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Welding for aerospace applications — Resistance spot and seam welding

Soudage pour applications aérospatiales — Soudage par résistance par points et à la molette

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by ISO/TC 44, *Welding and allied processes*, Subcommittee SC 14, *Welding and brazing in aerospace*.

This second edition cancels and replaces the first edition (ISO 16338:2013), of which it constitutes a minor revision.

The main changes compared to the previous edition are as follows:

a) notes on different determination of clear annulus zone for radiographic and metallographic examination have been added under the keys of Figures 8 and 9;

b) transposed numbering in column *t* in Table 14 has been corrected: row changed for 0,60 mm and 0,65 mm;

c) 17.5.1.2 Span *S* is no longer expressed in %;

d) to correct a hanging paragraph, a 14.1.3.1 "General" subheading has been introduced;

e) other editorial revisions.

Requests for official interpretations of any aspect of this document should be directed to the Secretariat of ISO/TC 44/SC 14 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

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Welding for aerospace applications — Resistance spot and seam welding

1 Scope

This document specifies requirements for resistance spot and seam welding for aerospace applications.

This document does not apply if resistance welding is simply an intermediate operation and does not affect the quality of the end product, for example when tacking basic parts prior to assembly with another process.

Resistance welding of dissimilar material group combinations is not covered by this document.

Safety and health issues and concerns are not covered by this document.

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.

ISO 6520-2, *Welding and allied processes — Classification of geometric imperfections in metallic materials — Part 2: Welding with pressure*

ISO 14731, *Welding coordination — Tasks and responsibilities*

ISO 17677-1:2009, *Resistance welding — Vocabulary — Part 1: Spot, projection and seam welding*

ISO/TR 25901-1:2016, *Welding and allied processes — Vocabulary — Part 1: General terms*

ISO/TR 25901-3, *Welding and allied processes — Vocabulary — Part 3: Welding processes*

ISO/TR 25901-4, *Welding and allied processes — Vocabulary — Part 4: Arc welding*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6520-2, ISO 14731, ISO 17677-1, ISO/TR 25901-1, ISO/TR 25901-3, ISO/TR 25901-4 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 http://www.iso.org/obp

3.1
chisel test
destructive or non-destructive test in which welds are tested by applying a predominantly tensile force that results in stresses primarily normal to the surface of the joint interface

[SOURCE: ISO 10447:2015, 3.1, modified — “or non-destructive test” has been added and the note 1 to entry has been deleted.]

3.2
close spaced welds
spot welds with weld pitch of less than two diameters

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3.3
coring
incipient melting
melting and resolidification of material at the grain boundaries of the heat affected zone and/or in the weld nugget

Note 1 to entry: These features appear to be cracks when examined at low magnification, but when examined at high magnification, are seen to be completely filled. This occurs primarily in nickel alloys.

3.4
design authority
engineering authority
organization having the responsibility for the structural integrity or maintenance of airworthiness of the hardware and compliance with all relevant documents

3.5
foil
joint member with a thickness of 0,20 mm or less

3.6
metallographic section
<resistance welding for aerospace applications> transverse cut on the diameter of a spot weld or across a seam weld, or a longitudinal cut down the centre of a seam weld

3.7
nugget
zone in spot, projection or seam weld where the metal has been melted

[SOURCE: ISO 17677-1:2009, 4.10, modified — "See Figure 2." following the term has been deleted.]

3.8
nugget diameter
diameter of nugget measured at the faying surface

3.9
nugget penetration
extent of the nugget or fusion zone into the thickness of a joined member

3.10
peel test
destructive test in which a resistance-welded lap joint is tested by applying a peel force which results in stresses mainly in the thickness direction of the weld

3.11
preliminary welding procedure specification
pWPS
document containing the required variables of the welding procedure which has to be qualified

[SOURCE: ISO/TR 25901-1:2016, 2.5.6]

3.12
production witness test specimen
weld of test specimen made in production setups and destructively tested to provide data on the qualities of production welds

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3.13
resistance seam welding
<resistance welding for aerospace applications> resistance welding process which produces coalescence at the faying surfaces by the heat obtained from resistance to electric current through the work parts held together under pressure by electrodes

Note 1 to entry: The resulting weld is a series of overlapping resistance spot welds made progressively along a joint by turning wheel electrodes or indexing the part under fixed electrodes.

3.14
resistance spot welding
resistance welding process that produces a weld at the faying surfaces between overlapping parts by the heat obtained from resistance to the flow of welding current through the workpieces from electrodes that serve to concentrate the welding current and pressure at the weld area

[SOURCE: ISO 17677-1:2009, 1.12]

3.15
roll spot welding
resistance welding process variant that makes intermittent spot welds using one or more rotating circular electrodes

Note 1 to entry: The rotation of the electrodes might or might not be stopped during the making of a weld.

[SOURCE: ISO 17677-1:2009, 3.5]

3.16
seam weld width
width of the weld metal in the plane of the faying surfaces in a direction normal to the longitudinal axis of the linear seam weld

[SOURCE: ISO 17677-1:2009, 4.14]

3.17
sheet
<resistance welding for aerospace applications> joint member with a thickness of more than 0,20 mm

3.18
weld pitch
centre-to-centre distance between adjacent spot welds

[SOURCE: ISO 14373:2015, 3.4]

3.19
welding condition
<resistance welding for aerospace applications> provision for the manufacture of a given weld, including material, configuration, material preparation, cooling, electrode material, electrode geometry, welding machine number, and all weld parameters that have a direct influence on the quality of the weld

3.20
welding parameter
<resistance welding for aerospace applications> machine setting or adjustment

EXAMPLE Examples are electrode force, welding current, welding speed, welding time.

3.21
welding procedure specification
WPS
document that has been qualified and provides the required variables of the welding procedure to ensure repeatability during production welding

[SOURCE: ISO/TR 25901-1:2016, 2.5.4]

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4 Symbols and abbreviated terms

D_s	minimum required nugget diameter or seam weld width (see Table 11)
e_l	lower electrode indentation
e_u	upper electrode indentation
F	force
l	length of test specimen
s_M	actual nugget diameter or seam weld width, as determined by metallographic examination
t	thickness of the thinner sheet
t_o	thickness of outer member
w	test specimen width/overlap
Ac	test lot average
NDT	non-destructive testing
pWPS	preliminary welding procedure specification
QA	quality assurance
SPC	statistical process control
WPQR	welding procedure qualification record
WPS	welding procedure specification

5 Specific engineering requirements

In the event of any conflict between the requirements of this document and those requirements specified in the engineering definition, the engineering definition shall take precedence.

The classification of the joint (see Clause 6) shall be designated on the part specification or drawing.

6 Classification of the joint

Classification of the joint is based on the following.

— Class I: a welded joint whose failure under operating conditions causes the loss of the aircraft/spacecraft or one of its main components, or constitutes a direct hazard to people.

— Class II: a welded joint whose failure causes malfunctions without compromising continued safe flight until the end of the mission.

— Class III: a welded joint whose failure does not affect the safety and the transport function of the aircraft/spacecraft.

7 Production requirements

Prior to production, the following requirements shall be met:

a) personnel qualification;

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