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FERROUS PIPES AND PIPING INSTALLATIONS

FOR & IN CONNECTION WITH LAND BOILERS

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BRITISH STANDARD SPECIFICATION

FERROUS PIPES AND PIPING INSTALLATIONS

FOR AND IN CONNECTION WITH LAND BOILERS

B.S. 806 : 1954

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THIS BRITISH STANDARD, having been approved by the Mechanical Engineering Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council on 15th January, 1954.

First published, August, 1938.
First revision, January, 1942.
Second revision, January, 1954.

The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the standards to which they refer.

This standard makes reference to the following British Standards:—

B.S. 10. Tables of pipe flanges (for land use).
B.S. 18. Tensile testing of metals.
B.S. 592. Carbon steel castings for general engineering purposes.
B.S. 639. Covered electrodes for the metal-arc welding of mild steel.
B.S. 759. Valves, gauges and other safety fittings for land boiler installations.
B.S. 1113. Water tube boilers and their integral superheaters.
B.S. 1387. Steel tubes and tubulars suitable for screwing to B.S. 21, Pipe threads.
B.S. 1398. Carbon-molybdenum steel castings.
B.S. 1452. Grey iron castings.
B.S. 1740. Wrought pipe fittings, iron and steel, screwed B.S.P. thread.
B.S. 1821. Oxy-acetylene welding of high temperature and high pressure pipe lines.
B.S. 2653.* Metal arc welding of high temperature and high pressure pipe lines.
B.S. 2079. Steam receivers and separators.

* In course of preparation.

MEE/34/8/4

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CO-OPERATING ORGANIZATIONS

The Mechanical Engineering Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government Departments and scientific and industrial organizations:—

*Admiralty
Air Ministry
*Associated Offices Technical Committee
*Association of Consulting Engineers (Incorporated)
*British Chemical Plant Manufacturers' Association
British Compressed Air Society
*British Electrical and Allied Manufacturers' Association
*British Electricity Authority and Area Boards
*British Engineers' Association
British Internal Combustion Engine Manufacturers' Association
*British Iron and Steel Federation
*British Railways, The British Transport Commission
*Crown Agents for the Colonies
D.S.I.R.—Mechanical Engineering Research Organization
*Engineering Equipment Users' Association
*Gas Council
*High Commission of India
*Institute of Marine Engineers
Institute of Petroleum
*Institution of Civil Engineers
*Institution of Gas Engineers
*Institution of Heating and Ventilating Engineers
*Institution of Mechanical Engineers
Institution of Mechanical Engineers (Automobile Division)
Institution of Production Engineers
*Locomotive Manufacturers' Association
Machine Tool Trades Association
*Ministry of Fuel and Power
*Ministry of Labour and National Service (Factory Department)
Ministry of Supply
*Ministry of Transport
*Ministry of Works
*National Physical Laboratory
Radio Industry Council
War Office

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, and the following scientific and industrial organizations, were directly represented on the committee entrusted with the preparation of this standard:—

Brass and Copper Tube Association
British Coal Utilization Research Association
British Welding Research Association
Combustion Engineering Association
Copper Development Association
Institute of Welding
Institution of Electrical Engineers
Insurance Engineers Ltd.
Lloyd's Register of Shipping
Oil Companies Materials Committee
Water-tube Boilermakers' Association
Individual Tube Manufacturers

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BRITISH STANDARD SPECIFICATION FOR

FERROUS PIPES AND PIPING INSTALLATIONS

FOR AND IN CONNECTION WITH LAND BOILERS

FOREWORD

This British Standard, first published in 1938 and subsequently revised in 1942, forms one of a series for land boiler installations, the preparation of which was authorized by the Mechanical Engineering Industry Standards Committee. The 1942 edition has been extensively revised to form the present edition.

The scope of this standard has been extended to provide for developments which have taken place in pipework installation practice, notably in the use of alloy steel.

Reference is made to standards for requirements to be observed for welding and associated techniques and to other standards for use in conjunction with this standard. Requirements for flange material and flange bolts and nuts have been transferred to B.S. 10, 'Tables of pipe flanges (for land use)' (under revision).

The testing procedure required by Part 2 applies to Part 3 throughout.

In determining values of design stresses for use in the appropriate formulae, account has been taken of current data on the physical properties of the materials covered by this standard.

The term 'maximum permissible working pressure' used in the Factories Act, 1937, has been omitted in favour of the term 'design pressure'. The terms 'design pressure' and 'design temperature' are used throughout the standard to denote the values of pressure and temperature to be employed for the purpose of calculations.

