
**Specification and approval of welding
procedures for metallic materials —**

Part 4:

Welding procedure tests for the arc welding of
aluminium and its alloys

AMENDMENT 1

*Descriptif et qualification d'un mode opératoire de soudage pour
les matériaux métalliques —*

*Partie 4: Épreuve de qualification d'un mode opératoire de soudage à l'arc
sur l'aluminium et ses alliages*

AMENDEMENT 1



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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

Amendment 1 to International Standard ISO 9956-4:1995 was prepared by ISO Technical Committee ISO/TC 44 *Welding and allied processes*, Subcommittee SC 10 *Unification of requirements in the field of welding*. It is based on – and equivalent to – EN 288-4:1992/A 1:1997.

This amendment was prepared with the aim of not changing the content technically, but of clarifying the existing standard by modifications brought about by experience gathered during application.

It is intended and under discussion to revise ISO 9956-4 technically, applying the parallel procedure according to the Vienna agreement under leadership of CEN/TC 121/SC 1. After the technical revision, the number of this International Standard will be changed to ISO 15614-2, and EN ISO 15614-2.

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Specification and approval of welding procedures for metallic materials —

Part 4:

Welding procedure tests for the arc welding of aluminium and its alloys

AMENDMENT 1

Page 1, clause 2

Delete the text of clause 2 and replace by the following:

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2092:1981, *Light metals and their alloys — Code of designation based on chemical symbols*.

ISO 2107:1983, *Aluminium, magnesium and their alloys — Temper designations*.

ISO 2437:1972, *Recommended practice for the X-ray inspection of fusion welded butt joints for aluminium and its alloys and magnesium and its alloys 5 to 50 mm thick*.

ISO 3452:1984, *Non-destructive testing — Penetrant inspection — General principles*.

ISO 4136:—¹⁾, *Destructive tests on welds in metallic materials — Transverse tensile test*.

ISO 5173:—²⁾, *Destructive tests on welds in metallic materials — Bend test*.

ISO 6947:1990, *Welds — Working positions — Definitions of angles of slope and rotation*.

ISO 9606-2:1994, *Approval testing of welders — Fusion welding — Part 2: Aluminium and aluminium alloys*.

ISO 9956-1:1995, *Specification and approval of welding procedures for metallic materials — Part 1: General rules for fusion welding*.

ISO 9956-2:1995, *Specification and approval of welding procedures for metallic materials — Part 2: Welding procedure specification for arc welding*.

ISO 10042:1992, *Arc-welded joints in aluminium and its weldable alloys — Guidance on quality levels for imperfections*.

EN 970:1997, *Non-destructive examination of fusion welds — Visual examination*.

EN 1321:1996, *Destructive tests on welds in metallic materials — Macroscopic and microscopic examination of welds*.

¹⁾ To be published. (Revision of ISO 4136:1989)

²⁾ To be published. (Revision of ISO 5173:1981)

Page 2, clause 4

Delete the text of clause 4 and replace by the following:

The preliminary welding procedure specification shall be prepared in accordance with ISO 9956-2. It shall specify the tolerance for all the relevant parameters.

Page 2, subclause 6.2

In the last sentence, replace "specified" by "agreed upon".

Page 3, subclause 6.3

Delete the text of 6.3 and replace by the following:

