
**Welding for aerospace applications —
Fusion welding of metallic
components —**

**Part 2:
Acceptance criteria**

*Soudage pour applications aérospatiales — Soudage par fusion des
composants métalliques —*

Partie 2: Critères d'acceptation

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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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, 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 www.iso.org/iso/foreword.html.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html. Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: <https://committee.iso.org/sites/tc44/home/interpretation.html>.

A list of all parts in the ISO 17927 series can be found on the ISO website.

Welding for aerospace applications — Fusion welding of metallic components —

Part 2: Acceptance criteria

1 Scope

This document specifies acceptance criteria for fusion weldments on metallic components.

It is to be applied provided it is referenced or approved by the responsible engineering/design authority.

This document covers the following processes given in [Table 1](#) and the material groups given in [Table 2](#).

Table 1 — Fusion welding processes covered by this document

Process	Process number (ISO 4063:2009)
Oxyfuel welding	31
Gas shielded arc welding with non-consumable tungsten electrode, gas tungsten arc welding	14
Plasma arc welding	15
Electron beam welding	51
Laser welding, laser beam welding	52

Table 2 — Material groups covered by this document

Material group	Description
A	Unalloyed steel, low alloyed steels, high alloyed ferritic steels
B	Austenitic, martensitic and precipitation hardening steels
C	Titanium and titanium alloys, niobium, zirconium and other reactive metals
D	Aluminium and magnesium alloys
E	Materials that do not conform to other material groups (e.g. molybdenum, tungsten, copper alloys)
F	Nickel alloys, cobalt alloys.

NOTE Material groups according to ISO 24394.

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 6520-1, *Welding and allied processes — Classification of geometric imperfections in metallic materials — Part 1: Fusion welding*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

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

[SOURCE: ISO 24394:2018, 3.8]

4 Symbols and abbreviated terms

- t* nominal wall or plate thickness
h dimension of imperfection
b width of weld reinforcement or fillet
a nominal throat thickness
z nominal leg length

5 Conformance

When conformance to this document is claimed, all provisions of this document are to be complied with, except those for provisions that the design/engineering authority specifically exempts.

6 Acceptance criteria

6.1 General

The dimension of any discontinuity shall be defined by its largest dimension. Two or more discontinuities shall be treated as one when the spacing between them is less than the dimension of the larger discontinuity.

Surface imperfections of the weld may be mechanically removed provided that the weld and adjacent base metal maintain the minimum thickness without undercutting the plane of the base metal. Any additional engineering requirements (e.g. surface roughness) shall also be met. In the case of weldments with variations in cross-section along the joint, the thickness, *t*, shall be considered to be the minimum thickness at the imperfections.

Imperfections that will be removed in subsequent machining shall not be cause for rejection provided inspection is carried out after machining. Any weldment with unacceptable imperfections which has gone through a subsequent manufacturing operation that affects the metallurgical characteristics (other than hydrogen embrittlement relief) or that cannot be rewelded without affecting final metallurgical or surface characteristics shall be rejected.

For fillet welds, the minimum size shall be as specified on the engineering drawings.

When fillet weld size is not specified, the minimum leg length shall be:

- for single side weld: $1,5 t_{\min}$;
- for double side weld: $1 t_{\min}$;

where t_{\min} is the minimum nominal wall or plate thickness.

6.2 Limits for imperfections

Quality level A weld: Weld with high quality acceptance requirements.

Quality level B weld: Weld with moderate quality acceptance requirements.

Quality level C weld: Weld with typical quality acceptance requirements.

The quality levels are as defined by the engineering/drawing and/or specified by the design/engineering authority.

Welds shall be acceptable if they satisfy the conditions of [Table 3](#). Welds not meeting these requirements shall be rejected.

