure.

NOTE It may be necessary to install protective devices such as those described in **18.1** in order to meet this criterion.

Fittings and materials other than asbestos cement should be selected by reference to relevant British Standards, or otherwise so as to have a comparable factor of safety against internal pressure during the design life of the pipeline.

16.3 Surge pressure

Although pressure pipes are capable of withstanding both degassing and full vapour pressure, it may be necessary to provide restraint against reversal of forces at bends, etc. (see **16.8**). Therefore minimum as well as maximum surge pressure should be calculated.

16.4 Combined external load and internal pressure

If at any point in the pipeline it is possible that the maximum allowable external load and internal pressure may occur simultaneously, consideration should be given to the effects of such combined loading.

NOTE The work of Schlick [11] [12] is relevant.

16.5 Thermal effects

Asbestos cement has a low coefficient of expansion and it is not generally necessary to make special provision for thermal movement.

Pipelines carrying water that have a depth of cover of at least 0.9 m are not normally subject to freezing in the UK. Where this depth of cover cannot be achieved, adequate thermal insulation should be provided and maintained (see CP 3009) or the system should be designed so that there is always a flow through the pipeline.

16.6 Sections of pipeline above ground

Where pipelines are exposed, precautions to prevent freezing of contents should be considered. The effects of fluid expansion on the internal pressure during shut-down periods should be taken into account and pressure-relieving devices installed if required.

16.7 Pipelines on steep gradients

Pipelines laid on gradients of 1 in 6 or steeper should be anchored into solid ground, at the spacing given in Table 1, to prevent movement. As soon as each joint assembly has been completed the pipe and joint should be held firmly in position whilst the trench is backfilled over the barrel of the pipe. The backfill should be well compacted.

Table 1 — Spacing of transverse anchors for steeply inclined pipelines

Gradient	Spacing	
	Pipe length 4 m	Pipe length 5 m
	m	m
1 in 2 or steeper	4	5
below 1 in 2, to 1 in 4	8	10
below 1 in 4, to 1 in 5	12	15
below 1 in 5, to 1 in 6	16	20
flatter than 1 in 6	Not usually required	

Where anchor blocks penetrate into solid ground on both sides and below the trench, they will prevent the backfilled trench from acting as a drain and so leading either to migration of fine material and loss of support for the pipeline, or to flooding at the bottom of the slope, or both. In the absence of this protection, e.g. on slopes somewhat flatter than 1 in 6, and especially where the backfill is open-textured, consideration should be given to incorporating clay dams at intervals across the trench.

16.8 Anchoring against hydraulic forces

Pipelines should be securely anchored at dead ends, tees, bends, tapers and valves to resist thrust arising from internal pressure. Anchors should be designed to withstand the forces resulting from the internal pressure when the pipeline is under test. It should be remembered that the internal pressure acts over the full external cross section of the pipe at each joint, and that the direction of the resultant thrust may change on the occurrence of any negative pressure due to surge.

Where the pipeline design pressure is significantly lower than the maximum allowable sustained pressure for the pipes, for example because the class of pipe is determined by consideration of external load, it may still be prudent to design anchors to withstand 1.5 times the maximum allowable sustained pressure, so as not to inhibit the operator's freedom to increase the operating pressure should the need arise (see **31.1**).

16.9 Pipelines on intermittent supports

For pipelines laid above ground or in tunnels on cradles or on piles (for example, in poor ground), special precautions in design and construction should be taken, especially if the pipe will be subject to external load.

The number and spacing of the supports should take into account the diameter and strength of the pipes and any anticipated external load.

No fewer than two supports should be provided for each pipe, situated not more than 1/5 of the length of the pipe from each end. Extra supports, if necessary, should be equally spaced between the end supports.

Supports should be shaped to give a minimum 60° angle of support. For heavily loaded pipes this should be increased to 120°. To ensure that the pipe circumference is uniformly supported, it is advisable that a layer of durable flexible material at least 5 mm thick (such as bitumen impregnated felt) be inserted between the pipe and support contact surfaces.

The width of the support (along the pipe axis) should not be less than 150 mm. The actual length will depend on pipe diameter, support angle and loading. If the pipeline does not follow a straight line, is laid in a tunnel which is liable to flood when the pipe is empty or is subject to internal pressure, it should be fastened to each support by a flat steel strap. The straps should be protected against corrosion and be at least 40 mm wide.

