
**Wrought magnesium and magnesium
alloys — Rolled plates and sheets**

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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 of 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 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*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document classifies the commercially available magnesium and magnesium alloy rolled plates and sheets into a number of grades suitable for the application to which they might be put.

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Wrought magnesium and magnesium alloys — Rolled plates and sheets

1 Scope

This document specifies chemical composition, mechanical properties, dimension and shape tolerance, heat treatment and the technical conditions for inspection and delivery of rolled magnesium and magnesium alloy plates and sheets.

It is applicable to rolled magnesium and magnesium alloy plates and sheets.

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.

ISO 3116, *Magnesium and magnesium alloys — Wrought magnesium and magnesium alloys*

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

3.1

sheet

product that is rectangular in cross-section with nominal thickness less than 6 mm, but not less than 0,20 mm, and with slit, sheared or sawed edges

3.2

plate

product that is rectangular in cross-section and with thickness not less than 6 mm with sheared or sawn edges

4 Orders or tenders

The order or tender shall define the product required and shall contain the following details:

- a) the type and form of the product:
 - 1) designation of the magnesium or magnesium alloy;
 - 2) form of the product (sheet, plate);
- b) the metallurgical temper (degree of hardness or heat treatment condition) of the material for delivery and, if different, the metallurgical temper for use;

- c) the number of this document, i.e. ISO 23700, the specification number, or, where none exists, the properties agreed between the supplier and the purchaser;
- d) the dimensions and shape of the product (thickness, width, length, diameter of the coil);
- e) the tolerances of the dimensions and form, with reference to the appropriate clause or subclause of this document;
- f) the quantity;
- g) any requirements for certificates of conformity, test and/or analysis;
- h) any special requirements agreed between the supplier and the purchaser (e.g. drawings).

5 Requirements

5.1 Designation

The following symbols shall be used for temper designation:

- 0: annealed;
- H112: strain hardened from working at elevated temperature or from a limited amount of cold work, and for which there are mechanical properties limits;
- 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.

The alloy designation and temper should be as given in [Table 1](#).

Table 1 — Alloy designation and temper

Alloy designation	Alloy symbol	Temper	Thickness mm
MAM61	ISO-MgAl6Mn1	H112	$1 \leq t \leq 5$
MAM91	ISO-MgAl9Mn1	H112	$1 \leq t \leq 5$
MAT11	ISO-MgAl1Sn1	0	$0.5 \leq t \leq 2$
MAT61	ISO-MgAl6Sn1	0	$0.5 \leq t \leq 2$
MAZ31a	ISO-MgAl3Zn1(A)	0, H × 4, H × 2	$0.5 \leq t \leq 25$
MAZ31b	ISO-MgAl3Zn1(B)	0, H112	$0.4 \leq t \leq 70$
MAZ40	ISO-MgAl4Zn	H112	$40 \leq t \leq 70$
MAZ41	ISO-MgAl4Zn1	H112	$10 \leq t \leq 70$
MAZX310	ISO-MgAl3Zn1Ca	0	$0,5 \leq t \leq 1,5$
MAZE310	ISO-MgAl3Zn1RE	0	$0,5 \leq t \leq 1,5$
MVWE751	ISO-MgGd7Y5RE1	T5	$10 \leq t \leq 20$
MVW76	ISO-MgGd7Y6	T5	$12 \leq t \leq 70$
MLAZ931	ISO-MgLi9Al3Zn1	0, H112	$0,5 \leq t \leq 60$
MME20	ISO-MgMn2RE	H112	$10 \leq t \leq 70$
MWE43c	ISO-MgY4RE3Zr(C)	T5	$12 \leq t \leq 70$
MWEK711	ISO-MgY7RE1Zr1	T5	$10 \leq t \leq 20$

Table 1 (continued)

Alloy designation	Alloy symbol	Temper	Thickness mm
MZE10	ISO-MgZn1RE	O	$0,5 \leq t \leq 1,5$
MZE20	ISO-MgZn2RE	O	$0,5 \leq t \leq 1,5$
MZM21	ISO-MgZn2Mn1	O, H × 4	$6 \leq t \leq 25$
MZK60	ISO-MgZn6Zr0	H112	$20 \leq t \leq 60$
MZK61	ISO-MgZn6Zr1	T5, H112	$10 \leq t \leq 70$

5.2 Production and manufacturing processes

Unless otherwise specified in the order, the production and manufacturing processes shall be left to the discretion of the producer. Unless it is explicitly stated otherwise in the order, no obligation shall be placed on the producer to use the same processes for subsequent and similar orders.

