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# Australian Standard H50 - 1971

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## WROUGHT ALUMINIUM AND ALUMINIUM ALLOY EXTRUDED ROD, BAR, SOLID AND HOLLOW SHAPES FOR GENERAL ENGINEERING PURPOSES



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Aluminium Diecasters Association of Australia  
Architectural Aluminium Fabricators Federation of Australia  
Associated Chambers of Manufactures of Australia  
Australian Association of Foundry Institutes  
Australian and New Zealand Railways Conferences  
Department of Supply  
Metal Trades Industry Association of Australia  
Royal Australian Institute of Architects  
Society of Automotive Engineers—Australasia

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This standard, prepared by Committee MT/3, Aluminium and Aluminium Alloys, was approved on behalf of the Council of the Standards Association of Australia on 13 April 1971.

To keep abreast of progress in industry, Australian standards are regularly reviewed. Suggestions for improvements to published standards are welcomed; these should be addressed to Headquarters of the Association, Sydney.

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*This standard was issued in draft form for public review as Doc. 1593.*

**AUSTRALIAN STANDARD SPECIFICATION**

**WROUGHT ALUMINIUM  
AND ALUMINIUM ALLOY  
EXTRUDED ROD, BAR, SOLID  
AND HOLLOW SHAPES  
FOR GENERAL ENGINEERING PURPOSES**

**AS H50 — 1971**

|                 |    |    |    |    |      |
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## PREFACE

This Australian standard was prepared by the Association's Committee on Aluminium and Aluminium Alloys. It is a revision of two Australian Standards, viz. AS H50—1961, Wrought Aluminium and Aluminium Alloy Extruded Tubes and Hollow Sections for General Engineering Purposes, and AS H54—1961, Wrought Aluminium and Aluminium Alloy Extruded Bars, Rods and Solid Sections for General Engineering Purposes. It is one of a series designed to satisfy the requirements of Australian industry for wrought aluminium and aluminium alloys. In particular, this standard applies to rod, bar, solid and hollow shapes produced by the hot extrusion method. For the purpose of this standard, extruded hollow shapes are synonymous with extruded tubes.

The system of nomenclature for wrought aluminium and aluminium alloys adopted by the committee in this standard is that currently in use in Australia. It replaces the several differing systems that existed in the past, and utilizes a letter-plus-four-digit designation, the four digits having the same significance as those used by the Aluminum Association (U.S.). Letter prefixes have been added to distinguish Australian alloys, and an explanation of this new system is included as Appendix A. Related composition specifications for wrought aluminium alloys are given in Appendix B, where the relationship between alloys detailed in this standard and other systems of nomenclature are shown in terms of equivalents and deviations.

The temper designation system adopted is the same as that used in previous Australian standards on wrought aluminium alloys. It is based on the sequence of basic treatments usually used to produce the various tempers. The significance of the various tempers is given in Appendix C. Mechanical property limits for the various tempers and associated thickness are detailed in Part II.

In preparing this standard, cognizance was taken of publications issued by the Aluminium Development Council of Australia (Ltd.), namely "Standards for Australian Aluminium Mill Products", Parts 1 and 2.

British and metric unit equivalents are given in Appendix H. Values quoted in the text are to be regarded as standard. The conversions are approximate; more accurate conversions should be based on the tables in BS 350, Conversion Factors and Tables.

This standard requires reference to the following Australian, British and ASTM standards:

AS A23 Tensile Testing of Metals.

BS 1639 Methods for Bend Testing of Metals.

BS 1729 Methods for the Analysis of Aluminium and Aluminium Alloys.

ASTM E34 Methods for Chemical Analysis of Aluminium and Aluminium Base Alloys.

ASTM Methods for Emission Spectrochemical Analysis.

# CONTENTS

|                                                                            | <i>Page</i> |
|----------------------------------------------------------------------------|-------------|
| <b>PART I. SCOPE AND GENERAL REQUIREMENTS</b>                              |             |
| 1.1 Scope .. .. .                                                          | 5           |
| 1.2 Designation .. .. .                                                    | 5           |
| 1.3 Definitions .. .. .                                                    | 5           |
| 1.4 Information to be Supplied by the Purchaser. .. .. .                   | 6           |
| 1.5 Process of Manufacture .. .. .                                         | 7           |
| 1.6 Finish .. .. .                                                         | 7           |
| 1.7 Chemical Composition .. .. .                                           | 7           |
| 1.8 Freedom from Defects .. .. .                                           | 7           |
| 1.9 Margins of Manufacture .. .. .                                         | 8           |
| 1.10 Mechanical Properties .. .. .                                         | 8           |
| 1.11 Selection and Preparation of Test Samples for Mechanical Test .. .. . | 8           |
| 1.12 Tensile Test .. .. .                                                  | 8           |
| 1.13 Retests .. .. .                                                       | 9           |
| 1.14 Facilities for Testing .. .. .                                        | 10          |
| 1.15 Test Certificate .. .. .                                              | 10          |
| 1.16 Inspection .. .. .                                                    | 10          |
| 1.17 Independent Tests .. .. .                                             | 10          |
| 1.18 Identification .. .. .                                                | 10          |
| 1.19 Packaging .. .. .                                                     | 11          |
| 1.20 Rounding of Numbers .. .. .                                           | 11          |
| <br><b>PART II. MATERIAL SPECIFICATIONS</b>                                |             |
| Alloy B1080 .. .. .                                                        | 14          |
| Alloy A1050 .. .. .                                                        | 15          |
| Alloy A1100 .. .. .                                                        | 16          |
| Alloy B1200 .. .. .                                                        | 17          |
| Alloy A2011 .. .. .                                                        | 18          |
| Alloy B2014 .. .. .                                                        | 19          |
| Alloy A4543 .. .. .                                                        | 20          |
| Alloy C5154 .. .. .                                                        | 21          |
| Alloy B5083 .. .. .                                                        | 22          |
| Alloy B6351 .. .. .                                                        | 23          |
| Alloy A6061 .. .. .                                                        | 24          |
| Alloy A6262 .. .. .                                                        | 25          |
| Alloy B6063 .. .. .                                                        | 26          |
| Alloy D6463 .. .. .                                                        | 27          |

