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

**AMENDMENT 1: Additional alloys**

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

*AMENDEMENT 1: Alliages supplémentaires*

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Case postale 56 • CH-1211 Geneva 20  
Tel. + 41 22 749 01 11  
Fax + 41 22 749 09 47  
E-mail [copyright@iso.org](mailto:copyright@iso.org)  
Web [www.iso.org](http://www.iso.org)

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## Foreword

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Amendment 1 to ISO 16220:2005 was prepared by Technical Committee ISO/TC 79, *Light metals and their alloys*, Subcommittee SC 5, *Magnesium and alloys of cast or wrought magnesium*.

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## Introduction

The purpose of ISO 16220:2005/Amd.1:2007 is to include two new commercial alloys based on the combination of rare earth metals, gadolinium and zirconium as alloying elements.

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# Magnesium and magnesium alloys — Magnesium alloy ingots and castings

## AMENDMENT 1: Additional alloys

### *Page 5, Table 1 — Chemical composition of magnesium alloy ingots*

Replace the existing Table 1 with the following new Table 1, where two new grades are added: ISO-MgAl4RE4 and ISO-MgRE3Gd1Zr.

NOTE 1 The new grades ISO-MgAl4RE4 and ISO-MgRE3Gd1Zr are not included in EN 1753.

### *Page 6, Table 2 — Chemical composition of magnesium alloy castings*

Replace the existing Table 2 with the following new Table 2, where two new grades are added: ISO-MgAl4RE4 and ISO-MgRE3Gd1Zr.

NOTE 2 The new grades ISO-MgAl4RE4 and ISO-MgRE3Gd1Zr are not included in EN 1753.

### *Page 7, Table 3 — Mechanical properties of sand-cast magnesium alloys*

Replace the existing Table 3 with the following new Table 3, where the new grade ISO-MgRE3Gd1Zr is added at the bottom of the table.

NOTE 3 The new grade ISO-MgRE3Gd1Zr is not included in EN 1753.

### *Page 7, Table 4 — Mechanical properties of permanent-mould cast magnesium alloys*

Replace the existing Table 4 with the following new Table 4, where the new grade ISO-MgRE3Gd1Zr is added at the bottom of the table.

NOTE 4 The new grade ISO-MgRE3Gd1Zr is not included in EN 1753.

### *Page 8, Table 5 — Mechanical properties of pressure die cast magnesium alloys*

Replace the existing Table 5 with the following new Table 5, where the new grade ISO-MgAl4RE4 is added.

NOTE 5 The new grade ISO-MgAl4RE4 is not included in EN 1753.

