

MAGYAR SZABVÁNY MSZ EN 1706:2020+A1

Alumínium és alumíniumötvözetek. Öntvények. Vegyí összetétel és mechanikai tulajdonságok

Az MSZ EN 1706:2020 helyett.

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

E nemzeti szabványt a Magyar Szabványügyi Testület a nemzeti szabványosításról szóló 1995. évi XXVIII. törvény alapján tette közzé. A szabvány alkalmazása előtt győződjön meg arról, hogy módosították vagy helyesbítették-e, nincs-e visszavonva, műszaki tartalmú jogszabály hivatkozik-e rá, vagy európai műszaki tartalmú jogszabályhoz harmonizált szabvány-e.

A szabvány alkalmazása e törvény 6. § (1) bekezdése alapján önkéntes. Az önkéntesség választási lehetőséget biztosít a szabvány alkalmazása vagy mellőzése tekintetében. A szabvány közmegegyezéssel elfogadott műszaki dokumentum, amelynek révén általánosan elismert megoldás érhető el.

Ha a szabvány alkalmazását dokumentumban hivatkozva önként vállalja, akkor a hivatkozás vonatkozásában a szabvány alkalmazása kötelező.

Ha a törvény 6. § (2) bekezdése értelmében műszaki tartalmú jogszabály hivatkozik vagy utal e szabványra, akkor e szabvány alkalmazása esetén vélelmezni kell, hogy érvényesülnek azok a jogszabályokban meghatározott alapvető követelmények, amelyekre e szabvány vonatkozik. A szabványtól való eltérés esetén megkövetelhető annak igazolása, hogy a választott megoldás is megfelel a jogszabályi követelményeknek.

Az európai műszaki tartalmú jogszabályhoz harmonizált szabvány ajánlást ad a jogszabály alapvető követelményeinek való megfelelésre. Az előzőekben leírtakkal összhangban a harmonizált szabvány alkalmazása esetén el kell fogadni, hogy az alkalmazó eleget tett az európai jogszabály, illetve az annak megfelelő magyar jogszabály azon követelményeinek, amelyekre a szabvány vonatkozik.

Mivel a szabványok harmonizáltsága időben változhat, a szabvány alkalmazása előtt győződjön meg arról, hogy alkalmazásának időpontjában harmonizáltak minősül-e.

A szabványnak való megfelelés akkor valósul meg, ha változtatás nélkül érvényesülnek az előírásai. Ezt a szabványra hivatkozva kell igazolni.

Jóváhagyó közlemény

Az EN 1706:2020+A1:2021 európai szabványt a Magyar Szabványügyi Testület a közzétételének napjától magyar nemzeti szabvánnyá nyilvánítja. Magyar nemzeti szabványként az európai szabvány angol nyelvű változatát kell alkalmazni.

Endorsement notice

The European Standard EN 1706:2020+A1:2021 is endorsed by the Hungarian Standards Institution as a Hungarian National Standard from the day of its publication. The English language version of the European Standard shall be considered as the Hungarian National Standard.

A szabvány megvásárolható vagy megrendelhető az MSZT Szabványboltban (1082 Budapest, Horváth Mihály tér 1., levélcím: 1450 Budapest 9., Pf. 24, telefon: 456-6893, telefax: 456-6841), illetve elektronikus formában beszerezhető a <http://www.mszt.hu/webaruhaz> címen.

ALU-BLOCK KFT ALU-BLOCK KFT

English Version

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

Aluminium et alliages d'aluminium - Pièces moulées -
Composition chimique et propriétés mécaniques

Aluminium und Aluminiumlegierungen - Gussstücke -
Chemische Zusammensetzung und mechanische
Eigenschaften

This European Standard was approved by CEN on 2 March 2020 and includes Amendment 1 approved by CEN on 1 July 2021.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of 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, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Contents

