



# SLOVENSKI STANDARD

## SIST EN 4677-001:2012

01-september-2012

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**Aeronavtika - Varjeni in trdo spajkani sestavi za konstrukcije v aeronavtiki - Spoji kovinskih materialov pri varjenju z elektronskim snopom - 001. del: Kakovost varjenih sestavov**

Aerospace series - Welded and brazed assemblies for aerospace construction - Joints of metallic materials by electron beam welding - Part 001: Quality of welded assemblies

Luft- und Raumfahrt - Schweiß- und Lötverbindungen für die Luft- und Raumfahrt - Verbindungen metallischer Werkstoffe mittels Elektronenstrahlschweißen - Teil 001: Qualität der Schweißverbindungen

Série aérospatiale - Assemblages soudés et brases pour constructions aérospatiales - Assemblages de matériaux métalliques soudés par faisceau d'électrons - Partie 001: Qualité des assemblages soudés

**Ta slovenski standard je istoveten z: EN 4677-001:2012**

### **ICS:**

25.160.40	Varjeni spoji in vari	Welded joints
49.035	Sestavni deli za letalsko in vesoljsko gradnjo	Components for aerospace construction

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**en**

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EUROPEAN STANDARD  
NORME EUROPÉENNE  
EUROPÄISCHE NORM

**EN 4677-001**

May 2012

ICS 25.160.40; 49.035

English Version

**Aerospace series - Welded and brazed assemblies for  
aerospace construction - Joints of metallic materials by electron  
beam welding - Part 001: Quality of welded assemblies**

Série aérospatiale - Assemblages soudés et brasés pour  
constructions aérospatiales - Assemblages de matériaux  
métalliques soudés par faisceau d'électrons - Partie 001:  
Qualité des assemblages soudés

Luft- und Raumfahrt - Schweiß- und Lötverbindungen für  
die Luft- und Raumfahrt - Verbindungen metallischer  
Werkstoffe mittels Elektronenstrahlschweißen - Teil 001:  
Qualität der Schweißverbindungen

This European Standard was approved by CEN on 16 January 2010.

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## Foreword

This document (EN 4677-001:2012) 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 November 2012, and conflicting national standards shall be withdrawn at the latest by November 2012.

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

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**EN 4677-001:2012 (E)****1 Scope**

This European Standard defines the rules to be satisfied to ensure the quality of joints of metallic materials by electron beam welding (reference number 51 according to EN ISO 4063).

It applies unreservedly to the manufacturing of new parts or for repair, these operations being under the responsibility of an approved manufacturer or supplier. The final responsibility is with the design authority

**2 Normative references**

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 875, *Destructive tests on welds in metallic materials — Impact tests — Test specimen location, notch orientation and examination*

EN 895, *Destructive tests on welds in metallic materials — Transverse tensile test*

EN 910, *Destructive tests on welds in metallic materials — Bend tests*

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

EN 4632-002, *Aerospace series — Welded and brazed assemblies for aerospace constructions — Weldability and brazeability of materials — Part 002: Homogeneous assemblies aluminium and aluminium alloys*

EN 4632-003, *Aerospace series — Weldability and brazeability of materials in aerospace constructions — Part 003: Welding and brazing of homogeneous assemblies of unalloyed and low alloy steels*

EN 4632-004, *Aerospace series — Welded and brazed assemblies for aerospace constructions — Weldability and brazeability of materials — Part 004: Homogeneous assemblies highly alloyed steels*

EN 4632-005, *Aerospace series, Weldability and brazeability of materials in aerospace constructions — Homogeneous assemblies of heat resisting Ni or Co base alloys*

EN 4632-006, *Welded and brazed assemblies for aerospace constructions — Weldability and brazeability of materials — Part 006: Homogeneous assemblies titanium alloys*

EN ISO 4063, *Welding and allied processes — Nomenclature of processes and reference numbers (ISO 4063)*

