

Specification for

Magnesium and magnesium alloy ingots and castings

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- Aluminium Federation
- Aluminium Stockholders' Association
- Association of Light Alloy Refiners' Limited
- Department of Trade and Industry (Minerals and Metals Division)
- Light Metal Founders' Association
- Magnesium Industry Council
- Royal Institute of British Architects
- Society of Motor Manufacturers and Traders Limited

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Foreword

This British Standard has been prepared under the direction of the Non-Ferrous Metals Standards Policy Committee. It is the second revision of BS 2970, which was originally published in 1959 and subsequently revised in 1972. It supersedes the 1972 edition, which is withdrawn.

The nine alloys specified in the 1972 edition have been retained and five new alloys added, two general purpose and three special purpose.

For castings, it is desirable that there should be the earliest possible consultation between the purchaser, particularly when he is the designer, and the supplier or manufacturer: early agreement should be reached on such matters as choice of alloy for a given application. The information given on the primary characteristics of the alloys listed in Table 1, Table 2 and Table 3 will provide an initial guide in this matter. Agreement should also be reached on the effects of methods of production and finish, with an agreed choice of the most effective and least expensive method of inspection appropriate to each pattern of castings.

Consultation may also lead to an agreed modification of the item to make it cheaper to produce both as a casting for the supplier and as a finished part by the purchaser. For example, for castings to be jig machined, agreement on the location points for jigging and any reference points for marking out for dimensional inspection is desirable prior to any production. Such consultation is especially advisable for QC/TS castings.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 18, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This British Standard specifies requirements for chemical composition, mechanical properties and other characteristics for the following two types of product for general engineering purposes:

- a) magnesium and magnesium alloy ingots intended to be remelted for the production of castings; and
- b) magnesium and magnesium alloy castings.

This standard applies to castings made by any metal casting process. For mechanical properties, however, requirements are specified only for castings made by the sand casting and chill casting processes.

Details of information to be supplied by the purchaser in any enquiry or order are given in Appendix A. Appendix B describes chemical analysis procedures for ingots and castings and Appendix C describes tensile testing of castings. Appendix D gives guidance on additional inspection and test procedures for castings, including a classification system for castings that enables these test procedures to be agreed readily at the design stage, for quotation purposes and for order. Typical hardness values are given in Appendix E; Appendix F specifies colour coding for ingots; Appendix G gives guidance on the selection of alloys; and Appendix H gives design considerations for corrosion resistance.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

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

2.1 ingot

a cast, unwrought product, in a form suitable for remelting

2.2 approved ingots

magnesium and magnesium alloy ingots which have been proved to comply with the appropriate material specification

2.3 approved scrap

that scrap which arises from a founder's own production from approved ingots, which is segregated and identifiable. It may include heavy fettling scrap but be free from all drosses and small particles such as sawings, grindings and chippings

2.4 ingot batch

a series of ingots cast from a single uniform melt

2.5 casting

a product at or near finished shape, formed by solidification of a metal or alloy in a mould

2.6 sand casting

a casting formed in a sand mould

2.7 chill casting

a casting formed in a metal mould

2.8 gravity die casting

a chill casting in which the molten metal is introduced by gravity

2.9 low-pressure casting

a chill or sand casting in which the molten metal is introduced by a low-pressure feed

2.10 pressure die casting

a chill casting in which the molten metal is introduced under a pressure in excess of 2×10^5 Pa

2.11 investment casting

a casting formed from an expendable pattern which has been invested in a suitable mould material

2.12 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

2.13 cast (continuous melting)

in continuous melting for the production of castings, 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 is 500 kg or fraction thereof of metal poured

2.14 manufacturer

manufacturer of ingots

2.15 supplier

foundry or founder which supplies castings

3 Ingots

3.1 Chemical composition

The chemical composition of magnesium ingots shall be as given in Table 1 for the appropriate alloy, when determined in accordance with Appendix B.

3.2 Certificate of analysis

A certificate of analysis shall be supplied with each cast of ingots. The certificate shall provide the analysis to the specified elements of sample(s) representative of the cast.

3.3 Marking

Ingots shall be marked clearly and durably with:

- a) the number and date of this British Standard, i.e. BS 2970:1989¹⁾; and
- b) either the manufacturer's mark, the material designation and the cast number; or
- c) in bundles, with each bundle marked with the manufacturer's mark, the material designation and the cast number. Ingots shall be colour-marked to identify the alloy in which they have been cast.