Page

European foreword.....	3
1 Scope.....	4
2 Normative references.....	4
3 Terms and definitions	5
4 Ordering information	6
5 Designation systems	7
5.1 Numerical designation system.....	7
5.2 Chemical symbol based designation system.....	7
5.3 Temper designations.....	7
5.4 Casting process designations.....	7
5.5 Designations to be included in drawings	7
6 Chemical composition	8
6.1 General.....	8
6.2 Samples for chemical analysis.....	8
7 Mechanical properties.....	14
7.1 General.....	14
7.2 Tensile tests	18
7.3 Test pieces	18
7.3.1 General.....	18
7.3.2 Separately cast test samples	18
7.3.3 Test pieces taken from castings.....	19
7.4 Hardness tests.....	20
8 Rounding rules for determination of compliance	20
Annex A (informative) Mechanical properties of high pressure die cast alloys.....	21
Annex B (informative) Potentially achievable mechanical properties of test pieces taken from a casting	22
Annex C (informative) Comparison of casting characteristics, mechanical and other properties	24
Annex D (informative) Comparison between cast aluminium alloy designations.....	33
Bibliography.....	35

European foreword

This document (EN 1706:2020+A1:2021) 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 February 2022, and conflicting national standards shall be withdrawn at the latest by February 2022.

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

CEN/TC 132 affirms it is its policy that in the case when a patentee refuses to grant licences on standardized products under reasonable and not discriminatory conditions, then this product shall be removed from the corresponding standard.

This document supersedes ^{A1} EN 1706:2020 ^{A1}.

^{A1} *deleted text* ^{A1}

This document includes Amendment 1 approved by CEN on 7 June 2021.

The start and finish of text introduced or altered by amendment is indicated in the text by tags ^{A1} ^{A1}.

Within its programme of work, Technical Committee CEN/TC 132 entrusted CEN/TC 132/WG 23 "Revision of EN 1676 and EN 1706" to revise EN 1706:2010.

^{A1} Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website. ^{A1}

According to the CEN-CENELEC Internal Regulations, the national standards organisations 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, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

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

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

This document 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 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.

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

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

EN 12258-1:2012, *Aluminium and aluminium alloys — Terms and definitions — Part 1: General terms*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12258-1:2012 and the following apply.

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

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

3.1

casting

product at or near finished shape, formed by solidification of the metal in a mould or a die

[SOURCE: EN 12258-1:2012, 2.5.1]

3.2

sand casting

casting produced by pouring molten metal into a sand mould and allowing it to solidify

[SOURCE: EN 12258-1:2012, 2.5.2]

3.3

permanent mould casting

casting produced by introducing molten metal by gravity or low pressure into a mould constructed of durable material, typically iron or steel, and allowing it to solidify

Note 1 to entry: Permanent mould casting where the metal solidifies in a metal mould under low pressure (typically less than 1 bar above atmospheric pressure) is also referred to as “low pressure die casting”.

Note 2 to entry: Permanent mould casting, which is made using an expendable core such as sand, is often (mainly in the USA) termed “semi-permanent mould casting”.

[SOURCE: EN 12258-1:2012, 2.5.3]

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)

Note 1 to entry: This process can also be used with a sand mould, being called “low pressure sand casting”.

3.5

high pressure die casting

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

3.6

investment casting

precision casting formed by a three step process comprising:

- a) fabrication of a ceramic mould around a wax or thermoplastic pattern with a refractory slurry that sets at room temperature;
- b) removal of the pattern through the use of heat;
- c) pouring of metal into this mould and allowing it to solidify.

[SOURCE: EN 12258-1:2012, 2.5.6]

3.7

fluidity

ability of a liquid metal to flow (into a mould)

[SOURCE: EN 12258-1:2012, 4.5.23]

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

absence of leakage at a specified pressure

[SOURCE: EN 12258-1:2012, 4.3.27]

3.10

order document

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

Note 1 to entry: An ordering document can be an order of the purchaser confirmed by the supplier or a quotation of the supplier confirmed by the purchaser.

[SOURCE: EN 12258-1:2012, 3.11.10]

4 Ordering information

The order document shall include a reference to this document. 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 (stabilized).

NOTE For aluminium alloy castings, solution heat treatment involves quenching from elevated temperatures and distortion can 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 high pressure die casting;
- L investment casting.

5.5 Designations to be included in drawings

The complete designation of the casting shall be included in the drawings being part of the order information. This designation includes:

- the number of this document;
- 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 castings 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.

The chemical analysis of elements for which specific limits are given in Table 1 shall be carried out. By agreement between supplier and purchaser other elements may be determined. 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 limits shall be inserted, in alphabetical order with respect to their chemical symbols after titanium, or be specified in footnotes.

