

AS 1565:2023



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Australia



Copper and copper alloys — Ingots and castings



AS 1565:2023

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- Australian Plumbing Manufacturers Association
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- Joint Accreditation System of Australia & New Zealand
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Preface

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee MT-002, Copper and Copper Alloys, to supersede AS 1565—1996.

After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this document as an Australian Standard rather than an Australian/New Zealand Standard.

The objective of this document is to specify the requirements for the manufacture and testing of copper and copper alloy ingots and castings.

The major changes in this edition are as follows:

- (a) Replacement of compositional range for listed alloys with a reference to AS 2738.
- (b) Movement of known mechanical property tables to an informative appendix.
- (c) Update to [Clause 9](#) for microstructure of casting alloy C86500.
- (d) Addition of [Clause 12](#) for Retest procedure.

The terms “normative” and “informative” are used in Standards to define the application of the appendices or annexes to which they apply. A “normative” appendix or annex is an integral part of a document, whereas an “informative” appendix or annex is only for information and guidance.

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NOTES

Australian Standard®

Copper and copper alloys — Ingots and castings

1 Scope

This document specifies requirements for the manufacture and testing of copper castings and copper alloy ingots and castings.

NOTE 1 Advice and recommendations on information to be supplied at the time of enquiry or order are contained in the purchasing guidelines set out in [Appendix A](#).

NOTE 2 Provision has been made for additional inspection requirements for castings which can be specified by a coding system (see [Appendix B](#)).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

NOTE Documents referenced for informative purposes are listed in the Bibliography.

AS 1391, *Metallic materials — Tensile testing — Method of test at room temperature*

AS 1515 (all parts), *Copper alloys*

AS 1696.1, *Copper—Determination of phosphorus—Spectrophotometric method*

AS 1696.2, *Copper, Part 2: Determination of copper content—Electrogravimetric method*

AS 1816.1, *Metallic materials—Brinell hardness test, Method 1: Test method (ISO 6506-1:1999, MOD)*

AS 2345, *Dezincification resistance of copper alloys*

AS 2614, *Copper and copper alloys—Sampling for chemical and spectrochemical analysis, and physical testing*

AS 2706, *Numerical values—Rounding and interpretation of limiting values*

AS 2738, *Copper and copper alloys — Compositions and designations of refinery products, wrought products, ingots and castings*

AS 2883, *Analysis of metals—Procedures for the setting up, calibration and standardization of atomic emission spectrometers using arc/spark discharge*

AS 3641.1, *Recommended practice for atomic emission spectrometric analysis, Part 1: Principles and techniques*

AS/NZS 3500.0, *Plumbing and drainage, Part 0: Glossary of terms*

IEC 60468, *Method of measurement of resistivity of metallic materials*

ASTM E478, *Standard Test Methods for Chemical Analysis of Copper Alloys*

BS 1748 (all parts), *Methods for the analysis of copper alloys*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in AS/NZS 3500.0 and the following apply.

3.1

cast

product of one furnace melt, one crucible melt, or a number of furnace or crucible melts that are aggregated and mixed prior to sampling

Note 1 to entry: With respect to continuous melting for the production of castings, a “cast” is defined as 500 kg of melted metal.

3.2

may

indicates the existence of an option

3.3

shall

indicates that a statement is mandatory

3.4

should

indicates a recommendation

4 Designation

The copper or copper alloy designation shall comprise the number of this document, i.e. AS 1565, followed by a slash and six additional characters commencing with the letter C, in accordance with the Unified Numbering System (UNS).

The suffix letter A indicates a deviation in chemical composition from the corresponding UNS composition.

EXAMPLE AS 1565/C85400, AS 1565/C92410A.

5 Chemical composition

5.1 General

The chemical composition of the copper and copper alloys listed shall conform to the limits given in AS 2738:2023 Section 7 for the appropriate alloy designation.

5.2 Chemical analysis

Chemical composition shall be determined from samples selected in accordance with AS 2614 and tested using methods not less accurate than those given in ASTM E478, AS 1515 (all parts), AS 1696.1, AS 1696.2, AS 2883, AS 3641.1 and BS 1748 (all parts).

NOTE A system for the colour coding of ingots is given in [Table C.1](#) in [Appendix C](#).