EN ISO 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections (ISO 5817)*

EN ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method (ISO 6507-1)*

EN ISO 6947, *Welding and allied processes — Welding positions (ISO 6947)*

EN ISO 10042, *Welding — Arc-welded joints in aluminium and its alloys — Quality levels for imperfections (ISO 10042)*

EN ISO 14731, *Welding coordination — Tasks and responsibilities (ISO 14731)*

EN ISO 14744-1, *Welding — Acceptance inspection of electron beam welding machines — Part 1: Principles and acceptance conditions (ISO 14744-1)*

EN ISO 14744-2, *Welding — Acceptance inspection of electron beam welding machines — Part 2: Measurement of accelerating voltage characteristics (ISO 14744-2)*

EN ISO 14744-3, *Welding — Acceptance inspection of electron beam welding machines — Part 3: Measurement of beam current characteristics (ISO 14744-3)*

EN ISO 14744-6, *Welding — Acceptance inspection of electron beam welding machines — Part 6: Measurement of stability of spot position (ISO 14744-6)*

EN ISO 15609-3, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 3: Electron beam welding*

EN ISO 17659:2004, *Welding — Multilingual terms for welded joints with illustrations (ISO 17659:2002)*

ISO 857-1:1998, *Welding and allied processes — Vocabulary — Part 1: Metal welding processes*

ISO 4969, *Steel — Macroscopic examination by etching with strong mineral acids*

ISO 22826, *Destructive tests on welds in metallic materials — Hardness testing of narrow joints welded by laser and electron beam (Vickers and Knoop hardness tests)*

ISO 24394, *Welding for aerospace applications — Qualification test for welders and welding operators — Fusion welding of metallic components*

ISO/TR 25901, *Welding and related processes — Vocabulary*

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### 3 Terms and definitions (standards.iteh.ai)

For the purposes of this document, the [terms and definitions](https://standards.iteh.ai/catalog/standards/sist/ed1b7ded-0850-4ee8-870f-ba9a34aded42/sist-en-4677-001-2012) given in ISO 857-1:1998 and EN ISO 17659:2004 and the following apply:

#### 3.1 General

##### 3.1.1 Electron beam welding

fusion welding process using the transformation of the kinetic energy of beam electrons into thermal energy when they strike the material

Note 1 to entry: The electrons are obtained from a cathode heated under a secondary vacuum (1 Pa to 10<sup>-4</sup> Pa).

Note 2 to entry: The welding operation may be performed under a controlled atmosphere, generally under a primary vacuum (100 Pa to 1 Pa) or secondary vacuum.

#### 3.2 Technical terms

##### 3.2.1 Welding parameters

###### 3.2.1.1

###### run-out

interval encompassing all geometrical irregularities of the joint plane

Note 1 to entry: This interval is measured on the detail parts, positioned in their welding setup, and is used as a reference to determine the minimum width of the weld zone.

###### 3.2.1.2

###### beam centering

alignment of the beam axis on the joint plane

**EN 4677-001:2012 (E)****3.2.1.3****beam deflection**

controlled movement of the beam in relation to the physical axis of the gun

**3.2.1.4****level distance**

difference in level (height) between two detail parts at the joint plane

**3.2.1.5****firing (working) distance**

distance between the impact point of the beam on detail parts and a reference surface linked to the gun or the machine (example: middle of the closest focusing coil of the detail part, electron gun base)

**3.2.1.6****specific welding energy**

defined by ratio between the beam power over the welding speed, multiplied by 60

$$\frac{U \text{ (Volt)} \times I \text{ (Ampere)} \times 60}{V \text{ (cm/min)} \times 1000} \text{ (in kJ/cm)}$$

**3.2.1.7****focusing current intensity**

intensity of the current crossing the focusing coil enabling electron beam concentration on a point called the focusing point

Note 1 to entry: The intensity may be constant or modulated.

**3.2.1.8****beam current**

electron flow emitted by the cathode

Note 1 to entry: This current may be constant or modulated.

