BRITISH STANDARD

BS EN 1706:2010

Aluminium and aluminium alloys — Castings — Chemical composition and mechanical properties

ICS 77.150.10

BSI
British Standards

National foreword

This British Standard is the UK implementation of EN 1706:2010. It supersedes BS EN 1706:1998 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee NFE/35, Light metals and their alloys.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Aluminium und Aluminiumlegierungen - Gußstücke - Chemische Zusammensetzung und mechanische Eigenschaften

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Foreword

This document (EN 1706:2010) has been prepared by Technical Committee CEN/TC 132 “Aluminium and aluminium alloys”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2010, and conflicting national standards shall be withdrawn at the latest by September 2010.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

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This document supersedes EN 1706:1998.

Within its programme of work, Technical Committee CEN/TC 132 entrusted CEN/TC 132/WG 10 "Castings" to revise EN 1706:1998.

In addition to some additional minor and editorial changes, the following technical modifications were introduced during the revision:

a) In the Scope, new reference to EN 576 was added and reference to EN ISO 8062-3 was updated.

b) New normative references were added (EN 576, EN 1559-1, EN 1559-4 and EN ISO 6506-1). Normative reference to EN 10003-1 was deleted.

c) Term and definition 3.10, order document, was added.

d) Clause 4, Ordering information, was added and subsequent numbering increased by one.

e) Second paragraph (reference to EN 576) in Clause 5.2 was added.

f) Clause 5.5, Designation to appear on drawings, was modified.

g) Clause 7.3.2.5, Pressure die cast test pieces, was modified.

h) In Clause 7.4, reference to EN ISO 6506-1 was updated from EN 10003-1.

i) In Table 1, new Alloy Group “Al” was added, including Al 99,6E and Al 99,7E grades.

j) In Table 1, the following alloys were deleted:

   1) EN AC-45200 [EN AC-Al Si5Cu3Mn];

   2) EN AC-51000 [EN AC-Al Mg3(b)];

   3) EN AC-71000 [EN AC-Al Zn5Mg].

k) In Table 1, the following new alloys were added:

   1) EN AC-21200 [EN AC-Al Cu4MnMg];

2) EN AC-43500 [EN AC-Al Si10MnMg];

3) EN AC-44500 [EN AC-Al Si12(Fe)(b)];

4) EN AC-45500 [EN AC-Al Si7Cu0,5Mg];

5) EN AC-48100 [EN AC-Al Si17Cu4Mg];

6) EN AC-51500 [EN AC-Al Mg5Si2Mn];

7) EN AC-71100 [EN AC-Al Zn10Si8Mg].

l) In Table 1, footnotes “b” to “j” were added.

m) In Table 2, the following alloys were deleted:

1) EN AC-45200 [EN AC-Al Si5Cu3Mn];

2) EN AC-51000 [EN AC-Al Mg3(b)];

3) EN AC-71000 [EN AC-Al Zn5Mg].

n) In Table 2, “Al” Alloy Group and the following alloys were added:

1) EN AC-21200 [EN AC-Al Cu4MnMg];

2) EN AC-44400 [EN AC-Al Si9];

3) EN AC-45500 [EN AC-Al Si7Cu0,5Mg];

4) EN AC-71100 [EN AC-Al Zn10Si8Mg].

o) In Table 3, the following alloys were deleted:

1) EN AC-45200 [EN AC-Al Si5Cu3Mn];

2) EN AC-51000 [EN AC-Al Mg3(b)];

3) EN AC-71000 [EN AC-Al Zn5Mg].

p) In Table 3, “Al” Alloy Group and the following alloys were added:

1) EN AC-21200 [EN AC-Al Cu4MnMg];

2) EN AC-44400 [EN AC-Al Si9];

3) EN AC-45500 [EN AC-Al Si7Cu0,5Mg];

4) EN AC-71100 [EN AC-Al Zn10Si8Mg].

q) In Table 4, EN AC-45200 [EN AC-Al Si5Cu3Mn] alloy was deleted.

r) In Table 4, “Al” Alloy Group and EN AC-48100 [EN AC-Al Si17Cu4Mg] alloy were added.

s) Former Annex A (informative) was split in Annex A (informative) and Annex B (informative).

t) In Table A.1, “Al” Alloy Group and the following alloys were added:

1) EN AC-43500 [EN AC-Al Si10MnMg];

2) EN AC-44500 [EN AC-Al Si12(Fe)(b)];

3) EN AC-48100 [EN AC-Al Si17Cu4Mg];

4) EN AC-51500 [EN AC-Al Mg5Si2Mn].

u) In Table B.1, the same alloys than in Table 1 were added and deleted. New footnote “k” was also added. The suitability for some casting methods was revised for some of the alloys.

v) New Annex C, Comparison between cast aluminium alloy designations, was added.

w) A Bibliography was also added.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies the chemical composition limits for aluminium casting alloys and mechanical properties of separately cast test pieces for these alloys.

Annex B is included as a guide to the selection of alloys for a specific use or process.

This European Standard is intended to be used in conjunction with EN 576, EN 1559-1, EN 1559-4, EN 1676 and EN ISO 8062-3.

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.

EN 576, *Aluminium and aluminium alloys — Unalloyed aluminium ingots for remelting — Specifications*

EN 1559-1, *Founding — Technical conditions of delivery — Part 1: General*

EN 1559-4, *Founding — Technical conditions of delivery — Part 4: Additional requirements for aluminium alloy castings*

EN 1780-1, *Aluminium and aluminium alloys — Designation of alloyed aluminium ingots for remelting, master alloys and castings — Part 1: Numerical designation system*

EN 1780-2, *Aluminium and aluminium alloys — Designation of alloyed aluminium ingots for remelting, master alloys and castings — Part 2: Chemical symbol based designation system*

EN 1780-3, *Aluminium and aluminium alloys — Designation of alloyed aluminium ingots for remelting, master alloys and castings — Part 3: Writing rules for chemical composition*

EN 10002-1, *Metallic materials — Tensile testing — Part 1: Method of test at ambient temperature*

EN 12258-1:1998, *Aluminium and aluminium alloys — Terms and definitions — Part 1: General terms*

EN ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method (ISO 6506-1:2005)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12258-1:1998 and the following apply.

3.1
casting
process in which molten metal is poured into a mould and solidified

[EN 12258-1:1998, 4.1.1]

3.2
sand casting
process in which molten metal is poured into a sand mould and solidified (at atmospheric pressure)

[EN 12258-1:1998, 4.1.8]

3.3
permanent mould casting
chill casting
process in which molten metal is poured into a permanent metal mould and solidified (at atmospheric pressure)

[EN 12258-1:1998, 4.1.9]

3.4
low pressure die casting
process in which molten metal is poured into a metal mould and solidified under low pressure (typically 7 kPa above atmospheric pressure)

[EN 12258-1:1998, 4.1.11]

NOTE This process can also be used with a sand mould, being called “low pressure sand casting”.

