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**Approval testing of welders — Fusion
welding —**

Part 2:

**Aluminium and aluminium alloys
(standards.iteh.ai)**

Qualification des soudeurs — Soudage par fusion —

ISO 9606-2:1994

Partie 2: Aluminium et ses alliages
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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.

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 9606-2 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 11, *Approval requirements for welding and allied processes personnel*.

ISO 9606 consists of the following parts, under the general title *Approval testing of welders — Fusion welding*:

- Part 1: *Steels*
- Part 2: *Aluminium and aluminium alloys*
- Part 3: *Nickel and nickel alloys*
- Part 4: *Magnesium and magnesium alloys*
- Part 5: *Titanium and titanium alloys*

Annexes A, B and C of this part of ISO 9606 are for information only.

Introduction

This part of ISO 9606 covers the principles to be observed in the approval testing of welder performance for the fusion welding of aluminium.

The quality of work involved in welding depends on the skill of the welder to a high degree.

The ability of the welder to follow verbal or written instructions and the testing of his skill are therefore important factors in ensuring the quality of the welded product.

Testing of skill in accordance with this part of ISO 9606 depends on welding methods in which uniform rules and test conditions are complied with, and standard test pieces are used.

This part of ISO 9606 applies to processes where the skill of the welder has a significant influence on weld quality.

This part of ISO 9606 is intended to provide the basis for the mutual recognition by examining bodies for approval relating to welders' competence in the various fields of application. It is intended that tests be carried out in accordance with this part of ISO 9606 unless more severe tests are specified by the relevant application standard.

The same test weld may be used to approve a welding procedure and a welder provided that all the relevant requirements, e.g. test piece dimensions, are satisfied (see ISO 9956-4).

The welder's skill and job knowledge continue to be approved only if the welder is working with reasonable continuity on welding work within the extent of approval.

However, this part of ISO 9606 does not invalidate previous welder approvals made to former national standards or specifications, providing the intent of the technical requirements is satisfied and the previous approvals are relevant to the application and production work on which they are to be employed.

Also, where additional tests have to be carried out to make the approval technically equivalent, it is only necessary to do the additional tests on a test piece made in accordance with this part of ISO 9606. Consideration of previous approvals to former national standards or specifications should be at the time of the enquiry/contract stage and agreed between the contracting parties.

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Approval testing of welders — Fusion welding —

Part 2: Aluminium and aluminium alloys

1 Scope

This part of ISO 9606 specifies essential requirements, ranges of approval, test conditions, acceptance requirements and certification for the approval testing of welder performance for the welding of aluminium. The recommended format for the certificate of approval testing is given in annex A.

During the approval test, the welder is required to show adequate practical experience and job knowledge (test nonmandatory) of the welding processes, materials and safety requirements for which he is to be approved; information on these aspects is given in annex C.

This part of ISO 9606 is applicable when the welder's approval testing is required by the purchaser, by inspection authorities or by other organizations.

This part of ISO 9606 applies to the approval testing of welders for the fusion welding of aluminium using a gas shield.

The welding processes referred to in this part of ISO 9606 include those fusion welding processes which are designated as manual or partly mechanized welding. It does not cover fully mechanized and fully automatic processes (see 5.2).

This part of ISO 9606 covers approval testing of welders for work on semifinished and finished products made from wrought, forged or cast material types listed in 5.4.

This part of ISO 9606 does not cover the issue of the certificate of approval testing which is under the sole responsibility of the examiner or test body.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9606. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9606 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 857:1990, *Welding, brazing and soldering processes — Vocabulary.*

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

ISO 4136:—¹⁾, *Welding — Welded butt joints in metallic materials — Transverse tensile tests.*

ISO 5173:—²⁾, *Welding — Welded butt joints in metallic materials — Bend tests.*

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

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

ISO 9956-2:—³⁾, *Specification and approval of welding procedures for metallic materials — Part 2: Welding procedure specification for arc welding.*

ISO 9956-4:—³⁾, *Specification and approval of welding procedures for metallic materials — Part 4: Welding procedure tests for the arc welding of aluminium and its alloys.*

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

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3 Definitions

For the purposes of this part of ISO 9606, the following definitions apply.