SPECIFICATION

PART 1. GENERAL

SCOPE

1. This standard applies to the design and construction of the ferrous pipework connecting a land steam boiler to engine, turbine or industrial plant and all auxiliary pipework in connection therewith, together with the pipes and pipe fittings forming parts of such installations for:

a. pipes of any bore where the pressure exceeds 50 lb/sq. in.

b. pipes over 10 in. bore for steam at pressures up to and including 50 lb/sq. in.

This standard does not apply to the use of carbon steel where the temperature exceeds 900°F., or to the use of alloy steel where the temperature exceeds 975°F.

The term 'pipe fitting' in this standard includes tees, elbows, and specials, but excludes everything covered by B.S. 759, 'Valves, gauges and similar fittings for land boiler installations'.

Steam receivers and separators are also excluded from this standard (see B.S. 2079, 'Steam receivers and separators').

Representation of pipes as complying with this standard is prohibited where any requirements of the standard have been waived (except as provided for in Clause 90 *b*).

CLASSIFICATION OF PIPES

2. The following classes of pipes are covered by this standard:—

Class A	Cold drawn seamless carbon steel pipes.
Classes B and C	Hot finished seamless carbon steel pipes.
Class D	Hydraulic lapwelded carbon steel pipes.
Class E	Roll lapwelded carbon steel pipes.
Amd. 2 Class F	Buttwelded carbon steel pipes.
Class M	Cold drawn seamless molybdenum steel pipes.
Class P	Cold drawn seamless chromium molybdenum steel pipes.
Class Q	Hot finished seamless chromium molybdenum steel pipes.
Castings	Cast iron, carbon steel, molybdenum steel.

SYMBOLS

3. The symbols used in the formulae in this standard shall be defined as follows:—

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D = outside diameter of the pipe in inches.*

d = bore of the pipe in inches.* This should not be confused with 'nominal bore' which is an accepted designation associated with outside diameters of standard rolling sizes.

t_f = thickness of pipe in inches calculated by the appropriate formula. This is used to determine the size of weld recesses and other dimensions of welds in fabricated items.

$t_b = t_f$ + bending allowance.

t_m = calculated thickness of branch or main at a branch position.

t = thickness (preferably specified from Appendix E) which, after allowance for manufacturing tolerance, gives a remainder of not less than t_f, t_b or t_m as the case may be.

T = design temperature in degrees Fahrenheit.

P = design pressure in pounds per square inch.

S = maximum permissible design stress in pounds per square inch.

e = weld efficiency factor.

H = hydraulic test pressure in pounds per square inch.

A = cross-sectional area of tensile test piece in square inches.

INFORMATION TO BE SUPPLIED BY THE PURCHASER

4. The purchaser shall state in all enquiries and orders:

a. The design pressures and temperatures as defined in Clause 5, except where straight pipes with plain ends are ordered to classes covered by this standard to specified outside diameters and thicknesses, when the design temperatures and pressures need not be stated. The values so specified shall be the design pressures and temperatures for the purposse of this standard.

NOTE. It is the responsibility of the purchaser to ensure that the requirements of Clause 5 are fulfilled.

b. The name of the inspecting authority, if any.

c. Whether or not the purchaser or his representative desires to witness the mechanical or other tests.

d. Whether or not the purchaser desires to receive test certificates.

e. For steel castings, whether or not repair by welding is permitted without the previous sanction of the purchaser or his representatives (see B.S. 592,† Cl. 15 *a*).

f. Whether in the case of Class B pipes the supplementary requirements of Clause 23 *a* (iii) apply.

If the purchaser omits to give the information required for items *b*, *c*, *d*, *e* or *f* the manufacturer shall be entitled to act as if items *b*, *c*, *d* or *f* have been answered negatively and item *e* affirmatively.

* These diameters are subject to manufacturing tolerances as given in Part 3, but these tolerances are not to be used in the evaluation of formulae.

† B.S. 592, 'Carbon steel castings for general engineering purposes'. See Amd. No.

DEFINITIONS

5. For the purposes of this British Standard the pressures and temperatures for which pipes and pipe fittings are designed, shall be defined as follows:—

a. Design pressure for steam piping. The design pressure for steam piping shall be the design pressure of the boiler except that:

(i) Where the total capacity of the safety valves on the superheater is not less than 20 per cent of the total evaporative capacity of the boiler, the design pressure of the steam piping thereafter shall be the highest pressure at which any superheater safety valve is to be set to lift, provided that in no case shall the design pressure be less than 90 per cent of the design pressure of the boiler.