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Table 3 — Limits for imperfections

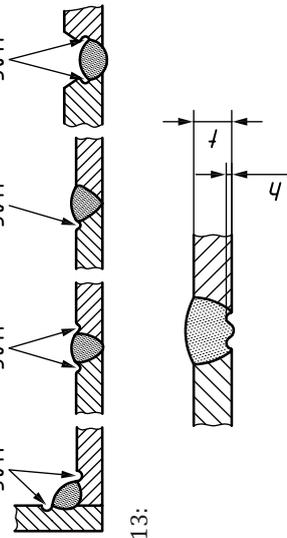
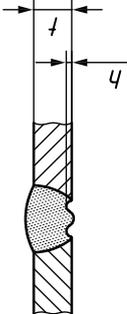
No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					A	B	C
1 Surface imperfections							
1.1	100	Crack		—	Not permitted	Not permitted	Not permitted
1.2	104	Crater crack		—	Not permitted	Not permitted	Not permitted
1.3	2017, 2018	Surface pore, Surface porosity	Individual size maximum	—	0,25 t or 0,76 mm, whichever is less	0,33 t or 1,50 mm, whichever is less	0,50 t or 2,30 mm, whichever is less
1.4	2018,	Surface porosity ^b	Spacing minimum ^a	—	8 times the size of the larger adjacent imperfection	4 times the size of the larger adjacent imperfection	2 times the size of the larger adjacent imperfection
1.5	516	Root porosity ^b	Accumulated length in any 75 mm of weld maximum	—	1 t or 3,00 mm, whichever is less	1,33 t or 6,00 mm, whichever is less	2 t or 9,00 mm, whichever is less
		Craters	Maximum depth	—	0,20 t or 0,80 mm whichever is less	0,20 t or 1,30 mm whichever is less	0,20 t or 1,30 mm whichever is less
			Maximum length	—	1 t	1 t	2 t
1.6	401	Lack of fusion (incomplete fusion)	—	—	Not permitted	Not permitted	Not permitted
1.7	402	Incomplete penetration	Not applicable for fillet welds.	—	Not permitted	Not permitted	Not permitted
1.8	5011, 5013	Continuous undercut Shrinkage groove (root undercut)	Undercut of significant length without interruption (in accordance with ISO 6520-1). Maximum depth, h 	—	0,05 mm	0,015 t or 0,05 mm, whichever is greater	0,025 t or 0,05 mm, whichever is greater
			5013: 	—			
			^a Multiple pores with spacing below the minimum may be evaluated as a single pore with a size measured from the furthest extent of one pore to the furthest extend of the other.				
			^b Ignore discontinuities that are 0,13 mm, or smaller.				

Table 3 (continued)

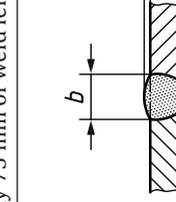
No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					A	B	C
1.9	5012,	Intermittent undercut	Short length of undercut, intermittent along the weld (in accordance with ISO 6520-1). Individual maximum depth 	—	0,07 t or 0,76 mm, whichever is less	0,10 t or 1,27 mm, whichever is less	0,20 t or 1,78 mm, whichever is less
	5013	Shrinkage groove (root undercut)			5013: 	5,08 mm	15,24 mm
1.10	502,	Excess weld metal (butt weld)	Maximum accumulated length greater than that allowed for No. 1.8 in any 75 mm of weld length. 	≤9,53	No stated requirement	No stated requirement	
	504	Excessive penetration Machine welds		>9,53	1/3 t or 0,76 mm whichever is greater	No stated requirement	No stated requirement
				<3,18	max. 3,18 mm	No stated requirement	No stated requirement
	Manual welds	3,18 to 12,9		1/3 t or 2,54 mm, whichever is greater	No stated requirement	No stated requirement	
>12,9	4,32 mm maximum	No stated requirement	No stated requirement				
^a Multiple pores with spacing below the minimum may be evaluated as a single pore with a size measured from the furthest extent of one pore to the furthest extend of the other. ^b Ignore discontinuities that are 0,13 mm, or smaller.							

Table 3 (continued)

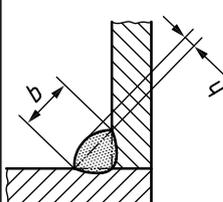
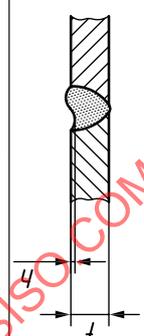
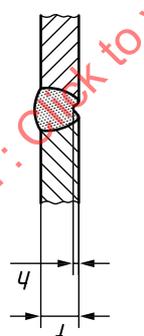
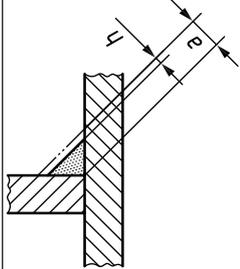
No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					A	B	C
1.11	503	Excessive convexity (fillet weld)		—	$b \leq 8$ mm, then $h \leq 1,6$ mm 8 mm $< b < 25$ mm, then $h \leq 3$ mm $b \geq 25$ mm, then $h \leq 5$ mm		
1.12	511,	Incompletely filled groove		—	0,130 mm		
	515	Root concavity		—	0,015 t or 0,130 mm whichever is greater		
1.13	510	Burn through	For the full length of weld — maximum depth	—	0,07 t or 0,76 mm, whichever is less		
			Individual defect — maximum depth	—	5,10 mm		
			Accumulated length in any in 75 mm of weld — maximum	—	15,2 mm		
1.14	5213	Insufficient throat thickness	—	—	Not permitted		
				—	Not permitted		
^a Multiple pores with spacing below the minimum may be evaluated as a single pore with a size measured from the furthest extent of one pore to the furthest extend of the other.							
^b Ignore discontinuities that are 0,13 mm, or smaller.							

