

© British Standards Institution. No part of this publication may be photocopied or otherwise reproduced without the prior permission in writing of BSI.

---

## British Standard Specification for Design and construction of ferrous piping installations for and in connection with land boilers

---

Calcul et construction des installations de conduites en métaux ferreux  
pour chaudières — Spécifications

Bauart und Konstruktion von Eisenrohrleitungssystemen für ortsfeste Heizkessel

Licensed copy: Techstreet Content, ISO Exchange - Michigan, Version correct as of 06/04/2023.

Currently in preview. Click buy full version.

## Contents

	Page		Page
Committees responsible	Inside front cover		
Enquiry cases—Introduction	i	<b>Section six. Inspection and testing</b>	
Summary of pages	ii	6.1 Tests on pipes and fittings	6/1
Foreword	v	6.2 Hydraulic tests on pipe systems after erection	6/2
<b>Section one. General</b>		6.3 Visual and non-destructive examination	6/2
1.1 Scope	1/1	6.4 Identification of materials	6/2
1.2 Interpretation	1/1	<b>Appendices</b>	
1.3 Definitions and prime symbols	1/1	A Pressures in safety valve discharge piping	A/1
1.4 Information and requirements to be agreed and to be documented	1/1	B Derivation of material nominal design stresses	B/1
<b>Section two. Design pressures and temperatures</b>		C Examples of branch pipe design	C/1
2.1 General	2/1	D Coefficient of linear expansion for pipes	D/1
2.2 Design pressure for steam piping	2/1	E Recommended proof and rupture data in connection with flexibility analysis (see 4.11.2)	E/1
2.3 Design temperature for steam piping	2/1	F Worked example of stress calculation in a section of a pipe system	F/1
2.4 Design conditions for feed piping	2/2	<b>Tables</b>	
2.5 Design pressure for blowdown and drain systems	2/2	3.1.2 British Standards covering materials/components for ferrous pipes and piping installations	3/1
2.6 Design temperature for blowdown and drain systems	2/2	3.1.3 Design stress values	3/3
2.7 Design conditions for safety valve discharge piping	2/2	3.1.3.1 Minimum bending radii for wrought steel bent pipes	4/2
2.8 Design lifetime	2/3	4.7.4(1) Maximum permissible pressures for screwed joints using pipe complying with BS 1387 and fittings complying with BS 1740	4/4
<b>Section three. Materials and maximum permissible design pressures, temperatures and stresses</b>		4.7.4(2) Minimum thickness of screwed pipe complying with 4.7.4(c)	4/4
3.1 Materials	3/1	4.7.4(3) Maximum pressure for screwed pipe complying with 4.7.4(c)	4/4
3.2 Maximum permissible design pressures, temperatures and stresses	3/2	4.8.5.2 Factor <i>C</i>	4/6
<b>Section four. Design</b>		4.10 Expansion allowance	4/8
4.1 General	4/1	4.11.1 Typical values of modulus of elasticity	4/8
4.2 Thickness of wrought steel straight pipes	4/1	4.11.2 Allocation of loads	4/9
4.3 Wrought steel bent pipes	4/1	5.2.1 Heat treatment of completed pipes	5/1
4.4 Gusseted bends	4/2	5.5.2.1 Maximum clearance between pipes and flanges	5/2
4.5 Thickness of cast steel straight pipes and bends	4/3	5.5.2.2 Limiting design conditions for flange types	5/3
4.6 Thickness of cast iron pipes and fittings	4/3	6.1.1 Values of the specified minimum yield stress ( $R_e$ )	6/1
4.7 Joints	4/3	6.1.5 Minimum duration for the hydraulic test	6/2
4.8 Branches	4/5	6.3.3 Type and extent of non-destructive examination for ferritic class I and austenitic welds	6/3
4.9 Safety valve discharge piping and safety valve mounting	4/7	6.3.4 Type and extent of non-destructive examination for carbon steel class II welds	6/4
4.10 Expansion allowance	4/7	6.3.5 Weld external surface finish	6/4
4.11 Flexibility	4/7	A.2 Compressible flow factors	A/2
4.12 Drainage	4/12	E.1(1) 0.2 % proof stress values for steel tubes and pipes	E/1
4.13 Pipework supports	4/13	E.1(2) 1 % proof stress values for steel tubes and pipes	E/1
<b>Section five. Construction and workmanship</b>			
5.1 General	5/1		
5.2 Heat treatment and final condition	5/1		
5.3 Welding	5/2		
5.4 Attachment of branches	5/2		
5.5 Attachment to flanges	5/2		
5.6 Ovality of bent pipes	5/3		
5.7 Gusseted bends	5/3		
5.8 Condition of pipes	5/3		
5.9 Marking of pipes	5/4		
5.10 Erection of pipework	5/4		