(ii) The design pressure of steam piping integral with the boiler shall comply with the requirements of B.S. 1113.*

(iii) The design pressure of reduced pressure systems shall be as specified in Clause 82.

b. Design pressure for feed piping. The design pressure shall be the maximum pressure which can be generated at the outlet of the boiler feed pumps, unless special provision is made which prevents that pressure from being wholly communicated to the pipeline, when the design pressure shall be the maximum pressure which can be communicated to the pipeline.

c. Design temperature for steam piping. The design temperature for steam piping shall be:

(i) For main steam piping, the rated temperature at the superheater outlet.

(ii) For reheated steam piping, the rated temperature at the reheater outlet.

(iii) For other steam piping the highest rated temperature at the higher temperature end of the pipes,

provided in all cases that in service:

A. The temperature on the average during any one year of operation does not exceed the design temperature, and

B. Normal fluctuations in temperature do not exceed the design temperature by more than 25°F., and

C. Abnormal fluctuations in temperature do not exceed the design temperature by more than:

35°F. for a maximum of 400 hours in any one year,
and not more than
60°F. for a maximum of 80 hours in any one year.

Where the maximum temperature exceeds these limits the design temperature shall be increased by the amount of this excess.

* B.S. 1113, 'Water tube boilers and their integral superheaters'.

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PART 2. TESTING PROCEDURE FOR PIPES BEFORE MANIPULATION OR FABRICATION

APPLICATION

6. The provisions of Part 2 of this standard shall apply to each class of pipe in Part 3.

TESTING FACILITIES

7. The manufacturer shall, at his own cost, furnish and prepare the necessary test pieces and perform the hydraulic test. If the testing is to be done on his own premises, the manufacturer shall supply the necessary labour and appliances. Failing facilities at his own works for making the tests, the manufacturer shall bear the cost of making the tests elsewhere.

NUMBER OF SETS OF TESTS

8. The number of pipes on which mechanical tests shall be performed (except insofar as Clause 23 *a* (iii) and Clause 25 apply) shall be as follows:

Seamless pipes;	
Up to and including 4½ in. o.d.	2 per cent of the lengths of pipes as made.
Over 4½ in. o.d.	5 per cent of the lengths of pipes as made, or 2 per cent of the pipes from each cast where the cast (i.e. melt) can be identified.
Welded pipes;	2 per cent of the lengths of pipes as made.

ADDITIONAL TESTS

9. Should a pipe selected for testing fail in any one or more of the specified tests appropriate to the class of pipe, two further tests of the same kind may be made from the same or another pipe from the same batch. Should either of these further tests fail, the pipes represented may be heat-treated again and then re-tested in accordance with all the appropriate clauses. If the repeat tests are satisfactory, the pipes shall be accepted, provided that they comply in all other respects with the requirements of this standard, but if failure again occurs, the pipes which the test pieces represent shall be deemed not to comply with this standard.

CONDITION OF PIPES

10. All pipes shall be commercially straight, free from longitudinal seaming, grooving, blistering, or other injurious surface marks, and shall be as free as is practicable from rust. Surface marks may be dressed provided

that the thickness of the pipe after dressing is not less than the required minimum thickness (t minus the manufacturing tolerance. See Clause 3). The ends shall be cut square.

INSPECTION

11. The purchaser or his representative shall have access, at all reasonable times, to those parts of the works engaged on the production and testing of the pipes which he has ordered.

TEST CERTIFICATES

12. Where test certificates are required they shall give the test results and a statement of the process of manufacture of the steel.

TENSILE TEST

13. The tensile test shall be made on any one of the following at the manufacturer's option:—

a. A test length taken from a finished pipe (ends of the test length to be plugged for grips)

b. A strip not more than 1½ in. wide, cut longitudinally from a pipe and tested in its curved condition. The ends may be flattened for gripping in the testing machine. For lapwelded pipes, the test piece may be cut transversely and flattened before testing (see also *d*).

c. Test piece ' C ', B.S. 18* (see Appendix C).

d. Test piece ' A ', B.S. 18,* cut transversely, if on the plate from which the pipe is to be made (see Appendix C).

In the tensile tests, both the tensile strength in tons per square inch and the percentage elongation shall be measured. For test lengths *a* and *b*, any gauge length may be used but the percentage elongation is specified in this standard with reference to a $4\sqrt{A}$ gauge length. For any gauge length used, the corresponding elongation on $4\sqrt{A}$ can be obtained by calculation, as shown in Appendix D. It is suggested, however, that for general convenience a gauge length of 2 in. should be used, when the corresponding elongation referred to $4\sqrt{A}$ can be obtained from Table 9.