Table 1 — Chemical composition of magnesium alloy ingots

Alloy group	Material designation		Composition % by mass																RE/Al ratio	
	In accordance with ISO 2092:1981 <sup>a</sup>	In accordance with EN 1753	Min. or max.	Mg	Al	Zn	Mn <sup>b</sup>	RE <sup>c</sup>	Zr	Ag	Y	Gd	Li	Si	Fe	Cu	Ni	Others each		
MgAlZn	ISO-MgAl9Zn1 (A)	ISO-MB21120	min.	Rem.	8,5	0,45	0,17	-	-	-	-	-	-	0,08	0,004	0,025	0,001	-	-	
			max.		9,5	0,9	0,40	-	-	-	-	-	-	-	0,08	0,004	0,025	0,001	0,01	-
				Rem.	8,0	0,3	0,1	-	-	-	-	-	-	-	0,3	0,03	0,20	0,01	0,05	-
MgAlMn	ISO-MgAl9Zn1 (B)	ISO-MB21121	min.	Rem.	10,0	1,0	0,50	-	-	-	-	-	-	0,05	0,004	0,008	0,001	0,01	-	-
			max.		1,7	0,20	0,35	-	-	-	-	-	-	0,05	0,004	0,008	0,001	0,01	-	-
				Rem.	2,5	0,20	0,60	-	-	-	-	-	-	0,08	0,004	0,008	0,001	0,01	-	-
MgAlSi	ISO-MgAl5Mn	ISO-MB21220	min.	Rem.	4,5	-	0,28	-	-	-	-	-	-	0,08	0,004	0,008	0,001	0,01	-	-
			max.		5,3	0,30	0,50	-	-	-	-	-	-	0,08	0,004	0,008	0,001	0,01	-	-
				Rem.	5,6	0,30	0,26	-	-	-	-	-	-	0,08	0,004	0,008	0,001	0,01	-	-
MgAlRE <sup>d</sup>	ISO-MgAl6Mh	ISO-MB21230	min.	Rem.	6,4	0,30	0,50	-	-	-	-	-	-	0,7	0,004	0,008	0,001	0,01	-	-
			max.		1,9	0,2	0,2	-	-	-	-	-	-	1,2	0,004	0,008	0,001	0,01	-	-
				Rem.	2,5	0,20	0,6	-	-	-	-	-	-	0,7	0,004	0,008	0,001	0,01	-	-
MgZnCu	ISO-MgAl4Si	ISO-MB21320	min.	Rem.	3,7	-	0,2	-	-	-	-	-	-	0,7	0,004	0,008	0,001	0,01	-	-
			max.		4,8	0,20	0,6	-	-	-	-	-	-	1,2	0,004	0,008	0,001	0,01	-	-
				Rem.	3,6	0,20	0,15	3,6	-	-	-	-	-	0,08	0,004	0,008	0,001	0,01	-	-
MgREAgZr <sup>e</sup>	ISO-MgAl4RE4	ISO-MB21410	min.	Rem.	4,4	0,20	0,50	4,6	-	-	-	-	-	0,08	0,004	0,008	0,001	0,01	-	-
			max.		0,2	5,5	0,25	-	-	-	-	-	-	0,20	0,05	2,4	-	-	-	-
				Rem.	0,2	6,5	0,75	-	-	-	-	-	-	0,20	0,05	3,0	0,01	0,01	-	-
MgZnREZr <sup>d</sup>	ISO-MgZn6Cu3Mn	ISO-MB32110	min.	Rem.	-	3,5	0,15	1,0	1,0	-	-	-	-	0,01	0,01	0,03	0,005	0,01	-	-
			max.		-	5,0	0,15	1,75	-	-	-	-	-	0,01	0,01	0,03	0,005	0,01	-	-
				Rem.	-	2,0	-	2,4	0,1	-	-	-	-	0,01	0,01	0,03	0,005	0,01	-	-
MgREAgZr <sup>e</sup>	ISO-MgRE3Zn2Zr	ISO-MB65120	min.	Rem.	-	3,0	0,15	4,0	1,0	-	-	-	-	0,01	0,01	0,03	0,005	0,01	-	-
			max.		-	2,0	-	2,0	0,1	-	-	-	-	0,01	0,01	0,03	0,005	0,01	-	-
				Rem.	-	0,2	0,15	3,0	1,0	3,0	-	-	-	0,01	0,01	0,03	0,005	0,01	-	-
MgYREZr <sup>f, g</sup>	ISO-MgAg2RE2Zr	ISO-MB6520	min.	Rem.	-	-	-	1,5	0,1	1,3	-	-	-	0,01	0,01	0,05	-	-	-	-
			max.		-	0,2	0,15	3,0	1,0	1,7	-	-	-	0,01	0,01	0,10	0,005	0,01	-	-
				Rem.	-	0,2	0,15	2,0	0,1	4,75	-	-	-	0,20	0,01	0,03	0,005	0,01	-	-
MgREGdZr <sup>h</sup>	ISO-MgY5RE4Zr	ISO-MB95310	min.	Rem.	-	0,20	0,15	4,0	1,0	-	-	-	-	0,20	0,01	0,03	0,005	0,01	-	-
			max.		-	-	-	2,4	0,1	-	-	-	-	0,20	0,01	0,03	0,005	0,01	-	-
				Rem.	-	0,20	0,15	4,4	1,0	4,3	-	-	-	0,20	0,01	0,03	0,005	0,01	-	-
MgREGdZr <sup>h</sup>	ISO-MgY4RE3Zr	ISO-MB95320	min.	Rem.	-	0,20	0,15	4,4	1,0	-	-	-	-	0,01	0,01	0,03	0,005	0,01	-	-
			max.		-	0,20	0,15	2,6	0,1	-	-	-	-	0,01	0,01	0,03	0,005	0,01	-	-
				Rem.	-	0,20	0,15	3,1	1,0	1,7	-	-	-	0,01	0,01	0,03	0,005	0,01	-	-

<sup>a</sup> Withdrawn in 2002.

<sup>b</sup> For maximum manganese content, see Annex B.

<sup>c</sup> RE = rare earth metals.

<sup>d</sup> Cerium-rich.

<sup>e</sup> Neodymium-rich.

<sup>f</sup> Neodymium- and heavy RE-rich.

<sup>g</sup> Improved corrosion resistance may 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 %.

