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

*Soudage pour applications aérospatiales — Épreuve de qualification  
pour soudeurs et opérateurs soudeurs — Soudage par fusion des  
composants métalliques*

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CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

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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 document 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](http://www.iso.org/directives)).

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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](http://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*.

This third edition cancels and replaces the second edition (ISO 24394:2018), which has been technically revised.

The main changes are as follows:

- [3.8](#): note to entry added;
- [Table 4](#) revised;
- editorial revisions.

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](http://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>.

## Introduction

A welder or welding operator qualification test properly passed in accordance with this document demonstrates that the welder or welding operator concerned has been proven to possess the minimum degree of skill and knowledge required for the fusion welding of aerospace hardware.

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# Welding for aerospace applications — Qualification test for welders and welding operators — Fusion welding of metallic components

## 1 Scope

This document specifies requirements for the qualification of welders and welding operators for fusion welding of metallic materials for aerospace applications.

NOTE Success in the test is an essential precondition for the qualification of welders and welding operators in new production and repair work in aerospace. However, welding equipment operators do not need to be qualified according to 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 6520-1, *Welding and allied processes — Classification of geometric imperfections in metallic materials — Part 1: Fusion welding*

ISO 6947, *Welding and allied processes — Welding positions*

ISO 9606-2, *Qualification test of welders — Fusion welding — Part 2: Aluminium and aluminium alloys*

ISO 14731, *Welding coordination — Tasks and responsibilities*

ISO 18490, *Non-destructive testing — Evaluation of vision acuity of NDT personnel*

EN 4179, *Aerospace series — Qualification and approval of personnel for non-destructive testing*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6520-1, ISO 9606-2 and ISO 14731 and the following apply.

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

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

### 3.1

#### parent material form

type of the semi-finished product

Note 1 to entry: Semi-finished products are sheets or plates, tubes and castings.

### 3.2

#### welder

person who holds and manipulates the electrode holder, welding torch or blowpipe by hand

Note 1 to entry: In this document, a blowpipe is considered to be a gas welding torch.

[SOURCE: ISO/TR 25901-1:2016, 2.5.24, modified — Definition revised and note 1 to entry added.]

**3.3  
welding operator**

<welding for aerospace applications> person who prepares the joint and sets up mechanized or automated welding equipment and thereby has direct influence on the welded joint quality

**3.4  
welding equipment operator**

<welding for aerospace applications> person who only operates automatic welding equipment and has no direct influence on the welded joint quality

**3.5  
examiner**

person who has been appointed to verify conformity to the applicable standard

Note 1 to entry: In certain cases, an external independent examiner can be required.

[SOURCE: ISO/TR 25901-1:2016, 2.5.29, modified — Definition revised.]

**3.6  
examining body**

organization that has been appointed to verify conformity to the applicable standard

Note 1 to entry: In certain cases, an external independent examining body can be required.

[SOURCE: ISO/TR 25901-1:2016, 2.5.30, modified – Definition revised.]

**3.7  
rework**

corrective action made to a weldment in the as-welded condition

**3.8  
design/engineering authority**

organization that has the responsibility for the structural integrity or maintenance of airworthiness of the hardware and compliance with all relevant documents

EXAMPLE Drawings, 3D models, specifications for manufacturing.

Note 1 to entry: In the case of a welded product, the engineering authority is usually the organization that has responsibility for the engineering definition of the product.

Note 2 to entry: In civil aviation, the design authority is normally the type certificate holder, a legal entity related to the airworthiness authorities.

**3.9  
backing**

material placed at the reverse side of a joint preparation for the purpose of supporting molten weld metal

**3.10  
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]



### 3.11 preliminary welding procedure specification pWPS

document containing the required variables of the welding procedure which is to be qualified

[SOURCE: ISO/TR 25901-1:2016, 2.5.6, modified — Definition revised.]

### 3.12 automatic welding

welding in which all operations are performed without welding operator intervention during the process

Note 1 to entry: Manual adjustment of welding variables by the welding operator during welding is not possible.

[SOURCE: ISO 14732:2013, 3.1]

## 4 Qualification test requirements

### 4.1 General

#### 4.1.1 Specific to the welder qualification test

The welder qualification tests are classified according to:

- a) parent material form;
- b) types of weld joint (butt/groove or fillet);
- c) welding processes;
- d) material groups;
- e) thickness ranges;
- f) welding positions.

