

# INTERNATIONAL STANDARD

**ISO**  
**10042**

First edition  
1992-12-15

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## **Arc-welded joints in aluminium and its weldable alloys — Guidance on quality levels for imperfections**

**iTeh STANDARD PREVIEW**

*Assemblages en aluminium et alliages d'aluminium soudables soudés à  
l'arc — Guide des niveaux d'acceptation des défauts*

ISO 10042:1992

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Reference number  
ISO 10042:1992(E)

## 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75% of the member bodies casting a vote.

International Standard ISO 10042 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Sub-Committee SC 10, *Unification of requirements in the field of metal welding*.

Annexes A and B of this International Standard are for information only.

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International Organization for Standardization  
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

## Introduction

This International Standard should be used as a reference in the drafting of application codes and/or other application standards. It may be used within a total quality system for the production of satisfactory welded joints. It provides three sets of dimensional values from which a selection can be made for a particular application. The quality level necessary in each case should be defined by the application standard or the responsible designer in conjunction with the manufacturer, user and/or other parties concerned. The level shall be prescribed before the start of production, preferably at the enquiry or order stage. For special purposes, additional details will possibly need to be prescribed.

The quality levels given in this International Standard are intended to provide basic reference data. They are not specifically related to any particular application. They refer to the types of welded joints in a fabrication and not to the complete product or component itself. It is possible, therefore, for different quality levels to be applied to individual welded joints in the same product or component.

Quality levels are listed in table 0.1.

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**Table 0.1 — Quality levels for weld imperfections**

Level symbol	Quality level
D	Moderate
C	Intermediate
B	Stringent

The three quality levels are arbitrarily identified as D, C and B and are intended to cover the majority of practical applications.

It would normally be hoped that for a particular welded joint the dimensional limits for imperfections could all be covered by specifying one quality level. In some cases, however, e.g. for certain types of aluminium and structures as well as for fatigue loading or leak tightness applications, it may be necessary to specify different quality levels for different imperfections in the same welded joint or to include additional requirements.

The choice of quality level for any application should take account of design considerations, subsequent processing (e.g. surfacing), mode of stressing (e.g. static, dynamic), service conditions (e.g. temperature, environment) and consequences of failure. Economic factors are also important and should include not only the cost of welding but also that of inspection, test and repair.

Although this International Standard includes types of imperfections relevant to the arc welding processes given in clause 1, only those which are applicable to the process and application in question need to be considered.

Imperfections are quoted in terms of their actual dimensions and their detection and evaluation can require the use of one or more methods of non-destructive testing. The detection and sizing of imperfections is dependent on the inspection methods and the extent of testing specified in the application standard or contract.

This International Standard does not include details of recommended methods of detection and sizing and therefore it needs to be supplemented by requirements for examination, inspection and testing. It should be appreciated that methods of non-destructive examination may not be able to give the detection, characterization and sizing necessary for use within certain types of imperfections in table 1.

Although this International Standard covers a material thickness range of 3 mm to 63 mm, it can possibly be applied to thicker or thinner joints provided consideration is given to those technical factors which influence the situation.

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# Arc-welded joints in aluminium and its weldable alloys — Guidance on quality levels for imperfections

## 1 Scope

This International Standard provides guidance on levels of imperfections in arc-welded joints in aluminium and its weldable alloys.

Three levels are given in such a way as to permit application for a wide range of welded fabrications. The levels refer to production quality and not to the fitness-for-purpose (see 3.1) of the product manufactured.

This International Standard applies to

- aluminium and weldable aluminium alloys;
- the following processes in accordance with ISO 4063:
  - 131 gas-shielded metal-arc welding (MIG);
  - 141 gas-shielded welding with non-consumable electrode (TIG);
  - 15 plasma arc welding;
- manual, mechanized and automatic processes;
- all welding positions;
- butt welds, fillet welds and welds on branch connections;
- materials in the thickness range 3 mm to 63 mm.

When significant deviations from the joint geometries and dimensions described in this International Standard are present in the welded product, it is necessary to evaluate to what extent the provisions of this International Standard can apply.