6.2 Samples for chemical analysis

When a chemical analysis is carried out by spark emission spectrometry, samples shall be taken from the melt at the time the castings are made and shall be cast into a metallic die.

If chemical 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 content of certain elements such as sodium, strontium and magnesium, is normally reduced by the remelting, and chemical analysis of such elements should be made directly on the casting.

For sampling the use of EN 14361 is recommended. For chemical analysis the use of EN 14242 and EN 14726 is recommended.

Table 1 — Chemical composition of aluminium castings

Expressed in percentage by mass

Alloy Group	Alloy designation		Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Pb ^m	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
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
	EN AC-42300 ⁱ	EN AC-Al Si7(Mg)	6,5 to 7,5	0,19 (0,15)	0,05 (0,03)	0,10	0,10 to 0,25 (0,10 to 0,30)	—	—	0,07	—	—	0,25 ^j (0,18)	0,03	0,10	Remainder
	EN AC-42400 ⁱ	EN AC-Al Si7MnMg ^c	6,5 to 8,5	0,25 (0,20)	0,05 (0,03)	0,35 to 0,75	0,10 to 0,45 (0,15 to 0,45)	—	—	0,03	—	—	0,20 (0,15)	0,05	0,15	Remainder
AlSi10Mg	EN AC-43000 ⁱ	EN AC-Al Si10Mg	9,0 to 11,0	0,55 (0,40)	0,05 ^k (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 1706:2020+A1:2021 (E)

Alloy Group	Alloy designation		Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Pb ^m	Sn	Ti ^h	Others ^{a g}		Aluminium
	Numerical	Chemical symbols												Each	Total	
	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	0,20 to 0,45 (0,25 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
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 ⁱ	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
	EN AC-44600 ⁱ	EN AC-Al Si10Mn	9,5 to 11,5	0,10 to 0,25 (0,10 to 0,20)	0,03	0,30 to 0,75	0,15	—	—	0,03	—	—	0,20 (0,15)	0,05	0,15	Remainder

Alloy Group	Alloy designation		Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Pb ^m	Sn	Ti ^h	Others ^{a g}		Aluminium
	Numerical	Chemical symbols												Each	Total	
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	0,29	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
	EN AC-45600	EN AC-Al Si7Cu1Mg0,6	6,5 to 7,5	0,19 (0,15)	0,8 to 1,6	0,10	0,45 to 0,70 (0,50 to 0,70)	—	—	0,07	—	—	0,25 ^j (0,18)	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	0,29	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	0,29	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

EN 1706:2020+A1:2021 (E)

Alloy Group	Alloy designation		Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Pb ^m	Sn	Ti ^h	Others ^{a g}		Aluminium
	Numerical	Chemical symbols												Each	Total	
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
	EN AC-47200 ^l	EN AC-Al Si12(Fe)	10,5 to 13,5	0,6 to 1,1	0,4	0,10 to 0,50	0,10 to 0,40	0,05	0,20	0,50	0,20	0,10	0,15 (0,20)	0,05	0,25	Remainder
AlSiCuMg	EN AC-48000	EN AC-Al Si12CuMgNi	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
	EN AC-48200	EN AC-Al Si15Cu3MgFe	14,5 to 16,5	0,7 to 1,2	3,0 to 4,0	0,40 to 0,60	0,55 to 0,90 (0,55 to 0,95)	0,05 to 0,30	0,30	1,0	—	0,30	0,05 to 0,15 (0,15)	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	4,3 to 6,8 (4,5 to 6,8)	—	—	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	0,45 (0,40)	0,10 (0,08)	0,45	0,20 to 0,50 (0,25 to 0,50)	—	—	9,0 to 10,5	—	—	0,15	0,05	0,15	Remainder

Alloy Group	Alloy designation		Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Pb ^m	Sn	Ti ^h	Others ^{a g}		Aluminium
	Numerical	Chemical symbols												Each	Total	
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 a maximum Be content of 0,005 % which is not considered as an impurity.															
c	Sr addition is recommended.															
d	These grades of unalloyed aluminium are specified in EN 576, and included in this document 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 should 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.															
k	If corrosion resistance is less important or not required, a maximum Cu content of 0,10 % is allowed.															
l	When intentionally modifying the alloy by adding strontium, sodium and/or antimony, a patent might be violated.															
m	European Regulations and Directives need to be taken into account. See [7] to [10] for information.															

