

BS 5L 101:2011



BSI Standards Publication

Procedure for inspection, testing and acceptance of aluminium-base and magnesium-base ingots and castings

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 26, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI and came into effect on 31 December 2011. It was prepared by Panel ACE/61/-/24, *Light alloys*, under the authority of Technical Committee ACE/61, *Metallic materials for aerospace purposes*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This standard supersedes BS 4L 101:1990, which is withdrawn.

Information about this document

This standard is a full revision of BS L 101. The principal changes from the previous edition are:

Section 1:

- a) Definitions amended.
- b) Information to be supplied by purchaser added.
- c) Information to be agreed between manufacturer and purchaser added.
- d) Qualification of foundry technique requirements added.
- e) Impregnation requirements added.
- f) HIPping requirements added.
- g) Temperature control during heat treatment to BS M 54 replaced by AMS 2750.
- h) Re-qualification requirements added.
- i) Application of values requirements added.
- j) Tensile testing at ambient temperature to BS A4-1.1 replaced by BS EN 2002-1.
- k) Hardness testing to BS A4-5 replaced by BS EN ISO 6506-1 and BS EN ISO 6508-1.
- l) Heat treatment temperature tolerances added.
- m) Penetrant flaw detection to BS M 39 replaced by EN 2006-16 and requirements for penetrant sensitivity added.
- n) Radiological examination to BS M 34 replaced by BS 2002-21.
- o) Protection requirements amended.

Section 3:

- Impregnation requirements deleted and transferred to Section 1.

Appendix A:

- Re-identified as Annex B and reference to withdrawn BS 1957 replaced by details for rounding of values.

Appendix B:

- Re-identified as Annex A and quenching temperature requirements amended.

Hazard warnings

WARNING. This British Standard calls for the use of substances and/or procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Use of this document

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its methods are expressed either as a set of instructions or in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Section 1: General

1 Scope

This British Standard specifies a procedure for the inspection and testing of aluminium alloy and magnesium alloy ingots and castings to be used for aerospace purposes and other critical applications.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 2002-1, *Metallic materials – Test methods – Part 1: Tensile testing at ambient temperature*

BS EN ISO 3452-2, *Non-destructive testing – Penetrant testing – Part 2: Testing of penetrant materials*

BS EN ISO 6506-1, *Metallic materials – Brinell hardness test – Part 1: Test method*

BS EN ISO 6508-1, *Metallic materials – Rockwell hardness test – Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

EN 2002-16, *Metallic materials – Test methods – Part 16: Non-destructive testing – Penetrant testing*¹⁾

EN 2002-21, *Metallic materials – Test methods – Part 21: Radiographic testing of castings*¹⁾

AMS 2750, *Pyrometry*

ASTM E155, *Standard reference radiographs for inspection of aluminium and magnesium castings*

3 Definitions

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

3.1 alloying additions

materials in elemental or alloy form for use in making up melts from a virgin metal base

3.2 approved ingot

ingot which has been proved to conform to the chemical composition specified in the material specification

3.3 approved scrap

scrap which arises from the founder's own production from approved material and which is segregated and identified. It may include headers, runners and heavy fettling scrap, but excludes all small particles

¹⁾ Published as ASD Prestandard at the date of publication of this standard.

3.4 batch

ingots for remelting or castings, each of which is:

- a) of the same form and of the same nominal dimensions or of the same drawing number; and
- b) from the same cast for ingots or from the same melt for castings; and
- c) from the same heat treatment charge.

3.5 cast (term used for ingots)

metal taken from the same furnace or from the same ladle or from several furnaces and mixed in the same furnace or in the same ladle before pouring where a continuous melting process is used, a cast may be defined as metal taken from the furnace before the next following charge

3.6 designated area

highly stressed or otherwise important region of a casting, the location of which is determined by the Design Authority and stated on the drawing or associated documents

3.7 design authority

organization responsible for the detailed design of materiel and which has the responsibility of certifying and/or sealing drawings and specifications

NOTE The Design Authority may not be the purchaser

3.8 melt (term used for castings)

metal taken from the same furnace or from the same ladle, or from several furnaces and mixed in the same furnace or in the same ladle before pouring

3.9 permanent mould casting

casting made by introducing molten metal by gravity or pressure into a metal mould

3.10 precision casting

casting made by any of the following processes or any similar process:

- a) investment, including ceramic shell, and block mould;
- b) ceramic piece moulding, e.g. Shaw;
- c) resin shell mould;
- d) plaster.

3.11 purchaser

body which purchases the products from a founder

NOTE The purchaser may not be the Design Authority

3.12 quality assurance authority

body responsible for authorizing the founder or supplier to issue certification, when to certify means to attest as meeting a standard

3.13 sand casting

casting made by a process involving the moulding of a pattern with a suitably bonded sand

3.14 undesignated area

regions within a casting which have not been designated

3.15 virgin metal

pure aluminium or magnesium with impurity levels such that they will conform to the material specification for which its use is intended

4 General

This standard details the basic requirements for the inspection and testing of British Standard Aerospace L series cast aluminium base and magnesium base alloys.

In addition to the definitive requirements, this standard also requires the items detailed in Clause 5 to be documented. For compliance with this standard, both the definitive requirements and the documented items have to be satisfied.