## PART III. MARGINS OF MANUFACTURE

|      |                                                                                                                                |    |
|------|--------------------------------------------------------------------------------------------------------------------------------|----|
| 3.1  | Scope of Part .. .. .                                                                                                          | 28 |
| 3.2  | Diameter Tolerances for Machining Rod—<br>Alloys A2011 and A6262 only .. .. .                                                  | 28 |
| 3.3  | Distance-Across-Flats Tolerances for Extruded Hexagonal<br>Bar .. .. .                                                         | 28 |
| 3.4  | Cross-Section Dimensional Tolerances for Rod, Bar and<br>Solid Shapes (Other than Machining Rod and Hexagonal<br>Bar). .. .. . | 28 |
| 3.5  | Cross-Section Dimensional Tolerances for Class 1 Hollow<br>Shapes .. .. .                                                      | 28 |
| 3.6  | Cross-Section Dimensional Tolerances for Class 2 Hollow<br>Shapes .. .. .                                                      | 29 |
| 3.7  | Cross-Section Dimensional Tolerances for Class 3 Hollow<br>Shapes .. .. .                                                      | 30 |
| 3.8  | Length Tolerances .. .. .                                                                                                      | 31 |
| 3.9  | Twist Tolerances .. .. .                                                                                                       | 32 |
| 3.10 | Straightness Tolerances .. .. .                                                                                                | 32 |
| 3.11 | Flatness (Flat Surfaces) Tolerances .. .. .                                                                                    | 32 |
| 3.12 | Angularity Tolerances .. .. .                                                                                                  | 32 |
| 3.13 | Corner and Fillet Radii Tolerances .. .. .                                                                                     | 32 |
| 3.14 | Contour Tolerances .. .. .                                                                                                     | 32 |
| 3.15 | Squareness-of-Cut-Ends Tolerances .. .. .                                                                                      | 32 |

## APPENDICES

|   |                                                                                     |    |
|---|-------------------------------------------------------------------------------------|----|
| A | Alloy Designation .. .. .                                                           | 58 |
| B | Related Composition Specifications .. .. .                                          | 59 |
| C | Temper Designation .. .. .                                                          | 60 |
| D | Determination of Yield Strength (0.2% Proof Stress) by the<br>Offset Method .. .. . | 63 |
| E | Deflection Due to Twist .. .. .                                                     | 64 |
| F | Rounding of Numbers .. .. .                                                         | 66 |
| G | Examples Illustrating the Use of Tolerance Tables .. .. .                           | 68 |
| H | British and Metric Unit Equivalents .. .. .                                         | 70 |

## STANDARDS ASSOCIATION OF AUSTRALIA

**Australian Standard Specification  
for****WROUGHT ALUMINIUM AND ALUMINIUM ALLOY  
EXTRUDED ROD, BAR,  
SOLID AND HOLLOW SHAPES  
FOR GENERAL ENGINEERING PURPOSES****PART I. SCOPE AND GENERAL REQUIREMENTS**

**1.1 SCOPE.** This specification applies to wrought aluminium and aluminium alloy extruded rod, bar, solid and hollow shapes for general engineering purposes.

**NOTE:** For the purpose of this specification, extruded hollow shapes are synonymous with extruded tubes.

**1.2 DESIGNATION.**

**1.2.1 Alloy Designation.** The material shall be given the appropriate alloy designation shown in column 1 of Table 1.1.

**1.2.2 Temper Designation.** The temper designation shall be used for all forms of wrought aluminium and aluminium alloys, and shall follow the alloy designation, the two being separated by a dash, e.g. A6061—T6.

**1.3 DEFINITIONS.** For the purpose of this specification the following definitions apply:

*Extruded Rod*—an extruded solid round section 0.375 in or greater in diameter whose length is great in relation to its diameter.

*Extruded Bar*—an extruded solid section, long in relation to its cross-sectional dimensions, having a symmetrical cross-section which is square, rectangular, hexagonal, or octagonal (excluding flattened wire), with sharp or rounded corners or edges, and whose width or greatest distance between parallel faces is 0.375 in or greater.

*Extruded Solid Shape*—an extruded section whose geometry does not form a void and which is long in relation to its cross-sectional dimensions.

*Class 1 Hollow Extruded Shape*—a hollow extruded shape whose void is round and 1 in or more in diameter, and of uniform wall thickness.

*Class 2 Hollow Extruded Shape*—any hollow extruded shape with a round, square, or rectangular void, and of uniform wall thickness.

**NOTE:** Conventional glazing nibs are permissible within this definition.

The shape will be of a single void and will not exceed a 5-in circumscribing circle. The void will not be less than 0.375 in in diameter or 0.110 in<sup>2</sup> in area.

**NOTE:** Internal and external radii up to 0.250 in are allowable.

*Class 3 Hollow Extruded Shape*—any single void hollow extruded shape other than Class 1 or Class 2.

**Class 4 Hollow Extruded Shape**—any hollow extruded shape with more than one void. Where a hollow shape incorporates a semi-hollow, it will be classed as Class 4.

