

Pipelines —

Part 2: Design and construction of steel pipelines in land

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Foreword

This Code of Practice makes reference to the following British Standards:

BS 10, *Flanges and bolting for pipes, valves and fittings*.

BS 21, *Pipe threads*.

BS 131, *Methods for notched bar tests — Part 2: The Charpy V-notch impact test*.

BS 143 & 1256, *Malleable cast iron and cast copper alloy screwed pipe fittings for steam, air, water, gas and oil*.

BS 534, *Steel pipes, fittings and specials for water, gas and sewage*.

BS 806, *Ferrous pipes and piping installations for and in connection with land boilers*.

BS 1218, *Sluice valves for waterworks purposes*.

BS 1387, *Steel tubes and tubulars suitable for screwing to BS 21 pipe threads*.

BS 1414, *Flanged and butt-welding end steel outside-screw-and-yoke wedge gate valves for the petroleum industry*.

BS 1500, *Fusion welded pressure vessels for general purposes*.

BS 1515, *Fusion welded pressure vessels for use in the chemical, petroleum and allied industries*.

BS 1560, *Steel pipe flanges and flanged fittings (nominal sizes $1\frac{1}{2}$ in to 24 in) for the petroleum industry*.

BS 1570, *Flanged and butt-welding end steel plug valves for the petroleum industry (excluding well-head and flow-line valves)*.

BS 1640, *Steel butt-welding pipe fittings for the petroleum industry — Part 1: Wrought carbon and ferritic alloy steel fittings*.

BS 1735, *Flanged cast iron outside-screw-and-yoke wedge gate valves, Class 125, sizes $1\frac{1}{2}$ in to 24 in, for the petroleum industry*.

BS 1740, *Wrought pipe fittings, iron and steel (screwed B.S.P. thread)*.

BS 1750, *Bolting for the petroleum industry*.

BS 1769, *Unified black hexagon bolts, screws and nuts (UNC and UNF threads). Heavy series*.

BS 1868, *Flanged steel check valves for the petroleum industry*.

BS 1873, *Flanged steel globe valves for the petroleum industry*.

BS 1952, *Copper alloy gate valves for general purposes*.

BS 1953, *Copper alloy check valves for general purposes*.

BS 1965, *Butt-welding pipe fittings for pressure purposes — Part 1: Carbon steel*.

BS 2060, *Copper alloy screw-down stop valves for general purposes*.

BS 2494, *Rubber joint rings for gas mains, water mains and drainage purposes*.

BS 2591, *Glossary for valves and valve parts (for fluids)*.

BS 2708, *Unified black square and hexagon bolts, screws and nuts (UNC and UNF threads). Normal series*.

BS 2815, *Compressed asbestos fibre jointing*.

BS 2910, *General recommendations for the radiographic examination of fusion welded circumferential butt joints in steel pipes*.

BS 2995, *Cast and forged steel wedge gate, globe, check and plug valves, screwed and socket-welding, sizes 2 in and smaller, for the petroleum industry*.

BS 3063, *Dimensions of gaskets for pipe flanges*.

BS 3293, *Carbon steel pipe flanges (over 24 inches nominal size) for the petroleum industry*.

BS 3351, *Piping systems for the petroleum industry*.

BS 3464, *Cast iron wedge and double disk gate valves for general purposes*.

BS 3601, *Steel pipes and tubes for pressure purposes. Carbon steel: ordinary duties.*

BS 3602, *Steel pipes and tubes for pressure purposes. Carbon steel: high duties.*

BS 3799, *Forged steel pipe fittings, screwed and socket-welding for the petroleum industry.*

BS 3808, *Cast and forged steel flanged screwed and socket-welding wedge gate valves (compact design), sizes 2 in and smaller, for the petroleum industry.*

BS 3948, *Cast iron parallel slide valves for general purposes.*

BS 3961, *Cast iron screw-down stop valves and stop and check valves for general purposes.*

BS 4090, *Cast iron check valves for general purposes.*

BS 4133, *Flanged steel parallel slide valves for general purposes.*

BS 4147, *Hot applied bitumen based coatings for ferrous products.*

BS 4164, *Coal tar based hot applied coating materials for protecting iron and steel, including suitable primers where required.*

