



# SLOVENSKI STANDARD

## SIST EN 12392:2016

01-maj-2016

Nadomešča:  
SIST EN 12392:2002

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### Aluminij in aluminijeve zlitine - Gnetne in ulite zlitine - Posebne zahteve za aluminijeve izdelke za izdelavo naprav, ki delajo pod tlakom

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

Aluminium und Aluminium-Legierungen - Knet- und Gusserzeugnisse - Besondere Anforderungen an Erzeugnisse für die Fertigung von Druckgeräten

Aluminium et alliage d'aluminium - Produits corroyés et moulés - Exigences particulières pour les produits destinés à la fabrication des appareils à pression

Ta slovenski standard je istoveten z: **EN 12392:2016**

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#### **ICS:**

77.150.10      Alumijski izdelki      Aluminium products

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EUROPEAN STANDARD

EN 12392

NORME EUROPÉENNE

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March 2016

ICS 77.150.10

Supersedes EN 12392:2000

English Version

## Aluminium and aluminium alloys - Wrought products and cast products - Special requirements for products intended for the production of pressure equipment

Aluminium et alliage d'aluminium - Produits corroyés et moulés - Exigences particulières pour les produits destinés à la fabrication des appareils à pression

Aluminium und Aluminium Legierungen - Knet- und Gusszeugnisse - Besondere Anforderungen an Erzeugnisse für die Fertigung von Druckgeräten

This European Standard was approved by CEN on 18 January 2016.

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.

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

**CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels**

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## EN 12392:2016 (E)

## European foreword

This document (EN 12392:2016) 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 2016, and conflicting national standards shall be withdrawn at the latest by September 2016.

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.

This document supersedes EN 12392:2000.

This document 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 document.

Comparing to EN 12392:2000 the following modifications were implemented in EN 12392:2016:

- modification of the scope (extension to cast aluminium and aluminium alloys) (Clause 1);
- new normative references (Clause 2);
- new definitions (Clause 3): melt, casting, forging, tube;
- modification of Clause 4 “Materials” which covers Wrought products and Cast products;
- modification of Clause 5 “Technical conditions for inspection and delivery”: new requirements for Manufacturing methods, Orders or tenders, Test procedures, Inspection documents, Marking, Packaging;
- modification of Clause 6 “Mechanical properties”: different specifications are included at room temperature and low and elevated temperature properties;
- modification of Clause 7 “Tolerances on dimensions and form”: inclusions of Tables 1 to 37;
- deletion of Clause 8 “Elevated temperature properties” (initially in 2000 version);
- new Annex A (Informative) “Materials and application range”;
- new Annex B (Informative) “Tensile properties at low and high temperature”;
- new Annex ZA (Informative) “Relationship with EU Directive 2014/68”;
- new references into Bibliography.

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, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

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**EN 12392:2016 (E)****1 Scope**

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

This European Standard covers:

- the products forms, grades and tempers of wrought and cast aluminium and aluminium alloys which may be used for such applications together with data for wrought and cast alloys over their permissible working temperature ranges;
- the permissible alloys/ tempers covered by this are those given in Table A.1 and in B.1 for wrought alloys and in Table A.2 and in B.2 for castings;
- the technical conditions for inspection and delivery, mechanical property limits and tolerances on form and dimensions by reference to the appropriate European standards for the relevant wrought and cast aluminium and aluminium alloys, and
- additional requirements which are specific to pressure equipment applications.

It applies to hot-rolled plate, cold-rolled sheet/ strip/ circles, extruded or extruded and cold drawn rod/bar, tube, extruded open / hollow profiles, forgings and castings, by this standard are those given in Table A.1 for wrought alloys and in Table A.2 for castings.

It is the sole objective of this standard to cover materials only for pressure purposes and it excludes any elements of fabrication or fabrication methods for pressure equipment; such information can be found in the relevant standards listed in the “Bibliography” section.