Metallurgical aspects, e.g. grain size, are not covered by this International Standard.

For the purposes of this International Standard the term aluminium covers aluminium and its weldable alloys.

## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2553:1992, *Welded, brazed and soldered joints — Symbolic representation on drawings*.

ISO 4063:1990, *Welding, brazing, soldering and braze welding of metals — Nomenclature of processes and reference numbers for symbolic representation on drawings*.

ISO 6520:1982, *Classification of imperfections in metallic fusion welds, with explanations*.

## 3 Definitions

For the purposes of this International Standard, the following definitions apply.

**3.1 fitness-for-purpose:** A product is fit for its intended purpose when it functions satisfactorily in service during its stipulated lifetime. The product may deteriorate in service, but not to such a degree that fracture and subsequent failure occurs. Products can, of course, be misused or overloaded; it is presumed that the actual conditions during service correspond to the intended conditions, including statistical variations, e.g. live loads.

### 3.2 Weld thickness

**3.2.1 fillet weld thickness,  $a$ ; nominal throat thickness:** Height of the largest isosceles triangle that can be inscribed in the weld section (see ISO 2553).

NOTE 1 In countries in which the leg length,  $z$ , is used as the dimension of a fillet weld, the limits for imperfections may be reformulated so that they refer to the leg length.

**3.2.2 butt weld thickness,  $s$ :** Minimum distance from the surface of the part to the bottom of the penetration, which cannot be greater than the thickness of the thinner of the parts (see ISO 2553).

**3.3 short imperfection:** One or more imperfections of total length not greater than 25 mm in any 100 mm length of the weld or a maximum of 25 % of the weld length for a weld shorter than 100 mm.

**3.4 long imperfection:** One or more imperfections of total length greater than 25 mm in any 100 mm length of the weld or a minimum of 25 % of the weld length for a weld shorter than 100 mm.

**3.5 projected area:** Area given by length of weld examined multiplied by the maximum width of weld. ISO 10042 (Nos. 19 to 23).

**3.6 surface crack area:** Area to be considered after fracture.

## 4 Symbols

The following symbols are used in table 1:

$A$	area of gas cavity
$a$	nominal fillet weld throat thickness (fillet thickness)
$b$	width of weld reinforcement
$d$	diameter of pore
$h$	size (height or width) of imperfection
$l$	length of imperfection
$s$	nominal butt weld thickness or, in the case of partial penetration, the prescribed depth of penetration
$t$	wall or plate thickness
$z$	nominal leg length of fillet welds (in case of isosceles right angle triangular section $z = a \cdot \sqrt{2}$ )

## 5 Evaluation of welds

Limits for imperfections are given in table 1.

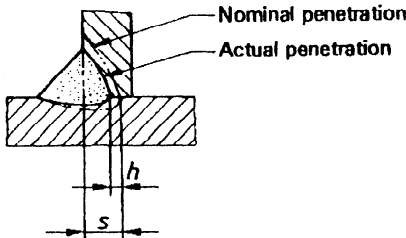
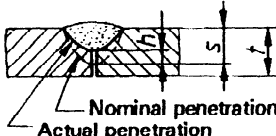
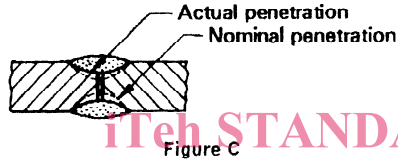
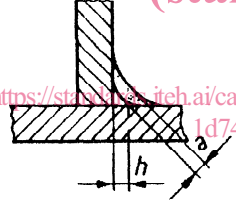
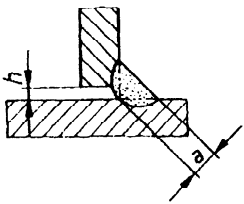

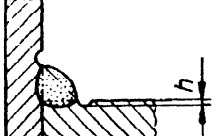
A welded joint should normally be evaluated separately for each individual type of imperfection (Nos. 19 to 23).

Different types of imperfection occurring at any cross-section of the joint can possibly need special consideration (see No. 24).

