
**Magnesium and magnesium alloys —
Magnesium alloy ingots and castings**

*Magnésium et alliages de magnésium — Lingots et pièces moulées en
alliage de magnésium*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 79, *Light metals and their alloys*, Subcommittee SC 5, *Magnesium and alloys of cast or wrought magnesium*.

This third edition cancels and replaces the second edition (ISO 16220:2005), which has been technically revised by the addition of new alloys. It also incorporates the amendment ISO 16220:2005/Amd.1:2007.

Introduction

This document classifies the magnesium alloys into a number of grades suitable for the applications to which they might be used.

Some of the alloys referenced in this document can be the subject of a patent or of patent applications and their listing herein is not to be construed in any way as the granting of a licence under such patent rights.

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Magnesium and magnesium alloys — Magnesium alloy ingots and castings

1 Scope

This document specifies the chemical composition of magnesium alloy ingots and castings. It also specifies the mechanical properties of separately cast samples of these alloys (see [Clause 7](#)). By agreement, it also specifies the mechanical properties of magnesium alloy castings determined from samples cut from a casting.

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. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE For information on equivalent International Standards see [Annex A](#).

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 80000-1:2009, *Quantities and units — Part 1: General*

EN 1559-5, *Founding — Technical condition of delivery — Part 5: Additional requirements for magnesium alloy castings*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

4 Material designation

4.1 General

The material shall be designated as given in [Tables 1](#) to [5](#).

4.2 Temper designation

The following symbols for temper designation shall be used.

- F: as-cast; applies to products that require no heat treatment following the casting processes.
- T4: solution heat-treated and naturally aged; applies to products that have no further treatment after solution heat treatment.
- T5: as-cast and artificially aged; applies to products that are cooled from the casting process, and then artificially aged to improve mechanical properties or dimensions.

- T6: solution heat-treated and artificially aged; applies to products that are solution heat treated followed by artificially aging.

4.3 Casting process designation

The following symbols shall be used for the designation of the different casting processes.

- S: sand casting.
- K: permanent mould casting.
- D: pressure die casting.
- L: investment casting.

4.4 Designation for ordering

The designation used for ordering shall include, in the following order, the number of castings, a mention of this document, the ISO alloy designation, the designation for the heat treatment process (temper), and the designation for the casting process.

EXAMPLE An order for 20 castings, conforming to this document, of magnesium alloy ISO-MC21120, delivered in as-cast (F temper) and made by sand casting (S) is as follows:

20 castings - ISO 16220 - ISO-MgAl9Zn1(A) (or ISO-MC21120 or ISO-AZ91D)-F-S

5 Requirements

5.1 Chemical composition

The chemical composition of magnesium alloy ingots shall conform to the requirements for the appropriate material given in [Table 1](#).

The chemical composition of magnesium alloy castings shall conform to the requirements for the appropriate material given in [Table 2](#).

Conformance shall be determined by the manufacturer by analysing samples taken at the time the ingots or castings are produced.

NOTE For additional information regarding the manganese and iron contents see [Annex B](#).

5.2 Mechanical properties of castings

The mechanical properties obtained from test pieces prepared from separately cast samples for sand castings and permanent mould castings shall meet the requirements given in [Tables 3](#) and [4](#). As appropriate, the tests shall be carried out in accordance with [Clause 8](#).

NOTE 1 Mechanical properties obtained from test pieces prepared from separately cast samples for investment castings are not specified, as experience is limited. As a general rule they are similar to those for permanent mould castings.

NOTE 2 The values obtained from test pieces cut from castings can differ from the minimum values specified in the tables because of imperfections (gas pores, shrinkage cavities, inclusions) and the machining process applied. Variation in the casting structure can also affect the property values.

NOTE 3 For pressure-die castings, the mechanical properties strongly depend on the process parameters; therefore, the properties given in [Table 5](#) are for guidance only.

The Brinell hardness test shall be carried out on sound areas of castings or on a test piece that has not been stressed. Hardness tests are only to be carried out where appropriate and when there is a real difference between the different states of heat treatment.

5.3 Frequency of testing

The frequency of testing shall be in accordance with EN 1559-5.

5.4 General condition of the product

Ingots shall be free of dust, burrs, salty inclusions and be homogeneous in thickness and weight to a standard agreed with the purchaser.

Castings shall have a clean surface and shall be free from visible and internal imperfections to a standard also agreed between the manufacturer and the purchaser.