5.3 Frequency of analysis

The frequency of analysis shall be as follows:

- (a) *For ingots* — At least one sample shall be taken and analysed from each cast. For casts of 2 t or more, at least two samples shall be taken and analysed, including one at the beginning and one at the end of each cast.
- (b) *For castings* — When the melt has not been prepared from ingots of known composition, nor together with properly segregated and identified foundry returns, checks on chemical composition shall be made on at least one cast in five for each alloy supplied to this document.

NOTE Where the contents of a melting furnace or crucible are supplemented from time to time by additions to maintain an adequate bulk of molten metal, additional samples need to be taken during the period of operation of the furnace.

6 Mechanical properties

6.1 Tensile properties

6.1.1 General

Where specified in the purchasing specification, the tensile test shall be carried out in accordance with [Clause 6.1.3](#).

The acceptance criteria for tensile strength, 0.2 % proof stress, and elongation shall be specified in the purchasing specification. [Table F.1](#) in [Appendix F](#) provides indicative mechanical test results for a selection of alloys.

Tensile test pieces shall be prepared from test samples manufactured in accordance with [Clause 6.1.2](#).

6.1.2 Test samples

Test samples for the tensile test shall be machined to the dimensions of test pieces given in AS 1391. The requirements for cast test samples are as follows:

- (a) *Sand castings* — Test samples shall be separately cast in sand moulds at the same time and from the same cast as the castings they represent. Test samples shall then be heat treated with the castings where applicable.
- (b) *Chill-cast and die-cast castings* — Test samples shall be separately cast in chill moulds at the same time and from the same cast as the castings they represent. Test samples shall be heat treated with the castings where applicable.
- (c) *Continuous castings* — Test samples shall be taken from the actual castings and machined to the largest practicable dimension in accordance with AS 1391. In the case of material subject to heat treatment, the test samples shall be taken after heat treatment.
- (d) *Centrifugal castings in chill moulds* — Test samples shall be separately cast in chill moulds at the same time and from the same cast as the castings they represent. In the case of material subject to heat treatment, the test samples shall be heat treated with the castings.

NOTE 1 If standard test pieces are precluded by the shape of the casting, as with a thin-walled casting, the shape of the test pieces and acceptance limits are subject to agreement.

NOTE 2 Recommended shapes of test samples are given in [Appendix D](#).

NOTE 3 The pouring temperature of the test samples may not necessarily be the same as that required for the casting.

6.1.3 Test procedure

The tensile strength, 0.2 % proof stress, and elongation shall be determined in accordance with AS 1391 from test pieces manufactured from test samples (see [Clause 6.1.2](#)).

If any test piece appears to contain casting defects, the results of the test shall be discarded, and a further test made using a test piece taken from the same or a duplicate test sample. The results obtained shall be substituted for those of the defective test piece.

The elongation results shall be reported on a gauge length of $L_0 = 5.65 \sqrt{S_0}$, where S_0 is the cross-sectional area of the test piece before testing.

NOTE The 0.1 % permanent set stress may also be used as a basis for acceptance (refer to AS 1391). The values of this test are approximately equivalent to the 0.2 % proof stress values.

6.2 Hardness

6.2.1 General

Where specified in the purchasing specification, hardness testing shall be carried out in accordance with [Clause 6.2.2](#).

The acceptance criteria for hardness shall be specified in the purchasing specification. [Table F.1](#) in [Appendix F](#) provides indicative mechanical test results for a selection of alloys.

6.2.2 Test procedure

Brinell hardness tests shall be made in accordance with AS 1816.1, using, whenever possible, a 10 mm ball and a load equivalent to a mass of 1 000 kg. If the test piece is small, an alternative is to use an F/D^2 ratio of 10, where F is the test force, in newtons, and D is the diameter of the ball, in millimetres.

The test shall consist of three determinations, the average result being regarded as the Brinell hardness of the material.

7 Resistance to dezincification

Where specified in the purchasing specification, castings shall be tested for resistance to dezincification in accordance with AS 2345.

NOTE General information on factors that affect the resistance of copper alloys to dezincification is given in AS 2345. Appropriate heat treatment of duplex copper alloys may be required at the conclusion of hot working processes to achieve dezincification resistance.