7 Mechanical properties

7.1 General

The minimum mechanical properties for separately cast test pieces for sand cast, chill cast, investment cast, low pressure die 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 high 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	Yield strength	Elongation ^a	Brinell hardness
	Numerical	Chemical symbols		R_m MPa min.	$R_{p0,2}$ MPa min.	A % min.	HBW min.
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 T64	300 280	200 180	3 5	95 85
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 T6	140 220	80 180	2 1	50 75
	EN AC-42100	EN AC-Al Si7Mg0,3	T6 T64	230 200	190 120	2 4	75 60
	EN AC-42200	EN AC-Al Si7Mg0,6	T6	250	210	1	85
	EN AC-42300	EN AC-Al Si7(Mg)	T6	200	140	3	60
AlSi10Mg	EN AC-43000	EN AC-Al Si10Mg	F T6	150 220	80 180	2 1	50 75
	EN AC-43200	EN AC-Al Si10Mg(Cu)	F T6	160 220	80 180	1 1	50 75
	EN AC-43300	EN AC-Al Si9Mg	F T6	160 230	80 190	2 2	50 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

Alloy group	Alloy designation		Temper designation	Tensile strength R_m MPa min.	Yield strength $R_{p0,2}$ MPa min.	Elongation ^a 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 T6	170 230	120 200	2 < 1	80 100
	EN AC-45500	EN AC-Al Si7Cu0,5Mg	T6	250	190	1	85
	EN AC-45600	EN AC-Al Si7Cu1Mg0,6	T7 T64	290 280	260 250	2 3	100 100
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	80
T4 tempers shall be avoided for castings subjected even temporarily to temperatures from 70 °C to 160 °C and thereafter subjected to corrosive media.							
NOTE 1 MPa = 1 N/mm ²							
^a Elongation values below 1 % mean that the material has no significant ductility beyond the yield strength.							

Table 3 — Mechanical properties of chill cast or low pressure die 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 T64	330 320	220 180	7 8	95 90
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 T64	290 250	210 180	4 8	90 80
EN AC-42200	EN AC-Al Si7Mg0,6	T6 T64	320 290	240 210	3 6	100 90	
EN AC-42300	EN AC-Al Si7(Mg)	T6 T64	220 170	160 110	8 10	70 55	
AlSi10Mg	EN AC-43000	EN AC-Al Si10Mg	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 T6	180 240	90 200	1 1	55 80	
EN AC-43300	EN AC-Al Si9Mg	F T6 T64	170 290 250	90 210 180	2,5 4 6	55 90 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	
EN AC-45600	EN AC-Al Si7Cu1Mg0,6	T64	320	270	4	100	

Alloy group	Alloy designation		Temper designation	Tensile strength	Yield strength	Elongation	Brinell hardness
	Numerical	Chemical symbols		R_m MPa min.	$R_{p0,2}$ MPa min.	A % min.	HBW min.
AlSi9Cu	EN AC-46200	EN AC-Al Si8Cu3	F	170	100	1	75
			T5	190	130	< 1	80
			T6	280	250	< 1	95
	EN AC-46300	EN AC-Al Si7Cu3Mg	F	180	100	1	80
AlMg	EN AC-46400	EN AC-Al Si9Cu1Mg	F	170	100	1	75
	T6		275	235	1,5	105	
AlSi9Cu	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
AlSiCuMg	EN AC-48000	EN AC-Al Si12CuMgNi	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	230	200	1	90
NOTE 1 MPa = 1 N/mm ²							

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

Alloy group	Alloy designation		Temper designation	Tensile strength	Yield strength	Elongation	Brinell hardness
	Numerical	Chemical symbols		R_m MPa min.	$R_{p0,2}$ MPa min.	A % min.	HBW min.
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 MPa = 1 N/mm²

7.2 Tensile tests

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

7.3 Test pieces

7.3.1 General

This document 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, these 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 can 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, having comparable thermal properties to the moulding material used to 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 ISO 6892-1.

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 ISO 6892-1.

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 into ceramic moulds 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 ISO 6892-1.

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

7.3.2.5 High pressure die cast test pieces

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

The values given in Table A.1 are for information only. These are not typical values, but are the minimum values that may be expected from separately high pressure die cast test pieces of 20,0 mm² 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, their geometry, location, test frequency and relevant values shall be agreed between supplier and purchaser. For round test pieces the minimum diameter shall be 4,0 mm.