NOTE Appendix F lists suitable colour codes.

4 Castings

4.1 Chemical composition

The chemical composition of magnesium alloy castings shall be as given in Table 2 for the appropriate alloy, when determined in accordance with Appendix B.

4.2 Condition

The castings shall be supplied in one of the following conditions (see Table 3):

- as cast (M)
- precipitation treated (TE)
- solution treated and quenched (TB)
- solution treated, quenched and precipitation treated (TF).

NOTE This should be advised by the purchaser when ordering. If stress-relieving treatment (TS) is required, details of the stress-relieving procedure to be applied should be stated on the order. [See item b) 3) of Appendix A.]

4.3 Mechanical properties

The tensile properties shall be as given in Table 3, when determined in accordance with Appendix C.

NOTE The tensile property requirements are specified for separately cast test samples. They do not necessarily represent the properties obtainable from all parts, or in all directions, of a casting, which will depend on a number of factors including wall thickness and cooling characteristics.

4.4 Certificate of compliance

When requested [see item b) 8) of Appendix A], the supplier shall certify that the castings comply with this standard.

4.5 Marking

Castings shall be marked clearly and durably with:

- a) the number and date of this British Standard, i.e. BS 2970:1989¹⁾; and
- b) the manufacturer's mark, the material designation and the cast number.

¹⁾ Marking BS 2970:1989 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 therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

