



DRAFT INTERNATIONAL STANDARD ISO/DIS 9606-2

ISO/TC 44/SC 11

Secretariat: **SUTN**

Voting begins on
2002-07-11

Voting terminates on
2002-12-11

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Qualification test of welders — Fusion welding —

Part 2:

Aluminium and aluminium alloys

[Revision of first edition (ISO 9606-2:1994) and its Amendment 1:1998]

Épreuve de qualification des soudeurs — Soudage par fusion —

Partie 2: Aluminium et alliages d'aluminium

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ICS 25.160.01

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ISO/CEN PARALLEL ENQUIRY

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Accordingly, ISO member bodies who are not CEN members are requested to send a copy of their comments on this DIS directly to CEN/TC 121 (DS, Kollegievej, 6, DK-2920 Charlottenlund) as well as returning their vote and comments in the normal way to the ISO Central Secretariat.

Should this DIS be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month FDIS vote in ISO and formal vote in CEN.

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July 2002

ICS

Will supersede EN 287-2:1992

English version

Qualification test of welders - Fusion welding - Part 2: Aluminium and aluminium alloys (ISO/DIS 9606-2:2002)

Epreuve de qualification des soudeurs - Soudage par
fusion - Partie 2: Aluminium et alliages d'aluminium
(ISO/DIS 9606-2:2002)

Prüfung von Schweißern - Schmelzschweißen - Teil 2:
Aluminium und Aluminiumlegierungen (ISO/DIS 9606-
2:2002)

This draft European Standard is submitted to CEN members for parallel enquiry. It has been drawn up by the Technical Committee CEN/TC 121.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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Introduction

The ability of a welder to follow verbal or written instructions and verification of a person's skills are important factors in ensuring the quality of the welded product.

The testing of a welder's skill in accordance with this standard depends on welding techniques and conditions used in which uniform rules are complied with, and standard test pieces are used.

The principle of this standard is that a qualification test qualifies the welder not only for the conditions used in the test, but also for all joints which are considered to weld easier on the presumption that the welder has received a particular training and/or has industrial practice within the range of qualification.

The qualification test can be used to qualify a welding procedure and a welder provided that all the relevant requirements, e.g. test piece dimensions, are satisfied.

Qualifications in accordance with EN 287-2 existing at the date of publication of this standard are, at the end of their period of validity, to be interpreted in accordance with the requirements of this standard.

1 Scope

This standard defines the qualification test of welders for the fusion welding of aluminium and aluminium alloys (see EN 1418).

It provides a set of technical rules for a systematic qualification test of the welder, and enables such qualifications to be uniformly accepted independently of the type of product, location and examiner/examining body.

When qualifying welders, the emphasis is placed on the welders ability to manually manipulate welding torch and thereby producing a weld of acceptable quality.

The welding processes referred to in this standard include those fusion welding processes which are designated as manual or partly mechanized welding. It does not cover fully mechanized and automated welding processes.

2 Normative references

This standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 910, *Destructive tests on welds in metallic materials — Bend tests*

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

EN 1320, *Destructive tests on welds in metallic materials — Fracture test*

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

EN 1435, *Non-destructive examination of welds — Radiographic examination of welded joints*

EN 1714, *Non destructive examination of welds — Ultrasonic examination of welded joints*

EN 30042, *Arc-welded joints in aluminium and its weldable alloys — Guidance on quality levels for imperfections (ISO 10042:1992)*

EN ISO 4063, *Welding and allied processes — Nomenclature of processes and reference numbers (ISO 4063)*

EN ISO 6947, *Welds — Working positions — Definitions of angles of slope and rotation (ISO 6947)*

prEN ISO 15607, *Specification and approval of welding procedures for metallic materials — General rules (ISO/DIS 15607:2000)*

CR ISO/TR 15608, *Welding — Guidelines for a metallic material grouping system*

prEN ISO 15609-1:2000, *Specification and approval of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding (ISO/DIS 15609-1:2000)*

prEN ISO 15614-2, *Specification and approval of welding procedures for metallic materials — Welding procedure test — Part 2: Arc welding of aluminium and its alloys (ISO/DIS 15614-2:2000)*

ISO 857-1, *Welding and allied processes — Vocabulary — Part 1: Welding processes*

NOTE A list of ISO Standards conforming to these EN Standards is given at the end of this standard in annex ZB.

