

Specification for

Wrought aluminium and aluminium alloys for general engineering purposes: bars, extruded round tubes and sections

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The preparation of this British Standard was entrusted by the Non-ferrous Metals Standards Committee (NFM/-) to Technical Committee NFM/35, upon which the following bodies were represented:

- Aluminium Federation
- Aluminium Stockholders' Association
- Association of Light Alloy Refiners Limited
- Department of Trade and Industry (Minerals and Metals Division)
- Light Metal Founders' Association
- Magnesium Industry Council
- Royal Institute of British Architects
- Society of Motor Manufacturers and Traders Limited

The following body was also represented in the drafting of the standard, through subcommittees and panels:

- Institution of Structural Engineers

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Foreword

This British Standard has been prepared under the direction of the Non-ferrous Metals Standards Committee. It is the fourth revision of this standard and replaces the 1972 edition which is withdrawn.

Other standards in this series of specifications for wrought aluminium and aluminium alloys for general engineering purposes are as follows.

BS 1470, *Plate sheet and strip*.

BS 1471, *Drawn tube*.

BS 1472, *Forging stock and forgings*.

BS 1473, *Rivet, bolt and screw stock*.

BS 1475, *Wire*.

New designation systems for both composition and tempers have been introduced in this revision.

As a major step towards alignment of aluminium and aluminium alloy compositions on an international basis a substantial number of countries have agreed to adopt a 4-digit classification for alloy composition designation. This system is administered by the Aluminium Association (AA) of the USA, which issues the "Registration record of international alloy designations and chemical composition limits for wrought aluminium and wrought aluminium alloys"¹⁾.

It has been decided to use this system in British Standards to designate the nominal chemical composition of the alloys specified. This has necessitated, in some cases, minor compositional changes from the previous alloys used. The details of the AA system are given in Appendix B, and a cross-reference table for the new and old British Standard alloy designations and the nearest equivalent ISO (International Organization for Standardization) alloy designations is included in Appendix C.

The temper designation system used is that given in BS EN 515.

The opportunity was taken in this revision to consider the alloys and tempers currently used commercially in significant quantities. As a consequence, one alloy previously in BS 4300/4 (alloy 6463) and a new alloy 6060 have been included.

The appendices contained in the 1972 edition concerning forms of material available, the annealing and heat treatment of wrought aluminium and its alloys, and standard sizes of material, have been omitted. Detailed information concerning the annealing and heat treatment of aluminium alloys can be obtained from the Aluminium Federation publication "Properties of aluminium and its alloys"²⁾.

In previous editions of this standard, clauses were included entitled "Inspection" and "Facilities for testing". As these clauses were contractual in nature and are not relevant to a product standard, they have been omitted from this revision.

¹⁾ Available from the Aluminum Association Inc., 900 19th Street, NW, Suite 300, Washington DC, 20006, USA.

²⁾ Available from the Aluminium Federation, Broadway House, Calthorpe Road, Five Ways, Birmingham, B15 1TN.

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 22, 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.

1 Scope

This British Standard specifies requirements for chemical composition, mechanical properties, dimensional tolerances, the selection of test samples and test methods for solid bars and sections and for extruded round tube and hollow sections made from two grades of aluminium (unalloyed) and ten aluminium alloys in various tempers.

NOTE 1 Information which purchasers are recommended to provide in any enquiry or order is given in Appendix A. Details of the international alloy designations and chemical composition limits for wrought aluminium alloys are given in Appendix B. Appendix C contains a cross-reference table for British Standard and ISO alloy and temper designations. A rule for the rounding on numbers is set out in Appendix E.

NOTE 2 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

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

2.1 bar

a round, rectangular or polygonal solid section supplied in straight lengths, applicable to materials not less than 6 mm diameter or minor dimension

2.2 extruded round tube

a circular hollow extrusion of uniform wall thickness not subjected to cold drawing

NOTE Extruded round tube may be seamless (see 2.3) or porthole/bridge (see 2.4) tube.

2.3 seamless tube

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

2.4 porthole/bridge tube

tube produced by extrusion of a solid billet through a porthole/bridge die (see 2.5)

2.5 porthole die

an extrusion die that incorporates a mandrel as an integral part of the die assembly

NOTE Bridge, spider, duo and self-stripping dies are special forms of porthole die.

2.6 heat treatment batch

a quantity of material of one alloy, of the same dimensions and produced in the same way, solution heat-treated and, if required, subsequently artificially aged in one furnace load

NOTE More than one heat treatment batch may comprise a furnace load.