Test piece ' C ', B.S. 18, has a 2 in. gauge length which is equal to $4\sqrt{A}$.

The percentage elongation required on $4\sqrt{A}$ is given as 700 divided by the tensile strength in tons per square inch. The tensile strength used in this connection is the actual value obtained from the same test piece.

FLATTENING TEST (ON PIPES UP TO AND INCLUDING 4½ IN. O.D. AND ON LARGER PIPES WHERE CLAUSE 23 *a* (iii) APPLIES)

14. A ring, not less than 1½ in. in length, cut from one end of each selected pipe, when cold, shall be flattened between two parallel flat

B.S. 18, ' Tensile testing of metals '.

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surfaces without showing either crack or flaw, until, when the pressure is released, the interior surfaces of the test piece remain at the middle a distance apart not greater than the value given in the appropriate clause in Part 3. The weld in a test piece from a welded pipe shall be placed at 45° to the direction of flattening.

BEND TEST (ON PIPES OVER 4½ IN. O.D.)

15. A strip, not less than 1½ in. wide, cut circumferentially from one end of each selected pipe or transversely from one end of each selected plate, when cold, shall be doubled over round a bar of the diameter specified in the appropriate clause in Part 3 without showing either crack or flaw. A circumferential test piece, cut from a pipe, shall be bent in the direction of original curvature.

On welded pipes: a. Where the test is on the pipe material, the strip shall be cut clear of the weld.

b. Where the test is on the weld, the strip shall be cut so that the weld is near the middle of the strip, and the weld shall be placed at the point of maximum bending.

HYDRAULIC TEST

16. Every pipe, while straight and with plain ends, shall be tested at the manufacturer's works, to the hydraulic pressure (pounds per square inch) calculated by the appropriate formula in the following table or to 1000 lb/sq. in., whichever is the less. The calculated hydraulic test pressures derived from the following formulae or from equation 9 in Clause 87, although exceeding 1000 lb/sq. in., may be applied by special arrangement between the purchaser and the manufacturer:—

Classification	Where D is specified	Where d is specified
Welded pipes	$30\,000\,\frac{t}{D}$	$30\,000\,\frac{t}{d+2t}$
Seamless carbon steel pipes	$35\,000\,\frac{t}{D}$	$35\,000\,\frac{t}{d+2t}$
Seamless molybdenum steel and chromium molybdenum steel pipes	$40\,000\,\frac{t}{D}$	$40\,000\,\frac{t}{d+2t}$

PART 3. PIPES

(See Part 2 for Testing Procedure)

CLASS A. COLD DRAWN SEAMLESS CARBON STEEL PIPES

MATERIALS

17. The pipes shall be made of steel produced by the open hearth or an electric process, acid or basic. The material of the pipes shall show on analysis not more than 0·05 per cent of sulphur and not more than 0·05 per cent of phosphorus. For design temperatures over 750°F., the steel shall be of non-segregated or fully-killed type.

HEAT-TREATMENT

18. The pipes shall be suitably heat-treated throughout their length after the operation of drawing.

TENSILE TEST

19. Tensile strength: Not less than 23 tons/sq. in.
Not more than 30 tons/sq. in.

Percentage elongation on gauge length of $4\sqrt{A}$: Not less than 700 divided by the tensile strength of the specimen.

FLATTENING TEST

20. Distance apart of interior surfaces:
$4t$ or two-thirds of the bore, whichever is the less.

BEND TEST

21. For pipes up to and including ⅜ in. thick: Bar diameter = $3t$

For pipes over ⅜ in. thick: Bar diameter = $4t$, or two-thirds of the bore, whichever is the less.

PERMISSIBLE VARIATION IN THICKNESS, DIAMETER AND LENGTH

22. The thickness, diameter and length of each pipe shall be within the following tolerances:—

	Under 6 in. bore	6 in. bore and over
a. Thickness	plus 10 per cent minus 10 per cent	plus 10 per cent minus 10 per cent
b. Bore	— —	plus 1/32 in. minus 1/16 in.
c. Outside diameter	plus 1 per cent minus 1 per cent	— —
d. Length where specified 'exact' or 'cut length'	plus ¼ in. minus 0.	plus ¼ in. minus 0.