5.3 Quality control

The supplier shall be responsible for the performances of all inspection and tests required by the relevant International Standard or specification, prior to shipment of the product.

If the purchaser wishes to inspect the product at the supplier's works, he or she shall notify the supplier at the time of placing the order.

5.4 Chemical composition

The chemical composition shall conform to the requirements for the appropriate material given in [Table 2](#) or to the requirements specified in ISO 3116.

If the purchaser requires content limits for elements not specified in [Table 2](#) or in ISO 3116, these limits shall be stated in the order document.

Table 2 — Chemical composition of rolled magnesium alloy plates and sheets

Alloy group	Material designation		Composition (% (mass fraction))																			
	Symbol	Designation	Element	Mg	Al	Zn	Mn	Gd	RE	Li	Zr	Y	Ca	Be	Si	Fe	Cu	Ni	Oth- ers each	Oth- ers total		
MgAlMn	ISO-MgAl6Mn1	MAM61	min.	Rem.	5,0	—	0,50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
			max.	—	7,0	—	1,50	—	—	—	—	—	—	—	—	—	—	—	—	—	0,01	0,30
MgAlZn	ISO-MgAl9Mn1	MAM91	min.	Rem.	8,0	—	0,50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			max.	—	10,0	—	1,50	—	—	—	—	—	—	—	—	—	—	—	—	—	0,01	0,30
MgAlZn	ISO-MgAl4Zn	MAZ40	min.	Rem.	3,0	0,20	0,15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			max.	—	4,0	0,8	0,50	—	—	—	—	—	—	—	0,01	0,10	0,05	0,05	0,005	0,01	0,30	
MgAlZn	ISO-MgAl4Zn1	MAZ41	min.	Rem.	3,7	0,8	0,30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			max.	—	4,7	1,4	0,6	—	—	—	—	—	—	—	0,01	0,10	0,05	0,05	0,005	0,01	0,30	
MgAlZn-Ca	ISO-MgAl3Zn-1Ca	MAZX310	min.	Rem.	2,4	0,5	0,15	—	—	—	—	—	—	0,1	—	—	—	—	—	—	—	—
			max.	—	3,6	1,5	0,40	—	—	—	—	—	—	—	0,3	—	—	—	—	—	—	—
MgAlZn-RE	ISO-MgAl3Zn-1RE	MAZE310	min.	Rem.	2,4	0,5	0,15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			max.	—	3,6	1,5	0,40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MgLiAl	ISO-MgLi-9Al3Zn1	MLAZ931	min.	Rem.	2,5	0,5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			max.	—	3,8	1,5	0,05	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MgMnRE	ISO-MgMn2RE	MME20	min.	Rem.	—	—	1,3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			max.	—	0,20	0,30	2,2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MgZnRE	ISO-MgZn1RE	MZE10	min.	Rem.	—	0,5	0,01	—	—	—	—	—	—	0,1	—	—	—	—	—	—	—	—
			max.	—	0,05	1,5	0,05	—	—	—	—	—	—	—	0,3	—	—	—	—	—	—	—
MgZnZr	ISO-MgZn2RE	MZE20	min.	Rem.	—	1,5	—	—	—	—	—	—	—	0,1	—	—	—	—	—	—	—	—
			max.	—	0,05	2,5	0,05	—	—	—	—	—	—	—	0,3	—	—	—	—	—	—	—
MgZnZr	ISO-MgZn6Zr1	MZK61	min.	Rem.	—	5,0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			max.	—	0,05	6,0	0,10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Key

Rem.: subtract the percentage of all elements except Mg from 100 %.

5.5 Dimensional tolerances

Thickness (t), width (W) and length (L) tolerances shall be in accordance with [Table 3](#). When the tolerance is specified as either all plus or all minus, the value in [Table 3](#) shall be doubled.

When tested with the plate and/or sheet resting on a flat surface against a straight edge, the flatness shall not exceed the appropriate value given in [Table 4](#).