Table 1 — Chemical composition of magnesium alloy ingots

Designation	Nominal composition	Aluminium		Zinc		Manganese		Zirconium		Rare earth metals		Thorium	Silver	Yttrium	Copper	Silicon	Iron	Nickel	Magnesium	Comments	Total other elements						
General		% (m/m)		% (m/m)		% (m/m)		% (m/m)		% (m/m)		% (m/m)	% (m/m)	% (m/m)	% (m/m)	% (m/m)	% (m/m)	% (m/m)			% (m/m)						
GENERAL PURPOSE ALLOYS		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		% (m/m)						
MAG 1	Mg-Al8 ZnMn	<u>7.5</u>	<u>8.5</u>	<u>0.3</u>	<u>1.0</u>	<u>0.2</u>	<u>0.4</u>	—	—	—	—	—	—	—	—	—	0.15	—	0.2	—	0.03	—	0.01	REM ^a	Cu+Si+Fe+Ni 0.35 % max.	0.15	
MAG 3	Mg-Al10 ZnMn	<u>9.0</u>	<u>10.5</u>	<u>0.3</u>	<u>1.0</u>	<u>0.2</u>	<u>0.4</u>	—	—	—	—	—	—	—	—	—	0.15	—	0.2	—	0.03	—	0.01	REM	Cu+Si+Fe+Ni 0.35 % max.	0.15	
MAG 4	Mg-Zn4.5 Zr	—	—	<u>3.5</u>	<u>5.5</u>	—	—	<u>0.1</u>	<u>1.0</u>	—	—	—	—	—	—	—	0.03	—	0.01	—	0.01	—	0.005	REM	—	0.15	
MAG 7	Mg-Al8.5 Zn1 Mn	<u>7.5</u>	<u>9.0</u>	<u>0.3</u>	<u>1.5</u>	<u>0.15</u>	<u>0.8</u>	—	—	—	—	—	—	—	0.25	—	0.3	—	0.3	—	0.05	—	0.02	REM	Cu+Si+Fe+Ni 0.65 % max.	0.30	
MAG 10	Mg-Al9.0 ZnMn + 0.001 Be	<u>8.1</u>	<u>9.3</u>	<u>0.4</u>	<u>1.0</u>	<u>0.2</u>	<u>0.4</u>	—	—	—	—	—	—	—	—	—	0.2	—	0.2	—	0.03	—	0.01	REM	<u>Be 0.0005 to 0.0015</u>	0.15	
MAG 11	Mg-Al9.0 ZnMn	<u>8.5</u>	<u>9.5</u>	<u>0.45</u>	<u>0.9</u>	<u>0.2</u>	<u>0.4</u>	—	—	—	—	—	—	—	—	—	0.015	—	0.02	—	0.004	—	0.001	REM	—	0.15	
SPECIAL PURPOSE ALLOYS																											
MAG 2	Mg-Al8 ZnMn	<u>7.5</u>	<u>8.5</u>	<u>0.3</u>	<u>1.0</u>	<u>0.2</u>	<u>0.7</u>	—	—	—	—	—	—	—	—	—	0.005	—	0.01	—	0.002	—	0.001	REM	—	0.15	
MAG 5	Mg-Zn4 RE1Zr	—	—	<u>3.5</u>	<u>5.0</u>	—	0.15	<u>0.1</u>	<u>1.0</u>	<u>1.0</u>	<u>1.75</u>	—	—	—	—	—	0.03	—	0.01	—	0.01	—	0.005	REM	—	0.15	
MAG 6	Mg-RE3 Zn2.5Zr	—	—	<u>0.8</u>	<u>3.0</u>	—	0.15	<u>0.1</u>	<u>1.0</u>	<u>2.5</u>	<u>4.0</u>	—	—	—	—	—	0.03	—	0.01	—	0.01	—	0.005	REM	—	0.15	
MAG 8	Mg-Th3 Zn2Zr	—	—	<u>1.7</u>	<u>2.5</u>	—	0.15	<u>0.1</u>	<u>1.0</u>	—	0.10	<u>2.5</u>	<u>4.0</u>	—	—	—	0.03	—	0.01	—	0.01	—	0.005	REM	—	0.15	
MAG 9	Mg-Zn5.5 Th2Zr	—	—	<u>5.3</u>	<u>6.0</u>	—	0.15	<u>0.1</u>	<u>1.0</u>	—	0.2	<u>1.5</u>	<u>2.3</u>	—	—	—	0.03	—	0.01	—	0.01	—	0.005	REM	—	0.15	
MAG 12	Mg-Ag2.5 RE2.5Zr	—	—	—	0.2	—	0.15	<u>0.1</u>	<u>1.0</u>	<u>2.0</u>	<u>3.0</u>	—	—	—	—	—	0.03	—	0.01	—	0.01	—	0.005	REM	—	0.15	
MAG 13	Mg-Ag1.5 RE ZrCu	—	—	—	0.2	—	0.15	<u>0.1</u>	<u>1.0</u>	<u>1.5</u>	<u>3.0</u>	—	—	—	—	—	<u>0.05</u>	<u>0.1</u>	—	0.01	—	0.01	—	0.005	REM	—	0.15
MAG 14	Mg-Y5 RE3.5Zr	—	—	—	0.2	—	0.15	<u>0.1</u>	<u>1.0</u>	<u>2.0</u>	<u>4.0</u>	—	—	—	—	—	<u>4.75</u>	<u>5.5</u>	—	0.03	—	0.01	—	0.005	REM	Li 0.2 max.	0.30
NOTE 1 Limits for essential alloying elements are underlined.																											
NOTE 2 Single figures are specified impurities. Analysis is required to verify that the contents of the specified impurities are not greater than the limits given in Table 1.																											
Analysis for other elements is made when their presence is suspected to be in excess of the “other elements” limits.																											
^a REM = Remainder.																											