3.5
pressure die casting
high pressure die casting
process in which molten metal is poured into a permanent metal mould and solidified under high pressure (typically 7 MPa)

[EN 12258-1:1998, 4.1.10]

3.6
investment casting
two step process comprising:

a) fabrication of a ceramic mould around a wax or thermoplastic pattern which is lost during this process; and

b) pouring of metal into this mould

[EN 12258-1:1998, 4.1.12]

3.7
fluidity
ability of an alloy to make thin wall castings and reproduce fine details

3.8
hot tearing
tendency for a crack to form in a casting due to the development of internal stress during solidification

3.9
pressure tightness
tendency not to leak on pressure testing

3.10
order document
document or set of documents to which supplier and purchaser agreed at the time of ordering

NOTE An order document may be an order of the purchaser confirmed by the supplier or a quotation of the supplier confirmed by the purchaser.

4 Ordering information

The order document shall include a reference to this European Standard. It shall include all the ordering information as required in EN 1559-1 and EN 1559-4.

5 Designation systems

5.1 Numerical designation system

The numerical designation system shall be in accordance with EN 1780-1.

5.2 Chemical symbol based designation system

The chemical symbol based designation system shall be in accordance with EN 1780-2.

For unalloyed grades, the designation shall be in accordance with EN 576.

5.3 Temper designations

The following abbreviations shall be used as temper designations for the conditions of heat treatment, referred in Tables 2, 3 and 4 and Table A.1:

— F as cast;

— O annealed;

— T1 controlled cooling from casting and naturally aged;

— T4 solution heat treated and naturally aged where applicable;

— T5 controlled cooling from casting and artificially aged or over-aged;

— T6 solution heat treated and fully artificially aged;

— T64 solution heat treated and artificially under-aged;

— T7 solution heat treated and artificially over-aged (stabilised).

NOTE For aluminium casting alloys, solution heat treatment involves quenching from elevated temperatures and distortion may occur.

5.4 Casting process designations

The following abbreviations shall be used as designations for the different casting processes:

— S sand casting;

— K chill or permanent mould casting;

— D pressure die casting;

— L investment casting.

5.5 Designations to appear on drawings

The complete designation of the casting shall appear on the drawings being part of the order information. This designation includes:

— the number of this European Standard;

— the alloy designation;

— the casting process designation;

— the temper designation.

EXAMPLE EN 1706 AC-42000-K-T6 is the complete designation of the alloy EN AC-42000, chill cast solution heat treated and fully artificially aged.

6 Chemical composition

6.1 General

Chemical composition shall be expressed in accordance with the writing rules given in EN 1780-3. The chemical composition of aluminium casting alloys shall be in conformity with the limits specified in Table 1.

NOTE Table 1 also includes the chemical compositions of ingots used to produce castings. These are shown in brackets where they differ from the casting limits and are taken from EN 1676.

When specified, analysis of elements for which specific limits are given in Table 1 shall be carried out. Analysis for other elements shall be carried out only when agreed between supplier and purchaser. This particularly applies to modifying or refining elements such as sodium, strontium, antimony and phosphorus. Alloying elements and impurities shall be expressed in the following sequence: silicon, iron, copper, manganese, magnesium, chromium, nickel, zinc, lead, tin, titanium, other elements each/total, aluminium.

Additional specified elements with specific limit shall be inserted, in alphabetical order with respect to their chemical symbols after titanium, or be specified in footnotes.

6.2 Samples for analysis

When samples are required for analysis by emission spectrometry, they shall be taken from the melt at the time the castings are made and shall be cast into a metallic die.

NOTE If analysis by emission spectrometry is carried out on a casting, it is recommended that a part of the casting is remelted and cast into a metallic die to minimize the unavoidable segregation effect. The level of certain elements such as sodium, strontium and magnesium, is normally reduced by the remelting, and analysis for such elements should be made directly on the casting.

For sampling and analysis, the use of existing rules or standards is recommended until a suitable European Standard is published.

Table 1 — Chemical compositions of casting alloys

expressed in percentage by mass

Alloy Group	Alloy designation		Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Pb	Sn	Ti [h]	Others [a, g]		Aluminium
	Numerical	Chemical symbols												Each	Total	
Al [d]	-	Al 99,6E	0,10	0,30	0,01	0,007	0,02	0,005	-	0,04	-	-	-	0,03 [e]	-	99,60 min.
	-	Al 99,7E	0,07	0,20	0,01	0,005	0,02	0,004	-	0,04	-	-	-	0,03 [f]	-	99,70 min.
AlCu	EN AC-21000	EN AC-Al Cu4MgTi	0,20 (0,15)	0,35 (0,30)	4,2 to 5,0	0,10	0,15 to 0,35 (0,20 to 0,35)	-	0,05	0,10	0,05	0,05	0,15 to 0,30 (0,15 to 0,25)	0,03	0,10	Remainder
	EN AC-21100	EN AC-Al Cu4Ti	0,18 (0,15)	0,19 (0,15)	4,2 to 5,2	0,55	-	-	-	0,07	-	-	0,15 to 0,30 (0,15 to 0,25)	0,03	0,10	Remainder
	EN AC-21200	EN AC-Al Cu4MnMg	0,10	0,20 (0,15)	4,0-5,0	0,20 to 0,50	0,15 to 0,50 (0,20 to 0,50)	-	0,05 (0,03)	0,10 (0,05)	0,03	0,03	0,10 (0,05)	0,03	0,10	Remainder
AlSiMgTi	EN AC-41000 [i]	EN AC-Al Si2MgTi	1,6 to 2,4	0,60 (0,50)	0,10 (0,08)	0,30 to 0,50	0,45 to 0,65 (0,50 to 0,65)	-	0,05	0,10	0,05	0,05	0,05 to 0,20 (0,07 to 0,15)	0,05	0,15	Remainder
AlSi7Mg	EN AC-42000 [i]	EN AC-Al Si7Mg	6,5 to 7,5	0,55 (0,45)	0,20 (0,15)	0,35	0,20 to 0,65 (0,25 to 0,65)	-	0,15	0,15	0,15	0,05	0,25 [j] (0,20)	0,05	0,15	Remainder
	EN AC-42100 [i]	EN AC-Al Si7Mg0,3	6,5 to 7,5	0,19 (0,15)	0,05 (0,03)	0,10	0,25 to 0,45 (0,30 to 0,45)	-	-	0,07	-	-	0,25 [j] (0,18)	0,03	0,10	Remainder
	EN AC-42200 [i]	EN AC-Al Si7Mg0,6	6,5 to 7,5	0,19 (0,15)	0,05 (0,03)	0,10	0,45 to 0,70 (0,50 to 0,70)	-	-	0,07	-		0,25 [j] (0,18)	0,03	0,10	Remainder
AlSi10Mg	EN AC-43000 [i]	EN AC-Al Si10Mg(a)	9,0 to 11,0	0,55 (0,40)	0,05 (0,03)	0,45	0,20 to 0,45 (0,25 to 0,45)	-	0,05	0,10	0,05	0,05	0,15	0,05	0,15	Remainder
	EN AC-43100 [i]	EN AC-Al Si10Mg(b)	9,0 to 11,0	0,55 (0,45)	0,10 (0,08)	0,45	0,20 to 0,45 (0,25 to 0,45)	-	0,05	0,10	0,05	0,05	0,15	0,05	0,15	Remainder
	EN AC-43200	EN AC-Al Si10Mg(Cu)	9,0 to 11,0	0,65 (0,55)	0,35 (0,30)	0,55	0,20 to 0,45 (0,25 to 0,45)	-	0,15	0,35	0,10	-	0,20 (0,15)	0,05	0,15	Remainder
	EN AC-43300 [i]	EN AC-Al Si9Mg	9,0 to 10,0	0,19 (0,15)	0,05 (0,03)	0,10	0,25 to 0,45 (0,30 to 0,45)	-	-	0,07	-	-	0,15	0,03	0,10	Remainder
	EN AC-43400 [i]	EN AC-Al Si10Mg(Fe)	9,0 to 11,0	1,0 (0,45 to 0,9)	0,10 (0,08)	0,55	0,20 to 0,50 (0,25 to 0,50)	-	0,15	0,15	0,15	0,05	0,20 (0,15)	0,05	0,15	Remainder
	EN AC-43500 [i]	EN AC-Al Si10MnMg [c]	9,0 to 11,5	0,25 (0,20)	0,05 (0,03)	0,40 to 0,80	0,10 to 0,60 (0,15 to 0,60)	-	-	0,07	-	-	0,20 (0,15)	0,05	0,15	Remainder