3 Terms and definitions

For the purposes of this part of EN ISO 9606, the relevant terms and definitions in prEN ISO 15607 and the following terms and definitions apply.

3.1 welder

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

3.2 examiner

a person who has been appointed to verify compliance with the applicable standard

NOTE In certain cases, an external independent examiner may be required.

3.3 examining body

an organization that has been appointed to verify compliance with the applicable standard

NOTE In certain cases, an external independent examining body may be required.

3.4 backing

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

3.5 root run

in multi layer welding, the run(s) of the first layer deposited in the root

3.6 filling run

in multi layer welding, the run(s) deposited after the root run(s) and before the capping run(s)

3.7 capping run

in multi layer welding, the run(s) visible on the weld face(s) after completion of welding

3.8 weld metal thickness

thickness of the weld metal excluding any reinforcement

4 Symbols and abbreviated terms

4.1 General

Where the full wording is not used, the following abbreviations and reference numbers shall be used when completing the welder's qualification test certificate (see annex A).

4.2 Reference numbers of welding processes

This standard covers the following manual or partly mechanized welding processes (reference numbers of welding processes for symbolic representation are listed in EN ISO 4063):

- 131 metal inert gas welding (MIG welding);
- 141 tungsten inert gas arc welding (TIG welding);
- 15 plasma arc welding.

NOTE The principles of this standard may be applied to other fusion welding processes.

4.3 Abbreviations

4.3.1 For test pieces

<i>a</i>	design throat thickness
BW	butt weld
<i>D</i>	outside pipe diameter
FW	fillet weld
<i>l</i> ₁	length of test piece
<i>l</i> ₂	half width of test piece
<i>l</i> _f	examination length
P	plate ¹⁾
<i>s</i>	weld metal thickness for butt welds only (plate thickness or pipe wall thickness for single process)
<i>s</i> ₁	weld metal thickness for welding process 1
<i>s</i> ₂	weld metal thickness for welding process 2
<i>t</i>	material thickness of test piece (plate or wall thickness)
T	pipe ²⁾
<i>z</i>	leg length of fillet weld.

4.3.2 For consumables

nm	no filler metal
S	solid wire/rod

4.3.3 For other weld details

bs	welding from both sides
mb	welding with backing
ml	multi layer
nb	welding without backing
sl	single layer
ss	single-side welding

1) The word "plate" alone or in combination is used to mean "wrought plate" and "flat extruded bars".

2) The word "pipe" alone or in combination, is used to mean "pipe", "tube" or "hollow section".

5 Essential variables and range of qualification

5.1 General

The qualification of welders is based on essential variables. For each essential variable a range of qualification is defined. All test pieces shall be welded using the essential variables independently, except for 5.7 and 5.8. If the welder has to weld outside the range of qualification a new qualification test is required. The essential variables are:

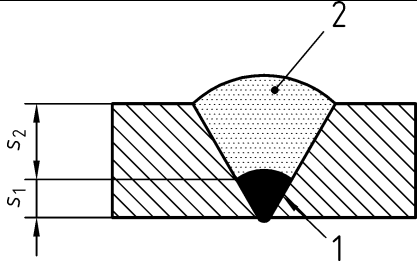
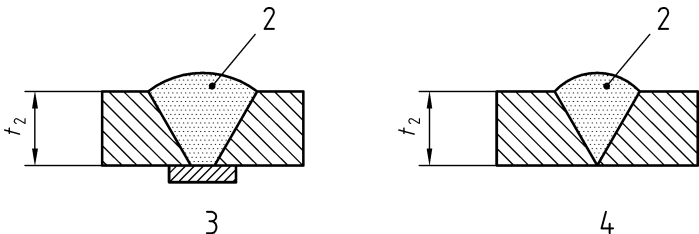
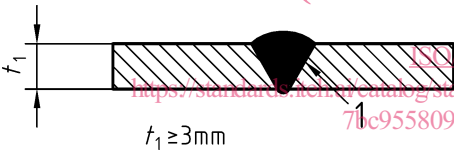
- welding processes,
- product type (plate and pipe),
- type of weld (butt and fillet),
- material groups,
- welding consumables,
- dimensions (material thickness and outside pipe diameter),
- welding positions,
- weld details (backing, single side welding, both side welding, single layer, multi layer).

