

BS 4S 500:2010



BSI Standards Publication

## AEROSPACE SERIES

# Procedure for inspection, testing and acceptance of steel sheet and strip

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## Foreword

### Publishing information

This British Standard is published by BSI and came into effect on 31 March 2010. It was prepared by Panel ACE/61/-/15, *Steels*, 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

This British Standard supersedes BS 3S 500:1996+A1:1997, which is withdrawn.

### Information about this document

This is a full revision of BS S 500, and introduces the following principal changes.

#### Section 1

- a) Heat treatment details amended to permit use of polymer quenchants.
- b) Tensile testing at ambient temperature to BS 4A4:1966, Part 1.1, replaced by BS EN 2002-1.
- c) Tensile testing at elevated temperature to BS 4A4:1966, Part 1.2, replaced by BS EN 2002-2.
- d) Creep and creep-rupture testing to BS 4A4:1966, Part 1.3, replaced by BS EN 2002-005.
- e) Hardness testing to BS 4A4:1966, Part 5, replaced by BS EN ISO 6506-1, BS EN ISO 6507-1 and BS EN ISO 6508-1.
- f) Conversion of hardness values to BS 860 replaced by BS EN ISO 18265.
- g) Bend testing to BS 4A4:1966, Part 3, replaced by BS EN ISO 7438.
- h) Decarburization examination to BS 6617-1 replaced by BS EN ISO 3887.
- i) Reference to new Annex A (rules for application of values for mechanical properties given in material specifications) added.

#### Section 5

- j) Requirements for corrosion and heat resisting austenitic steel sheet and strip (high temperature properties not verified) transferred from Section 6. (In the previous edition Section 5 was unallocated.)

#### Section 6

- k) Requirements for precipitation-hardening steel sheet and strip transferred from Section 7.

#### Section 7

- l) Requirements for final heat-treated parts (made from sheet and strip delivered in other than the final heat-treated condition) transferred from Section 8.

#### Section 8

- m) Requirements for the acceptance of small quantities of steel transferred from Section 9.

## Section 9

- n) Section deleted and requirements transferred to Section 8.
- o) Magnetic flaw detection to BS 6072 replaced by BS EN ISO 9934-1.

## Annex A

- p) New Annex A (rules for application of values for mechanical properties given in material specifications) added.

## 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 requirements are expressed in sentences in which the principal auxiliary verb is "shall".

*Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.*

## 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 the requirements for the inspection, testing and acceptance of wrought steel sheet and strip, or parts made from such products, to be used for aerospace purposes. The standard is applicable to material specifications in the British Standard Aerospace S series.

## 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 S 100, *Procedure for inspection, testing and acceptance of wrought steels (other than plate, sheet, strip and tube)*

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 005: Uninterrupted creep and stress-rupture testing*

BS EN ISO 3887, *Steels – Determination of depth of decarburization*

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 9934-1, *Non-destructive testing – Magnetic particle testing – Part 1: General principles*

AMS 2750, *Pyrometry*<sup>1)</sup>

## 3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in BS S 100 and the following apply.

### 3.1 sheet

flat-rolled product of rectangular cross-section and uniform thickness between 0.2 mm and 6.35 mm supplied in straight lengths with slit or sheared edges

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<sup>1)</sup> Available from [www.sae.org](http://www.sae.org).

**3.2 slab**

cast or wrought product of rectangular cross-section of width greater than or equal to twice the thickness intended for the production of sheet or strip

**3.3 strip**

flat rolled product of rectangular cross-section and uniform thickness between 0.2 mm and 6.35 mm supplied in coils with slit edges

**4 General**

This standard details the basic requirements for the inspection and testing of British Standard Aerospace series wrought steel sheet and strip.

Where product manufactured as coil is subsequently delivered as straight lengths, the testing requirements of strip shall prevail.

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 have to 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 manufacturer and the purchaser 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 to be 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 standard<sup>2)</sup> can be made and verified.

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<sup>2)</sup> Marking a British Standard identifier (e.g. BS S 538:1975) 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.

## a) General:

- 1) the identity of the material specification with which this standard is to be used;
- 2) if surface dressing is required when not specified in the material specification (see Clause 9);
- 3) whether sulfur printing and/or deep etching tests are also required on samples corresponding to the bottom of ingots (see Clause 12);
- 4) the required sampling frequency for sulfur printing and/or deep etching tests, if different from the material specification and this standard (see Clause 12);
- 5) the cleanness if other than that specified in the material specification (see Clause 13);
- 6) the ultrasonic inspection procedure, test sensitivity and area to be evaluated (see Clause 14);
- 7) the heat treatment condition in which the material and parts are to be supplied, if different from the material specification (see 15.1);
- 8) the required heat treatment temperature (and tolerance), if different from the material specification (see 15.4);
- 9) if the use of polymer quenching is to be precluded where it is not precluded by the material specification (see 15.7);
- 10) the tests to determine properties, if different from the material specification or this standard (see 17.1);
- 11) the orientation of mechanical test pieces, if different from Table 1 (see 17.2.6);
- 12) the frequency of creep and creep-rupture tests, if more than one per batch is required (see 17.4.1);
- 13) the frequency of hardness testing, if different from 17.2 (see 17.5.1);
- 14) the frequency of bend testing, if different from 17.2 (see 17.6.1);
- 15) the retest procedure for tests not covered in 17.9.5 (see 17.9.5);
- 16) the class of tolerance required, if Table 7 tolerances are specified [see Clause 18b)];

## b) Final heat-treated parts:

- 1) the mechanical tests and mechanical properties required, if different from the material specification (see Clause 48);
- 2) the location of hardness test impressions, if necessary (see Clause 49).