(continued)

Table 1 *(continued)*

Alloy Group	Alloy designation		Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Pb	Sn	Ti [h]	Others [a, g]		Aluminium
	Numerical	Chemical symbols												Each	Total	
AlSi	EN AC-44000 [i]	EN AC-Al Si11	10,0 to 11,8	0,19 (0,15)	0,05 (0,03)	0,10	0,45	-	-	0,07	-	-	0,15	0,03	0,10	Remainder
	EN AC-44100 [i]	EN AC-Al Si12(b)	10,5 to 13,5	0,65 (0,55)	0,15 (0,10)	0,55	0,10	-	0,10	0,15	0,10	-	0,20 (0,15)	0,05	0,15	Remainder
	EN AC-44200 [i]	EN AC-Al Si12(a)	10,5 to 13,5	0,55 (0,40)	0,05 (0,03)	0,35	-	-	-	0,10	-	-	0,15	0,05	0,15	Remainder
	EN AC-44300	EN AC-Al Si12(Fe)(a)	10,5 to 13,5	1,0 (0,45 to 0,9)	0,10 (0,08)	0,55	-	-	-	0,15	-	-	0,15	0,05	0,25	Remainder
	EN AC-44400 [i]	EN AC-Al Si9	8,0 to 11,0	0,65 (0,55)	0,10 (0,08)	0,50	0,10	-	0,05	0,15	0,05	0,05	0,15	0,05	0,15	Remainder
	EN AC-44500 [i]	EN AC-Al Si12(Fe)(b)	10,5 to 13,5	1,0 (0,45 to 0,9)	0,20 (0,18)	0,55	0,40	-	-	0,30	-	-	0,15	0,05	0,25	Remainder
AlSi5Cu	EN AC-45000	EN AC-Al Si6Cu4	5,0 to 7,0	1,0 (0,9)	3,0 to 5,0	0,20 to 0,65	0,55	0,15	0,45	2,0	0,30	0,15	0,25 (0,20)	0,05	0,35	Remainder
	EN AC-45100	EN AC-Al Si5Cu3Mg	4,5 to 6,0	0,60 (0,50)	2,6 to 3,6	0,55	0,15 to 0,45 (0,20 to 0,45)	-	0,10	0,20	0,10	0,05	0,25 (0,20)	0,05	0,15	Remainder
	EN AC-45300	EN AC-Al Si5Cu1Mg	4,5 to 5,5	0,65 (0,55)	1,0 to 1,5	0,55	0,35 to 0,65 (0,40 to 0,65)	-	0,25	0,15	0,15	0,05	0,25 [j] (0,20)	0,05	0,15	Remainder
	EN AC-45400	EN AC-Al Si5Cu3	4,5 to 6,0	0,60 (0,50)	2,6 to 3,6	0,55	0,05	-	0,10	0,20	0,10	0,05	0,25 (0,20)	0,05	0,15	Remainder
	EN AC-45500	EN AC-Al Si7Cu0,5Mg	6,5 to 7,5	0,25	0,2 to 0,7	0,15	0,20 to 0,45 (0,25 to 0,45)	-	-	0,07	-	-	0,20 [j]	0,03	0,10	Remainder
AlSi9Cu	EN AC-46000	EN AC-Al Si9Cu3(Fe)	8,0 to 11,0	1,3 (0,6 to 1,1)	2,0 to 4,0	0,55	0,05 to 0,55 (0,15 to 0,55)	0,15	0,55	1,2	0,35	0,15	0,25 (0,20)	0,05	0,25	Remainder
	EN AC-46100	EN AC-Al Si11Cu2(Fe)	10,0 to 12,0	1,1 (0,45 to 1,0)	1,5 to 2,5	0,55	0,30	0,15	0,45	1,7	0,25	0,15	0,25 (0,20)	0,05	0,25	Remainder
	EN AC-46200	EN AC-Al Si8Cu3	7,5 to 9,5	0,8 (0,7)	2,0 to 3,5	0,15 to 0,65	0,05 to 0,55 (0,15 to 0,55)	-	0,35	1,2	0,25	0,15	0,25 (0,20)	0,05	0,25	Remainder
	EN AC-46300	EN AC-Al Si7Cu3Mg	6,5 to 8,0	0,8 (0,7)	3,0 to 4,0	0,20 to 0,65	0,30 to 0,60 (0,35 to 0,60)	-	0,30	0,65	0,15	0,10	0,25 (0,20)	0,05	0,25	Remainder
	EN AC-46400	EN AC-Al Si9Cu1Mg	8,3 to 9,7	0,8 (0,7)	0,8 to 1,3	0,15 to 0,55	0,25 to 0,65 (0,30 to 0,65)	-	0,20	0,8	0,10	0,10	0,20 [j] (0,18)	0,05	0,25	Remainder
	EN AC-46500	EN AC-Al Si9Cu3(Fe)(Zn)	8,0 to 11,0	1,3 (0,6 to 1,2)	2,0 to 4,0	0,55	0,05 to 0,55 (0,15 to 0,55)	0,15	0,55	3,0	0,35	0,15	0,25 (0,20)	0,05	0,25	Remainder
	EN AC-46600	EN AC-Al Si7Cu2	6,0 to 8,0	0,8 (0,7)	1,5 to 2,5	0,15 to 0,65	0,35	-	0,35	1,0	0,25	0,15	0,25 (0,20)	0,05	0,15	Remainder

(continued)

