
Specification for

Steel castings for pressure purposes

Spécification des pièces en acier moulé pour appareils à pression

Spezifikation für Stahlguss für Verwendung mit Druckgeräten

Contents

	Page		Page
Foreword	Inside front cover	37. BS 1504-304C12 } Austenitic chromium-nickel	
Cooperating organizations	Back cover	BS 1504-347C17 } steel castings: low carbon	
			and stabilized grades 17
Specification		38. BS 1504-315C16 } Austenitic chromium-nickel —	
Section one. General requirements			1½ % molybdenum steel
1. Scope	2		castings 18
2. References	2	39. BS 1504-316C12 } Austenitic chromium-nickel —	
3. Designation	2	BS 1504-316C16 } 2½ % molybdenum steel	
4. Information to be supplied by the purchaser	2	BS 1504-316C71 } castings 19	
5. Requirements	3	BS 1504-318C17 } 3½ % molybdenum steel	
6. Chemical composition	3	40. BS 1504-317C12 } Austenitic chromium-nickel —	
7. Fettling and dressing	3	BS 1504-317C16 } castings 20	
8. Heat treatment	3	41. BS 1504-364C11 } Austenitic chromium-nickel-	
9. Testing	3	BS 1504-332C11 } molybdenum-copper high	
10. Number, selection, preparation and heat			alloy steel castings 20
treatment of test samples	3	42. BS 1504-310C40 } Austenitic chromium-nickel	
11. Mechanical tests	4		high alloy steel castings 21
12. Mechanical properties at room and low		43. BS 1504-330C11 } Austenitic chromium-nickel	
temperatures	4		high alloy steel castings 21
13. Mechanical properties at elevated temperatures	4		
14. Retests	5		
15. Visual inspection	5	Appendices	
16. Non-destructive tests	5	A. Nearest equivalents or replacements for steels in	
17. Pressure tests	5	the previous edition 22	
18. Rectification of defects	5	B. Examination of castings in relation to quality 22	
19. Freedom from defects	5	C. Verification procedure 23	
20. Testing facilities	5		
21. Inspection	6	Tables	
22. Identification	6	1. Parameters for 95 % lower confidence lines for	
23. Manufacturer's certificate	6	BS 1504-161, grades 430 and 480 23	
24. Defects revealed after delivery	6	2. Parameters for 95 % lower confidence lines for	
		BS 1504-245 23	
Section two. Specific requirements		3. Parameters for 95 % lower confidence lines for	
25. BS 1504-161 Carbon steel castings	8	BS 1504-622 23	
26. BS 1504-245 Carbon-molybdenum steel		4. Parameters for 95 % lower confidence lines for	
castings 9		BS 1504-625 23	
27. BS 1504-503 3½ % nickel steel castings	10	5. Parameters for 95 % lower confidence lines for	
28. BS 1504-621 1¼ % chromium-molybdenum		BS 1504-316C16 and BS 1504-316C71 23	
steel castings 10			
29. BS 1504-622 2¼ % chromium — 1 %		Figures	
molybdenum steel castings 11		1. 95 % lower confidence lines: cast carbon	
30. BS 1504-623 3 % chromium-molybdenum		steels (BS 1504-161, grades 430 and 480) 24	
steel castings 12		2. 95 % lower confidence lines: C — 0.5 % Mo cast	
31. BS 1504-625 5 % chromium-molybdenum		steel (BS 1504-245) 25	
steel castings 13		3. 95 % lower confidence lines: 2¼ % Cr — 1 % Mo	
32. BS 1504-629 9 % chromium-molybdenum		cast steel (normalized and tempered)	
steel castings 14		(BS 1504-622) 26	
33. BS 1504-660 Chromium-molybdenum-		4. 95 % lower confidence lines: 5 % Cr — Mo cast	
vanadium steel castings 14		steel (normalized and tempered) (BS 1504-625) 27	
34. BS 1504-420C29 13 % chromium steel castings	15	5. 95 % lower confidence lines: 18 % Cr — 10 % Ni —	
35. BS 1504-425C11 13 % chromium — 4 % nickel		3 % Mo cast steel (BS 1504-316C16,	
steel castings 15		BS 1504-316C71) 28	
36. BS 1504-304C15 Austenitic chromium-nickel			
steel castings 16			



Amendment No. 2
published and effective from 30 April 1987
to BS 1504 : 1976

Specification for steel castings for pressure purposes

Revised text

AMD 5514
April 1987

Clause 24. Defects revealed after delivery

Delete the existing clause entirely and substitute the following:

'24. Defects revealed after delivery.

