
**Magnesium and magnesium alloys —
Wrought magnesium alloys**

*Magnésium et alliages de magnésium — Alliages de magnésium
corroyés*

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 3116 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 fourth edition cancels and replaces the third edition (ISO 3116:2001), which has been technically revised. The reason for this fourth edition is to clarify that requirements for chemical composition relate to cast analysis, and to adjust elongation values for some alloys and tempers.

Introduction

This International Standard classifies the commercially available magnesium alloys into a number of grades suitable for the application to which they might be put.

Some of the alloys referenced in this International Standard 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 — Wrought magnesium alloys

1 Scope

This International Standard specifies the chemical composition and mechanical properties of magnesium alloys for wrought products in the form of bars and solid sections, tubes and hollow sections, forgings, and plate and sheet.

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.

ISO 31-0:1992, *Quantities and units — Part 0: General principles*

ISO 2092, *Light metals and their alloys — Code of designation based on chemical symbols*

ISO 6892, *Metallic materials — Tensile testing at ambient temperature*

EN 515, *Aluminium and aluminium alloys — Wrought products — Temper designations*

3 Designation

3.1 Material

The material shall be designated by symbols as given in Tables 1 to 11.

The material symbol designations are in accordance with ISO 2092.

NOTE A list of national designations corresponding to this International Standard is given in Annex A and a table of physical properties of the listed alloys is given in Annex B.

3.2 Temper designation

The following symbols shall be used for temper designation:

- O: annealed;
- F: as fabricated;
- H×8: fully hardened (strain hardened to give maximum ultimate tensile strength);
- H×4: half hardened (strain hardened to give an ultimate tensile strength approximately midway between that of annealed and H×8 temper);

- H×2: quarter hardened (strain hardened to give an ultimate tensile strength approximately midway between that of annealed and H×4 temper);
- T5: cooled from an elevated temperature shaping process and then artificially aged;
- T6: solution heat treated and then artificially aged.

The temper designations are in accordance with EN 515.

3.3 Designations of product form

The following symbols shall be used for product form:

- B: bars and solid sections;
- T: tubes and hollow sections;
- F: forgings;
- P: plate and sheet.

3.4 Designation for ordering

EXAMPLE

An order for magnesium bars, conforming to this International Standard, of magnesium alloy ISO-WD 21150, delivered in the as-fabricated condition (F) is as follows:

ISO 3116 - ISO-MgAl3Zn1 (A) (or WD21150) - F - B

Tonnage and dimensions are to be specified in addition.

4 Requirements

4.1 Chemical composition

The chemical composition of wrought magnesium alloys, taken as cast analysis at the time the material is cast, shall conform to the requirements for the appropriate material given in Table 1.

4.2 Mechanical properties

The minimum values of the mechanical properties of wrought products in magnesium alloys in the defined temper conditions shall be as given in Tables 2 to 11.

4.3 Frequency of testing

The frequency of testing shall be subject to an agreement between the manufacturer and the purchaser.

5 Sampling

Conditions for sampling, formation of batches and frequency of verification shall be subject to an agreement between the manufacturer and the purchaser.

6 Test pieces

Test pieces shall be taken in the longitudinal direction. For rolled flat products of thickness $> 0,6$ mm, test pieces may be taken in the long transverse direction.

7 Test methods

7.1 Chemical composition

The determination of the alloying elements given in Table 1 shall be performed in accordance with normal practice.

7.2 Tensile test

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

8 Retests

Conditions for retests shall be subject to an agreement between the manufacturer and the purchaser.

9 Rounding of results

The number representing the result for any value specified in this International Standard shall be expressed to the same number of decimal places as the corresponding number in this International Standard. The rounding of numbers shall meet the requirements of Annex B, Clause B.3, rule A or B in ISO 31-0:1992. 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 wrought magnesium alloys