7.3.3.2 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 on the 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 high pressure die castings.

On cut-off test pieces taken from castings, it is possible to achieve higher values than those given in Tables 2, 3 and 4. Annex B contains potentially achievable values observed on cut-off test pieces from permanent mould castings or sand castings (usually with chills). The values in Table B.1 are given for information only.

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 a 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 document shall be expressed to the same number of decimal places as the corresponding number in this document.

The following rounding rules shall be used for the determination of compliance with this document:

- 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 high pressure die cast alloys

Table A.1 — Mechanical properties of high 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 ^b A % min.	Brinell hardness HBW min.
	Numerical	Chemical symbols					
Al	—	Al 99,6E	F	75	—	10	17
	—	Al 99,7E	F	75	—	10	17
AlSi7Mg	EN AC-42400	EN AC-Al Si7MnMg	F	200	100	7	60
			T5	210	120	7	60
AlSi10Mg	EN AC-43400	EN AC-Al Si10Mg(Fe)	F	240	140	1	70
	EN AC-43500	EN AC-Al Si10MnMg	F	200	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
	EN AC-44600	EN AC-Al Si10Mn	F	240	100	10	70
AlSi9Cu	EN AC-46000	EN AC-Al Si9Cu3(Fe)	F	240	140	< 1	80
			T5	240	165	< 1	85
	EN AC-46100	EN AC-Al Si11Cu2(Fe)	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
	EN AC-47200	EN AC-Al Si12(Fe)	F	220	140	1	65
AlSiCuMg	EN AC-48000	EN AC-Al Si12CuMgNi	F	240	140	1	90
	EN AC-48100	EN AC-Al Si17Cu4Mg	F	220	160	< 1	90
	EN AC-48200	EN AC-Al Si15Cu3MgFe	F	270	240	< 1	100
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
AlZnSiMg	EN AC-71100	EN AC-Al Zn10Si8Mg	T1	260	220	< 1	100

NOTE 1 1 MPa = 1 N/mm²

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.

^b Elongation values below 1 % mean that the material has no significant ductility beyond the yield strength.

Annex B (informative)

Potentially achievable mechanical properties of test pieces taken from a casting

On cut-off test pieces taken from castings, it is possible to achieve higher values than those given in Tables 2, 3 and 4. However, this may require additional measures during the production process.

This annex contains achievable values observed on cut-off test pieces from permanent mould castings or sand castings (usually with chills). These values are given for **information only**.

It cannot be assumed that the given values can be reached throughout the casting since mechanical properties depend strongly on the solidification rate, the heat treatment and the soundness of the casting. Therefore, the values and the position of the area where those values can be achieved shall be agreed between supplier and customer.

**Table B.1 — Potentially achievable mechanical properties of test pieces taken from the casting
(see 7.3.3.2)**

Alloy group	Alloy designation		Tensile strength	Yield strength	Elongation	Brinell hardness
	Numerical	Chemical symbols	R_m MPa	$R_{p0,2}$ MPa	A %	HBW
AlCu	EN AC-21000	EN AC-Al Cu4MgTi	410	290	7	115
	EN AC-21100	EN AC-AlCu4Ti	400	230	8	100
AlSi7Mg	EN AC-42100	EN AC-Al Si7Mg0,3	300	240	11	100
	EN AC-42200	EN AC-Al Si7Mg0,6	315	240	8	100
	EN AC-42300	EN AC-Al Si7(Mg)	200	150	14	70
AlSi10Mg	EN AC-43000	EN AC-Al Si10Mg	280	240	3	100
	EN AC-43300	EN AC-Al Si9Mg	280	240	5	100
AlSi	EN AC-44000	EN AC-Al Si11 (with Mg < 0,05 %)	150	85	14	55
	EN AC-44000	EN AC-Al Si11 (with Mg > 0,05 %)	280	250	5	100
	EN AC-44200	EN AC-Al Si12(a)	170	75	8	55
AlSi5Cu	EN AC-45000	EN AC-Al Si6Cu4	160	135	2	65
	EN AC-45300	EN AC-Al Si5Cu1Mg	280	210	1	110
	EN AC-45400	EN AC-Al Si5Cu3Mg	430	360	3	130
	EN AC-45500	EN AC-Al Si7Cu0,5Mg	310	260	5	100