3.1 welder: Person who performs the welding.

NOTE 1 Collective term used for both manual welders and welding operators. It does not cover operators for fully mechanized and fully automatic welding processes.

3.1.1 manual welder: Welder who holds and manipulates the welding gun or torch by hand.

3.1.2 welding operator: Welder who operates welding equipment with partly mechanized relative movement between the welding gun or torch and the workpiece.

3.2 examiner or test body: Person or organization appointed by the contracting parties to verify compliance with this part of ISO 9606.

3.3 welding procedure specification (WPS): Document providing in detail the required variables for a specific application to assure repeatability.

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

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

3) To be published.

3.4 heat treatment: One of the following procedures:

- preheat;
- controlled heat input;
- postweld heat treatment; and
- ageing.

3.5 range of approval: Extent of approval for an essential variable.

3.6 test piece: Welded assembly which is used in the approval test.

3.7 test specimen: Part or portion cut from the test piece in order to perform a specified destructive test.

3.8 test: Series of operations which will include the making of a welded test piece and subsequent non-destructive and/or destructive testing reporting of results.

4 Symbols and abbreviations

4.1 General

Where the full wording is not used, the following symbols and abbreviations shall be used when completing the test certificate (see annex A).

4.2 Test piece

<i>a</i>	nominal throat thickness
BW	butt weld
<i>D</i>	outside diameter of pipe
FW	fillet weld
P	plate
<i>t</i>	plate or pipe wall thickness
T	pipe
<i>z</i>	leg length of fillet weld

4.3 Filler metal

nm	no filler metal
wm	with filler metal

4.4 Miscellaneous

ag	ageing
bs	welding from both sides
gb	welding with gas backing
gg	back gouging or back grinding of welds
mb	welding with backing material
nb	welding without backing
ng	no back gouging or no back grinding
ss	single-side welding

5 Essential variables for approval testing

5.1 General

The criteria specified in this clause shall be examined in order to identify the ability of the welder in these areas. Each criterion is considered to be a significant factor in the approval testing.

The welder's approval test shall be carried out on test pieces and is independent of the type of construction.

5.2 Welding processes

Welding processes are defined in ISO 857 and reference numbers of welding processes for symbolic representation are listed in ISO 4063.

This part of ISO 9606 covers the following welding processes:

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

other fusion welding processes by agreement.

5.3 Joint types (butt and fillet welds)

Test pieces shall be produced for butt weld (BW) and fillet weld (FW) in plates⁴⁾ (P) or pipes⁵⁾ (T) for approval tests in accordance with 7.2.

5.4 Material groups

5.4.1 General

In order to minimize unnecessary multiplication of technically identical tests, aluminium with similar metallurgical and welding characteristics are grouped for the purpose of a welder's approval (see 5.4.2).

In general, a welder's approval test shall involve depositing weld metal having a chemical composition compatible with the parent metal.

The welding of any one material in a group confers approval on the welder for the welding of all other materials within the same group.

When welding parent metals from two different groups which do not give approval to each other according to tables 4 and 5, an approval for the combination as a separate group is required.

When the filler metal is dissimilar to the parent metal group, an approval for that combination of parent metal group and filler metal is needed, except when permitted by tables 4 and 5.

5.4.2 Aluminium groups of parent metal

Aluminium casting alloys are included in the following groups but the filler metal shall be compatible with the filler metal used for the wrought materials in the same group.

5.4.2.1 Group W21: Pure aluminium

Pure aluminium and aluminium-manganese-alloys with impurities or alloying content less than or equal to 1,5 %, e.g.

Al 99,8 Al 99,5 Al 99 AIMn 1

5.4.2.2 Group W22: Non-heat-treatable alloys

Aluminium-magnesium-alloys, e.g.

AlMg 1 to 5
AlMg 3 Mn AlMg 4,5 Mn
Aluminium-silicon-alloys

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

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

5.4.2.3 Group W23: Heat-treatment alloys

Heat treatable alloys, e.g.

