

Procedure for

# Inspection, testing and acceptance of steel sheet and strip

ICS 49.025.10

# Committees responsible for this British Standard

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- Aluminium Federation
- British Forging Industry Association
- British Investment Casting Trade Association
- British Iron and Steel Producers' Association
- Copper Development Association
- Light Metal Founders' Association
- Ministry of Defence
- Society of British Aerospace Companies

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# Foreword

This British Standard has been prepared by Technical Committee ACE/61. It supersedes BS 2S 500:1969, which is withdrawn.

This procedure is primarily for use in conjunction with related material specifications in the “S” series of British Standards Aerospace Series and the Ministry of Defence DTD series; it may also be used with other material specifications by agreement between the purchaser and the supplier. The inspection, testing and acceptance procedures for wrought steels other than plate, sheet, strip and tube are contained in BS 5S 100:1993 and that for tube in BS 3T 100:1978.

In this revision the text has been brought into line with modern steel-making practices and current procedures required by the aerospace industry. In particular, section 1 has been extensively revised, much greater reference has been made to BS 5S 100:1993 for common requirements and a new section 9 has been added to replace the former Appendix A. The requirements for strip in the hardened and tempered condition, which were previously in section 5, have been included in section 4, which now covers sheet and strip. Section 5 is therefore now unallocated. Throughout the standard the tables have been renumbered.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

## Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 18, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.



# Section 1. General requirements

## 1.1 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, and the Ministry of Defence (Procurement Executive) DTD series.

## 1.2 General

This standard details the basic requirements for the inspection and testing of British Standard Aerospace series and DTD 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 **1.5** 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 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.

## 1.3 References

### 1.3.1 Normative references

This British Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the inside back cover. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

### 1.3.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

## 1.4 Definitions

For the purpose of this standard the definitions given in BS 5S 100:1993 apply, together with the following.

### 1.4.1

#### 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

### 1.4.2

#### 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

### 1.4.3

#### 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

## 1.5 Information to be supplied by the purchaser

The following information to be supplied by the purchaser shall be fully documented on the order, drawing or inspection schedule along with the number of this British Standard. Clauses specifying a requirement for information are shown in brackets.

### a) General

- 1) the identity of the material specification with which this standard is to be used;
- 2) whether sulfur printing and/or deep etching tests are required also on samples corresponding to the bottom of ingots (see **1.12**);
- 3) the required sampling frequency for sulfur printing and/or deep etching tests, if different from the material specification and BS 5S 100:1993 (see **1.12**);
- 4) the ultrasonic inspection procedure, test sensitivity, area to be evaluated and the standard of acceptance, if required (see **1.14**);

- 5) the heat treatment condition in which the material and parts are to be supplied, if different from the material specification (see 1.15);
  - 6) the required heat treatment temperature (and tolerance), if different from the material specification (see 1.15);
  - 7) the tests to determine mechanical properties, if different from the material specification (see 1.17);
  - 8) the orientation of mechanical test pieces, if different from Table 1 (see 1.18.4);
  - 9) the frequency of hardness testing, if different from 1.18 (see 1.21);
  - 10) the frequency of creep and creep rupture tests, if more than one per batch is required (see 1.22);
  - 11) the class of tolerance required, if Table 5 tolerances are specified (see item b of 1.25);
  - 12) the tolerance for flatness, if required (see item d of 1.25);
  - 13) the retest procedure for tests not covered in 1.24 (see 1.24.4);
- b) Finally heat treated parts
- 1) the mechanical tests and mechanical properties required, if different from the material specification (see 8.4);
  - 2) the location of hardness test impressions, if necessary (see 8.4).

## 1.6 Chemical composition

The chemical composition of the steel shall conform to the material specification and section 1 of BS 5S 100:1993.

## 1.7 Manufacture

The method of manufacture shall be in accordance with section 1 of BS 5S 100:1993, or, in the case of small quantities of steel, in accordance with section 9 of this standard.

Subclause 1.7.8 of BS 5S 100:1993 shall apply to slabs for the purposes of this standard.

## 1.8 Temporary identification up to the cast approval stage

Temporary identification shall be maintained in accordance with section 1 of BS 5S 100:1993.

## 1.9 Surface dressing of slabs and intermediate products

Where surface dressing is required by the material specification or order it shall be effected in accordance with section 1 of BS 5S 100:1993.

NOTE Where not specified, local dressing is acceptable.

## 1.10 Surface inspection of slabs and intermediate products

The surfaces of slabs and intermediate products shall be inspected by visual inspection for defects which may be detrimental to subsequent use. 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.

## 1.11 Freedom from defects

All material shall be free from any defect detrimental to the end use.

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

## 1.12 Sulfur printing and/or deep etching tests

Sulfur printing and/or deep etching shall be carried out in accordance with section 1 of BS 5S 100:1993.

## 1.13 Cleanness

Unless otherwise specified in the material specification or order, the material shall conform to the cleanness requirements specified in section 1 of BS 5S 100:1993.

## 1.14 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. The standard of acceptance shall be agreed between the purchaser and the manufacturer and stated on the order.

### 1.15 Heat treatment

Material and parts shall be supplied in the heat treatment condition specified in the material specification, drawing or order.

Heat treatment shall be carried out in accordance with section 1 of BS 5S 100:1993.

### 1.16 Surface finish

The surfaces of sheet and strip shall be inspected by visual inspection 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.

### 1.17 Mechanical properties

Tests for mechanical properties required by the material specification, order, inspection schedule or drawing shall be made in accordance with the specified test method.

The values for mechanical properties specified in the material specification shall be applied in accordance with Annex D of BS 5S 100:1993.

### 1.18 Selection and preparation of mechanical test samples

**1.18.1** Unless otherwise stated in the relevant section of this standard the frequency of sampling shall be:

- a) sheet — two samples per batch;
- b) coil — one sample from each end of each coil.

**1.18.2** Test samples for products supplied finally heat treated, shall be fully representative of the material in its delivery condition.

