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Ferrous Pipes

AND

Piping Installations

FOR AND IN CONNECTION

WITH LAND BOILERS

BRITISH STANDARDS INSTITUTION

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BRITISH STANDARD SPECIFICATION

FERROUS PIPES
AND
PIPING INSTALLATIONS

FOR AND IN CONNECTION
WITH LAND BOILERS

B.S. 806 : 1942

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BRITISH STANDARDS INSTITUTION
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CO-OPERATING ORGANISATIONS

The Mechanical Industry Committee under whose supervision this British Standard was prepared consists of representatives of the following Government Departments and Scientific and Industrial Organisations :

*Admiralty.
Crown Agents for the Colonies.
*Department of Scientific and Industrial Research.
*High Commissioner for India.
*Home Office.
Ministry of Supply.
Ministry of Transport.
Ministry of Works and Buildings.
War Office.
Agricultural and Road Machinery Manufacturers' Association.
British Chemical Plant Manufacturers' Association.
British Electrical and Allied Manufacturers' Association.
British Engineers' Association.
*British Iron and Steel Federation.
British Marine Oil-Engine Manufacturers' Association.
Engineering Insurance Companies.
*Institute of Marine Engineers.
Institution of Automobile Engineers.
*Institution of Civil Engineers.
Institution of Gas Engineers.
Institution of Heating and Ventilating Engineers.
Institution of Mechanical Engineers.
Institute of Petroleum.
Locomotive Manufacturers' Association.
Machine Tool Trades Association.
*Railway Companies of Great Britain.

The Government Departments and Scientific and Industrial Organisations marked with an asterisk in the above list, together with the following, nominated members to serve upon the Committee entrusted with the preparation of this British Standard :

Board of Trade.
Association of Consulting Engineers.

Brass and Copper Tube Association.
British Corporation Register of Shipping and Aircraft.
Copper Development Association.
Lloyds Register of Shipping.
Boiler Makers.
Insurance Companies.
Tube Makers.

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THIS SPECIFICATION having been approved by the Mechanical Engineering Industry Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council as a British Standard on 26th January, 1942.

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

The Institution desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a contract.

In order to keep abreast of progress in the industries concerned, the British Standards are subjected 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.

A complete list of British Standards, indexed and cross-indexed for reference, will be found in the Institution's Handbook.

This Specification requires reference to the following British Standards :

No. 10, Parts 1-5. Table of Pipe Flanges (For Land Use).
- Part 1. Working Gas Pressures up to 30 lb. per square inch. Working Water Pressures up to 175 lb. per square inch.
- Part 2. Working Steam Pressures up to 450 lb. per square inch.
- Part 3. Working Steam Pressures above 450 lb. and up to 600 lb. per square inch.
- Part 4. Working Steam Pressures above 600 lb. and up to 900 lb. per square inch and Temperatures up to 800°F. (427°C.) Steel Flanges for Pipes, Valves and Fittings for.
- Part 5. Working Steam Pressures above 900 lb. and up to 1 400 lb. per square inch and Temperatures up to 800°F. (427°C.) Steel Flanges for Pipes, Valves and Fittings for.

No. 21. Pipe Threads.
No. 321. General Grey Iron Castings (Grades A and C).
No. 592. Steel Castings for General Engineering Purposes.

No. 639. Covered Electrodes for Metal Arc Welding Wrought Iron and Mild Steel.
No. 759. Valves, Gauges and Similar Fittings for Land Boiler Installations.
No. 788. Wrought Iron Tubes and Tubulars, Gas (Light), Water (Medium), Steam (Heavy) Qualities.
No. 789. Steel Tubes and Tubulars, Gas (Light), Water (Medium), Steam (Heavy) Qualities.

The following British Standards have been issued dealing with Land Boilers :

B.S. 494. Cold Drawn Weldless Steel Boiler and Superheater Tubes for Designed Steam Temperatures not exceeding 850°F.
B.S. 512. Hot Finished Weldless Steel Boiler and Superheater Tubes for Designed Steam Temperatures not exceeding 850°F.
B.S. 527. Lapwelded Wrought Iron Boiler Tubes for External Pressure.
B.S. 528. Lapwelded Steel Boiler Tubes for External Pressure.
B.S. 537. Lancashire and Cornish Boilers.
B.S. 609. Multitubular Horizontal Boilers (Dryback and Wasteheat).
B.S. 665. Vertical Cross Tube Boilers.
B.S. 759. Valves, Gauges, and Similar Fittings for Land Boiler Installations.
B.S. 761. Cylindrical Vertical Multitubular Boilers.
B.S. 779. Cast Iron Boilers for Central Heating and Hot Water Supply.
B.S. 780. Riveted Steel Boilers for Hot Water Central Heating and Hot Water Supply.
B.S. 853. Calorifiers.
B.S. 854. Welded Steel Boilers for Steam Central Heating.
B.S. 855. Welded Steel Boilers for Hot Water Central Heating and Hot Water Supply.
B.S. 931. Loco-type Multitubular Boilers.