Alloy group	Material designation		Product form ^a	Composition % (mass fraction)														Others each	Others total
	Symbol	Numbers		Element	Mg	Al	Zn	Mn	RE ^b	Zr	Y	Li	Si	Fe	Cu	Ni			
MgAlZn	ISO-MgAl3Zn1(A)	ISO-WD21150	B, T, F, P	min.	Rem. ^c	2,4	0,50	0,15	—	—	—	—	—	—	—	—	—	—	
				max.	—	3,6	1,5	0,40	—	—	—	—	0,10	0,005	0,05	0,005	0,05	0,30	
	ISO-MgAl3Zn1(B)	ISO-WD21151	B, T, F, P	min.	Rem.	2,4	0,5	0,05	—	—	—	—	—	—	—	—	—	—	
				max.	—	3,6	1,5	0,4	—	—	—	—	0,1	0,05	0,05	0,005	0,05	0,30	
MgMn	ISO-MgAl6Zn1	ISO-WD21160	B, T, F	min.	Rem.	5,5	0,50	0,15	—	—	—	—	—	—	—	—	—	—	
				max.	—	6,5	1,5	0,40	—	—	—	—	0,10	0,005	0,05	0,005	0,05	0,30	
	ISO-MgAl8Zn	ISO-WD21170	B, F	min.	Rem.	7,8	0,20	0,12	—	—	—	—	—	—	—	—	—	—	
				max.	—	9,2	0,8	0,40	—	—	—	—	0,10	0,005	0,05	0,005	0,05	0,30	
MgZnZr	ISO-MgMn2	ISO-WD43150	B, T	min.	Rem.	—	—	1,2	—	—	—	—	—	—	—	—	—	—	
				max.	—	—	—	2,0	—	—	—	—	0,10	—	0,05	0,01	0,05	0,30	
	ISO-MgZn3Zr	ISO-WD32250	B, T, F	min.	Rem.	—	2,5	—	—	0,45	—	—	—	—	—	—	—	—	
				max.	—	—	4,0	—	—	0,8	—	—	—	—	—	—	0,05	0,30	
MgZnMn	ISO-MgZn6Zr	ISO-WD32260	B, T, F	min.	Rem.	—	4,8	—	—	0,45	—	—	—	—	—	—	—	—	
				max.	—	—	6,2	—	—	0,8	—	—	—	—	—	—	0,05	0,30	
	ISO-MgZn2Mn1	ISO-WD32350	B, T, F, P	min.	Rem.	—	1,75	0,6	—	—	—	—	—	—	—	—	—	—	
				max.	—	0,1	2,3	1,3	—	—	—	—	0,10	0,06	0,1	0,005	0,05	0,30	
MgZnCu	ISO-MgZn7Cu1	ISO-WD32150	B	min.	Rem.	—	6,0	0,5	—	—	—	—	—	—	1,0	—	—	—	
				max.	—	0,2	7,0	1,0	—	—	—	—	0,10	0,05	1,5	0,01	0,05	0,30	
	ISO-MgY5RE4Zr	ISO-WD95350	B, F	min.	Rem.	—	—	—	1,5	0,4	4,75	—	—	—	—	—	—	—	
				max.	—	—	0,20	0,03	4,0	1,0	5,5	0,2	0,01	0,010	0,02	0,005	0,01	0,30	
MgYREZr	ISO-MgY4RE3Zr	ISO-WD95360	B, F	min.	Rem.	—	—	—	2,4	0,4	3,7	—	—	—	—	—	—	—	
				max.	—	—	0,20 ^d	0,03	4,4	1,0	4,3	0,2	0,01	0,010	0,02	0,005	0,01	0,30	

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^a B = Bars and solid sections; T = Tubes and hollow sections; F = Forgings; P = Plate and sheet.^b RE = Neodymium and other heavy rare earth metals.^c Remainder.^d Zn + Ag.

Table 2 — Alloy ISO-MgAl3Zn1

Temper	Thickness mm	Tensile strength R_m N/mm ² min.	0,2 % Proof stress $R_{p0,2}$ N/mm ² min.	Elongation A % min.
Bars and solid sections $t = D$ for solid round bars				
F	$1 \leq t \leq 10$	220	140	10
	$10 < t \leq 65$	240	150	10
Tubes and hollow sections				
F	$1 \leq t \leq 10$	220	140	10
Forgings				
F	All	235	130	8
Plate and sheet				
O	$0,5 \leq t \leq 6$	220	105	11
	$6 < t \leq 25$	210	105	9
H×2	$0,5 \leq t \leq 6$	250	160	5
	$6 < t \leq 25$	220	120	8
H×4	$0,5 \leq t \leq 6$	260	200	4
	$6 < t \leq 25$	250	160	6
NOTE Values for separately forged test pieces must be agreed between the manufacturer and customer.				

Table 3 — Alloy ISO-MgAl6Zn1

Temper	Thickness mm	Tensile strength R_m N/mm ² min.	0,2 % Proof stress $R_{p0,2}$ N/mm ² min.	Elongation A % min.
Bars and solid sections $t = D$ for solid round bars				
F	$1 \leq t \leq 10$	260	160	6
	$10 < t \leq 40$	270	180	10
	$40 < t \leq 65$	260	160	10
Tubes and hollow sections				
F	$1 \leq t \leq 10$	260	150	10
Forgings				
F	All	270	152	6
NOTE Values for separately forged test pieces must be agreed between the manufacturer and customer.				

Table 4 — Alloy ISO-MgAl8Zn

Temper	Thickness mm	Tensile strength R_m N/mm ² min.	0,2 % Proof stress $R_{p0,2}$ N/mm ² min.	Elongation A % min.
Bars and solid sections $t = D$ for solid round bars				
F	$t \leq 40$	295	195	10
	$40 < t \leq 60$	295	195	8
	$60 < t \leq 130$	290	185	8
T5	$t \leq 6$	325	205	4
	$6 < t \leq 60$	330	230	4
	$60 < t \leq 130$	310	205	2
Tubes and hollow sections				
F	$t \leq 10$	295	195	7
Forgings				
F	All	290	200	6
NOTE Values for separately forged test pieces must be agreed between the manufacturer and customer.				

