

BS 4HR 100:2010+A1:2012



BSI Standards Publication

AEROSPACE SERIES

Procedure for inspection, testing and acceptance of wrought heat-resisting alloys

bsi.

...making excellence a habit.
AVA Documents™
Document Sharing Hub

Publishing and copyright information

The BSI copyright notice displayed in this document indicates when the document was last issued.

© The British Standards Institution 2012
Published by BSI Standards Limited 2012

ISBN 978 0 580 78019 6

ICS 49.025.01

The following BSI references relate to the work on this standard:

Committee reference ACE/61

Draft for comment 09/30199939 DC, 12/30259039 DC

Publication history

First published December 1968

Second edition, December 1971

Third edition, October 1978

Fourth (present) edition, January 2010

Amendments issued since publication

Date	Text affected
July 2012	A1: see Foreword.

Contents

Foreword v

Section 1: General requirements 1

- 1 Scope 1
- 2 Normative references 1
- 3 Terms and definitions 2
- 4 General 4
- 5 Information and requirements to be agreed and documented 5
- 6 Manufacture and freedom from defects 8
- 7 Preparation for inspection 9
- 8 Heat treatment 9
- 9 Chemical composition 10
- 10 Testing 10
- 11 Maintenance of identity 13
- 12 Marking 13
- 13 Protection and packaging 14
- 14 Certification 14

Section 2: Bars for machining and sections 16

- 15 General 16
- 16 Dimensions and tolerances 16
- 17 Tensile, creep and stress-rupture tests 16
- 18 Hardness test 17
- 19 Internal defects 17
- 20 External defects 18
- 21 Macroexamination 18
- 22 Marking 19

Section 3: Forging stock and billets and bars for subsequent working 20

- 23 General 20
- 24 Dimensions and tolerances 20
- 25 Tensile, creep and stress-rupture tests 20
- 26 Internal defects 21
- 27 External defects 21
- 28 Macroexamination 21
- 29 Marking 22

Section 4: Forgings 23

- 30 General 23
- 31 Manufacture 23
- 32 Pre-production forgings 23
- 33 Production forgings 24
- 34 Procedure X for process control testing 24
- 35 Forgings subject to heat treatment after delivery 25
- 36 Selection and preparation of mechanical test samples for batch release testing 25
- 37 Hardness test 28
- 38 Internal defects 28
- 39 External defects 29
- 40 Grain flow and grain size 29
- 41 Marking 29

Section 5: Plate, sheet and strip 30

- 42 General 30
- 43 Dimensions and tolerances 30
- 44 Tensile, creep and stress-rupture tests 30



Documents

Document Sharing Hub

© The British Standards Institution 2012 • 1

45	Hardness test	31
46	Single bend test	32
47	External defects	32
48	Marking	32

Section 6: Tubes 34

49	General	34
50	Dimensions and tolerances	34
51	Tensile, creep and stress-rupture tests	34
52	Hardness test	35
53	Drifting test	35
54	Distension test	36
55	Flattening test	36
56	Pressure test	37
57	External defects	37
58	Marking	38

Section 7: Wire 39

59	General	39
60	Dimensions and tolerances	39
61	Tensile, creep and stress-rupture tests	39
62	Ductility tests	40
63	External defects	41
64	Macroexamination	41
65	Marking	42

Section 8: Parts finally heat treated after machining 43

66	General	43
67	Manufacture	43
68	Condition	43
69	Heat treatment	43
70	Mechanical tests	43
71	Hardness test	44
72	External defects	44

Section 9: Bar and wire intended for the manufacture of fasteners 45

73	General	45
74	Dimensions and tolerances	45
75	Hardness test	45
76	Macroexamination	46
77	Grain size determination	46
78	Surface contamination	47

Annexes

Annex A (normative) Rules for application of values for chemical composition and mechanical properties given in material specifications 48

Annex B (normative) Dimensional tolerances 48

Bibliography 55

List of tables

Table 1 – Number of bars or sections to be sampled 18

Table 2 – Minimum reduced diameter, section or thickness of side forged test samples for billets, bars and sections 20

Table 3 – Maximum number of forgings to be manufactured between the collection of test samples 25

Table 4 – Minimum reduced diameter, section or thickness of side forged test samples for forging stock 26