5.2 Welding processes

Welding processes are defined in ISO 857-1 and listed in 4.2.

Each test normally qualifies only one welding process. A change of welding process requires a new qualification test. However, it is permitted for a welder to be qualified for two or more welding processes by welding a single test piece (multi process joint) or by two or more separate qualification tests. The ranges of qualification for each welding process used and for the multi processes joint for butt welds are given in table 1.

Table 1 — Thickness range for single and multi process joints for butt welds

Welding process used for the test piece	Thickness range	
	Single process joint	Multi process joint
 <p>1 Welding process 1 2 Welding process 2</p>	<p>according to table 3 for welding process 1: $t = s_1$ for welding process 2: $t = s_2$</p>	<p>according to table 3 with $t = s_1 + s_2$</p>
 <p>2 Welding process 2 3 Welding with backing (mb) 4 Welding without backing (nb)</p>	<p>according to table 3 for welding process 1: $t = t_1$ for welding process 2: $t = t_2$</p>	<p>according to table 3 $t = t_1 + t_2$ Welding process 1 only for welding of the root area</p>
 <p>1 Welding process 1</p> <p>$t_1 \geq 3\text{mm}$</p>		

5.3 Product type

The qualification test shall be carried out on plate or pipe. The following criteria are applicable:

- a) welds in pipes, outside pipe diameter $D > 25$ mm, cover welds in plates;
- b) welds in plates cover welds in pipe:
 - of outside pipe diameter $D \geq 150$ mm, for welding positions PA, PB and PC;
 - of outside pipe diameter $D \geq 500$ mm, for all other welding positions.

5.4 Type of weld

The qualification test shall be carried out as butt or fillet weld. The following criteria are applicable:

- a) butt welds cover butt welds in any type of joint except branch connections;
- b) in cases where the majority of work is fillet welding, the welder shall also be qualified by an appropriate fillet welding test; in case where the majority of work is butt welding, butt welds qualify fillet welds;
- c) butt welds in pipes without backing qualify branch connections with an angle $\geq 60^\circ$ and the same range of qualification as in tables 1 to 7. For a branch weld the range of qualification is based on the outside pipe diameter of the branch;

- d) for applications where the type of weld cannot be qualified by means of either a butt or fillet weld test then a specific test piece should be used to qualify the welder, e.g. branch connection, finish welding of castings, preheating.

5.5 Material groups

5.5.1 Aluminium groups of parent material

In order to reduce the number qualification tests, aluminium with similar welding characteristics are grouped according to CR ISO/TR 15608.

5.5.2 Range of qualification

The welding of any one metal in a group confers qualification on the welder for the welding of all other metal within the same group as well as other groups according to table 2.

When welding parent materials outside the grouping system a separate test is required.

Any dissimilar joint between materials of groups 21 to 23 with materials of groups 24 to 26 requires a specific qualification test. This qualifies any dissimilar joint obtained from any combination between materials from groups 21 to 23 with materials from groups 24 to 26.

Table 2 — Range of qualification for parent metal

Material group ^a of the test piece	Range of qualification					
	21	22	23	24	25	26
21	X	X	—	—	—	—
22	X	X	—	—	—	—
23	X	X	X ^b	—	—	—
24	—	—	—	X	X	X
25	—	—	—	X	X	X
26	—	—	—	X	X	X

^a Material group according to CR ISO/TR 15608.

^b See also 5.6.

Key:

X indicates those material groups for which the welder is qualified.