In the event of subsequent manufacturing operations revealing defects capable of detection by the agreed inspection techniques prior to delivery and of a severity level greater than the acceptance standards agreed between the manufacturer and purchaser, the casting shall be deemed not to comply with this British Standard.'

AMD 5514
April 1987

Back cover

In column 2 of the text delete 'Committee references ISE/62 and ISE/62/3' and substitute 'Committee reference ISM/6'.

At the foot of the page, on the right hand side, insert the committee reference 'ISM/6'.

8704

ISM/6



Amendment Slip No.1, published 31 March 1978
to BS 1504 : 1976
Specification for steel castings for pressure purposes

Revised text

AMD 2494
March 1978

Clause 19. Freedom from defects

Delete the entire existing text and substitute the following:

'The castings shall be free from adhering sand and scale, and free from defects capable of detection by the method of inspection and of a severity level greater than the acceptance standards agreed between the manufacturer and the purchaser.'

7803

Gr 0

Foreword

This British Standard, prepared under the authority of the Iron and Steel Standards Committee, is a metric revision of the previous edition included in BS 1501-6, which was published in 1958.

To provide greater flexibility it has been decided, in revising BS 1501-6, to publish the individual specifications for the different product forms under separate covers which retain the existing numbering system for the standards except that Parts of BS 1501 now relate to plates and the previously unused number, BS 1502, has been allocated to sections and bars. The separate publications for the different product forms are as follows:

- BS 1501 for plates;
- BS 1502 for sections and bars (other than bolting material);
- BS 1503 for forgings;
- BS 1504 for castings;
- BS 1506 for bars for bolting material (in course of preparation).

BS 1505 has not been allocated to a specific steel product.

In preparing this revision, account has been taken of the demand for castings complying with the requirements of the various specifications included in the previous edition;

as a result the BS 1504-101 type has been deleted and several steels have been added. The opportunity has also been taken to review the chemical composition and mechanical property requirements. The Izod impact values have been replaced by Charpy V-notch impact values.

Included in this standard for the first time are specified elevated temperature proof stress values and low temperature impact properties for several of the steels. Stress rupture properties are given for information only for BS 1504-245 and BS 1504-622.

The designation system for carbon and low alloy steels has not been changed from the previous edition except that BS 1504-240 has been amended to BS 1504-245.

The designation system for corrosion resisting, heat resisting and high alloy steel castings has been aligned with that used for similar steels in most of the recently published British Standards. Wherever possible the first three digits correspond to the AISI stainless steel designation.

The letter C as the fourth character denotes castings and the last two digits are arbitrary.

Nearest equivalents or replacements for steels in the 1958 edition are given in appendix A.

British Standard Specification for

Steel castings for pressure purposes

Section one. General requirements

1. Scope

This British Standard specifies requirements for steel castings for pressure purposes.

NOTE. BS 3100 covers castings in similar steels and also other types of steel for general purpose use.

Provision has been made for the supply of steel castings to meet different combinations of service conditions and the castings can be supplied as follows:

- (a) to the room temperature properties specified in section two only; or
- (b) to the room temperature properties and elevated temperature properties specified in section two; or
- (c) to the room temperature properties and low temperature properties specified in section two; or
- (d) in the case of certain steels and subject to agreement at the time of enquiry and order, to specified room temperature properties, elevated temperature properties and low temperatures properties specified in section two.

Inspection categories, which may be specified by agreement between the manufacturer and the purchaser, are included in appendix B.

2. References

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

3. Designation

Castings for which elevated temperature properties are not required shall be designated by the suffix 'A'. Castings for which elevated temperature properties are required shall be designated by the suffix 'E'.