The welding coordinator of the plant or the fabricator shall select from [Figure 1](#) to [Figure 6](#) the test piece as required for the production work on which the welder is to be employed. Two complementary specific test pieces (TP5 and TP6) may also be chosen as defined in [4.4](#) and [4.7.1](#).

#### 4.1.2 Specific to the welding operator qualification test

The welding operator qualification tests are classified according to welding process and welding machine type.

NOTE Machine type within the scope of this document stands for longitudinal, orbital, circumferential and robotic welding machines.

For multiple welding machine types, additional qualification shall be at the discretion of the responsible welding coordinator.

The welding operator has to show theoretical knowledge of the welding process.

In the practical part of the qualification test, the welding operator shall demonstrate competency in operating the welding machine according to an established WPS.

A test weld of any type of weld with a process on a given welding machine type shall qualify for all product types or semi-finished products and all types of welds with this process and this machine type.

The test weld can be performed on dedicated test pieces or production parts.

When substituting test pieces with actual production parts, testing shall be carried out according to [Table 6](#).

## 4.2 Welding processes

This document covers qualification testing for the following welding processes with their reference numbers in accordance with ISO 4063:1998:<sup>1)</sup>

- 111 manual metal arc welding (metal arc welding with covered electrode);<sup>2)</sup>
- 12 submerged arc welding;<sup>2)</sup>
- 13 gas-shielded metal arc welding;
- 141 TIG welding/gas tungsten arc welding;
- 15 plasma arc welding;
- 31 oxy-fuel gas welding;
- 51 electron beam welding;
- 52 laser beam welding.

NOTE 1 Other fusion welding processes not specified in ISO 4063:1998 can be covered.

NOTE 2 Attention is drawn to the fact that ISO 4063:1998 and ISO 4063:2023 sometimes have different processes for the same process number. The main differences are as follows (see [Table 1](#)):

- a) process designation was changed or modified for processes 121, 131, 135, 136 and 141;
- b) process 137 was split into processes 132 and 133;
- c) process 136 was split into processes 136 and 138.

**Table 1 — Equivalent process numbers and designations between ISO 4063:1998 and ISO 4063:2023**

Process number	Process designation in ISO 4063:1998	Process designation in ISO 4063:2023
121	Submerged arc welding with one wire electrode	Submerged arc welding with solid wire electrode
131	Metal inert gas welding; MIG welding	MIG welding with solid wire electrode
132	—	MIG welding with flux cored electrode
133	—	MIG welding with metal cored electrode
135	Metal active gas welding; MAG welding	MAG welding with solid wire electrode
136	Tubular cored metal arc welding with active gas shield	MAG welding with flux cored electrode
137	Tubular cored metal arc welding with inert gas shield	—
138	—	MAG welding with metal cored electrode
141	Tungsten inert gas welding; TIG welding	TIG welding with solid filler material (wire or rod)

1) Cancelled and replaced by ISO 4063:2023.

2) This process can require a special qualification test as defined in [4.7](#).

### 4.3 Welding positions

Depending on welding positions in actual production, the welding position of the test piece shall be chosen in accordance with [Table 2](#), [Table 3](#), [Table 4](#) and/or [Table 5](#).

A test piece welded in the fixed position also qualifies for welding parts when not in the fixed position, for example rotational turntable for tubes.

TP6 shall be welded in PA or PB, which qualifies for all welding positions for in-process welding of castings in casting facilities.

### 4.4 Product types or semi-finished products applicable to welder qualification tests

Depending on the types of products in actual production, a distinction is made between welder qualification tests for sheet or plate (S), tube (T) and castings (C).

Test pieces with tube (TP3, TP4 and TP5) do not qualify for sheet or plate.

NOTE 1 Tube welding has overlapping start and stop points. This is not the case for sheet or plate welding. Therefore, test pieces with tube (TP3, TP4 and TP5) do not qualify for sheet or plate.

The range of qualification for each welding position is given in [Table 2](#), [Table 3](#), [Table 4](#) and [Table 5](#). The welding positions are specified in ISO 6947. The test pieces shall be welded in accordance with the nominal angles of the welding positions given in ISO 6947.

Test piece TP5 (see [Figure 5](#)) is mandatory for structural tube frameworks of outside diameter  $D < 26$  mm. It is optional for structural tube frameworks of  $D \geq 26$  mm.

Test piece TP 6 is required for in-process welding of castings in casting facilities.

NOTE 2 Within the scope of this document, in-process welding is welding on castings to correct casting defects.