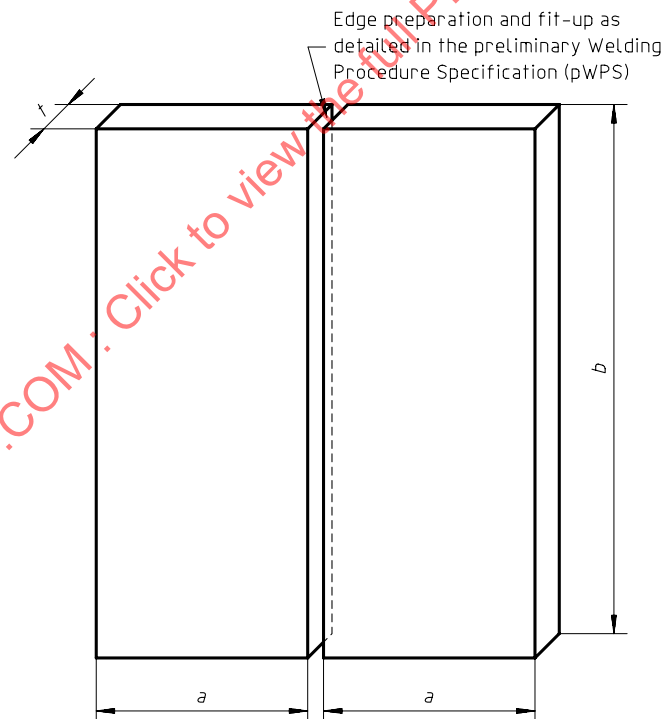
Preparation and welding of test pieces shall be carried out in accordance with the pWPS, and under the general conditions of welding in production which they shall represent. Welding positions and limitations for the angle of slope and rotation of the test piece shall be in accordance with ISO 6947.

If tack welds are to be fused into the final joint they shall be included in the test piece.

Welding and testing of the test pieces shall be witnessed by an examiner or examining body.

Page 3, figure 1

Amend as follows:



$a = 3t$; minimum value 150 mm

$b = 6t$; minimum value 350 mm

Figure 1 — Test piece for a butt weld in plate

Page 5, subclause 7.3

Delete the text of 7.3 and replace by the following:

7.3.1 Method

After any required post-weld heat treatment, natural or artificial ageing and prior to the cutting of test specimens, all test pieces shall be examined visually and non-destructively in accordance with 7.1.

Depending upon joint geometry, materials and the requirements for work, the NDE shall be carried out in accordance with EN 970 (visual examination) and ISO 3452 (penetrant testing).

Page 6, table 1

Replace footnote 3) of table 1 by the following :

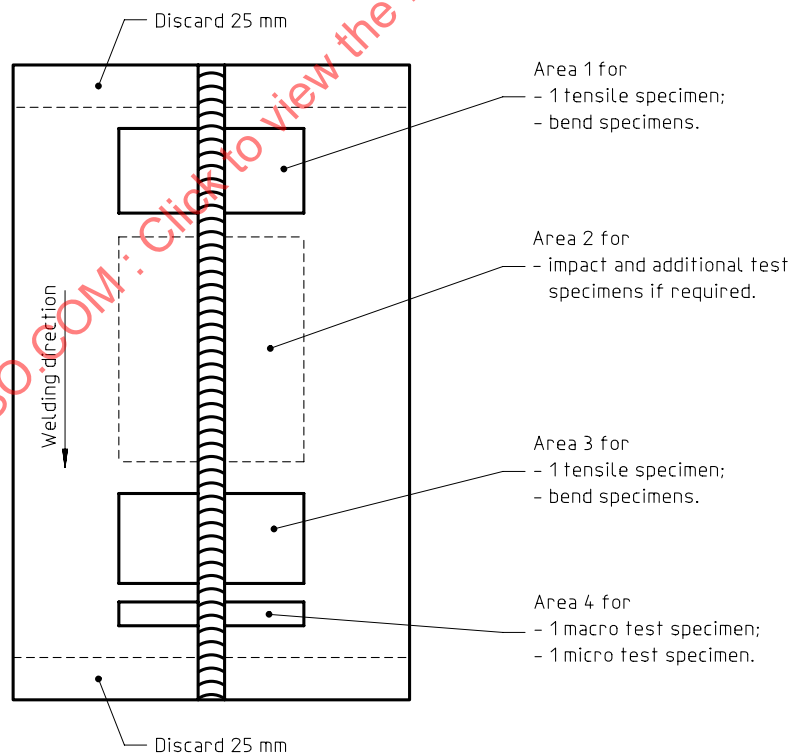
3) Testing as detailed does not provide information on the mechanical properties of the joint. Where these properties are relevant to the application an additional approval shall also be held e.g. a butt weld approval.

Delete footnote 5) of table 1.

In column 2 replace three times "dye penetrant" by "penetrant".

