

Aluminium and aluminium alloys — Wrought products — Special requirements for products intended for the production of pressure equipment

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- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
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This European Standard was approved by CEN on 3 December 1999.

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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 Central Secretariat has the same status as the official versions.

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 132, Aluminium and aluminium alloys, the Secretariat of which is held by AFNOR.

Within its programme of work, Technical Committee CEN/TC 132 has entrusted CEN/TC 132/WG 7, Sheets, strips and plates, to prepare the following standard:

EN 12392, *Aluminium and aluminium alloys – Wrought products – Special requirements for products intended for the production of pressure equipment.*

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of an identical text or by endorsement, at the latest by September 2000, and conflicting national standards shall be withdrawn at the latest by September 2000.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this standard.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies particular requirements and testing procedures applicable to wrought aluminium and aluminium alloys intended for the production of pressure equipment.

It includes:

- the products forms, grades and tempers of wrought aluminium and aluminium alloys which may be used for such application, together with their permissible working temperature range;
- the technical conditions for inspection and delivery, mechanical property limits and tolerances on form and dimensions by reference to the applicable European Standards for wrought aluminium and aluminium alloys;
- additional requirements specific to pressure vessel application.

It applies to hot-rolled or cold-rolled sheet, strip, plate and circle, extruded or extruded and cold drawn rod/bar and tube, extruded open and hollow sections, and forgings.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 485-1, *Aluminium and aluminium alloys - Sheet, strip and plate - Part 1: Technical conditions for inspection and delivery.*

EN 485-2, *Aluminium and aluminium alloys - Sheet, strip and plate - Part 2: Mechanical properties.*

EN 485-3, *Aluminium and aluminium alloys - Sheet, strip and plate - Part 3: Tolerances on shape and dimensions for hot-rolled products.*

EN 485-4, *Aluminium and aluminium alloys - Sheet, strip and plate - Part 4: Tolerances on shape and dimensions for cold-rolled products.*

EN 586-1, *Aluminium and aluminium alloy - Forgings - Part 1: Technical conditions for inspection and delivery.*

EN 586-2, *Aluminium and aluminium alloy - Forgings - Part 2: Mechanical properties and additional property requirements.*

prEN 586-3:1996, *Aluminium and aluminium alloy - Forgings - Part 3: Tolerances on dimensions and form.*

EN 754-1, *Aluminium and aluminium alloy - Cold drawn rod/bar and tube - Part 1: Technical conditions for inspection and delivery.*

EN 754-2, *Aluminium and aluminium alloy - Cold drawn rod/bar and tube - Part 2: Mechanical properties.*

EN 754-3, *Aluminium and aluminium alloy - Cold drawn rod/bar and tube - Part 3: Round bars, tolerances on dimensions and form.*

EN 754-4, *Aluminium and aluminium alloy - Cold drawn rod/bar and tube - Part 4: Square bars, tolerances on dimensions and form.*

EN 754-5, *Aluminium and aluminium alloy - Cold drawn rod/bar and tube - Part 5: Rectangular bars, tolerances on dimensions and form.*

EN 754-6, *Aluminium and aluminium alloy - Cold drawn rod/bar and tube - Part 6: Hexagonal bars, tolerances on dimensions and form.*

EN 754-7, *Aluminium and aluminium alloy - Cold drawn rod/bar and tube - Part 7: Seamless tubes, tolerances on dimensions and form.*

EN 754-8, *Aluminium and aluminium alloy - Cold drawn rod/bar and tube - Part 8: Porthole tubes, tolerances on dimensions and forms.*

EN 755-1, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 1: Technical conditions for inspection and delivery.*

EN 755-2, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 2: Mechanical properties.*

EN 755-3, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 3: Round bars, tolerances on dimensions and form.*

EN 755-4, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 4: Square bars, tolerances on dimensions and form.*

EN 755-5, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 5: Rectangular bars, tolerances on dimensions and form.*

EN 755-6, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 6: Hexagonal bars, tolerances on dimensions and form.*

EN 755-7, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 7: Seamless tubes, tolerances on dimensions and form.*

EN 755-8, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 8: Porthole tubes, tolerances on dimensions and form.*

prEN 755-9:1998, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 9: Profiles, tolerances on dimensions and form.*

EN 941, *Aluminium and aluminium alloy - Circle and circle stock for general applications – Specifications.*

prEN 2002-20:1996, *Aerospace series - Test methods for metallic materials - Part 20: Eddy current inspection of circular cross-section tubes.*

EN 2101, *Aerospace series - Chromic anodisation of aluminium and wrought aluminium alloys.*

EN 10204, *Metallic products - Types of inspection documents.*

EN 10233, *Metallic materials - Tube - Flattening test.*

EN 10234, *Metallic materials - Tube - Drift expanding test.*

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

3 Terms and definitions

For the purposes of this standard the definitions of EN 12258-1 apply together with the following:

3.1

heat-treatment batch or lot

quantity of products of the same grade or alloy, form, thickness or cross-section and produced in the same way, heat-treated in one furnace load, or such products solution-treated and subsequently precipitation-treated in one furnace load. More than one solution-treatment lot can be included in one furnace load

For the heat-treatment in a continuous furnace, the products heat-treated during a time less than 8 h can be considered. This limit of 8 h can be exceeded, in the case of a thick plate, solution heat treated in a continuous furnace.