## 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 standard<sup>3)</sup> can be made and verified:

- a) the acceptance standard for ultrasonic inspection (see Clause 14);
- b) the method of temperature control if other than AMS 2750 (see 15.3);
- c) the tolerance for flatness, if required [see 18d)];
- d) tolerances on width and length of guillotine-sheared material for  $w > 1\,250$  mm and  $l > 3\,050$  mm (see Table 7).

## 6 Chemical composition

The chemical composition of the steel shall conform to the requirements of the relevant material specification and Section 1 of BS S 100.

## 7 Manufacture

The method of manufacture shall be in accordance with Section 1 of BS S 100, or, in the case of small quantities of steel, in accordance with Section 8 of this standard.

At some stage, or stages, in the manufacture of the product, adequate discard shall be removed from the portions corresponding to the top and the bottom of each ingot or the beginning and end of each strand.

## 8 Temporary identity up to the cast approval stage

Temporary identification shall be maintained in accordance with Section 1 of BS S 100.

## 9 Surface dressing of slabs and intermediate products

Where surface dressing is required by the material specification or order [see 5.1a2)] it shall be carried out in accordance with Section 1 of BS S 100.

*NOTE Where not specified, local dressing is acceptable.*

## 10 Surface inspection of slabs and intermediate products

The surfaces of slabs and intermediate products shall be visually inspected for defects which might be detrimental to subsequent use.

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<sup>3)</sup> Marking a British Standard identifier (e.g. BS S 538:1975) 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.

Slabs and intermediate products shall be descaled, if necessary, to enable the surface to be inspected.

The presence of any surface defect after dressing which is likely to be detrimental to the end use shall be cause for rejection.

## 11 Freedom from defects

**11.1** All material shall be free from any defects detrimental to the end use.

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

## 12 Sulfur printing and deep etching tests

Sulfur printing and deep etching tests shall be carried out in accordance with Section 1 of BS S 100 [see 5.1a3) and 5.1a4)].

## 13 Cleanness

Unless otherwise specified in the material specification or order [see 5.1a5)], the material shall conform to cleanness requirements specified in Section 1 of BS S 100.

## 14 Ultrasonic inspection

When required by the material specification, sheet and strip thicker than or equal to 3 mm shall be ultrasonically tested in the delivery condition.

Products thinner than 3 mm shall be ultrasonically tested at an intermediate stage before rolling to the final size. The test procedure, test sensitivity and the area to be evaluated shall be stated on the order or the inspection schedule [see 5.1a6)]. The acceptance standard shall be agreed between the manufacturer and the purchaser and stated on the order [see 5.2a)].

## 15 Heat treatment

**15.1** Material and parts shall be supplied in the heat treatment condition specified in the material specification, drawing or order [see 5.1a7)].

**15.2** No material, part or test sample shall be subjected to refining, hardening, normalizing, softening, solution treatment, primary hardening or precipitation, or a combination thereof, more than three times in total.

**15.3** Unless otherwise agreed between the manufacturer and the purchaser [see 5.2b)], and except in the case of material destined for further hot working, temperature control during heat treatment shall be in accordance with AMS 2750.

**15.4** If a specific temperature (value and tolerance) is given in the material specification, drawing or order [see 5.1a8)] 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 gives the properties specified in the material specification.

**15.5** The total volume of the charge shall be maintained at the selected temperature ( $\theta$ ), 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)  $750\text{ }^{\circ}\text{C} \leq \theta \leq 1\,250\text{ }^{\circ}\text{C}$ :  $\pm 10\text{ }^{\circ}\text{C}$
- c)  $\theta > 1\,250\text{ }^{\circ}\text{C}$ :  $\pm 15\text{ }^{\circ}\text{C}$

**15.6** If no period or temperature are given in the material specification, these shall be at the discretion of the manufacturer.

**15.7** Unless specifically precluded by the material specification or order [see 5.1a9)], where the material specification specifies the use of an oil quenchant, it is permissible for material to be quenched in a polymer quenchant.

**15.8** When substituting a polymer quenchant for an existing oil quenchant, the polymer and concentration being substituted shall achieve cooling characteristics that are similar to the existing oil quenchant and the properties being produced shall be equivalent to those for oil-quenched parts.

## 16 Surface finish

The surfaces of sheet and strip shall be visually inspected for defects which might be detrimental to subsequent use. The presence of such defects shall be a cause for rejection.

The surface finish of the delivered product shall conform to the material specification.

## 17 Testing

### 17.1 General

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

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

*NOTE* See 5.1a10).

### 17.2 Selection and preparation of test samples

**17.2.1** Test samples shall be selected and prepared in accordance with the relevant requirements of this standard and the material specification, and shall be fully representative of the material in its delivery condition.