Table 5 – Tensile, creep and stress-rupture property requirements for forgings	27
Table 6 – Tolerances for plate, sheet and strip	30
Table 7 – Position of the test sample axis within the plate, sheet or strip	30
Table B.1 – Tolerances on diameters of drawn and ground bars	48
Table B.2 – Tolerances on widths across flats of bright drawn bars	49
Table B.3 – Tolerances on diameters of machined round bars	49
Table B.4 – Tolerances on thicknesses of cold rolled plate and sheet	49
Table B.5 – Tolerances on thicknesses of hot rolled plate and sheet	49
Table B.6 – Tolerances on thicknesses of cold rolled strip	50
Table B.7 – Tolerances on widths and lengths of cold rolled plate and sheet	50
Table B.8 – Tolerances on widths and lengths of hot rolled plate and sheet	50
Table B.9 – Tolerances on widths of cold rolled strip	50
Table B.10 – Tolerances on dimensions of cold worked tubes	52
Table B.11 – Tolerances on diameters of wire	54

Summary of pages

This document comprises a front cover, an inside front cover, pages i to viii, pages 1 to 56, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 January 2010. It was prepared by Panel ACE/61/-/48, *Heat resisting alloys*, under the authority of Technical Committee ACE/61, *Metallic materials for aerospace purposes*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

BS 4HR 100:2010+A1:2012 supersedes BS 4HR 100:2010, which is withdrawn.

Information about this document

The start and finish of text introduced or altered by Amendment No. 1 is indicated in the text by tags $\boxed{A1}$ $\triangleleft A1 \triangleright$. Minor editorial changes are not tagged.

This is a full revision of BS HR 100, and introduces the following principal changes.

Section 1

- a) Definitions have been amended.
- b) Information to be supplied by purchaser has been added.
- c) Information to be agreed by contracting parties has been added.
- d) Reference to AMS 2750 has been added for heat treatment temperature control.
- e) Heat treatment temperature tolerances have been added.
- f) Reference to AS 5491 for calculation of Electron Vacancy Number has been added.
- g) Rules for application of values have been added.
- h) Tensile testing at ambient temperature to BS 4A 4 has been replaced by BS EN 2002-1.
- i) Tensile testing at elevated temperature to BS 4A 4-1.2 has been replaced by BS EN 2002-2.
- j) Creep and stress-rupture testing to BS 4A 4-1.3 has been replaced by BS EN 2002-005.
- k) Brinell hardness testing to BS 240 has been replaced by BS EN ISO 6506-1.
- l) Vickers hardness testing to BS 427 has been replaced by BS EN ISO 6507-1.
- m) Rockwell hardness testing to BS 891 and BS 4175 has been replaced by BS EN ISO 6508-1.
- n) Reference to ASTM E112 for grain size determination has been added.
- o) Protection and packaging requirements have been added.
- p) Certification requirements have been amended.

Section 2

- a) Requirement for internal defects has been added and reference to EN 4050 has been added.
- b) External defects requirements have been added and requirements for non-destructive testing have been amended.
- c) Etch test has been re-identified as macroexamination and reference to BS EN 2950 has been added.

Section 3

- a) Requirement for internal defects has been added and reference to EN 4050 has been added.
- b) External defects requirements have been added and requirements for non-destructive testing have been amended.
- c) Etch test has been re-identified as macroexamination and reference to BS EN 2950 has been added.

Section 4

Completely re-written to reflect current methodology.

Section 5

- a) BS EN ISO 7438 has been added as single bend test method.
- b) External defects requirements have been added.

Section 6

- a) Test piece dimensions have been added by reference to BS EN 2002.
- b) BS EN ISO 8493 has been added as drift test method and 74° has been added as conical mandrel angle.
- c) BS EN ISO 8492 has been added as flattening test method.
- d) External defects requirements have been added.

Section 7

- a) Test piece dimensions have been added by reference to BS EN 2002.
- b) BS ISO 7800 has been added as simple torsion test method.
- c) External defects requirements have been added.
- d) Surface contamination requirements have been added.

Section 9

Re-written to indicate that material shall conform to either Section 2 or Section 7, with additional requirements.

Appendix A has been deleted – requirements for calculation of N_v value have been transferred to Section 1.

New Annex A has been added – rules for application of values for chemical composition and mechanical properties given in material specifications.

Appendix B has been re-identified as Annex B and tables 1 to 11 re-identified as Tables B.1 to B.11.