Alloy group	Alloy designation		Tensile strength	Yield strength	Elongation	Brinell hardness
	Numerical	Chemical symbols	R_m MPa	$R_{p0,2}$ MPa	A %	HBW
AlSi9Cu	EN AC-46200	EN AC-Al Si8Cu3	370	310	2	120
	EN AC-46300	EN AC-Al Si7Cu3Mg	225	180	1	85
	EN AC-46400	EN AC-Al Si9Cu1Mg	230	220	2	90
AlSi(Cu)	EN AC-47000	EN AC-Al Si12(Cu)	200	90	5	55
AlSiCuMg	EN AC-48000	EN AC-Al Si12CuMgNi	230	190	1	85
AlMg	EN AC-51100	EN AC-Al Mg3	175	80	8	50
	EN AC-51300	EN AC-Al Mg5	150	80	12	55
AlZnMg	EN AC-71100	EN AC-Al Zn10Si8Mg	260	210	3	95

Annex C
(informative)

Comparison of casting characteristics, mechanical and other properties

This annex is included in this document 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 C.1 — Comparison of casting characteristics, mechanical and other properties^a

Alloy Group	Alloy designation		Casting method				Castability			Other properties								Mechanical properties ^{f1}				
	Numerical	Chemical symbols	Sand casting	Permanent mould casting / Low pressure die casting ^{A1}	High pressure die casting ^{A1}	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 at 200 °C ^g	Ductility (Shock resistance) ^{g,h}	Fatigue resistance ⁱ 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

EN 1706:2020+A1:2021 (E)

Alloy Group	Alloy designation		Casting method			Castability			Other properties									Mechanical properties ^{f1}				
	Numerical	Chemical symbols	Sand casting	[A] Permanent mould casting / Low pressure die casting [A]	[A] High pressure die casting [A]	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 at 200 °C ^g	Ductility (Shock resistance) ^{g h}	Fatigue resistance ⁱ MPa
										As cast	After heat treatment											
	EN AC-42300	EN AC-Al Si7(Mg)	•	•		•	B	A	B	—	B	B	D	B	C	22	20 to 27	160 to 180	A	C	A	80 to 110
	EN AC-42400	EN AC-Al Si7MnMg			•		B	A	B	—	B	B	E	B	C	22	18 to 25	140 to 170	B	C	A	80 to 110
AlSi10Mg	EN AC-43000	EN AC-Al Si10Mg	•	•			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	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	—	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 to 25	140 to 170	A	C	A	80 to 90

Alloy Group	Alloy designation		Casting method			Castability			Other properties									Mechanical properties ^{f1}				
	Numerical	Chemical symbols	Sand casting	[A] Permanent mould casting / Low pressure die casting [A]	[A] High pressure die casting [A]	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 at 200 °C ^g	Ductility (Shock resistance) ^{g h}	Fatigue resistance ^j MPa
										As cast	After heat treatment											
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	—	B/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	—	B/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	—	B/C	E	D	D	20	16 to 22	130 to 160	B	C	C	60 to 90
	EN AC-44600	EN AC-Al Si10Mn			•		A	A	B	B/C	B	B	E	A	D	21	20 to 25	145 to 170	B	C	A	80 to 110

Alloy Group	Alloy designation		Casting method			Castability			Other properties										Mechanical properties ^{f1}			
	Numerical	Chemical symbols	Sand casting	[A] Permanent mould casting / Low pressure die casting [A]	[A] High pressure die casting [A]	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 at 200 °C ^g	Ductility (Shock resistance) ^{g h}	Fatigue resistance ⁱ 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
	EN AC-45600	EN AC-Al Si7Cu1Mg0,6	•	•			B	B	B	B	B	C	D	B	C	22	16 to 22	150 to 165	A	A/B	A/B	80 to 110

Alloy Group	Alloy designation		Casting method			Castability			Other properties									Mechanical properties ^{f1}				
	Numerical	Chemical symbols	Sand casting	[A] Permanent mould casting / Low pressure die casting [A]	[A] High pressure die casting [A]	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 at 200 °C ^g	Ductility (Shock resistance) ^{g h}	Fatigue resistance ⁱ MPa
										As cast	After heat treatment											
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	C	B	—	D	E	F	C	21	13 to 17	110 to 120	B	B	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