AlMgSi 0,5 to 1,5
 AlSiMgMn
 AlSiMg (castings)
 AlSiCu (castings)
 AlZn 4,5 Mg 1

5.5 Filler metal and shielding gas

In the approval test, the filler metal and the shielding gas, including plasma gas, shall be compatible with the parent metal and the process used in accordance with the relevant WPS (see ISO 9956-2).

5.6 Dimensions

The welder approval test should be based on the thickness of the material (i.e. plate thickness or wall thickness of pipe) and pipe diameters which the welder will use in production. A test is listed for each of the two ranges of plate thickness and pipe wall thickness or pipe diameter as specified in tables 1 and 2.

It is not intended that thicknesses or diameters should be measured precisely but rather the general philosophy behind the values given in tables 1 and 2 should be applied.

Table 1 — Test piece (plate or pipe) and range of approval

Test piece thickness, t mm	Range of approval
$t \leq 6$	$0,7t$ to $2,5t$
$6 < t \leq 15$	$6 \text{ mm} < t \leq 40 \text{ mm}$ ¹⁾
1) A special test is required for material thickness greater than 40 mm. Such a special test shall be indicated on the welder's certificate.	

Table 2 — Test piece diameter and range of approval

Test piece diameter, D ¹⁾ mm	Range of approval
$D \leq 125$	$0,25D$ to $2D$
$D > 125$	$\geq 0,5D$
1) For structural hollow sections, D is the dimension of the smallest side.	

5.7 Welding positions

For the purposes of this part of ISO 9606, the welding positions identified in figures 1 and 2 shall apply (in accordance with ISO 6947). Angles of slope and rotation for straight welds in the welding positions shall be in accordance with ISO 6947.

The positions and angles used in the approval test shall be based on the same tolerances as used in production.

6 Range of approval for the welder

6.1 General

As a general rule, the test piece approves the welder not only for the conditions used in the test, but also for all joints which are considered easier to weld. The range of approval for each type of test is given in the relevant subclauses and tables. In these tables the range of approval is indicated in the same horizontal

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6.2 Welding process

Each test normally approves one process. A change of process requires a new approval test. However, it is possible for a welder to be approved for more than one welding process by a single test or by two separate approval tests to be used to cover a multi-process joint. For example, in a case where approval is required for a single-side butt joint with the root to be welded by TIG (141) without backing and to be filled by MIG (131), the welder may be approved by either of the following routes:

- successful completion of an approval test simulating the multi-process joint, i.e. the root run welded by TIG (141) without backing, subsequent runs or layers welded by MIG (131) within the limits of the range of approval;
- successful completion of separate relevant approval tests one for TIG (141) without backing for the root run and a separate test for the fill by MIG (131) with backing or welded from both sides with or without backing.