**2 Normative references**

[SIST EN 12392:2016](https://standards.iteh.ai/catalog/standards/sist/315b9c7b-e086-4396-8ac7-147890ad7cca/sist-en-12392-2016)

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The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

EN 485-3, *Aluminium and aluminium alloys - Sheet, strip and plate - Part 3: Tolerances on dimensions and form 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 alloys - Forgings - Part 1: Technical conditions for inspection and delivery*

EN 586-3, *Aluminium and aluminium alloys - Forgings - Part 3: Tolerances on dimensions and form*

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

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



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

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

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

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

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

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

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

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

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

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

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

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

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

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

EN 755-9, *Aluminium and aluminium alloys - Extruded rod/bar, tube and profiles - Part 9: Profiles, tolerances on dimensions and form*

EN 941, *Aluminium and aluminium alloys - Circle and circle stock for the production of general applications - Specifications*

EN 1371-1, *Founding - Liquid penetrant testing- Part 1: Sand, gravity die and low pressure die castings*

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*

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EN 1779, *Non-destructive testing - Leak testing - Criteria for method and technique selection*

EN 2101, *Aerospace series - Chromic acid anodizing of aluminium and wrought aluminium alloys*

EN 4050-1, *Aerospace series - Test method for metallic materials - Ultrasonic inspection of bars, plates, forging stock and forgings - Part 1: General requirements*

EN 4050-2, *Aerospace series - Test method for metallic materials - Ultrasonic inspection of bars, plates, forging stock and forgings - Part 2: Performance of test*

EN 4050-3, *Aerospace series - Test method for metallic materials - Ultrasonic inspection of bars, plates, forging stock and forgings - Part 3: Reference blocks*

EN 4050-4, *Aerospace series - Test method for metallic materials - Ultrasonic inspection of bars, plates, forging stock and forgings - Part 4: Acceptance criteria*

EN 10204:2004, *Metallic products - Types of inspection documents*

EN 12020-1, *Aluminium and aluminium alloys - Extruded precision profiles in alloys EN AW-6060 and EN AW-6063 - Part 1: Technical conditions for inspection and delivery*

EN 12020-2, *Aluminium and aluminium alloys - Extruded precision profiles in alloys EN AW-6060 and EN AW-6063 - Part 2: Tolerances on dimensions and form*

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

EN 12681, *Founding - Radiographic examination*

EN 13957, *Aluminium and aluminium alloys - Extruded round, coiled tube for general applications - Specification*

EN 13958, *Aluminium and aluminium alloys - Cold drawn, round, coiled tube for general applications - Specification*

EN 14361, *Aluminium and aluminium alloys - Chemical analysis - Sampling from metal melts*

EN 14726, *Aluminium and aluminium alloys - Chemical analysis - Guideline for spark optical emission spectrometric analysis*

EN ISO 3452-1, *Non-destructive testing - Penetrant testing - Part 1: General principles (ISO 3452-1)*

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

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

EN ISO 8062, *Castings - System of dimensional tolerances and machining allowances (ISO 8062)*

EN ISO 8492, *Metallic materials - Tube - Flattening test (ISO 8492)*

EN ISO 8493, *Metallic materials - Tube - Drift-expanding test (ISO 8493)*

EN ISO 8495, *Metallic materials - Tube - Ring-expanding test (ISO 8495)*

EN ISO 8496, *Metallic materials - Tube - Ring tensile test (ISO 8496)*

ASTM B548, *Standard Test Method for Ultrasonic Inspection of Aluminium-Alloy Plate for Pressure Vessels*

ASTM B594, *Standard Practice for Ultrasonic Inspection of Aluminium-Alloy Wrought Products*

ASTM E112, *Standard Test Methods for Determining Average Grain Size*

ASTM E215, *Standard Practice for Standardizing Equipment for Electromagnetic Testing of Seamless Aluminum-Alloy Tube*

### 3 Terms and definitions

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

#### 3.1

##### **heat-treatment batch or lot**

quantity of products of the same alloy or purity grade of alloy, form, thickness or cross-section and produced in the same way and heat-treated in one furnace load; or such products solution-treated and subsequently precipitation treated in one furnace load

Note 1 to entry: More than one solution-treatment batch can be included in one ageing furnace load.

Note 2 to entry: For heat treatment in a continuous furnace (vertical or horizontal), the products continuously heat-treated during a specified time (e.g. 8 h) can be considered as one heat treatment lot.

Note 3 to entry: For forgings, a heat-treatment lot may consist of a group of forgings of similar size and shape.

#### 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

Note 1 to entry: For forgings, an inspection lot may consist of a group of forgings of similar size and shape.