**1.18.3** Test samples representing products in a condition other than the condition of use shall be heat treated in accordance with the material specification before testing.

**NOTE 1** Test samples for precipitation hardening steels for which the specified minimum tensile strength is 1 250 MPa or more may be machined after solution treatment (and primary hardening if applicable) to test piece size, plus a grinding allowance if required, and precipitation hardened at that size.

**NOTE 2** Test samples for steels other than precipitation hardening steels for which the specified minimum tensile strength is 1 300 MPa or more may be machined to test piece size, plus a grinding allowance if required, and heat treated at that size.

**1.18.4** Unless otherwise required by the material specification, order or inspection schedule, the orientation of test pieces shall be as defined in Table 1.

**Table 1 — Orientation of test pieces**

| Test                                   | Product width<br>mm | Orientation of test<br>piece axis to rolling<br>direction |
|----------------------------------------|---------------------|-----------------------------------------------------------|
| Tensile, creep<br>and creep<br>rapture | ≥ 200<br>< 200      | Transverse<br>Parallel                                    |
| Bend                                   | ≥ 50<br>< 50        | Transverse<br>Parallel                                    |

**1.18.5** Test samples shall not be worked after removal from the product they represent.

**1.18.6** Test samples and associated test pieces shall be marked in such a manner that their identity, location and orientation, with respect to the product and batch, is maintained.

### 1.19 Tensile test

The test pieces shall be prepared from the test sample and tested in accordance with part 1, section 1 of BS 4A 4:1966 and BS 4A 4-1.2:1967.

For material thinner than 0.5 mm, the tensile strength only shall be determined. The properties obtained shall conform to the material specification, and the results of each test shall be reported in accordance with part 1 of BS 4A 4:1966.

### 1.20 Bend test

One test piece shall be prepared from each sample selected in accordance with 1.18 and shall be tested in accordance with part 3 of BS 4A 4:1966.

The properties obtained shall conform to the material specification, and the results of each test shall be reported in accordance with part 3 of BS 4A 4:1966.

### 1.21 Hardness test

Hardness tests shall be carried out in accordance with part 5 of BS 4A 4:1966.

**NOTE** If a maximum hardness only is specified, the Rockwell test may be substituted for the specified method, using the conversion tables in BS 860:1967.

All hardness tests carried out on the same batch of material, and, where applicable, on the tensile test samples, shall be made by the same method and under the same conditions of loading.

Tests shall be made at the frequency stated in 1.18 unless otherwise specified in the relevant section of this standard, on the order, drawing or inspection schedule.

The hardness results obtained shall conform to the material specification and be reported in accordance with the requirements of part 5 of BS 4A 4:1966.

**1.22 Creep and creep rupture test**

If required by the material specification, creep and creep rupture tests shall be made at a frequency of one per batch, unless otherwise specified on the order, drawing or inspection schedule.

The test pieces shall be prepared and tested in accordance with BS 4A 4-1-3:1967.

The results meet the requirement of the material specification.

**1.23 Examination for decarburization**

A sample shall be selected in accordance with the relevant section of this standard. The sample shall be suitably mounted to protect the edge of the cross-section and shall be examined in accordance with BS 6617-1:1985.

Any decarburization detected shall not exceed the maximum depth specified in the material specification.

**1.24 Retest procedure****1.24.1 Tensile, creep, creep rupture and bend tests**

If any test fails to meet the requirements, additional identical test samples shall be selected at twice the original frequency. At least one of the samples shall be taken from the product or products from which the original result was obtained. If all results are satisfactory, the batch shall be accepted. If one or more results are unsatisfactory, the batch shall be either:

- a) rejected; or
- b) partially or fully reheat treated and tested as a completely new batch, except for chemical composition and inclusion content.

**1.24.2 Hardness test**

If any test fails to meet the requirement, either:

- a) the remaining products in the batch shall be tested and those which pass shall be accepted and those which fail shall either be rejected or be reheat treated and retested as a new batch except for chemical composition and inclusion content; or
- b) the entire batch shall be reheat treated and retested as a new batch except for chemical composition and inclusion content; or
- c) the products with an incorrect value shall be submitted to an alternative procedure agreed between the manufacturer and the purchaser.

**1.24.3 Sulfur printing, deep etching, cleanness and decarburization tests**

If any test fails to meet the requirements, the batch shall be either:

- a) rejected; or
- b) partially or fully reheat treated and tested as a completely new batch except for chemical composition if the structure can be corrected by heat treatment; or
- c) cut back before retesting if the material fails the cleanness requirements.

**1.24.4 Other tests**

For other tests specific to a product, the retest procedure shall be as defined in the relevant section of this standard or on the order.

Table 2 — Tolerances on thickness of hot-rolled steel sheet and strip (excluding mild steel)