Table 1 *(concluded)*

Alloy Group	Alloy designation		Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Pb	Sn	Ti [h]	Others [a, g]		
	Numerical	Chemical symbols												Each	Total	Aluminium
AlSi(Cu)	EN AC-47000	EN AC-Al Si12(Cu)	10,5 to 13,5	0,8 (0,7)	1,0 (0,9)	0,05 to 0,55	0,35	0,10	0,30	0,55	0,20	0,10	0,20 (0,15)	0,05	0,25	Remainder
	EN AC-47100	EN AC-Al Si12Cu1(Fe)	10,5 to 13,5	1,3 (0,6 to 1,1)	0,7 to 1,2	0,55	0,35	0,10	0,30	0,55	0,20	0,10	0,20 (0,15)	0,05	0,25	Remainder
AlSiCuNiMg	EN AC-48000	EN AC-Al Si12CuNiMg	10,5 to 13,5	0,7 (0,6)	0,8 to 1,5	0,35	0,8 to 1,5 (0,9 to 1,5)	-	0,7 to 1,3	0,35	-	-	0,25 (0,20)	0,05	0,15	Remainder
	EN AC-48100	EN AC-Al Si17Cu4Mg	16,0 to 18,0	1,3 (1,0)	4,0 to 5,0	0,50	0,25 to 0,65 (0,45 to 0,65)	-	0,3	1,5	-	0,15	0,25 (0,20)	0,05	0,25	Remainder
AlMg [b]	EN AC-51100 [i]	EN AC-Al Mg3	0,55 (0,45)	0,55 (0,40)	0,05 (0,03)	0,45	2,5 to 3,5 (2,7 to 3,5)	-	-	0,10	-	-	0,20 (0,15)	0,05	0,15	Remainder
	EN AC-51200 [i]	EN AC-Al Mg9	2,5	1,0 (0,45 to 0,9)	0,10 (0,08)	0,55	8,0 to 10,5 (8,5 to 10,5)	-	0,10	0,25	0,10	0,10	0,20 (0,15)	0,05	0,15	Remainder
	EN AC-51300 [i]	EN AC-Al Mg5	0,55 (0,35)	0,55 (0,45)	0,10 (0,05)	0,45	4,5 to 6,5 (4,8 to 6,5)	-	-	0,10	-	-	0,20 (0,15)	0,05	0,15	Remainder
	EN AC-51400 [i]	EN AC-Al Mg5(Si)	1,5 (1,3)	0,55 (0,45)	0,05 (0,03)	0,45	4,5 to 6,5 (4,8 to 6,5)	-	-	0,10	-	-	0,20 (0,15)	0,05	0,15	Remainder
	EN AC-51500 [i]	EN AC-Al Mg5Si2Mn	1,8 to 2,6	0,25 (0,20)	0,05 (0,03)	0,4 to 0,8	4,7 to 6,0 (5,0 to 6,0)	-	-	0,07	-	-	0,25 (0,20)	0,05	0,15	Remainder
AlZnSiMg	EN AC-71100	EN AC-Al Zn10Si8Mg	7,5 to 9,5	0,30 (0,27)	0,10 (0,08)	0,15 (0,10)	0,20 to 0,5 (0,25 to 0,5)	-	-	9,0 to 10,5	-	-	0,15	0,05	0,15	Remainder

NOTE 1 Figures in brackets are ingot compositions (prefix EN AB instead of EN AC) where they differ from the casting. See EN 1676 for information.

NOTE 2 Limits are expressed as a maximum unless shown as a range.

[a] "Others" does not include modifying or refining elements such as Na, Sr, Sb and P.

[b] For alloys with Mg ≥ 3 %, the alloy may contain 0,005 % Be max.

[c] Sr addition is recommended.

[d] These grades of unalloyed aluminium are specified in EN 576, and included in this European Standard due to its importance for electrotechnical applications.

[e] B max. 0,04; Mn + Ti + Cr + V max. 0,030.

[f] B max. 0,04; Mn + Ti + Cr + V max. 0,020.

[g] "Others" includes all the elements which are not listed in this Table or without specific values.

[h] Refining agents such as Ti, B or master alloys containing nucleating particles such as TiB_2 shall not be considered as impurities. Nevertheless, the minimum and maximum content of refining elements shall be agreed between the manufacturer and the purchaser.

[i] These alloys are in compliance with EN 601 (for information only).

[j] Minimum Ti limits are not required if the grain refining is not required or reached by other means.

7 Mechanical properties

7.1 General

The minimum mechanical properties for separately cast test pieces for sand cast, chill cast, investment cast and pressure die cast processes shall be in accordance with Tables 2, 3 and 4.

For each alloy, mechanical properties are only specified for the commonly used methods of casting and for commonly used tempers. For other processes and tempers, characteristics shall be agreed between supplier and purchaser.

NOTE 1 The mechanical properties of pressure die castings are very dependent on injection parameters and the properties in Table A.1 are for guidance only.

NOTE 2 For F temper, the values specified in Tables 2, 3 and 4 can be eventually obtained only after holding a few days at room temperature.

Table 2 — Mechanical properties of sand cast alloys for separately cast test pieces

Alloy group	Alloy designation		Temper designation	Tensile strength R_m MPa min.	Yield strength $R_{p0,2}$ MPa min.	Elongation A % min.	Brinell hardness HBW min.
	Numerical	Chemical symbols					
Al	-	Al 99,6E	F	75	-	30	17
	-	Al 99,7E	F	75	-	30	17
AlCu	EN AC-21000	EN AC-Al Cu4MgTi	T4	300	200	5	90
	EN AC-21100	EN AC-Al Cu4Ti	T6	300	200	3	95
			T64	280	180	5	85
	EN AC-21200	EN AC-Al Cu5MgMn	T4	330	225	3	100
			T7	370	310	2	110
AlSiMgTi	EN AC-41000	EN AC-Al Si2MgTi	F	140	70	3	50
			T6	240	180	3	85
AlSi7Mg	EN AC-42000	EN AC-Al Si7Mg	F	140	80	2	50
			T6	220	180	1	75
	EN AC-42100	EN AC-Al Si7Mg0,3	T6	230	190	2	75
	EN AC-42200	EN AC-Al Si7Mg0,6	T6	250	210	1	85
AlSi10Mg	EN AC-43000	EN AC-Al Si10Mg(a)	F	150	80	2	50
			T6	220	180	1	75
	EN AC-43100	EN AC-Al Si10Mg(b)	F	150	80	2	50
			T6	220	180	1	75
	EN AC-43200	EN AC-Al Si10Mg(Cu)	F	160	80	1	50
			T6	220	180	1	75
	EN AC-43300	EN AC-Al Si9Mg	T6	230	190	2	75
AlSi	EN AC-44000	EN AC-Al Si11	F	150	70	6	45
	EN AC-44100	EN AC-Al Si12(b)	F	150	70	4	50
	EN AC-44200	EN AC-Al Si12(a)	F	150	70	5	50
	EN AC-44400	EN AC-Al Si9	F	170	80	4	50

(continued)

Table 2 *(concluded)*

Alloy group	Alloy designation		Temper designation	Tensile strength R_m MPa min.	Yield strength $R_{p0,2}$ MPa min.	Elongation A % min.	Brinell hardness HBW min.
	Numerical	Chemical symbols					
AlSi5Cu	EN AC-45000	EN AC-Al Si6Cu4	F	150	90	1	60
	EN AC-45300	EN AC-Al Si5Cu1Mg	T4	170	120	2	80
			T6	230	200	< 1	100
	EN AC-45500	EN AC-Al Si7Cu0,5Mg	T6	250	190	1	85
AlSi9Cu	EN AC-46200	EN AC-Al Si8Cu3	F	150	90	1	60
	EN AC-46400	EN AC-Al Si9Cu1Mg	F	135	90	1	60
	EN AC-46600	EN AC-Al Si7Cu2	F	150	90	1	60
AlSi(Cu)	EN AC-47000	EN AC-Al Si12(Cu)	F	150	80	1	50
AlMg	EN AC-51100	EN AC-Al Mg3	F	140	70	3	50
	EN AC-51300	EN AC-Al Mg5	F	160	90	3	55
	EN AC-51400	EN AC-Al Mg5(Si)	F	160	100	3	60
AlZnSiMg	EN AC-71100	EN AC-Al Zn10Si8Mg	T1	210	190	1	90

T4 tempers shall be avoided for castings subjected even temporarily to temperatures from 70 ºC to 160 ºC and thereafter subjected to corrosive media.