Hazard warnings

WARNING. This British Standard calls for the use of substances and/or procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Use of this document

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its methods are expressed as a set of instructions, a description, or in sentences in which the principal auxiliary verb is “shall”.

Contractual and legal considerations

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

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

Section 1: General requirements

1 Scope

This British Standard specifies procedures for inspection, testing and acceptance of wrought heat-resisting alloys for aerospace purposes.

The standard is applicable to material specifications in the British Standard Aerospace HR series and also to other British Standard material specifications for wrought heat-resisting alloys which are suitable for aerospace use.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 2002-1, *Metallic materials – Test methods – Part 1: Tensile testing at ambient temperature*

BS EN 2002-2, *Metallic materials – Test methods – Part 2: Tensile testing at elevated temperature*

BS EN 2002-005, *Metallic materials – Test methods – Part 5: Uninterrupted creep and stress-rupture testing*

BS EN 2950, *Test method – Wrought heat resisting alloys – Semi-finished products and parts – Conditions for macrographic and micrographic examination – Atlas of structures and defects*

BS EN ISO 6506-1, *Metallic materials – Brinell hardness test – Part 1: Test method*

BS EN ISO 6507-1, *Metallic materials – Vickers hardness test – Part 1: Test method*

BS EN ISO 6508-1, *Metallic materials – Rockwell hardness test – Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

BS EN ISO 7438, *Metallic materials – Bend test*

BS EN ISO 8492, *Metallic materials – Tube – Flattening test*

BS EN ISO 8493, *Metallic materials – Tube – Drift-expanding test*

BS ISO 7800, *Metallic materials – Wire – Simple torsion test*

EN 4050-2, *Test method for metallic materials – Ultrasonic inspection of bars, plates, forging stock and forgings – Part 2: Performance of test*¹⁾

EN 4050-4, *Test method for metallic materials – Ultrasonic inspection of bars, plates, forging stock and forgings – Part 4: Acceptance criteria*¹⁾

AMS 2750, *Pyrometry*²⁾

AS 5491, *Calculation of electron vacancy number in superalloys*³⁾

ASTM E112, *Test methods for determining average grain size*⁴⁾

¹⁾ Published as ASD Prestandard at the date of publication of this standard.

²⁾ Available from www.sae.org.

³⁾ Available from www.ansi.org.

⁴⁾ Available from www.astm.org.

3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

- 3.1 bar**
wrought material of uniformly round, half round, square, rectangular, hexagonal, octagonal or regular polygonal solid section supplied in straight lengths
- 3.2 batch**
products which are from the same cast; of the same form and manufactured under the same processing conditions; of the same nominal dimensions to within $\pm 10\%$ or of similar ruling section; and in the same heat treatment condition and from the same heat treatment charge or, in the case of continuous heat treatment, from a run of not more than 8 h except in the case of coil when the maximum time is that required to heat treat one full coil
- 3.3 billet**
rolled, extruded or forged solid or hollow product intended for further working
- 3.4 blade blank**
product with controlled structure, grain size and dimensions such that it is suitable for the direct machining of a turbine blade
- 3.5 cast**
mass of solid metal all resulting from the same final melting operation
- 3.6 coil**
length of a product wound into a cylindrical or annular form, without joint or seam
- 3.7 design authority**
organization responsible for the detailed design of matériel and which has the responsibility of certifying designs and/or sealing drawings and specifications
- 3.8 edge straightness**
deviation from straightness of the edge of a sheet, strip or plate when laid flat
- 3.9 extruded length**
length produced from one cast extrusion ingot using a single or multihole die
- 3.10 extruded section**
length of extruded material other than bar, wire or tube
- 3.11 flash welded ring**
product formed by bending and resistance welding a bar or section
- 3.12 forging**
shape produced by hammering or pressing between open or closed dies, usually when hot

NOTE The term includes drop forgings, open die forgings, stampings, pressings, hot rolled rings and forgings made from tubular material