Castings that are required to have specified low temperature impact properties shall be designated by the suffix 'LT' followed by a number representing the temperature of test in °C below zero.

Examples of the complete steel designation are as follows.

- (a) BS 1504-161, carbon steel castings having a specified tensile strength not less than 430 N/mm², supplied to specified room temperature properties only, shall be designated BS 1504-161, grade 430A.
- (b) BS 1504-161, carbon steel castings having a specified tensile strength not less than 480 N/mm², supplied to specified room and elevated temperature properties, shall be designated BS 1504-161, grade 480E.

(c) BS 1504-161, carbon steel castings having a specified tensile strength not less than 430 N/mm², supplied to specified room temperature properties and impact properties at -40 °C, shall be designated BS 1504-161, grade 430A LT40.

(d) BS 1504-316C16, austenitic chromium-nickel -2½ % molybdenum steel castings supplied to specified room and elevated temperature properties shall be designated BS 1504-316C16E.

4. Information to be supplied by the purchaser

The following information shall be stated on the order. In certain cases it may be desirable to agree details with the manufacturer at the time of enquiry. It is always desirable that a drawing of the finished machined casting be supplied.

- (a) The complete steel designation of the material, with which the castings shall comply (see clause 3).
- (b) The heat treated condition in which the castings are to be supplied, if different from that stated in the relevant material specification (see clause 8).
- (c) *If castings having specified elevated temperature yield or proof stress properties are required:
 - (1) whether the properties are to be verified with or without acceptance testing (see clause 13); and
 - (2) if the material is to be tested at elevated temperature, the temperature at which the yield or proof stress value is required from one of those tabulated in the relevant material specification, unless otherwise agreed with the manufacturer.
- (d) *Whether castings having specified low temperature properties are required.
- (e) Whether bend test values are to be adopted as the criteria to be met, when these are included in the relevant material specification as an alternative to impact tests (see 10.3.1).
- (f) If required, the location and number of test samples (see 10.1.1).
- (g) Whether substantially non-magnetic castings are required when BS 1504-304C15 or BS 1504-330C40 is specified.
- (h) Whether intercrystalline corrosion tests are required (see austenitic stainless steel castings in section two).
- (i) If appropriate, whether Brinell hardness testing of castings is required and, if so, the location and extent of any such tests (see 11.5) and whether other mechanical tests are required.

*Only castings for which elevated temperature yield stress properties, proof stress properties or low temperature impact properties are specified in the relevant material specification may be so ordered.

- (j) Whether values for residual elements are required (see 6.1).
- (k) Reference to any agreement on test category, methods and location of non-destructive tests and acceptance standards (see clauses 15 and 16 and appendix B).
- (l) Whether pressure tests are required (see clause 17).
- (m) Whether the castings are to be inspected and tested in the presence of the purchaser's representative (see 10.1.3 and clause 21).
- (n) Whether the sanction of the purchaser is required prior to weld rectification (see clause 18).
- (o) Any requirements as to identification (see clause 22).
- (p) Type of certificate(s) (see clauses 6 and 23).

5. Requirements

The castings shall comply with the requirements of this section and with the appropriate requirements of section two.

Subject to agreement between the manufacturer and the purchaser castings may be manufactured in two or more pieces subsequently joined by welding where this is considered to offer technical or economic advantage. Such welding shall be carried out in accordance with the requirements of BS 4570 : Part 2.

6. Chemical composition

6.1 Specified analysis. The specified ranges of chemical composition are based on cast analyses. Where the order requires a full manufacturer's certificate this shall include the analyses of each cast of steel used, but shall not include the determination of residual elements unless requested by the purchaser or unless there is reason to suspect the presence of such elements in excessive amounts (see clause 23).

6.2 Residual elements. Elements that are designated residual elements in the individual specifications shall not be intentionally added to the steel and these and all undesignated residual elements shall be kept as low as practicable.

7. Fettling and dressing

All castings shall be properly fettled and dressed and all surfaces shall be satisfactorily cleaned for inspection purposes.

8. Heat treatment

Unless otherwise stated on the enquiry and order (see clause 4(b)) the castings shall be heat treated as required by the relevant material specification in section two.