**Semi-hollow Extruded Shape**—any extruded shape whose cross-section partially encloses a void, the area of which is substantially greater than the square of the width of the gap in the enclosure.

**Structural Finish**—a surface finish not controlled for uniformity of appearance.

**NOTE:** Rod, bar and solid shapes are supplied in structural finish unless otherwise specified.

**Architectural Finish**—a controlled surface finish of substantially uniform appearance; buffing will not produce a die line-free surface finish unless a preliminary grinding or sanding operation is employed.

**Trim Finish**—a special surface finish designed for subsequent polishing; buffing will normally produce a surface substantially free from die lines. This finish is not applicable to hollow shapes.

**NOTE:** Trim finish is available only over a maximum width of any unbroken surface of  $1\frac{1}{2}$  in, i.e. broken by a lower grade of finish. A change of contour does not break surface.

**Circumscribing Circle Diameter (or Circle Size)**—the diameter of the smallest circle that will completely enclose the cross-section of the shape.

**Lot**—all material of the same section, size, alloy, temper and finish in a shipment. In respect of heat-treated material, a lot shall consist of all material of the same section, size, alloy, temper and finish and from the same furnace load.

**Die Line**—a longitudinal line or scratch resulting from the use of a roughened tool or the drag of a foreign particle between tool and product.

**Orange Peel**—a surface roughening encountered in forming products from material which has a coarse grain size.

## 1.4 INFORMATION TO BE SUPPLIED BY THE PURCHASER.

**1.4.1 General.** The purchaser shall supply the following information:

- (i) Designation of alloy and temper (see Clause 1.2).
- (ii) Quantity (weight or number of pieces).
- (iii) Nominal cross-sectional dimensions as follows:
  - Rod: diameter
  - Square cornered bars: depth and width.
  - Sharp cornered hexagonal or octagonal bars: distance across flats.
  - Class 1 Hollow: outside *or* inside diameter and wall thickness.
  - Class 2 Hollow: distance across flats and wall thickness.
- (iv) Section number, as appropriate.
- (v) Length.
- (vi) Required finish (see Clause 1.6).

- (vii) Whether a test certificate is required (see Clause 1.15).
- (viii) Any information concerning end use which the purchaser considers would assist the supplier (see Clause 1.4.2).
- (ix) Any exceptions to the specification and any special or supplementary requirements, e.g. special requirements in respect of packing, or special tolerances.
- (x) Whether it is the intention of the purchaser to inspect the material at the supplier's works (see Clause 1.16).

**1.4.2 End Use.** If possible the purchaser should indicate the purpose for which the material is to be used.

NOTE: A drawing and/or sample of the part in question is useful.

**1.5 PROCESS OF MANUFACTURE.** The process of manufacture shall be at the option of the supplier, who shall be responsible for the performance of all inspection and tests required by this specification, prior to shipment of material.

**1.6 FINISH.** The surface finish of the material shall be as agreed between purchaser and supplier, in accordance with the relevant definition in Clause 1.3.

## **1.7 CHEMICAL COMPOSITION.**

**1.7.1 General.** Unless otherwise agreed between the purchaser and supplier, the material shall conform to the chemical composition limits given in Table 1.1 for the alloy specified by the purchaser. Conformance shall be determined by the supplier by analysing samples taken at the time the ingots are poured, or samples taken from the finished or semi-finished product. If the supplier has determined the chemical composition of the material during the course of manufacture, he shall not be required to sample and analyse the finished product.

**1.7.2 Residual Elements.** Elements not quoted in the relevant specification shall not be intentionally added to the material without the agreement of the purchaser other than for the purpose of finishing the heat. Such elements shall not be present in sufficient quantities to be detrimental to the subsequent working or end use of the material.

**1.7.3 Check Analysis.** Any subsequent analytical checks shall take into consideration the heterogeneity normal to the type of material and shall not be used as a basis for rejection unless the supply of an incorrect alloy is indicated.

**1.8 FREEDOM FROM DEFECTS.** The material shall be free from defects and contaminants detrimental to its subsequent processing and to its end use.

NOTE: All incoming shipments should be inspected promptly, since suppliers generally have a time limit in which damage claims will be honoured.

Notwithstanding the fact that material has been passed as complying with this specification, if faults in manufacture are revealed in subsequent processing of the material it may then be deemed not to comply.



**1.9 MARGINS OF MANUFACTURE.** Unless closer tolerances are required as agreed between purchaser and supplier, the margins of manufacture shall be in accordance with the limits given in Part III, as appropriate.

**NOTES:**

1. Class 4 hollow shapes, because of their complexity of shape cannot be covered by standard tolerance tables, and tolerances should be agreed between purchaser and supplier.
2. Examples illustrating the use of dimensional tolerances tables are given for guidance in Appendix G.

**1.10 MECHANICAL PROPERTIES.** The mechanical properties shall be determined on test pieces prepared from samples selected and prepared as specified in Clause 1.11 and tested as specified in Clause 1.12.

The tensile test shall comply with the requirements of Part II for the alloy specified by the purchaser.

When specifically requested by the purchaser, yield strength or proof stress (0.2% offset) shall be determined on material as indicated in Part II.

**NOTES:**

1. Elongation is not determined for shapes less than 0.062 in thick.
2. No mechanical property limits are specified for material ordered to F temper.