BS 4190, *ISO metric black hexagon bolts, screws and nuts.*

BS 4515, *Field welding of carbon steel pipelines.*

CP 2005, *Sewerage.*

CP 2008, *Protection of iron and steel structures from corrosion.*

CP 2010, *Pipelines — Part 1: Installation of pipelines in land.*

CP 2011, *Safety precautions in the construction of large diameter boreholes for piling and other purposes.*

CP 3003, *Lining of vessels and equipment for chemical processes.*

CP. . . , *Cathodic protection*¹⁾.

CP. . . , *Thermally insulated underground piping systems*¹⁾.

PD 8010-1, *Code of practice for pipelines — Part 1: Steel pipelines on land.*

PD 8010-2, *Code of practice for pipelines — Part 2: Subsea pipelines.*

BS EN 14161, *Petroleum and natural gas — Pipeline transportation systems.*

The essentials of a pipeline are the pipes themselves and the many types of joint which make them into pipelines. It is not feasible to write a simple Code which would apply to all the possible combinations of these essentials. The Code is therefore arranged in parts; this part covers the design and construction of pipelines utilizing steel pipes. Appendix A shows the types of pipeline covered by this and other parts of the Code and against each type are shown some of the present general applications. The choice of pipeline for any particular application depends on the service and environmental conditions to be satisfied. With the increasing use of pipelines and the development of new materials and jointing methods, changes in application and in design can be expected, but it is the responsibility of every pipeline promoter to ensure that the pipeline selected will be entirely suitable and safe for the duty envisaged.

The start and finish of text introduced by Amendment No. 1:2006 is indicated in the text by tags **A1** **A1**. Only the foreword is affected by this amendment.

A1 For all pipeline design, construction and operation, refer to BS EN 14161, PD 8010-1 and PD 8010-2.

CP 2010-2:1970 has been retained for the use of some methods and details of design for Category A pipeline fluids. It is not suitable for Category B, C, D or E fluids. **A1**

¹⁾ In course of preparation

Metric conversions are given in International System (SI) units and are approximate. More accurate conversions should be based on BS 350, *“Conversion factors and tables”*, Part 2, *“Detailed conversion tables”*, and Supplement No. 1 (PD 6203), *“Additional tables for SI conversions”*.

For further information, reference should be made to BS 3763, *“The International System (SI) units”*, and PD 5686, *“The use of SI units”*.

This part of the Code will be revised in metric terms as part of BSI’s programme of metrication.

NOTE This part of the Code includes reference to certain API Standards in the absence of international agreement in this field. ISO/TC 67, Materials and Equipment for Petroleum and Natural Gas Industries, is however preparing ISO Recommendations based on these API Standards, and as soon as international agreement has been reached comparable British Standards will be prepared.

This Code of Practice represents a standard of good practice and takes the form of recommendations.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard Code of Practice cannot confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to vi, pages 1 to 34 and a back cover.

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1 General

1.1 Scope

This part of the Code gives recommendations for the materials, components, design, fabrication, construction, workmanship and testing of steel pipelines. Recommendations which are specific to butt-welded pipelines are dealt with in Section 2, whilst those for pipelines with other than butt-welded joints are dealt with in Section 3. The Code does not apply to pipeline installations which are covered by BS 806²⁾ nor to piping systems which are covered by BS 3351³⁾. Reference should be made to **1.3** and to Table 1. This part of the Code should be read in conjunction with Part 1⁴⁾; Clauses **103** and **206**, in particular, deal with considerations which may affect the design of the pipeline.

NOTE In place of the customary, but incorrect, use of the pound as a unit of force, the unit called a pound-force (abbreviation lbf) has been used in this Code. It is that force which, when acting on a body of mass one pound, gives it an acceleration equal to that of standard gravity.