8 Electrical resistivity (applicable to alloys C80100 and C81500)

8.1 General

Where specified in the purchasing specification, the electrical resistivity of these alloys shall be determined in accordance with [Clause 8.2](#) and meet the following requirements:

- (a) *For C80100 (high conductivity copper)* — The electrical resistivity of castings shall be 19 nΩ.m maximum.
- (b) *For C81500 (copper chromium)* — The electrical resistivity of castings after heat treatment for 30 min minimum at 1 000 °C, water quench, then heat for 4 h at 480 °C and air cool shall be 22 nΩ.m maximum.

NOTE Resistivities of 19 nΩ.m and 22 nΩ.m correspond approximately to electrical conductivities of 90 % and 80 % IACS (International Annealed Copper Standard) respectively. A conductivity of 100 % IACS corresponds to a resistivity of 17.241 nΩ.m.

8.2 Resistivity test

When specified in the purchasing specification, the resistivity test shall be carried out in accordance with IEC 60468 on a cast test piece to give the accuracy required.

For calibration and in cases of dispute, the accuracy of the measurement shall be ± 1 % and the resistivity corrected to a temperature of 20 °C.

8.3 Conductivity

Where specified in the purchasing specification, conductivity may be determined as an alternative to resistivity.

Conductivity testing shall be carried out using an eddy current testing instrument calibrated and operated in accordance with the manufacturer's instructions.

9 Microstructure of casting alloy C86500

Microscopic examination of test samples shall be carried out to determine the proportion of the alpha phase. At least one test shall be made to represent each cast. The proportion of alpha phase, determined from the average of at least five counts, shall not be less than 15 % of the total area. No continuous beta phase grain boundaries shall be evident in the microstructure.

10 Freedom from defects

Castings shall be clean and free from defects detrimental to their subsequent processing and end use.

If, after the acceptance of castings, and provided that they have been properly treated after delivery, subsequent processing reveals that they contain manufacturing defects found to be detrimental, the castings shall be deemed not to conform to this document.

NOTE Defects referred to in this clause cannot be completely quantified. Where the presence, size or frequency of any defect is of concern, arrangements should be made between the parties. These may involve acceptable type samples or methods of test.

11 Rounding of test result values

11.1 General

With the exception of the results of the determination of dimensions which shall not be rounded, and tensile test results, the observed or calculated values shall be rounded to the same number of figures as the specified values and then compared with the specified values in accordance with AS 2706.

NOTE 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.

11.2 Tensile test results

The determined value of tensile strength shall be rounded to the nearest 10 MPa. The determined value of the 0.2 % proof stress shall be rounded to the nearest 5 MPa.

12 Retests

Should any of the test pieces first selected fail to pass the relevant tests specified in [Clauses 5 to 8](#), at least one of the following procedures shall be adopted:

- (a) The sample which failed shall either be withdrawn or set aside for further testing and two additional test samples shall be taken from the remainder of the same batch. If the test pieces from both additional samples pass, the remainder of the batch shall be deemed to conform to this document. If one or both additional test pieces fail, the batch shall be deemed not to conform to this document.

- (b) The original sample which failed shall be retested, with two test pieces taken from this sample. If both test pieces pass, the original sample shall be deemed to conform to this document. If one or both test pieces fail, the original sample shall be deemed not to conform to this document.
- (c) The batch shall be reprocessed and retested in accordance with this document.

13 Marking

13.1 Ingots

Where applicable and specified, ingots should be colour coded. Batches of ingots shall be clearly marked to —

- (a) identify the manufacturer;
- (b) indicate the alloy designation of the material;
- (c) enable traceability of the cast; and
- (d) enable them to be referenced to this document, i.e. AS 1565.

NOTE A scheme for the colour coding of copper alloy ingots is given in [Table C.1](#) in [Appendix C](#).

13.2 Castings

Where specified, castings shall be legibly and durably marked by appropriate means to —

- (a) identify the manufacturer;
- (b) indicate the alloy designation of the material;
- (c) enable traceability of the cast; and
- (d) enable them to be referenced to this document, i.e. AS 1565.

Where it is impractical or undesirable to mark the product due to manufacturing technique, product size or end use, the marking details outlined in items (a) to (d) shall be marked on the product packaging.

NOTE Manufacturers making a statement of conformity with this Australian Standard on a product, or on packaging or promotional material, are advised to ensure that such conformance is capable of being verified.