- 3.13 forging stock**
wrought or cast material intended for the production of forgings
- 3.14 harmful defect**
any defect prejudicial to the suitable and proper use of the material
- 3.15 ingot**
material cast into static moulds prior to subsequent hot working
- 3.16 inspection schedule**
details of inspection and test requirements specified by the purchaser
- 3.17 inspection stamp**
unique stamp of the person approved by the manufacturer to carry out final inspection
- 3.18 lateral curvature**
deviation from straightness of a plate, sheet or strip edge when the product is laid flat on a table with a calibrated surface
- 3.19 manufacturer**
company that produces the material in the form and condition in which it is supplied to the purchaser
- 3.20 melting processes**
- 3.20.1 air melting**
practice of melting, by an electric process, in air and casting in air
- 3.20.2 consumable electrode**
electrode, for subsequent remelting, produced from air-melted, vacuum-melted or vacuum-refined material
- 3.20.3 consumable electrode remelting**
practice of remelting consumable electrodes of known analysis under one of the following conditions:
a) vacuum-arc remelting: in vacuum;
b) electroflux remelting: through a flux
- 3.20.4 vacuum melting**
practice of melting, by induction heating, under vacuum and casting in a vacuum chamber
- 3.20.5 vacuum refining**
treatment of an air-melted liquid alloy in a vacuum, followed by casting in air or under vacuum
- 3.21 parent cast**
melt of known chemical composition which is to be subsequently remelted
- 3.22 plate**
rolled product of rectangular section and of uniform thickness over 3.0 mm supplied in flat form with sheared or sawn edges
- 3.23 pre-production forgings**
forgings produced to a particular design to qualify the method of manufacture and equipment configuration and to demonstrate that the requirements of the purchaser can be met

3.24 procedure X

process control procedure for forgings in which test samples are machined from specified locations in forgings and tested to demonstrate that the forgings continue to conform to specified requirements

NOTE 1 The forgings from which the samples are taken are destroyed.

NOTE 2 This procedure is used in conjunction with procedures A, B or C.

3.25 purchaser

organization which orders and purchases the product

3.26 quality assurance authority

body responsible for authorizing the manufacturer or supplier to issue certification, when to certify means to attest as meeting a standard

3.27 seamless tube

tube in which there is no deliberate longitudinal bonding of two or more edges by pressure, fusion or mechanical means

3.28 section

extruded, rolled or formed product of uniform solid or hollow cross-section other than bar, wire, tube, sheet, strip or plate, generally supplied in straight lengths

3.29 sheet

flat rolled product of rectangular section and of uniform thickness from 0.2 mm up to and including 6.0 mm, supplied in straight lengths with slit, sawn or sheared edges

3.30 strip

flat rolled product of rectangular section and of uniform thickness from 0.2 mm up to and including 6.0 mm, supplied in coil form with slit edges

3.31 supplier

organization which has not necessarily made the product, but which supplies it to the purchaser

3.32 tube

extruded and/or drawn hollow product of uniform wall thickness, generally supplied in straight lengths

3.33 wire

product with a regular or consistent solid section obtained by the cold working of rod and normally supplied in coils

4 General

This standard details the basic requirements for the inspection and testing of British Standard Aerospace HR series wrought heat-resisting alloys.

In addition to the definitive requirements, this standard also requires the items detailed in Clause 5 to be documented. For compliance with this standard, both the definitive requirements and the documented items shall be satisfied.

If the purchaser wishes to specify an inspection, testing or acceptance procedure for any property of any product which differs from that specified in this standard, this shall be agreed between the purchaser and the manufacturer and shall be fully documented on the order, drawing or inspection schedule, provided that the purchaser is also

the quality assurance authority. If the purchaser is not also the quality assurance authority, deviations from the requirements of this standard shall only be agreed and documented after written approval has been obtained from the quality assurance authority.

5 Information and requirements to be agreed and documented

5.1 Information to be supplied by the purchaser

The following information to be supplied by the purchaser, which is specified in the clauses referred to, shall be fully documented on the order, drawing or inspection schedule, on which the number of this British Standard shall also be given.

Both the definitive requirements specified throughout the standard and the following documented items shall be satisfied before a claim of compliance with the standard⁵⁾ can be made and verified.

a) General:

- 1) the number of the material specification with which this standard is to be used;
- 2) if a particular method of melting is required where alternatives are given in the material specification (see 6.1.1);
- 3) material condition if other than that specified by the material specification (see 6.2);
- 4) if descaling, etching or machining is not required prior to inspection (see 7.1);
- 5) if a particular sequence and method of descaling and cleaning is required prior to inspection (see 7.2);
- 6) the heat treatment required if different from that specified in the material specification (see 8.1);
- 7) if the material is required to be identifiable to its ingot and position in the ingot where this is not a requirement of the material specification (see 11.1);
- 8) if required, the type of characters used and the nature and colour of any marking ink or similar medium (see 12.4);
- 9) if a coating of corrosion preventative is not required (see 13.1).

b) Bars for machining and sections:

- 1) if required, the dimensional tolerances of sections and hot rolled bars [see 16b)];
- 2) if required, the tolerances on the straightness of bars [see 16c)];
- 3) for ultrasonic testing, the acceptance level if other than class 3 of EN 4050-4 (see Clause 19).