1.2 Definitions

For the purposes of this part of the Code, the following definitions apply:

1.2.1

grade tapering

the changing of pipe thickness or material to suit different internal design pressures along sections of a pipeline depending upon the operating hydraulic gradient and its relation with the pipeline profile

1.2.2

holiday detector

a device for detecting flaws in pipe coatings

1.2.3

night-cap

a temporary end closure

1.2.4

“orange peel” swage

a method of reducing the diameter of a pipe to that of a smaller diameter pipe by vee-notching the larger pipe-end longitudinally and closing and welding the seams

1.2.5 Pig

A device which is passed through the pipeline for various purposes. Pigs may be propelled by air, gas or water, or carried in the fluid passing through the pipeline. The following are the main types:

1.2.5.1

batching pig

a pig used on multiproduct lines to separate one product from the next. It is constructed on the same principle as a swabbing pig

1.2.5.2

cleaning pig

a pig used for cleaning the inside surface of pipelines. It consists of a central bar with two driving cups and a circular wire brush at the front. A second circular wire brush may be mounted between the two driving cups. Some types have spring loaded arms carrying wire brush segments instead of circular brushes

1.2.5.3

foam pig

a cylinder of material such as expanded polyurethane which can be compressed for insertion into the pipeline and used for cleaning or swabbing

²⁾ BS 806, “Ferrous pipes and piping installations for and in connection with land boilers”.

³⁾ BS 3351, “Piping systems for the petroleum industry”.

⁴⁾ CP 2010, Part 1, “Installation of pipelines in land”.

1.2.5.4

gauging pig

a pig used to test the internal diameter of a pipeline. It is essentially a swabbing pig with a hard-faced steel disc on the front, the disc diameter usually being 95 % of the internal diameter of the pipeline

1.2.5.5

scraping pig (go-devil)

a pig which consists of a bar on which are mounted driving cups, spring loaded scraper blades and spring loaded serrated wheels. These pigs are usually longer than other types and are therefore sometimes articulated

1.2.5.6

sphere

a thick neoprene sphere which can be inflated by internal water (or other liquid) pressure and which is used in the same manner as a batching pig

1.2.5.7

swabbing pig

a pig used for cleaning. Generally it consists of a central bar with two or four driving cups

1.2.6

pipeline

a line of pipes having an appreciable length; it may have branch lines, but these would not normally be numerous. It does not include piping systems such as process plant piping within refineries, factories or treatment plant, short connections between adjacent plant nor distribution and service mains which are characterized by numerous branch connections. (Reference should also be made to Figure 1)

1.2.7

purging

the removal of air from a section of pipeline prior to commissioning for conveyance of a gas

1.2.8

steel

material used for the manufacture of pipes listed in Table 2a

1.2.9

stopple

a device which can be inserted into a pipe in such a way as to stop the flow

1.2.10

stray flash

the damage on the parent material resulting from the accidental striking of an arc away from the weld

1.2.11

stringing

the distribution of single pipes in the approximate position in which they will be joined into the pipeline

1.2.12

tie-in

a weld made to join together two previously-welded lengths of pipeline

1.3 Application

Table 1 shows the present general applications for steel pipelines. The choice of pipeline will depend upon service conditions and environment. Service conditions include maximum operating pressure, maximum and minimum operating temperatures, the extent of chemical and physical reaction between the material carried and the pipe and joint material, and the flammability or toxicity of the material carried.

Environmental factors relate to the route of the pipeline and include the amount of open country or built-up areas along the route, the nature of the soil, the presence of areas liable to subsidence, the existence of exposed aquifers, fire risks of the areas traversed and any other condition which might affect the pipeline.