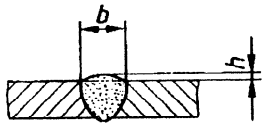
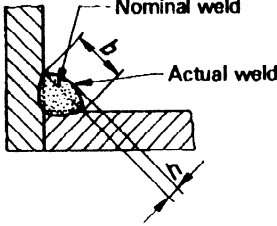
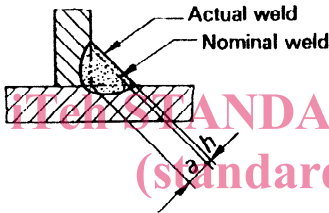
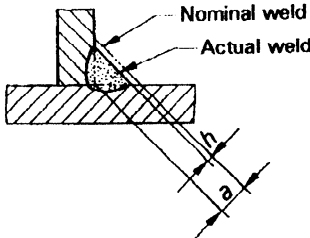
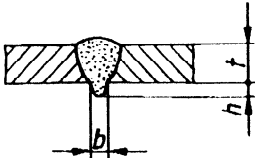
**Table 1 — Limits for imperfections**

No.	Imperfection designation	ISO 6520 reference	Remarks	Limits for imperfections for quality levels		
				Moderate D	Intermediate C	Stringent B
1	Cracks	100	All types of cracks except micro cracks ( $h \cdot l \leq 1 \text{ mm}^2$ ), crater cracks see No. 2	Not permitted		
2	Crater crack	104		$h \leq 0,2 s$ or $0,2 a$	Not permitted	
3	Gas cavity	201	The term "gas cavity" includes: uniformly distributed porosity, localized porosity, linear porosity and gas pore.	$A \leq 8 s$ or $8 a \text{ mm}^2$	For 100 mm length: $A \leq 4 s$ or $4 a \text{ mm}^2$	$A \leq 2 s$ or $2 a \text{ mm}^2$
4	Gas pore	2011	The total pore area within the cluster should be summed: an envelope surrounding all the pores or a circle with a diameter corresponding to the weld width.	$d \leq 0,5 s$ or $0,5 a$ max. 5,5 mm	$d \leq 0,3 s$ or $0,3 a$ max. 4,5 mm	$d \leq 0,25 s$ or $0,25 a$ max. 3,5 mm
5	Uniformly distributed porosity	2012	The permitted porous area should be local. The possibility of masking of other imperfections should be taken into consideration.	$d \leq 0,5 \text{ mm} + 0,035 s$ or $0,035 a$ max. 2 mm	$d \leq 0,5 \text{ mm} + 0,02 s$ or $0,02 a$ max. 1,5 mm	$d \leq 0,5 \text{ mm} + 0,01 s$ or $0,01 a$ max. 1 mm
6	Localized (clustered) porosity	2013		$d \leq 0,5 \text{ mm} + 0,05 s$ or $0,05 a$ max. 3 mm	$d \leq 0,5 \text{ mm} + 0,035 s$ or $0,035 a$ max. 2 mm	$d \leq 0,5 \text{ mm} + 0,02 s$ or $0,02 a$ max. 1,5 mm
7	Surface pore (visible gas cavity)	2017		$A \leq 2 t \text{ mm}^2$ $d \leq 0,5 \text{ mm} + 0,035 s$ or $0,035 a$ max. 2 mm	For 100 mm length: $A \leq 1 t \text{ mm}^2$ $d \leq 0,5 \text{ mm} + 0,02 s$ or $0,02 a$ max. 1,5 mm	$A \leq 0,5 t \text{ mm}^2$ $d \leq 0,5 \text{ mm} + 0,01 s$ or $0,01 a$ max. 1 mm
8	Solid inclusions (other than copper and tungsten)	300	Solid inclusions include inclusions for oxides. If several inclusions $h_1, h_2, h_3 \dots$ exist in a cross section, the summation is $\sum h = h_1 + h_2 + h_3 \dots$	Long imperfections: Not permitted		
				Short imperfections: $\sum h \leq 0,1 s$ or $0,1 a$ max. 3 mm		Not permitted
9	Tungsten inclusions	3041		$h \leq 0,1 s$ or $0,1 a$ max. 3 mm	$h \leq 0,1 s$ or $0,1 a$ max. 1,5 mm	$h \leq 0,05 s$ or $0,05 a$ max. 0,8 mm
10	Copper inclusions	3042		Not permitted		
11	Lack of fusion (incomplete fusion)	401	If lack of fusion occurs at several places $h_1, h_2, h_3 \dots$ the summation is $\sum h = h_1 + h_2 + h_3 \dots$	Long imperfections: Not permitted		
				Short imperfections: $\sum h \leq 0,1 s$ or $0,1 a$ max. 3 mm		Not permitted

