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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



Reference number
ISO 16220:2005/Amd.1:2007(E)

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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*.

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 ^a	In accordance with EN 1753	Min. or max.	Mg	Al	Zn	Mn ^b	RE ^c	Zr	Ag	Y	Gd	Li	Si	Fe	Cu	Ni	Others each	
MgAlZn	ISO-MgAl9Zn1 (A)	ISO-MB21120	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	min. max.	Rem.	8,0 10,0	0,3 1,0	0,1 0,50	- -	- -	- -	- -	- -	- -	0,3	0,03	0,20	0,01	- 0,05	- -
MgAlMn	ISO-MgAl2Mn	ISO-MB21210	min. max.	Rem.	1,7 2,5	- 0,20	0,35 0,60	- -	- -	- -	- -	- -	- -	0,05	0,004	0,008	0,001	- 0,01	- -
	ISO-MgAl5Mn	ISO-MB21220	min. max.	Rem.	4,5 5,3	- 0,30	0,28 0,50	- -	- -	- -	- -	- -	- -	0,08	0,004	0,008	0,001	- 0,01	- -
	ISO-MgAl6Mn	ISO-MB21230	min. max.	Rem.	5,6 6,4	- 0,30	0,26 0,50	- -	- -	- -	- -	- -	- -	0,08	0,004	0,008	0,001	- 0,01	- -
MgAlSi	ISO-MgAl2Si	ISO-MB21310	min. max.	Rem.	1,9 2,5	- 0,20	0,2 0,6	- -	- -	- -	- -	- -	- -	0,7 1,2	0,004	0,008	0,001	- 0,01	- -
	ISO-MgAl4Si	ISO-MB21320	min. max.	Rem.	3,7 4,8	- 0,20	0,2 0,6	- -	- -	- -	- -	- -	- -	0,7 1,2	0,004	0,008	0,001	- 0,01	- 0,9
MgAlRE ^d	ISO-MgAl4RE4	ISO-MB21410	min. max.	Rem.	3,6 4,4	- 0,20	0,15 0,50	3,6 4,6	- -	- -	- -	- -	- -	0,08	0,004	0,008	0,001	0,01	-
MgZnCu	ISO-MgZn6Cu3Mn	ISO-MB32110	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	- -
	ISO-MgZn4RE1Zr	ISO-MB35110	min. max.	Rem.	- -	3,5 5,0	0,15 1,75	1,0 4,6	0,1 1,0	- -	- -	- -	- -	0,01	0,01	0,03	0,005	- 0,01	- -
MgZnREZr ^d	ISO-MgRE3Zn2Zr	ISO-MB65120	min. max.	Rem.	- -	2,0 3,0	- 0,15	2,4 4,0	0,1 1,0	- -	- -	- -	- -	0,01	0,01	0,03	0,005	- 0,01	- -
	ISO-MgAg2RE2Zr	ISO-MB65210	min. max.	Rem.	- -	- 0,2	- 0,15	2,0 3,0	0,1 1,0	2,0 3,0	- -	- -	- -	0,01	0,01	0,03	0,005	- 0,01	- -
MgREAgZr ^e	ISO-MgRE2Ag1Zr	ISO-MB65220	min. max.	Rem.	- -	- 0,2	- 0,15	1,5 3,0	0,1 1,0	1,3 1,7	- -	- -	- -	0,01	0,01	0,05 0,10	0,005	- 0,01	- -
	ISO-MgY5RE4Zr	ISO-MB95310	min. max.	Rem.	- -	0,20	- 0,15	2,0 4,0	0,1 1,0	- -	4,75 5,5	- -	0,20	0,01	0,01	0,03	0,005	- 0,01	- -
MgYREZr ^{f, g}	ISO-MgY4RE3Zr	ISO-MB95320	min. max.	Rem.	- -	- 0,20	- 0,15	2,4 4,4	0,1 1,0	- -	3,7 4,3	- -	0,20	0,01	0,01	0,03	0,005	- 0,01	- -
	ISO-MgRE3Gd1Zr	ISO-MB65410	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	0,010	0,01	0,0020	- 0,01	- -

