

Code of practice for

Pipelines —

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

Section 2.1 Ductile iron

UDC 621.644

Committees responsible for this British Standard

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- Association of Consulting Engineers
- British Compressed Gases Association
- British Gas Corporation
- British Plastics Federation
- British Precast Concrete Federation Ltd.
- British Railways Board
- Chemical Industries Association
- Concrete Pipe Association
- Country Landowners' Association
- County Surveyor's 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
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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 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 will supersede 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 is divided into several Sections which will be published as separate documents as follows.

- *Section 2.1: Ductile iron;*
- *Section 2.2: Steel;*
- *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.*

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.

This Section supersedes CP 2010-3:1972. The content and the title of the 1972 edition have been changed to refer to ductile iron only, as grey iron is no longer used as a material for pipelines. By the exclusive use of ductile iron it has been possible to raise the pressure ratings and introduce self-anchoring joints.

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 the conveyed material.

Appendix A describes and illustrates some typical types of joint used with ductile iron pipe.

Appendix B gives requirements for non-metallic materials for use with potable water.

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 statutory legislation in the UK. 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;

Countryside (Scotland) Acts 1967 and 1981;
Gas Acts 1965 and 1972;
Land Powers (Defence) Act 1958;
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;
Water (Scotland) Acts 1946, 1949, 1967 and 1980.

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 26, 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.

Subsection 1. General

1 Scope

This Section of BS 8010 gives design considerations and construction and installation recommendations for ductile iron pipelines and should be read in conjunction with Part 1¹⁾.

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

NOTE 1 The numbers in square brackets in the text of this Section refer to the numbered references in Appendix C.

NOTE 2 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Section of BS 8010, the following definitions apply.

2.1

ductile iron²⁾

iron in which graphite is present substantially in spheroidal form, instead of in flakes such as occur in grey iron

2.2

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

2.3

flexible joint²⁾

a connection between individual pipes and/or fittings that provides angular deflection or axial movement, or a combination of both, in service, without impairing the efficiency of the connection

NOTE See Appendix A.

2.4

rigid joint

a connection that is designed not to permit angular deflection or axial movement in service

NOTE See Appendix A.

2.5

self-anchoring joint

a connection that is designed to prevent separation under the axial thrust induced by internal pressure, temperature fluctuations or ground movement whilst still permitting angular deflection and/or axial movement without impairing the efficiency of the joint

NOTE See Appendix A.

2.6

stringing

the placing of pipes in line on the ground ready for laying

2.7

surge pressure

pressure that is produced by a change in velocity of the moving fluid. Surge pressure may be positive or negative

3 Applications

The pipelines covered by this Section of BS 8010 are generally suitable for conveying water, sewage, trade waste, slurries, sludges, non-corrosive gases, brine and certain chemicals. Ductile iron pipes are used in distribution systems for natural and town gases and they may also be used in pipelines for the conveyance of these fuel gases under similar service conditions. For limits of pressure adopted by the British Gas Corporation in the United Kingdom and guidance in connection with the installation of ductile iron pipelines for gas, reference may be made to IGE/TD/3 [1]. When used for the conveyance of sewage, reference should be made to BS 8301 and CP 2005. Ductile iron is suitable for pipelines in locations where ground instability, traffic loading and frost effects present potential hazards and in areas where damage risks are high.

4 Safety

4.1 General

The recommendations of this Section of BS 8010 are considered to be adequate for public safety under conditions usually encountered in ductile iron pipelines, including pipelines within towns, cities, water catchments and industrial areas. Attention is called to the need to consider measures to prevent damage or leakage arising from:

- a) corrosive soil conditions;
- b) internal corrosion/erosion;
- c) external damage by mechanical equipment used on other works;
- d) erosion or ground subsidence;
- e) any abnormal circumstances.

4.2 Preventative measures

Consideration should be given to the use of preventative measures such as the following:

- a) additional external protection (see 19.2);

¹⁾ In preparation.

²⁾ Definition repeated from BS 4772 which is currently under revision.