Bends and tees should likewise be securely strapped to their anchor blocks, and the design should take account of any negative pressure under surge conditions.

16.10 Unstable ground

In the case of unstable ground, the pipeline designer should consider all the factors in order to determine the appropriate laying method. The following possibilities should be taken into account:

a) use of short lengths;

b) use of long or locked joints, if available;

c) special preparation of trench bottom and pipe foundation.

17 Joints and flexibility

17.1 Joints

Joints for use with asbestos cement pipes are generally of the sleeve type comprising two basic designs:

a) an asbestos cement sleeve with two grooves housing sealing rings (see Appendix A, Figure 1);

b) a metallic sleeve with two sealing rings compressed between the sleeve and the pipe by bolted glands (see Appendix A, Figure 2).

Where metal sleeves are used, adequate anti-corrosion measures should be taken such as the application of a suitable mastic compound, with an outer tape protection.

17.2 Flexibility

Asbestos cement pipelines do not normally require any special provisions to be made for flexibility because of the flexible joints used and the absence of significant thermal movement. However, in situations where abrupt variations in settlement along the pipeline may occur, as for example where the line crosses a roadway at shallow depth, the possibility of the breakage of an individual pipe as a beam should be considered, especially in the case of pipes of small diameter. The risk of such breakage may be minimized by the use of short pipes or by positioning joints to coincide with wheel-tracks. Where a pipe is built into a chamber, a short length of pipe with two flexible joints should be installed immediately outside. The advice of the manufacturer should be sought on permissible deflections at joints (see **28.3**).

18 Protective devices and valves

18.1 Protective devices

Protective devices such as relief valves, surge vessels and controlled shut-down equipment should be provided where necessary to ensure that the instantaneous internal pressure at any point in the pipeline system does not exceed the design pressure by more than 20 %. This is particularly important where any pipeline is connected to another pipeline which is designed for a higher pressure.

18.2 Valve location: general

Valves should be placed in positions which allow easy access and cause the least interference with the use of the land. The provision of locking arrangements for valves should be considered, especially for those which are normally in the closed position or which are vulnerable to interference.

18.3 Isolating valves: size, position and spacing

In considering the diameter of in-line sluice or gate valves in relation to the diameter of the pipeline, and whether to use, for example, sluice or butterfly valves, account should be taken of any need to provide for swabbing the pipeline, both before and after commissioning.

Valves should be placed in the pipeline at intervals so that sections of the pipeline can be isolated and emptied, if necessary, within a reasonable time and without too great a loss of contents. At points where escape of the pipeline contents could seriously affect public safety, e.g. crossings of railways, motorways and (where the contents are of a polluting nature) watercourses, isolating valves should be installed close on either side.

18.4 Air valves

Air valves should be installed on all except the smallest pipelines, for the release and admission of air during filling and emptying of sections of the pipeline between isolating valves and to bleed-off air released from solution during operation of the pipeline.

The type of air valve (see **8.3**) should be selected after consideration of the duty and location of each valve. Air valves should be located at all topographic high points and high points on the pipelines with respect to the hydraulic gradient, and should also be located at intervals along any sections where the gradient of the pipeline is parallel to or less than the hydraulic gradient.

The chamber housing an air valve should be designed to be free draining and free from risk of flooding or back siphonage. It is essential that the chamber housing an air valve should be provided with an adequate discharge into the atmosphere.

18.5 Drainage valves and washouts

Drainage valves should be installed on all except the smallest pipelines, for emptying sections between isolating valves and for flushing out the pipeline while in service. Drainage valves, on water pipelines, should discharge to a watercourse or ditch through a washout pipe, although in urban areas it may be necessary to construct a discharge chamber from which water is pumped to the surface water drainage system. The relevant water or drainage authority should be consulted with respect to the allowable size and location of washout discharges.

18.6 Direction of rotation

A clear indication should be given on all valves, of the direction of rotation needed to close the valve. The direction of rotation should be the same for all valves on any one pipeline installation.

On new installations consideration should be given to standardizing the direction of rotation to close the valve as clockwise.