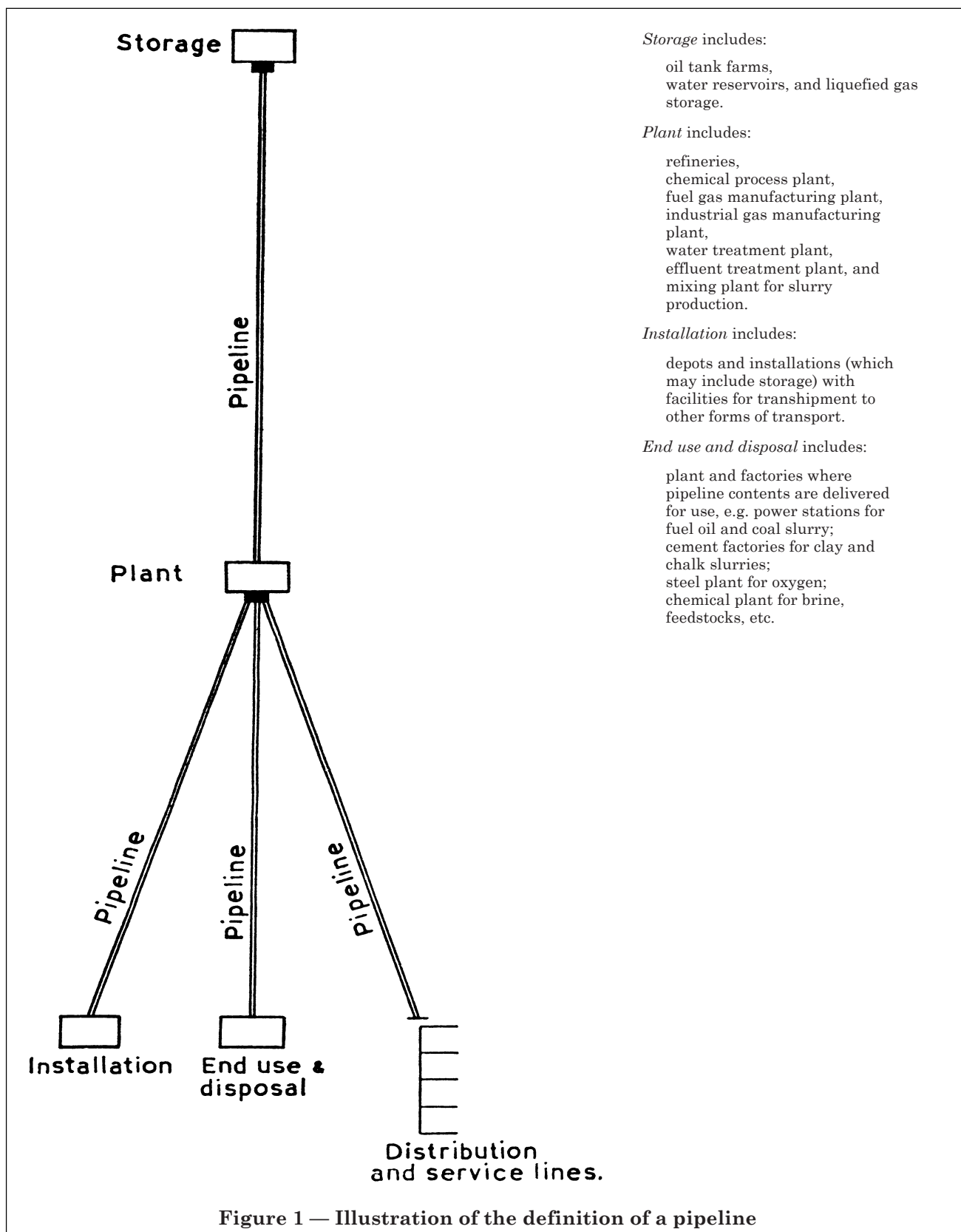


Table 1 — Present general applications of the steel pipeline

Fluid	Pipelines with butt-welded joints	Pipelines with other than butt-welded joints
Crude oil and petroleum products	A	
Liquefied petroleum gases	A	
Natural gas	A	A ^c
Town gas	A	A ^c
Industrial gases	A	
Water	A ^b	A ^b
Slurries and sludges	A	A
Chemicals	A ^b	A ^b
Trade effluents and sewage ^a	A ^b	A ^b
Brine	A ^b	A ^b
A = the general application.		
^a See also CP 2005, “Sewerage”.		
^b These applications may require the pipeline to be lined to prevent internal corrosion.		
^c This type of pipeline is used for the conveyance of town and natural gases at lower operating pressures.		