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No.	Imperfection designation	ISO 6520 reference	Remarks	Limits for imperfections for quality levels		
				Moderate D	Intermediate C	Stringent B
12	Lack of penetration (incomplete penetration)	402	 <p>Figure A</p>  <p>Figure B</p>  <p>Figure C</p>	<p>A few permitted, no systematic ones.</p> $h \leq 0,4 s$ max. 3 mm	$h \leq 0,2 s$ max. 2 mm	Not permitted
12.1	Lack of penetration (incomplete penetration), fillet welds	—		Long imperfections: Not permitted	Short imperfections: $h \leq 0,2 a$ max. 1,5 mm	$h \leq 0,1 a$ max. 1 mm
13	Bad fit-up, fillet welds	—	<p>An excessive or insufficient gap between the parts to be joined.</p>  <p>Gaps exceeding the appropriate limit may in certain cases be compensated for by a corresponding increase in the throat.</p>	$h \leq 1 \text{ mm} + 0,2 a$ max. 4 mm	$h \leq 0,5 \text{ mm} + 0,15 a$ max. 3 mm	$h \leq 0,5 \text{ mm} + 0,1 a$ max. 2 mm
14	Undercut	5011 5012	<p>Smooth transition is required.</p>  	$h \leq 0,6 \text{ mm}$	Long imperfections: $h \leq 0,4 \text{ mm}$	$h \leq 0,2 \text{ mm}$
				$h \leq 1,5 \text{ mm}$	Short imperfections: $h \leq 1 \text{ mm}$	$h \leq 0,5 \text{ mm}$



No.	Imperfection designation	ISO 6520 reference	Remarks	Limits for imperfections for quality levels		
				Moderate D	Intermediate C	Stringent B
15	Excess weld metal <sup>1)</sup>	502	Smooth transition is required. 	$h \leq 1,5 \text{ mm} + 0,2 b$ max. 10 mm	$h \leq 1,5 \text{ mm} + 0,15 b$ max. 7 mm	$h \leq 1,5 \text{ mm} + 0,1 b$ max. 5 mm
16	Excessive convexity	503		$h \leq 1,5 \text{ mm} + 0,3 b$ max. 5 mm	$h \leq 1,5 \text{ mm} + 0,15 b$ max. 4 mm	$h \leq 1,5 \text{ mm} + 0,1 b$ max. 3 mm
17	Fillet weld having a throat thickness greater than the nominal value	—	For many applications a throat thickness greater than the nominal one may not be a reason for rejection. 	$h \leq 1 \text{ mm} + 0,3 a$ max. 7 mm	$h \leq 1 \text{ mm} + 0,2 a$ max. 6 mm	$h \leq 1 \text{ mm} + 0,15 a$ max. 5 mm
18	Fillet weld having a throat thickness smaller than the nominal value	—	A fillet weld with an apparent throat thickness smaller than prescribed should not be regarded as being imperfect if the actual throat thickness with a compensating greater depth of penetration complies with the nominal value. 	$h \leq 0,3 a$ max. 2 mm	Long imperfections: Not permitted Short imperfections: $h \leq 0,2 a$ max. 1,5 mm	$h \leq 0,1 a$ max. 1 mm
19	Excessive penetration	504		$h \leq 5 \text{ mm}$	$h \leq 4 \text{ mm}$	$h \leq 3 \text{ mm}$