**1.11 SELECTION AND PREPARATION OF TEST SAMPLES FOR MECHANICAL TESTS.** Material shall be grouped in lots. A sample of sufficient size to allow the preparation of the necessary tensile test pieces shall be taken to represent the following:

- (a) *Material having a nominal weight of less than 1 lb per linear foot.*  
One sample from the first 500 lb or fraction thereof, and an additional sample from each additional 1000 lb or fraction thereof.
- (b) *Material having a nominal weight of 1 lb or more per linear foot.*  
One sample from the first 500 ft or fraction thereof, and an additional sample from each additional 1000 ft or fraction thereof.

The sample shall not, except for the necessary straightening, be mechanically worked or re-heat-treated before testing.

**1.12 TENSILE TEST.**

**1.12.1 Test Method.** The tensile test shall be carried out in accordance with AS A23\* on a test piece having a gauge length of four times the square root of the original cross-sectional area of the test piece ( $S_0$ ) or on a non-proportional rectangular test piece as specified in Clause 6 of that standard on a 2-in gauge length.

Yield strength or proof stress (0.2 per cent offset) shall be determined by the offset method described in Appendix D.

**NOTE:** The Association's Committee on Aluminium and Aluminium Alloys, under whose direction this specification was prepared, has endorsed the decision of Technical Committee 79, Light Metals and Their Alloys, of the International Organization for Standardization (ISO), that 5.65 times the square root of the original cross-sectional area ( $S_0$ ) be adopted as the international preferred proportional gauge length.

As an interim measure, elongation values for a gauge length of 4 times the square root of the original cross-sectional area ( $S_0$ ), the proportional gauge length hitherto most commonly used in Australia, are prescribed in Part II of this specification.

\*AS A23, Tensile Testing of Metals

**1.12.2 Tensile Test Pieces.** Tensile test pieces shall be taken in the longitudinal direction, and where the size makes it impracticable to use a full-section test piece, a test piece shall be prepared as follows:

- (a) *For rod and bar over 1.500 inches in diameter or thickness.* Test piece of circular cross-section, machined from material taken midway between the centre and surface of the section.
- (b) *For rod and bar 1.500 inches and less in diameter or thickness.* Test piece of circular cross-section, machined from material taken from the centre of the section, except for rectangular bar less than 0.500 inch in thickness, where a test piece of rectangular cross-section may be used as agreed between purchaser and supplier.
- (c) *For solid shapes over 1.500 inches in thickness.* Test piece of circular cross-section, machined from material taken midway between the centre and surface and midway between the centre and edge of the thickest part of the shape.
- (d) *For solid shapes 1.500 inches and less in thickness.* Test piece of circular cross-section taken from the thickest part of the shape, except for solid shapes with parallel faces and less than 0.500 inch in thickness, where a test piece of rectangular cross-section may be used as agreed between purchaser and supplier.

For shapes which cannot be tested in full section, and from which standard machined test pieces cannot be obtained, a rectangular or round specimen of the largest possible dimensions shall be used, and elongation is not determined.

- (e) *Hollow shapes.* Test piece of circular cross-section, or a test piece of rectangular cross-section from a flat-walled hollow, or a test piece of curved rectangular cross-section from a hollow having a curved wall.

**1.13 RETESTS.** Should any test piece first selected fail to pass the relevant test specified in Clause 1.10 one or both of the following procedures shall be adopted at the option of the supplier:

- (a) The material represented by the test piece which failed shall either be withdrawn or be set aside for further testing and two further test samples shall be taken from the remainder of the same material. Should the test pieces from both these additional samples pass, the remainder of the lot shall be deemed to comply with this specification. If one or both of these additional samples fail, the lot shall be deemed not to comply with this specification. At the option of the supplier, each individual piece may be tested and compliance with this specification will depend on the results of each individual test.
- (b) The lot shall be reprocessed and retested in accordance with this specification.

**1.14 FACILITIES FOR TESTING.** The supplier shall provide and prepare the necessary material and supply labour and appliances for such testing as may be carried out on his premises in accordance with this specification. Unless otherwise agreed, material for testing shall remain the property of the supplier. Failing facilities at his own works for making the prescribed tests, the supplier shall be responsible for making the tests elsewhere.

**1.15 TEST CERTIFICATE.** Where tests, as agreed between the purchaser and the supplier, have been performed by the manufacturer for the purpose of establishing compliance with this specification, the supplier shall provide a certificate showing such test results as may be required by agreement between the purchaser and the supplier.

**1.16 INSPECTION.** The purchaser shall notify the supplier, when placing his order, if it is his intention to inspect the material at the supplier's works.

The supplier shall afford the purchaser all reasonable facilities to satisfy himself that the material is in accordance with this specification. For this purpose, the purchaser or his representative may, by prior arrangement, attend to inspect the material, to select and identify the test samples for testing, and to witness the tests being made, provided that this is carried out in a manner which will not interfere unnecessarily with the operation of the works.

The purchaser shall be at liberty to take samples from the material and have them tested. The cost of such testing shall be borne by the purchaser, and the results communicated to the supplier if they are not in accordance with this specification.

**1.17 INDEPENDENT TESTS.** Should there be a dispute about the compliance of the material with the requirements of this specification, the supplier and the purchaser shall have the right to have the material tested by an approved independent testing authority. The results obtained by the approved independent testing authority shall be accepted as final.

**NOTE:** Facilities for such testing are afforded by laboratories registered by the National Association of Testing Authorities, Australia, for the field and class of testing concerned.

If the material does not comply with this specification the cost of independent testing shall be borne by the supplier; if the material complies with this specification the cost shall be borne by the purchaser.

The methods of sampling for analysis and the methods of analysis shall be not less accurate than those prescribed in BS 1728\*, ASTM E34†, or ASTM Methods for Emission Spectrochemical Analysis.