NOTE 1 N/mm² = 1 MPa

Table 3 — Mechanical properties of chill cast alloys for separately cast test pieces

Alloy group	Alloy designation		Temper designation	Tensile strength R_m MPa min.	Yield strength $R_{p0,2}$ MPa min.	Elongation A % min.	Brinell hardness HBW min.
	Numerical	Chemical symbols					
Al	-	Al 99,6E	F	75	-	30	17
	-	Al 99,7E	F	75	-	30	17
AlCu	EN AC-21000	EN AC-Al Cu4MgTi	T4	320	200	8	90
	EN AC-21100	EN AC-Al Cu4Ti	T6	330	220	7	95
			T64	320	180	8	90
	EN AC-21200	EN AC-Al Cu5MgMn	T4	400	240	8	110
			T7	410	325	5	120
AlSiMgTi	EN AC-41000	EN AC-Al Si2MgTi	F	170	70	5	50
			T6	260	180	5	85
AlSi7Mg	EN AC-42000	EN AC-Al Si7Mg	F	170	90	2,5	55
			T6	260	220	1	90
			T64	240	200	2	80
	EN AC-42100	EN AC-Al Si7Mg0,3	T6	290	210	4	90
			T64	250	180	8	80
	EN AC-42200	EN AC-Al Si7Mg0,6	T6	320	240	3	100
			T64	290	210	6	90

(*continued*)

Table 3 (*concluded*)

Alloy group	Alloy designation		Temper designation	Tensile strength R_m MPa min.	Yield strength $R_{p0,2}$ MPa min.	Elongation A % min.	Brinell hardness HBW min.
	Numerical	Chemical symbols					
AlSi10Mg	EN AC-43000	EN AC-Al Si10Mg(a)	F	180	90	2,5	55
			T6	260	220	1	90
			T64	240	200	2	80
	EN AC-43100	EN AC-Al Si10Mg(b)	F	180	90	2,5	55
			T6	260	220	1	90
			T64	240	200	2	80
	EN AC-43200	EN AC-Al Si10Mg(Cu)	F	180	90	1	55
			T6	240	200	1	80
	EN AC-43300	EN AC-Al Si9Mg	T6	290	210	4	90
			T64	250	180	6	80
AlSi	EN AC-44000	EN AC-Al Si11	F	170	80	7	45
	EN AC-44100	EN AC-Al Si12(b)	F	170	80	5	55
	EN AC-44200	EN AC-Al Si12(a)	F	170	80	6	55
	EN AC-44400	EN AC-Al Si9	F	180	90	5	55
AlSi5Cu	EN AC-45000	EN AC-Al Si6Cu4	F	170	100	1	75
	EN AC-45100	EN AC-Al Si5Cu3Mg	T4	270	180	2,5	85
			T6	320	280	< 1	110
	EN AC-45300	EN AC-Al Si5Cu1Mg	T4	230	140	3	85
			T6	280	210	< 1	110
	EN AC-45400	EN AC-Al Si5Cu3	T4	230	110	6	75
	EN AC-45500	EN AC-Al Si7Cu0,5Mg	T6	320	240	4	100
AlSi9Cu	EN AC-46200	EN AC-Al Si8Cu3	F	170	100	1	75
	EN AC-46300	EN AC-Al Si7Cu3Mg	F	180	100	1	80
	EN AC-46400	EN AC-Al Si9Cu1Mg	F	170	100	1	75
			T6	275	235	1,5	105
	EN AC-46600	EN AC-Al Si7Cu2	F	170	100	1	75
AlSi(Cu)	EN AC-47000	EN AC-Al Si12(Cu)	F	170	90	2	55
AlSiCuNiMg	EN AC-48000	EN AC-Al Si12CuNiMg	T5	200	185	< 1	90
			T6	280	240	< 1	100
AlMg	EN AC-51100	EN AC-Al Mg3	F	150	70	5	50
	EN AC-51300	EN AC-Al Mg5	F	180	100	4	60
	EN AC-51400	EN AC-Al Mg5(Si)	F	180	110	3	65
AlZnSiMg	EN AC-71100	EN AC-Al Zn10Si8Mg	T1	260	210	1	100

NOTE 1 N/mm² = 1 MPa

Table 4 - Mechanical properties of investment cast alloys for separately cast test pieces

Alloy group	Alloy designation		Temper designation	Tensile strength R_m MPa min.	Yield strength $R_{p0,2}$ MPa min.	Elongation A % min.	Brinell hardness HBW min.
	Numerical	Chemical symbols					
Al	-	Al 99,6E	F	75	-	30	17
	-	Al 99,7E	F	75	-	30	17
AlCu	EN AC-21000	EN AC-Al Cu4MgTi	T4	300	220	5	90
AlSi7Mg	EN AC-42000	EN AC-Al Si7Mg	F	150	80	2	50
			T6	240	190	1	75
	EN AC-42100	EN AC-Al Si7Mg0,3	T6	260	200	3	75
	EN AC-42200	EN AC-Al Si7Mg0,6	T6	290	240	2	85
AlSi	EN AC-44100	EN AC-Al Si12(b)	F	150	80	4	50
AlSiCuNiMg	EN AC-48100	EN AC-Al Si17Cu4Mg	F	200	180	1	90
			T5	295	260	1	125
AlMg	EN AC-51300	EN AC-Al Mg5	F	170	95	3	55

NOTE 1 N/mm² = 1 MPa

7.2 Tensile tests

Tensile tests shall be carried out in accordance with EN 10002-1.

7.3 Test pieces

7.3.1 General

This European Standard does not specify the exact design of test pieces that shall be agreed between supplier and purchaser. The use of existing rules or standards is recommended until a suitable European Standard is published. However, the following conditions shall apply.

7.3.2 Separately cast test samples

7.3.2.1 General

When tensile tests are required on separately cast test samples then the test samples shall be cast at the same time and from the same melt or melts as the castings using the same casting process. When applicable, they shall be heat treated with the castings.

NOTE Separately cast test pieces have a valuable function as a check on melt quality. However, the values obtained from castings may differ from the minimum values specified in the tables because of variations in structure arising from differences in section thickness and soundness (see 7.3.3).

7.3.2.2 Sand cast test pieces

The following conditions apply to sand cast test pieces:

1) they shall be cast in sand moulds without artificial chilling, using the same sand system as used for the castings;

2) as cast diameter shall be a minimum of 12,0 mm;

3) the gauge length and parallel length shall conform to EN 10002-1.

NOTE Test pieces may be tested in the machined or unmachined condition.

7.3.2.3 Chill cast test pieces

The following conditions shall apply to chill cast test pieces:

1) they shall be cast into metallic moulds;

2) as cast diameter shall be a minimum of 12,0 mm;

3) the gauge length and parallel length shall conform to EN 10002-1.

NOTE Test pieces may be tested in the machined or unmachined condition.