Pipelines are unlikely to be required to operate outside the temperature range – 13 °F to + 250 °F (– 25 °C to + 120 °C). Within this range of metal temperatures the specified minimum yield stress f_y (see 2.2.2.2) need not be varied. In the event of pipelines being required to operate outside this range reference should be made to specifications such as BS 806⁵⁾ and BS 3351⁶⁾, where design stresses for pipe materials at other temperatures are given.

There are bound to be certain border-line cases between a pipeline and a piping system (see 1.2.6). In such cases, this Code should be used if its adoption would lead to greater safety.

1.4 Safety

1.4.1 The recommendations of this Code are considered to be adequate to ensure public safety under conditions usually encountered in pipelines, including lines within towns, cities, water catchments and industrial areas. In designing a pipeline, extra protection should be considered to prevent damage arising from unusual conditions, for example abnormal corrosive conditions, river crossings, bridges, areas of heavy traffic, long self-supported spans, vibration, weight of special attachments, ground movement and any other abnormal forces, and in areas where the depth of cover is less than the recommended minimum.

1.4.2 Examples of protective measures which may be provided are:

- 1) increasing the pipe wall thickness,
- 2) adding a protective coating of concrete or similar protective material that does not screen cathodic protection measures,
- 3) using thicker coatings to give better protection against external corrosion,
- 4) placing the line at a greater depth than is normal,
- 5) indicating the presence of the line with additional markers,
- 6) providing a sleeve,
- 7) adopting a pipeline layout which provides adequate flexibility, and
- 8) providing protection from impact for above-ground pipelines.

⁵⁾ BS 806, “Ferrous pipes and piping installations for and in connection with land boilers”.

⁶⁾ BS 3351, “Piping systems for the petroleum industry”.

Since the object of these measures is to give increased safety, care is needed to ensure that the extra protection given does in fact lead to greater safety. Extra thickness in steel pipes does not necessarily give adequate additional protection against corrosion and, where this is a danger, attention should be given to the use of thicker protective coatings, with adequate cathodic protection, and to the use of inhibitors or linings, depending on whether the corrosion is external or internal. Similarly, extra thickness may not give effective protection against damage to pipes as a result of excavating in proximity to them; here the use of protective concrete or other coatings, distinctive marker tiles or additional marker posts should be considered. The use of sleeves is recommended where the pipeline has to be shielded from live loads or where it may be necessary to withdraw the pipe without further excavation.

1.5 Inspection

The safety of a completed pipeline depends more on the standards and quality of inspection applied at all stages, than on any other single feature.

Inspection starts at the factory where pipes and components are manufactured (clauses concerning the rights of inspection are covered in the relevant British Standards and API Standards) and continues through all stages of construction.

Particular emphasis is laid on the inspection of welding, coating, lowering, backfilling and testing, and any sub-standard materials or workmanship should be rectified, or where necessary rejected, before any further work is done on the particular part.

2 Steel pipelines with butt-welded joints

2.1 Suitability, materials and components

2.1.1 Suitability. The pipelines covered by this section are suitable for conveying all fluids although, where the pipeline contents are corrosive to steel, the pipeline should be lined⁷⁾ or suitable inhibitors added to the contents. This type of construction should be used where 100 % line tightness is essential for reasons of safety. The butt-welded steel pipeline is less liable to leakage as a result of ground movement.

2.1.2 Materials and components. The mechanical properties and weldability of the pipe and components should be at least equivalent to those required by the specifications listed in Table 2. All materials should be adequate to meet the maximum operating conditions and the appropriate tests given in 2.5.

Materials which will be exposed to low temperatures should have properties suitable for the lowest temperature to be encountered.

The transition temperature to brittle fracture of the pipe steel should be below the lowest temperature to which the pipeline is likely to be subjected either during testing or during operation. This may be determined by Charpy V-notch tests to BS 131, Part 2⁸⁾, drop weight tear tests or similar tests, at different temperatures.

2.1.3 Factory-made bends

2.1.3.1 Bends made from pipe. All bends made from pipe, whether bent hot or cold, result in a thinning of the pipe wall at the outer arc to an extent depending upon the radius of the bend relative to the diameter of the pipe; due allowance should be made for this when designing.