All dimensions in mm

| Nominal thickness ( <i>t</i> )<br><br>$x < t \leq y$ |          | Tolerances on thickness for width ( <i>w</i> ) |       |                                  |       |                                     |       |
|------------------------------------------------------|----------|------------------------------------------------|-------|----------------------------------|-------|-------------------------------------|-------|
|                                                      |          | Strip                                          |       | Sheet <sup>a</sup>               |       |                                     |       |
|                                                      |          | $w \leq 450$ mm                                |       | $450 \text{ mm} < w \leq 750$ mm |       | $750 \text{ mm} < w \leq 1\,250$ mm |       |
| <i>x</i>                                             | <i>y</i> | Plus                                           | Minus | Plus                             | Minus | Plus                                | Minus |
| —                                                    | 0.56     | 0.05                                           | 0.05  | 0.05                             | 0.08  | 0.08                                | 0.08  |
| 0.56                                                 | 0.80     | 0.05                                           | 0.08  | 0.05                             | 0.08  | 0.08                                | 0.10  |
| 0.80                                                 | 0.90     | 0.05                                           | 0.08  | 0.08                             | 0.08  | 0.10                                | 0.10  |
| 0.90                                                 | 1.00     | 0.08                                           | 0.08  | 0.08                             | 0.08  | 0.10                                | 0.10  |
| 1.00                                                 | 1.40     | 0.08                                           | 0.08  | 0.08                             | 0.10  | 0.10                                | 0.13  |
| 1.40                                                 | 1.60     | 0.08                                           | 0.10  | 0.10                             | 0.10  | 0.13                                | 0.13  |
| 1.60                                                 | 1.80     | 0.10                                           | 0.10  | 0.10                             | 0.10  | 0.13                                | 0.13  |
| 1.80                                                 | 2.00     | 0.10                                           | 0.13  | 0.10                             | 0.13  | 0.13                                | 0.15  |
| 2.00                                                 | 2.50     | 0.13                                           | 0.13  | 0.13                             | 0.13  | 0.15                                | 0.15  |
| 2.50                                                 | 3.15     | 0.13                                           | 0.15  | 0.13                             | 0.15  | 0.15                                | 0.18  |
| 3.15                                                 | 4.00     | 0.15                                           | 0.15  | 0.15                             | 0.15  | 0.18                                | 0.18  |
| 4.00                                                 | 4.50     | 0.15                                           | 0.18  | 0.15                             | 0.18  | 0.18                                | 0.20  |
| 4.50                                                 | 5.00     | 0.18                                           | 0.18  | 0.18                             | 0.18  | 0.20                                | 0.23  |
| 5.00                                                 | 5.60     | 0.18                                           | 0.18  | 0.20                             | 0.20  | 0.23                                | 0.23  |
| 5.60                                                 | 6.35     | 0.18                                           | 0.18  | 0.23                             | 0.23  | 0.25                                | 0.25  |

NOTE 1 Thickness shall be measured not less than 12.5 mm from the edge of material of widths from 25 mm to 450 mm (on the centre line for strips 25 mm wide or less) and not less than 37.5 mm from the sheared edge of material over 450 mm wide. On unsheared sheets thickness shall be measured not less than 50 mm from the edge.

NOTE 2 On hand mill sheets, thickness shall be measured not less than 100 mm from any corner.

<sup>a</sup> Where, by agreement with the purchaser, strips cut from sheet are supplied, these tolerances shall apply.

Table 3 — Tolerances on thickness of cold-rolled steel sheet and strip (excluding mild steel)

All dimensions in mm

| Nominal thickness ( <i>t</i> ) |          | Tolerances on thickness for width ( <i>w</i> ) |       |                            |       |                            |       |                              |       |
|--------------------------------|----------|------------------------------------------------|-------|----------------------------|-------|----------------------------|-------|------------------------------|-------|
|                                |          | Strip                                          |       | Sheet <sup>a</sup>         |       |                            |       |                              |       |
|                                |          | <i>w</i> ≤ 300 mm                              |       | 300 mm < <i>w</i> ≤ 450 mm |       | 450 mm < <i>w</i> ≤ 750 mm |       | 750 mm < <i>w</i> ≤ 1 250 mm |       |
| <i>x</i>                       | <i>y</i> | Plus                                           | Minus | Plus                       | Minus | Plus                       | Minus | Plus                         | Minus |
| —                              | 0.45     | 0.03                                           | 0.03  | 0.03                       | 0.03  | 0.03                       | 0.05  | 0.05                         | 0.08  |
| 0.45                           | 0.50     | 0.03                                           | 0.03  | 0.03                       | 0.05  | 0.05                       | 0.05  | 0.08                         | 0.08  |
| 0.50                           | 0.56     | 0.03                                           | 0.03  | 0.03                       | 0.05  | 0.05                       | 0.08  | 0.08                         | 0.08  |
| 0.56                           | 0.63     | 0.03                                           | 0.03  | 0.05                       | 0.05  | 0.05                       | 0.08  | 0.08                         | 0.08  |
| 0.63                           | 0.90     | 0.03                                           | 0.05  | 0.05                       | 0.05  | 0.05                       | 0.08  | 0.08                         | 0.08  |
| 0.90                           | 1.00     | 0.03                                           | 0.05  | 0.05                       | 0.08  | 0.08                       | 0.08  | 0.08                         | 0.08  |
| 1.00                           | 1.25     | 0.03                                           | 0.05  | 0.05                       | 0.08  | 0.08                       | 0.08  | 0.08                         | 0.10  |
| 1.25                           | 1.40     | 0.05                                           | 0.05  | 0.05                       | 0.08  | 0.08                       | 0.08  | 0.08                         | 0.10  |
| 1.40                           | 1.60     | 0.05                                           | 0.05  | 0.05                       | 0.08  | 0.08                       | 0.10  | 0.10                         | 0.10  |
| 1.60                           | 1.80     | 0.05                                           | 0.05  | 0.08                       | 0.08  | 0.08                       | 0.10  | 0.10                         | 0.10  |
| 1.80                           | 2.00     | 0.05                                           | 0.08  | 0.08                       | 0.08  | 0.08                       | 0.10  | 0.10                         | 0.10  |
| 2.00                           | 2.24     | 0.05                                           | 0.08  | 0.08                       | 0.08  | 0.10                       | 0.10  | 0.10                         | 0.13  |
| 2.24                           | 2.50     | 0.08                                           | 0.08  | 0.08                       | 0.10  | 0.10                       | 0.10  | 0.13                         | 0.13  |
| 2.50                           | 2.80     | 0.08                                           | 0.08  | 0.08                       | 0.10  | 0.10                       | 0.10  | 0.13                         | 0.15  |
| 2.80                           | 3.15     | 0.08                                           | 0.08  | 0.10                       | 0.10  | 0.10                       | 0.13  | 0.15                         | 0.15  |
| 3.15                           | 3.55     | 0.08                                           | 0.08  | 0.10                       | 0.10  | 0.10                       | 0.13  | 0.15                         | 0.18  |
| 3.55                           | 4.50     | 0.08                                           | 0.08  | 0.13                       | 0.13  | 0.13                       | 0.13  | 0.18                         | 0.18  |
| 4.50                           | 5.00     | 0.08                                           | 0.10  | 0.13                       | 0.13  | 0.15                       | 0.15  | 0.20                         | 0.20  |
| 5.00                           | 5.60     | 0.10                                           | 0.10  | 0.13                       | 0.13  | 0.15                       | 0.18  | 0.23                         | 0.23  |
| 5.60                           | 6.35     | 0.10                                           | 0.10  | 0.15                       | 0.15  | 0.18                       | 0.18  | 0.23                         | 0.23  |

NOTE 1 Thickness shall be measured not less than 12.5 mm from the edge of material of widths from 25 mm to 450 mm (on the centre line for strips 25 mm wide or less) and not less than 37.5 mm from the sheared edge of material over 450 mm wide. On unsheared sheets thickness shall be measured not less than 50 mm from the edge.