- b) additional internal linings (see **19.3**) and/or limitation of flow velocities;
- c) provision of increased cover or a concrete cover as a protection against external mechanical damage, or erosion;
- d) for serious subsidence, additional flexible joints, anchored joints, rafts or piling;
- e) indication of the presence of the pipeline with additional markers particularly in congested areas or areas where future development is known to be planned, and adequate marking at river and water course crossings;
- f) provision of protection from frost for pipelines above ground or in ducts.

5 Inspection

The integrity of a properly designed pipeline depends more on the standards and quality of inspection applied at all stages than on any other single feature.

Particular attention should be given to inspection of the pipe and coating before installation for possible damage, of the bedding of the pipeline, jointing and anchoring and to testing. Any sub-standard materials or workmanship detected should be rectified or, where necessary, rejected, before any further work is done.

Subsection 2. Materials and availability

6 General

Ductile iron pipes and fittings should comply with BS 4772. Ductile iron possesses high tensile strength, ductility and resistance to impact fracture, which makes it suitable for the applications referred to in clause 3. It is capable of deforming to a significant extent before fracture.

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

All materials, including repair materials, likely to come in contact with potable water should be incapable of permitting bacterial growth.

Non-metallic materials should comply with the requirements for the effect of non-metallic materials on water quality (see Appendix B).

7 Pipes

7.1 Spigot and socket pipes

Ductile iron pipes are manufactured in accordance with BS 4772 in lengths of 5.5 m for DN 80 to DN 800 inclusive and lengths of 8 m for DN 900 to DN 1600 inclusive.

A percentage of the pipes supplied may be of shorter length, in accordance with BS 4772. Special arrangements should be made for procuring shorter lengths, where these are considered necessary.

External diameters for metric size ductile iron pipes complying with BS 4772 and metric size grey iron pipes complying with BS 4622 are such that the pipes are directly interchangeable. Metric size ductile iron pipes are not directly interchangeable with ductile or grey iron pipes in imperial sizes and appropriate change fittings should be used in accordance with BS 4772.

7.2 Flanged pipes

Flanged ductile iron spun pipes are manufactured by casting the pipe barrel centrifugally and then welding or screwing loose ductile iron flanges on to specially prepared ends. Short lengths are often supplied with integrally cast flanges. The lengths available will vary according to the source of supply. Flanged pipework is available in sizes DN 80 to DN 1600 inclusive.

7.3 Fittings

Fittings are generally of the all socket or flanged type. BS 4772 permits the supply of fittings beyond the specified range in certain aspects, such as:

- a) laying dimensions;
- b) pressure rating;
- c) permutations of branch/main diameters;
- d) configurations such as angle branches, crosses, etc;

e) joint ends, e.g. socket and spigot bends.

Such fittings are deemed to comply with BS 4772 and are required to be marked as specified in BS 4772.

8 Valves

8.1 Control valves

Control valves should comply with one of the British Standard specifications listed below.

- | | |
|---------|---|
| BS 5150 | Cast iron wedge and double disk gate valves for general purposes. |
| BS 5152 | Cast iron globe and globe stop and check valves for general purposes. |
| BS 5153 | Cast iron check valves for general purposes. |
| BS 5155 | Specification for butterfly valves. |
| BS 5163 | Double flanged cast iron wedge gate valves for waterworks purposes. |

Valves outside the range of sizes, or differing in type or otherwise not complying with the specifications listed may be used, 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.

A clear indication should be given on all valves of the direction of rotation needed to close the valve (see clause 12).

8.2 Air valves

Automatic air valves are available in a number of forms. The most common are single orifice, double orifice and kinetic. Reference should be made to the manufacturer's recommendations.

9 Flanges

Dimensional details of flanges designated PN 10, PN 16, PN 25 and PN 40 should comply with BS 4772. These are dimensionally compatible with the corresponding flanges in accordance with BS 4504. Unless otherwise specified by purchaser, PN 16 flanges are supplied for working pressures up to and including 16 bar.

BS 4772 permits the use of high tensile steel bolts of smaller diameter than the corresponding low carbon steel bolts, to facilitate manufacture and installation of larger diameter flanges. Such flanges are marked accordingly. Where high tensile bolts are used with flanges holed for low carbon steel bolts, special washers should be used in accordance with the pipe manufacturer's recommendations.