Table 5 — Alloy ISO-MgMn2

Temper	Thickness mm	Tensile strength R_m N/mm ² min.	0,2 % Proof stress $R_{p0,2}$ N/mm ² min.	Elongation A % min.
Bars and solid sections $t = D$ for solid round bars				
F	$t \leq 10$	230	120	3
	$10 < t \leq 50$	230	120	3
	$50 < t \leq 100$	200	120	3
Tubes and hollow sections				
F	$t \leq 2$	225	165	2
	$t > 2$	200	145	1,5

Table 6 — Alloy ISO-MgZn3Zr

Temper	Thickness mm	Tensile strength R_m N/mm ² min.	0,2 % Proof stress $R_{p0,2}$ N/mm ² min.	Elongation A % min.
Bars and solid sections $t = D$ for solid round bars				
F	$t \leq 10$	280	200	8
	$10 < t \leq 100$	300	225	8
T5	All	275	255	4
Tubes and hollow sections				
T5	All	275	255	4
Forgings				
F	All	290	205	7
NOTE Values for separately forged test pieces must be agreed between the manufacturer and customer.				

Table 7 — Alloy ISO-MgZn6Zr

Temper	Thickness mm	Tensile strength R_m N/mm ² min.	0,2 % Proof stress $R_{p0,2}$ N/mm ² min.	Elongation A % min.
Bars and solid sections $t = D$ for solid round bars				
F	$t \leq 50$	300	210	5
T5	$t \leq 50$	310	230	5
Tubes and hollow sections				
F	All	275	195	5
T5	All	315	260	4
Forgings				
T5	$t \leq 75$	290	180	7
T6	$t \leq 75$	295	220	4
NOTE Values for separately forged test pieces must be agreed between the manufacturer and customer.				

Table 8 — Alloy ISO-MgZn2Mn1

Temper	Thickness mm	Tensile strength R_m N/mm ² min.	0,2 % Proof stress $R_{p0,2}$ N/mm ² min.	Elongation A % min.
Bars and solid sections $t = D$ for solid round bars				
F	$t \leq 10$	230	150	8
	$10 < t \leq 75$	245	160	10
Tubes and hollow sections				
F	$t \leq 10$	230	150	8
	$10 < t \leq 75$	245	160	10
Forgings				
F	All	200	125	9
Plate and sheet				
O	$6 \leq t \leq 25$	220	120	8
H×4	$6 \leq t \leq 25$	250	165	5
NOTE Values for separately forged test pieces must be agreed between the manufacturer and customer.				

Table 9 — Alloy ISO-MgZn7Cu1

Temper	Thickness mm	Tensile strength R_m N/mm ² min.	0,2 % Proof stress $R_{p0,2}$ N/mm ² min.	Elongation A % min.
Bars and solid sections $t = D$ for solid round bars				
F	$10 \leq t \leq 130$	250	160	7
T6	$10 \leq t \leq 130$	325	300	3

Table 10 — Alloy ISO-MgY5RE4Zr

Temper	Thickness mm	Tensile strength R_m N/mm ² min.	0,2 % Proof stress $R_{p0,2}$ N/mm ² min.	Elongation A % min.
Bars and solid sections $t = D$ for solid round bars				
T5	$10 \leq t \leq 50$	250	170	6
	$50 < t \leq 100$	250	160	6
T6	$10 \leq t \leq 50$	250	160	6
	$50 < t \leq 100$	250	160	6
Forgings				
T5	All	290	155	6
T6	All	260	165	6
NOTE Values for separately forged test pieces must be agreed between the manufacturer and customer.				

Table 11 — Alloy ISO-MgY4RE3Zr

Temper	Thickness mm	Tensile strength R_m N/mm ² min.	0,2 % Proof stress $R_{p0,2}$ N/mm ² min.	Elongation A % min.
Bars and solid sections $t = D$ for solid round bars				
T5	$10 \leq t \leq 50$	230	140	5
	$50 < t \leq 100$	220	130	5
T6	$10 \leq t \leq 50$	220	130	6
	$50 < t \leq 100$	220	130	6
Forgings				
T5	All	280	150	6
T6	All	255	160	6
NOTE Values for separately forged test pieces must be agreed between the manufacturer and customer.				

Annex A

(informative)

List of national designations corresponding to the ISO designation

Table A.1

Material designation in accordance with ISO 2092	USA ASTM	Germany DIN Number	United Kingdom BS Series	France NF
ISO-MgAl3Zn1	AZ31B	3.5312	MAG 110	G-A3Z1
ISO-MgAl6Zn1	AZ61A	3.5612	MAG 121	G-A6Z1
ISO-MgAl8Zn	AZ80A	3.5812	—	—
ISO-MgMn2	—	—	—	—
ISO-MgZn3Zr	—	—	MAG 151	—
ISO-MgZn6Zr	—	—	—	—
ISO-MgZn2Mn1	—	—	MAG 131	—
ISO-MgZn7Cu1	ZC71A	—	—	—
ISO-MgY5RE4Zr	WE54A	—	—	—
ISO-MgY4RE3Zr	WE43A	—	—	—