⁵⁾ Marking a British Standard identifier (e.g. BS 3HR 1:2010) on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

- c) Forging stock and billets and bars for subsequent working:
 - 1) for ultrasonic testing, the acceptance level if other than class 3 of EN 4050-4 (see Clause 26);
 - 2) if macroexamination is not required on each forging “use” length (see 28.1.3).
- d) Forgings:
 - 1) the dimensional tolerances if other than those given in the material specification (see 33.2.1);
 - 2) any dimensions which require checking on each forging (see 33.2.2);
 - 3) where procedure X is invoked, the position, size and number of test pieces to be machined from each forging, the properties required and the frequency of testing (see 34.1 and 34.2 and Table 3);
 - 4) for forgings subject to heat treatment after delivery and tested in accordance with procedure A, the number of the test samples required with each delivery (see 35.2);
 - 5) if a sampling procedure other than procedure A is to be used for batch acceptance tensile tests (see 36.1.1);
 - 6) for procedure A, the location of test pieces if other than those given in 36.2.1.4;
 - 7) for forgings tested in accordance with procedure C, the number, location, form and size of the test samples (see 36.2.2.1);
 - 8) if, in the case of procedure C, separation of the test samples from the forgings before heat treatment is permitted (see 36.2.2.2);
 - 9) the location of the test samples to be machined from forgings in accordance with procedure D (see 36.2.3.2);
 - 10) the mechanical properties required from forgings tested in accordance with procedure C or procedure D, if other than in accordance with the material specification, or forgings tested in accordance with procedure X (see 36.3, 36.4 and 36.5);
 - 11) if ultrasonic testing is required, where this is not specified in the material specification, the method to be used if other than EN 4050-2, the stage of manufacture and the heat treatment condition in which it is to be carried out and the acceptance level if other than class 3 of EN 4050-4 (see Clause 38);
 - 12) if grain flow examination and grain size measurement are required (see 40.1); if so, the type of examination, and the sampling procedure as specified under procedure X (see 40.1) and the required characteristics (see 40.2);
 - 13) the location and method of marking if not given in the material specification, and if other than at the discretion of the manufacturer (see 41.2).
- e) Tubes:
 - 1) the percentage of each batch to be pressure tested if higher than 10% (see 56.1).

- f) Parts finally heat treated after machining:
 - 1) the heat treatment required if different from that specified in the material specification (see 69.1).
- g) Bar and wire intended for the manufacture of fasteners:
 - 1) if required, the tolerances on the straightness (see 74.2);
 - 2) if inspection for freedom from surface contamination is required, in cases where this is not a requirement of the material specification (see 78.1).

5.2 Items to be agreed between the contracting parties

The following items to be agreed between the contracting parties, which are specified in the clauses referred to, shall be fully documented.

Both the definitive requirements specified throughout the standard and the following documented items shall be satisfied before a claim of compliance with the standard⁶⁾ can be made and verified:

- a) method of melting if other than that required by the material specification (see 6.1.1);
- b) method of temperature control if other than AMS 2750 (see 8.2);
- c) frequency of grain size determination and locations to be tested if different from that specified in the material specification (see 10.10.2);
- d) requirements for flaw detection (see 20.2, 27.2, 39.2, 57.2, 63.2 and 72.2);
- e) dimensional tolerances of forging stock (see Clause 24);
- f) method of preparation of test samples (see 25.2.2 and 36.2.1.2);
- g) locations at which hardness tests are to be made and the values to be obtained (see 37.1.3);
- h) if required, flatness standard for sheet and strip (see Table 6);
- i) the tolerances on the dimensions of hot finished tubes (see 50.3);
- j) the test requirements for other than round wire (see 62.1.2);
- k) if test samples may be machined to a diameter representative of the parts being treated (see 70.1.2);
- l) the selection of test samples for flash butt welded rings (see 70.1.3);
- m) the required mechanical properties if different from the material specification (see 70.2.2);
- n) if all the parts and their representative test samples are not required to be hardness tested (see 71.1.1);
- o) the hardness sampling frequency for small items manufactured in large production batches (see 71.1.2);

⁶⁾ Marking a British Standard identifier (e.g. BS 3HR 1: 2010) on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

- p) the locations at which hardness tests are to be made and the values to be obtained (see 71.1.3);
- q) if surface contamination determination is required, the method of examination and the acceptance standard (see 78.2).