<sup>h</sup> Neodymium is 2,6 % to 3,1 %; other rare earth metals may also be present to a total 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 % by mass														RE/Al ratio			
	In accordance with ISO 2092:1981 <sup>a</sup>	In accordance with EN 1753	Casting process	Min. or max.	Mg	Al	Zn	Mn <sup>b</sup>	RE <sup>c</sup>	Zr	Ag	Y	Gd	Li	Si	Fe		Cu	Ni	Others each
MgAlZn	ISO-MgAl9Zn1(A)	ISO-MC21120	D	min. max.	Rem.	8,3 9,5	0,35 0,9	0,15 0,50	-	-	-	-	-	-	0,08	0,005	0,025	0,001	-	0,032
		ISO-MC21120	S, K, L	min. max.	Rem.	8,3 9,7	0,40 1,0	0,17 0,35	-	-	-	-	-	-	0,20	0,005	0,030	0,001	-	0,032
	ISO-MgAl9Zn1(B)	ISO-MC21121	D, S, K, L	min. max.	Rem.	8,0 10,0	0,3 1,0	0,1 0,6	-	-	-	-	-	-	0,3	0,03	0,20	0,01	-	0,05
		ISO-MC21210	D	min. max.	Rem.	1,6 2,5	0,20 0,70	0,33 0,70	-	-	-	-	-	-	0,08	0,004	0,008	0,001	-	0,012
MgAlMn	ISO-MgAl5Mn	ISO-MC21220	D	min. max.	Rem.	4,4 5,3	0,26 0,30	0,26 0,60	-	-	-	-	-	-	0,08	0,004	0,008	0,001	-	0,015
		ISO-MC21230	D	min. max.	Rem.	5,5 6,4	0,24 0,30	0,24 0,60	-	-	-	-	-	0,08	0,005	0,008	0,001	-	0,021	
	ISO-MgAl2Si	ISO-MC21310	D	min. max.	Rem.	1,8 2,5	0,18 0,20	0,18 0,70	-	-	-	-	-	0,7 1,2	0,004	0,008	0,001	-	0,022	
MgAlSi	ISO-MgAl4Si	ISO-MC21320	D	min. max.	Rem.	3,5 4,8	0,20 0,70	0,18 0,70	-	-	-	-	-	0,5 1,2	0,004	0,008	0,001	-	0,022	
		ISO-MC21410	D	min. max.	Rem.	3,5 4,5	0,15 0,20	0,15 0,50	3,5 4,5	-	-	-	-	0,08	0,005	0,008	0,001	-	0,8	
MgZnCu	ISO-MgZn4RE1Zr	ISO-MC32110	S, K, L	min. max.	Rem.	0,2	5,5 6,5	0,25 0,75	-	-	-	-	-	0,20	0,05	2,4 3,0	0,01	0,01	0,01	-
		ISO-MC35110	S, K, L	min. max.	Rem.	-	3,5 5,0	0,15 1,75	0,4 1,75	0,4 1,0	-	-	-	0,01	0,01	0,03	0,005	0,01	-	
MgREAgZr <sup>e</sup>	ISO-MgRE3Zn2Zr	ISO-MC65120	S, K, L	min. max.	Rem.	-	2 3	0,15 0,15	2,5 4,0	0,4 1,0	-	-	-	0,01	0,01	0,03	0,005	0,01	-	
		ISO-MC65210	S, K, L	min. max.	Rem.	-	0,2 0,2	0,15 0,15	3 3,0	0,4 1,0	2,0 3,0	-	-	0,01	0,01	0,03	0,005	0,01	-	
MgYREZr <sup>g, h</sup>	ISO-MgY8RE4Zr	ISO-MC95310	S, K, L	min. max.	Rem.	-	0,2 0,2	0,15 0,15	4,0 4,0	1,0 1,0	4,75 5,5	-	0,2	0,01	0,01	0,03	0,005	0,01	-	
		ISO-MC95320	S, K, L	min. max.	Rem.	-	0,2 0,2	0,15 0,15	4,4 4,4	1,0 1,0	3,7 4,3	-	0,2	0,01	0,01	0,03	0,005	0,01	-	
MgREGaZr <sup>i</sup>	ISO-MgRE3Gd1Zr	ISO-MB65410	S, K, L	min. max.	Rem.	-	0,20 0,50	0,4 0,03	2,6 3,1	0,4 1,0	-	-	1,0 1,7	-	0,010	0,01	0,01	0,0020	-	

<sup>a</sup> Withdrawn in 2002.

<sup>b</sup> For maximum manganese content, see Annex B.

<sup>c</sup> RE = rare earth metals.