Alloy Group	Alloy designation		Casting method				Castability			Other properties									Mechanical properties ^{f1}			
	Numerical	Chemical symbols	Sand casting	[A] Permanent mould casting / Low pressure die casting [A]	[A] High pressure die casting [A]	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 at 200 °C ^g	Ductility (Shock resistance) ^{g h}	Fatigue resistance ^j MPa
										As cast	After heat treatment											
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
	EN AC-47200	EN AC-Al Si12Cu1(Fe)			•		A	A	C	C	—	B/C	E	F	C	20	15 to 20	120 to 150	B	B	C	60 to 90
AlSiCuMg	EN AC-48000	EN AC-Al Si12CuMgNi		•	•		A	A	A	B	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
	EN AC-48200	EN AC-Al Si15Cu3MgFe	•	•	•		A	B	B	C	—	D	—	D	D	19	10 to 15	100 to 120	A	A	D	90 to 110

Alloy Group	Alloy designation		Casting method			Castability			Other properties									Mechanical properties ^{f1}				
	Numerical	Chemical symbols	Sand casting	[A] Permanent mould casting / Low pressure die casting [A]	[A] High pressure die casting [A]	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 at 200 °C ^g	Ductility (Shock resistance) ^{g h}	Fatigue resistance ⁱ 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			•		B	D	C	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	• ⁱ	•	•		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 MPa = 1 N/mm²

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.

Alloy Group	Alloy designation		Casting method			Castability			Other properties							Mechanical properties ^{f1}					
	Numerical	Chemical symbols	Sand casting	Permanent mould casting / Low pressure die casting ^{A1}	High pressure die casting ^{A1}	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 at 200 °C ^g	Ductility (Shock resistance) ^{g h}

^a Rankings are only applicable in the column concerned.

^b Ability to weld high 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 EN AC-46200, pressure tightness becomes C for the high 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 10⁷ 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.

^l To estimate the compressive strength of aluminium casting alloys, it can generally be calculated with a factor 1,5 × tensile strength.

Annex D (informative)

Comparison between cast aluminium alloy designations

Table D.1 — EN, ISO, Aluminium Association (AA) and Japanese Industrial Standard (JIS) alloy designations