NOTE 2 On sheet cold-reduced to thickness by single sheet rolling, thickness shall be measured not less than 100 mm from any corner.

<sup>a</sup> Where, by agreement with the purchaser, strips cut from sheet are supplied, these tolerances shall apply.

Table 4 — Tolerances on width of rotary-sheared material<sup>a</sup>

All dimensions in mm

| Nominal thickness ( <i>t</i> ) |          | Tolerances on width ( <i>w</i> ) |       |                          |       |                          |       |
|--------------------------------|----------|----------------------------------|-------|--------------------------|-------|--------------------------|-------|
| $x < t \leq y$                 |          | $w \leq 150$ mm                  |       | 150 mm < $w \leq 450$ mm |       | 450 mm < $w \leq 900$ mm |       |
| <i>x</i>                       | <i>y</i> | Plus                             | Minus | Plus                     | Minus | Plus                     | Minus |
| —                              | 0.63     | 0.18                             | 0.20  | 0.31                     | 0.33  | 0.31                     | 0.33  |
| 0.63                           | 1.00     | 0.25                             | 0.25  | 0.38                     | 0.38  | 0.38                     | 0.38  |
| 1.00                           | 1.60     | 0.31                             | 0.33  | 0.43                     | 0.46  | 0.51                     | 0.51  |
| 1.60                           | 2.50     | 0.31                             | 0.33  | 0.43                     | 0.46  | 0.51                     | 0.51  |
| 2.50                           | 4.00     | 0.38                             | 0.38  | 0.51                     | 0.51  | 0.56                     | 0.58  |

<sup>a</sup> For corrosion resisting and heat resisting steels, the tolerances given in Table 4 shall apply only to material in widths up to 300 mm; for widths greater than 300 mm the tolerances shall be in accordance with Table 5.

Table 5 — Tolerances on width and length of guillotine-sheared material

| Class of tolerance | Size of material: width ( <i>w</i> ), length ( <i>l</i> ) and thickness ( <i>t</i> ) | Tolerance                                       |
|--------------------|--------------------------------------------------------------------------------------|-------------------------------------------------|
| A                  | $w \leq 1\,250$ mm,<br>$l \leq 3\,050$ mm, $t \leq 1.60$ mm                          | $+1.6$<br>$0$ mm on width and length            |
|                    | $w \leq 1\,250$ mm,<br>$l \leq 3\,050$ mm, $t > 1.60$ mm                             | $+t$<br>$0$ mm on width and length              |
|                    | $w > 1\,250$ mm, $l > 3\,050$ mm                                                     | To be agreed between purchaser and manufacturer |
| B                  | $w \leq 900$ mm, any $t$ , $l$                                                       | $+6.3$<br>$0$ mm                                |
|                    | $w > 900$ mm, any $t$ , $l$                                                          | $+9.5$<br>$0$ mm                                |
|                    | All lengths, any $w$ , $t$                                                           | $+2$<br>$0$ %                                   |

## 1.25 Dimensions and tolerances

The dimensions of the product shall be measured and shall fall within the following tolerances.

- Thickness. Table 2, Table 3, Table 6 or Table 7 as relevant.
- Width. Table 4 or Table 5, as stated on the order. If Table 5 tolerances are specified, the order shall also state the class of tolerance required.
- Edge bow. The lateral departure (*c*) of the edge from a straight line forming a 2 m chord for sheet (see Figure 1) and a 3 m chord for strip (see Figure 1) shall not exceed the requirements of Table 8. The frequency of measurement shall be at the discretion of the manufacturer.
- Flatness. If required by the purchaser, tolerances for flatness shall be agreed between the supplier and the purchaser.

**Table 6 — Tolerances on thickness of hot-rolled mild steel sheet and strip**

All dimensions in mm

| Nominal thickness ( <i>t</i> ) |          | Tolerances on thickness for width ( <i>w</i> ) |       |                              |       |
|--------------------------------|----------|------------------------------------------------|-------|------------------------------|-------|
|                                |          | Strip                                          |       | Sheet <sup>a</sup>           |       |
|                                |          | <i>w</i> ≤ 450 mm                              |       | 450 mm < <i>w</i> ≤ 1 250 mm |       |
| <i>x</i>                       | <i>y</i> | Plus                                           | Minus | Plus                         | Minus |
| —                              | 0.56     | 0.05                                           | 0.05  | 0.08                         | 0.08  |
| 0.56                           | 0.80     | 0.05                                           | 0.08  | 0.08                         | 0.10  |
| 0.80                           | 0.90     | 0.05                                           | 0.08  | 0.10                         | 0.10  |
| 0.90                           | 1.00     | 0.08                                           | 0.08  | 0.10                         | 0.10  |
| 1.00                           | 1.40     | 0.08                                           | 0.08  | 0.10                         | 0.13  |
| 1.40                           | 1.60     | 0.08                                           | 0.10  | 0.13                         | 0.13  |
| 1.60                           | 1.80     | 0.10                                           | 0.10  | 0.13                         | 0.13  |
| 1.80                           | 2.00     | 0.10                                           | 0.13  | 0.13                         | 0.15  |
| 2.00                           | 2.50     | 0.13                                           | 0.13  | 0.15                         | 0.15  |
| 2.50                           | 3.15     | 0.13                                           | 0.15  | 0.15                         | 0.18  |
| 3.15                           | 4.00     | 0.15                                           | 0.15  | 0.18                         | 0.18  |
| 4.00                           | 4.50     | 0.15                                           | 0.18  | 0.18                         | 0.20  |
| 4.50                           | 5.00     | 0.18                                           | 0.18  | 0.20                         | 0.23  |
| 5.00                           | 5.60     | 0.18                                           | 0.18  | 0.23                         | 0.23  |
| 5.60                           | 6.35     | 0.18                                           | 0.18  | 0.25                         | 0.25  |