<sup>d</sup> If the minimum Mn limit is not met.

<sup>e</sup> Cerium-rich.

<sup>f</sup> Neodymium-rich.

<sup>g</sup> Neodymium- and heavy RE-rich.

<sup>h</sup> Improved corrosion resistance may 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 %.

<sup>i</sup> Neodymium is 2,6 % to 3,1 %; other rare earth metals may also be present to a total maximum of 0,4 %. These RE shall principally be cerium, lanthanum and praseodymium.

Table 3 — Mechanical properties of sand-cast magnesium alloys

Alloy group	Material designation		Temper designation	Tensile strength $R_m$ N/mm <sup>2</sup> min.	0,2% proof stress $R_{p0,2}$ N/mm <sup>2</sup> min.	Elongation $\Delta L$ % min.	Brinell hardness HBW <sup>a</sup>
	In accordance with ISO 2092:1981 <sup>b</sup>	In accordance with EN 1753					
MgAlZn	ISO-MgAl9Zn1(A)	ISO-MC21120	F	160	90	2	50 to 65
			T4	240	110	6	55 to 70
			T6	240	150	2	60 to 90
MgZnCu	ISO-MgZn6Cu3Mn	ISO-MC32110	T6	195	125	2	55 to 65
MgZnREZr	ISO-MgZn4RE1Zr	ISO-MC35110	T5	200	135	2,5	55 to 70
	ISO-MgRE3Zn2Zr	ISO-MC65120	T5	140	95	2,5	50 to 60
MgREAgZr	ISO-MgAg2RE2Zr	ISO-MC65210	T6	240	175	2	70 to 90
	ISO-MgRE2Ag1Zr	ISO-MC65220	T6	240	175	2	70 to 90
MgYREZr	ISO-MgY5RE4Zr	ISO-MC95310	T6	250	170	2	80 to 90
	ISO-MgY4RE3Zr	ISO-MC95320	T6	220	170	2	75 to 90
MgREGdZr	ISO-MgRE3Gd1Zr	ISO-MC65410	T6	248 <sup>c</sup>	145 <sup>c</sup>	2	70 to 90

NOTE 1 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, except for ISO-MgRE3Gd1Zr where samples cut from castings are the same as separately cast test bars, see footnote c.

NOTE 2 1 N/mm<sup>2</sup> is equivalent to 1 MPa.

<sup>a</sup> These values are for guidance only.

<sup>b</sup> Withdrawn in 2002.

<sup>c</sup> This value applies to both separately cast test pieces and samples cut from castings, for thicknesses up to 30 mm.

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

Alloy group	Material designation		Temper designation	Tensile strength $R_m$ N/mm <sup>2</sup> min.	0,2% proof stress $R_{p0,2}$ N/mm <sup>2</sup> min.	Elongation $\Delta L$ % min.	Brinell hardness HBW <sup>a</sup>
	In accordance with ISO 2092:1981 <sup>b</sup>	In accordance with EN 1753					
MgAlZn	ISO-MgAl9Zn1(A)	ISO-MC21120	F	160	110	2	55 to 70
			T4	240	120	6	55 to 70
			T6	240	150	2	60 to 90
MgZnCu	ISO-MgZn6Cu3Mn	ISO-MC32110	T6	195	125	2	55 to 65
MgZnREZr	ISO-MgZn4RE1Zr	ISO-MC35110	T5	210	135	3	55 to 70
	ISO-MgRE3Zn2Zr	ISO-MC65120	T5	145	100	3	50 to 60
MgREAgZr	ISO-MgAg2RE2Zr	ISO-MC65210	T6	240	175	3	70 to 90
	ISO-MgRE2Ag1Zr	ISO-MC65220	T6	240	175	2	70 to 90
MgYREZr	ISO-MgY5RE4Zr	ISO-MC95310	T6	250	170	2	80 to 90
	ISO-MgY4RE3Zr	ISO-MC95320	T6	220	170	2	75 to 90
MgREGdZr	ISO-MgRE3Gd1Zr	ISO-MC65410	T6	248 <sup>c</sup>	145 <sup>c</sup>	2	70 to 90

NOTE 1 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, except for ISO-MgRE3Gd1Zr where samples cut from castings are the same as separately cast test bars, see footnote c.

NOTE 2 1 N/mm<sup>2</sup> is equivalent to 1 MPa.

<sup>a</sup> These values are for guidance only.

<sup>b</sup> Withdrawn in 2002.

<sup>c</sup> This value applies to both separately cast test pieces and samples cut from castings, for thicknesses up to 30 mm.