6 Manufacture and freedom from defects

6.1 Melting

6.1.1 General

Unless otherwise agreed between the manufacturer and the purchaser and stated on the order, [see 5.2a)] the method of melting shall conform to the material specification.

If alternative methods are given in the material specification, the method selected shall be at the discretion of the manufacturer unless a particular method is specified by the purchaser and stated on the order [see 5.1a2)].

6.1.2 Consumable electrode remelted material

6.1.2.1 Except as provided in 6.1.2.3 or 6.1.2.4, at no time during remelting shall material of any other composition or type be introduced into the melting chamber, i.e. starter material and electrode stub-ends shall be of the same composition as the material being remelted.

6.1.2.2 Whenever possible and except as provided in 6.1.2.3, weld material used to join electrodes together and to join the electrode to the stub-end shall be of the same composition as the material being remelted. If such weld material is not obtainable, material of a similar composition to, or compatible with, the material being remelted shall be used at the discretion of the manufacturer, unless the purchaser indicates that his prior agreement is required.

6.1.2.3 Alternatively to 6.1.2.1 and 6.1.2.2, for electro-flux and vacuum arc remelting, the stub and any weld material used to join the electrode to the stub-end shall be of a different material from that being remelted, provided that the remelted material is not contaminated with material from the stub-ends or weld and that for vacuum arc remelting, the stub welding takes place outside the furnace. Remelting shall be terminated not less than 20 mm from the electrode/stub interface and, after completion of the remelting cycle, the electrode/stub interface shall be examined to verify that the stub and weld are intact.

6.1.2.4 For electro-flux remelting, material compatible with the composition of that being remelted shall be permitted to provide electrical contact to the furnace base plate, provided that the chemical composition of the melt is maintained.

6.2 Products

Products shall be delivered in the condition specified in the material specification or order [see 5.1a3)].

6.3 Freedom from defects

6.3.1 The material shall be free from harmful defects.

6.3.2 Notwithstanding prior acceptance of a material as conforming to this British Standard, any defect in the material which is found at a later stage, and which is likely to be detrimental to subsequent use, shall be a cause for rejection.

6.4 Local dressing

6.4.1 Surface defects on material in the condition of supply shall be removed by local dressing provided the dimensions of the product remain within the tolerance limits. Dressed areas shall be blended smoothly into the surrounding material and the bottom radius of a dressed area shall be not less than three times the depth of the defect. Care shall be taken to avoid grinding abuse.

6.4.2 On completion of local dressing, the dressed areas shall be re-inspected using the same method as that which revealed the original defect.

7 Preparation for inspection

7.1 Unless otherwise stated on the drawing, order or inspection schedule [see 5.1a4)], all wrought products shall be either descaled and etched or machined all over and etched to enable them to be inspected.

7.2 Unless otherwise stated on the drawing, order or inspection schedule [see 5.1a5)], the sequence and methods of descaling and cleaning shall be at the option of the manufacturer.

8 Heat treatment

8.1 Heat treatment shall be carried out in accordance with the material specification or order [see 5.1a6)].

8.2 Unless otherwise agreed between the manufacturer and the purchaser [see 5.2b)], temperature control during heat treatment shall be in accordance with AMS 2750.

8.3 If a specific temperature (value and tolerance) is given in the material specification, that temperature shall be used. If a temperature range is given in the material specification, a temperature within that range, reduced by the furnace tolerance, shall be selected that will give the properties specified in the material specification.

8.4 The total volume of the charge shall be maintained at the selected temperature (θ), subject to the following furnace tolerances, for the period stated in the material specification.

- a) $\theta < 750\text{ }^{\circ}\text{C}$: $\pm 5\text{ }^{\circ}\text{C}$.
- b) $750\text{ }^{\circ}\text{C} \leq \theta \leq 1250\text{ }^{\circ}\text{C}$: $\pm 10\text{ }^{\circ}\text{C}$.
- c) $\theta > 1250\text{ }^{\circ}\text{C}$: $\pm 15\text{ }^{\circ}\text{C}$.