6 Sampling

Conditions for sampling, formation of batches and frequency of verification shall be as specified in EN 1559-5.

7 Test pieces for mechanical properties

7.1 Design

The design of test pieces shall be subject to an agreement between the manufacturer and the purchaser.

7.2 Test pieces obtained from separately cast samples

7.2.1 Sand-cast samples

Test pieces may be in the machined or unmachined condition.

The following conditions shall apply:

- samples shall be cast in sand moulds and without artificial chilling;
- the minimum diameter of the test piece shall be 12 mm;
- the gauge length and the parallel length shall conform to ISO 6892-1.

7.2.2 Permanent-mould cast samples

Test pieces may be in the machined or unmachined condition.

The following conditions shall apply:

- the minimum diameter of the test piece shall be 12 mm;
- the gauge length and parallel length shall conform to ISO 6892-1.

7.2.3 Pressure-die cast samples

For pressure die castings, it is not recommended to test mechanical properties on separately cast bars or coupons. It is more appropriate to test the whole casting under conditions comparable to the ones expected in service.

The values given in [Table 5](#) are for guidance only. These are not typical, but they are the minimum values that can be expected on separately pressure cast bars (with none or very limited machining) and with a cross section of 20 mm² and a typical thickness of 2 mm.

7.2.4 Investment cast samples

Test pieces may be in the machined or unmachined condition.

The following conditions shall apply:

- the minimum diameter of the test piece shall be 5 mm;
- the gauge length and parallel length shall conform to ISO 6892-1.

7.3 Test pieces cut from castings

The geometry and location of test pieces cut from castings shall be specified by agreement between the manufacturer and the purchaser.

If it is agreed between the manufacturer and the purchaser to use circular cross-section test pieces, the minimum diameter shall be 4 mm.

8 Test methods

8.1 Tensile test

Tensile tests shall be carried out in accordance with ISO 6892-1.

8.2 Brinell hardness test

Brinell hardness tests shall be carried out in accordance with ISO 6506-1.

A test ball of 5 mm diameter is recommended. By agreement between the manufacturer and the purchaser, a smaller ball diameter may be used for thin-wall castings.

9 Retests

Retests shall be carried out in accordance with EN 1559-5.

10 Rounding of numbers

The number representing the result for any value specified in this document shall be expressed with the same number of decimal places as the corresponding number in this document. The rounding of numbers shall meet the requirements of ISO 80000-1:2009, B.3, rule A or B. The choice shall be left to the discretion of the manufacturer, unless the use of one of the rules is agreed by the time of acceptance of the order.

Table 1 — Chemical composition of magnesium alloy ingots

Alloy group	Material designation			Composition % mass fraction																	
	Designation by symbols	Designation by numbers	ASTM designation	Min. or max.	Mg	Al	Zn	Mn ^a	RE ^b	Zr	Ag	Y	Gd	Li	Sr	Ca	Si	Fe	Cu	Ni	Other each
MgAlZn	ISO-MgAl8Zn1	ISO-MB21110	AZ81	min. max.	Rem.	7,2 8,5	0,45 0,9	0,17 0,4									0,05	0,004	0,025	0,001	0,05
	ISO-MgAl9Zn1(A)	ISO-MB21120	AZ91	min. max.	Rem.	8,5 9,5	0,45 0,9	0,17 0,40									0,08	0,004	0,025	0,001	0,01
	ISO-MgAl9Zn1(B)	ISO-MB21121	AZ91	min. max.	Rem.	8,0 10,0	0,3 1,0	0,1 0,50									0,3	0,03	0,020	0,01	0,05
	ISO-MgAl9Zn-1Ca	ISO-MB21122	AZ91	min max	Rem.	8,5 9,5	0,45 0,9	0,17 0,40								0,5					
MgAlMn	ISO-MgAl6Zn3	ISO-MB21130	AZ63	min. max.	Rem.	5,5 6,5	2,7 3,3	0,15 0,35									0,05	0,005	0,015	0,001	0,05
	ISO-MgAl2Mn	ISO-MB21210	AM20	min. max.	Rem.	1,7 2,5	0,20 0,60	0,35 0,60									0,08	0,004	0,008	0,001	0,01
	ISO-MgAl5Mn	ISO-MB21220	AM50	min. max.	Rem.	4,5 5,3	0,28 0,30	0,50									0,08	0,004	0,008	0,001	0,01
	ISO-MgAl6Mn	ISO-MB21230	AM60	min. max.	Rem.	5,6 6,4	0,30 0,50	0,26 0,50									0,2	0,004	0,008	0,001	0,01
MgAlSi	ISO-MgAl10Mn	ISO-MB21240	AM100	min. max.	Rem.	9,4 10,6	0,20 0,35	0,13 0,35									0,7 1,2	0,004	0,008	0,001	0,01
	ISO-MgAl2Si	ISO-MB21310	AS21	min. max.	Rem.	1,9 2,5	0,20 0,6	0,2 0,6									0,7 1,2	0,004	0,008	0,001	0,01
MgAlRE	ISO-MgAl4Si	ISO-MB21320	AS41	min. max.	Rem.	3,7 4,8	0,20 0,6	0,2 0,6									0,08	0,004	0,008	0,001	0,01
	ISO-MgAl4RE4	ISO-MB21410	AE44	min. max.	Rem.	3,6 4,4	0,20 0,50	0,15 0,50	3,6 4,6								0,08	0,004	0,008	0,001	0,01
MgAlSr	ISO-MgAl5Sr2	ISO-MB21510	AJ52	min. max.	Rem.	4,6 5,5	0,20 0,6	0,24 0,6									1,8 2,3	0,004	0,008	0,001	0,01
	ISO-MgAl6Sr2	ISO-MB21520	AJ62	min. max.	Rem.	5,5 6,6	0,20 0,6	0,24 0,6									2,1 2,8	0,004	0,008	0,001	0,01
MgAlCa	ISO-MgAl-6Ca2RE2	ISO-MB25120	AE62	min. max.	Rem.	6,1 6,7	0,4	0,13 0,35	2,2 2,8							2,0 2,4					