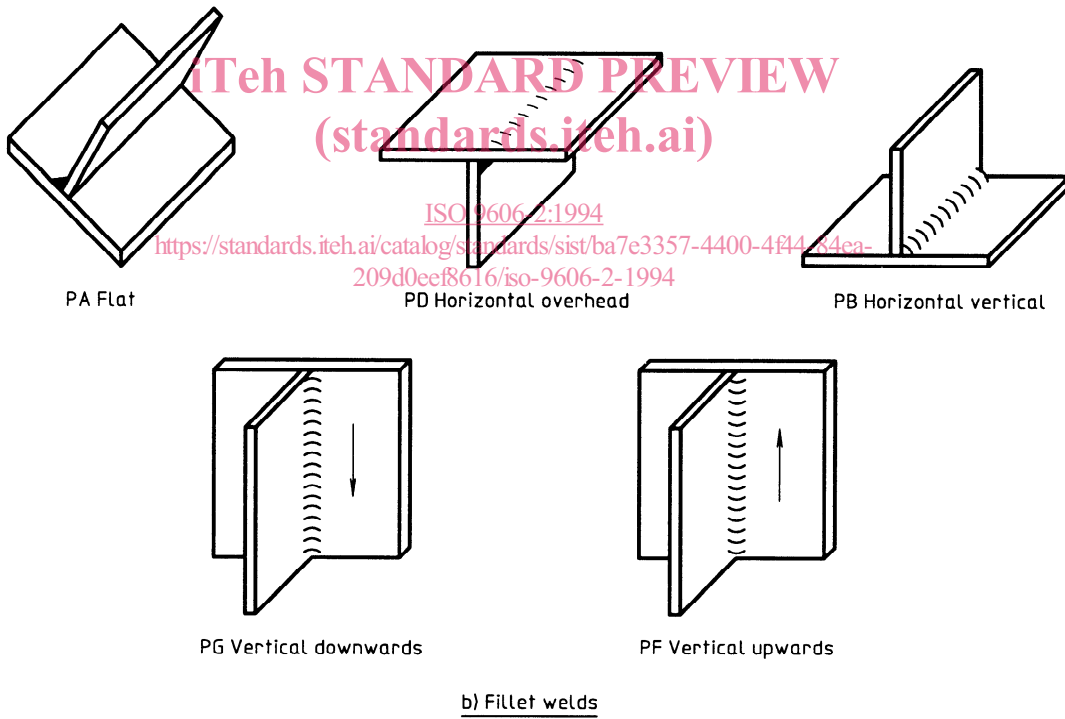
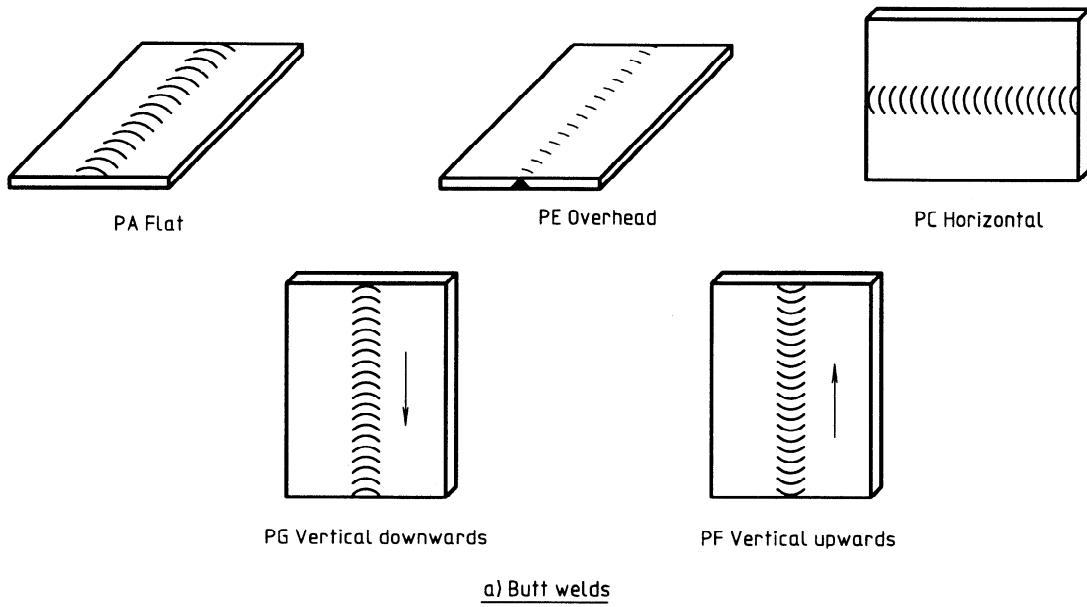
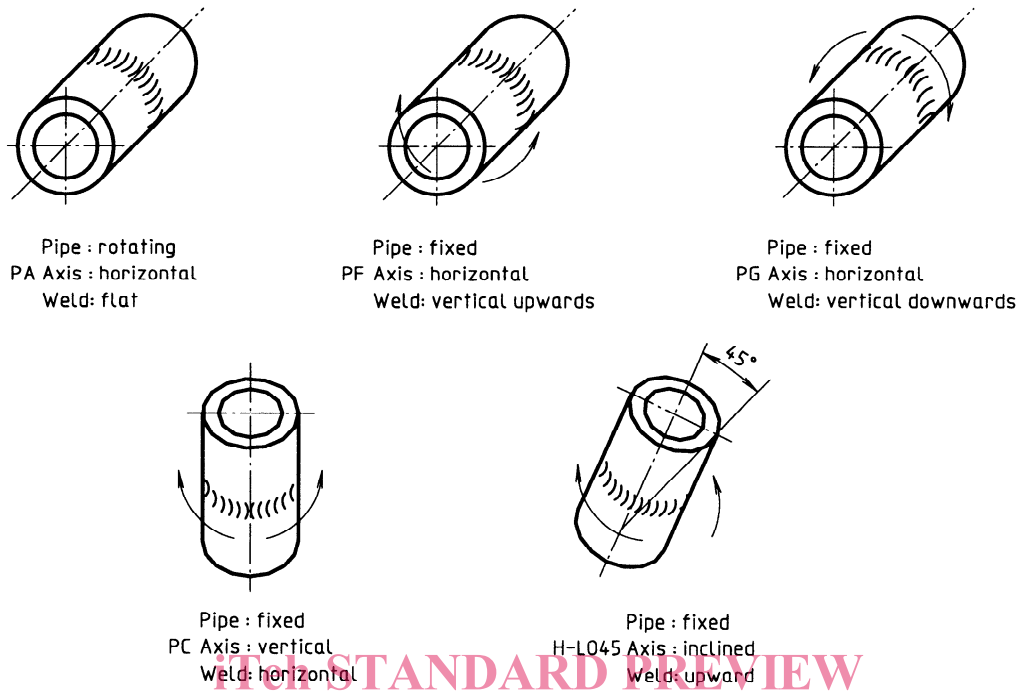
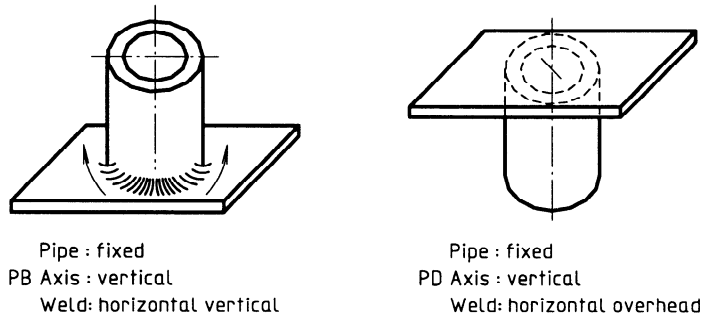