NOTE 1 Thickness shall be measured not less than 12.5 mm from the edge of material of widths from 25 mm to 450 mm (on the centre line for strips 25 mm wide or less) and not less than 37.5 mm from the sheared edge of material over 450 mm wide. On unsheared sheets thickness shall be measured not less than 50 mm from the edge.

NOTE 2 On hand mill sheets, thickness shall be measured not less than 100 mm from any corner.

<sup>a</sup> Where, by agreement with the purchaser, strips cut from sheet are supplied, these tolerances shall apply.

**Table 7 — Tolerances on thickness of cold-rolled mild steel sheet and strip**

All dimensions in mm

| Nominal thickness ( <i>t</i> ) |          | Tolerances on thickness for width ( <i>w</i> ) |       |                              |       |
|--------------------------------|----------|------------------------------------------------|-------|------------------------------|-------|
|                                |          | Strip                                          |       | Sheet <sup>a</sup>           |       |
|                                |          | <i>w</i> ≤ 450 mm                              |       | 450 mm < <i>w</i> ≤ 1 250 mm |       |
| <i>x</i>                       | <i>y</i> | Plus                                           | Minus | Plus                         | Minus |
| —                              | 0.45     | 0.02                                           | 0.03  | 0.05                         | 0.05  |
| 0.45                           | 0.63     | 0.03                                           | 0.03  | 0.05                         | 0.05  |
| 0.63                           | 0.71     | 0.03                                           | 0.05  | 0.05                         | 0.05  |
| 0.71                           | 0.80     | 0.03                                           | 0.05  | 0.05                         | 0.08  |
| 0.80                           | 1.00     | 0.03                                           | 0.05  | 0.08                         | 0.08  |
| 1.00                           | 1.25     | 0.05                                           | 0.05  | 0.08                         | 0.10  |
| 1.25                           | 1.40     | 0.05                                           | 0.05  | 0.10                         | 0.10  |
| 1.40                           | 1.60     | 0.05                                           | 0.05  | 0.10                         | 0.13  |
| 1.60                           | 1.80     | 0.05                                           | 0.08  | 0.13                         | 0.13  |
| 1.80                           | 2.24     | 0.05                                           | 0.08  | 0.13                         | 0.15  |
| 2.24                           | 2.80     | 0.05                                           | 0.08  | 0.15                         | 0.15  |
| 2.80                           | 3.15     | 0.08                                           | 0.08  | 0.15                         | 0.18  |
| 3.15                           | 4.00     | 0.08                                           | 0.08  | 0.18                         | 0.18  |
| 4.00                           | 4.50     | 0.08                                           | 0.10  | 0.18                         | 0.18  |
| 4.50                           | 5.00     | 0.08                                           | 0.10  | 0.18                         | 0.20  |
| 5.00                           | 6.35     | 0.08                                           | 0.10  | 0.20                         | 0.20  |

NOTE 1 Thickness shall be measured not less than 12.5 mm from the edge of material of widths from 25 mm to 450 mm (on the centre line for strips 25 mm wide or less) and not less than 37.5 mm from the sheared edge of material over 450 mm wide. On unsheared sheets thickness shall be measured not less than 50 mm from the edge.

NOTE 2 On sheet cold-reduced to thickness by single sheet rolling, thickness shall be measured not less than 100 mm from any corner.

<sup>a</sup> Where, by agreement with the purchaser, strips cut from sheet are supplied, these tolerances shall apply.

**Table 8 — Edge bow of sheet and strip**

|       | Width ( <i>w</i> )<br>mm | Length ( <i>l</i> )<br>m | Maximum edge<br>bow <sup>a</sup> ( <i>c</i> )<br>mm |
|-------|--------------------------|--------------------------|-----------------------------------------------------|
| Sheet | ≤ 1 250                  | ≤ 3                      | 1.5                                                 |
| Sheet | > 1 250<br>Any           | Any<br>> 3               | 3.0<br>3.0                                          |
| Strip | Any                      | Any                      | 6.0                                                 |

<sup>a</sup> Measured in accordance with Figure 1.

## 1.26 Maintenance of identity

The material shall retain its cast identity and, if appropriate, its heat treatment test batch identity, to enable final identification marking to be made in accordance with 1.27.

Test samples shall be identifiable to the material they represent.

## 1.27 Final marking

**1.27.1** Each sheet and strip shall carry the following identification markings.

- The inspector's mark.
- The material designation, and the number of the material specification.
- Markings to ensure traceability of the material (see 1.26).
- Manufacturer's identity.
- Nominal thickness.

**1.27.2** Sheet shall be repeatedly marked along its length. Coils shall be either repeatedly marked along their length or shall be identified with a securely attached durable label bearing the identification markings.

## 1.28 Certification

### 1.28.1 Certification by manufacturer

The manufacturer shall supply, with each delivery, a certificate of conformity bearing the name and address of the manufacturer and a printed serial number, containing the following minimum information.