**3.2.1.9****clearance before welding (*Fit up*)**

distance measured on a straight section of the joint between the surfaces to be welded

**3.2.1.10****slope (or ramp) up**

operating conditions for which the penetration depth varies incrementally

**3.2.1.11****focusing level**

distance between the beam impact point on the detail parts and the focusing point

Note 1 to entry: Conventionally, this distance is negative when the focusing point is within the detail parts.

**3.2.1.12****perveance**

ratio of the beam current over the acceleration voltage at power 3/2

$$\frac{I}{U^{\frac{3}{2}}} = c^{te}$$

**3.2.1.13****beam power**

product of the acceleration voltage and the beam current



**3.2.1.14****acceleration voltage**

difference in potential between the cathode and the anode, used to create the electric field intended to accelerate the electrons

**3.2.1.15****beam oscillation**

periodic movement of the beam axis in relation to the weld pool

Note 1 to entry: This oscillation is defined by the signal shape, its amplitude, frequency and direction in relation to that of welding.

**3.2.1.16****welding speed**

length of the weld on beam impact side produced per time unit

**3.2.2 Other technical terms****3.2.2.1****welding campaign**

series of welding operations on identical parts, executed on the same machine, without any changes of welding parameters, without performing other welds on the machine, without interrupting manufacturing for more than a week

**3.2.2.2****welding cycle**

succession of different welding phases performed by the welding machine to make a weld

**3.2.2.3****tacking pass**

pre-assembling of elementary detail parts using the same process as the one used for welding, consisting of making a slightly penetrating, narrow weld, continuous or discontinuous along the joint plane, with the purpose of maintaining the detail parts in position

**3.2.2.4****adjustment verification specimen**

a flat test specimen of the same material, subjected to the same heat treatments as the detail parts, on which a melt run will be made in the middle using the parameters identical to those used for parts, and for which the relationship between the micrographic shape of the cross section cut of the bead and that obtained on test specimens or real parts has been previously defined

**3.2.2.5****structural state**

metal crystalline structural state

**3.2.2.6****manufacturing**

performance of welding operations on new parts or repairs to existing assemblies (or products)

**3.2.2.7****stabilized manufacturing**

manufacturing for which the reliability can be established without quality issue over several welding campaigns, of which the number is previously defined by the appropriate department of the design authority

**3.2.2.8****smoothing pass or cosmetic pass**

remelted surface of the welded zone

**EN 4677-001:2012 (E)****3.2.2.9****batch of parts**

set of parts with the same reference from:

- the same welding campaign;
- the same heat treatment batch;
- traced material (processing, chemical analysis, ...).

**3.2.2.10****material/Parent material**

material or metal used to make the detail parts

**3.2.2.11****filler material**

additional alloy or metal used to make the weld of an assembly or a deposit

**3.2.2.12****tooling**

equipment required to hold and position parts before and during welding

**3.2.2.13****beam stopper (catcher)**

part intended to intercept the residual energy crossing the beam in the case of a through weld

Note 1 to entry: The material making up the beam catcher should be of a same grade or a grade compatible with the required quality of the assembly.

**3.2.2.14****detail part**

individual element to be assembled with other elements to make up a complete part

**3.2.2.15****part - product**

assembly comprising several assembled detail parts

**3.2.2.16****tack welding**

pre-assembly of detail parts by welding consisting of a set of tacks along the joint plane, intended to hold the detail parts in position

**3.2.2.17****pre-heating**

heating of detail parts before welding without fusion

Note 1 to entry: This operation will be carried out with an unfocused beam or any other process not involving magnetism.

**3.2.2.18****through weld**

case where the beam crosses all the thickness of parts to weld and case where the beam propagates through all the parts to be welded

**3.2.2.19****blind weld**

case where the beam only crosses part of the thickness of the parts to weld and case where the beam only partially propagates through the thickness of the parts to be welded

**3.2.2.20****qualification test specimen**

welded assembly to be used for inspection purposes

**3.2.2.21****manufacturing test specimen**

- test specimen representing manufactured parts to be welded under the same conditions as those parts;
- test specimen made from the same material grade, in the same condition, with the same dimensions as the manufactured part.