9. Testing

The mechanical properties required shall be obtained from test bars cast either separately from, or attached to, the castings to which they refer. The test values so exhibited therefore represent the quality of steel from which the castings have been poured: they do not necessarily represent the properties of the castings themselves, which may be affected by solidification conditions and rate of cooling during heat treatment, which in turn are influenced by casting thickness, size and shape.

10. Number, selection, preparation and heat treatment of test samples

10.1 Number and selection of test samples

10.1.1 In all cases at least one set of tests as required by the relevant material specification shall be made from each cast.

10.1.2 Unless otherwise stated on the enquiry and order the location and number of test samples shall be at the discretion of the manufacturer.

If a casting is made from more than one cast (except when the casts are all mixed in one ladle before pouring and may be considered as a single cast) the number and position of the test samples shall be agreed between the purchaser and the manufacturer.

10.1.3 If the purchaser requires tests to be carried out in his presence or in the presence of his representative he shall state this on the enquiry and order, and the following shall be agreed between the purchaser and the manufacturer:

- (a) whether test samples shall be attached to or separate from the casting;
- (b) when test samples are attached, the precise location and method of attachment, since the attachment of test samples may adversely affect the quality of the casting;
- (c) when test samples are separate, the number of tests required.

10.2 Heat treatment of test samples

10.2.1 When separate test samples are used they shall be cast from the same heat of steel as the castings they represent and shall be submitted to the same heat treatment, but not necessarily at the same time.

10.2.2 When test samples are cast attached to the casting, they shall not be detached until after the heat treatment of the castings has been completed by the manufacturer, or, when testing has to be witnessed by the purchaser or his representative, until they have been stamped by the purchaser or his representative. Test samples shall be stamped after the heat treatment process.

10.2.3 In the case of BS 1504-161, if agreed at the time of enquiry and order test samples or the test pieces shall finally be stress relieved at $600 \pm 10^\circ\text{C}$ for 3 h followed by cooling in still air.

10.3 Preparation of test pieces

10.3.1 *Room temperature tensile test and impact or bend tests.* One test piece for the room temperature tensile test shall be prepared in accordance with BS 18: Part 2, if required by the relevant material specification.

When a bend test and a room temperature impact test are specified as alternatives in the relevant material specification the manufacturer shall prepare three test pieces in accordance with BS 131: Part 2 for the Charpy V-notch impact test, unless a bend test has been specified on the enquiry and order by the purchaser (see clause 4(e)) in which event no impact test shall be carried out.

One test piece for the bend test shall be prepared if the test is required by the relevant material specification. Bend test pieces shall be smooth machined either to 25 mm diameter, or to a rectangular section 25 mm wide by 20 mm thick, or in the same proportions for small castings. The corners of rectangular test pieces may be slightly rounded to a radius not exceeding 1.5 mm.

10.3.2 Elevated temperature tensile tests. When elevated temperature tests are required (see clause 13) test pieces shall be prepared from samples selected in a similar manner to those used for room temperature testing.

10.3.3 Low temperature impact tests. Three impact test pieces shall be prepared in accordance with BS 131: Part 2.

11. Mechanical tests

11.1 Tensile tests at room temperature. Tensile tests at room temperature shall be carried out in accordance with BS 18: Part 2, including the determination of lower yield or proof stress if specified.

For acceptance purposes the upper yield stress, R_{eH} , may be determined in place of the lower yield stress, R_{eL} , and in this case the material shall comply with an upper yield stress value 20 N/mm² above the specified lower yield stress.

Should a test piece break outside the middle third of its gauge length, resulting in an elongation below the value specified, the test may, at the manufacturer's option, be discarded and another test made from the same material.

11.2 Tensile tests at elevated temperature. Tensile tests at elevated temperatures shall be performed in accordance with BS 3688: Part 1.

The tests shall be made at the temperature stated on the enquiry and order; unless otherwise agreed this shall be selected by the purchaser from those temperatures tabulated in the relevant material specification in section two. By arrangement between the manufacturer and the purchaser tests at more than one designated temperature may be carried out.