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CLASSES B AND C. HOT FINISHED SEAMLESS CARBON STEEL PIPES

MATERIAL

23. *a. Class B for design temperatures up to and including 900°F.*

(i) For design temperatures up to and including 750°F., the pipes shall be made of steel produced by an open hearth or an electric process, acid or basic. The material of the pipes shall show on analysis not more than 0·05 per cent of sulphur and not more than 0·05 per cent of phosphorus.

(ii) For design temperatures over 750°F. up to and including 800°F., the pipes shall be made of steel in accordance with paragraph (i) above, and in addition the steel shall be of the non-segregated or fully-killed type.

(iii) *Supplementary requirements.* For design temperatures over 800°F. up to and including 900°F. or other applications where a superior grade of pipe is required, the pipes shall be made of steel in accordance with paragraph (ii) above and in addition special precautions shall be taken to ensure that the surface condition of the pipes is suitable for these requirements. The manufacturer shall test every pipe over 4½ in. o.d. in accordance with Clause 14.

b. Class C for design temperatures up to and including 500°F. The pipes shall be made of steel produced by the Bessemer, open hearth or an electric process, acid or basic. If the Bessemer process is used, the steel shall be made by a manufacturer approved by the purchaser. The material of the pipes shall show on analysis not more than 0·06 per cent of sulphur and not more than 0·06 per cent of phosphorus.

TENSILE TEST

24. CLASS B:

Tensile strength:	Not less than 23 tons/sq. in. Not more than 30 tons/sq. in.
Percentage elongation on gauge length of $4\sqrt{A}$:	Not less than 700 divided by the tensile strength of the specimen.

CLASS C:

Tensile strength:	Not less than 22 tons/sq. in. Not more than 30 tons/sq. in.
Percentage elongation on gauge length of $4\sqrt{A}$:	Not less than 700 divided by the tensile strength of the specimen.

FLATTENING TEST

25. *For materials specified in Clause 23 a (i) and in Clause 23 a (ii) and in Clause 23 b.* For pipes up to and including 4½ in. o.d. Distance apart of interior surfaces:

$4t$ or two-thirds of the bore, whichever is the less.

For material specified in Clause 23 a (iii). All pipes over 4½ in. o.d. shall be tested in accordance with Clause 14. Distance apart of interior surfaces:

$4t$ or two-thirds of the bore, whichever is the less.

BEND TEST

26.

For pipes up to and including ⅜ in. thick	Bar diameter = $3t$
For pipes over ⅜ in. thick	Bar diameter = $4t$, or two-thirds of the bore, whichever is the less.

PERMISSIBLE VARIATION IN THICKNESS, DIAMETER AND LENGTH

27. The thickness, outside diameter and length of each pipe shall be within the following tolerances:—

	Ratio: thickness/o.d.	Tolerance
a. Thickness	Up to and including 3 per cent	plus 15 per cent minus 15 per cent
	Over 3 per cent up to and including 10 per cent	plus 12½ per cent minus 12½ per cent
	Over 10 per cent: pipes up to and including 6⅝ in. o.d.	plus 12½ per cent minus 12½ per cent
	Over 10 per cent: pipes over 6⅝ in. o.d.	plus 10 per cent minus 10 per cent
b. Outside diameter	Up to and including 1²⁹⁄₃₂ in. o.d.	plus ½₄ in. minus ½₃₂ in.
	Over 1²⁹⁄₃₂ in. o.d.	plus 1 per cent minus 1 per cent
c. Length where specified 'exact' or 'cut length'		plus ¼ in. minus 0.

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CLASS D. HYDRAULIC LAPWELDED CARBON STEEL PIPES

MATERIAL

28. The pipes shall be made of steel produced by the open hearth or an electric process, acid or basic.

The material shall show on analysis not more than 0·05 per cent of sulphur and not more than 0·05 per cent of phosphorus.

TENSILE TEST

29. Tensile strength:	Not less than 23 tons/sq. in. Not more than 28 tons/sq. in.
Percentage elongation on gauge length of $4\sqrt{A}$:	Not less than 700 divided by the tensile strength of the specimen.

BEND TEST

30. *On the material:*

Up to and including ⅜ in thick	Bar diameter = $3t$
Over ⅜ in. thick	Bar diameter = $4t$
On the weld:	Bar diameter = $8t$

PERMISSIBLE VARIATION IN THICKNESS, DIAMETER AND LENGTH

31. The thickness, outside diameter and length of each pipe shall be within the following tolerances:—

a. Thickness. On the body excluding the weld	plus 10 per cent minus 5 per cent
At the weld For pipes: Under ⅜ in. thick	plus 10 per cent minus 3/64 in.
⅜ in. thick up to and including ⅞ in. thick	plus 10 per cent minus 1/16 in.
Over ⅞ in. thick	plus 10 per cent minus 3/32 in.
b. Outside diameter	plus 1 per cent minus 1 per cent
c. Length where specified 'exact' or 'cut length'	plus ¼ in. minus 0.