E.1(3)	Average rupture stress values for steel tubes and pipe	E/2	4.11.1(6)	Maximum non-directional stress factors (branches)	4/26
E.3(1)	0.2 % proof stress values for steel forgings complying with BS 1503	E/4	4.11.1(7)	In-plane and out-of-plane flexibility factor, $K$ , for multi-mitred bends	4/27
E.3(2)	1 % proof stress values for steel forgings complying with BS 1503	E/5	4.11.1(8)	Stress intensification factors for mitred bends	4/28
E.3(3)	Average rupture stress values for steel forgings complying with BS 1503	E/6	4.11.1(9)	Stress intensification and flexibility correction factor for flanged bends	4/29
F.6(1)	Stress range: cold-to-hot	F/2	4.11.5.1	Branch connections	4/30
F.6(2)	Stress range: sectionalized system, maximum difference (no cold pull allowance)	F/3	4.11.5.2	Pressure/stress multiplier	4/31
F.6(3)	Hot stress all-hot: hot expansion minus cold pull	F/4	5.3.3	Use of class I and class II welding for ferritic materials	5/5
F.6(4)	Hot stress, sectionalized system, highest or difference (hot expansion, minus cold pull)	F/5	5.4	Minimum dimensions for external profiles of welds at branches: class 1 welding	5/6
<b>Figures</b>			5.5(1)	Type 1 'welding neck' flange	5/7
4.4.2.2	Dimensional parameters for mitred bends and lugs	4/14	5.5(2)	Type 2 'face and back' welded-on flange (for metal-arc welding)	5/8
4.4.2.4	$X$ values required to satisfy mitred bend design requirements	4/15	5.5(3)	Type 3 'bore and back' welded-on flange (for metal-arc welding)	5/9
4.8.2	Dimensional parameters for branch connections to mitred gusseted bends	4/15	5.5(4)	Type 3A 'bore and back' welded-on flange (weld preparation for use only with flange positionally welded on by the metal-arc process)	5/10
4.8.4	Typical branch pipes	4/16	5.5(5)	Types 4 and 4A 'face and fillet' welded-on flanges (for metal-arc welding)	5/11
4.8.5.1	Reinforcement of branch pipes ( $x:f_1/p$ )	4/18	5.5(6)	Type 5 'bore and fillet' welded-on flange (for metal-arc welding)	5/12
4.8.5.2(1)	Reinforcement of branch pipes ( $x_a:Z$ )	4/19	5.5(7)	Type 5A 'bore and fillet' welded-on flanges (weld preparation for use only with flange positionally welded on by the metal-arc process)	5/12
4.8.5.2(2)	Reinforcement of branch pipes ( $h:Zn$ )	4/20	5.5(8)	Types 6 and 6A 'slip-on' welded-on flanges (for metal-arc welding)	5/13
4.11.1(1)	Flexibility factor in- and out-of-plane (bends)	4/21	5.5(9)	Type 7 'slip-on' welded-on bossed flange (for oxy-acetylene welding)	5/14
4.11.1(2)	Maximum in-plane longitudinal stress factor (bends)	4/22	6.3.5.1	External finish categories	6/5
4.11.1(3)	Maximum in-plane transverse stress factor (bends)	4/23	C.1	Example 1 of branch pipe design	C/4
4.11.1(4)	Maximum out-of-plane longitudinal stress factor (bends)	4/24	C.2	Example 2 of branch pipe design	C/4
4.11.1(5)	Maximum out-of-plane transverse stress factor (bends)	4/25	F.3	Specimen configuration	F/1
			F.4	Ordinates of reference	F/2