Although certain steels exhibit a well-defined yield stress at room temperature this becomes less well-defined with increase of test temperature. If at any particular temperature the lower yield extension is less than 0.2 % then the 0.2 %* proof stress shall be taken as the criterion for acceptance purposes. If the lower yield extension is more than 0.2 % then the lower yield shall be taken as the criterion for acceptance purposes.

11.3 Bend tests. If bend tests are required by the relevant material specification, they shall be performed in accordance with BS 1639. The test piece shall, at room temperature, be bent through the angle and to the internal radius, optionally round a former, specified in the relevant material specification in section two. The test piece shall have passed the test if it remains free of cracks. Minor surface cracking shall not be a cause for rejection.

11.4 Impact tests. Impact tests shall be carried out in accordance with the requirements of BS 131: Part 2. The average of three impact tests made shall be not less than the value specified. No single value shall be lower than 70 % of the specified average value.

11.5 Hardness tests. If specified by the relevant material specification, and called for by the purchaser on the enquiry and order, tests to establish the hardness values on castings shall be carried out on a representative number of castings from each cast or heat treatment batch. They shall be performed in accordance with BS 240: Part 1 or, when this is not practicable, by a procedure to be agreed between the manufacturer and the purchaser. The location of such tests shall be agreed between the manufacturer and the purchaser.

*1.0 % in the case of austenitic steels.

The surface shall be prepared by grinding and sufficient material shall be removed to ensure freedom from decarburization.

11.6 Intercrystalline corrosion test. If required by the order and specified in the relevant material specification, a special bend test shall be carried out as described in 11.6.1 to 11.6.3.

11.6.1 Two similar test pieces shall be prepared, not larger than 12.5 mm in diameter or thickness. Unless otherwise stated in the relevant material specification, each test piece shall be heated for 30 min at a temperature of 650 °C and cooled in air. One test piece shall then be immersed for 24 h in a boiling solution, having the following composition, made up to 1 litre with distilled water:

111 g copper sulphate (CuSO₄·5H₂O);

98 g sulphuric acid, ($d = 1.84$).

11.6.2 Approximately 50 g of copper turnings or filings shall be put into the boiling flask at the beginning of the test and the test piece shall be in contact with the copper. Precautions shall be taken during boiling to prevent concentration due to evaporation.

11.6.3 Both test pieces shall then be bent through 90 ° round a radius equal to three times the diameter or thickness of the test piece. Should the test piece that has been immersed in the test solution contain cracks not characteristic of any that may be present on the test piece that has not been immersed in the test solution, the material shall be considered to have failed the intercrystalline corrosion test.

12. Mechanical properties at room and low temperatures

The mechanical properties obtained from the test pieces shall comply with the requirements of the relevant material specification in section two.

13. Mechanical properties at elevated temperatures

13.1 Proof stress

13.1.1 Minimum values. The minimum elevated temperature proof stress values derived in accordance with BS 3920 are given in the relevant material specification in section two of this standard.

13.1.2 Verification procedures

13.1.2.1 Elevated temperature proof stress. If verification of elevated temperature proof stress properties is required against a particular order this shall be carried out at the option of the manufacturer either by elevated temperature acceptance testing or by the procedure specified in BS 3920.

13.1.2.2 Verification by acceptance tests. Where elevated temperature proof stress is verified by acceptance tests these shall be carried out in accordance with the requirements of clause 10 and 11.2, at the temperature or temperatures specified by the purchaser, and the mechanical properties obtained shall comply with the requirements of the relevant material specification in section two. If, however, tests at the appropriate temperature or temperatures have been made on samples representing other casts from the same melt subjected to the same treatment and are of the same or greater section than those ordered the results of such tests may be considered as evidence that the castings have the required properties.

13.1.2.3 *Verification without acceptance tests.*

Where elevated temperature properties are verified without acceptance tests the procedure given in BS 3920 shall be used. The 95 % lower confidence limits of the elevated temperature proof stress values that are necessary for the application of that procedure are given in appendix C for the various steels.

13.2 Stress rupture properties. Stress rupture properties are given, where available, for information only in the relevant material specifications in section two.