Subsection 4. Corrosion protection

19 Pipes and fittings

Although neither BS 3656 nor BS 486 provides for any protection against aggressive conditions, pipes can be supplied with a bitumen coating suitable for use in contact with potable water (see BS 3416). Under climatic conditions similar to those in the United Kingdom, the use of such a coating is advisable when the pH value of the soil or pipe contents is between 5.5 and 6.0 and/or the SO_3 level is between 2 g/L and 5 g/L. In warmer climates, asbestos pipes, even with bitumen coatings, have been found to be vulnerable to certain aggressive conditions, including sulphate-bearing soils, very soft waters and septic sewage. Specialist advice should therefore be sought where such conditions are expected in warm climates; also in the UK where the pH value is below 5.5 or the SO_3 level exceeds 5g/L.

Further protective measures may include various grades of coal tar and epoxy coating, and/or installation within tubular polyethylene film complying with BS 6076.

In aggressive conditions, cast iron bends, valves, etc. will also need greater protection than that given by normal coatings. Where such is considered necessary, reference should be made to BS 5493.

Coatings should be applied in such a manner as not to interfere with the seal at the joint.

20 Bolted joints

Protection can be afforded by packing a suitable mastic material over the components and the adjacent external surface of the pipe so as to form a continuous layer with a smooth profile which can subsequently be wrapped with a compatible, cold-applied tape (e.g. petrolatum-based or plastic-backed types, depending on the mastic used). Care should be taken to ensure that there are no voids between the mastic and the pipe component substrate, nor between the tape and the mastic.

Alternatively, heat-shrinkable sleeves can be obtained for the protection of certain profiles, e.g. flanged joints, bolted flange couplings.

Subsection 5. Transport, handling and storage

21 General

NOTE See BS 8010-1 for procedures to be followed before any work in land is commenced.

Asbestos cement pipes and fittings should be handled with care at all times in accordance with the manufacturer's instructions.

Impact on asbestos cement pipes can cause damage, particularly in the form of crushed laminations at the extremities or hair-cracks in the bore in the region of the pipe ends. The precautions set out in this subsection should be taken to prevent such damage.

22 Transport

Whatever the length of journey, and whether at the works or on site, pipes should be loaded for transport in such a way that they are secure and that no more than an absolute minimum of movement can take place on the vehicle during transit.

23 Handling and storage

23.1 Off-loading

Cranes should be used for off-loading, although pipes less than 300 mm (12 in) nominal bore may be rolled down skid-timbers under restraint of ropes passed round both ends of the pipe and securely anchored. When cranes are used the whole sequence of operations should be carried out smoothly and without snatch. Rope or nylon slings or lifting beams with flattened hooks should be used. Hooks should be well padded to prevent the pipe being damaged and should be fitted with a locking device. It is essential that steadying ropes are used.

23.2 Stacking

The first layer of pipes should be placed on a firm foundation consisting of solid timbers set level on the ground. Wedges should be firmly nailed to the timbers to prevent the pipes from moving. If timber battens are placed between each layer of pipes to enable the stack to be vertical-sided, wedges should be similarly nailed to each batten. Alternatively, each layer may consist of one less pipe than the layer below, forming a tapered stack without intermediate battens, in which case particular care should be given to restraining the bottom tier. The height of any stack should not normally exceed 2.5 m, and may be further limited by the lifting gear available for stacking or unstacking.

23.3 Storage of joints and fittings

Until required for use joint rings, gaskets and lubricant should be stored securely under cover. Other fittings should be stored in a compound. Joint rings and gaskets should be kept in the bags or cartons in which they have been delivered, and protected from sunlight, oils, greases and heat. If the joint rings have been tied, they should be separated a few days before use in order to eliminate minor impressions which the ties may have caused. Ties should be of a type which, during normal handling and separating, will not cut the joint rings.

23.4 Stringing

Stringing consists of placing pipes on the ground in line ready for laying. Care should be taken to prevent damage during this operation (see also BS 8010-1).

Subsection 6. Construction

24 Trenching

NOTE See BS 8010-1 for general considerations regarding trenching.

The preparation of the trench bottom to give an even bed for the barrel of the pipe and the proper alignment of the pipes is of primary importance. In rocky ground the trench should be excavated at least 100 mm deeper than required and then made up to the required level by the addition of well rammed compactible material which will not be washed away; alternatively, the pipe may be embedded in a layer of freshly mixed concrete leaving the joint free.