## Foreword

This British Standard, first published in 1938 and subsequently revised in 1942, 1954, 1967, 1975 and 1986, has been prepared under the direction of the Pressure Vessel Standards Policy Committee. It supersedes the 1986 edition which is withdrawn.

This British Standard forms one of a series for boiler installations, the others in the series being:

BS 1113 Specification for design and manufacture of water-tube steam generating plant (including superheaters, reheaters and steel tube economizers)

BS 2790 Specification for design and manufacture of shell boilers of welded construction

For information on the materials and the standard sizes of steel pipes applicable to this standard, reference should be made to the following standards.

BS 1387 Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads

BS 3600 Specification for dimensions and masses per unit length of welded and seamless steel pipes and tubes for pressure purposes

BS 3601 Specification for carbon steel pipes and tubes with specified room temperature properties for pressure purposes

BS 3602 Specification for steel pipes and tubes for pressure purposes: carbon and carbon manganese steel with specified elevated temperature properties

Part 1 Specification for seamless and electric resistance welded including induction welded tubes

Part 2 Submerged arc welded tubes

BS 3604 Specification for steel pipes and tubes for pressure purposes: ferritic alloy steel with specified elevated temperature properties

BS 3605 Specification for seamless and welded austenitic stainless steel pipes and tubes for pressure purposes

Integral piping for water-tube boilers as determined in the scope and definition clauses of BS 1113 is excluded from this standard and is dealt with in BS 1113.

This 1990 edition incorporates all technical changes up to and including Amendment No. 4 (31 July 1989) associated with the 1986 edition. Changes of significance in these amendments have included the development of the following:

- (a) requirements for the use of cast iron pipes and fittings;
- (b) requirements for the application of screwed joints;
- (c) requirements for the non-destructive examination of welds.

In this standard pressures are expressed as 'gauge' unless otherwise stated.

Fluid pressure is expressed in bar except in the case of calculations where  $\text{N/mm}^2$  is used. 1 bar = 100 kN/m<sup>2</sup> = 100 kPa.

A format has been adopted that will facilitate annual amendment. It is intended to keep this standard up to date by the issue of replacement or additional pages when necessary. Each replacement or added page will carry an issue number (with date) indicating its relationship to the original issue of this revised standard, the pages of which are marked 'Issue 1'. For example:

Issue 1 will indicate an original page of, or one that has been added to, the original issue of this revised standard and has not been amended since insertion;

Issue 2 will indicate a first amendment of either an original page or an added page;

Issue 3 will indicate a second amendment of either an original page or an added page.

Side-lining on replacement pages will indicate that changes of technical or reference significance have been made at that point.

Because of the wide range of pipes and piping installations that may be designed and manufactured in accordance with this standard, general guidance has been given on some aspects with specific requirements being for agreement between the parties concerned according to the particular design and manufacturing details. The purpose of this standard, however, is unchanged from previous editions.

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.

This standard is included in the list of 'Standards significant to Health and Safety at Work' published by the UK Health and Safety Executive (HSE)\* and is also referred to by HSE in giving guidance.

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

\* Health and Safety Executive, Baynards House, 1 Chepstow Place, London, W2 4TF.

## Section one. General

### 1.1 Scope

This British Standard specifies requirements for the design and construction, including materials and design parameters, workmanship, inspection and testing, for ferrous pipes and piping installations for and in connection with land boilers.

This standard applies to the following.