**1.18 IDENTIFICATION.** Each shipping unit shall be marked or tagged with the lot number, or other identification number, material size or section number as appropriate, alloy and temper, and the manufacturer's name or

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\*BS 1728 Methods for the Analysis of Aluminium and Aluminium Alloys.

†ASTM E34 Methods for Chemical Analysis of Aluminium and Aluminium Base Alloys.

trademark, to enable it to be identified with this specification. Alternative methods of identification shall be subject to agreement between purchaser and supplier.

**1.19 PACKAGING.** Unless otherwise agreed between the supplier and purchaser, the type of packing and gross weight of containers shall be at the discretion of the supplier, who shall provide adequate protection during normal handling and transportation, and shall ensure each package shall contain only one size, alloy, temper and finish of material.

**1.20 ROUNDING OF NUMBERS.** For the purpose of deciding whether a particular requirement of this specification is complied with, the determined value, observed or calculated, expressing the result of a mechanical test or a chemical analysis shall be rounded off in accordance with Appendix F. The number of significant places retained in the rounded-off value shall be the same as that of the specified value in this specification.

**TABLE 1.1**  
**CHEMICAL COMPOSITION LIMITS**

| 1     | 2                                            | 3    | 4    | 5      | 6    | 7         | 8    | 9         | 10   | 11       | 12   | 13   | 14       | 15                          | 16    | 17                 |
|-------|----------------------------------------------|------|------|--------|------|-----------|------|-----------|------|----------|------|------|----------|-----------------------------|-------|--------------------|
| ALLOY | Chemical Composition (per cent) <sup>a</sup> |      |      |        |      |           |      |           |      |          |      |      |          |                             |       |                    |
|       | Silicon                                      |      | Iron | Copper |      | Manganese |      | Magnesium |      | Chromium |      | Zinc | Titanium | Other Elements <sup>b</sup> |       | Alumi-<br>nium     |
|       | min.                                         | max. | max. | min.   | max. | min.      | max. | min.      | max. | min.     | max. | max. | max.     | Each                        | Total | min.               |
| B1080 | —                                            | 0.15 | 0.15 | —      | 0.02 | —         | 0.02 | —         | 0.02 | —        | —    | 0.03 | 0.02     | max.                        | max.  | min.               |
| A1050 | —                                            | 0.25 | 0.40 | —      | 0.05 | —         | 0.05 | —         | 0.05 | —        | —    | 0.05 | 0.03     | 0.03                        | —     | 99.80 <sup>c</sup> |
| A1100 | Si + Fe:1.0                                  | max. | 0.05 | 0.20   | —    | 0.05      | —    | —         | —    | —        | —    | 0.10 | —        | 0.05                        | 0.15  | 99.00 <sup>c</sup> |
| B1200 | —                                            | 0.40 | 0.6  | —      | 0.05 | —         | 0.05 | —         | —    | —        | —    | 0.10 | —        | 0.05                        | 0.15  | 99.00 <sup>c</sup> |
| A2011 | —                                            | 0.40 | 0.7  | 5.0    | 6.0  | —         | —    | —         | —    | —        | —    | 0.30 | —        | 0.05 <sup>d</sup>           | 0.15  | Rem.               |
| B2014 | 0.50                                         | 0.8  | 0.7  | 3.9    | 4.8  | 0.40      | 1.2  | 0.20      | 0.8  | —        | 0.10 | 0.25 | 0.15     | 0.05                        | 0.15  | Rem.               |
| A4543 | 5.0                                          | 7.0  | 0.50 | —      | 0.10 | —         | 0.05 | 0.10      | 0.40 | —        | 0.05 | 0.10 | 0.10     | 0.05                        | 0.15  | Rem.               |
| C5154 | —                                            | 0.6  | 0.50 | —      | 0.10 | —         | 0.6  | 2.8       | 4.0  | —        | 0.25 | 0.25 | 0.15     | 0.05                        | 0.15  | Rem.               |
| B5083 | —                                            | 0.40 | 0.40 | —      | 0.10 | 0.50      | 1.0  | 4.0       | 4.9  | 0.05     | 0.25 | 0.25 | 0.15     | 0.05                        | 0.15  | Rem.               |
| B6351 | 0.7                                          | 1.3  | 0.50 | —      | 0.10 | 0.40      | 0.8  | 0.40      | 0.8  | —        | —    | 0.10 | 0.20     | 0.05                        | 0.15  | Rem.               |
| A6061 | 0.40                                         | 0.8  | 0.7  | 0.15   | 0.40 | —         | 0.15 | 0.8       | 1.2  | 0.04     | 0.35 | 0.25 | 0.15     | 0.05                        | 0.15  | Rem.               |
| A6262 | 0.40                                         | 0.8  | 0.7  | 0.15   | 0.40 | —         | 0.15 | 0.8       | 1.2  | 0.04     | 0.14 | 0.25 | 0.15     | 0.05 <sup>e</sup>           | 0.15  | Rem.               |
| B6063 | 0.30                                         | 0.6  | 0.35 | —      | 0.10 | —         | 0.10 | 0.45      | 0.9  | —        | 0.10 | 0.10 | 0.10     | 0.05                        | 0.15  | Rem.               |
| D6463 | 0.20                                         | 0.6  | 0.15 | —      | 0.25 | —         | 0.05 | 0.30      | 0.9  | —        | —    | —    | —        | 0.05                        | 0.15  | Rem.               |