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BRITISH STANDARD SPECIFICATION FOR

FERROUS PIPES AND PIPING INSTALLATIONS

FOR AND IN CONNECTION WITH LAND BOILERS

FOREWORD

This Specification forms one of a series of British Standards for Land Boiler Installations, the preparation of which was authorised by the Mechanical Industry Committee in June, 1931.

The Specification applies to the general and detailed construction of the pipework connecting a land steam boiler to engine, turbine or industrial plant and all auxiliary pipework in connection therewith, together with the individual pipes and pipe fittings forming parts of such installations for :

a. Pipes of any bore where the pressure exceeds 50 lb. per square inch.

b. Pipes over 10 in. bore for steam at pressures of 50 lb. per square inch and below.

The Specification does not apply where the temperature exceeds 900°F.

In determining the maximum working stresses to which pipes may be subjected, the various physical properties of the pipe material have received attention.

After consideration of the ultimate tensile stress, yield point, proof stress and proportional limit of steel, it has been decided to use the Proportional Limit as the basis for working stresses, and the reasons for this are set forth in Appendix A.

This Specification applies only to ferrous pipes, pipework and fittings. Additional requirements are in course of preparation for copper and copper alloy piping for land boiler installations.

The terms ' maximum permissible working pressure ' and ' safety valve blow-off pressure ' are used in the series of British Standards for boilers and boiler fittings. These terms, with the following definitions, are used in the Factories Act, 1937.

The maximum permissible working pressure is the maximum pressure at which a boiler may be operated.

The safety valve blow-off pressure is that at which the safety valves shall be set to prevent the boiler being worked at a pressure greater than the maximum permissible working pressure.

The Factories Act, 1937, further requires that the steam pressure gauge fitted to a boiler shall have marked upon it in a distinctive colour, the maximum permissible working pressure. (See Clause 46 B.S. 759, ' Valves, Gauges and Similar Fittings for Land Boiler Installations.')

NOTE. It is desirable that there should be a margin between the actual pressure at which the boiler is to be operated and the set blow-off pressure to prevent the unnecessary blowing-off of the safety valves.

SPECIFICATION

PART ONE : GENERAL

SCOPE

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

a. Pipes of any bore where the pressure exceeds 50 lb. per square inch.

b. Pipes over 10 in. bore for steam at pressures of 50 lb. per square inch and below.

The Specification does not apply where the temperature exceeds 900°F.

Steam receivers, separators and other unfired pressure vessels are excluded (see B.S.).*

The term ' pipe fitting ' in this Specification includes tees, elbows and specials, but excludes valves and fittings, which are dealt with in B.S. 759, ' Valves, Gauges and Similar Fittings for Land Boiler Installations.'

DEFINITIONS

2. The pressures and temperatures for which pipes and pipe fittings are designed shall be defined as hereunder :

Design Pressure for Steam Piping. For boilers having a maximum permissible working pressure not exceeding 400 lb. per square inch the design pressure shall be the maximum permissible working pressure of the boiler. For boilers having a maximum permissible working pressure exceeding 400 lb. per square inch, the design pressure shall be the maximum superheater safety valve pressure providing that :

* In course of preparation.

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1. In no case shall pipes be designed for a pressure less than 90 per cent of the maximum permissible working pressure of the boiler.

2. The capacity of the safety valves on the superheater shall be not less than 20 per cent of the total safety valve capacity of the unit.

If these provisions are not complied with, the design pressure shall be the maximum permissible working pressure of the boiler.

Where the piping is not connected directly to the boiler or superheater, the design pressure shall be the maximum to which the piping can be subjected.

Design Pressure for Feed Piping. The design pressure shall be the maximum permissible working pressure of the boiler(s) plus the pressure generated in overcoming friction and other losses in the feed piping under ordinary working conditions, or the maximum pressure which can be generated by the boiler feed pumps unless special provision is made to prevent that pressure being communicated to the pipe line.