3.2

inspection lot

consignment, or a part thereof, submitted for inspection, comprising products of the same grade or alloy, form, thickness or cross-section, and processed in the same manner

3.3

cast

group of ingots poured simultaneously from the same source of molten metal. In the case of continuous casting, the cast is identified as the quantity of metal poured continuously from the same source of molten metal while no additional metal input is made to that source (except for possible grain refining addition)

3.4

working temperature range

permitted working temperature range of the material in pressure equipment application

4 Materials

4.1 The materials used for the production of pressure equipment shall be suitable for the intended purpose. Account shall be taken of mechanical properties, temperature and internal as well external environment.

They shall have adequate ductility and toughness and not be adversely affected by ageing. They shall display adequate resistance to stress corrosion and to intercrystalline corrosion (see e.g. EN 485-2) and not be adversely affected by long time exposure at maximum working temperature (see Tables 5 and 6).

They shall have a lead content not exceeding 150 µg/g. For particularly safety-sensitive applications (e.g. high volumes at high pressure), it is recommended that lower values be agreed upon between producer and purchaser.

NOTE For that purpose, specific national variants have been developed for some alloys, such as EN AW-6061A, EN AW-6082A, EN AW-6351A. The only difference of these national variants with respect to the parent alloy is the upper limit of lead content.

4.2 Unless otherwise specified in a specific application standard, the minimum percentage elongation at fracture A , as specified in the relevant material standard (see clause 6) shall not be lower than 5 %.

The conversion of A into $A_{50\text{mm}}$ and vice versa shall be done as specified in Annex A.

NOTE In order to facilitate the use of this standard a list of materials which comply with the 14 % elongation (A) criterium is given for information in Annex C.

4.3 Materials (alloys and tempers), which may be used in compliance with the present standard in accordance with 4.1 and 4.2, are listed in Table 1 together with their welding characteristics, main field of application and working temperature ranges. The corresponding product forms for which mechanical properties at ambient temperature are specified in the referenced European Standards are given for convenience in Annex B, Table B.1.

NOTE For heat exchangers, for use in equipment not subject to the requirements of the EU directive listed in Annex ZA, other materials can be used after written agreement between purchaser and manufacturer.

4.4 If the pressure equipment is operating above room temperature for time exceeding 100 h, than the long time behaviour of the material according to Tables 5 and 6 shall be considered.

4.5 For products intended to be formed, proper consideration shall be given to the formability to the material.

5 Technical conditions for inspection and delivery

5.1 General

5.1.1 The provisions of EN 485-1 (sheets, strips and plates), EN 941 (circles), EN 755-1 (extruded rods/bars, tubes and profiles), EN 754-1 (cold drawn rods/bars, and tubes) and EN 586-1 (forgings) apply with the amendments and additions specified in 5.2 to 5.5 below.

5.1.2 Generally, the production and manufacturing processes shall be left to the discretion of the producer. However, for tubes and hollow profiles, the porthole die extrusion technique may only be used after written agreement between producer and purchaser, and which shall include specific testing schedules (see 5.3.10).

5.1.3 It is recommended that the material to be used for welded components be produced from rolling or extrusion ingots with an hydrogen level no greater than 0,2 ml per 100 g aluminium, measured on liquid metal during casting.

5.2 Orders or tenders

5.2.1 Orders or tenders shall refer to the present standard, expressly implying that the ordered material is to be used for the construction of pressure equipment.

5.2.2 Particular requirements such as flattening test, leak test, ultrasonic test, etc., shall be expressly stated together with the criteria to which the material shall be verified.

5.3 Test procedure

5.3.1 General

Unless otherwise specified by the contracting parties and stated on the order, the following minimum test frequencies shall apply.

5.3.2 Chemical analysis

The specimens for chemical analysis shall be taken at the time of casting. At least one specimen shall be taken from each cast.

5.3.3 Tensile test

Tensile testing shall be carried out as specified in EN 485-1, EN 586-1, EN 754-1 and EN 755-1, as applicable, noting the following:

a) frequency of test:

- 1) for sheet, strip and plate at least one test-piece shall be taken from each cast represented in each inspection lot, or heat-treatment lot where applicable, of 10 000 kg or part thereof. For single plate or coil weighing more than 10 000 kg each, only one test-piece per plate or coil shall be taken;
- 2) for extruded or extruded and cold drawn products:
 - i) for products having a nominal mass up to and including 1 kg/m, at least one test piece shall be taken from each cast represented in each inspection lot or heat-treatment lot of 1 000 kg or part thereof;
 - ii) for products having a nominal mass comprised over 1 kg/m to 5 kg/m including, at least one test piece shall be taken from each cast represented in each inspection lot or heat-treatment lot of 2 000 kg or part thereof;
- 3) for forgings:
 - i) for forgings weighing up to 2 kg at least one test piece shall be taken from each inspection lot or heat treatment lot of 1 000 kg or part thereof;
 - ii) for forgings weighing greater than 2 kg up to and including 10 kg at least one test piece shall be taken from each inspection lot or heat-treatment lot of 2 000 kg or part thereof;
 - iii) for forgings weighing greater than 10 kg at least one test piece shall be taken from each inspection lot or heat-treatment lot of 3 000 kg or part thereof;

b) proof stress measurement:

- 1) $R_{p0,2}$ shall be measured for all alloys;
- 2) for aluminium grades EN AW-1080A, EN AW-1070A and EN AW-1050A, in temper O or H111, $R_{p1,0}$ (proof stress at 1 % permanent elongation) shall also be measured. Results shall meet the requirements specified in Table 2.