Table 1 (continued)

Alloy group	Material designation				Composition % mass fraction																	
	Designation by symbols	Designation by numbers	ASTM designation	Min. or max.	Mg	Al	Zn	Mn ^a	RE ^b	Zr	Ag	Y	Gd	Li	Sr	Ca	Si	Fe	Cu	Ni	Other each	
	ISO-MgAl-6Ca2Sr	ISO-MB25130	AX62	min.	Rem.	5,7	-	0,30							0,22	1,8	-	-	-	-	-	-
				max.		6,4	0,10	0,40									0,30	2,3	0,10	0,004	0,001	0,001
MgZnCu	ISO-MgZn-6Cu3Mn	ISO-MB32110	ZC63	min.	Rem.	-	5,5	0,25									-	-	2,4	-	-	-
				max.		0,2	6,5	0,75											0,20	0,05	3,0	0,01
MgZn-REZr	ISO-MgZn-4RE1Zr ^d	ISO-MB35110	ZE41	min.	Rem.	-	3,5	-	1,0	0,1							-	-	-	-	-	-
				max.		-	5,0	0,15	1,75	1,0									0,01	0,01	0,03	0,005
MgZn-REZr	ISO-MgRE3Zn-2Zr ^d	ISO-MB65120	EZ33	min.	Rem.	-	2,0	-	2,4	0,1							-	-	-	-	-	-
				max.		-	3,0	0,15	4,0	1,0									0,01	0,01	0,03	0,005
MgREAg-Zr	ISO-MgRE3Zn-Zr ^d	ISO-MB65130	EZ30	min.	Rem.	-	0,14	-	2,0	0,3						-	-	-	-	-	-	-
				max.		-	0,7	0,05	3,5	1,0								0,05	0,01	0,01	0,03	0,005
MgREAg-Zr	ISO-MgAg2RE2Zr ^e	ISO-MB65210	QE22	min.	Rem.	-	-	-	2,0	0,1	2,0						-	-	-	-	-	-
				max.		-	0,2	0,15	3,0	1,0	3,0								0,01	0,01	0,03	0,005
MgYREZr	ISO-MgRE2Ag-1Zr ^e	ISO-MB65220	EQ21	min.	Rem.	-	-	-	1,5	0,1	1,3						-	-	-	-	-	-
				max.		-	0,2	0,15	3,0	1,0	1,7								0,01	0,01	0,10	0,005
MgYREZr	ISO-MgY5RE4Zr ^f	ISO-MB95310	WE54	min.	Rem.	-	-	-	1,5	0,1	4,75						-	-	-	-	-	-
				max.		-	0,2	0,15	4,0	1,0	5,5								0,01	0,01	0,03	0,005
MgGdYZr	ISO-MgY4RE3Zr ^f	ISO-MB95320	WE43	min.	Rem.	-	-	-	2,4	0,1	3,7						-	-	-	-	-	-
				max.		-	0,2	0,15	4,4	1,0	4,3								0,01	0,01	0,03	0,005
MgGdYZr	ISO-MgGd7Y6Zr	ISO-MB69110	VW76	min.	Rem.	-	-	-	5,5	0,2	5,5						-	-	-	-	-	-
				max.		-	-	0,03	6,5	7,5	6,5								0,01	0,010	0,02	0,005
MgGdYZr	ISO-MgGd10Y3Zr	ISO-MB69120	VW103	min.	Rem.	-	-	-	2,5	0,3	2,5						-	-	-	-	-	-
				max.		-	0,2	0,05	3,5	10,5	10,5								0,01	0,01	0,03	0,005