2.7 hollow section

an extruded shape other than round, the cross section of which completely encloses a void or voids, and which is not subjected to cold drawing

2.8 purchaser

the party, whether user, retailer, wholesaler or corporate body or his/its agent(s) as appropriate, responsible for ordering the material standardized

2.9 regular section

a solid drawn or extruded section not otherwise covered by the definition of a bar, which can be conveniently divided into approximate rectangles with measurable dimensions, e.g. angles, channels, tees, etc. and where the ratio of maximum thickness to minimum thickness of such regular sections does not exceed 4 : 1

3 General requirements

Bars, extruded round tubes and sections shall comply with clauses 4 to 8.

When tests are carried out to verify that a batch of bars, extruded round tubes or sections complies with the requirements for mechanical properties (see clause 6), the selection of test samples and the test methods used shall be in accordance with clauses 9 and 10.

4 Chemical composition

The chemical composition of bars, extruded round tubes and sections shall be as given in Table 1 and Table 2 for the appropriate material.

NOTE Alloy 6060 is new to this British Standard. Alloy 6463 was previously included in BS 4300/4.

5 Tempers

The material shall be supplied to a temper in accordance with BS EN 515 as specified by the purchaser and selected from Table 1 or Table 2.

- F As fabricated.
- O Annealed.
- T4 Solution heat-treated and naturally aged.
NOTE Properties of some alloys in this temper are unstable.
- T5 Cooled from an elevated temperature shaping process and then artificially aged.
- T6 Solution heat-treated and artificially aged.

6 Mechanical properties

The mechanical properties (i.e. 0.2 % proof stress, tensile strength and elongation, as appropriate) of bars, extruded round tubes and sections shall be as given in Table 1 and Table 2, except that for tubes and hollow sections having a wall thickness greater than 75 mm, no mechanical properties are specified.

Where a tensile strength range is specified in Table 1, the requirements of the standard shall be regarded as being met if the upper limit of the range is exceeded by a maximum of 10 N/mm², provided that the minimum value specified for the elongation after fracture is achieved.

NOTE 1 The tensile strength requirements given in Table 1 and Table 2 are either single minimum or maximum values, or ranges, depending upon the technical requirements and application of the individual materials.

NOTE 2 There are no mandatory mechanical properties specified for materials in the "F" temper. Table 1 and Table 2 give properties for the "F" temper for information only.

7 Tolerances on dimensions

7.1 General

The dimensional and shape tolerances of bars, extruded round tubes and sections for the various materials, shapes, sizes and end-uses covered by this standard shall be as given in 7.2 to 7.7.

NOTE The dimensional and shape tolerances of materials outside the size ranges covered in Table 3 to Table 17 should be agreed between the purchaser and the supplier at the time of the enquiry and order.

7.2 Tolerances on round bar

7.2.1 The tolerances on the diameter, straightness and length of round bars (other than those covered by 7.2.2 and 7.2.3) shall be as given for the appropriate size in Table 6, Table 14 and Table 15, except that for bars in alloy 5083 the tolerances in Table 6 shall be increased by one-third.

7.2.2 The tolerances on the diameter, straightness and length of round bars intended for use on automatic lathes shall be as given for the appropriate size in Table 3, Table 14 and Table 15.

NOTE When round bar is required for use on automatic lathes, this should be clearly stated in the enquiry and order (see item f) in Appendix A).

7.2.3 The tolerances on the diameter, straightness and length of controlled stretched round bar shall be as given for the appropriate size in Table 5, Table 14 and Table 15.

7.3 Tolerances on hexagonal and regular polygonal bar

7.3.1 The tolerances on the width across flats, the straightness and the length of hexagonal bars intended for use in the manufacture of nuts and bolts shall be as given for the appropriate size in Table 4, Table 14 and Table 15.

NOTE When hexagonal bar for the manufacture of nuts and bolts is required, this should be clearly stated in the enquiry and order (see item h) in Appendix A).

7.3.2 The tolerances on the width across flats, the straightness and the length of hexagonal bars, other than those covered by 7.3.1, and of regular polygonal bar shall be as given for the appropriate size in Table 6, Table 14 and Table 15, except that for bars in alloy 5083 the tolerances in Table 6 shall be increased by one-third.

7.4 Tolerances on rectangular bar and solid regular sections

The tolerances on the width, thickness, angular dimensions, corner radii, straightness, length, and the concavity, convexity and twist (when measured on a flatness inspection table) of rectangular bar and solid regular sections shall be as given for the appropriate size in Table 6, Table 7, Table 9, Table 10, Table 14, Table 15, Table 16 and Table 17, except that for bars and sections in alloy 5083 the tolerances in Table 6 and Table 7 shall be increased by one-third.