- Purchaser's name and address.
- Contract and/or order number.
- Quality assurance authority under which the material is supplied and, where appropriate, the registration or approval number.
- Identity of the material specification including the material designation where appropriate, and the number of this British Standard.

e) Description of the material supplied, including dimensions, drawing numbers and part numbers, if appropriate, and any other identification, together with the number(s) of the inspection or manufacturing schedule, where applicable.

f) Quantity supplied.

g) Cast number(s) and batch number(s) including the ingot and the position within the ingot, where applicable.

h) Process by which the material was melted.

i) Condition of the material as delivered.

j) Heat treatment details, including details of test samples heat treatment where appropriate, and, for material supplied in the fully heat treated condition and subject to quenching, the type of quenchant used.

k) Details of all tests carried out, or the reference numbers of the relevant test reports, copies of which shall be attached.

l) The inspector's mark.

m) In the case of small quantities of steel conforming to section 9, the statement: "This material has been released in accordance with the requirements of section 9 of BS 3S 500:1996".

n) A certification clause signed by a duly authorized employee of the manufacturer, in the following form unless otherwise required by the quality assurance authority.

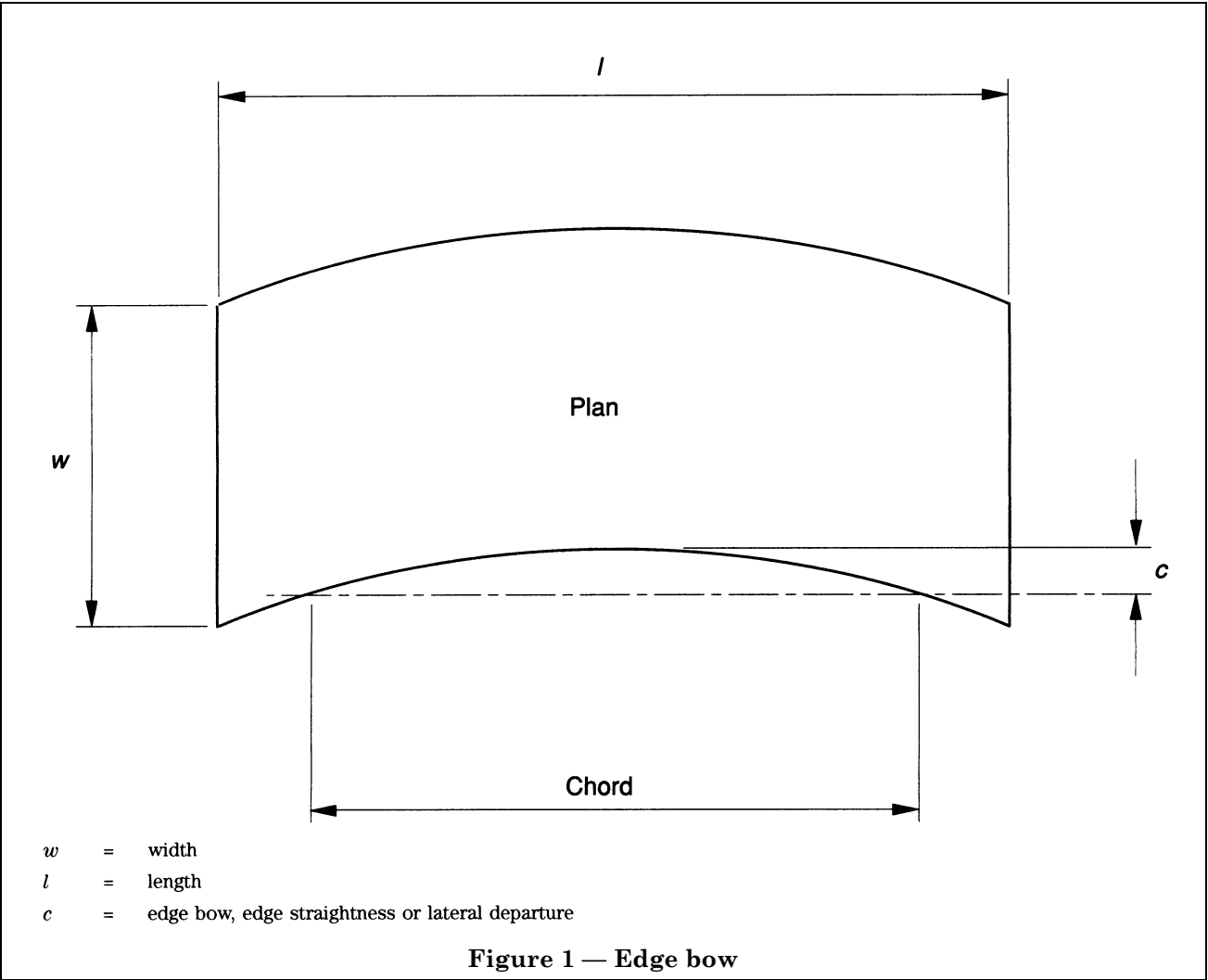
"Certified that the whole of the supplies detailed herein have been inspected and tested and, unless otherwise stated above, conform in all respects to the requirements of the contract and/or order."

### 1.28.2 Certification by supplier

**1.28.2.1** When certification is issued by a supplier, who is not the manufacturer, this supplier shall hold equivalent certification issued by the manufacturer of the material. All the information required by 1.28.1 as provided by the manufacturer shall be supplied with each delivery.

**1.28.2.2** If a batch of material consigned by the manufacturer is subdivided, or the material cut to size, by a supplier before reconsignment, the supplier shall carry out any additional dimensional inspection or identification marking and shall certify accordingly.

**1.28.2.3** Except for cutting to size, material consigned by a supplier who is not the manufacturer shall be in the same condition and to the same specification as originally received from the manufacturer. The supplier shall certify accordingly.



## Section 2. Sheet and strip delivered in the normalized or softened condition for use without further heat treatment (excluding austenitic steel)

### 2.1 General

This section covers the inspection and testing procedures for sheet and strip delivered in the normalized or softened condition for use without further heat treatment (excluding austenitic steel), and is to be used in conjunction with section 1.

### 2.2 Condition

Sheet and strip shall be supplied in the condition required by the material specification.

### 2.3 Tensile test

Test samples shall be selected in accordance with 1.18 for the tests specified in the material specification and shall be prepared, tested and reported in accordance with 1.19.