7.3.2.4 Investment cast test pieces

The following conditions shall apply to investment cast test pieces:

1) they shall be cast entirely in a ceramic mould without artificial chilling;

2) as cast diameter shall be a minimum of 5,0 mm;

3) the gauge length and parallel length shall conform to EN 10002-1.

NOTE Test pieces may be tested in the machined or unmachined condition.

7.3.2.5 Pressure die cast test pieces

Pressure die cast test pieces are normally not produced. To test the entire casting with loads reflecting the intended service conditions is more meaningful.

The values given in Table A.1 are for guidance only. These are not typical values, but are the minimum values that may be expected from separately pressure die cast test pieces of 20,0 mm^2 cross sectional area with a typical wall thickness of 2,0 mm.

7.3.3 Test pieces taken from castings

7.3.3.1 If test pieces are taken from castings, then their geometry, location, test frequency and relevant values shall be agreed between supplier and purchaser.

7.3.3.2 For round test pieces the minimum diameter shall be 4,0 mm.

For yield strength and tensile strength, the value obtained in the castings may be greater than the values specified in Tables 2, 3 and 4 or not less than 70 % of the values specified.

For elongation, the values obtained from castings may be greater than the values specified in the tables or up to 50 % less in some locations.

NOTE This does not apply to pressure die castings.

7.4 Hardness tests

Hardness tests shall be carried out in accordance with EN ISO 6506-1 on porosity free areas of castings or on the portion of a test piece that has not been stressed.

8 Rounding rules for determination of compliance

In recording chemical analysis or mechanical property results, the number representing the result for any value specified in this European Standard shall be expressed to the same number of decimal places as the corresponding number in this European Standard.

The following rounding rules shall be used for determination of compliance with this European Standard:

a) when the figure immediately after the last figure to be retained is less than 5, the last figure to be retained remains unchanged;

b) when the figure immediately after the last figure to be retained is greater than 5, or equal to 5 and followed by at least one figure other than zero, the last figure to be retained is increased by one;

c) when the figure immediately after the last figure to be retained is equal to 5 and followed by zeros only, the last figure to be retained remains unchanged if even, and is increased by one if odd.

Annex A
(informative)

Mechanical properties of pressure die cast alloys

Table A.1 — Mechanical properties of pressure die cast alloys (see 7.3.2.5)

Alloy group	Alloy designation		Temper designation	Tensile strength R_m MPa min.	Yield strength $R_{p0,2}$ MPa min.	Elongation A % min.	Brinell hardness HBW min.
	Numerical	Chemical symbols					
Al	-	Al 99,6E	F	75	-	10	17
	-	Al 99,7E	F	75	-	10	17
AlSi10Mg	EN AC-43400	EN AC-Al Si10Mg(Fe)	F	240	140	1	70
	EN AC-43500	EN AC-Al Si10MnMg	F	250	120	5	65
			T5	270	150	4	80
			T7	200	120	12	60
AlSi	EN AC-44300	EN AC-Al Si12(Fe)(a)	F	240	130	1	60
	EN AC-44400	EN AC-Al Si9	F	220	120	2	55
	EN AC-44500	EN AC-Al Si12(Fe)(b)	F	240	140	1	60
AlSi9Cu	EN AC-46000	EN AC-Al Si9Cu3(Fe)	F	240	140	< 1	80
	EN AC-46100	EN AC-Al Si11Cu2(Fe)	F	240	140	< 1	80
	EN AC-46200	EN AC-Al Si8Cu3	F	240	140	1	80
	EN AC-46500	EN AC-Al Si9Cu3(Fe)(Zn)	F	240	140	< 1	80
AlSi(Cu)	EN AC-47100	EN AC-Al Si12Cu1(Fe)	F	240	140	1	70
AlSiCuNiMg	EN AC-48100	EN AC-Al Si17Cu4Mg	F	220	160	< 1	90
AlMg	EN AC-51200	EN AC-Al Mg9	F	200	130	1	70
	EN AC-51500 [a]	EN AC-Al Mg5Si2Mn	F	250	140	5	70

NOTE 1 1 N/mm² = 1 MPa

NOTE 2 For F temper, the values specified in this table can be eventually obtained only after holding a few days at room temperature.

[a] These mechanical properties are typical for wall thickness up to 4 mm.

Annex B
(informative)

Comparison of casting characteristics, mechanical and other properties

Annex B is included in this European Standard for the guidance of designers and users of casting alloys and aims to indicate the common casting methods used and to broadly rank the alloys in the property listed. Rankings vary with the production method and with the heat treatment condition of the casting and rankings are only applicable in the column concerned. Some numerical values are also included for guidance.

Table B.1 — Comparison of casting characteristics, mechanical and other properties [a]

Alloy Group	Alloy designation		Casting method				Castability			Other properties									Mechanical properties [f]			
	Numerical	Chemical Symbols	Sand casting	Permanent mould casting	Pressure die casting	Investment casting	Fluidity	Resistance to hot tearing	Pressure tightness	Machinability		Resistance to corrosion	Decorative anodizing	Ability to be welded [b]	Ability to be polished	Linear thermal expansion 10^{-6}/K 293 K-373 K	Electrical conductivity [c] MS/m	Thermal conductivity [c] W/(m K)	Strength at room temperature [g]	Strength at elevated temperature to 200 °C [g]	Ductility (Shock resistance) [g h]	Fatigue resistance [j] MPa
										As cast	After heat treatment											
Al	-	Al 99,6E	•	•	•	•	C	B	A	D	D	A	A	B	B	24	33 [k]	180 to 210	E	E	A	-
	-	Al 99,7E	•	•	•	•	C	B	A	D	D	A	A	B	B	24	34 [k]	180 to 210	E	E	A	-
AlCu	EN AC-21000	EN AC-Al Cu4MgTi	•	•		•	C	D	D	-	A	D	C	D	B	23	16 to 23	120 to 150	A	B	A	80 to 110
	EN AC-21100	EN AC-Al Cu4Ti	•	•			C	D	D	-	A	D	C	D	B	23	16 to 23	120 to 150	A	B	A	80 to 110
	EN AC-21200	EN AC-Al Cu5MgMn	•	•			D	D	D	-	A	D	C	C	B	23	16 to 23	120 to 150	A	B	A	80 to 110
AlSiMgTi	EN AC-41000	EN AC-Al Si2MgTi	•	•			C	C	C	C	B	B	B	B	B	23	19 to 25	140 to 160	B		B	-
AlSi7Mg	EN AC-42000	EN AC-Al Si7Mg	•	•		•	B	A	B	B/C	B	B/C	D	B	C	22	19 to 25	150 to 170	B	C	C	80 to 110
	EN AC-42100	EN AC-Al Si7Mg0,3	•	•		•	B	A	B	-	B	B	D	B	C	22	20 to 27	160 to 180	A	C	A	80 to 110
	EN AC-42200	EN AC-Al Si7Mg0,6	•	•		•	B	A	B	-	B	B	D	B	C	22	20 to 26	150 to 180	A	C	A	80 to 110
AlSi10Mg	EN AC-43000	EN AC-Al Si10Mg(a)	•	•			A	A	B	B/C	B	B	E	A	D	21	18 to 25	140 to 170	B	C	C	80 to 110
	EN AC-43100	EN AC-Al Si10Mg(b)	•	•			A	A	B	B/C	B	C	E	A	D	21	18 to 25	140 to 170	B	C	C	80 to 110
	EN AC-43200	EN AC-Al Si10Mg(Cu)	•	•			A	A	B	B/C	B	C	E	A	C	21	16 to 24	130 to 170	B	C	C	80 to 110
	EN AC-43300	EN AC-Al Si9Mg	•	•			A	A	B	B/C	B	B	E	A	D	21	20 to 26	150 to 180	A	C	A	80 to 110
	EN AC-43400	EN AC-Al Si10Mg(Fe)			•		A	A	C	B	-	C	E	C	B/C	21	16 to 21	130 to 150	B	C	C	60 to 90
	EN AC-43500	EN AC-Al Si10MnMg			•		A	A	C	B/C	B	B	E	B	D	21	19-25	140-170	A	C	A	80 to 90
AlSi	EN AC-44000	EN AC-Al Si11	•	•			A	A	A	C [d]	-	B	E	A	D	21	18 to 24	140 to 170	D	C	A	60 to 90
	EN AC-44100	EN AC-Al Si12(b)	•	•		•	A	A	A	C	-	B/C	E	A	D	20	16 to 23	130 to 160	D	C	B	60 to 90
	EN AC-44200	EN AC-Al Si12(a)	•	•			A	A	A	C	-	B	E	A	D	20	17 to 24	140 to 170	D	C	A	60 to 90
	EN AC-44300	EN AC-Al Si12(Fe)(a)			•		A	A	C	C	-	C	E	D	D	20	16 to 22	130 to 160	B	C	C	60 to 90
	EN AC-44400	EN AC-Al Si9	•	•	•		A	A	C	C	-	C	E	D	D	21	16 to 22	130 to 150	C	C	C	60 to 90
	EN AC-44500	EN AC-Al Si12(Fe)(b)			•		A	A	C	C	-	C	E	D	D	20	16 to 22	130 to 160	B	C	C	60 to 90