NOTE The tolerances on the shape and dimensions of non-regular sections should be agreed between the supplier and the purchaser at the time of the enquiry and order.

7.5 Tolerances on channels and I-beams

In addition to the tolerances given in 7.4, the tolerances on the open end dimension(s) of channels and I-beams shall be as given for the appropriate size in Table 8 (see also Figure 1).

7.6 Tolerances on extruded round tube

7.6.1 The tolerances on the outside diameter, straightness and length of tube in all materials shall be as given in Table 12, Table 14 and Table 15.

7.6.2 In addition to the tolerances given in 7.6.1, and if no tolerances for the inside diameter are required (see item k) in Appendix A), the tolerances on the wall thickness of tube shall be as given for the appropriate size and class in Table 11 as follows:

- a) tube in materials 1050A, 1200, 6060, 6061, 6063, 6063A, 6082 and 6463 shall comply with class A, class B or class C tolerances, as specified by the purchaser (see item i) in Appendix A);
- b) tube in materials 5251, 5083, 5154A and 2104A shall comply with class B or class C tolerances, as specified by the purchaser (see item j) in Appendix A).

NOTE Class A tolerances are normally applied to porthole/bridge tube. Class B tolerances may be applied to both seamless and porthole/bridge tube. Class C tolerances apply to seamless tube produced by extrusion over a tapered mandrel. This method of production results in a tube whose wall thickness tapers along the length of the extrusion.

7.6.3 If a wall thickness tolerance is not specified and the outside and inside diameters are specified, then the tolerances on these dimensions shall be as given for the appropriate size in Table 12.

NOTE The tolerances on eccentricity for class A and class B tube when a wall thickness tolerance is not specified should be agreed between the purchaser and the supplier at the time of the enquiry and order.

7.7 Tolerances on hollow sections

7.7.1 The tolerances on the width and length, and on concavity, convexity, straightness and twist (when measured on a flatness inspection table), of hollow regular sections shall be as given in Table 6, Table 14, Table 15, Table 16 and Table 17, except that for hollow sections in alloy 5083 the tolerances in Table 6 shall be increased by one-third.

7.7.2 In addition to the tolerances given in 7.7.1, the tolerances on the thickness of hollow regular sections shall be as given for the appropriate size and class in Table 13 as follows:

- a) hollow regular section in materials 1050A, 1200, 6060, 6061, 6063, 6063A, 6082 and 6463 shall comply with class A or class B tolerances, as specified by the purchaser (see item l) in Appendix A);
- b) hollow regular section in materials 5154A, 5251 and 2014A shall comply with class B tolerances;
- c) hollow regular section in material 5083 shall comply with class B tolerances in Table 13, increased by one-third.

7.7.3 The tolerances on the straightness, length and permitted twist of hollow non-regular sections shall be as given in Table 14, Table 15 and Table 17.

NOTE The tolerances on all other dimensions of hollow non-regular sections should be agreed between the supplier and the purchaser at the time of the enquiry and order.

8 Freedom from defects

The material shall be free from defects prejudicial to its suitability and proper use.

9 Selection and preparation of test samples

9.1 Bars, extruded round tube and sections of aluminium and non-heat-treatable aluminium alloys

Material of the same cross-sectional dimensions, produced in the same way and of the same nominal composition shall be grouped into batches as follows:

- a) for round bar of diameter up to and including 10 mm, and for other shapes having a cross-sectional area less than 80 mm², a batch shall consist of 1 000 kg or fraction thereof;
- b) for round bar of diameter over 10 mm, and for other shapes having a cross-sectional area equal to or greater than 80 mm², a batch shall consist of 2 000 kg or fraction thereof.

One test sample shall be cut from a bar, tube or section selected from each batch. Before the test samples are cut off, they shall be suitably marked to identify them with the batch represented. The test samples shall be taken from the material or its offcuts in the "as supplied" temper and shall not be annealed or mechanically worked (except for straightening and machining the test piece) before being tested.

9.2 Bars, extruded round tube and sections of heat-treatable aluminium alloys

Material of the same cross-sectional dimensions, produced in the same way and of the same nominal composition shall be grouped into batches as in 9.1 to form a heat treatment load, unless the heat treatment load is smaller, in which event that shall constitute the batch.

One test sample shall be cut from a bar, tube or section selected from each batch. Before the test samples are cut off, they shall be suitably marked to identify them with the batch represented. The test samples shall be taken from the material or its offcuts in the "as supplied" temper (but see note) and shall not be further heat treated or mechanically worked (except for straightening and machining the test piece) before being tested.