The trench should be cut to the minimum width necessary to permit the pipes to be properly laid and the backfill properly compacted. For pipes over 500 mm internal diameter, the width of the trench should be typically pipe outside diameter + 600 mm. For smaller pipes, the width of trench should be typically pipe outside diameter + 300 mm.

Where a maximum trench width up to pipe crown level has been assumed in the design of any part of the pipeline to resist external loading, the designer will have specified accordingly (see **16.1**) and should be consulted if site conditions make it essential to exceed the specified width, as this may result in a significant increase of load.

Joint holes should be provided to give sufficient room for the joint to be properly made and to ensure that the pipe rests on the barrel and not on the joint. Provision should be made to allow slings to be removed without disturbing the pipe once it has been laid on its bedding.

25 Inspection of pipe before laying

The turned ends of all pipes should be inspected to ensure that they are free from any local irregularities which could affect the watertightness of the joint. All pipes should be visually inspected for evidence of impact damage. Where such damage is detected, a thorough examination of the internal surface in the region of the pipe ends should be made for signs of hair cracks.

26 Reclamation of damaged pipes

Minor irregularities or scoring which may affect the watertightness of the joint should be smoothed away by careful rasping in such a way as to avoid a "flat". Where the irregularities or scoring are too pronounced to be smoothed away by such treatment, the pipe end should be trimmed back and the chamfer reformed.

Where impact damage has been detected, consideration may be given to reclaiming the sound portion of the pipe. In the case of crushed ends or hair cracks, a sound pipe will usually remain if the end is trimmed back to at least 200 mm beyond the visible extent of the damage.

After trimming back, the turned end may still be of sufficient length to accommodate one half of the joint; if not, it will be necessary to extend the length of the prepared surface by the use of a hand-turning machine.

NOTE See clause **4** for safety precautions when cutting, rasping and turning pipes.

27 Closure pipes

Where closure pipes are to be cut on site the safety precautions in clause **4** should be observed.

28 Laying and jointing

28.1 Laying

Pipes should be lowered into the trench with tackle suitable for the weight of pipes. For smaller sizes, say up to 300 mm nominal bore, the pipe may be lowered by the use of ropes. For heavier pipes, either a mobile crane or the excavator may be used if certified for lifting. The positioning of the sling to ensure a proper balance should be checked when the pipe is just clear of the ground.

All persons should vacate any section of trench into which a pipe is being lowered.

All debris should be cleared from the inside of the pipe before a joint is made. This should be done by passing a pull-through along the pipe, or by hand, depending on the diameter of the pipe. When laying is not in progress the open end of the pipeline should be fitted with a temporary end closure. This may make the pipe buoyant in the event of the trench becoming flooded, in which case the pipes should be held down by partial refilling of the trench.

28.2 Jointing

Jointing procedure will vary according to the type of joint being used. Basic requirements for all types are:

a) cleanliness of all parts;

b) correct assembly of components;

c) proper alignment of pipes;

d) proper location of joint sleeve;

e) proper lubrication;

f) strict compliance with manufacturer's jointing instructions.

All jointing components should be cleaned and inspected for damage. Pipe ends should be wiped clean. Care should be taken to see that gaskets are correctly placed and not twisted. Where cast iron joints are used, the components should be suspended and "rung" with a hammer to check for cracks. Where lifting gear has been used to place the pipe in the trench, it should also be used to assist in aligning the pipes and joint. A gap of at least 5 mm should be left between the adjacent pipe ends at the centre of the sleeve.

28.3 Changes of direction

It is permissible for small changes in direction to be made by deflecting the last laid pipe after the joint has been made, the trench being widened if necessary. The maximum angle will vary with the type of joint used and the diameter of the pipe. Manufacturer's recommendations give permissible angles. Initial deflection of any joint should not exceed 75 % of the permissible angle, to allow for subsequent movement. Sharper changes in direction should be negotiated using short pipes or by inclusion of bends or angled couplings (if available).

29 Backfilling

See BS 8010-1 for general considerations regarding backfilling, clearing up and reinstatement. It is permissible for the trench to be backfilled and properly compacted as soon as the joints have been made.

If it is decided that the joints should be individually inspected during subsequent testing, the trench should be backfilled only over the barrel of each pipe and the backfill compacted to prevent movement of the pipe during the testing process (see **31.2**).