(*continued*)

Table B.1 *(continued)*

Alloy Group	Alloy designation		Casting method				Castability			Other properties										Mechanical properties [f]			
	Numerical	Chemical Symbols	Sand casting	Permanent mould casting	Pressure die casting	Investment casting	Fluidity	Resistance to hot tearing	Pressure tightness	Machinability		Resistance to corrosion	Decorative anodizing	Ability to be welded [b]	Ability to be polished	Linear thermal expansion 10^{-6}/K 293 K-373 K	Electrucal conductivity [c] MS/m	Thermal conductivity [c] W/(m K)		Strength at room temperature [g]	Strength at elevated temperature to 200 °C [g]	Ductility (Shock resistance) [g h]	Fatigue resistance [i j] MPa
										As cast	After heat treatment												
AlSi5Cu	EN AC-45000	EN AC-Al Si6Cu4	•	•			B	B	B	B	-	D	D	C	B	22	14 to 17	110 to 120		D	A	C	60 to 90
	EN AC-45100	EN AC-Al Si5Cu3Mg		•			B	B	B	B	A	D	D	C	B	22	16 to 19	130		A	A	C	80 to 110
	EN AC-45300	EN AC-Al Si5Cu1Mg	•	•			C	B	C	B	B	D	D	C	B	22	19 to 23	140 to 150		B	B	B	70 to 100
	EN AC-45400	EN AC-Al Si5Cu3		•			B	B	B	B	B	D	D	C	B	22	16 to 19	120 to 130		B	A	A	70 to 100
	EN AC-45500	EN AC-Al Si7Cu0,5Mg	•	•			B	B	B	B	B	B/C	D	B	C	22	16 to 22	150 to 165		A	B	A/B	80 to 110
AlSi9Cu	EN AC-46000	EN AC-Al Si9Cu3(Fe)			•		B	B	C	B	-	D	E	F	C	21	13 to 17	110 to 120		B	B	D	60 to 90
	EN AC-46100	EN AC-Al Si11Cu2(Fe)			•		A	B	C	C	-	D	E	F	C	20	14 to 18	120 to 130		B	B	D	60 to 90
	EN AC-46200	EN AC-Al Si8Cu3	•	•	•		B	B	B [e]	B	-	D	E	B	C	21	14 to 18	110 to 130		B	A	C	60 to 90
	EN AC-46300	EN AC-Al Si7Cu3Mg		•			B	B	B	C	-	D	E	B	C	21	14 to 17	110 to 120		D	A	C	60 to 90
	EN AC-46400	EN AC-Al Si9Cu1Mg	•	•			B	B	B	B	B	D	E	B	D	21	16 to 22	130 to 150		A	B	C	60 to 90
	EN AC-46500	EN AC-Al Si9Cu3 (Fe)(Zn)			•		B	B	B	B	-	D	E	F	C	21	13 to 17	110 to 120		B	A	D	60 to 90
	EN AC-46600	EN AC-Al Si7Cu2	•	•			B	B	B	B	-	D	E	C	C	21	15 to 19	120 to 130		D	B	C	50 to 70
AlSi(Cu)	EN AC-47000	EN AC-Al Si12(Cu)	•	•			A	A	A	C	-	C	E	A	C	20	16 to 22	130 to 150		D	B	C	60 to 90
	EN AC-47100	EN AC-Al Si12Cu1(Fe)			•		A	A	C	C	-	C	E	F	C	20	15 to 20	120 to 150		B	B	C	60 to 90
AlSiCu NiMg	EN AC-48000	EN AC-Al Si12CuNiMg		•			A	A	A	-	B	C	E	A	C	20	15 to 23	130 to 160		A	A	D	80 to 110
	EN AC-48100	EN AC-Al Si17Cu4Mg			•	•	A	C	B	E	B	D	D	D	D	18	14 to 17	120 to 130		B	B	E	60 to 90

(*continued*)

Table B.1 *(concluded)*

Alloy Group	Alloy designation		Casting method				Castability			Other properties										Mechanical properties [f]			
	Numerical	Chemical Symbols	Sand casting	Permanent mould casting	Pressure die casting	Investment casting	Fluidity	Resistance to hot tearing	Pressure tightness	Machinability		Resistance to corrosion	Decorative anodizing	Ability to be welded [b]	Ability to be polished	Linear thermal expansion 10^{-6}/K 293 K-373 K	Electrucal conductivity [c] MS/m	Thermal conductivity [c] W/(m K)	Strength at room temperature [g]	Strength at elevated temperature to 200 °C [g]	Ductility (Shock resistance) [g h]	Fatigue resistance [i j] MPa
										As cast	After heat treatment												
AlMg	EN AC-51100	EN AC-Al Mg3	•	•			C	D	D	A	-	A	A	C	A	24	14 to 16	130 to 140	B	B	A	80 to 110
	EN AC-51200	EN AC-Al Mg9			•		C	D	D	A	-	A	B	E	A	24	11 to 14	60 to 90	C	B	C	60 to 90
	EN AC-51300	EN AC-Al Mg5	•	•		•	C	D	D	A	-	A	A	C	A	24	15 to 21	110 to 130	D	B	B	60 to 90
	EN AC-51400	EN AC-Al Mg5(Si)	•	•			C	D	D	A	-	A	B	C	A	24	15 to 21	110 to 140	D	B	B	60 to 90
	EN AC-51500	EN AC-Al Mg5Si2Mn			•		C	D	D	A	-	A	E	C	A	24	14 to 16	110 to 130	B	B	A	80 to 110
AlZnSiMg	EN AC-71100	EN AC-Al Zn10Si8Mg	•	•			B	A	B	A	-	C	E	A	C	21	17 to 20	120 to 130	B	C	C	80 to 110

● Indicates the casting process most commonly used for each alloy; A: Excellent; B: Good; C: Fair; D: Poor; E: Not recommended; F: Unsuitable

NOTE 1 1 N/mm² = 1 MPa

NOTE 2 Within a family of alloys, the use of two letters with an oblique stroke, for example B/C, allows small differences to be indicated.