Table 2 — Chemical composition of magnesium alloy castings

Designation		Nominal composition	Aluminium		Zinc		Manganese		Zirconium		Rare earth metals		Thorium		Silver		Yttrium		Copper		Silicon		Iron		Nickel		Magnesium	Comments	Total other elements
General	Aerospace equivalent		% (m/m)		% (m/m)		% (m/m)		% (m/m)		% (m/m)		% (m/m)		% (m/m)		% (m/m)		% (m/m)		% (m/m)		% (m/m)		% (m/m)				
GENERAL PURPOSE ALLOYS			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.			
MAG 1	3L 122	Mg-Al8 ZnMn	<u>7.5</u>	<u>9.0</u>	<u>0.3</u>	<u>1.0</u>	<u>0.15</u>	<u>0.4</u>	—	—	—	—	—	—	—	—	—	0.15	—	0.3	—	0.05	—	0.01	REM ^a	Cu+Si+Fe+Ni 0.40 % max.	0.15		
MAG 3	3L 125 3L 124	Mg-Al10 ZnMn	<u>9.0</u>	<u>10.5</u>	<u>0.3</u>	<u>1.0</u>	<u>0.15</u>	<u>0.4</u>	—	—	—	—	—	—	—	—	—	0.15	—	0.3	—	0.05	—	0.01	REM	Cu+Si+Fe+Ni 0.40 % max.	0.15		
MAG 4	2L 127	Mg-Zn4.5 Zr	—	—	<u>3.5</u>	<u>5.5</u>	—	—	<u>0.4</u>	<u>0.1</u>	—	—	—	—	—	—	—	0.03	—	—	—	—	—	0.005	REM	—	0.15		
MAG 7		Mg-Al8.5 Zn1Mn	<u>7.5</u>	<u>9.0</u>	<u>0.3</u>	<u>1.5</u>	<u>0.15</u>	<u>0.8</u>	—	—	—	—	—	—	—	—	—	0.35	—	0.4	—	0.05	—	0.02	REM	Cu+Si+Fe+Ni 0.75 % max.	0.15		
MAG 10		Mg-Al9.0 ZnMn + 0.001 Be	<u>8.1</u>	<u>9.3</u>	<u>0.4</u>	<u>1.0</u>	<u>0.13</u>	<u>0.4</u>	—	—	—	—	—	—	—	—	—	0.2	—	0.2	—	0.03	—	0.01	REM	<u>Be 0.005 to 0.0015</u>	0.15		
MAG 11		Mg-Al9.0 ZnMn	<u>8.5</u>	<u>9.5</u>	<u>0.45</u>	<u>0.9</u>	<u>0.15</u>	<u>0.4</u>	—	—	—	—	—	—	—	—	—	0.015	—	0.02	—	0.005	—	0.001	REM	—	0.15		
SPECIAL PURPOSE ALLOYS																													
MAG 2	DTD 684A DTD 690A	Mg-Al8 ZnMn	<u>7.5</u>	<u>9.5</u>	<u>0.3</u>	<u>1.0</u>	<u>0.15</u>	<u>0.7</u>	—	—	—	—	—	—	—	—	—	—	0.005	—	0.01	—	0.003	—	0.001	REM	—	0.15	
MAG 5	2L 128	Mg-Zn4 RE1Zr	—	—	<u>3.5</u>	<u>5.0</u>	—	—	<u>0.4</u>	<u>1.0</u>	<u>0.75</u>	<u>1.75</u>	—	—	—	—	—	—	0.03	—	—	—	—	—	0.005	REM	—	0.15	
MAG 6	2L 126	Mg-Re3 Zn2.5Zr	—	—	<u>0.8</u>	<u>3.0</u>	—	—	<u>0.4</u>	<u>1.0</u>	<u>2.5</u>	<u>4.0</u>	—	—	—	—	—	—	0.03	—	—	—	—	—	0.005	REM	—	0.15	
MAG 8	DTD 5005A	Mg-Th3 Zn2 Zr	—	—	<u>1.7</u>	<u>2.5</u>	—	0.15	<u>0.4</u>	<u>1.0</u>	—	0.10	<u>2.5</u>	<u>4.0</u>	—	—	—	—	0.03	—	0.01	—	0.01	—	0.005	REM	—	0.15	
MAG 9	DTD 5015A	Mg-Zn5.5 Th2 Zr	—	—	<u>5.0</u>	<u>6.0</u>	—	0.15	<u>0.4</u>	<u>1.0</u>	—	0.2	<u>1.5</u>	<u>2.3</u>	—	—	—	—	0.03	—	0.01	—	0.01	—	0.005	REM	—	0.15	
MAG 12	DTD 5035A	Mg-Ag2.5 RE2.5 Zr	—	—	—	0.2	—	0.15	<u>0.4</u>	<u>1.0</u>	<u>2.0</u>	<u>3.0</u>	—	—	2.0	3.0	—	—	—	0.03	—	0.01	—	0.01	—	0.005	REM	—	0.15
MAG 13		Mg-Ag1.5 RE ZrCu	—	—	—	0.2	—	0.15	<u>0.4</u>	<u>1.0</u>	<u>1.5</u>	<u>3.0</u>	—	—	1.3	1.7	—	—	<u>0.05</u>	<u>0.1</u>	—	0.01	—	0.01	—	0.005	REM	—	0.15
MAG 14		Mg-Y5 RE3.5 Zr	—	—	—	0.2	—	0.15	<u>0.4</u>	<u>1.0</u>	<u>2.0</u>	<u>4.0</u>	—	—	—	—	<u>4.75</u>	<u>5.5</u>	—	0.003	—	0.01	—	0.01	—	0.005	REM	Li 0.2 max.	0.30
NOTE 1 Limits for essential alloying elements are underlined.																													
^a REM = Remainder.																													