# SLOVENSKI STANDARD
# SIST EN 4632-002:2008

**01-julij-2008**

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**Aeronavtika - Varjeni in trdo spajkani sestavi za konstrukcije v aeronavtiki - Varilnost in spajkalnost materialov - 002. del: Homogeni sestavi iz aluminija in aluminijevih zlitin**

Aerospace series - Welded and brazed assemblies for aerospace constructions - Weldability and brazeability of materials - Part 002: Homogeneous assemblies aluminium and aluminium alloys



Luft- und Raumfahrt - Schweiß- und Lötverbindungen für die Luft- und Raumfahrt - Schweißbarkeitsgrad und Lötbarkeitsgrad von Werkstoffen - Teil 002: Gleichartige Verbingungen Aluminium und Aluminiumlegierungen



Série aérospatiale - Assemblages soudés et brasés pour constructions aérospatiales - Soudabilité et brasabilité des matériaux - Partie 002 : Assemblages homogènes de l'aluminium et des alliages d'aluminium

**Ta slovenski standard je istoveten z: EN 4632-002:2008**

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**ICS:**

| | | |
|---|---|---|
| 25.160.01 | Varjenje, trdo in mehko spajkanje na splošno | Welding, brazing and soldering in general |
| 49.025.20 | Aluminij | Aluminium |

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 4632-002

April 2008

ICS 49.025.01

English Version

# Aerospace series - Welded and brazed assemblies for aerospace constructions - Weldability and brazeability of materials - Part 002: Homogeneous assemblies aluminium and aluminium alloys

Série aérospatiale - Assemblages soudés et brasés pour constructions aérospatiales - Soudabilité et brasabilité des matériaux - Partie 002 : Assemblages homogènes de l'aluminium et des alliages d'aluminium

Luft- und Raumfahrt - Schweiß- und Lötverbindungen für die Luft- und Raumfahrt - Schweißbarkeitsgrad und Lötbarkeitsgrad von Werkstoffen - Teil 002: Gleichartige Verbingungen Aluminium und Aluminiumlegierungen

This European Standard was approved by CEN on 7 March 2008.

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 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 Management Centre has the same status as the official versions.



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

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Ref. No. EN 4632-002:2008: E

## Contents

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## Foreword

This document (EN 4632-002:2008) has been prepared by the Aerospace and Defence Industries Association of Europe - Standardization (ASD-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of ASD, prior to its presentation to CEN.

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 October 2008, and conflicting national standards shall be withdrawn at the latest by October 2008.

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.

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, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

## 1 Scope

This standard defines degrees of weldability and brazeability for materials or families of materials used in the aerospace industry.

It comprises a series of sheets, by materials or by material family which:

— indicate the main titles, the typical chemical composition and the main characteristics,

— contain recommendations for welding and brazing,

— indicate a degree of weldability or brazeability for a given process under defined conditions.

— indicate a value of the mechanical strength coefficient of the welded joint for each welding process, when it could be extracted from bibliographic references referring to it. The joint coefficient is expressed as a ratio of the tensile strength of the welded joint to the tensile strength of the base alloy.

It is applicable without restriction for the manufacturing of new parts or for repair.

## 2 Normative references

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

EN 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 515, *Aluminium and aluminium alloys — Wrought products — Temper designations.*



EN 573-2, *Aluminium and aluminium alloys — Chemical composition and form of wrought products — Part 2: Chemical symbol based designation system.*

EN 573-3, *Aluminium and aluminium alloys — Chemical composition and form of wrought products — Part 3: Chemical composition and form of products.*

EN 1011-4, *Welding — Recommendations for welding of metallic materials — Part 4: Arc welding of aluminium and aluminium alloys.*

EN 1706, *Aluminium and aluminium alloys — Castings — Chemical composition and mechanical properties.*

EN 2032-1, *Aerospace series — Metallic materials — Part 1: Conventional designation.*

EN 2726, *Aerospace series — Aluminium alloy AL-C42201 — T6 — Sand casting — a ≤ 20 mm.* [1)]

EN 2728, *Aerospace series — Aluminium alloy AL-C42101 — T6 — Sand casting — a ≤ 20 mm.* [1)]

EN 4632-001, *Aerospace series — Welded and brazed assemblies for aerospace constructions — Weldability and brazeability of materials — Part 001: General requirements.*

EN ISO 18273, *Welding consumables — Wire electrodes, wires and rods for welding of aluminium and aluminium alloys — Classification.*

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1) Published as ASD Prestandard at the date of publication of this standard.