If site conditions prevent achievement of the standard of backfill specified to enable the pipe to withstand external loading (see **16.1**), the structural design of the pipeline should be reviewed. In all conditions, particular attention should be paid to the thorough compaction of backfill under the barrels of pipes larger than 600 mm.

Where selected excavated material from the trench is used for backfilling, it should be free from debris, organic material, frozen soil, large stones, rocks, tree roots or similar large objects.

Particular care should be taken to ensure that pipes are not damaged by heavy stones or compaction equipment during backfilling. Backfill up to about 300 mm above the pipes should be carefully compacted.

Subsection 7. Cleaning, testing and commissioning

30 Cleaning

Before a pipeline can be considered ready for service it should be cleaned internally as thoroughly as possible to ensure that no foreign matter remains inside the pipe. The first stage of the cleaning operation is referred to in **28.1**, i.e. the cleaning of individual pipes before the joint is made. Where the pipeline is to be tested with water, the filling and emptying of the pipeline may to some extent cleanse the line. Pigs of suitable design, e.g. polyurethane swabs, may be used provided that the pipeline has been constructed to allow the passage of such pigs.

31 Testing of pressure pipelines

31.1 General

Before being brought into service, the pipeline should be hydrostatically tested, normally to 75 % of the works hydraulic test pressure specified in BS 486, measured at the lowest point of each section. Sections should be 500 m to 1 000 m long, and selected so that the test pressure at high points is not less than 60 % of the works hydraulic test pressure.

If it is not practical or economic to provide anchor blocks to withstand the test pressure specified above, the designer may specify a lower pressure, which should be not less than 150 % of the pipeline design pressure.

31.2 Backfilling before the test

31.2.1 *Partial backfill.* The pipes comprising the test section should be anchored by partially backfilling the trench to at least 300 mm above the crown of pipes not exceeding 200 mm diameter, and to about 500 mm for pipes of larger diameter.

The backfill should be placed and compacted so that the internal pressure will not give rise to any transverse or vertical displacement of the pipes. Where possible, the joints should remain uncovered for visual inspection during the test.

31.2.2 *Complete backfill.* In certain circumstances the trench may be completely backfilled. Consideration should be given to the risk of re-excavation should hydraulic testing prove unsatisfactory.

31.3 Anchorage

Each test section should be properly sealed off, preferably with special stop ends designed for the safe introduction and disposal of the test water and release of air, which should be secured by adequate temporary anchors. The thrust on the stop ends should be calculated on the full external diameter and the anchors designed to resist it. It may often be economical to provide a concrete anchor block which has subsequently to be demolished, rather than risk movement of the stop ends during testing. It is permissible for hydraulic jacks to be inserted between temporary anchors and stop ends to take up any horizontal movement of the temporary anchors. All permanent anchors should be in position and, if of concrete, should have developed adequate strength before testing begins.

31.4 Filling the test section

The section of the pipeline to be tested should be filled with water at a rate sufficiently slow to ensure that all air is expelled. A rate approximating to a velocity of 0.05 m/s in the full pipe is appropriate. The water should preferably be introduced at the lowest point of the section under test. Air vents should be kept open during filling until there is no further escape of air.

Consideration should additionally be given to the removal of air by passing a suitable swab through the test section, provided that the pipeline has been constructed to allow this.

31.5 Test equipment

Test equipment should include:

a) a pump to raise the hydraulic pressure in the test section;

b) a means of measuring quantities of water added to or removed from the pipeline during test (see **31.7**);

c) a calibrated pressure gauge (preferably a recording one) connected to the pipeline (preferably at its lowest point) capable of being read to an accuracy of ± 0.01 MPa.

31.6 Preliminary test

After having been filled with water, the test section should stand for an initial uninterrupted period of at least 24 h under the intended working pressure in the section. Should a failure occur and some or all of the water be lost, repairs should be made and the procedure repeated. Any exposed parts of the test section should be visually inspected. If neither appreciable movement of the pipeline nor any leakage is found the pressure test should proceed.

31.7 Duration of pressure test and water absorption

When an asbestos cement pipeline is initially filled with water, some is absorbed at a rate dependent upon the diameter and length of the test section, and upon the internal pressure. Although after a short period of service this absorption becomes negligible, it should be considered in relation to the pressure test.