NOTE Flanges complying with other standards may be supplied against special orders.

10 Bolts, nuts and washers

Low carbon steel bolts and nuts should comply with BS 4190 and high tensile steel bolts and nuts should comply with BS 3692, minimum grade 8.8. Washers should comply with BS 4320.

11 Gaskets

11.1 General

Elastomeric components of gaskets should comply with the requirements of BS 2494 but other materials may be used if they have been proven to be more suitable.

The section of gaskets which is likely to come in contact with potable water, and gasket lubricants, should be incapable of permitting bacterial growth and should comply with the requirements for the effect of materials on water quality (see Appendix B). Where the product conveyed might have a deleterious effect on the gasket, the gasket should be provided with a protective tip of suitable material to isolate it from the contents of the pipeline.

Maximum temperature limitations apply to the use of both natural and synthetic rubbers. These limitations 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 (see Appendix A).

Gaskets should be protected from unnecessary exposure to the effects of ultra-violet light and ozone.

NOTE Gaskets for flexible joints are frequently referred to as joint rings.

11.2 Flange gaskets

The dimensions of gaskets for flanges designated PN 10, PN 16, PN 25 and PN 40 should comply with BS 4865. The use of moulded gaskets designed to suit a range of nominal pressure ratings is permitted.

Subsection 3. Design considerations

12 Pipeline design

The necessary hydraulic, structural and economic assessments should be made in accordance with recognized practice [2] and [3].

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

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

13 Pipe design

13.1 Works hydrostatic test pressure

Each pipe and fitting should be subjected to a hydrostatic test at the manufacturer's works. The pressure is required to be applied steadily and maintained for a period sufficient to facilitate adequate inspection and not less than 15 s.

NOTE Practical considerations limit the works hydrostatic test pressure to values which may be lower than the site test pressure.

13.2 Working pressure

Maximum working pressures for classes of pipes and fittings in accordance with BS 4772 are given in Table 1.

13.3 Surge pressures

The maximum surge pressure should be calculated. It is essential that the total pressure of the pipeline, including surge, does not exceed the pressure given in Table 2. Should it be found that this pressure is likely to be exceeded then protective devices, such as those described in clause 17, should be installed to reduce the actual surge pressure so that the above criterion can be met.

13.4 Site hydrostatic test pressure

The site hydrostatic test pressures for ductile iron pipes and fittings and flanged joints in accordance with BS 4772 should be not less than:

- a) the working pressure + 5 bar;
- b) the maximum pressure under surge conditions;

but should not exceed the pressures given in Table 2.

14 Service and environmental considerations

14.1 General

The pipeline internal pressure may be subject to limitations according to the service and environmental conditions in which the pipeline operates.

14.2 Pipelines for liquids

The internal design pressures for the conveyance of liquids should not exceed the pressures given in Table 1.

14.3 Pipelines for gases

Where the pipeline conveys a gas and there is, therefore, a considerable amount of energy stored in the compressed gas in the pipeline, operating pressures are restricted, see IGE/TD/3 [1]. Gas operating pressures of the order of 8 bar may be permitted in ductile iron pipelines depending on the type of joint used and the environmental conditions. At these pressures, consideration should be given to the use of self-anchored mechanical joints.

NOTE Such joints provide restraint within the joint and thus dispense with the need for the traditional form of concrete thrust or anchor block (see Appendix A).

14.4 Pipelines for liquids and gases

14.4.1 Vacuum and external fluid pressure. The pipeline should be capable of withstanding a differential pressure brought about by internal vacuum or external fluid pressure

(e.g. ground water). Where external pressure exceeds internal pressure by more than 1 bar, the manufacturer's advice should be sought on the choice of joint.

14.4.2 External loading. Ductile iron pipes have adequate strength for all normal installations when operating up to the maximum recommended internal pressures for each type of pipe.

Where it is necessary to consider the effects of external loads, calculations should be made in accordance with one of several recognized approaches for computing trench loads, pipe deflection and pipe stress, some of which are listed in Appendix D. Consultation with manufacturers should be made where abnormal laying conditions are encountered, e.g. very deep or very shallow with vehicular loading.

14.4.3 Thermal insulation. 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.