Design Temperature for Steam Piping. The design temperature for steam piping shall be the temperature at the superheater outlet where the maximum temperature under extraordinary conditions does not exceed the following limits for a continuous period of two hours :

	Excess permissible
For temperatures up to and including 825°F.	25°F.
For temperatures above 825°F.	15°F.

Where the excess temperature exceeds these limits the design temperature shall be increased by the amount by which the actual excess exceeds the permissible excess.

The design pressures and temperatures for all pipes to be supplied to this Specification shall be stipulated by the Purchaser, and the values so specified shall be the design pressures and temperatures for the purposes of this Specification

INFORMATION TO BE SUPPLIED BY THE PURCHASER

3. The purchaser shall disclose to the manufacturer at the time of enquiry :

a. The name of the inspecting engineer authority representing the purchaser.

b. Whether any variation is desired from the requirements of this Specification.

c. Any special statutory or other regulations with which the pipes and/or piping installation(s) are required to comply.

PART TWO : MATERIALS

A. COLD DRAWN WELDLESS STEEL PIPES

GENERAL

4. This section of the Specification provides for Cold Drawn Weldless Steel Pipes which shall comply with the requirements herein specified.

Where the purchaser desires to witness the mechanical or other tests, or to receive certificates, this shall be stated in the enquiry and order, and the processes of manufacture of the steel from which the pipes are made shall, in such cases, be stated on the certificate.

MATERIAL

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

NOTE. For pressures up to and including 250 lb. per sq. in. and/or temperatures up to and including 425°F. Bessemer steel, acid or basic, manufactured by an approved manufacturer, may be used, provided the inspecting authority has been satisfied in each instance that the material possesses the required properties and fulfils the necessary mechanical tests.

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

NOTE. Where the material is used for design steam temperatures above 750°F. the steel shall be of non-segregated, or fully killed type.

HEAT TREATMENT

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

CONDITION OF PIPES

7. All pipes shall be commercially straight, free from longitudinal seaming, grooving or other injurious surface marks, and shall be as free as possible from rust. The ends of the pipes shall be cut square.

MECHANICAL TESTS

8. The pipes shall be presented for mechanical testing in accordance with Clauses 9, 10, 11 and 12. Test samples shall be provided as follows :

Pipes up to 4½ in. o/d	2 per cent of the lengths of tubes as drawn.
Pipes over 4½ in. o/d and up to and including 7 in. o/d	10 per cent of the lengths of tubes as drawn.
Pipes over 7 in. o/d	20 per cent of the lengths of tubes as drawn.

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In the event of any pipe being found not to be in accordance with this Specification in the course of being worked, such pipe may be rejected, notwithstanding any previous acceptance, provided that the pipe has not been improperly treated in working.

TENSILE TEST

9. Longitudinal strips or lengths cut from the ends of the selected pipes shall comply with the following requirements :

	Ultimate tensile stress in tons per sq. in.		Minimum elongation per cent			
			On 8 in.		On 2 in.	
	Not less than	Not more than	¼ in. thick and over	Less than ¼ in. thick	¼ in. thick and over	Less than ¼ in. thick
Strips cut from the pipes and tested in their curved condition	23	30	20	18	32	30
Test lengths taken from finished pipes (ends of pipes to be plugged for grips)	23	30	25	23	—	—

FLATTENING TEST
(For pipes up to and including 4¾ in. o/d)

see p. 11 X

10. A ring not less than 2 in. in length cut from one end of each selected pipe shall when cold withstand, without showing either crack or flaw, being flattened between two parallel flat surfaces until, when the pressure is released, the interior surfaces of the test piece remain at the middle a distance apart equal to four times the thickness of the pipe or two-thirds of the bore, whichever is the less.

COLD BEND TEST
(For pipes over 4½ in. o/d)

11. A strip 1½ in. wide cut circumferentially from one end of each selected pipe shall when cold withstand, without showing either crack or flaw, being doubled over in the direction of original curvature round a bar, the diameter of the bar being :

For pipes up to and including ⅜ in. thick	3 times the thickness.
For pipes over ⅜ in. thick	4 times the thickness, or two-thirds of the bore, whichever is the less.

ADDITIONAL TESTS BEFORE REJECTION

12. Should a pipe selected for testing purposes fail in any one or more of the tests specified in Clauses 9, 10 and 11, two further tests of the same kind may be made from the same or other pipe. Should either of these fail, the pipes represented may be re-heat-treated and then re-tested in accordance with Clauses 9, 10 and 11. If the repeat tests are satisfactory the pipes shall be accepted, provided that in other respects they comply with the requirements of this Specification, but if failure again occurs the pipes which the test pieces represent shall be rejected.