As a result of water absorption by the pipes, the pressure initially applied will drop. Each time the pressure drops to 95 % of the test pressure (see **31.1**), additional water should be pumped into the test section to restore the required pressure. This procedure should be continued for at least 4 h. The quantity of water added each time should be measured, recorded and totalled at the end of the test. If the rate of addition does not show a decline, the reason should be investigated in accordance with **31.8**.

Finally the test pressure should be restored, the pump disconnected and the pressure drop observed over a period of 1 h. The test pressure should then again be restored and the quantity of water required to be bled-off, to reproduce the observed pressure drop, should be measured. This quantity should not exceed that represented by 2 litres per metre nominal bore per kilometre length per metre head (calculated as the average over the section) per 24 h.

31.8 Repetition of pressure test

If the requirements of **31.7** are not met, the section should be inspected visually. If leakages are found, remedial work should be carried out and the pressure test repeated. If no leakage is found and the pressure test result is unsatisfactory, the possibility of air in the pipeline should be investigated, and the test repeated. If faults persist, more sophisticated leak-detection measures should be employed, e.g.:

a) use of a bar probe to detect signs of water in the vicinity of joints, if backfilled;

b) aural inspection using a stethoscope or a listening stick in contact with the pipeline;

c) use of an electronic listening device which detects and amplifies the sound of any escaping fluids; actual contact between the probe and the pipe is not essential;

d) use of an electronic leak-noise correlator;

e) injection of a dye into the test water (this measure is particularly suitable for water-logged ground);

f) introduction of nitrous oxide in solution into the test water and use of an infra-red gas concentration indicator to detect the presence of any nitrous oxide that has escaped through the leak;

g) use of sodium hexafluoride as a tracer;

h) air at less than 100 mm watergauge (approximately 0.1 bar[1)]) to produce bubbles in water-logged ground or with the use of soap solution at joints (see **31.11**).

31.9 Final test

After the successfully tested sections of the pipeline have been coupled together and backfilling completed, except at the closure joints, the pipeline should be subjected to the test procedure given in **31.7**.

The test pressures at the lowest point in the pipeline should comply with **31.1** but the requirement of that clause regarding the pressure at high points may not be achievable.

The duration of this test will be determined by the time required to carry out a visual inspection of the closure joints between the previously tested individual sections of the pipeline.

31.10 Disposal of water

It is important to ensure that proper arrangements are made for the disposal of water from the pipeline after completion of hydrostatic testing and that all consents which may be required from landowners and occupiers, and from drainage and water authorities, have been obtained. In some cases, e.g. heavily chlorinated water, some treatment may be necessary before final disposal.

31.11 Testing with air

Testing with air, even at pressures of the order of 0.05 N/mm^2 (0.5 bar), creates a substantial store of energy whose magnitude depends upon the volume of the test section. The consequent risk of injury from explosive rupture of the pipeline is unacceptable because safer and satisfactory alternative test methods are available. Accordingly testing with air is not recommended.

32 Commissioning

Commissioning consists of replacing the test water in the pipeline with the liquid to be conveyed.

If air release and drainage valves have been installed this may be done by draining and refilling. Otherwise, the test water should be displaced by the liquid to be conveyed using a separating pig if necessary.

[1)] 1 bar = 10^5 N/m^2 = 10^5 Pa.

If the pipeline is intended to carry potable water, it should be thoroughly flushed with clean water, where feasible. It should then be disinfected by contact for 24 h with water containing at least 20 mg/L of free chlorine, then emptied and filled with potable water. The chlorinated water should receive treatment to dilute the chlorine to an acceptable level before discharge to a sewer or watercourse. After a further 24 h, samples should be taken for bacteriological examination at a number of points along the pipeline and at all extremities.

The pipeline should not be brought into service until the water at each sampling point, having stood in the pipeline for 24 h, has maintained a satisfactory potable standard as described in DHSS Report 71 [13].

All temporary connections used during the testing and commissioning procedure should be closed off and securely blanked before the pipeline is brought up to full operating pressure.

33 Records

Records should be kept of all tests and inspections carried out on the pipeline. Copies of "as built" plans indicating the pipeline's size, depth and location related to surface features should be provided for each owner and occupier by the promoter.

Appendix A Joints

The joints shown in Figure 1 and Figure 2 are suitable for asbestos cement pipelines.