Table 1 (continued)

Alloy group	Material designation		Composition % mass fraction																		
	Designation by symbols	Designation by numbers	ASTM designation	Min. or max.	Mg	Al	Zn	Mn ^a	RE ^b	Zr	Ag	Y	Gd	Li	Sr	Ca	Si	Fe	Cu	Ni	Other each
MgREG-dZr ^h	ISO-MgRE3G-d1Zr	ISO-MB65410	EV31	min. max.	Rem. -	-	0,20 0,50	- 0,03	2,6 3,1	0,1 1,0	- 0,05		1,0 1,7					- 0,01	- 0,01	- 0,002	- 0,01

a For maximum manganese content see [Annex B](#).
b RE = rare earth elements.
c Cerium-rich.
d Neodymium.
e Neodymium-rich.
f Neodymium and heavy RE-rich.
g Improved corrosion resistance can be obtained by reducing the maximum manganese content to 0,03 %, the maximum iron content to 0,01 %, the maximum copper content to 0,02 % and the maximum zinc + silver content to 0,2 %.
h Neodymium is 2,6 % to 3,1 %; other rare earth metals may also be present to a maximum of 0,4 %. These RE shall principally be cerium, lanthanum and praseodymium.

Table 2 — Chemical composition of magnesium alloy castings

Alloy group	Material designation			Composition % mass fraction																				
	Designation by symbols	Designation by numbers	ASTM designation	Casting process	Min. or max.	Mg	Al	Zn	Mn ^a	RE ^b	Zr	Ag	Y	Gd	Li	Sr	Ca	Si	Fe	Cu	Ni	Other each	Fe/Mn	
MgAlZn	ISO-MgAl8Zn1	ISO-MB21110	AZ81	S,K,L	min. max.	Rem.	7,0 8,5	0,40 1,0	0,13 0,50									0,05	0,004	0,025	0,001	0,05	0,032	
	ISO-MgAl9Zn1(A)	ISO-MB21120	AZ91	D	min. max.	Rem.	8,5 9,5	0,35 0,9	0,15 0,50									0,08	0,004	0,025	0,001	0,01	0,032	
	ISO-MgAl9Zn1(A)	ISO-MB21120	AZ91	S,K,L	min. max.	Rem.	8,3 9,7	0,40 1,0	0,17 0,35									0,08	0,004	0,025	0,001	0,01	0,032	
	ISO-MgAl9Zn1(B)	ISO-MB21121	AZ91	D,S,K,L	min. max.	Rem.	8,0 10,0	0,3 1,0	0,1 0,60									0,3	0,03	0,020	0,01	0,05	0,032	
	ISO-MgAl9Zn-1Ca	ISO-MB21122	AZ91	D	min. max.	Rem.	8,3 9,7	0,35 1,0	0,15 0,50								0,5 2,5		0,05	0,005	0,003	0,002	0,01	0,032
	ISO-MgAl6Zn3	ISO-MB21130	AZ63	S,K,L	min. max.	Rem.	5,3 6,7	2,5 3,5	0,10 0,50									0,08	0,005	0,015	0,001	0,05	0,032	
	ISO-MgAl2Mn	ISO-MB21210	AM20	D	min. max.	Rem.	1,6 2,5	0,20 0,70	0,33 0,70									0,08	0,004	0,008	0,001	0,01	0,012	
	ISO-MgAl5Mn	ISO-MB21220	AM50	D	min. max.	Rem.	4,4 5,3	0,26 0,30	0,26 0,60										0,08	0,004	0,008	0,001	0,01	0,015
	ISO-MgAl6Mn	ISO-MB21230	AM60	D	min. max.	Rem.	5,5 6,4	0,30 0,50	0,24 0,50										0,2	0,004	0,008	0,001	0,01	0,021
	ISO-MgAl10Mn	ISO-MB21240	AM100	S,K,L	min. max.	Rem.	9,4 10,6	0,20 0,50	0,10 0,50										0,7 1,2	0,004	0,008	0,001	0,01	0,022
MgAlSi	ISO-MgAl2Si	ISO-MB21310	AS21	D	min. max.	Rem.	1,8 2,5	0,20 0,70	0,18 0,70									0,7 1,2	0,004	0,008	0,001	0,01	0,022	
	ISO-MgAl4Si	ISO-MB21320	AS41	D	min. max.	Rem.	3,5 4,8	0,20 0,70	0,18 0,70									0,08	0,004	0,008	0,001	0,01	0,022	
MgAlRE ^c	ISO-MgAl4RE4	ISO-MB21410	AE44	D	min. max.	Rem.	3,5 4,5	0,15 0,50	0,15 0,50	3,5 4,5								0,08	0,004	0,008	0,001	0,01	0,022	