### 2.4 Bend test

When required by the material specification, samples shall be selected in accordance with 1.18 and prepared, tested and reported in accordance with 1.20.

### 2.5 Hardness test

When required by the material specification, samples shall be selected, tested and reported in accordance with 1.21.

### 2.6 Retests

All retests shall be carried out in accordance with 1.24.

## Section 3. Sheet and strip delivered in the softened condition for use in the hardened and tempered condition

### 3.1 General

This section covers the inspection and testing procedures for sheet and strip delivered in the softened condition for use in the hardened and tempered condition and is to be used in conjunction with section 1.

### 3.2 Condition

Sheet and strip shall be supplied in the softened condition as required by the material specification.

### 3.3 Tensile test

Sampling shall be in accordance with 1.18 and one test piece from each sample shall be prepared and tested in accordance with 1.19. The tensile properties shall conform to the material specification.

To demonstrate that the material will respond to the hardening and tempering treatment, the tensile test samples shall be selected from material of the thickest gauge in the cast, and shall be heat treated in accordance with the material specification.

Where tests in the softened condition are required, a further set of test samples shall be selected.

### 3.4 Bend test

When required by the material specification, samples shall be selected in accordance with 1.18, and prepared, tested and reported in accordance with 1.20.

### 3.5 Hardness test

When required by the material specification, samples shall be selected, tested and reported in accordance with 1.21.

### 3.6 Decarburization

If required by the material specification, one sample selected from each batch shall be examined in accordance with 1.23.

### 3.7 Retests

#### 3.7.1 Decarburization retest

If the sample fails to conform to 3.6, two additional samples shall be selected from the batch, one of which shall be from the same piece of material which originally failed on the decarburization examination. Both of the additional samples shall conform to the requirements of 1.23.

#### 3.7.2 Other retests

All other retests shall be carried out in accordance with 1.24.

## Section 4. Sheet and strip delivered in the hardened and tempered condition

### 4.1 General

This section covers the inspection and testing procedures for sheet and strip delivered in the hardened and tempered condition and is to be used in conjunction with section 1.

### 4.2 Condition

Sheet and strip shall be supplied in the hardened and tempered condition as required by the material specification.

Strip supplied in the hardened and tempered condition shall have been heat treated by a continuous process.

### 4.3 Hardness test

Each sheet and both ends of each coil shall be hardness tested in accordance with 1.21.

### 4.4 Tensile test

Sampling shall be in accordance with 1.18. In the case of sheet, one of the tensile test samples shall be taken from a sheet of the lowest hardness and one from a sheet of the highest hardness in the batch. In the case of strip, a sample shall be selected from each end of each coil.

One test piece shall be prepared from each sample in accordance with 1.19. Each test piece shall be tested in accordance with 1.19 and the tensile properties shall conform to the material specification.

### 4.5 Bend test

When required by the material specification, samples shall be selected in accordance with 1.18, and prepared, tested and reported in accordance with 1.20.

### 4.6 Decarburization

If required by the material specification, a sample for sheet shall be selected from a sheet of the lowest hardness (see 4.3) on each batch and examined in accordance with 1.23. In the case of strip, a sample shall be selected from each end of each coil and examined in accordance with 1.23.

### 4.7 Retests

#### 4.7.1 Decarburization retest

If the sample fails to conform to 4.6, two additional samples shall be selected from the batch of sheet, or two additional samples, one from each end of the coil which shall be airdropped before selecting the samples. Both additional samples shall conform to the requirements of 1.23.

#### 4.7.2 Other retests

All other retests shall be carried out in accordance with 1.24.

## Section 5. Not allocated.

Previous requirements are included in section 4.

## Section 6. Corrosion and heat resisting austenitic steel sheet and strip (high temperature properties not verified)

### 6.1 General

This section covers the inspection and testing procedures for corrosion and heat resisting austenitic steel sheet and strip (high temperature properties not verified) and is to be used in conjunction with section 1.

### 6.2 Condition

Sheet and strip shall be supplied in the condition required by the material specification.

The final softening of strip shall be by a continuous process.

### 6.3 Tensile test

Test samples shall be selected in accordance with 1.18 for the tests specified in the material specification and shall be prepared, tested and reported in accordance with 1.19.

### 6.4 Bend test

When required by the material specification, samples shall be selected in accordance with 1.18 and prepared, tested and reported in accordance with 1.20.

### 6.5 Hardness test

When required by the material specification, samples shall be selected, tested and reported in accordance with 1.21.

### 6.6 Intercrystalline corrosion test

An intercrystalline corrosion test shall be carried out as required by the material specification, and the results shall conform to the requirements specified in the material specification.

### 6.7 Retests

#### 6.7.1 Intercrystalline retest

If the sample tested fails to conform to 6.6, two additional samples shall be taken and tested in the same manner. If either of the additional samples fails, the batch shall be rejected or reheat treated and tested as a new batch.

#### 6.7.2 Other retests

All other retests shall be carried out in accordance with 1.24.

## Section 7. Precipitation hardening steel sheet and strip

### 7.1 General

This section covers the inspection and testing procedures for precipitation hardening steel sheet and strip and is to be used in conjunction with section 1.

### 7.2 Condition

Sheet and strip shall be supplied in the condition required by the material specification.

The final solution treatment or primary hardening of strip shall be by a continuous process.

### 7.3 Tensile test

Test samples shall be selected from solution treated or primary hardened material in accordance with 1.18 for the tests specified in the material specification and precipitation hardened in accordance with the material specification.

One test piece shall be prepared from each sample in accordance with 1.19.

Each test piece shall be tested in accordance with 1.19 and the tensile properties shall conform to the material specification.

### 7.4 Bend test

When required by the material specification, samples shall be selected in accordance with 1.18 and prepared, tested and reported in accordance with 1.20.

### 7.5 Hardness test

When required by the material specification, samples shall be selected, tested and reported in accordance with 1.21.

### 7.6 Retests

All retests shall be carried out in accordance with 1.24.