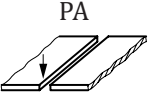

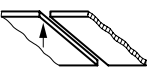

Excluding in-process welding in casting facilities, a welder who is qualified to weld sheet or plate or tube is also qualified to weld on castings within his or her range of qualification regarding the welding position and geometric shape of the work piece (planar or tubular).

NOTE 3 Casting facilities are excluded because casting methods and in-process welding of castings are subject to specific engineering requirements.

In instances of structural welding of castings requiring specific welding techniques, for example Nickel Alloy 718, the welder qualification test pieces (TP1 to TP4) shall be of the same casting alloy.

As an alternative, qualifications according to SAE AMS 2694C are acceptable for in-process welding of castings, but the period of validity according to [Clause 11](#) applies.

Table 2 — Range of qualification for welding positions, joint type and base metal form for TP1

Test weld		Qualified welding position								
		Butt weld on sheet or plate				Butt weld on tube				
Form or joint type	Test piece welding position (ISO 6947)	PA	PC	PE	PF	PA	PC	PE	PF	H-L 045
Sheet or plate butt weld		X				X <sup>a,b</sup>				
		X	X			X <sup>a,b</sup>	X <sup>a,b,c</sup>			
		X		X		X <sup>a,b</sup>		X <sup>a,b</sup>		
		X			X	X <sup>a,b</sup>			X <sup>a,b</sup>	

NOTE 1 X indicates what the welder is qualified for.

NOTE 2 The arrows in PA, PC and PE show the welding position.

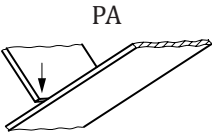
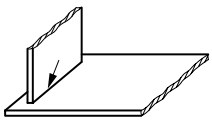
NOTE 3 The arrow in PF shows the weld progression or direction.

<sup>a</sup> Applicable for longitudinal weld on a tube.

<sup>b</sup> Applicable for circumferential weld on a rotating tube if tube diameter is  $D > 26$  mm.

<sup>c</sup> Applicable for circumferential weld on a tube in a fixed position if tube diameter is  $D > 26$  mm.

Table 3 — Range of qualification for welding positions, joint type and base metal form for TP2

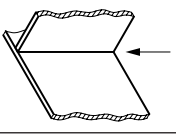
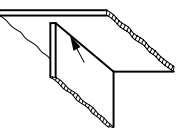
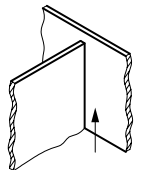
Test weld		Qualified welding position				
		Fillet weld on sheet or plate				
Form or joint type	Test piece welding position (ISO 6947)	PA	PB	PC	PD	PF
Sheet or plate fillet weld		X				
		X	X			

NOTE 1 X indicates for which the welder is qualified.

NOTE 2 The arrows in PA, PB, PC and PD show the welding position

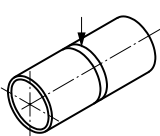
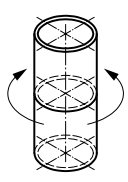
NOTE 3 The arrow in PF shows the weld progression or direction.

Table 3 (continued)

Test weld		Qualified welding position				
Form or joint type	Test piece welding position (ISO 6947)	Fillet weld on sheet or plate				
		PA	PB	PC	PD	PF
Sheet or plate fillet weld	<p>PC</p> 	X	X	X		
	<p>PD</p> 	X	X		X	
	<p>PF</p> 	X	X			X

NOTE 1 X indicates for which the welder is qualified.  
 NOTE 2 The arrows in PA, PB, PC and PD show the welding position  
 NOTE 3 The arrow in PF shows the weld progression or direction.

Table 4 — Range of qualification for welding positions, joint type and base metal form for TP3

Form or joint type	Test piece welding position (ISO 6947)	Qualified welding position					
		Butt weld on tube			Butt weld on sheet or plate <sup>b</sup>		
		PA	PC	PH	PA	PC	PF
Tube butt weld	<p>PA<sup>a</sup></p> 	X					
	<p>PC<sup>c</sup></p> 	X <sup>a</sup>	X				

NOTE 1 The qualification is valid for any tube of outer diameter equal to or larger than the outer diameter of the test piece.  
 NOTE 2 The arrows in PA and PC show the welding position  
 NOTE 3 The arrows in PH and H-L045 show the weld progression or direction.

<sup>a</sup> Only applicable for a rotated tube with the torch in welding position PA.  
<sup>b</sup> Qualification is only valid for sheet or plate if run-on and run-off tabs are used in production.  
<sup>c</sup> Pipe is not rotating during welding. Only one welding direction is required.