Tolerances for the products exceeding the range of specified value shall be agreed upon by the supplier and the purchaser.

Table 3 — Thickness, width, and length tolerance of sheets and plates (in mm)

Thickness	Thickness tolerance		Width and length tolerance of sheared sheets and plates		Width and length tolerance of sawed sheets and plates				
	Specified width		Width tolerance	Length tolerance	Specified width and length				
	$W \leq 1\,000$	$1\,000 < W \leq 1\,200$			$W, L \leq 800$	$800 < W, L \leq 1\,000$	$1\,000 < W, L \leq 1\,200$	$1\,200 < W, L \leq 2\,000$	$W, L > 2\,000$
$0,40 \leq t < 0,80$	$\pm 0,04$	—	± 3	± 8	± 4	± 5	± 6	± 7	± 8
$0,80 \leq t < 1,00$	$\pm 0,05$	—	± 3	± 8					
$1,00 \leq t < 1,20$	$\pm 0,06$	$\pm 0,08$	± 3	± 8					
$1,20 \leq t < 2,00$	$\pm 0,07$	$\pm 0,10$	± 4	± 8					
$2,00 \leq t < 3,00$	$\pm 0,10$	$\pm 0,12$	± 4	± 10					
$3,00 \leq t < 4,00$	$\pm 0,11$	$\pm 0,15$	± 5	± 10					
$4,00 \leq t < 5,00$	$\pm 0,14$	$\pm 0,17$	± 5	± 10					
$5,00 \leq t < 6,00$	$\pm 0,17$	$\pm 0,18$	± 6	± 10					
$6,00 \leq t < 8,00$	$\pm 0,20$	$\pm 0,20$	± 7	± 10					
$8,00 \leq t < 10,00$	$\pm 0,22$	$\pm 0,22$	± 8	± 10					
$10,00 \leq t < 12,00$	$\pm 0,25$	$\pm 0,25$	± 9	± 12					
$12,00 \leq t < 20,00$	$\pm 0,50$	$\pm 0,50$	± 10	± 16					
$20,00 \leq t < 26,00$	$\pm 0,75$	$\pm 0,75$	—	—					
$26,00 \leq t < 40,00$	$\pm 1,00$	$\pm 1,00$	—	—					
$40,00 \leq t < 60,00$	$\pm 1,50$	$\pm 1,50$	—	—					
$60,00 \leq t \leq 70,00$	$\pm 1,90$	$\pm 1,90$	—	—					

Table 4 — Flatness tolerances of sheets and plates (in mm)

Thickness	Flatness of sheets and plates in any 1 000 mm length, maximum		
	Specified width		
	$W \leq 800$	$800 < W \leq 1\,000$	$1\,000 < W$
$0,40 \leq t < 2,00$	1	2	—
$2,00 \leq t < 6,00$	2	3	4
$6,00 \leq t < 20,00$	2	3	5
$20,00 \leq t \leq 70,00$	3	5	7

5.6 Mechanical properties

The minimum mechanical properties of magnesium alloy sheets and plates in the defined temper conditions shall be as given in [Table 5](#).

Table 5 — Mechanical properties of sheets and plates

Alloys	Temper	Thickness mm	Tensile strength R _m MPa		Tensile yield strength R _{p0.2} MPa		Elongation A %		Erichsen value ^a mm
			RD	TD	RD	TD	RD	TD	
MAM61	H112	1,00 ≤ t ≤ 5	320	350	275	280	6	7	—
MAM91	H112	1,00 ≤ t ≤ 5	400	450	350	380	5	7	—
MAT11	0	0,50 ≤ t < 2,00	240	250	170	220	12	10	2,7
MAT61	0	0,50 ≤ t < 2,00	300	305	210	220	21	18	4,2
MAZ31a	0	0,50 ≤ t < 6,00	220	—	105	—	11	—	—
		6,00 ≤ t < 25,00	210	—	105	—	9	—	—
		0,50 ≤ t < 6,00	250	—	160	—	5	—	—
H × 2	0	6,00 ≤ t < 25,00	220	—	120	—	8	—	—
		0,50 ≤ t < 6,00	260	—	200	—	4	—	—
MAZ31b	0	6,00 ≤ t < 25,00	250	—	160	—	6	—	—
		0,40 ≤ t < 3,00	230	225	150	145	12	12	2,2
		3,00 ≤ t < 12,50	225	220	140	135	12	12	—
H112	0	12,50 ≤ t ≤ 70,00	225	220	150	135	7	7	—
		12,50 ≤ t < 20,00	235	230	150	145	8	8	—
		20,00 ≤ t < 32,00	230	225	140	135	8	8	—
MAZ40	H112	32,00 ≤ t ≤ 70,00	230	225	130	125	8	8	—
		40,00 ≤ t ≤ 70,00	255	250	165	155	10	8	—
MAZ41	H112	12,50 ≤ t < 20,00	250	250	150	150	10	10	—
		20,00 ≤ t ≤ 70,00	250	250	140	140	12	12	—
MAZE311	0	0,50 ≤ t < 1,50	325	335	200	210	20	23	4,1
MAZX311	0	0,50 ≤ t < 1,50	340	330	185	190	21	20	5,5
MVWE751	T5	10,00 ≤ t < 20,00	380	330	300	260	5	3	—