- (a) The ferrous pipework connecting steam generating plant to engine, turbine or industrial plant and all ancillary steam and water pipework in connection therewith.
- (b) The pipes and pipe fittings forming parts of the installations described in (a) for:
  - (1) pipes of any bore, where the pressure exceeds 3.5 bar; and
  - (2) pipes over 250 mm bore for steam at pressures up to and including 3.5 bar.

NOTE 1. The term 'pipe fitting' used in this standard includes tees, elbows and special components, but excludes valves and everything covered by BS 759 and BS 6759.

- (c) Ferrous pipes and piping installations constructed in materials used up to the design temperature limits given in table 3.2.

This standard does not apply to the component parts of the boiler unit or to integral piping which are dealt with in BS 1113.

NOTE 2. Attention is drawn to the safety requirements specified in section seven of BS 1113 : 1985 for certain valves and fittings which may require installation in piping systems beyond the scope of BS 1113.

NOTE 3. The titles of the publications referred to in this standard are listed on the last page.

### 1.2 Interpretation

If any ambiguity or doubt arises as to the meaning or effect of any part of this standard or as to whether anything ought to be done in order to comply with this standard in full, the question shall be referred to the Piping Systems Technical Committee (PVE/10) of the British Standards Institution, whose interpretation of the requirements of this standard upon the matter at issue will be given free of charge and shall be accepted as final and conclusive. Parties adopting this standard for the purposes of any contract shall be deemed to have accepted this provision unless by their contract they either expressly exclude it or else include an arbitration provision extending the interpretation of this standard; however, this provision shall be limited to interpretation and shall not confer upon the committee any power or jurisdiction to adjudicate upon the contractual rights or duties of any person under a contract except in so far as they may necessarily be affected by the interpretations arrived at by the committee.

Findings or rulings of the committee upon all enquiries, including matters of interpretation, that are of sufficient

importance for both enquiries and replies to be made public as soon as possible will be published in an enquiry-reply form for inclusion in the BS 806 ring-binder as Enquiry Cases. Their availability will be notified in *BSI News*.

After taking into account any public comment thereon, Enquiry Cases will be incorporated, if appropriate, into the standard either by amendment or in the course of the next convenient annual updating.

### 1.3 Definitions and prime symbols

#### 1.3.1 Definitions

For the purposes of this British Standard the following definitions apply.

**1.3.1.1 purchaser.** The organization or individual who buys the finished piping installation for its own use or as an agent for the purchaser.

**1.3.1.2 manufacturer.** The organization that designs, fabricates and erects the piping installation in accordance with the purchaser's order. The design, fabrication and erection functions may be carried out by separate organizations.

#### 1.3.2 Prime symbols

The prime symbols used in the equations in this British Standard are defined as follows.

- $D$  mean outside diameter\* of the pipe (in mm)
- $d$  mean inside diameter\* of the pipe (in mm). This should not be confused with nominal size, which is an accepted designation associated with outside diameters of standard rolling sizes.
- $t_f$  minimum thickness of the pipe calculated by the appropriate equation (in mm)
- $t_b$  minimum thickness of the pipe before bending, i.e.  $t_f +$  bending allowance (in mm)
- $t_m$  minimum thickness of the branch or main at the branch position (in mm)
- $t$  mean thickness based on limiting thickness tolerances of the ordered pipe (in mm)
- $T$  design temperature (in °C)
- $p$  design pressure (in N/mm<sup>2</sup>)
- $f$  maximum permissible design stress (in N/mm<sup>2</sup>)
- $P_t$  hydraulic test pressure (in N/mm<sup>2</sup>)

### 1.4 Information and requirements to be agreed and to be documented

#### 1.4.1 Information to be supplied by the purchaser

The following information shall be supplied by the purchaser and shall be fully documented. Both the definitive requirements specified throughout this standard and the documented items shall be satisfied before a claim of compliance with the standard can be made and verified.

\* The mean diameter for the purposes of calculation is the diameter midway between the maximum and minimum diameters possible using tolerances specified in the tube manufacturing specifications.