Table 2 (continued)

Alloy group	Material designation				Composition % mass fraction																			
	Designation by symbols	Designation by numbers	ASTM designation	Casting process	Min. or max.	Mg	Al	Zn	Mn ^a	RE ^b	Zr	Ag	Y	Gd	Li	Sr	Ca	Si	Fe	Cu	Ni	Other each	Fe/Mn	
MgAlSr	ISO-MgAl5Sr2	ISO-MB21510	AJ52	D	min. max.	Rem.	4,5	-	0,2							1,8		0,08	0,004	0,008	-	-	-	-
							5,5	0,20	0,6															
MgAlCa	ISO-MgAl6Sr2	ISO-MB21520	AJ62	D	min. max.	Rem.	5,5	-	0,2							2,1		0,08	0,004	0,008	-	-	-	-
							6,6	0,20	0,6															
MgAlCa	ISO-MgAl5Ca2RE2	ISO-MB25120	AE62	D	min. max.	Rem.	6,1	-	0,13	2,2							2,0		-	-	-	-	-	-
							6,7	0,04	0,35	2,8														
MgAlCa	ISO-MgAl6Ca2Sr	ISO-MB25130	AX62	D	min. max.	Rem.	5,5	-	0,30							0,20	1,8		-	-	-	-	-	-
							6,5	0,10	0,40															
MgZnCu	ISO-MgZn6Cu3Mn	ISO-MB32110	ZC63	S,K,L	min. max.	Rem.	-	5,5	0,25							0,30	2,5	0,10	0,004	0,001	0,001	0,001	0,01	-
							0,2	6,5	0,75															
MgZn-REZr	ISO-MgZn4RE1Zr ^c	ISO-MB35110	ZE41	S,K,L	min. max.	Rem.	-	3,5	-	0,75	0,4							0,01	0,01	0,03	-	-	-	-
							-	5,0	0,15	1,75	1,0													
MgZn-REZr	ISO-MgRE3Zn-2Zr ^c	ISO-MB65120	EZ33	S,K,L	min. max.	Rem.	-	2,0	-	2,4	0,4							-	0,01	0,03	-	-	-	-
							-	3,0	0,15	4,0	1,0													
MgREAg-Zr	ISO-MgRE3Zn-Zr ^d	ISO-MB65130	EZ30	S,K,L	min. max.	Rem.	-	0,10	-	2,0	0,4						0,5	-	0,01	0,01	-	-	-	-
							-	0,8	0,10	3,7	1,0													
MgREAg-Zr	ISO-MgAg2RE2Zr ^e	ISO-MB65210	QE22	S,K,L	min. max.	Rem.	-	-	-	2,0	0,4	2,0						-	0,01	0,03	-	-	-	-
							-	0,2	0,15	3,0	1,0	3,0												
MgYREZr	ISO-MgRE2Ag-1Zr ^e	ISO-MB65220	EQ21	S,K,L	min. max.	Rem.	-	-	-	1,5	0,4	1,3						-	0,01	0,03	-	-	-	-
							-	0,2	0,15	3,0	1,0	1,7												
MgYREZr	ISO-MgY5RE4Zr ^f	ISO-MB95310	WE54	S,K,L	min. max.	Rem.	-	-	-	1,5	0,4	4,75						-	0,01	0,03	-	-	-	-
							-	0,2	0,15	4,0	1,0	5,5	0,2											
MgYREZr	ISO-MgY4RE3Zr ^f	ISO-MB95320	WE43	S,K,L	min. max.	Rem.	-	-	-	2,4	0,4	3,7						-	0,01	0,03	-	-	-	-
							-	0,2	0,15	4,4	1,0	4,3	0,2											