**FOOTNOTES TO TABLE 1.1:**

**<sup>a</sup>Standard limits for alloying elements and impurities are expressed to the following places:**

Less than  $\frac{1}{1000}$  % 0.000X

$\frac{1}{1000}$  % to less than  $\frac{1}{100}$  % 0.00X

$\frac{1}{100}$  % to less than  $\frac{1}{10}$  %

Unalloyed aluminium made by a refining process 0.0XX

Alloys and unalloyed aluminium not made by a refining process 0.0X

$\frac{1}{10}$  % up to  $\frac{1}{2}$  % 0.XX

Over  $\frac{1}{2}$  % 0.X, X.X, etc

**<sup>b</sup>Analysis is regularly required only for the elements for which specific limits are shown, except for unalloyed aluminium. If, however, the presence of other elements is suspected, or indicated in the course of routine analysis, further analysis is required to determine that these other elements are not present in excess of the amount specified.**

**<sup>c</sup>The aluminium content for unalloyed aluminium not made by a refining process is the difference between 100.00% and the sum of all other metallic elements present in amounts of 0.010% or more, each expressed to the second decimal.**

**<sup>d</sup>Lead, bismuth : 0.20 to 0.6% each.**

**<sup>e</sup>Lead, bismuth : 0.40 to 0.7% each.**

## PART II. MATERIAL SPECIFICATIONS

### 2.1 ALLOY B1080.

**2.1.1 General.** The material shall comply with the general requirements of Part I and shall have the following chemical composition and mechanical properties.

#### 2.1.2 Chemical Composition.

|               |                     |                    |
|---------------|---------------------|--------------------|
| Silicon       | .. .. .             | 0.15 per cent max. |
| Iron          | .. .. .             | 0.15 per cent max. |
| Copper        | .. .. .             | 0.02 per cent max. |
| Manganese     | .. .. .             | 0.02 per cent max. |
| Magnesium     | .. .. .             | 0.02 per cent max. |
| Zinc          | .. .. .             | 0.03 per cent max. |
| Titanium      | .. .. .             | 0.02 per cent max. |
| <i>Others</i> |                     |                    |
| Each          | .. .. .             | 0.02 per cent max. |
| Aluminium     | 99.80 per cent min. |                    |

#### 2.1.3 Mechanical Properties.

| 1      | 2                   | 3                                            | 4                                           |
|--------|---------------------|----------------------------------------------|---------------------------------------------|
| Temper | Specified thickness | Tensile strength<br>lbf/in <sup>2</sup> min. | Elong.* in 2 in, 4√S <sub>0</sub><br>% min. |
| H112   | All thicknesses     | 7 800                                        | 30                                          |

\*For material of such dimensions that a standard test piece cannot be taken or for material thinner than 0.062 in, the test for elongation is not required.

**2.2 ALLOY A1050.**

**2.2.1 General.** The material shall comply with the general requirements of Part I and shall have the following chemical composition and mechanical properties.

**2.2.2 Chemical Composition.**

|           |         |                    |
|-----------|---------|--------------------|
| Silicon   | .. .. . | 0.25 per cent max. |
| Iron      | .. .. . | 0.40 per cent max. |
| Copper    | .. .. . | 0.05 per cent max. |
| Manganese | .. .. . | 0.05 per cent max. |
| Magnesium | .. .. . | 0.05 per cent max. |
| Zinc      | .. .. . | 0.05 per cent max. |
| Titanium  | .. .. . | 0.03 per cent max. |

*Others*

|           |                     |                    |
|-----------|---------------------|--------------------|
| Each      | .. .. .             | 0.03 per cent max. |
| Aluminium | 99.50 per cent min. |                    |

**2.2.3 Mechanical Properties.**

| 1      | 2                   | 3                                            | 4                                           |
|--------|---------------------|----------------------------------------------|---------------------------------------------|
| Temper | Specified thickness | Tensile strength<br>lbf/in <sup>2</sup> min. | Elong.* in 2 in, 4√S <sub>0</sub><br>% min. |
| H112   | All thicknesses     | 9 000                                        | 25                                          |

\*For material of such dimensions that a standard test piece cannot be taken, or for material thinner than 0.062 in, the test for elongation is not required.

## 2.3 ALLOY A1100.

**2.3.1 General.** The material shall comply with the general requirements of Part I and shall have the following chemical composition and mechanical properties.

### 2.3.2 Chemical Composition.

|                   |                    |                    |
|-------------------|--------------------|--------------------|
| Silicon plus Iron | .. ..              | 1.0 per cent max.  |
| Copper            | 0.05 per cent min. | 0.20 per cent max. |
| Manganese         | .. ..              | 0.05 per cent max. |
| Zinc              | .. ..              | 0.10 per cent max. |

#### Others

|           |                     |                    |
|-----------|---------------------|--------------------|
| Each      | .. ..               | 0.05 per cent max. |
| Total     | .. ..               | 0.15 per cent max. |
| Aluminium | 99.00 per cent min. |                    |

### 2.3.3 Mechanical Properties.

| 1      | 2                   | 3                                           | 4                                                        | 5                                        |
|--------|---------------------|---------------------------------------------|----------------------------------------------------------|------------------------------------------|
| Temper | Specified thickness | Tensile strength (lb/in <sup>2</sup> ) min. | Yield strength† (0.2% offset) (lb/in <sup>2</sup> ) min. | Elong.* in 2 in, 4√S <sub>0</sub> % min. |
| H112   | All thicknesses     | 11 000                                      | 3 000                                                    | 20                                       |

\*For material of such dimensions that a standard test piece cannot be taken, or for material thinner than 0.062 in, the test for elongation is not required.

†Yield strength not determined or guaranteed unless specifically requested.