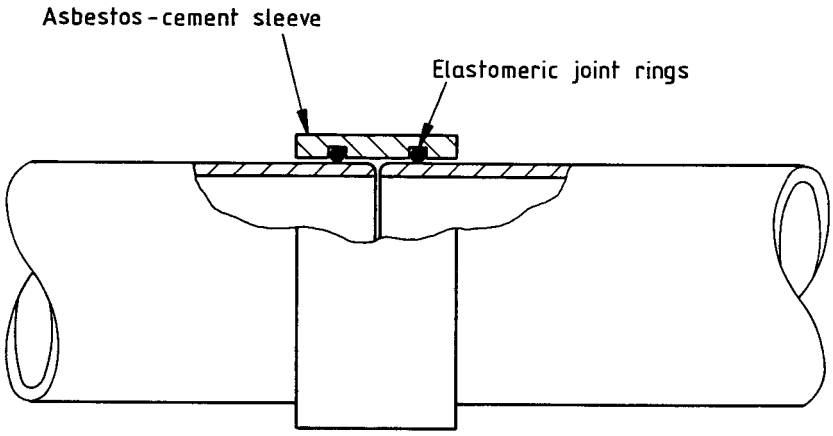

Figure 1 — Push-on type joint

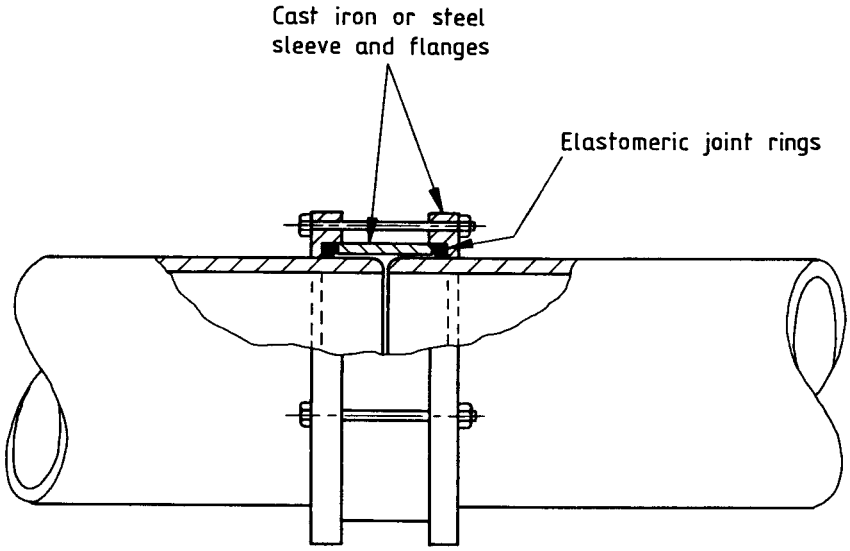

Figure 2 — Detachable type joint

Appendix B Effect of non-metallic materials on water quality

The following requirements apply to asbestos cement pipelines intended to be used in contact with potable water.

When used under the conditions for which they are designed, non-metallic materials in contact with or likely to come into contact with potable water shall not constitute a toxic hazard, shall not support microbial growth and shall not give rise to unpleasant taste or odour, cloudiness or discoloration of the water.

Concentrations of substances, chemicals and biological agents, leached from materials in contact with water and measurements of organoleptic/physical parameters, shall not exceed the maximum values recommended by the World Health Organization in its publication "Guidelines for drinking water quality" Vol. 1 "Recommendations" (WHO, Geneva 1984) or required by the EEC Council Directive of 15 July 1980 relating to the quality of water intended for human consumption (Official Journal of the European Communities L229 pp 11-29), whichever in each case is more stringent.

NOTE 1 Requirements for the testing of materials in these respects are set out in the UK Water Fittings Byelaws Scheme Installation and Guidance Note No. 5-01-02, ISSN 0266-5298 obtainable from the Water Research Centre, Water Byelaws Advisory Service, Fittings Testing Station, 600 Ajax Avenue, Slough, Berkshire SL1 4BG.

NOTE 2 Pending the determination of suitable means of characterizing the toxicity of leachates from materials in contact with potable water, materials approved by the Department of the Environment Committee on Chemicals and Materials of Construction for use in Public Water Supply and Swimming Pools are considered free from toxic hazard for the purpose of compliance with this appendix. A list of approved chemicals and materials is available from the Technical Secretary of that Committee at the Department of the Environment, Water Division, Romney House, 43 Marsham Street, London SW1P 3PY.