EN numerical designation	EN symbolic designation	Corresponding ISO designation	Corresponding AA designation	Corresponding JIS designation
EN AC-21000	EN AC-Al Cu ₄ MgTi	Al Cu ₄ MgTi	204.0	AC1B.1
EN AC-21100	EN AC-Al Cu ₄ Ti	Al Cu ₄ Ti	—	Al-Cu ₄ Ti
EN AC-41000	EN AC-Al Si ₂ MgTi	—	—	—
EN AC-42000	EN AC-Al Si ₇ Mg	Al Si ₇ Mg	356.0	AC4C
EN AC-42100	EN AC-Al Si ₇ Mg _{0,3}	Al Si ₇ Mg _{0.3}	A356.0	AC4CH
EN AC-42200	EN AC-Al Si ₇ Mg _{0,6}	Al Si ₇ Mg _{0.6}	357.0	—
EN AC-42300	EN AC-Al Si ₇ (Mg)	—	—	—
EN AC-42400	EN AC-Al Si ₇ MnMg	—	—	—
EN AC-43000	EN AC-Al Si ₁₀ Mg	Al Si ₁₀ Mg	—	AC4A, Al-Si ₁₀ Mg
EN AC-43200	EN AC-Al Si ₁₀ Mg(Cu)	Al Si ₁₀ Mg(Cu)	—	Al-Si ₁₀ Mg(Cu)
EN AC-43300	EN AC-Al Si ₉ Mg	Al Si ₉ Mg	—	Al-Si ₉ Mg
EN AC-43400	EN AC-Al Si ₁₀ Mg(Fe)	Al Si ₁₀ Mg(Fe)	A360.0	ADC3
EN AC-43500	EN AC-Al Si ₁₀ MnMg	—	365.0	AC4A.2
EN AC-44000	EN AC-Al Si ₁₁	Al Si ₁₁	—	Al-Si ₁₁
EN AC-44100	EN AC-Al Si ₁₂ (b)	Al Si ₁₂ (b)	B413.0	AC3A, Al-Si ₁₂ (b)
EN AC-44200	EN AC-Al Si ₁₂ (a)	Al Si ₁₂ (a)	—	Al-Si ₁₂ (a)
EN AC-44300	EN AC-Al Si ₁₂ (Fe)(a)	Al Si ₁₂ (Fe)	A413.2	ADC1
EN AC-44400	EN AC-Al Si ₉	Al Si ₉	—	—
EN AC-44500	EN AC-Al Si ₁₂ (Fe)(b)	—	413.0	—
EN AC-44600	EN AC-Al Si ₁₀ Mn	—	375.0	—
EN AC-45000	EN AC-Al Si ₆ Cu ₄	Al Si ₆ Cu ₄	A319.0	AC2B, Al-Si ₆ Cu ₄
EN AC-45100	EN AC-Al Si ₅ Cu ₃ Mg	Al Si ₅ Cu ₃ Mg	—	Al-Si ₅ Cu ₃ Mg
EN AC-45300	EN AC-Al Si ₅ Cu ₁ Mg	Al Si ₅ Cu ₁ Mg	355.0	AC4D, Al-Si ₅ Cu ₁ Mg
EN AC-45400	EN AC-Al Si ₅ Cu ₃	Al Si ₅ Cu ₃	—	Al-Si ₅ Cu ₃
EN AC-45500	EN AC-Al Si ₇ Cu _{0,5} Mg	—	—	—
EN AC-45600	EN AC-Al Si ₇ Cu ₁ Mg _{0,6}	—	—	—
EN AC-46000	EN AC-Al Si ₉ Cu ₃ (Fe)	Al Si ₉ Cu ₃ (Fe)	A380.0	ADC10
EN AC-46100	EN AC-Al Si ₁₁ Cu ₂ (Fe)	Al Si ₁₁ Cu ₂ (Fe)	383.0	ADC12Z
EN AC-46200	EN AC-Al Si ₈ Cu ₃	Al Si ₈ Cu ₃	333.0	AC4B, Al-Si ₈ Cu ₃
EN AC-46300	EN AC-Al Si ₇ Cu ₃ Mg	Al Si ₇ Cu ₃ Mg	320.0	Al-Si ₇ Cu ₃ Mg

EN numerical designation	EN symbolic designation	Corresponding ISO designation	Corresponding AA designation	Corresponding JIS designation
EN AC-46400	EN AC-Al Si9Cu1Mg	Al Si9Cu1Mg	—	Al-Si9Cu1Mg
EN AC-46500	EN AC-Al Si9Cu3(Fe)(Zn)	Al Si9Cu3(Fe) (Zn)	E380, 383.0	ADC10Z
EN AC-46600	EN AC-Al Si7Cu2	Al Si7Cu2	328.0	—
EN AC-47000	EN AC-Al Si12(Cu)	Al Si12(Cu)	—	Al-Si12Cu
EN AC-47200	EN AC-Al Si12(Fe)	—	—	—
EN AC-47100	EN AC-Al Si12Cu1(Fe)	Al Si12Cu1(Fe)	—	ADC1C
EN AC-48000	EN AC-Al Si12CuMgNi	Al Si12CuNiMg	—	AC8A
EN AC-48100	EN AC-Al Si17Cu4Mg	Al Si17Cu4Mg	B390.0	ADC14, Al-Si17Cu4Mg
EN AC-48200	EN AC-Al Si15Cu3MgFe	—	—	—
EN AC 51100	EN AC-Al Mg3	—	—	—
EN AC-51200	EN AC-Al Mg9	Al Mg9	518.0	—
EN AC-51300	EN AC-Al Mg5	Al Mg5	—	Al-Mg5
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	—	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 14242, *Aluminium and aluminium alloys — Chemical analysis — Inductively coupled plasma optical emission spectral analysis*
- [4] EN 14361, *Aluminium and aluminium alloys — Chemical analysis — Sampling from metal melts*
- [5] EN 14726, *Aluminium and aluminium alloys — Determination of the chemical composition of aluminium and aluminium alloys by spark optical emission spectrometry*
- [6] 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)*
- [7] Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)
- [8] Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of-life vehicles
- [9] Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment
- [10] Directive 2015/863/EU of the European Parliament and of the Council of 31 March 2015 on the amending of Annex II to Directive 2011/65/EU