#### 3.3

##### **melt**

quantity of molten metal that has simultaneously undergone the same preparatory treatment in the furnace before the casting operation

#### 3.4

##### **cast**

quantity of products cast simultaneously from the same melt

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casting**

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

Note 1 to entry: Pressure die-cast products are excluded from the scope of the present standard.

Note 2 to entry: The mould of concern can be a single use mould (sand) or a permanent mould (e.g. cast iron or steel).

Note 3 to entry: As pressure die casting is not of concern in the present Standard, only permanent moulds and no dies are applicable for cast products.

**3.6  
forging**

wrought product formed by hammering or pressing, typically when hot, such as open die forging, drop or closed die forging or seamless rolled ring forging

**3.7  
tube**

hollow, wrought product with a uniform cross-section, with only one enclosed void and with a uniform wall thickness, supplied in straight lengths or in coiled form

Note 1 to entry: Cross-sections are in the shape of circles, ovals, squares, rectangles, equilateral triangles or regular polygons and can have rounded corners, provided the inner and outer cross-sections are concentric and have the same form and orientation.

**3.8  
operating temperature range**

temperature range at which the material is exposed during its use

**4 Materials****4.1 General**

The materials covered by this standard are to be used in a wide range of pressure equipment operating over diverse range of both pressure and temperature. The range of applications extends from relatively low pressure automotive equipment such as heat exchangers to heavy duty applications including unfired pressure vessels and piping used in pressure equipment. As a result, it will be necessary for the standard to detail an extensive range of aluminium product forms, alloys and tempers as follows:

- sheet, strip, plate and circles (EN 485, EN 941);
- cold drawn rod/bar and tube (EN 754);
- extruded rod/bar, tube and profiles (EN 755);
- precision profiles (EN 12020);
- extruded coiled tube (EN 13957);
- cold drawn coiled tube (EN 13958);
- forgings (EN 586);
- castings (EN 1706).

Materials (alloys and tempers), which may be used in compliance with the present standard are listed in Tables 1, A.1 and A.2, together with their welding characteristics, main field of application and operating temperature ranges.

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 supplier and purchaser.

If the pressure equipment is operating above room temperature for times exceeding 100 h, then the long time behaviour of the material according to Tables B.1 to B.4 shall be considered.

## 4.2 Wrought products

Applicable alloys and the chemical compositions for wrought alloys are given in Table 2. The chemical compositions of aluminium and aluminium alloys are specified in percentage by mass. Limits for impurities are expressed as maxima that also will apply to alloying elements unless expressed as a range. Aluminium is specified as a minimum for unalloyed aluminium, and as a remainder for aluminium alloys.

## 4.3 Cast products

Applicable alloys and the chemical compositions for cast alloys are given in Table 3. The chemical compositions of aluminium and aluminium alloys are specified in percentage by mass. Limits for impurities are expressed as maxima which also will apply to alloying elements unless expressed as a range.

## 5 Technical conditions for inspection and delivery

### 5.1 Manufacturing methods

#### 5.1.1 General

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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), EN 12020-1, EN 13957, EN 13958, EN 586-1 (forgings incl. seamless rolled rings), EN 1559-1 (Founding) and EN 1559-4 (Founding) apply with the amendments and additions specified in 5.2 to 5.5 below.

Unless otherwise agreed between supplier and purchaser, the manufacturing methods used shall be left to the discretion of the supplier. In addition, there shall be no obligation on the supplier to use the same processes or process route for subsequent or similar orders.

#### 5.1.2 Specific requirements regarding porthole extruded and/or drawn products

Regarding porthole extruded and/or drawn products, limitations for safe application of porthole extruded and/or drawn products are provided at Tables 4 and 5:

- Table 4 applies to porthole extruded tube (EN 755-8), porthole extruded and drawn tube (EN 754-8), porthole extruded hollow profiles (EN 755-9) and porthole extruded precision profiles (EN 12020) and may be used up to and including an outside diameter of 600 mm (DN 600) and a thickness (t) of maximum 20 mm
- Table 5 applies to porthole extruded coiled tube (EN 13957) and porthole extruded and drawn coiled tube EN 13958 and may be used up to and including an outside diameter 50 mm (DN 50) and a thickness (t) of maximum 5 mm.

The stated values for allowable maximum pressure (PS) and volume (V) in Tables 4 and 5 are limitations superseding those disclosed in (PED) 97/23/EC .