CLASS E. ROLL LAPWELDED CARBON STEEL PIPES

MATERIAL

32. The pipes shall be made of steel produced by the Bessemer, open hearth or an electric process, acid or basic.

The material shall show on analysis not more than 0·06 per cent of sulphur and not more than 0·06 per cent of phosphorus.

FLATTENING TEST

33. Distance apart of interior surfaces:

$4t$ or two-thirds of the bore, whichever is the less.

EXPANDING TEST

34. The ends of the selected pipes, when cold, shall be expanded to the following increase in diameter without showing either crack or flaw:—

Up to and including 6 S.W.G.	7·5 per cent
Thicker than 6 S.W.G.	5 per cent

TENSILE TEST

35. Tensile strength:	Not less than 22 tons/sq. in. Not more than 28 tons/sq. in.
Percentage elongation on gauge length of $4\sqrt{A}$:	Not less than 700 divided by the tensile strength of the specimen.

BEND TEST

36. *On the material:*

Up to and including ⅜ in. thick	Bar diameter = $3t$
Over ⅜ in. thick	Bar diameter = $4t$
On the weld:	Bar diameter = $8t$

PERMISSIBLE VARIATION IN THICKNESS, DIAMETER AND LENGTH

37. The thickness, outside diameter and length of each pipe shall be within the following tolerances:—

a. Thickness	plus 10 per cent minus 10 per cent
b. Outside diameter	plus 1 per cent minus 1 per cent
c. Length where specified 'exact' or 'cut length'	plus ¼ in. minus 0.

CLASS F. BUTTWELDED CARBON STEEL PIPES

BUTTWELDED STEEL PIPES

38. The pipes shall comply with B.S. 1387, 'Steel tubes and tubulars suitable for screwing to B.S. 21, Pipe threads'.

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CLASS M. COLD DRAWN SEAMLESS MOLYBDENUM STEEL PIPES

MATERIAL

39. The pipes shall be made of molybdenum steel produced by the open hearth or an electric process, acid or basic.

The material shall show on analysis the following composition:—

Carbon		0·15–0·20 per cent
Silicon		0·10–0·35 per cent
Sulphur	0·05 per cent max. (acid)	0·04 per cent max. (basic)
Phosphorus	0·05 per cent max. (acid)	0·04 per cent max. (basic)
Manganese		0·40–0·70 per cent
Molybdenum		0·45–0·65 per cent
Copper		0·2 per cent max.
Nickel		0·3 per cent max.
Tin		0·05 per cent max.

The steelmaker shall certify that the steel is of a good standard of cleanliness, complies with the above analysis, and has a reasonably uniform McQuaid-Ehn grain size not finer than Grade 5. If aluminium be added, the amount shall not exceed ½ lb/ton of molten steel.

Pipes shall not come into contact with non-ferrous metals or their compounds during manufacture.

COLOUR IDENTIFICATION

40. Before leaving the manufacturer's works the pipes shall be painted at each end with two adjacent 3-in. wide bands of paint (see Clause 72). The bands nearer to the ends of the pipes shall be glossy black and the inner bands white.

HEAT-TREATMENT

41. The pipes shall be delivered in the normalized condition unless it is agreed between contractor and manufacturer that the contractor shall be responsible for final normalizing (see Clause 73 *c*), in which case the pipes shall be delivered in a condition suitable for subsequent manipulation.

TENSILE TEST

42. Tensile strength: Not less than 28 tons/sq. in.
Not more than 35 tons/sq. in.

Percentage elongation on gauge length of $4\sqrt{A}$: Not less than 700 divided by the tensile strength of the specimen.

FLATTENING TEST

43. Distance apart of interior surfaces:

$4t$ or two-thirds of the bore, whichever is the less.

BEND TEST

44. For pipes up to and including ⅜ in. thick — Bar diameter = $3t$

For pipes over ⅜ in. thick — Bar diameter = $4t$, or two-thirds of the bore, whichever is the less.

