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

Part 1:
Steels

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Qualification des soudeurs — Soudage par fusion —

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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 9606-1 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*

Annex A forms an integral part of this part of ISO 9606. Annexes B, C and D 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 steels.

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 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 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 9956-3).

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 1: Steels

1 Scope

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

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 D.

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 steels.

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 1106-1:1984, *Recommended practice for radiographic examination of fusion welded joints — Part 1: Fusion welded butt joints in steel plates up to 50 mm thick*.

ISO 1106-2:1985, *Recommended practice for radiographic examination of fusion welded joints — Part 2: Fusion welded butt joints in steel plates thicker than 50 mm and up to and including 200 mm in thickness*.

ISO 1106-3:1984, *Recommended practice for radiographic examination of fusion welded joints — Part 3: Fusion welded circumferential joints in steel pipes of up to 50 mm wall thickness*.

ISO 2560:—¹⁾, *Specification for carbon-manganese steel electrodes for shielded metal arc welding.*

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

ISO 3580:1975, *Covered electrodes for manual arc welding of creep-resisting steels — Code of symbols for identification.*

ISO 3581:1976, *Covered electrodes for manual arc welding of stainless and other similar high alloy steels — Code of symbols for identification.*

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

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

ISO 5817:1992, *Arc-welded joints in steel — Guidance on quality levels for imperfections.*

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

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 electrode holder, welding gun, torch or blowpipe by hand.

1) To be published. (Revision of ISO 2560:1973)

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

3) To be published.

3.1.2 welding operator: Welder who operates welding equipment with partly mechanized relative movement between the electrode holder, welding gun, torch or blowpipe 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.

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

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

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

3.7 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 B).

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 Consumable (including auxiliaries, e.g. shielding gas, flux)

nm	no filler metal
wm	with filler metal
A	acid covering
B	basic covering
C	cellulosic covering
R	rutile covering
RA	rutile-acid covering
RB	rutile-basic covering
RC	rutile-cellulosic covering
RR	rutile thick covering
S	other types

4.4 Miscellaneous

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:

111	metal-arc welding with covered electrode;
114	flux-cored wire metal-arc welding without gas shield;
12	submerged arc welding;
131	metal-arc inert gas welding (MIG welding);
135	metal-arc active gas welding (MAG welding);
136	flux-cored wire metal-arc welding with active gas shield;
141	tungsten inert gas arc welding (TIG welding);
15	plasma arc welding;
311	oxy-acetylene 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 plates (P) or pipes⁴⁾ (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, steels 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 any of the steels in the parent metal group(s).

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 (see 6.4) an approval for the combination as a separate group is required.

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

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 Steel groups of parent metal

For the comparison of steel groups for the approval of welders and welding procedure testing in accordance with ISO 9956-3, see annex A.

Steels are grouped according to parent metal as follows.

5.4.2.1 Group W01

Low-carbon unalloyed (carbon-manganese) steels and/or low alloyed steels.

This group also includes fine-grained structural steel with a yield stress, $R_{eH} \leq 355 \text{ N/mm}^2$.

5.4.2.2 Group W02

Chromium-molybdenum (CrMo) and/or chromium-molybdenum-vanadium (CrMoV) creep-resisting steels.

5.4.2.3 Group W03

Fine-grained structural steels normalized, quenched and tempered as well as thermomechanically treated steels with a yield stress, $R_{eH} > 355 \text{ N/mm}^2$ as well as similarly welded nickel steels, with a nickel content of 2 % to 5 %.

5.4.2.4 Group W04

Ferritic or martensitic stainless steels, with a chromium content of 12 % to 20 %.

5.4.2.5 Group W11

Stainless ferritic-austenitic and austenitic stainless chromium-nickel (CrNi) steels.

5.5 Filler metal, shielding gas and flux

5.5.1 General

It is assumed that in most approval tests the filler metal will be similar to the parent metal. When a welder's test has been carried out using a filler metal,

shielding gas or flux suitable for that material group, this test will confer approval on the welder to use any other similar consumables (filler metal, shielding gas or flux) for the same material group.

5.5.2 Metal-arc welding with covered electrodes

Covered electrode groups are classified with respect to the most important characteristics in accordance with ISO 2560 as follows:

- A acid covering;
- B basic covering;
- C cellulosic covering;
- R rutile covering;
- RA rutile-acid covering;
- RB rutile-basic covering;
- RC rutile-cellulosic covering;
- RR rutile thick covering;
- S others.

NOTE 2 For further details on covered electrodes reference should be made to ISO 2560, ISO 3580 or ISO 3581 according to the steel in question.

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 three 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
$t \leq 3$	t to $2t$ ¹⁾
$3 < t \leq 12$	3 mm to $2t$ ²⁾
$t > 12$	≥ 5 mm

1) For oxy-acetylene welding (311): t to $1,5t$
 2) For oxy-acetylene welding (311): 3 mm to $1,5t$

Table 2 — Test piece diameter and range of approval

Test piece diameter, D ¹⁾ mm	Range of approval
$D \leq 25$	D to $2D$
$25 < D \leq 150$	$0,5D$ to $2D$ (25 mm min.)
$D > 150$	$\geq 0,5D$

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 line.