Key

RD: Rolling direction

TD: Transverse direction

^a If the purchaser has special requirements on tensile strength, tensile yield strength, elongation in a TD and Erichsen value, they shall be agreed between the supplier and the purchaser.

Table 5 (continued)

Alloys	Temper	Thickness mm	Tensile strength R _m MPa		Tensile yield strength R _{p0,2} MPa		Elongation A %		Erichsen value ^a mm
			RD	TD	RD	TD	RD	TD	
MLAZ931	T5	12,00 ≤ t ≤ 70,00	440	—	310	—	9	—	—
	O	0,5 ≤ t < 6	170	160	135	130	12	12	—
		6 ≤ t < 14	160	155	120	115	12	12	—
		14 < t ≤ 60	155	150	115	110	12	12	—
H	0,5 ≤ t < 6	180	175	140	135	10	10	—	
	6 ≤ t < 14	170	165	135	130	10	10	—	
	14 ≤ t < 60	165	160	130	120	10	10	—	
MME20	O	2,00 ≤ t < 3,00	—	230	—	120	—	12	—
		3,00 ≤ t < 10,00	—	220	—	110	—	10	—
	H112	8,00 ≤ t < 12,50	—	220	—	110	—	10	—
		12,50 ≤ t < 20,00	210	210	110	110	10	10	—
MWE43c	T5	20,00 ≤ t < 32,00	210	210	110	110	7	7	—
		32,00 ≤ t ≤ 70,00	200	200	90	90	6	6	—
	T5	12,00 ≤ t < 32,00	370	—	260	—	20	—	—
		32,00 ≤ t ≤ 70,00	375	—	240	—	17	—	—
MWEK711	T5	10,00 ≤ t < 20,00	330	280	250	220	7	5	—
	O	6,00 ≤ t < 25,00	220	—	120	—	8	—	—
MZE10		6,00 ≤ t < 25,00	250	—	165	—	5	—	—
	MZE20	0,50 ≤ t < 1,50	235	225	170	150	25	20	6,0
MZE20		0,50 ≤ t < 1,50	245	230	170	120	35	35	7,7
	MZK60	F	275	255	160	155	8	6	—

Key

RD: Rolling direction

TD: Transverse direction

^a If the purchaser has special requirements on tensile strength, tensile yield strength, elongation in a TD and Erichsen value, they shall be agreed between the supplier and the purchaser.

Table 5 (continued)

Alloys	Temper	Thickness mm	Tensile strength R _m MPa		Tensile yield strength R _{p0.2} MPa		Elongation A %		Erichsen value ^a mm
			RD	TD	RD	TD	RD	TD	
MZK61	H112	12,50 ≤ t < 20,00	275	275	160	160	7	7	—
		20,00 ≤ t < 32,00	270	270	160	160	7	7	—
		32,00 ≤ t ≤ 70,00	265	265	160	160	7	7	—
	T5	12,50 ≤ t < 20,00	285	285	210	210	5	5	—
		20,00 ≤ t < 32,00	280	280	200	200	5	5	—
		32,00 ≤ t ≤ 70,00	280	280	190	190	5	5	—

Key
 RD: Rolling direction
 TD: Transverse direction

^a If the purchaser has special requirements on tensile strength, tensile yield strength, elongation in a TD and Erichsen value, they shall be agreed between the supplier and the purchaser.