**2.4 ALLOY B1200.**

**2.4.1 General.** The material shall comply with the general requirements of Part I and shall have the following chemical composition and mechanical properties.

**2.4.2 Chemical Composition.**

|           |    |    |    |                    |
|-----------|----|----|----|--------------------|
| Silicon   | .. | .. | .. | 0.40 per cent max. |
| Iron      | .. | .. | .. | 0.6 per cent max.  |
| Copper    | .. | .. | .. | 0.05 per cent max. |
| Manganese | .. | .. | .. | 0.05 per cent max. |
| Zinc      | .. | .. | .. | 0.10 per cent max. |

*Others*

|       |    |    |    |                    |
|-------|----|----|----|--------------------|
| Each  | .. | .. | .. | 0.05 per cent max. |
| Total | .. | .. | .. | 0.15 per cent max. |

Aluminium 99.00 per cent min.

**2.4.3 Mechanical Properties.**

| 1      | 2                   | 3                                           | 4                                                        | 5                                        |
|--------|---------------------|---------------------------------------------|----------------------------------------------------------|------------------------------------------|
| Temper | Specified thickness | Tensile strength (lb/in <sup>2</sup> ) min. | Yield strength† (0.2% offset) (lb/in <sup>2</sup> ) min. | Elong.* in 2 in, 4√S <sub>0</sub> % min. |
| H112   | All thicknesses     | 11 000                                      | 3 000                                                    | 20                                       |

\*For material of such dimensions that a standard test piece cannot be taken, or for material thinner than 0.062 in, the test for elongation is not required.

†Yield strength not determined or guaranteed unless specifically requested.

## 2.5 ALLOY A2011.

**2.5.1 General.** The material shall comply with the general requirements of Part I, and shall have the following chemical composition and mechanical properties.

### 2.5.2 Chemical Composition.

|         |    |                    |    |                    |
|---------|----|--------------------|----|--------------------|
| Silicon | .. | ..                 | .. | 0.40 per cent max. |
| Iron    | .. | ..                 | .. | 0.7 per cent max.  |
| Copper  |    | 5.0 per cent min.  |    | 6.0 per cent max.  |
| Zinc    | .. | ..                 | .. | 0.30 per cent max. |
| Lead    |    | 0.20 per cent min. |    | 0.6 per cent max.  |
| Bismuth |    | 0.20 per cent min. |    | 0.6 per cent max.  |

#### Others

|       |    |    |    |                    |
|-------|----|----|----|--------------------|
| Each  | .. | .. | .. | 0.05 per cent max. |
| Total | .. | .. | .. | 0.15 per cent max. |

Aluminium

Remainder.

### 2.5.3 Mechanical Properties.

| 1      | 2                          | 3               | 4                                                                  | 5                                                                               | 6                                               |
|--------|----------------------------|-----------------|--------------------------------------------------------------------|---------------------------------------------------------------------------------|-------------------------------------------------|
| Temper | Specified thickness†<br>in |                 | Tensile<br>strength<br>(lb <sub>f</sub> /in <sup>2</sup> )<br>min. | Yield strength<br>(0.2 % offset)<br>(lb <sub>f</sub> /in <sup>2</sup> )<br>min. | Elongation* in 2 in, 4√S <sub>0</sub><br>% min. |
|        | from                       | up to & incl.   |                                                                    |                                                                                 |                                                 |
| T4     | All thick-<br>nesses       | All thicknesses | 40 000                                                             | 18 000                                                                          | 16                                              |
| T6     | —                          | 1.000           | 51 000                                                             | 32 000                                                                          | 10                                              |
|        | 1.001                      | 3.000           | 50 000                                                             | 32 000                                                                          | 10                                              |
|        | Over<br>3.000              |                 | 49 000                                                             | 29 000                                                                          | 10                                              |

\*For material of such dimensions that a standard test piece cannot be taken, or for material thinner than 0.062 in, the test for elongation is not required.

†The thickness of the cross section or wall thickness from which the tensile test piece is taken determines the applicable properties.

**2.6 ALLOY B2014.**

**2.6.1 General.** The material shall comply with the general requirements of Part I, and shall have the following chemical composition and mechanical properties.

**2.6.2 Chemical Composition.**

|           |                    |                    |
|-----------|--------------------|--------------------|
| Silicon   | 0.50 per cent min. | 0.8 per cent max.  |
| Iron      |                    | 0.7 per cent max.  |
| Copper    | 3.9 per cent min.  | 4.8 per cent max.  |
| Manganese | 0.40 per cent min. | 1.2 per cent max.  |
| Magnesium | 0.20 per cent min. | 0.8 per cent max.  |
| Chromium  |                    | 0.10 per cent max. |
| Zinc      |                    | 0.25 per cent max. |
| Titanium  | .. ..              | 0.15 per cent max. |

**Others**

|       |       |                    |
|-------|-------|--------------------|
| Each  | .. .. | 0.05 per cent max. |
| Total | .. .. | 0.15 per cent max. |

Aluminium

Remainder.