Table 2 (continued)

Alloy group	Material designation			Composition % mass fraction																				
	Designation by symbols	Designation by numbers	ASTM designation	Casting process	Min. or max.	Mg	Al	Zn	Mn ^a	RE ^b	Zr	Ag	Y	Gd	Li	Sr	Ca	Si	Fe	Cu	Ni	Other each	Fe/Mn	
MgG-dYZr	ISO-MgGd7Y6Zr	ISO-MB69110	VW76	K	min.	Rem.	-	-	-	-	0,2	-	5,5	6,5	-	-	-	-	-	-	-	-	-	-
					max.		-	0,03		0,5		6,5	7,5	0,2										
MgREG-dZr ^h	ISO-MgG-d10Y3Zr	ISO-MB69120	VW103	S,K,L	min.	Rem.	-	-	-	8,3	0,4	-	2,3	-	-	-	-	-	-	-	-	-	-	-
					max.		-	0,2		1,0		3,7												
	ISO-MgRE3G-d1Zr	ISO-MB65410	EV31	S,K,L	min.	Rem.	-	-	-	2,6	0,4	-	-	1,0	-	-	-	-	-	-	-	-	-	
					max.		-	0,2	0,03	3,1	1,0	0,05		1,7					0,01	0,01	0,002	0,01	-	

a For maximum manganese content see [Annex B](#).
b RE = rare earth elements.
c Cerium-rich.
d Neodymium.
e Neodymium-rich.
f Neodymium and heavy RE-rich.
g Improved corrosion resistance can be obtained by reducing the maximum manganese content to 0,03 %, the maximum iron content to 0,01 %, the maximum copper content to 0,02 % and the maximum zinc + silver content to 0,2 %.
h Neodymium is 2,6 % to 3,1 %; other rare earth metals may also be present to a maximum of 0,4 %. These RE shall principally be cerium, lanthanum and praseodymium.
For information on trace elements see [Annex C](#).

Table 3 — Mechanical properties of sand-cast magnesium alloys

Alloy group	Material designation			Temper designation	Tensile strength R_m MPa min.	0,2 % proof stress $R_{p0,2}$ MPa min.	Elongation A_{50} % min.	Brinell hardness HBW ^a
	Designation by symbols	Designation by numbers	ASTM designation					
MgAlZn	ISO-MgAl9Zn1(A)	ISO-MC21120	AZ91	F	160	90	2	50 to 65
				T4	240	110	6	55 to 70
				T6	240	150	2	60 to 90
	ISO-MgAl6Zn3	ISO-MC21130	AZ63	F	179	76	4	45 to 55
				T4	234	76	7	50 to 60
				T5	179	83	2	50 to 60
				T6	234	110	3	65 to 80
	ISO-MgAl8Zn1	ISO-MC21110	AZ81	T4	234	76	7	50 to 60
	MgAlMn	ISO-MgAl10Mn	ISO-MC21240	AM100	T6	241	117	2
MgZnCu	ISO-MgZn-6Cu3Mn	ISO-MC32110	ZC63	T6	195	125	2	55 to 65
MgZnREZr	ISO-MgZn4RE1Zr	ISO-MC35110	ZE41	T5	200	135	2,5	55 to 70
	ISO-MgRE3Zn2Zr	ISO-MC65120	EZ33	T5	140	95	2,5	50 to 60
	ISO-MgRE3ZnZr	ISO-MC65130	EZ30	T6	245 ^b	140 ^b	4	65 to 80
MgREAgZr	ISO-MgAg2RE2Zr	ISO-MC65210	QE22	T6	240	175	2	70 to 90
	ISO-MgRE2Ag1Zr	ISO-MC65220	EQ21	T6	240	175	2	70 to 90
MgYREZr	ISO-MgY5RE4Zr	ISO-MC95310	WE54	T6	250	170	2	80 to 90
	ISO-MgY4RE3Zr	ISO-MC95320	WE43	T6	220	170	2	75 to 90
	ISO-MgRE10Y3Zr	ISO-MC65310	VW103	T6	300 ^b	220 ^b	2	90 to 110
MgREGdZr	ISO-MgRE3Gd1Zr	ISO-MC65410	EV31	T6	248 ^c	145 ^c	2	70 to 90

^a These values are for guidance only.