— indicates those material groups for which the welder is not qualified.

5.6 Welding consumables

Qualification with filler metal, e.g. with processes 141 and 15, qualifies for welding without filler metal but not vice versa.

If the qualification test is welded with AlMg alloy types the qualification is also given for AlSi alloy types, but not vice versa.

A change of the percentage of Helium in the shielding gas from more than 30 % requires a new qualification test.

5.7 Dimensions

The welder qualification test of butt welds is based on the material thickness and outside pipe diameters. The ranges of qualification are specified in tables 3 and 4.

NOTE It is not intended that material thickness or outside pipe diameters should be measured precisely but rather the general philosophy behind the values given in tables 3 and 4 should be applied.

For fillet welds the range of qualification for material thickness is specified in table 5.

In the case of branch welding the material thickness criteria to which table 3 applies and the outside pipe diameter criteria to which table 4 applies is as follows:

- Set on: The material thickness and outside pipe diameter of the branch;
- Set in or set through: The material thickness of the main pipe or shell and the outside pipe diameter of the branch.

For test pieces of different outside pipe diameters and material thicknesses, the welder is qualified for:

- 1) the thinnest and thickest material thickness qualified in accordance with table 3.
- 2) the smallest and largest outside pipe diameter qualified in accordance with table 4;

Table 3 — Range of qualification of material thickness of test piece for butt welds

Dimension in millimetres

Material thickness of test piece <i>t</i>	Range of qualification
$t \leq 6$	$0,5 \times t$ to $2 \times t$
$t > 6$	≥ 6

Table 4 — Range of qualification for outside pipe diameter

Dimension in millimetres

Outside pipe diameter of test piece ^a <i>D</i>	Range of qualification
$D \leq 25$	D to $2 \times D$
$D > 25$	$\geq 0,5 \times D$ (25 mm min.)

^a For structural hollow sections, *D* is the dimension of the smaller side.

Table 5 — Range of qualification of material thickness of test piece for fillet welds^a

Dimension in millimetres

Material thickness of test piece <i>t</i>	Range of qualification
$t < 3$	t to 3
$t \geq 3$	≥ 3

^a See also table 8.

5.8 Welding positions

The range of qualification for each welding position is given in table 6. The welding positions and symbols refer to EN ISO 6947.

The test pieces shall be welded in accordance with the nominal angles of the welding positions according to EN ISO 6947.

Qualification tests welded in position on plates qualify the same position on rotating pipes (see 5.3 b)

The welding position H-L045 for pipes qualifies for all pipe angles.

Welding two pipes with the same outside pipe diameter, one in welding position PF and one in welding position PC, also covers the range of qualification of a pipe welded in welding position H-L045.

Outside pipe diameters $D \geq 150$ mm can be welded in two welding positions (PF 2/3 of circumference, PC 1/3 of circumference) using only one test piece.

Table 6 — Range of qualification for welding positions

Welding position of test piece	Range of qualification ^a									
	PA	PB ^b	PC	PD ^b	PE	PF (Plate)	PF (Pipe)	PG (Plate)	PG (Pipe)	H-L045
PA	X	X	—	—	—	—	—	—	—	—
PB ^b	X	X	—	—	—	—	—	—	—	—
PC	X	X	X	—	—	—	—	—	—	—
PD ^b	X	X	X	X	—	X	—	—	—	—
PE	X	X	X	X	X	X	—	—	—	—
PF (Plate)	X	X	—	—	—	X	—	—	—	—
PF (Pipe)	X	X	—	X	X	X	X	—	—	—
PG (Plate)	—	—	—	—	—	—	—	X	—	—
PG (Pipe)	X	X	—	X	X	—	—	X	X	—
H-L045	X	X	X	X	X	X	X	—	—	X

^a Additionally the requirements of 5.3 and 5.4 shall be observed.

^b Welding position PB and PD are only used for fillet welds (see 5.4 b) and can only qualify fillet welds in other welding positions.

Key:

X indicates those welding positions for which the welder is qualified

— indicates those welding positions for which the welder is not qualified