Page 6, figure 5

Amend the notes on the figure as follows:

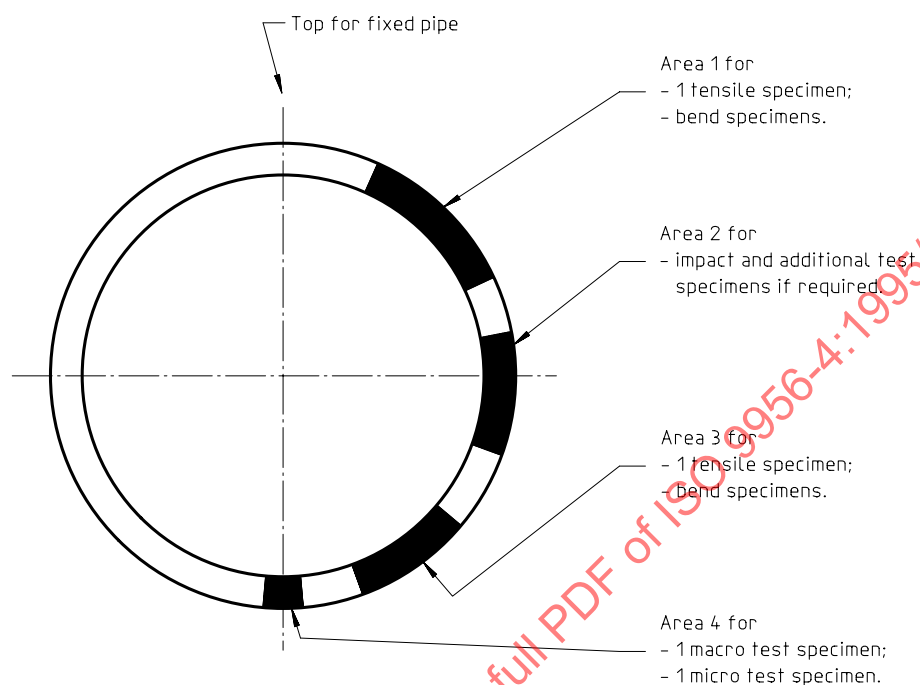


NOTE Not to scale.

Figure 5 — Location of test specimens for a butt weld in plate

Page 7, figure 6

Amend the notes on the figure as follows:



NOTE Not to scale.

Figure 6 — Location of test specimens for a butt weld in pipe

Page 8, subclause 7.4

7.4.1 Transverse tensile testing

Delete the text of 7.4 and replace by the following:

Specimens and testing for transverse tensile testing for butt joints shall be in accordance with ISO 4136.

For pipes of outside diameter > 50 mm, the excess weld metal shall be removed on both faces to give the test specimen a thickness equal to the wall thickness of the pipe.

For pipes of outside diameter ≤ 50 mm, and when full section small diameter pipes are used, the excess weld metal may be left undressed on the inside surface of the pipe.

The tensile strength of the test specimen shall normally be not less than the corresponding specified minimum value for the parent metal, in the soft conditions for groups 21, 22.1, and 22.2, (see table 2).

The tensile strength [$R_m(w)$] of the welded test specimen shall satisfy the following requirement :

$$R_m(w) = R_m(pm) \times T$$

where

$R_m(pm)$ is the specified minimum tensile strength of the parent metal in Newtons per square millimetre;

T is the joint efficiency factor.

Table 2 — Efficiency for tensile strength of butt welds

Material group (see table 4)		Temper/ Condition of parent metal before welding ^{a b}	Post weld ageing ^c	$T = \frac{R_m(w)}{R_m(pm)}$
21		F O H12 H14 H16 H18 H19	—	1,0 ^d
22.1 and 22.2		H112 H22 H24 H26 H28 H29 H32 H34 H38 H39	—	1,0 ^d
23	Al-Mg-Si alloys	T4 T4 T5-T6 T5-T6	Natural Artificial Natural Artificial	0,9 0,7 ^{e, g} 0,6 0,7 ^g
	Al-Zn-Mg alloys	T4 T4 T6 T6	Natural Artificial Natural Artificial	0,9 0,75 ^{e, g} 0,75 0,75 ^g
Other alloy		T4 and T6	— ^f	— ^f

^a See ISO 2107.