## Section 8. Finally heat treated parts (made from sheet and strip delivered in other than the finally heat treated condition)

### 8.1 General

This section covers the inspection and testing procedures for finally heat treated parts (made from sheet and strip delivered in other than the finally heat treated condition) and is to be used in conjunction with section 1.

### 8.2 Condition

The parts shall be made from sheet and strip conforming to section 3 or section 7 and shall be supplied in the finally heat treated condition as required by the material specification.

### 8.3 Selection of mechanical test samples

Parts made from the same material batch and heat treated together shall be grouped in batches.

At least one test sample from the same material batch as that from which the parts were made shall be selected to represent each batch. After heat treatment with the batch, the test sample shall not be additionally heat treated or mechanically worked.

**NOTE** If heat treatment batches consist of small numbers of parts, a reduced frequency of sampling may be applied for mechanical tests, but shall be not less than one test sample per furnace load.

### 8.4 Mechanical properties

The mechanical properties of test pieces prepared and tested in accordance with 1.18 and 1.19 from test samples selected as specified in 8.3 shall conform to the material specification or drawing.

If the material specification or drawing states a hardness value for parts in the finally heat treated condition, each part and each representative test sample shall be hardness tested in accordance with 1.21. The hardness shall conform to the material specification or drawing. The location of the hardness impressions shall be at the manufacturer's discretion unless the drawing indicates the position at which the hardness test shall be made.

### 8.4 Retests

All retests shall be carried out in accordance with 1.24.

## Section 9. Modified requirements for the acceptance of small quantities of steel

### 9.1 General

If a small quantity of steel conforming to this standard is required, the use of a portion of a cast already made, but which has not been proved to conform to 1.7.7 of BS 5S 100:1993, and 1.8, 1.9, 1.12, 1.13, and 1.14 of this standard, shall be acceptable provided that the following conditions are met.

- a) The consent in writing of the quality assurance authority is obtained.
- b) The steel has been manufactured and supplied by a company, or companies, whose quality assurance system has been approved by the quality assurance authority.
- c) A steelmaker's certificate stating the process by which the steel was made is provided as proof of conformity to 1.7.1 of BS 5S 100:1993.
- d) The steelmaker's certificate of analysis (see 1.6.1 of BS 5S 100:1993) is provided as proof of conformity to 1.6.
- e) Each of the pieces of steel concerned is identifiable as to its cast, and adequate documentary evidence is available to secure correlation with the steelmaker's certificates (see items c and d of 9.1) and each piece of steel is checked in accordance with 1.30.2 of BS 5S 100:1993.
- f) Visual examination and the tests detailed in 9.2 and 9.3 do not reveal any harmful defects.
- g) The steel conforms to all other requirements of this standard and the material specification.

### 9.2 Micro-cleanness assessment

A micro-cleanness examination of one or more samples shall be carried out to verify that the material conforms to Annex A of BS 5S 100:1993.

### 9.3 Other tests

#### 9.3.1 General

The steel shall be examined at a suitable stage to verify freedom from harmful defects, as described in 9.3.2 to 9.3.6.

#### 9.3.2 Selection of samples

Samples shall be selected as follows.

- a) Slabs or pieces over 50 kg each. One sample shall be taken from each piece.

b) Slabs or pieces up to 50 kg each. One sample shall be taken from each 50 kg or part thereof.

c) Sheet and strip. One sample shall be taken from each 50 kg or part thereof, or each sheet or coil of mass greater than 50 kg. The sample shall be approximately 200 mm long and not less than 25 mm wide and shall be cut from the edge of the sheet or strip at right angles to the direction of rolling. If the direction of rolling is not known, samples shall be taken from two adjacent edges.

#### 9.3.3 Examination for segregation

The samples of thickness greater than 3 mm shall be sulfur printed, deep etched or microscopically examined.

#### 9.3.4 Examination for surface condition

The samples of thickness greater than 3 mm shall be subjected to one of the following tests:

- a) magnetic flaw detection in accordance with BS 6072:1981, after descaling if necessary; or
- b) the pickling test as described in 9.3.5.

The samples shall be free from harmful defects.

#### 9.3.5 Pickling test

A sample approximately 200 mm long shall be immersed for 10 min in a solution of equal volumes of concentrated hydrochloric acid (density 1.16 g/ml to 1.18 g/ml) and water, maintained at a temperature of not less than 85 °C. It shall then be removed from the solution, washed and dried.

NOTE 1 Other pickling solutions may be used in the case of corrosion resisting steel

NOTE 2 The pickling test may be employed for examination for both soundness and surface condition, provided that one end of the sample is machined square with the longitudinal axis.

#### 9.3.6 Ultrasonic test

When the size, shape and surface condition of the material permit, it shall be ultrasonically tested in accordance with 1.14.

### 9.4 Certification

The certification for material released in accordance with section 9 of this standard shall clearly state the tests that have been carried out in accordance with 9.2 and 9.3.

# List of references

## Normative references

### BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 860:1967, *Tables for comparison of hardness scales.*

BS 6072:1981, *Method of magnetic particle flaw detection.*

BS 6617, *Determination of decarburization in steel.*

BS 6617-1:1985, *Methods for determining decarburization by microscopic and micro-hardness technique.*

BS 4A 4:1966, *Test pieces and test methods for metallic materials for aircraft. Metric units.*

BS 4A 4, *Specification for test pieces and test methods for metallic materials.*

BS 4A 4-1, *Tensile tests.*

BS 4A 4-1-2:1967, *Tensile tests — elevated temperature. Metric units.*

BS 4A 4-1-3:1967, *Uninterrupted creep and rupture tests. Metric units.*

BS 5S 100:1993, *Procedure for inspection, testing and acceptance of wrought steels (other than plate, sheet, strip and tubes).*

## Informative references

### BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 3T 100:1978, *Procedure for inspection and testing of steel tubes*<sup>1)</sup>.

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<sup>1)</sup> Referred to only in the Foreword.

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