For hot bends, where using steel pipe whose mechanical properties depend upon previous cold expansion, it should be remembered that subsequent heating can reduce the yield stress; due allowance should be made for this.

At no point along a bend should ovality reduce the bore diameter by more than 2.5 %.

Wrinkle bends should not be used.

2.1.3.2 Fabricated bends. The use of gusseted bends made from wedge-shaped sections of straight pipe should be avoided wherever possible. Where used, they should be stress relieved and subjected to 100 % radiographic inspection.

Fabricated bends of smooth radius may be made by shaping plate and subsequent welding. These are used mainly in the larger diameters.

⁷⁾ CP 3003, "Lining of vessels and equipment for chemical processes".

⁸⁾ BS 131, "Methods for notched bar tests", Part 2, "The Charpy V-notch impact test".

Table 2 — Standards for materials and components for butt-welded pipelines

a. Pipes

Number	Title
BS 3601	<i>Steel pipes and tubes for pressure purposes. Carbon steel: ordinary duties.</i>
BS 3602	<i>Steel pipes and tubes for pressure purposes. Carbon steel: high duties.</i>
API Std 5L ^a	<i>Specification for line pipe.</i>
API Std 5LX ^a	<i>Specification for high-test line pipe.</i>
API Std 5LS ^a	<i>Specification for spiral weld line pipe.</i>

b. Components

Number	Title	Remarks
BS 534	<i>Steel pipes, fittings and specials for water, gas and sewage.</i>	These pipes are intended for the uses named.
BS 1414	<i>Flanged and butt-welding end steel outside-screw-and-yoke wedge gate valves for the petroleum industry.</i>	
BS 1570	<i>Flanged and butt-welding end steel plug valves for the petroleum industry (excluding well-head and flow-line valves).</i>	
BS 1640	<i>Steel butt-welding pipe fittings for the petroleum industry — Part 1: Wrought carbon and ferritic alloy steel fittings.</i>	
BS 1868	<i>Flanged steel check valves for the petroleum industry.</i>	
BS 1965	<i>Butt-welding pipe fittings for pressure purposes — Part 1: Carbon steel.</i>	These pipe fittings are not normally used for petroleum or for liquefied petroleum gases. (See BS 1640.)
BS 2591	<i>Glossary for valves and valve parts (for fluids).</i>	
API Std 6D ^a	<i>Specification for steel gate, plug, ball, and check valves for pipeline service.</i>	
API Std 600 ^a	<i>Flanged and butt-welding-end steel gate and plug valves for refinery use.</i>	
See Table 7 <i>b</i> for standards for components, other than butt-welding, sometimes used in butt-welded pipelines.		
^a Published by the American Petroleum Institute and available from the British Standards Institution.		

2.1.3.3 Butt-welding elbows. Butt-welding elbows should comply with BS 1640, Part 1⁹⁾, or BS 1965, Part 1¹⁰⁾. Butt-welding elbows to BS 1965, Part 1¹⁰⁾, are not normally used for petroleum or for liquefied petroleum gases.

2.1.3.4 Dimensions. The dimensions of factory-made bends should be such that pipeline pigs and swabs, where used, will negotiate the bends.

In all bends the minimum thickness of the finished bend and the material used should be such as to give a pressure rating equivalent to that of the pipes to which they will be connected.

2.1.4 Miscellaneous fittings

2.1.4.1 Reducers. Reductions in pipe diameter should be made by means of smoothly-contoured reducers complying with BS 1640, Part 1⁹⁾, or BS 1965, Part 1¹⁰⁾, or by fabricated taper pipes for larger sizes than those covered by these specifications.

“Orange peel” swages should not be used.

2.1.4.2 Branch connections. Tees complying with BS 1640, Part 1⁹⁾, or BS 1965, Part 1¹⁰⁾, should be used for branch connections (see also 2.2.6).

⁹⁾ BS 1640, “Steel butt-welding pipe fittings for the petroleum industry”, Part 1, “Wrought carbon and ferritic alloy steel fittings”.

¹⁰⁾ BS 1965, “Butt-welding pipe fittings for pressure purposes”, Part 1, “Carbon steel”.