^b For parent metal in the other tempers not shown in the table, $R_m(w)$ shall be agreed upon between the contracting parties.

^c See 7.3.1.

^d $R_m(pm)$ is based on the specified minimum tensile strength of the "O" condition, irrespective of the actual parent metal temper used for the test.

^e When the test pieces are artificially aged after welding and prior to testing, the efficiency factor T applies to the T6 parent metal condition.

^f The post weld ageing conditions and $R_m(w)$ shall be agreed upon between the contracting parties.

^g Higher properties may be achieved if post-weld full heat treatment is applied to group 23 alloys and $R_m(w)$ shall be agreed upon between the contracting parties.

7.4.2 Bend testing

Specimens and testing for bend testing for butt joints shall be in accordance with ISO 5173.

For all groups the bend angle shall be 180° using the former diameter given in table 3.

During testing, the test specimens shall not reveal any one single flaw > 3 mm in any direction. Flaws appearing at the corners of a test specimen during testing shall be ignored in the evaluation.

For alloys of low ductility (group 22.2 and 23) there are two options :

- the test specimens are annealed before testing and then the "O" conditions given in table 3 are applied - see 7.4.1;
- the test specimens are not annealed before testing and then the conditions given in table 3 related to the appropriate temper are applied.

Table 3 — Former diameter of bend tests

Group of materials	Former diameter								
	Temper or condition (see ISO 2107)								
		F							
	O	H112 H12 H22 H32	H14 H24 H34	H16 H26 H36	H18 H28 H38	H19 H29 H39	T4	T5-T6	T7
21	2 _t	3 _t	3 _t	3 _t	4 _t	4 _t	—	—	—
22.1	3 _t	3 _t	3 _t	4 _t	5 _t	5 _t	—	—	—
22.2	6 _t	6 _t	6 _t	6 _t	6 _t	6 _t	—	—	—
23	4 _t	—	—	—	—	—	6 _t	7 _t	8 _t

7.4.3 Macro-examination

The test specimen shall be prepared and etched in accordance with EN 1321 on one side to clearly reveal the fusion line, the HAZ and the build up of the runs.

The macro examination shall include unaffected parent metal.

The acceptance levels stated in 7.3.2 shall apply.

7.4.4 Micro-examination

The test specimen shall be prepared and etched in accordance with EN 1321 on one side to clearly reveal the fusion line, the structure of the weld metal and of the HAZ.

Page 10, subclause 7.5

Delete "geometric" in the second paragraph.

Page 10, table 4

Amend as follows:

Table 4 — Grouping system for aluminium and its alloys

Group	Type of aluminium and aluminium alloys
21	Pure aluminium Pure aluminium with $\leq 1,5$ % impurities or alloy content
22	Non heat-treatable alloys
22.1	Aluminium-magnesium alloys with $\leq 3,5$ % Mg
22.2	Aluminium-magnesium alloys with 4 % Mg to 5,6 % Mg
23	Heat-treatable alloys Aluminium-magnesium-silicon alloys and Aluminium-zirconium-magnesium heat-treatable alloys which require controlled heat input and heat treatment or ageing after welding

Page 11, table 5

Amend as follows:

Table 5 — Range of approval for dissimilar metal joints

Existing approved welding procedure test for group of aluminium	Range of approval
21	21 welded to 21
22.1	22.1 welded to 22.1
22.2	22.1 welded to 22.1 22.1 welded to 22.2 22.2 welded to 22.2
23	22.1 welded to 22.1 22.1 welded to 22.2 ^a 22.2 welded to 22.2 ^a 23 welded to 23
^a Provided that an Al-Mg alloy filler is used.	

Page 11, subclause 8.3.2.3

Delete the text of 8.3.2.3 and replace by the following:

In addition to the requirements of table 6, the range of approval of the throat thickness "a" shall be "0,75a" to "1,5a". However, a test with a throat thickness ≥ 10 mm, shall give approval for all throat thickness ≥ 10 mm.

Where a fillet weld is approved by means of a butt weld test, the throat thickness range approved shall be based on the thickness of the deposited weld metal of butt joint.