ANSI/AWS A5.10-80, *Specification for bare aluminum and aluminum alloy welding electrodes and rods.* [2)]

ASTM/ANSI B209, *Standard specification for aluminum and aluminium alloy sheet and plate.*

SAE-AMS 4031, *Aluminum alloy, sheet and plate 6.3Cu - 0.30Mn - 0.18Zr - 0.10V - 0.06Ti (2219-0) annealed.* [3)]

SAE-AMS 4191, *Aluminum alloy, welding wire 6.3Cu - 0.30Mn - 0.18Zr - 0.15Ti - 0.10V (2319).* [3)]

SAE-AMS-QQ-A-250/30, *Aluminum alloy 2219, plate and sheet.* [3)]

SAE-AMS-A-21180, *Aluminum-alloy casting, high strength.* [3)]

## 3 Terms, definitions, symbols and abbreviations

For the purposes of this document, the terms and definitions given in EN 4632-001 apply.

PWHT: Post-Welding Heat Treatment

F: Foil

p: powder

w: wire

AFB: Air Furnace Brazing

FLB: Flame Brazing

VFB: Vacuum Furnace Brazing



## 4 Use of this standard

The index of material sheets contained in this standard, classified by family based on the main element used in the chemical composition and on the alloy structure, is given in Clause 6 in this standard.

The degree of weldability or brazeability to be used is the value indicated by the material sheet considered for the process chosen. In the operating cycle, choose thermal states that give the lowest degree in preference.

If two degrees are indicated, the responsible person must select the degree that is most appropriate for the definition of the assembly.

## 5 Updating this standard

See EN 4632-001.

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2) Published by: AWS, 550 N.W. LeJeune Road, Miami, Florida 33126.

3) Published by: Society of Automotive Engineers, Inc. (SAE), 400 Commonwealth Drive, Warrendale, PA 15096-0001, USA.

# 6 Index of aluminium and aluminium alloy sheets

## 6.1 Index by material family

— family 1000: sheet 7.1

— family 2000: sheets 7.2 to 7.7

— family 5000: sheets 7.8 and 7.9

— family 6000: sheet 7.10

— family 7000: sheets 7.11 and 7.12

— foundry alloys family: sheet 7.13

## 6.2 Numeric index

| Sheet | Material |
|---|---|
| 7.1 | 1050A - 1060 |
| 7.2 | 2001 |
| 7.3 | 2014 |
| 7.4 | 2017A |
| 7.5 | 2024 |
| 7.6 | 2219 |
| 7.7 | 2618A |
| 7.8 | 5056A, 5083, 5086, 5182, 5456 |
| 7.9 | 5754 |
| 7.10 | 6005A, 6013, 6016, 6056, 6060, 6061, 6063, 6081, 6082, 6181 |
| 7.11 | 7020, 7051 |
| 7.12 | 7050, 7075, 7175, 7475 |
| 7.13 | Al Si 7 Mg 0,3 and Al Si 7 Mg 0,6 |

# 7 Material sheets

## 7.1

**Designation:**

EN 573-2 : EN AW-1050A; EN AW-1060

Old designation : A5, A6

EN 2032-1 : AL-P1050A; AL-P1060

ISO : Al 99,5; Al 99,6

Other standards :

**Typical composition:**

See EN 573-3.

| Grade | Al | Si | Fe | Cu | Mn | Mg | Zn | Ti |
|---|---|---|---|---|---|---|---|---|
| 1050A | base | ≤ 0,25 | ≤ 0,40 | ≤ 0,05 | ≤ 0,05 | ≤ 0,05 | ≤ 0,07 | ≤ 0,05 |
| 1060 | base | ≤ 0,25 | ≤ 0,35 | ≤ 0,05 | ≤ 0,03 | ≤ 0,03 | ≤ 0,05 | ≤ 0,05 |