^b This value applies to both separately cast test pieces and samples cut from castings, for thickness up to 20 mm.

^c This value applies to both separately cast test pieces and samples cut from castings, for thickness up to 30 mm.

NOTE Values given are for separately cast test pieces. The properties of the casting are expected to be 70 % of the values from separately cast test pieces for thicknesses of casting up to 20 mm.

Table 4 — Mechanical properties of permanent-mould cast magnesium alloys

Alloy group	Material designation			Temper designation	Tensile strength R_m MPa min.	0,2 % proof stress $R_{p0,2}$ MPa min.	Elongation A_{50} % min.	Brinell hardness HBW _a
	Designation by symbols	Designation by numbers	ASTM designation					
MgAlZn	ISO-MgAl9Zn1(A)	ISO-MC21120	AZ91	F	160	110	2	55 to 70
				T4	240	120	6	55 to 70
				T6	240	150	2	60 to 90
	ISO-MgAl8Zn1	ISO-MC21110	AZ81	T4	234	76	2	50 to 60
MgAlMn	ISO-MgAl10Mn	ISO-MC21240	AM100	F	138	69	2	50 to 60
				T4	234	69	6	50 to 60
				T6	234	103	2	60 to 80
MgZnCu	ISO-MgZn-6Cu3Mn	ISO-MC32110	ZC63	T6	195	125	2	55 to 65
MgZnREZr	ISO-MgZn4RE1Zr	ISO-MC35110	ZE41	T5	210	135	3	55 to 70
	ISO-MgRE3Zn2Zr	ISO-MC65120	EZ33	T5	145	100	3	50 to 60
	ISO-MgRE3ZnZr	ISO-MC65130	EZ30	T6	245 ^b	140 ^b	4	65 to 80
MgREAgZr	ISO-MgAg2RE2Zr	ISO-MC65210	QE22	T6	240	175	2	70 to 90
	ISO-MgRE2Ag1Zr	ISO-MC65220	EQ21	T6	240	175	2	70 to 90
MgYREZr	ISO-MgY5RE4Zr	ISO-MC95310	WE54	T6	250	170	2	80 to 90
	ISO-MgY4RE3Zr	ISO-MC95320	WE43	T6	220	170	2	75 to 90
	ISO-MgGd7Y6Zr	ISO-MC69110	VW76	T6	300 ^b	200 ^b	1	110 to 118
MgGdYZr	ISO-MgGd10Y3Zr	ISO-MC65310	VW103	T6	300 ^b	220 ^b	2	90 to 110
MgREGdZr	ISO-MgRE3Gd1Zr	ISO-MC65410	EV31	T6	248 ^c	145 ^c	2	70 to 90

^a These values are for guidance only.

^b This value applies to both separately cast test pieces and samples cut from castings, for thickness up to 20 mm.

^c This value applies to both separately cast test pieces and samples cut from castings, for thickness up to 30 mm.

NOTE Values given are for separately cast test pieces. The properties of the casting are expected to be 70 % of the values from separately cast test pieces for thicknesses of casting up to 20 mm.

Table 5 — Mechanical properties of pressure die cast magnesium alloys

Alloy group	Material designation			Temper designation	Tensile strength Rm MPa	0,2 % proof stress Rp0,2 MPa	Elongation A ₅₀ %	Brinell hardness HBW
	Designation by symbols	Designation by numbers	ASTM designation					
MgAlZn	ISO-MgAl9Zn1(A)	ISO-MC21120	AZ91	F	200 to 260	140 to 170	1 to 9	65 to 85
	ISO-MgAl9Zn-1Ca	ISO-MC21122	AZ91	F	220 to 270	160 to 190	2 to 5	55 to 65
MgAlMn	ISO-MgAl2Mn	ISO-MC21210	AM20	F	150 to 220	80 to 100	8 to 25	40 to 55
	ISO-MgAl5Mn	ISO-MC21220	AM50	F	180 to 230	110 to 130	5 to 20	50 to 65
	ISO-MgAl6Mn	ISO-MC21230	AM60	F	190 to 250	120 to 150	4 to 18	55 to 70
MgAlSi	ISO-MgAl2Si	ISO-MC21310	AS21	F	170 to 230	110 to 130	4 to 14	50 to 70
	ISO-MgAl4Si	ISO-MC21320	AS41	F	200 to 250	120 to 150	3 to 12	55 to 80
MgAlSr	ISO-MgAl5Sr2	ISO-MC21410	AJ52	F	190 to 235	110 to 150	3 to 9	50 to 70
	ISO-MgAl6Sr2	ISO-MC21420	AJ62	F	200 to 260	120 to 160	3 to 10	55 to 80
MgAlCa	ISO-MgAl-5Ca2RE2	ISO-MC25120	AE62	F	225 to 255	160 to 175	5,5 to 8,5	45 to 55
	ISO-MgAl-6Ca2Sr	ISO-MC25130	AX62	F	200 to 250	165 to 185	3 to 6	70 to 80
MgAlRE ^a	ISO-MgAl4RE4	ISO-MC21410	AE44	F	220 to 260	130 to 160	6 to 15	60 to 80