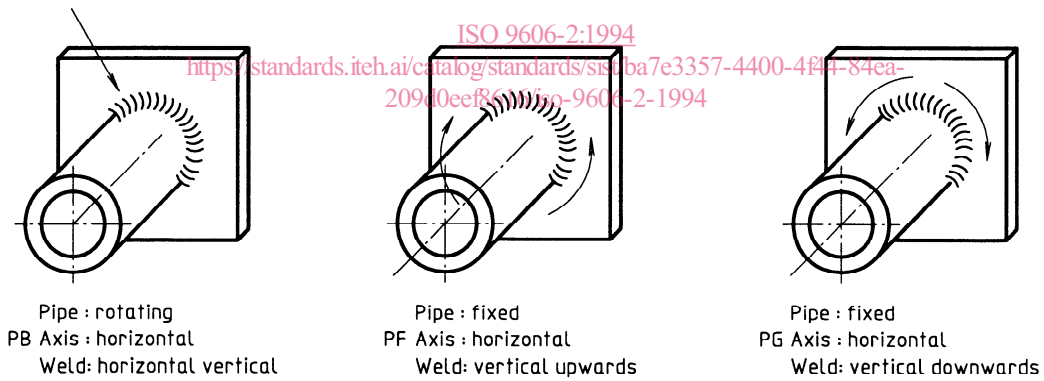


Figure 1 — Welding positions for plates



(a) Butt welds



(b) Fillet welds

Figure 2 — Welding positions for pipes