

Australian Standard™

**Aluminium and aluminium
alloys—Ingots and castings**



This Australian Standard was prepared by Committee MT/3, Aluminium and Aluminium Alloys. It was approved on behalf of the Council of Standards Australia on 15 February 2000 and published on 12 May 2000.

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Australasian Railway Association
Australian Aluminium Council
Australian Automobile Association
Australian Chamber of Commerce and Industry
Australian Window Association
New Zealand Manufacturers Federation
Society of Automotive Engineers—Australasia
Australian Automobile Association

Additional interests participating in the preparation of this Standard:

Non-ferrous foundries
Light metal consultants

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Australian Standard™

Aluminium and aluminium alloys—Ingots and castings

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee MT/3, Aluminium and Aluminium Alloys, to supersede AS 1874—1988.

The objective of this revision is to upgrade the requirements for aluminium and aluminium alloy ingots and castings.

This Standard is the result of a consensus among Australian and New Zealand representatives on the Joint Committee to produce it as an Australian Standard.

During the preparation of this Standard cognizance was taken of the publication, *Aluminium Standards and Data—Ingots and Castings*, published in 1997 by the Australian Aluminium Council. Cognizance was also taken of the following International, National and European Standards:

ISO 3522:1984	Cast aluminium alloys—Chemical composition and mechanical properties
BS 1490:1988	Aluminium and aluminium alloy ingots and castings for general engineering purposes
EN 1706:1998	Aluminium and aluminium alloys—Castings—Chemical composition and mechanical properties

Whereas the alloys contained in the above three Standards are similar to those listed in this Standard, Australian industry favours the use of designations of American origin rather than adopting the ISO and European designations which comprise chemical symbols and numbers.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

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STANDARDS AUSTRALIA

Australian Standard

Aluminium and aluminium alloys—Ingots and castings

1 SCOPE This Standard specifies requirements for aluminium ingots and aluminium alloy ingots and castings.

NOTE: Advice and recommendations on information to be supplied by the purchaser at the time of enquiry or order are contained in Appendix A.

2 REFERENCED DOCUMENTS The following documents are referred to in this Standard:

AS

- 1391 Methods for tensile testing of metals
- 2062 Non-destructive testing—Penetrant testing of products and components
- 2612 Aluminium and aluminium alloys—Sampling for chemical and spectrochemical analysis
- 2706 Numerical values—Rounding and interpretation of limiting values
- 3719 Aluminium and aluminium alloys
- 3719.1 Part 1: Determination of iron—Spectrophotometric method
- 3719.2 Part 2: Determination of silicon—Gravimetric method

BS

- 1728 Methods for the analysis of aluminium and aluminium alloys (all parts)

ASTM

- E 34 Test methods for chemical analysis of aluminium and aluminium-base alloys
- E 227 Test method for optical emission spectrometric analysis of aluminium and aluminium alloys by the point-to-plane technique

3 DEFINITIONS For the purpose of this Standard, the definitions below apply.

3.1 Annealing—thermal treatment to soften metal by the removal of strain hardening resulting from cold working, by recrystallization and/or by coalescing precipitates from the solid solution.

3.2 Artificial ageing—a thermal treatment of an alloy carried out above room temperature to produce strengthening by precipitation of soluble constituents from a super-saturated solid solution. Also known as ‘precipitation heat treatment’.

3.3 Batch (ingot)—a series of ingots cast from a single uniform melt.

3.4 Cast (non-continuous melting)—the product of either one furnace melt, or a number of furnace melts where such are aggregated and mixed prior to sampling or pouring.

3.5 Cast (continuous melting)—the product of continuous melting when the contents of a melting/holding furnace are supplemented from time to time by the addition of metal to maintain an adequate bulk of liquid metal. A cast comprises up to 500 kg of metal poured.

3.6 Dressing (fettling)—the cleaning up of a casting by removing flashes and runners.

3.7 Ingot—a cast metal product prepared in a suitable form for remelting.

3.8 Natural ageing—the strengthening of an alloy by the spontaneous precipitation of soluble constituents from a super-saturated solid solution at room temperature.

3.9 Permanent mould casting—a metal product prepared by introducing molten metal by gravity or at low pressure into a mould constructed of durable material, usually iron or steel, and allowing it to solidify.

3.10 Pressure die casting—a metal product produced by introducing molten metal at high pressure into a mould constructed of a durable metal, usually steel, and allowing it to solidify.

3.11 Sand casting—a metal product produced by pouring molten metal into a sand mould and allowing it to solidify.

3.12 Solution heat treatment—a process in which an alloy is heated to, and held at, a suitable temperature long enough to allow soluble constituents to enter into solid solution, and quenched to retain them in a super-saturated state.

3.13 Squeeze casting—a precision casting process utilizing a steel mould capable of producing complex, close tolerance components. The process is characterized by a non-turbulent cavity fill cycle and the application of high solidification pressures with a cycle time similar to that of high pressure die casting.

3.14 Stabilizing—a thermal treatment used to promote stability of dimensions, mechanical properties, structure or internal stress.

3.15 Temper—a state of a metal or alloy resulting from processing by mechanical and/or thermal treatments, to produce characteristic physical and mechanical properties.

3.16 Thixocasting (also known as semi-solid casting or forming)—a process that involves the production of near-net shape components from a specially produced starting material that is partly solid and partly liquid. The process characteristics include permanent metal dies and high solidification pressures.

4 DESIGNATION

4.1 General The aluminium or aluminium alloy designation shall comprise the number of this Australian Standard, i.e. AS 1874 followed by a slash and additional characters in accordance with Clauses 4.2 and 4.3.

4.2 Alloy designation The alloy designation system for aluminium ingots and aluminium alloy ingots and castings, is set out in Appendix B.

4.3 Temper designation The temper designation system is set out in Appendix C. The temper designation follows the alloy designation, the two being separated by a dash.

Examples of complete designation: AS 1874/AA303-T6, AS 1874/CA401-F1.

5 FREEDOM FROM DEFECTS

5.1 Ingots Ingots shall be free from dross, slag and other harmful contamination.

5.2 Castings Castings shall be clean and free from defects detrimental to their subsequent processing and end use. If, after acceptance of the casting and provided that it has been properly treated after delivery, subsequent processing reveals that it contains defects found to be detrimental, the casting shall be deemed not to comply with this Standard.

NOTE: Defects referred to in this Clause cannot be completely quantified. Where the presence, size or frequency of any defect is considered to be of concern, arrangements should be made between the purchaser and the manufacturer. This may be achieved by acceptable type samples or methods of test.

6 RECLAMATION AND REPAIR OF CASTINGS Rectification of defects in castings shall be permitted, provided that the subsequent processing and the usefulness of the castings are not impaired. Repair or reclamation of castings is subject to the written approval of the purchaser and the purchaser's acceptance of the proposed repair methods.

If castings have been subjected to non-destructive testing, all areas subsequently repaired shall be re-examined.

7 SHAPE AND DIMENSIONS OF CASTINGS The shape and dimensions of castings shall agree with the purchaser's drawing, after pattern draft, die draft, foundry and die casting shop requirements, machining allowances and permissible variations on untoleranced dimensions have been taken into account.

Castings that have been machined to finished dimensions shall not show evidence of the cast surface.

8 CHEMICAL COMPOSITION

8.1 General The method of sampling for chemical analysis shall be in accordance with AS 2612. Chemical composition shall be determined by any procedures which are not less accurate than those given in AS 3719.1, AS 3719.2, or any of the relevant parts of BS 1728, ASTM E 34 or ASTM E 227, and shall comply with the chemical composition limits specified in Table 1.

NOTES:

- 1 Related composition specifications are given in Appendix D.
- 2 Guidance for the selection of alloys is contained in Appendix E.

8.2 Frequency of analysis For ingots, at least one sample shall be taken for each cast, and poured from the same source of molten metal.

NOTE: The frequency of analysis for castings is subject to agreement between supplier and purchaser.

9 MECHANICAL PROPERTIES OF CASTINGS (EXCLUDING PRESSURE DIE CASTINGS) When required, mechanical properties of castings shall be determined on test pieces sampled, prepared and tested in accordance with Clauses 11, 12 and 13 respectively and shall comply with the requirements of Table 2.

NOTES:

- 1 Typical physical properties of aluminium casting alloys are given in Appendix F.
- 2 The mechanical properties of pressure die castings are subject to agreement between supplier and purchaser.

10 ADDITIONAL INSPECTION REQUIREMENTS FOR CASTINGS

10.1 Pressure testing When required, each casting shall be pressure tested to an agreed Standard.

10.2 Non-destructive testing

10.2.1 Penetrant testing (surface defects) When required, each casting shall be examined by penetrant testing in accordance with AS 2062.

10.2.2 Radiographic testing (internal defects) When required, each casting shall be examined by radiography to an agreed Standard.

11 PROVISION AND PREPARATION OF TEST SAMPLES

11.1 Type of test sample Test samples for mechanical testing shall be in one of the following forms:

- (a) Cast test bars for subsequent machining (see Figures 1 to 4).
- (b) Cast-to-shape test pieces which require no machining (see Figures 5 and 6).

NOTES:

- 1 The choice of test sample depends on the casting process and the final application of the casting and should be determined at the time of enquiry and order.
- 2 The design of the mould for cast-to-shape test pieces is the responsibility of the supplier.

11.2 Casting of test samples A minimum of three separate test samples shall be taken from the crucible or ladle from which the castings are to be poured and shall not be subjected to further treatment other than adjustment of temperature to suit the pouring conditions.

It shall be the responsibility of the supplier to cast sufficient test samples to allow for retesting, if required (see Clause 14).

The test samples shall be cast using one of the following methods:

- (a) Permanent mould casting—in a gravity mould (see Figures 1 and 4).
- (b) Pressure die casting—in a cold chamber high pressure die casting machine (see Figure 6).
- (c) Sand casting—in a sand mould (see Figures 1, 2, 3 and 5).

11.3 Processing of test samples Test samples representing heat-treated castings shall be heat-treated with the castings they represent; they shall not be further heat-treated, mechanically worked or otherwise treated prior to testing. Similarly, test samples representing non-heat-treated castings shall not be heat treated, mechanically worked or otherwise treated prior to testing.

12 PREPARATION OF TEST PIECES

12.1 Permanent mould and sand castings Cast-to-shape test pieces or test pieces machined from test bars shall conform to the requirements of Figure 5 and Table 3.

12.2 Pressure die castings Pressure die casting test pieces shall conform to the requirements of Figure 6 and Table 4.

13 MECHANICAL TESTS The tensile test shall be carried out in accordance with AS 1391 on test pieces prepared in accordance with Clause 12.

NOTE: Straining rate is negotiable.

14 RETESTS

14.1 Chemical composition If chemical analysis shows results to be outside the specified limits, two further portions of the same sample shall be submitted for check analysis. Should these two portions comply with the specified limits, the castings represented by the sample shall be deemed to comply with this Standard. Should either of these portions not comply with the specified limits, the castings shall be deemed not to comply with this Standard.

14.2 Tensile test Should any test sample first selected fail to pass the tensile test, two further test samples which represent the same cast shall be tested in the same manner. Should these two samples pass the tensile test, the castings represented by the original test sample shall be deemed to comply with this Standard. Should either of these additional test samples fail, the castings shall be deemed not to comply with this Standard.

NOTES:

- 1 If failure of the first tensile test that represents heat-treated castings occurs, the supplier may subject both the castings and representative test pieces to one further heat treatment only, prior to the retests.
- 2 If additional test samples are not available to carry out the retest procedure, alternative test samples taken from finished castings may be used (see Appendix A, Paragraph A8.5).

15 IDENTIFICATION

15.1 Ingots Each ingot shall bear one or more marks to enable it to be identified by cast number and alloy grade. The identifying marks shall be in a position which is clearly visible when the ingots are stacked.

15.2 Castings Castings shall be identified by the number of the drawing, pattern, or die, together with the appropriate designation (see Clause 4).

When castings are to be subjected to pressure testing or non-destructive testing (see Clause 10), they shall be individually marked, or batched and tabled as soon as possible after casting. The identification shall be maintained in a manner to ensure that the castings can be related to their relevant inspection records at the time of despatch from the foundry. The inspection records shall be kept and shall be made available to the purchaser or his representative on request.

16 ROUNDING OF TEST RESULT VALUES With the exception of the tensile strength results, which shall not be rounded, the observed or calculated values shall be rounded to the same number of figures as in the specified values, and then compared with the specified values. For example, for specified maximum or minimum values of 2.5, 2.50 and 2.500, the observed or calculated value would be rounded to the nearest 0.1, 0.01 and 0.001 respectively. (See also AS 2706.)

TABLE 1
CHEMICAL COMPOSITION (see Note 1)

Chemical composition, percent														
Alloy design	Aluminum min.	Silicon max.or range	Iron max.or range	Copper max.or range	Manganese max.or range	Magnesium max.or range (See Note 2)	Chromium max.or range	Nickel max.or range	Zinc max.or range	Tin max.	Lead max.	Titanium max.or range	Others, max.	
													Each	Total
AA150	99.50	0.30	0.40	—	—	—	—	—	—	—	—	—	0.03	0.15
AA160	99.60	0.10	0.30 (Note 3)	—	—	—	—	—	—	—	—	—	0.02	0.10
AA170	99.70	0.10	0.20	—	—	—	—	—	0.03	—	—	—	0.03	0.10 (Note 4)
BA170	99.70	—	— (Note 5)	—	—	—	—	—	—	—	—	—	0.03	0.10
AA175	99.75	0.20	0.20	0.02	—	—	—	—	—	—	—	—	0.03	0.10
AA180	99.80	0.10	0.10	0.02	—	—	—	—	—	—	—	—	0.03	0.10
AA185	99.85	0.10	0.10	0.02	—	—	—	—	—	—	—	—	0.03	0.10
AA190	99.90	0.05	0.07	—	—	—	—	—	0.03	—	—	—	0.02	0.05 (Note 6)
AA303	Rem.	4.0–5.0	0.8 (Note 7)	2.0–4.0	0.7 (Note 7)	0.15	0.10	0.30	0.50	0.15	0.15	0.20	0.05	0.20
AA305	Rem.	8.5–10.5	0.9	2.0–4.0	0.50	0.6–1.5	0.10	0.50	1.0	0.15	0.25	0.25	0.05	0.20
AA307	Rem.	9.0–11.5	1.0	0.7–2.5	0.50	0.30	0.10	0.50	2.0	0.25	0.35	0.20	0.05	0.20
AA309	Rem.	4.5–5.5	0.25	1.0–1.5	0.05	0.50–0.6	—	—	0.05	—	—	0.20	0.05	0.15
AA311	Rem.	4.0–6.0	0.15	1.0–1.5	0.05	0.05	—	—	0.10	—	—	0.20	0.05	0.20
CA313	Rem.	7.5–9.5	1.3	3.0–4.0	0.50	0.30	0.10	0.50	3.0	0.25	0.35	0.20	0.05	0.20
AA315	Rem.	10.5–12.0	1.3	3.0–4.5	0.50	0.10	0.10	0.50	1.0	0.35	0.25	0.20	0.05	0.20
AA317	Rem.	6.0–8.0	0.8	1.5–2.5	0.20–0.60	0.35	0.10	0.35	1.0	0.15	0.25	0.20	0.05	0.20
AA319	Rem.	11.0–13.0	0.7	0.8–1.3	0.35	0.8–1.3	0.10	1.0–2.5	0.25	0.20	0.15	0.20	0.05	0.20
BA323	Rem.	7.5–8.5	0.30	3.5–4.0	0.30–0.50	0.30–0.40	—	0.05	0.10	—	—	0.15	0.05	0.15
BB325	Rem.	7.5–8.5	0.8	2.0–3.5	0.10–0.30	0.20–0.50	—	0.30	0.20–0.50	0.10	0.20	0.15	0.05	0.15
CA327	Rem.	5.5–6.8	0.25	3.0–4.0	0.50	0.10–0.18	—	0.10	0.10	—	—	0.15	0.05	0.15
(continued)														

(continued)

TABLE 1 (continued)

Chemical composition, percent														
Alloy design	Alum- inium min.	Silicon max.or range	Iron max.or range	Copper max.or range	Manganese max.or range	Magnesium max.or range (See Note 2)	Chromium max.or range	Nickel max.or range	Zinc max.or range	Tin max.	Lead max.	Titanium max.or range	Others, max.	
													Each	Total
AC331	Rem.	13.8–14.5	0.6–1.0	1.9–2.2	0.35–0.50	0.50–0.7	—	1.0–1.4	—	—	—	0.10	0.05	0.15 (Note 8)
AA335	Rem.	9.6–12.0	0.9 (Note 9)	1.5–3.5	0.50	0.30	0.10	0.50	1.0	0.30	0.25	0.20	0.05	0.20
AA337	Rem.	8.5–10.5	0.8 (Note 9)	2.0–4.0	0.50	0.6–1.5 (Note 10)	0.10	0.50–1.5	0.50	0.20	0.15	0.20	0.05	0.20
AA339	Rem.	5.0–7.0	0.8 (Note 9)	2.0–4.0	0.50	0.50	0.10	0.30	1.0	0.20	0.15	0.20	0.05	0.20
CA401	Rem.	12.0–13.0	0.40	0.10	0.10	0.05	—	0.05	0.10	—	—	0.20	0.05	0.15
CB401	Rem.	12.0–13.0	0.40	0.10	0.05	0.05	—	0.05	0.10	—	—	0.20	0.05	0.20
CC401	Rem.	12.0–13.0	0.40	0.10	0.05	0.05	—	0.05	0.10	—	—	0.20	0.05	0.20
DA401	Rem.	10.0–13.0	1.0	0.6	0.50	0.25	0.10	0.50	0.40	0.15	0.15	0.20	0.05	0.25
EA401	Rem.	11.0–13.0	0.6	0.15	0.50	0.10	0.10	0.10	0.15	0.05	0.15	0.20	0.05	0.20
AB405	Rem.	6.5–7.5	0.15	0.10	0.10	0.05	—	—	0.10	—	—	0.20	0.05	0.15
AA505	Rem.	0.3	0.6	0.1	0.3–0.7	3.0–6.0	—	0.1	0.1	0.05	0.05	0.20	0.05	0.15 (Note 11)
AA601	Rem.	6.5–7.5	0.20	0.05	0.05	0.30–0.40	—	—	0.05	—	—	0.20	0.05	0.15
AC601	Rem.	6.5–7.5	0.20	0.05	0.05	0.30–0.40	—	—	0.05	—	—	0.20	0.05	0.15
CC601	Rem.	6.5–7.5	0.20	0.05	0.05	0.25–0.35	—	—	0.05	—	—	0.20	0.05	0.15
DA601	Rem.	6.5–7.5	0.50	0.25	0.35	0.30–0.50	—	—	0.35	—	—	0.25	0.05	0.15
AA603	Rem.	6.5–7.5	0.15	0.05	0.03	0.45–0.7	—	—	0.05	—	—	0.20	0.05	0.15
AC603	Rem.	6.5–7.5	0.15	0.05	0.03	0.45–0.7	—	—	0.05	—	—	0.20	0.05	0.15
CA605	Rem.	9.0–10.0	0.7–1.1	0.6	0.35	0.45–0.6	—	0.50	0.50	0.15	—	—	0.05	0.25
BA701	Rem.	0.25	0.50	0.15	0.15	0.50–0.7	0.40–0.6	0.10	4.8–5.7	0.05	0.05	0.15–0.25	0.05	0.15
AA941	Rem.	2.6–3.3	0.40	0.03	—	—	—	—	—	—	0.01	—	0.03	0.15 (Note 12)

NOTES TO TABLE 1:

- 1 Analysis of aluminium alloys is regularly made only for the elements for which specific limits are shown except for minimum purities of 99.0% or greater. If, however, the presence of other elements is suspected to be, or in the course of routine analysis is indicated to be, in excess of the specified limits, further analysis is required to determine their actual concentration.
- The aluminium content of unalloyed aluminium is the difference between 100% and the sum of all other metallic elements present in amounts of 0.010% or more each, expressed to the second decimal.
- 2 For aluminium alloys which have a specified magnesium range of 0.15% or less, the castings may contain 0.05% less magnesium than the minimum of the range.
- 3 $\%Fe \text{ min.} = 2 \times \%Si. Mn + Ti + Cr + V = 0.01\% \text{ max.}$
- 4 $Ga \text{ } 0.04\% \text{ max, } V \text{ } 0.03\% \text{ max.}$
- 5 $\%Fe \text{ min.} = 1.5 \times \%Si. Mn + Ti + Cr + V = 0.025\% \text{ max.}$
- 6 $Ga \text{ } 0.03\% \text{ max., } V \text{ } 0.02\% \text{ max.}$
- 7 $Fe + Mn, 1.3\% \text{ max.}$
- 8 In addition, the following ranges apply:
Sr 0.05% to 0.08%. Zr 0.04% to 0.06%.
- 9 For alloys AA335, AA337 and AA339, the iron maximum relates to ingot. The maximum iron content for castings may vary as follows:
If Fe maximum in ingot is 0.9%, then castings 0.40% greater.
If Fe maximum in ingot is 0.8%, then castings 0.20% greater.
If Fe maximum in ingot is 0.7%, then castings 0.10% greater.
If Fe maximum in ingot is $\leq 0.20\%$, then castings 0.05% greater.
- 10 For castings in this alloy the magnesium range is 0.50%–1.5%.
- 11 Be in the range 0.002%–0.005% is added to control oxidation.
- 12 Sb 0.01% max., Cd 0.01% max. Alloy AA941 is not a casting alloy; it is used as an aluminium hardener.