**2.6.3 Mechanical Properties.**

| 1      | 2                          | 3             | 4                                                    | 5                                                                | 6                                               |
|--------|----------------------------|---------------|------------------------------------------------------|------------------------------------------------------------------|-------------------------------------------------|
| Temper | Specified thickness†<br>in |               | Tensile<br>strength<br>(lb/in <sup>2</sup> )<br>min. | Yield strength<br>(0.2% offset)<br>(lb/in <sup>2</sup> )<br>min. | Elongation* in 2 in, 4√S <sub>0</sub><br>% min. |
|        | from                       | up to & incl. |                                                      |                                                                  |                                                 |
| T4     | —                          | 0.375         | 54 000                                               | 35 000                                                           | 15                                              |
|        | 0.376                      | 4.000         | 56 000                                               | 35 800                                                           | 15                                              |
|        | 4.001                      | 6.000         | 56 000                                               | 35 800                                                           | 12                                              |
|        | 6.001                      | 8.000         | 54 000                                               | 35 000                                                           | 12                                              |
|        |                            |               |                                                      |                                                                  |                                                 |
| T6     | —                          | 0.375         | 62 700                                               | 56 000                                                           | 8                                               |
|        | 0.376                      | 1.000         | 67 200                                               | 60 500                                                           | 8                                               |
|        | 1.001                      | 4.000         | 71 700                                               | 65 000                                                           | 8                                               |
|        | 4.001                      | 6.000         | 67 200                                               | 60 500                                                           | 8                                               |
|        |                            |               |                                                      |                                                                  |                                                 |

\*For material of such dimensions that a standard test piece cannot be taken, or for material thinner than 0.062 in, the test for elongation is not required.

†The thickness of the cross-section or wall thickness from which the tensile test piece is taken determines the applicable mechanical properties.

## 2.7 ALLOY A4543.

**2.7.1 General.** The material shall comply with the general requirements of Part I, and shall have the following chemical composition and mechanical properties.

### 2.7.2 Chemical Composition.

|                   |                    |                    |
|-------------------|--------------------|--------------------|
| Silicon           | 5.0 per cent min.  | 7.0 per cent max.  |
| Iron .. .. .      | .. .. .            | 0.50 per cent max. |
| Copper .. .. .    | .. .. .            | 0.10 per cent max. |
| Manganese .. .. . | .. .. .            | 0.05 per cent max. |
| Magnesium         | 0.10 per cent min. | 0.40 per cent max. |
| Chromium .. .. .  | .. .. .            | 0.05 per cent max. |
| Zinc .. .. .      | .. .. .            | 0.10 per cent max. |
| Titanium .. .. .  | .. .. .            | 0.10 per cent max. |

#### Others

|               |         |                    |
|---------------|---------|--------------------|
| Each .. .. .  | .. .. . | 0.05 per cent max. |
| Total .. .. . | .. .. . | 0.15 per cent max. |

Aluminium

Remainder.

### 2.7.3 Mechanical Properties.

| 1      | 2                          | 3             | 4                                                                  | 5                                                                              | 6                                               |
|--------|----------------------------|---------------|--------------------------------------------------------------------|--------------------------------------------------------------------------------|-------------------------------------------------|
| Temper | Specified thickness†<br>in |               | Tensile<br>strength<br>(lb <sub>f</sub> /in <sup>2</sup> )<br>min. | Yield strength<br>(0.2% offset)<br>(lb <sub>f</sub> /in <sup>2</sup> )<br>min. | Elongation* in 2 in, 4√S <sub>0</sub><br>% min. |
|        | from                       | up to & incl. |                                                                    |                                                                                |                                                 |
| T1     | All thicknesses            |               | 16 000                                                             | 8 000                                                                          | 12                                              |
| T5     | —                          | 0.500         | 22 000                                                             | 16 000                                                                         | 8                                               |

\*For material of such dimensions that a standard test piece cannot be taken, or for material thinner than 0.062 in, the test for elongation is not required.

†The thickness of the cross-section or wall thickness from which the tensile test piece is taken determines the applicable properties.

**2.8 ALLOY C5154.**

**2.8.1 General.** The material shall comply with the general requirements of Part I, and shall have the following chemical composition and mechanical properties.

**2.8.2 Chemical Composition.**

|           |                   |    |    |                    |
|-----------|-------------------|----|----|--------------------|
| Silicon   | ..                | .. | .. | 0.6 per cent max.  |
| Iron      | ..                | .. | .. | 0.50 per cent max. |
| Copper    | ..                | .. | .. | 0.10 per cent max. |
| Manganese | ..                | .. | .. | 0.6 per cent max.  |
| Magnesium | 2.8 per cent min. | .. | .. | 4.0 per cent max.  |
| Chromium  | ..                | .. | .. | 0.25 per cent max. |
| Zinc      | ..                | .. | .. | 0.25 per cent max. |
| Titanium  | ..                | .. | .. | 0.15 per cent max. |

*Others*

Each .. .. . 0.05 per cent max.

Total .. .. . 0.15 per cent max.

Aluminium .. .. . Remainder.

**2.8.3 Mechanical Properties.**

| 1      | 2                          | 3             | 4                                                     | 5                                                                 | 6                                               |
|--------|----------------------------|---------------|-------------------------------------------------------|-------------------------------------------------------------------|-------------------------------------------------|
| Temper | Specified thickness†<br>in |               | Tensile<br>strength<br>(lbf/in <sup>2</sup> )<br>min. | Yield strength<br>(0.2% offset)<br>(lbf/in <sup>2</sup> )<br>min. | Elongation* in 2 in, 4√S <sub>0</sub><br>% min. |
|        | from                       | up to & incl. |                                                       |                                                                   |                                                 |
| H112   | —                          | 2.000         | 31 500                                                | 14 600                                                            | 18                                              |
|        | Over<br>2.000              | —             | 29 500                                                | 14 600                                                            | 18                                              |

\*For material of such dimensions that a standard test piece cannot be taken, or for material thinner than 0.062 in, the test for elongation is not required.

†The thickness of the cross-section or wall thickness from which the tensile test piece is taken determines the applicable mechanical properties.