Some stress rupture values have been obtained by extrapolation. Experience suggests that reliable extrapolation may be made covering a range of $\pm 20^\circ\text{C}$ about each test temperature, on the basis of a series of tests from at least five casts of steel, the longest test of each series exceeding a certain minimum duration.

The confidence that can be placed upon such properties will be related to the extent of extrapolation. For the purposes of this standard, extrapolations exceeding approximately three times the above minimum duration are described as 'extended time extrapolations' and marked with an asterisk in the relevant material specifications in section two.

The values may also be obtained by extending the parametric master curves to stresses beyond those at which the casts have been tested. Such values obtained by 'extended stress extrapolation' are enclosed in parentheses in the relevant material specification in section two. They are subject to greater uncertainty than other values.

14. Retests

14.1 Should the results of any mechanical test carried out on test pieces fail to comply with the requirements of the specification, the manufacturer may, if he so desires, adopt one of the procedures described in 14.1.1 to 14.1.3.

14.1.1 The manufacturer may repeat the mechanical test (including the intercrystalline corrosion test), under which failure occurred, on two additional test pieces. In the event of either of these duplicate test pieces failing to meet the requirements of the specification, the manufacturer may then follow the procedure given in 14.1.3.

14.1.2 In the case of Charpy V-notch impact tests, if the average of three impact values is lower than the specified value, or if any one value is lower than 70 % of this specified value, three additional test pieces shall be taken from the same sample and tested. The material represented complies with the requirements of this British Standard provided the average value of the six tests is not less than the specified value, not more than two of the individual values being lower than the specified value and not more than one being lower than 70 % of this value. In the event of the new average value or any individual value failing to meet the requirements of the specification the manufacturer may then follow the procedure given in 14.1.3.

14.1.3 The manufacturer may submit the castings, together with the test samples, may be submitted to not more than one further heat treatment, after which the test samples shall be subjected to all mechanical tests required by the specification.

In the case of further failure, the castings, together with the test samples, may be submitted to not more than one further heat treatment, after which the test samples shall be subjected to all mechanical tests required by the specification.

In no instance shall the castings and test samples be subjected to more than two additional heat treatments (excluding tempering).

14.2 The castings shall comply with the requirements of this British Standard if the results obtained from the retests are satisfactory. If the results obtained from the final retests fail to meet the requirements of the specification, the castings represented by those results shall not comply with the requirements of this British Standard.

15. Visual inspection

All castings shall be visually inspected (see 16.3 and clauses 18 and 19).

16. Non-destructive tests

16.1 When called for on the order the casting shall be subjected to the non-destructive testing techniques agreed between the purchaser and the manufacturer to the extent appropriate to the inspection category (see appendix B) or other agreed level of inspection.

16.2 The technique of examination (see BS 4080), the inspection procedure and the standard of quality required shall be agreed between the manufacturer and the purchaser, bearing in mind the service conditions to which the castings will be subjected.

16.3 Castings exhibiting unacceptable defects may be rectified in accordance with clause 18. Grinding or other means may be used to remove superficial surface defects.

17. Pressure tests

If specified by the purchaser on the enquiry and order, castings shall be pressure tested in a manner agreed between the purchaser and the manufacturer (see BS 4080).

The castings shall not be cleaned or plugged to stop leaks and shall not be impregnated unless agreed between the manufacturer and the purchaser.

18. Rectification of castings

18.1 Welding. Unless otherwise specified by the purchaser on the enquiry and order, castings may be rectified by welding without the previous sanction of the purchaser.

Rectification by welding shall be carried out in accordance with BS 4570: Part 1.

18.2 Re-examination. If castings have been subjected to non-destructive testing by agreement between the manufacturer and the purchaser, the castings shall, following any rectifying operation performed on them, be re-examined in the area of the repair by the techniques and in compliance with the requirements specified on the order.

19. Freedom from defects

The surface of the castings shall be free from adhering sand and scale, from defects capable of detection by the method(s) of inspection and from defects of a severity level greater than the acceptance standards agreed between the manufacturer and the purchaser.

20. Testing facilities

The manufacturer shall supply the test samples required for testing and shall prepare from them the necessary test pieces and where possible supply the labour and appliances for making all tests on his premises in accordance with the relevant material specification.