HYDRAULIC TEST

X

13. Every pipe, while straight and with plain ends, shall be tested at the manufacturer's works to a hydraulic pressure (H lb. per square inch) determined as follows :

a. For working pressures up to and including 500 lb. per square inch :

$$H = 35\,000 \frac{t}{D}$$

See Clause No 3

where t = minimum thickness of pipe in inches

$$= \frac{PD}{2Se} + 0{\cdot}09 \text{ (see Clause 82)}$$

P = design pressure in lb. per square inch
D = outside diameter of pipe in inches.

b. For working pressures over 500 lb. per square inch :

H = twice the working pressure.

In no case shall the hydraulic test pressure exceed 1000 lb. per sq. in.

PERMISSIBLE VARIATION IN THICKNESS, DIAMETER AND LENGTH

14. *a. Thickness.* The thickness of the pipes shall be within the following tolerances :

Plus 10 per cent.
Minus 10 per cent.

b. External Diameter. The external diameter of the pipes shall be within the following tolerances :

Plus 1 per cent.
Minus 1 per cent.

c. Length. The lengths of the pipes shall be not less than those specified and shall be not more than 3/16 in. greater.

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INSPECTION

15. The representative of the purchaser shall have free access to the works of the manufacturer at all reasonable times and shall be at liberty to inspect the manufacture at any stage and to reject any material that does not conform to the requirements of this Specification.

TESTING FACILITIES

16. The manufacturer shall, at his own cost, furnish and prepare the necessary test pieces, and supply labour and appliances for such testing as may be carried out on his premises in accordance with this Specification. Failing facilities at his own works for making the prescribed tests, the manufacturer shall bear the cost of carrying out the tests elsewhere.

B. HOT-FINISHED WELDLESS STEEL PIPES

FOR PRESSURES OVER 250 LB. PER SQUARE INCH AND/OR TEMPERATURES EXCEEDING 425°F.

GENERAL

17. This section of the Specification provides for Hot-finished Weldless Steel Pipes which shall comply with the requirements herein specified.

Where the purchaser desires to witness the mechanical or other tests, or to receive certificates, this shall be stated in the enquiry and order, and the processes of manufacture of the steel from which the pipes are made shall, in such cases, be stated on the certificate.

MATERIAL

18. 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 or of phosphorus.

NOTE. Where the material is used for design steam temperatures above 750°F. the steel shall be of non-segregated or fully killed type.

CONDITION OF PIPES

19. All pipes shall be commercially straight, free from longitudinal seaming, grooving, blistering or other injurious surface marks, and shall be as free as possible from rust. The ends of the pipes shall be cut square.

MECHANICAL TESTS

20. The pipes shall be presented for mechanical testing in accordance with Clauses 21, 22, 23 and 24. Test samples shall be provided as follows :

Pipes up to 4½ in. o/d	2 per cent of the lengths of tubes as drawn.
Pipes over 4½ in. o/d and up to and including 7 in. o/d	10 per cent of the lengths of tubes as drawn.
Pipes over 7 in. o/d	20 per cent of the lengths of tubes as drawn.

In the event of any pipe being found not to be in accordance with this Specification in the course of being worked, such pipe may be rejected, notwithstanding any previous acceptance, provided that the pipe has not been improperly treated in working.

TENSILE TEST

21. Longitudinal strips or lengths cut from the ends of the selected pipes shall comply with the following requirements :

	Ultimate tensile stress in tons per sq. in.		Minimum elongation per cent			
			On 8 in.		On 2 in.	
	Not less than	Not more than	¼ in. thick and over	Less than ¼ in. thick	¼ in. thick and over	Less than ¼ in. thick
Strips cut from the pipes and tested in their curved condition	23	30	20	18	32	30
Test lengths taken from finished pipes (ends of pipes to be plugged for strips)	23	30	25	23	—	—

FLATTENING TEST

(For pipes up to and including 4½ in. o/d)

22. A ring not less than 2 in. in length cut from one end of each selected pipe shall when cold withstand, without showing either crack or flaw, being flattened between two parallel flat surfaces until when the pressure is released the interior surfaces of the test piece remain at the middle a distance apart equal to four times the thickness of the pipe, or two-thirds of the bore, whichever is the less.

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