6.2 Welding process

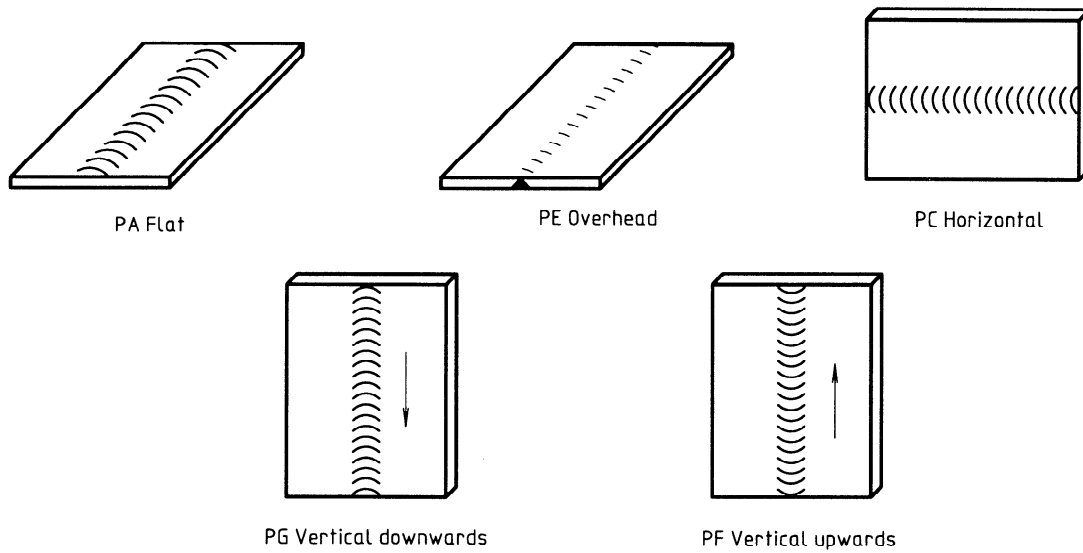
Each test normally approves one process. A change of process requires a new approval test. However, it is possible for a welder to be approved for more than one welding process by a single test or by two separate approval tests to be used to cover a multi-process joint. For example, in a case where approval is required for a single-side butt joint with the root to be welded by TIG (141) without backing and to be filled by metal-arc welding with covered electrode (111), the welder may be approved by either of the following routes:

- a) 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 metal-arc welding with covered electrode (111) within the limits of the range of approval;
- b) 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 metal-arc welding with covered electrode (111) with backing or welded from both sides with or without backing.

6.3 Joint types

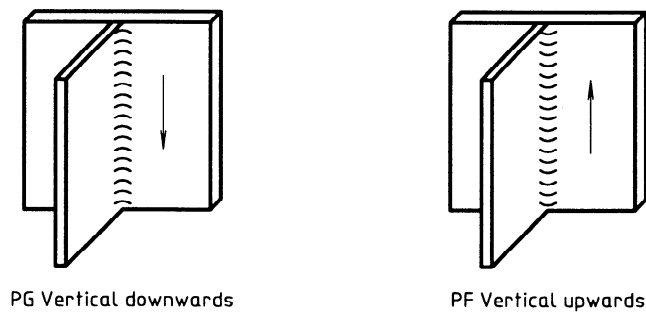
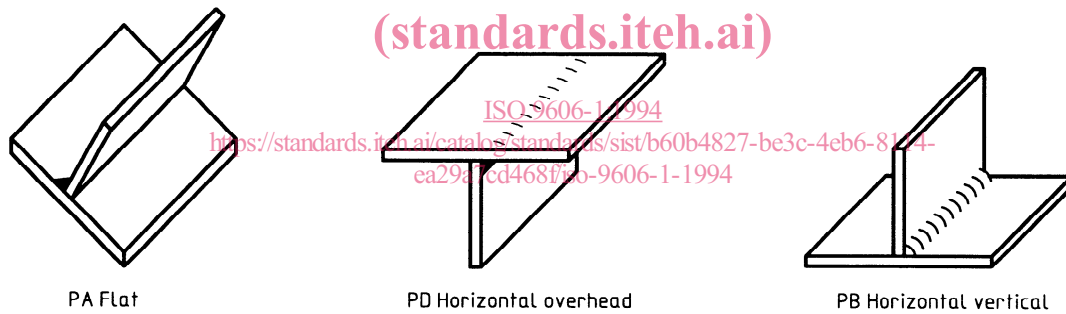
Depending on the piece, the range of welds for which the welder is approved is shown in table 3; the following criteria are applicable:

- a) approval for butt welds in pipes includes butt welds in plates;
- b) approval for butt welds in plates in all relevant positions covers butt welds on pipes having an outside diameter greater than or equal to 500 mm, for rotating pipes item c) applies;
- c) approval on test butt joints in plates welded in the flat (PA) or horizontal (PC) position shall include approval for butt joints in pipes of outside diameter greater than or equal to 150 mm welded in similar positions according to table 7;
- d) welding from one side without backing approves welds from one side with backing and welds from both sides with and without gouging;
- e) welding in plates or pipes with backing approves welds made from both sides, but not for welds without backing;
- f) butt welds approve fillet welds for similar welding conditions;
- g) in cases where the production work is predominantly fillet welding, it is recommended that the welder should be approved also by an appropriate fillet welding test, i.e. on plate, pipe or branch connection (see ISO 9956-3);
- h) welding from both sides without gouging approves welds from one side with backing and welds from both sides with gouging;



a) Butt welds

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b) Fillet welds

Figure 1 — Welding positions for plates