[a] Rankings are only applicable in the column concerned.

[b] Ability to weld pressure die castings depends on the amount of included gas and in most cases is very poor. With special die casting processes, values from B to C may be obtained.

[c] Electrical and thermal conductivities are influenced by variations of chemical composition within a specification, the metallurgical structure, soundness, cooling rate and temper.

[d] With Mg > 0,1 the ranking is B.

[e] For alloy 46200, pressure tightness becomes C for the pressure die cast version.

[f] Most suitable temper, the best strength and ductility are not found in the same temper.

[g] Rankings are derived from tensile and ductility values of the alloys, equally divided from A to E.

[h] The ductility (shock resistance) of an alloy is directly related to its elongation, the higher the elongation, the better the shock resistance. In contrast to ferrous alloys, aluminium alloys do not exhibit a transition temperature below which there is a sudden deterioration in shock resistance.

[i] Most suitable casting method.

[j] Values for rotating bending conditions up to 50 x 10^6 cycles (Wöhler curves).

[k] Electrical conductivity can be improved after a heat treatment, 4 h to 5 h at 450 °C. This treatment does not significantly modify the other properties.

Annex C
(informative)

Comparison between cast aluminium alloy designations

Table C.1 — EN, ISO, AA and JIS designation

EN numerical alloy designation	EN symbolic alloy designation	Corresponding ISO alloy designation	Corresponding AA alloy designation	Corresponding JIS alloy designation
EN AC-21000	EN AC-Al Cu4MgTi	Al Cu4MgTi	204.0	AC1B
EN AC-21100	EN AC-Al Cu4Ti	Al Cu4Ti	—	Al-Cu4Ti
EN AC-21200	EN AC-Al Cu5MnMg	—	—	—
EN AC-41000	EN AC-Al Si2MgTi	Al Si2MgTi	—	—
EN AC-42000	EN AC-Al Si7Mg	Al Si7Mg	356.0	AC4C
EN AC-42100	EN AC-Al Si7Mg0,3	Al Si7Mg0.3	A356.0	AC4CH
EN AC-42200	EN AC-Al Si7Mg0,6	Al Si7Mg0.6	357.0	—
EN AC-43000	EN AC-Al Si10Mg(a)	Al Si10Mg	—	AC4A, Al-Si10Mg
EN AC-43100	EN AC-Al Si10Mg(b)	Al Si10Mg	-	AC4A, Al-Si10Mg
EN AC-43200	EN AC-Al Si10Mg(Cu)	Al Si10Mg(Cu)	—	—
EN AC-43300	EN AC-Al Si9Mg	Al Si9Mg	—	—
EN AC-43400	EN AC-Al Si10Mg(Fe)	Al Si10Mg(Fe)	—	ADC3
EN AC-43500	EN AC-Al Si10MnMg	—	365.0	—
EN AC-44000	EN AC-Al Si11	Al Si11	—	—
EN AC-44100	EN AC-Al Si12(b)	Al Si12(b)	B413.0	AC3A, Al-Si12
EN AC-44200	EN AC-Al Si12(a)	Al Si12(a)	—	—
EN AC-44300	EN AC-Al Si12(Fe)(a)	Al Si12(Fe)	A413.0	ADC1
EN AC-44400	EN AC-Al Si9	Al Si9	—	—
EN AC-44500	EN AC-Al Si12(Fe)(b)	—	—	—
EN AC-45000	EN AC-Al Si6Cu4	Al Si6Cu4	—	Al-Si6Cu4
EN AC-45100	EN AC-Al Si5Cu3Mg	Al Si5Cu3Mg	363.0	—
EN AC-45300	EN AC-Al Si5Cu1Mg	Al Si5Cu1Mg	355.0	AC4D
EN AC-45400	EN AC-Al Si5Cu3	Al Si5Cu3	—	Al-Si5Cu3
EN AC-45500	EN AC-Al Si7Cu0,5Mg	—	—	—
EN AC-46000	EN AC-Al Si9Cu3(Fe)	Al Si9Cu3(Fe)	—	ADC10
EN AC-46100	EN AC-Al Si11Cu2(Fe)	Al Si11Cu2(Fe)	—	ADC12Z
EN AC-46200	EN AC-Al Si8Cu3	Al Si8Cu3	380.0	AC4B
EN AC-46300	EN AC-Al Si7Cu3Mg	Al Si7Cu3Mg	320.0	—
EN AC-46400	EN AC-Al Si9Cu1Mg	Al Si9Cu1Mg	—	—

(*continued*)

Table C.1 *(concluded)*

EN numerical alloy designation	EN symbolic alloy designation	Corresponding ISO alloy designation	Corresponding AA alloy designation	Corresponding JIS alloy designation
EN AC-46500	EN AC-Al Si9Cu3(Fe)(Zn)	Al Si9Cu3(Fe) (Zn)	—	ADC10Z
EN AC-46600	EN AC-Al Si7Cu2	Al Si7Cu2	—	—
EN AC-47000	EN AC-Al Si12(Cu)	Al Si12(Cu)	—	Al-Si12Cu
EN AC-47100	EN AC-Al Si12Cu1(Fe)	Al Si12Cu1(Fe)	—	—
EN AC-48000	EN AC-Al Si12CuNiMg	Al Si12CuNiMg	—	AC8A
EN AC-48100	EN AC-Al Si17Cu4Mg	Al Si17Cu4Mg	B390.0	ADC14
EN AC 51100	EN AC-Al Mg3	—	—	—
EN AC-51200	EN AC-Al Mg9	Al Mg9	518.0	Al-Mg10
EN AC-51300	EN AC-Al Mg5	Al Mg5	—	ADC5, AC7A, Al-Mg6
EN AC-51400	EN AC-Al Mg5(Si)	Al Mg5(Si)	—	Al-Mg5Si1
EN AC-51500	EN AC-Al Mg5Si2Mn	—	—	—
EN AC-71100	EN AC-Al Zn10Si8Mg	Al Zn10Si8Mg	—	—

Bibliography

[1] EN 601, *Aluminium and aluminium alloys — Castings — Chemical composition of castings for use in contact with foodstuff*

[2] EN 1676, *Aluminium and aluminium alloys — Alloyed ingots for remelting — Specifications*

[3] EN ISO 8062-3, *Geometrical Product Specifications (GPS) — Dimensional and geometrical tolerances for moulded parts — Part 3: General dimensional and geometrical tolerances and machining allowances for castings (ISO 8062-3:2007)*

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