PERMISSIBLE VARIATION IN THICKNESS, DIAMETER AND LENGTH

45. The thickness, diameter and length of each pipe shall be within the following tolerances:—

	Under 6 in. bore	6 in. bore and over
a. Thickness	plus 10 per cent minus 10 per cent	plus 10 per cent minus 10 per cent
b. Bore	— —	plus 1/32 in. minus 1/16 in.
c. Outside diameter	plus 1 per cent minus 1 per cent	— —
d. Length where specified 'exact' 'or 'cut length'	plus ¼ in. minus 0.	plus ¼ in. minus 0.

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CLASS P. COLD DRAWN SEAMLESS CHROMIUM MOLYBDENUM STEEL PIPES

MATERIAL

46. The pipes shall be made of chromium molybdenum steel produced by the open hearth or an electric process, acid or basic.

The material shall show on analysis the following composition:—

Carbon		0·15 per cent max.
Silicon		0·35 per cent max.
Sulphur	0·05 per cent max. (acid)	0·04 per cent max. (basic)
Phosphorus	0·05 per cent max. (acid)	0·04 per cent max. (basic)
Manganese		0·30–0·70 per cent
Molybdenum		0·40–0·60 per cent
Chromium		0·70–1·0 per cent
Copper		0·2 per cent max.
Nickel		0·3 per cent max.
Tin		0·05 per cent max.

The steelmaker shall certify that the steel is of a good standard of cleanliness, complies with the above analysis, and has a reasonably uniform McQuaid-Ehn grain size not finer than Grade 5. If aluminium be added, the amount shall not exceed ½ lb/ton of molten steel.

Pipes shall not come into contact with non-ferrous metals or their compounds during manufacture.

COLOUR IDENTIFICATION

47. Before leaving the manufacturer's works the pipes shall be painted at each end with two adjacent 3-in. wide bands of paint (see Clause 72). The bands nearer to the ends of the pipes shall be glossy black and the inner bands red.

HEAT-TREATMENT

48. The pipes shall be delivered in the normalized condition unless it is agreed between contractor and manufacturer that the contractor shall be responsible for final normalizing (see Clause 73 *c*), in which case the pipes shall be delivered in a condition suitable for subsequent manipulation.

TENSILE TEST

49. Tensile strength: Not less than 27 tons/sq. in.
Not more than 38 tons/sq. in.

Percentage elongation on gauge length of $4\sqrt{A}$: Not less than 700 divided by the tensile strength of the specimen.

FLATTENING TEST

50. Distance apart of interior surfaces:

$4t$ or two-thirds of the bore, whichever is the less.

BEND TEST

51. For pipes up to and including
⅜ in. thick — Bar diameter = $3t$
For pipes over ⅜ in. thick — Bar diameter = $4t$, or two-thirds of the bore, whichever is the less.

PERMISSIBLE VARIATION IN THICKNESS, DIAMETER AND LENGTH

52. The thickness, diameter and length of each pipe, shall be within the following tolerances:—

	Under 6 in. bore	6 in. bore and over
a. Thickness	plus 10 per cent minus 10 per cent	plus 10 per cent minus 10 per cent
b. Bore	— —	plus 1/32 in. minus 1/16 in.
c. Outside diameter	plus 1 per cent minus 1 per cent	— —
d. Length where specified 'exact' or 'cut length'	plus ¼ in. minus 0.	plus ¼ in. minus 0.

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CLASS Q. HOT FINISHED SEAMLESS CHROMIUM MOLYBDENUM STEEL PIPES

MATERIAL

53. The pipes shall be made of chromium molybdenum steel produced by the open hearth or an electric process, acid or basic.

The material shall show on analysis the following composition:—

Carbon		0·15 per cent max.
Silicon		0·35 per cent max.
Sulphur	0·05 per cent max (acid).	0·04 per cent max. (basic)
Phosphorus	0·05 per cent max. (acid)	0·04 per cent max. (basic)
Manganese		0·30–0·70 per cent
Molybdenum		0·40–0·60 per cent
Chromium		0·70–1·0 per cent
Copper		0·2 per cent max.
Nickel		0·3 per cent max.
Tin		0·05 per cent max.

The steelmaker shall certify that the steel is of a good standard of cleanliness, complies with the above analysis, and has a reasonably uniform McQuaid-Ehn grain size not finer than Grade 5. If aluminium be added, the amount shall not exceed ½ lb/ton of molten steel.

Pipes shall not come into contact with non-ferrous metals or their compounds during manufacture.

COLOUR IDENTIFICATION

54. Before leaving the manufacturer's works the pipes shall be painted at each end with two adjacent 3-in. wide bands of paint (see Clause 72). The bands nearer to the ends of the pipes shall be glossy black and the inner bands red.