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5.7 Surface finish

The products shall be free from defects detrimental to their use.

While an operation designed to mask a fault is not permitted, the elimination of a superficial fault is permissible, provided that the dimensional tolerances continue to be observed.

6 Test procedure

6.1 Sampling

6.1.1 Sampling for chemical analysis

Unless otherwise specified, sampling for chemical composition tests shall be in accordance with ISO 3116.

6.1.2 Sampling for mechanical testing

6.1.2.1 Location and size

Specimens shall be taken from samples in such a way that it is possible to orientate the test pieces in relation to the product, as specified in [6.1.2.2](#).

The specimens shall be large enough to allow the manufacture of sufficient test pieces for the required tests, and for any retests which are required.

6.1.2.2 Orientation of specimens

Normally, tests in the rolling direction are required. If the width is insufficient (less than 300 mm) to obtain a transverse specimen, then tests in the longitudinal direction are permitted.

If the purchaser intends to require the tests in the transverse direction, the tests shall be agreed between the supplier and the purchaser.

6.1.2.3 Identification of specimens

Each specimen shall be marked in such a manner that, after removal, it is still possible to identify the product from which it was taken, and its location and orientation. If, during the course of subsequent operations, removal of the markings cannot be avoided, new markings shall be made before the originals are removed.

6.1.2.4 Preparation of specimens

Specimens shall be taken from the sample after completion of all the mechanical and heat treatments that the product has to undergo before delivery, and which may influence the mechanical properties of the metal. In cases where this is not possible, the sample or specimens may be taken at an earlier stage, but they shall be subjected to the same treatment as that to which it is intended to submit the product concerned.

NOTE If the purchaser intends to convert the material to a final temper which is different from the “as supplied” temper, then additional testing can be requested by the purchaser in order to satisfy himself or herself that the material is capable of meeting the specified properties of the final temper. It is only necessary for the supplier to confirm that selected samples, heat-treated using the supplier’s laboratory conditions, meet the properties specified for the final temper required by the purchaser.

Cutting shall be carried out in such a manner that it does not change the characteristics of the part prepared. Thus, the dimensions of the specimens shall provide an adequate machining allowance to permit removal of the zone affected by cutting.

Specimens shall not be machined or treated in any way such that their mechanical properties can be altered. Any straightening required shall be carried out with great care, preferably by hand.

6.1.2.5 Number of specimens

Unless otherwise specified, one tension and test specimen shall be taken from a sheet representing each 500 kg of sheets or from a plate representing each 1000 kg of plates of the same alloy, temper and thickness, or such other quantity as is agreed upon by the supplier and the purchaser.

If the Erichsen value is required, the number of specimens for the Erichsen test shall be agreed between the supplier and the purchaser.

6.1.2.6 Type and location of test pieces

Flat test pieces shall be used for specified thicknesses up to and including 12,5 mm. The test piece shall be prepared so that both rolled surfaces are included in an undisturbed condition.

For specified thicknesses exceeding 12,5 mm, round test pieces shall be used.

For specified thicknesses up to and including 40 mm, the longitudinal axis of the round test pieces shall be located at a distance from the surface equal to half the thickness.

For specified thicknesses over 40 mm, the longitudinal axis of the round test pieces shall be located at a distance from one of the surfaces equal to one quarter of the thickness.

6.2 Test methods

6.2.1 Chemical composition

Chemical composition tests shall be carried out in accordance with ISO 3116.

6.2.2 Tensile test

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

6.2.3 Erichsen test

The sheet and plate being clamped between a cushion die and a moulding die shall be punched by a spherical head (e.g. with a diameter of 20 mm) to be penetrated. The result shall be determined by the displacement of the punch and as given in [Table 5](#).

6.2.4 Measurement of dimensions

The dimensions shall be measured by means of measuring instruments which are of the accuracy required by the dimensions and the dimensional tolerances.

All dimensions shall be checked at the ambient temperature of the workshop or laboratory and, in case of dispute, at a temperature of between 10 °C and 35 °C.

6.2.5 Surface finish

Unless otherwise specified, examination of surface appearance shall be carried out without the assistance of magnifying apparatus on products before delivery.