If the purchaser wishes to specify an inspection, testing or acceptance procedure for any property of any product, which differs from that specified in this standard, this shall be agreed between the purchaser and the manufacturer and shall be fully documented on the order, drawing or inspection schedule, provided that the purchaser is also the quality assurance authority. If the purchaser is not also the quality assurance authority, deviations from the requirements of this standard shall only be agreed and documented after written approval has been obtained from the quality assurance authority.

5 Information and requirements to be agreed and to be documented

5.1 Information to be supplied by the purchaser

The following information to be supplied by the purchaser, which is specified in the clauses referred to, shall be fully documented on the order, drawing or inspection schedule, on which the number of this British Standard shall also be given.

Both the definitive requirements specified throughout the standard and the following documented items shall be satisfied before a claim of compliance with the standard ²⁾ can be made and verified.

a) General:

- 1) the number of the material specification with which this standard is to be used;
- 2) all details relating to pre-production castings in order to optimize and qualify the method of manufacture and mould configuration and to demonstrate that the requirements of the Design Authority can be met (see 6.1);
- 3) the heat treatment required if different from that specified in the material specification (see 9.1);
- 4) radiological examination technique (see 13.7.1);

²⁾ Marking a British Standard identifier (e.g. BS 2L 169:2002) on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

- 5) the radiological acceptance standard if other than level B (see 13.7.3);
- 6) all details relating to any special protective treatment (see Clause 16);
- b) Castings not subject to cut-up testing:
 - 1) if one test sample per casting is required (see 24.1.4);
- c) Castings subject to cut-up testing:
 - 1) the method of obtaining the test samples (see 30.1.1)

5.2 Items to be agreed between the founder and the purchaser

The following items to be agreed between the contracting parties, which are specified in the clauses referred to, shall be fully documented.

Both the definitive requirements specified throughout the standard and the following documented items shall be satisfied before a claim of compliance with the standard ³⁾ can be made and verified.

- a) if weld repair is permitted in order to consistently produce castings fully compliant with drawing requirements (see 6.3);
- b) if correction of distortion is permitted (see 7.2);
- c) if impregnation is permitted (see 7.3);
- d) if Hot Isostatic Pressing (HIPping) is permitted (see 7.4);
- e) method of temperature control if other than AMS 2750 (see 9.2);
- f) if the use of polyalkylene glycol is permitted as a quenchant (see 9.4);
- g) if non-standard test pieces cut from castings, cast integrally with castings or gated to castings are permitted (see 13.2.2);
- h) if non-standard separately cast test-pieces are permitted (see 13.2.3);
- i) if flaw detection using non-fluorescent penetrants is permitted (see 13.6.1);
- j) standards of acceptance for other than cracks or crack-like defects (see 13.6.4);
- k) if weld repair of series production castings is permitted (see 14.1);
- l) any special requirements for approved ingots (see Clause 20);
- m) if it is permissible to relax the frequency of chemical composition determination (see 23.2);
- n) if it is permissible to use one test sample to represent a series of melts made from one cast of approved ingot (see 24.1.2);
- o) if it is permissible, for re-test purposes, to submit one or more representative castings to cut-up test (see 26.1 3);
- p) for re-test purposes, the form, size and location of the test pieces and the minimum mechanical test values to be obtained (see 26.1 3);
- q) if it is permissible for the number of test pieces machined from each casting to be less than that machined from the pre-production approval casting(s) during routine cut-up testing (see 30.1.2);

³⁾ Marking a British Standard identifier (e.g. BS 2L 169:2002) on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

6 Pre-production castings – qualification of foundry technique

6.1 Prior to commencing series production of a design, pre-production castings shall be produced in order to optimize and qualify the method of manufacture and mould configuration and to demonstrate that the requirements of the Design Authority can be met.

NOTE It is strongly recommended that the technical representative of the founder should be given the opportunity to examine the casting drawing at the initial stages of design and to advise on the optimum design which will enable acceptable castings to be produced consistently.

The following requirements shall be specified on the order, drawing and / or inspection schedule [see 5.1a)2]):

- a) number of pre-production castings to be produced for evaluation / qualification;
- b) heat treatment condition of the pre-production castings including any requirements for machining prior to heat treatment;
- c) any areas on the castings which are critical and for which a high internal and / or external defect standard is required;
- d) type, number and locations of tests / inspections necessary to evaluate and qualify the method of manufacture such as dimensions, mechanical properties, microstructure, macrostructure, etc;
- e) whether the method of manufacture needs to be agreed with the Design Authority or shall be at the founder's discretion;
- f) the surface finish required;
- g) any special requirements for the repair and impregnation of the castings;
- h) who shall perform the evaluation / qualification.

6.2 Qualification of the pre-production castings shall be carried out and include those inspections and tests which will be performed on production castings. All manufacturing parameters shall be recorded with the following foundry techniques, in particular, being noted:

- a) position of runners and risers;
- b) position and nature of chills;
- c) type of moulding material and details of mould manufacturing parameters;
- d) mould temperature;
- e) maximum amount of approved scrap which may be added to the melt (at the founder's discretion);
- f) casting temperature range;
- g) heat treatment details;
- h) method of surface finishing.

6.3 Unless otherwise agreed with the Design Authority, it shall be demonstrated that the casting procedure developed is capable of consistently producing castings fully compliant with drawing requirements, without the need for weld repair [see 5.2a)].

6.4 When all inspection and test results relating to pre-production castings required by 6.2 have been reported and considered as satisfactory by the Design Authority, the founder shall compile a manufacturing schedule defining the