^a Values given are from separately cast 6 mm round tensile test bars (L₀ = 50 mm)

NOTE 1 The values given in this table are for guidance only, see 5.2.

NOTE 2 Values given are for separately cast test pieces of 20 mm² cross-sectional area and a minimum thickness of 2 mm.

Annex A (informative)

List of ISO and equivalent international alloy designations

Material designation		European (in accordance with EN 1754)		USA	Germany		United Kingdom		France	Japan	China
In accordance with ISO 2092:1981 ^a	In accordance with EN 1753	Symbol	Number	ASTM	DIN	Pre-vious com-mon designa-tion	BS	Previous common designa-tion	NF	JIS	SAC
ISO-MgAl8Zn1	ISO-MC21110	EN-MCMgAl8Zn1	EN-MC21110	AZ81	—	—	—	—	—	—	AZ81
ISO-MgAl9Zn1(A)	ISO-MC21120	EN-MC-MgAl9Zn1(A)	EN-MC21120	AZ91	MgAl9Zn	AZ91	MAG 7	C, AZ91	G-A9Z1	MD1D	AZ91
ISO-MgAl9Zn1(B)	ISO-MC21120	EN-MC-MgAl9Zn1(B)	EN-MC21120	AZ91	—	AZ91	—	AZ91	—	—	AZ91
ISO-MgAl9Zn-1Ca	ISO-MC21122	EN—MC-MgAl9Zn1Ca	—	AZ91	—	—	—	—	—	—	—
ISO-MgAl6Zn3	ISO-MC21130	EN-MC-MgAl6Zn3	EN-MC21130	AZ63	—	—	—	—	—	—	AZ63
ISO-MgAl2Mn	ISO-MC21210	EN-MC-MgAl2Mn	EN-MC21210	AM20	MgAl12Zn	AM20	—	—	—	MD5	AM20
ISO-MgAl5Mn	ISO-MC21220	EN-MC-MgAl5Mn	EN-MC21220	AM50	MgAl5Mn	AM50	—	—	—	MD4	AM50
ISO-MgAl6Mn	ISO-MC21230	EN-MC-MgAl6Mn	EN-MC21230	AM60	MgAl6Mn	AM60	—	—	—	MD2B	AM60
ISO-MgAl10Mn	ISO-MC21240	EN-MC-MgAl10Mn	EN-MC21240	AM100	—	—	—	—	—	MC15	AM100
ISO-MgAl2Si	ISO-MC21310	EN-MCMgAl-2Si	EN-MC21310	AS21	—	AS21	—	—	—	MD6	AS21
ISO-MgAl4Si	ISO-MC21320	EN-MCMgAl-4Si	EN-MC21320	AS41	MgAl4Si	AS41	—	—	G-A4S1	MD3B	AS41
ISO-MgAl5Sr2	ISO-MC21410	EN-MC-MgAl5Sr2	EN-MC21410	AJ52	—	—	—	—	—	—	AJ52
ISO-Mg6Sr2	ISO-MC21520	EN-MC-MgAl6Sr2	EN-MC21420	AJ62	—	—	—	—	—	—	AJ62
ISO-MgAl-5Ca2RE2	ISO-MC25120	EN-MCMgAl-5Ca2RE	—	AE62	—	—	—	—	—	—	—
ISO-MgAl-6Ca2Sr	ISO-MC25130	EN-MCMgAl-6Ca2Sr	—	AJ62	—	—	—	—	—	—	—
ISO-MgAl-4RE4	ISO-MC21410	EN-MCMgAl-4RE4	EN-MC21410	AE44	—	—	—	—	—	—	AE44

^a Withdrawn in 2002.