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The purchaser and or equipment manufacturer (when different) is responsible for the design of the final equipment.

As a result, the purchaser and/ or equipment manufacturer (if different) shall, when placing an order with the supplier (material manufacturer), provide the following information to ensure that the correct Hazard Category and adequate quality assurance is applied to the particular combination of criteria:

- the type of pressure equipment being considered (vessel or piping acc. to 97/23/EC Art. 1 and intended use);
- the state of the fluid in the equipment (gas or liquid);
- the hazard group of the fluid (acc. to PED 97/23/EC Art. 9);
- design maximum pressure (PS);
- confirmation that the completed equipment assembly will be pressure tested.

The supplier (material manufacturer) shall not be liable for any issues arising from inaccurate information provided by the purchaser/equipment manufacturer.

NOTE 1 Some further comment is necessary on the methods of extrusion used for tube and hollow profiles. In particular seamless extrusion produces a product that does not contain any seams or weld lines in the product cross-section. On the other hand extruded products manufactured using a porthole or bridge die will contain at least one longitudinal weld or seam. The presence of such welds or seams can be a major concern on products that are to be used for e.g. pressure vessels since the weld/seam could lead to premature failure of the vessel under pressure.

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NOTE 2 In addition despite rigorous process control during the extrusion process, there is no definitive non-destructive test method that can provide total assurance of the integrity of the welds in the product cross-section. In view of the safety implications of using porthole products, it is necessary to provide guidelines in this standard as to the permitted product areas where porthole products may or may not be used.

NOTE 3 It needs to be highlighted that, beside the limits for nominal size DN and thickness t, Tables 4 and 5 provide additional limitations regarding pressure PS, volume V and testing procedures. The equipment supplier can decide to use porthole extrusion for products exceeding the stated limits/hazard categories, but this can only be done after written agreement between supplier and purchaser, and provided that adequate quality assurance/testing procedures are agreed.

**5.1.3 Quality control**

The manufacturer/supplier shall be responsible for the performance of all inspection and tests required by the relevant European standard and/or the particular specification prior to shipment of the product. If the purchaser wishes to carry out an inspection prior to shipment, this shall be agreed with the supplier and the request shall be stated on the original order.

**5.2 Orders or tenders**

The order or tender documents shall define the product required and contain the following minimum information:

- a) the type and form of the product. In the case of tube whether extruded, cold drawn or coiled, it is also essential to state the method of extrusion to be used i.e. seamless or porthole (see also point i) below);
- b) reference to this particular Standard EN 12392;
- c) the dimensions and shape of the particular product required;

- 1) plate: thickness, width and length;
- 2) sheet: thickness, width and length;
- 3) strip: thickness width and coil dimensions;
- 4) circles: thickness and diameter;
- 5) round tube: method of production, outside (OD) or inside (ID) diameter, wall thickness (WT), and length;

NOTE 1 Two of the OD/ID/WT dimensions may be given tolerances but not all three.

- 6) coiled round tube: outside (OD) or inside (ID) diameter, wall thickness (WT), coil dimensions and tube length if required in straight lengths;

NOTE 2 Two of the OD/ID/WT dimensions may be given tolerances but not all three.

- 7) round bar: diameter and length;
  - 8) square and hexagonal bar: width across flats and length;
  - 9) rectangular bar: width, thickness and length;
  - 10) extruded profiles and hollow sections: drawing of cross section and length;
  - 11) forgings (open-die forgings, closed-die forgings and seamless rolled rings): reference to drawing or finished size;
  - 12) castings: reference to a drawing;
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- d) the product tolerances on dimensions and form together with particular reference to the relevant European standard for the specific product concerned;
  - e) quantity required: whether it is weight, number of pieces, total length and the quantity tolerance on the total amount of the order;
  - f) product certification requirement with particular reference to EN 10204:2004;
  - g) identification marking requirements;
  - h) surface finish requirements particularly details of any surface treatments to be carried out;
  - i) the order shall clearly show if the ordered product is to be produced by the porthole extrusion method. In case of porthole extrusion, additional information as expressed in 5.1.2 shall be provided;
  - j) any other special requirements agreed between supplier and purchaser (e.g. grain size). Reference to design standard, test methods, test frequency, reference to drawings, part numbers or any other special requirements;

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

- k) any additional inspection to be carried out prior to delivery;