**Structure:**

Without structural hardening

**Particular characteristics:**

**Recommendations for welding and filling with EN AW-1050A and EN AW-1060**

| Process | Thickness range in mm | State before welding | PWHT | Degree of weldability | Joint coefficient | Comments and bibliographic references [ ] |
|---|---|---|---|---|---|---|
| OA | – | O or H111 | none | 1 | – | – |
| TIG | ≤ 2 | O or H111 | none | 1 | 1 | Filler metal same grade 1050 or 1080 [45] |
| EBW | – | O or H111 | none | 1 | 1 | – |
| RSEW, RSW | – | O or H111 or H24 | none | 2 | – | – |

## 7.2

**Designation:**

EN 573-2 : EN AW-2001

Old designation : AU6 MGT

EN 2032-1 : AL-P2001-

ISO : Al Cu 5,5 Mg Mn

Other standards :

**Typical composition:**

See EN 573-3.

| Grade | Al | Si | Fe | Cu | Mn | Mg | Cr | Zn | Ti | Ni | Zr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001- | base | ≤ 0,20 | ≤ 0,20 | 5,2 to 6,0 | 0,15 to 0,50 | 0,20 to 0,45 | ≤ 0,10 | ≤ 0,10 | ≤ 0,20 | ≤ 0,05 | ≤ 0,05 |



**Structure:**

With structural hardening



**Particular characteristics:**

**Recommendations for welding and filling with EN AW-2001**

| Process | Thickness range in mm | State before welding | PWHT | Degree of weldability | Joint coefficient | Comments and bibliographic references [ ] |
|---|---|---|---|---|---|---|
| EBW | ≤ 1 | T4 | T | 2 | – | Micro-porosity in the weld [49] |
| | | T6 | none | 2 | – | No porosity<br>Area with large grains in the base metal |
| | ≤ 8 | T4 | T | 2 | – | Micro-porosity in the weld [49] |
| | | T6 | none | 2 | – | No porosity |
| | ≤ 30 | T4 | T | 2 | – | No porosity [49] |
| | | T6 | none | 2 | | |
| RSEW, RSW | – | T6 | – | 2 | – | – |

**7.3**

**Designation:**

EN 573-2 : EN AW-2014

Old designation : AU4 SG

EN 2032-1 : AL-P2014-

ISO : Al Cu 4 Si Mg

Other standards:

**Typical composition:**

See EN 573-3.

| **Grade** | Al | Si | Fe | Cu | Mn | Mg | Cr | Zn | Ti | Ni |
|---|---|---|---|---|---|---|---|---|---|---|
| 2014- | base | 0,50 to 1,2 | ≤ 0,7 | 3,9 to 5,0 | 0,40 to 1,2 | 0,20 to 0,8 | ≤ 0,10 | ≤ 0,25 | ≤ 0,15 | ≤ 0,10 |



| Al | Ti + Zr | |
|---|---|---|
| base | ≤ 0,20 | only for extruded or forged products with agreement between supplier and customer |



**Structure:**

With structural hardening

**Particular characteristics:**

**Recommendations for welding and filling with EN AW-2014**

| Process | Thickness range in mm | State before welding | PWHT | Degree of weldability | Joint coefficient | Comments and bibliographic references [ ] |
|---|---|---|---|---|---|---|
| OA | – | – | – | 4 | – | – |
| TIG | – | – | – | 4 | – | – |
| EBW | ≤ 1 | T4 | T4 | 2 | – | Porosity in the weld |
| | | T6 | none | 2 | – | No porosity and area with large grains in the base metal [50] |
| | ≤ 8 | T4 | T6 | 2 | – | Micro-porosity |
| | | T6 | none | | – | No porosity [50] |
| | ≤ 30 | T4 | T6 | 2 to 3 | – | No porosity [50] |
| | | T6 | none | 2 to 3 | | |
| RSEW, RSW | – | T6 | – | 2 | – | – |
| FSW | ≤ 22 | T6 | none | 2 | – | [43] |
| | ≤ 6,35 | T651 | none | 2 | 0,68 | [44] |