8.5 If no period or temperature is given in the material specification for a particular heat treatment, these and their tolerances shall be at the discretion of the manufacturer.

8.6 If any material is heat treated in bundles at a temperature exceeding 950 °C and subsequently air cooled, the bundles shall be split after removal from the furnace and the components shall be individually cooled.

8.7 No product or test sample shall be subjected to the specified heat treatment more than twice.

9 Chemical composition

9.1 The chemical composition of the alloy shall conform to the material specification.

9.2 The samples taken for analysis shall be representative of the melt.

9.3 An analysis shall be made of each sample for the specified elements and certificates of analysis shall be supplied to the purchaser.

9.4 In the case of remelted material (vacuum arc remelted or electroflux remelted), samples shall be taken from the bottom or the top of one ingot or ingot product.

9.5 Elements not quoted in the material standard shall not be intentionally added to the alloy without the agreement of the purchaser, except for the purpose of finishing the heat (e.g. addition of deoxidant); reasonable precautions shall be taken to prevent their inclusion during manufacture.

9.6 The specified ranges of chemical composition are based on cast analyses; any subsequent analytical checks shall take into consideration the heterogeneity normal to the alloy.

9.7 Additionally for remelted products, the samples shall be representative for the remelted ingot, taking into account any macro segregation.

9.8 If in the course of routine analysis the presence of elements other than those named in the material specification is detected, the amounts of these other elements and/or their total shall not exceed the limits given in the material specification.

9.9 Values for chemical composition given in the material specification shall be applied in accordance with Annex A.

9.10 If the material specification requires the calculation of the Electron Vacancy Number (N_v), the value for each cast shall be calculated in accordance with AS 5491 or other method acceptable to the quality assurance authority. The value obtained shall conform to the material specification and shall be quoted on the certification.

10 Testing

10.1 General

10.1.1 The tests carried out and the test methods used shall conform to either:

- a) the material specification; or
- b) the relevant section of this standard; or
- c) the order or inspection schedule.

NOTE See Clause 5.

10.1.2 The frequency of sampling shall be as given in the relevant section of this standard.

10.2 Selection and preparation of test samples

10.2.1 Test samples shall be selected and prepared in accordance with the relevant section of this standard, and shall be fully representative of the material in its delivery condition. Where test samples represent products in the final heat treatment condition specified in the material specification, they shall not be subjected to further heat treatment. Where test samples represent products to be delivered in a condition other than the condition of use, they shall be heat treated to the use condition in accordance with the material specification before testing.

10.2.2 Test samples and associated test pieces shall be identified in such a manner that they are traceable to the batch from which they were taken and their orientation with respect to the product is clear.

10.2.3 Unless otherwise specified in the relevant section of this standard, test samples shall not be mechanically worked after removal from the products they represent.

10.3 Tensile test at ambient temperature

10.3.1 Tensile testing at ambient temperature shall be carried out in accordance with BS EN 2002-1.

10.3.2 Unless otherwise specified in the relevant section of this standard, test pieces shall be to the dimensions of the largest practicable size of proportional round test piece specified in BS EN 2002-1.

10.3.3 The tensile test piece direction and location within the product shall be as specified in the relevant section of this standard.

10.4 Tensile test at elevated temperature

10.4.1 Tensile testing at elevated temperature shall be carried out in accordance with BS EN 2002-2.

10.4.2 Unless otherwise specified in the relevant section of this standard, test pieces shall be to the dimensions of the largest practicable size of proportional round test piece specified in BS EN 2002-2.

10.4.3 The tensile test piece direction and location within the product shall be as specified in the relevant section of this standard.

10.5 Creep and stress-rupture test

10.5.1 Creep and stress-rupture testing shall be carried out in accordance with BS EN 2002-005.

10.5.2 Unless otherwise specified in the relevant section of this standard, test pieces shall be to the dimensions of the largest practicable size of proportional round test piece specified in BS EN 2002-005.

10.5.3 The creep and stress-rupture test piece direction and location within the product shall be as specified in the relevant section of this standard.

A1 10.5.4 A stress higher than that required by the material specification may be used where the minimum specified life is attained; unless otherwise agreed, the stress shall not be increased after the test has been commenced. The actual stress(es) used shall be stated in the release note. **A1**