Table 3 (continued)

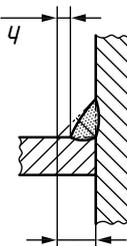
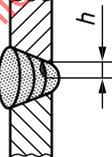
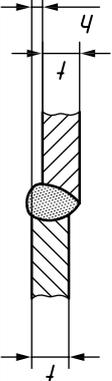
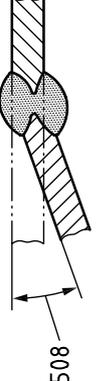
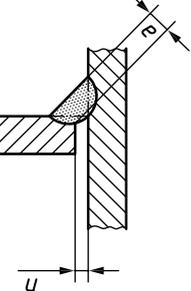
No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					A	B	C
1.15		Insufficient leg length		—	Not permitted	Not permitted	Not permitted
1.16	5214	Excessive throat thickness	The actual throat thickness of the fillet weld is too large.	<2,30	2 times the minimum throat thickness		
				2,30 to 3,96	1,5 times the minimum throat thickness		
				4,00 to 19,05	1,25 times the minimum throat thickness		
			19,10	1,1 times the minimum throat thickness			
1.17		Excessive leg length	The actual leg length <i>a</i> of the fillet weld is too large.	<2,30	2 times the minimum fillet weld leg length		
				2,30 to 3,99	1,5 times the minimum fillet weld leg length		
				4,00 to 19,09	1,25 times the minimum fillet weld leg length		
			>19,10	1,1 times the minimum fillet weld leg length			
1.18	601	Arc strike	—	—	Not permitted	Not permitted	Not permitted
1.19	602	Spatter	—	—	Not permitted	Not permitted	Not permitted
1.20	610	Temper colour (Discolouration)	—	—	See Table 4.		
<p>^a Multiple pores with spacing below the minimum may be evaluated as a single pore with a size measured from the furthest extent of one pore to the furthest extend of the other.</p> <p>^b Ignore discontinuities that are 0,13 mm, or smaller.</p>							

Table 3 (continued)

No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels			
					A	B	C	
2 Internal imperfections								
2.1	100	Cracks	All types of crack	—	Not permitted	Not permitted	Not permitted	
2.2		Subsurface porosity and/or inclusions ^b	Individual size maximum	—	0,33 t or 1,50 mm, whichever is less	0,50 t or 2,30, whichever is less	Not permitted	
			Spacing minimum ^a	Accumulated length in any 75 mm of weld maximum	—	4 times the size of the larger adjacent imperfection	2 times the size of the larger adjacent imperfection	2 times the size of the larger adjacent imperfection
2.3	401	Lack of fusion (incomplete fusion)		—	Not permitted	Not permitted	Not permitted	
			4011	Lack of side wall fusion		—	Not permitted	Not permitted
					4012	Lack of inter-run fusion	—	Not permitted
2.4	402	Lack of penetration		—	Not permitted	Not permitted	Not permitted	
3 Imperfections in joint geometry								
3.1	507	Linear misalignment after welding		—	See Table 5.			
3.2	508	Angular misalignment		—	Five degrees of the angle shown on the engineering drawing.			
3.3	617	Incorrect root gap for fillet welds		—	$h \leq 0,2 \text{ mm} + 0,1 t_{\text{min}}$ but not greater than 0,5 mm			
^a Multiple pores with spacing below the minimum may be evaluated as a single pore with a size measured from the furthest extent of one pore to the furthest extent of the other. ^b Ignore discontinuities that are 0,13 mm, or smaller.								