HEAT-TREATMENT

55. The manufacturer shall deliver hot finished pipes in the as-rolled or hot drawn condition, or in the normalized condition, provided they comply with the requirements of this standard.

TENSILE TEST

56. Tensile strength: Not less than 27 tons/sq. in.
Not more than 38 tons/sq. in.

Percentage elongation on gauge length of $4\sqrt{A}$: Not less than 700 divided by the tensile strength of the specimen.

FLATTENING TEST

57. Distance apart of interior surfaces:

$4t$ or two-thirds of the bore, whichever is the less.

BEND TEST

58. For pipes up to and including ⅜ in. thick — Bar diameter = $3t$

For pipes over ⅜ in. thick — Bar diameter = $4t$, or two-thirds of the bore, whichever is the less.

PERMISSIBLE VARIATION IN THICKNESS, DIAMETER AND LENGTH

59. The thickness, outside diameter and length of each pipe shall be within the following tolerances:—

	Ratio thickness/o.d.	Tolerance
a. Thickness	Up to and including 3 per cent	plus 15 per cent minus 15 per cent
	Over 3 per cent, up to and including 10 per cent	plus 12½ per cent minus 12½ per cent
	Over 10 per cent: pipes up to and including 6⅝ in. o.d.	plus 12½ per cent minus 12½ per cent
	Over 10 per cent: pipes over 6⅝ in. o.d.	plus 10 per cent minus 10 per cent
b. Outside diameter	Up to and including 1²⁹⁄₃₂ in.	plus 1/64 in. minus 1/32 in.
	Over 1²⁹⁄₃₂ in.	plus 1 per cent minus 1 per cent

c. Length where specified 'exact' or 'cut length'.
plus ¼ in.
minus 0.

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PART 4. CASTINGS (IRON AND STEEL)

IRON CASTINGS

60. Iron castings shall comply with the requirements of B.S. 1452, ' Grey iron castings '. or BS 2035

CARBON STEEL CASTINGS

61. Carbon steel castings shall comply with the requirements of B.S. 592, ' Carbon steel castings for general engineering purposes ', Grade A.

MOLYBDENUM STEEL CASTINGS

62. Molybdenum steel castings shall comply with the requirements of B.S. 1398, ' Carbon-molybdenum steel castings '.

PART 5. DESIGN REQUIREMENTS

MAXIMUM PERMISSIBLE DESIGN PRESSURES AND TEMPERATURES

63. The limits within which pipes and pipe fittings of various materials are permitted to be used are given in Table 1.

THICKNESS OF WROUGHT STEEL STRAIGHT STEAM PIPES

64. The minimum thickness of straight pipes shall be determined from Equation 1*:

$$t_f = \frac{PD}{2Se} + 0{\cdot}04 \quad . \quad . \quad . \quad . \quad \text{Equation 1}$$

where (see Clause 3)

t_f = minimum thickness in inches.
P = design pressure, in pounds per square inch.
D = outside diameter of pipe, in inches.
S = maximum permissible design stress in pounds per square inch as specified in Table 1. a allowance resistance material
e = 1·0 for seamless steel pipes.
= 0·9 for welded steel pipes for values for t_f up to and including ⅞ in.
= 0·85 for welded steel pipes for values of t_f over ⅞ in. up to and including 1⅛ in.
= 0·80 for welded steel pipes for values of t_f over 1⅛ in.

NOTE. The value of t_f is the minimum thickness for straight pipes and provision must be made for any minus tolerances. Manufacturing considerations may make it necessary for pipes thicker than this minimum to be used.

* The equation below corresponds to and is derived from Equation 1, and may be used where the bore is the basis for tolerance.

$$t_f = \frac{Pd + 0{\cdot}08Se}{2(Se - P)} \quad . \quad . \quad . \quad . \quad . \quad \text{Equation 1A}$$

where d = bore, in inches.

BENT PIPES

65. *a. Thickness of wrought steel bent steam pipes.* The minimum thickness (t_b) of a straight pipe, from which a bent pipe is to be made, shall be determined from Equation 2, except where it can be demonstrated that the use of a thickness less than t_b would not reduce the thickness below t_f at any point after bending.

$$t_b = 1{\cdot}125t_f \quad . \quad . \quad . \quad . \quad . \quad \text{Equation 2}$$

NOTE. The value of t_b is the minimum thickness and provision must be made for any minus tolerances. Manufacturing considerations may make it necessary for pipes thicker than this minimum to be used.

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