^a Withdrawn in 2002.^b For maximum manganese content, see Annex B.^c RE = rare earth metals.^d Cerium-rich.^e Neodymium-rich.^f Neodymium- and heavy RE-rich.^g 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 %.^h 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																	Fe/Mn ratio ^d	RE/Al ratio
	In accordance with ISO 2092:1981 ^a	In accordance with EN 1753	Casting process	Min. or max.	Mg	Al	Zn	Mn ^b	RE ^c	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	- -	0,01	- 0,032	
	ISO-MgAl9Zn1(A)	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	0,001	0,01	- 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	0,01	0,05	- -	
	ISO-MgAl2Mn	ISO-MC21210	D	min. max.	Rem.	2,5	-	0,20	0,70	- -	- -	- -	- -	- -	0,08	0,004	0,008 0,001	- -	0,01	- 0,012	
MgAlMn	ISO-MgAl5Mn	ISO-MC21220	D	min. max.	Rem.	4,4 5,3	0,30	0,60	- -	- -	- -	- -	- -	- -	0,08	0,004	0,008 0,001	- -	0,01	- 0,015	
	ISO-MgAl6Mn	ISO-MC21230	D	min. max.	Rem.	5,5 6,4	-	0,24 0,60	- -	- -	- -	- -	- -	- -	0,08	0,005	0,008 0,001	- -	0,01	- 0,021	
	ISO-MgAl2Si	ISO-MC21310	D	min. max.	Rem.	1,8 2,5	-	0,18 0,70	- -	- -	- -	- -	- -	0,7 1,2	0,004	0,008 0,001	- -	0,01	- 0,022		
	ISO-MgAl4Si	ISO-MC21320	D	min. max.	Rem.	3,5 4,8	-	0,18 0,70	- -	- -	- -	- -	- -	0,5 1,2	0,004	0,008 0,001	- -	0,01	- 0,022		
MgAlRE ^e	ISO-MgAl4RE4	ISO-MC21410	D	min. max.	Rem.	3,5 4,5	0,20	0,50	3,5 4,5	- -	- -	- -	- -	- -	0,08	0,005	0,008 0,001	- -	0,01	- 0,8	
MgZnCu	ISO-MgZn6Cu3Mn	ISO-MC32110	S, K, L	min. max.	Rem.	-	5,5 6,5	0,25 0,75	- -	- -	- -	- -	- -	- -	0,20	0,05	2,4 3,0	- 0,01	0,01	- -	
	ISO-MgZn4RE1Zr	ISO-MC35110	S, K, L	min. max.	Rem.	-	3,5 5,0	- 0,15	0,75 1,75	0,4 1,0	- -	- -	- -	- -	0,01	0,01	0,03 0,005	- 0,005	0,01	- -	
MgREAgZr ^f	ISO-MgRE3Zn2Zr	ISO-MC65120	S, K, L	min. max.	Rem.	-	2 3	- 0,15	2,5 4,0	0,4 1,0	- -	- -	- -	- -	0,01	0,01	0,03 0,005	- 0,005	0,01	- -	
	ISO-MgAg2RE2Zr	ISO-MC65210	S, K, L	min. max.	Rem.	-	-	-	2 3	0,4 1,0	2,0 3,0	- -	- -	- -	0,01	0,01	0,03 0,005	- 0,005	0,01	- -	
	ISO-MgRE2Ag1Zr	ISO-MC65220	S, K, L	min. max.	Rem.	-	-	-	1,5 3,0	0,4 1,0	1,3 1,7	- -	- -	- -	0,01	0,01	0,05 0,10	- 0,005	0,01	- -	
	ISO-MgY5RE4Zr	ISO-MC95310	S, K, L	min. max.	Rem.	-	-	-	2,0 4,0	0,4 1,0	4,75 5,5	- -	- -	- -	0,2	0,01	0,03 0,005	- 0,005	0,01	- -	
MgYREZr ^{g, h}	ISO-MgY4RE3Zr	ISO-MC95320	S, K, L	min. max.	Rem.	-	-	-	2,4 4,4	0,4 1,0	- -	3,7 4,3	- -	- -	0,02	0,01	0,03 0,005	- 0,005	0,01	- -	
	ISO-MgRE3Gd1Zr	ISO-MB65410	S, K, L	min. max.	Rem.	-	0,20 0,50	- 0,03	2,6 3,1	0,4 1,0	- 0,05	- -	1,0 1,7	- -	- -	0,010	0,01	0,0020	0,01	- -	

a Withdrawn in 2002.

b For maximum manganese content, see Annex B.

c RE = rare earth metals.

d If the minimum Mn limit is not met.

e Cerium-rich.

f Neodymium-rich.

g Neodymium- and heavy RE-rich.

h 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 %.

i 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 ² min.	0,2% proof stress $R_{p0,2}$ N/mm ² min.	Elongation ΔL % min.	Brinell hardness HBW ^a
	In accordance with ISO 2092:1981 ^b	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 ^c	145 ^c	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 ² is equivalent to 1 MPa.							
^a These values are for guidance only.							
^b Withdrawn in 2002.							
^c 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 ² min.	0,2% proof stress $R_{p0,2}$ N/mm ² min.	Elongation ΔL % min.	Brinell hardness HBW ^a
	In accordance with ISO 2092:1981 ^b	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 ^c	145 ^c	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 ² is equivalent to 1 MPa.							
^a These values are for guidance only.							
^b Withdrawn in 2002.							
^c This value applies to both separately cast test pieces and samples cut from castings, for thicknesses up to 30 mm.							