NOTE 3 Products manufactured for installation and use in the United Kingdom which are verified and listed under the UK Water Fittings Byelaws Scheme administered by the Water Research Centre (address as in note 1), are deemed to satisfy the requirements detailed in this appendix.

Appendix C References

1. Guidance Note EH10 — Asbestos — Control limits, measurement of airborne dust concentrations and the assessment of control measures. Health and Safety Executive

2. Guidance Note MS13 — Asbestos. Health and Safety Executive

3. Guidance Note EH36 — Work with asbestos cement. Health and Safety Executive

4. Guidance Note EH35 — Probable asbestos dust concentrations at construction processes. Health and Safety Executive

5. Certificate of Approval (Respiratory Protective Equipment) HMSO

6. Guidance Note EH41 — Respiratory protective equipment for use against asbestos. Health and Safety Executive

7. Hydraulics Research Station. Charts for the hydraulic design of channels and pipes

8. Hydraulics Research Station. Tables for the hydraulic design of pipes and sewers — 4th edition 1983

9. A guide to Design Loadings for Rigid Pipes — O C Young and M P O' Reilly (Transport and Road Research Laboratory) HMSO. 1983

10. Simplified Tables of External Loads on Buried Pipelines HMSO.1986

11. Supporting strengths of cast iron pipe for gas and water services Bull. No. 146. lowa Engineering Experimental Station

12. Buried Rigid Pipes pp 99 et seq. O C Young and J J Trott (1984) Elsevier Applied Science Publishers

13. Department of Health and Social Services. The bacteriological examination of water supplies. DHSS Report 71, 1982

blank

Publications referred to

BS 10, *Specification for flanges and bolting for pipes, valves and fittings.*
BS 78, *Specification for cast iron spigot and socket pipes (vertically cast) and spigot and socket fittings.*
BS 78-2, *Fittings.*
BS 486, *Specification for asbestos cement pressure pipes and joints.*
BS 534, *Specification for steel pipes and specials for water and sewage.*
BS 916, *Black bolts, screws and nuts.*
BS 1769, *Unified black hexagon bolts, screws and nuts (UNC and UNF threads). Heavy series.*
BS 2035, *Specification for cast iron flanged pipes and flanged fittings.*
BS 2494, *Specification for materials for elastomeric joint rings for pipework and pipelines.*
BS 3416, *Specification for bitumen coating solutions suitable for use in contact with potable water.*
BS 3656, *Specification for asbestos cement pipes, joints and fittings for sewerage and drainage.*
BS 4190, *Specification for ISO metric black hexagon bolts, screws and nuts.*
BS 4275, *Recommendations for the selection, use and maintenance of respiratory protective equipment.*
BS 4320, *Specification for metal washers for general engineering purposes.*
BS 4504, *Specification for flanges and bolting for pipes, valves and fittings.*
BS 4504-1, *Ferrous.*
BS 4504-2, *Copper alloy and composite flanges.*
BS 4622, *Specification for grey iron pipes and fittings.*
BS 4865, *Specification for dimensions of gaskets for pipe flanges to BS 4504.*
BS 4865-1, *Dimensions of non-metallic gaskets for pressures up to 64 bar.*
BS 4865-2, *Dimensions of metallic spiral-wound gaskets for pressures from 10 to 250 bar.*
BS 5150, *Specification for cast iron wedge and double disk gate valves for general purposes.*
BS 5151, *Specification for cast iron gate (parallel slide) valves for general purposes.*
BS 5152, *Specification for cast iron globe and globe stop and check valves for general purposes.*
BS 5153, *Specification for cast iron check valves for general purposes.*
BS 5155, *Specification for butterfly valves.*
BS 5163, *Specification for predominantly key-operated cast iron gate valves for waterworks purposes.*
BS 5493, *Code of practice for protective coating of iron and steel structures against corrosion.*
BS 6076, *Specification for tubular polyethylene film for use as protective sleeving for buried iron pipes and fittings.*
BS 8005, *Sewerage.*
BS 8010, *Code of practice for pipelines.*
BS 8010-1, *Pipelines on land: general.*
CP 3009, *Thermally insulated underground piping systems.*
ISO 2785, *Guide to the selection of asbestos cement pipes subject to external loads with or without internal pressure.*

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL