

Australian/New Zealand Standard®

**Aluminium and aluminium alloys—
Extruded rod, bar, solid and hollow
shapes**

AS/NZS 1866:1997

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee MT/3, Aluminium and Aluminium Alloys. It was approved on behalf of the Council of Standards Australia on 9 May 1997 and on behalf of the Council of Standards New Zealand on 29 April 1997. It was published on 5 September 1997.

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

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Australian/New Zealand Standard[®]

Aluminium and aluminium alloys— Extruded rod, bar, solid and hollow shapes

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STANDARDS AUSTRALIA
1 The Crescent,
Homebush NSW 2140 Australia

STANDARDS NEW ZEALAND
Level 10, Radio New Zealand House,
155 The Terrace,
Wellington 6001 New Zealand

PREFACE

This Standard was prepared by the joint Standards Australia/Standards New Zealand Committee MT/3, Aluminium and Aluminium Alloys, to supersede AS 1866—1986.

The objective of this revision is to upgrade the requirements for aluminium and aluminium alloy extruded rod, bar, solid and hollow products for general engineering purposes.

During the preparation of this Standard cognizance was taken of the publication, *Aluminium Standards, Data and design—Wrought products*, published in 1994 by the Aluminium Development Council of Australia. Cognizance was also taken of the following International Standards:

ISO

- | | |
|-------------|---|
| 6362 | Wrought aluminium and aluminium alloy extruded rods/bars, tubes and profiles |
| 6362-1:1986 | Part 1: Technical conditions for inspection and delivery |
| 6362-2:1990 | Part 2: Mechanical properties |
| 6362-3:1990 | Part 3: Extruded rectangular bars—Tolerances on dimensions and form |
| 6362-4:1988 | Part 4: Extruded profiles—Tolerances on shape and dimensions |
| 6362-5:1991 | Part 5: Extruded round, square and hexagonal bars—Tolerances on form and dimensions |

These International Standards were not considered appropriate replacements for AS 1866 because the preference of Australian/New Zealand industry is to contain the requirements for aluminium and aluminium alloy extruded rod, bar, solid and hollow shapes in the one Standard.

Statements expressed in mandatory terms in notes to tables and figures are deemed to be requirements of this Standard.

The term 'informative' has been used in this Standard to define the application of the appendix to which it applies. An 'informative' appendix is only for information and guidance.

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Aluminium and aluminium alloys—Extruded rod,
bar, solid and hollow shapes**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE This Standard specifies requirements for aluminium and aluminium alloy extruded rod, bar, solid and hollow products for general engineering purposes.

NOTES:

- 1 Advice and recommendations on information to be supplied by the purchaser at the time of enquiry or order are contained in the purchasing guidelines set out in Appendix A.
- 2 Typical fabrication characteristics and application data for wrought aluminium and aluminium alloys are given in Appendix B.

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

AS

- | | |
|--------|--|
| 1391 | Methods for tensile testing of metals |
| 1815 | Metallic materials—Rockwell hardness test |
| 1816 | Metallic materials—Brinell hardness test |
| 1817 | Metallic materials—Vickers hardness test |
| 2025 | Metallic materials—Rockwell superficial hardness test—N and T scales |
| 2338 | Preferred dimensions of wrought metal products |
| 2504 | Rigid aluminium busbars |
| 2612 | Aluminium and aluminium alloys—Sampling and preparation of solid samples for optical emission spectrometry |
| 2706 | Numerical values—Rounding and interpretation of limiting values |
| 2848 | Aluminium and aluminium alloys —Compositions and designations |
| 2848.1 | Part 1: Wrought products |

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 (all parts) |
| E 227 | Test method for optical emission spectrometric analysis of aluminium and aluminium alloys by the point-to-plane technique |

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

1.3.1 Bar—a solid section, long in relation to its cross-sectional dimensions, having a symmetrical cross-section which may be square, rectangular, hexagonal or octagonal (excluding flattened wire) with sharp or rounded corners or edges, and a width or distance between parallel faces of at least 10 mm.

1.3.2 Batch—all product of the same section, size, alloy, temper and finish in a shipment. For thermally treated product (annealed, solution heat treated, aged and stress relieved), a batch also consists of product from the same furnace load.

1.3.3 Circumscribing circle diameter (or circle size)—the diameter of the smallest circle that will completely enclose the cross-section of the shape.

1.3.4 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.

1.3.5 Finish

1.3.5.1 Architectural finish—a controlled surface finish of uniformly good appearance.

NOTE: Buffing does not produce a surface finish free from die lines unless a preliminary grinding or sanding operation is employed.

1.3.5.2 Structural finish—a standard mill finish that may contain die lines and handling defects. It is not normally suitable for architectural applications.

1.3.5.3 Trim finish—a special surface finish designed for subsequent polishing, but not applicable to hollow shapes.

NOTE: Buffing of trim finish product will normally produce a surface substantially free from die lines.

1.3.6 Machining stock—a free cutting aluminium alloy that can be machined at a very high rate to produce a good surface finish.

1.3.7 Rod—a finished product of solid round section that is 10 mm or greater in diameter.

1.3.8 Semi-hollow section—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 or opening of the enclosure (see Table 1.1).

1.4 DESIGNATION

1.4.1 General The aluminium and aluminium alloy designation shall comprise the number of this Standard, i.e. AS/NZS 1866 followed by a diagonal slash and additional characters in accordance with Clauses 1.4.2 and 1.4.3.

1.4.2 Alloy designation The aluminium alloy designation shall comprise a four-digit number to identify the chemical composition (see AS 2848.1). A suffix letter 'A' indicates a nationally derived variation in chemical composition from the registered standard chemical composition.

1.4.3 Temper designation The temper designation shall be in accordance with AS 2848.1 and shall be used for all forms of wrought aluminium and aluminium alloys. It shall follow the alloy designation, the two being separated by a hyphen.

Examples of complete designation: AS/NZS 1866/5083-H112, AS/NZS 1866/3003-O, AS/NZS 1866/6061-T42

1.5 CLASSIFICATION OF HOLLOW EXTRUDED SHAPES Hollow extruded shapes are classified as follows:

- (a) **Class A**—a hollow extruded shape having a single void with no internal or external protrusions, and which is greater than 15 mm in diameter or 177 mm² in area. The void may be round, square or rectangular, provided that the width/depth ratio is less than 5:1. It has uniform wall thickness except that a non-uniform wall is allowed at corners having internal or external radii up to 7.5 mm.
- (b) **Class B**—a single void hollow extruded shape other than a Class A shape, or a solid shape incorporating a single semi-hollow area classified as a hollow according to Table 1.1.

- (c) *Class C*—a hollow extruded shape having two or more fully enclosed voids.
- (d) *Class D*—any hollow shape that incorporates a semi-hollow area, or any solid shape that incorporates multiple semi-hollow areas that are classified as hollows according to Table 1.1.
- (e) *Yacht mast extrusion*—a hollow or solid extruded shape, which is basically round or elliptical in section and which incorporates a sail track or has provision for a sail track, used in the manufacture of masts and booms for yachts.

TABLE 1.1
CRITERION FOR THE CLASSIFICATION OF A
SEMI-HOLLOW AREA AS A HOLLOW
(Applicable to symmetrical semi-hollow areas only)

Gap dimension, G (see Figure 1.1) mm	Ratio A/G^2 , above which a semi-hollow area is classified as a hollow*†
≤ 1.5	2.0
$> 1.5 \leq 3.0$	2.5
$> 3.0 \leq 6.0$	3.0
> 6.0	4.0

* A = area of semi-hollow section, in square millimetres.

† For an asymmetrical area the ratio A/G^2 is subject to negotiation.

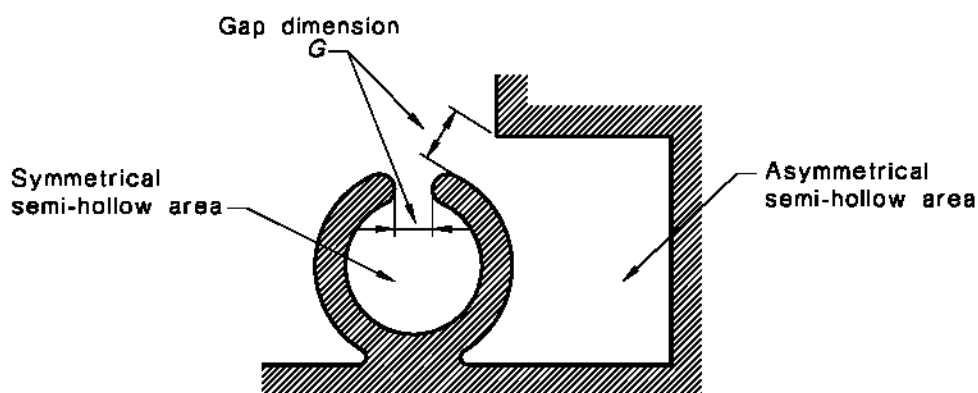


FIGURE 1.1 ILLUSTRATION OF A SYMMETRICAL SEMI-HOLLOW AREA
AND AN ASYMMETRICAL SEMI-HOLLOW AREA

1.6 ROUNDING OF TEST RESULTS VALUES

1.6.1 General Unless otherwise indicated, 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).

1.6.2 Measured dimensions Measured dimensions shall not be rounded.

1.6.3 Tensile test results The determined value of tensile strength and the determined value of 0.2% proof stress shall be rounded to the nearest 1 MPa. The elongation result shall be rounded to the nearest whole percent.

1.7 MARKING The packaging containing the supplied product shall be legibly and durably marked by appropriate means to—

- (a) identify the manufacturer;
- (b) indicate the alloy designation, temper, size, shape and quantity of material; and
- (c) enable identification with this Standard, i.e. AS/NZS 1866.

The manner of marking of individual lengths of product, if required, shall be agreed to at the time of enquiry or order.

NOTE: Manufacturers making a statement of compliance with this Australian/New Zealand Standard on a product, packaging or promotional material related to that product are advised to ensure that such compliance is capable of being verified.

1.8 TRACEABILITY If traceability of the product back to the cast number of the billet used in the manufacturing process is required, this requirement shall be stated and agreed to at the time of enquiry or order.

SECTION 2 MANUFACTURING REQUIREMENTS

2.1 SCOPE This Section specifies general quality requirements including chemical composition and mechanical properties for extruded products.

2.2 CHEMICAL COMPOSITION

2.2.1 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 BS 1728 (all parts), ASTM E 34 or ASTM E 227.

2.2.2 Chemical analysis Chemical analysis shall be performed on samples taken at the time the billets are poured, or on samples taken from the finished or semi-finished product, and shall conform to the limits specified in Table 2.1.

If the supplier has determined the chemical composition of the product during the course of manufacture, it is not required to sample and analyse the finished product.

2.3 SURFACE FINISH The product shall be supplied with a structural finish, unless otherwise agreed to between the purchaser and the supplier.

NOTE: Architectural finishes are normally satisfactory for exposed surfaces other than feature components and are applied to those surfaces nominated by the purchaser.

2.4 FREEDOM FROM DEFECTS The product shall be free from defects and contaminants detrimental to its subsequent processing and end use. If, after acceptance of the product and provided that it has been properly treated after delivery, subsequent processing reveals that it contains defects found to be detrimental, the product 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.

2.5 MECHANICAL PROPERTIES Acceptance testing for extrusions is normally carried out by hardness testing. If required, tensile testing shall be carried out in accordance with the requirements of Section 3. When hardness testing is used to determine product acceptance, correlation between the hardness test results and tensile test values shall be established and documented.

NOTE: Requirements for the hardness testing of metals are contained in AS 1815, AS 1816, AS 1817 and AS 2025.

When tested in accordance with Clause 3.4, the tensile strength, 0.2% proof stress and elongation shall comply with the requirements of Table 2.2.

NOTES:

- 1 Elongation is not specified for product less than 1.6 mm thick.
- 2 Mechanical property limits are not specified for product ordered to the F (as fabricated) temper.

2.6 MANUFACTURING TOLERANCES Manufacturing tolerances for aluminium and aluminium alloy extruded rod, bar, solid and hollow shapes shall comply with the requirements of Section 4.

TABLE 2.1
REQUIREMENTS FOR CHEMICAL COMPOSITION

Alloy designation	Chemical composition, %											
	Aluminium min.	Silicon max. or range	Iron max. or range	Copper max. or range	Manganese max. or range	Magnesium max. or range	Chromium max. or range	Zinc max. or range	Titanium max. or range	Other specific elements max. or range	Others (Note 1) max.	
											Each	Total
1200	99.90 (Notes 2 and 3)	Si + Fe 1.00	—	0.05	0.05	—	—	0.10	0.05	(Note 4)	0.05	0.15
1350 (Note 5)	99.50 (Notes 2 and 3)	0.10	0.40	0.05	0.01	—	0.01	0.05	Ti + V 0.02	Ga 0.03 B 0.05	0.03	0.10
2011	Rem.	0.40	0.7	5.0–6.0	—	—	—	0.30	—	(Note 6)	0.05	0.15
2014	Rem.	0.50–1.2	0.7	3.9–5.0	0.40–1.2	0.20–0.8	0.10	0.25	0.15		0.05	0.15
2014A	Rem.	0.50–0.9	0.50	3.9–5.0	0.40–1.2	0.20–0.8	0.10	0.25	Ti + Zr 0.20	Ni 0.10	0.05	0.15
2024	Rem.	0.50	0.50	3.8–4.9	0.30–0.9	1.2–1.8	0.10	0.25	0.15		0.05	0.15
3003	Rem.	0.6	0.7	0.05–0.20	1.0–1.5	—	—	0.10	—		0.05	0.15
5083	Rem.	0.40	0.40	0.10	0.40–1.0	4.0–4.9	0.05–0.25	0.25	0.15		0.05	0.15
6005	Rem.	0.6–0.9	0.35	0.10	0.10	0.40–0.6	0.10	0.10	0.10		0.05	0.15
6005A	Rem.	0.50–0.9	0.35	0.30	0.50	0.40–0.7	0.30	0.20	0.10	Mn + Cr 0.12–0.50	0.05	0.15
6060	Rem.	0.30–0.6	0.10–0.30	0.10	0.10	0.35–0.6	0.05	0.15	0.10		0.05	0.15
6061	Rem.	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
6063	Rem.	0.20–0.6	0.35	0.10	0.10	0.45–0.9	0.10	0.10	0.10		0.05	0.15
6082	Rem.	0.70–1.3	0.50	0.10	0.40–1.0	0.6–1.2	0.25	0.20	0.10		0.05	0.15
6101 (Note 5)	Rem.	0.30–0.7	0.50	0.10	0.03	0.35–0.8	0.03	0.10	—	B 0.06	0.03	0.10
6103	Rem.	0.35–1.0	0.6	0.2–0.3	0.8	0.8–1.5	0.35	0.20	0.10		0.05	0.15
6106	Rem.	0.30–0.6	0.35	0.25	0.05–0.20	0.40–0.8	0.20	0.10	—		0.05	0.10
6201A	Rem.	0.50–0.7	0.50	0.04	—	0.6–0.9	—	—	—	B 0.06	0.03	0.10

(continued)

Alloy designation	Chemical composition, %											
	Aluminium min.	Silicon max. or range	Iron max. or range	Copper max. or range	Manganese max. or range	Magnesium max. or range	Chromium max. or range	Zinc max. or range	Titanium max. or range	Other specific elements max. or range	Others (Note 1) max.	
											Each	Total
6261	Rem.	0.4–0.7	0.40	0.15–0.40	0.20–0.35	0.7–1.0	0.10	0.20	0.10	(Note 7)	0.05	0.15
6262	Rem.	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	0.15
6351	Rem.	0.7–1.3	0.50	0.10	0.40–0.8	0.40–0.8	—	0.20	0.20		0.05	0.15
6463A	Rem.	0.20–0.6	0.15	0.25	0.05	0.30–0.9	—	0.05	—		0.05	0.15
7005	Rem.	0.35	0.40	0.10	0.20–0.7	1.0–1.8	0.06–0.20	4.0–5.0	0.01–0.06	Zr 0.08–0.20	0.05	0.15
7072	Rem.	0.7 Si + Fe	—	0.10	0.10	0.10	—	0.8–1.3	—		0.05	0.15

NOTES:

- 1 Analysis of aluminium alloys is regularly made only for the elements for which specific limits are shown. 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.
- 2 The aluminium content of unalloyed aluminium not made by a refining process 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.
- 3 The aluminium content of unalloyed aluminium made by a refining process is the difference between 100% and the sum of all other metallic elements present in amounts of 0.0010% or more each, expressed to the third decimal.
- 4 Be 0.0008% max. for welding electrodes and filler wire only.
- 5 Used for aluminium busbars (see AS 2504).
- 6 Bi 0.20%–0.6%, Pb 0.20–0.6%.
- 7 Bi 0.40%–0.7%, Pb 0.40%–0.7%.

TABLE 2.2
MECHANICAL PROPERTY REQUIREMENTS—EXTRUDED PRODUCTS

Alloy and temper	Thickness mm	Tensile strength MPa		0.2% Proof stress MPa		Elongation (Notes 1 and 2) $L_0 = 50 \text{ mm}$ or $5.65 \sqrt{S_0}$, % min.
		Min.	Max.	Min.	Max.	
1200 — H112	All thicknesses	75	—	20 (Note 3)	—	18
1350 — H112	All thicknesses	60	—	—	—	23
2011 — T4	All thicknesses	275	—	125	—	14
2011 — T6	≤25.0	350	—	220	—	8
	>25.0 ≤75.0	345	—	220	—	8
	>75.0	340	—	200	—	8
2014 — T4	≤10.0	370	—	240	—	15
	>10.0 ≤100.0	385	—	245	—	13
	>100.0 ≤150.0	385	—	245	—	10
	>150.0 ≤200.0	370	—	240	—	10
2014 — T6	≤10.0	430	—	385	—	8
	>10.0 ≤25.0	465	—	415	—	6
	>25.0 ≤100.0	480	—	435	—	6
	>100.0 ≤150.0	465	—	415	—	6
2014A — T4	≤20.0	370	—	230	—	11
	>20.0 ≤75.0	390	—	250	—	11
	>75.0 ≤150.0	390	—	250	—	8
	>150.0 ≤200.0	370	—	230	—	8
2014A — T6	≤20.0	435	—	370	—	7
	>20.0 ≤75.0	480	—	435	—	7
	>75.0 ≤150.0	465	—	420	—	7
	>150.0 ≤200.0	435	—	390	—	7
3003 — O	All thicknesses	95	130	35	—	25
3003 — H112	All thicknesses	95	—	35	—	—
5083 — H111	≤125.0	275	—	165	—	10
5083 — H112	≤125.0	270	—	110	—	10
6005 — T1	≤12.0	170	—	105	—	16
6005 — T5	≤3.0	260	—	240	—	8
	>3.0 ≤25.0	260	—	240	—	10
6005A — T4	All thicknesses	180	—	110	—	14
6005 A — T5	All thicknesses	260	—	240	—	8

(continued)