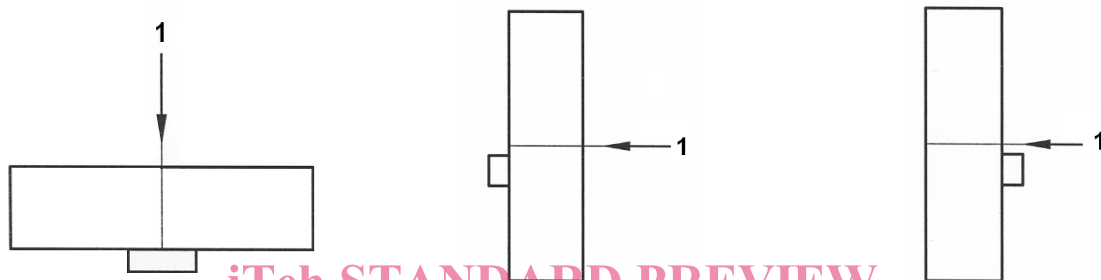
Note 1 to entry: Manufacturing test specimens may be actual parts.

**3.2.2.22****pool support**

element positioned on detail parts to prevent the fused metal from overflowing

Note 1 to entry: The material making up the pool support shall be of the same base alloy as the detail parts, to prevent any weld contamination.

Note 2 to entry: The pool support may be positioned as illustrated in Figures 1 to 3:

**Keys**

1 E.B.

**Keys**

1 E.B.

**Keys**

1 E.B.

Figure 1 — Back support

Figure 2 — Back-side support

Figure 3 — Front-side support

**3.2.2.23****witness lines**

alignment lines on both sides (upper and root) of the detail parts to ensure good location and the avoidance of lack of fusion

**3.2.2.24****post-weld heat-treatment**

treatment intended to provide the parent material and the weld zone with the requisite conditions and properties

**3.3 General terms****3.3.1****manufacturer or subcontractor**

organisation who assembles, or manufactures and assembles the elements or subassemblies into assemblies

**3.3.2****supplier**

individual or company holding a contract or order that it has accepted, binding it to the customer to perform the services defined therein

**3.3.3****customer**

individual or company placing a contract or order and who may or may not be the design authority

**3.3.4****operator**

person who performs the welding operations using a mechanised or automated process

**EN 4677-001:2012 (E)****3.3.5****qualification**

action recognizing that a welder, product, etc. is capable of fulfilling the role for which he/it is intended

**3.3.6****repair**

act consisting in making acceptable a part that was felt to be beyond the acceptance criteria after its normal manufacturing and inspection cycle

Note 1 to entry: Bringing into conformity of a part which had been damaged during operation

**3.3.7****setter**

person responsible for fully programming the machine, the beam analysis and finalization of welding procedure specification parameters and, if necessary, performing welding operations by a mechanized or automated process

**3.3.8****repairer**

supplier in the specific field of repairs

**3.3.9****competent department**

specialist department with specific duties within a company, such as:

- design office,
- quality department,
- laboratory,
- methods office

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**3.3.10****official supervisory body**

governmental authorities or approved organisations responsible for ensuring equipment conformity with the definition file

**3.3.11****design authority**

the organisation responsible for the design of the welded assembly and for defining the performance and inspection requirements

**3.3.12****welding coordinator**

See EN ISO 14731:2006

**3.4.1****Flat position PA**

horizontal welding, with beam axis vertical

**3.4.1.1****Horizontal-vertical position PB**

horizontal welding

**3.4.1.2****Horizontal position PC**

horizontal welding, welding axis horizontal

**3.4.1.3****Horizontal overhead position PD**

horizontal welding, overhead