INTERNATIONAL STANDARD

ISO 9606-1

First edition
1994-08-15

Approval testing of welders — Fusion welding —

Part 1: Steels

Qualification des soudeurs — Soudage par fusion —
Partie 1: Aciers

Reference number
ISO 9606-1:1994(E)

Contents

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

Printed in Switzerland

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.

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.

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

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

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

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

3) To be published.

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 pipes[4] (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 W 01

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

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

5.4.2.2 Group W 02

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

5.4.2.3 Group W 03

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

5.4.2.4 Group W 04

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

5.4.2.5 Group W 11

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
$t \leqslant 3$	t to $2t$ [1]
$3 < t \leqslant 12$	3 mm to $2t$ [2]
$t > 12$	$\geqslant 5$ 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
$D \leqslant 25$	D to $2D$
$25 < D \leqslant 150$	$0{,}5D$ to $2D$ (25 mm min.)
$D > 150$	$\geqslant 0{,}5D$

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;

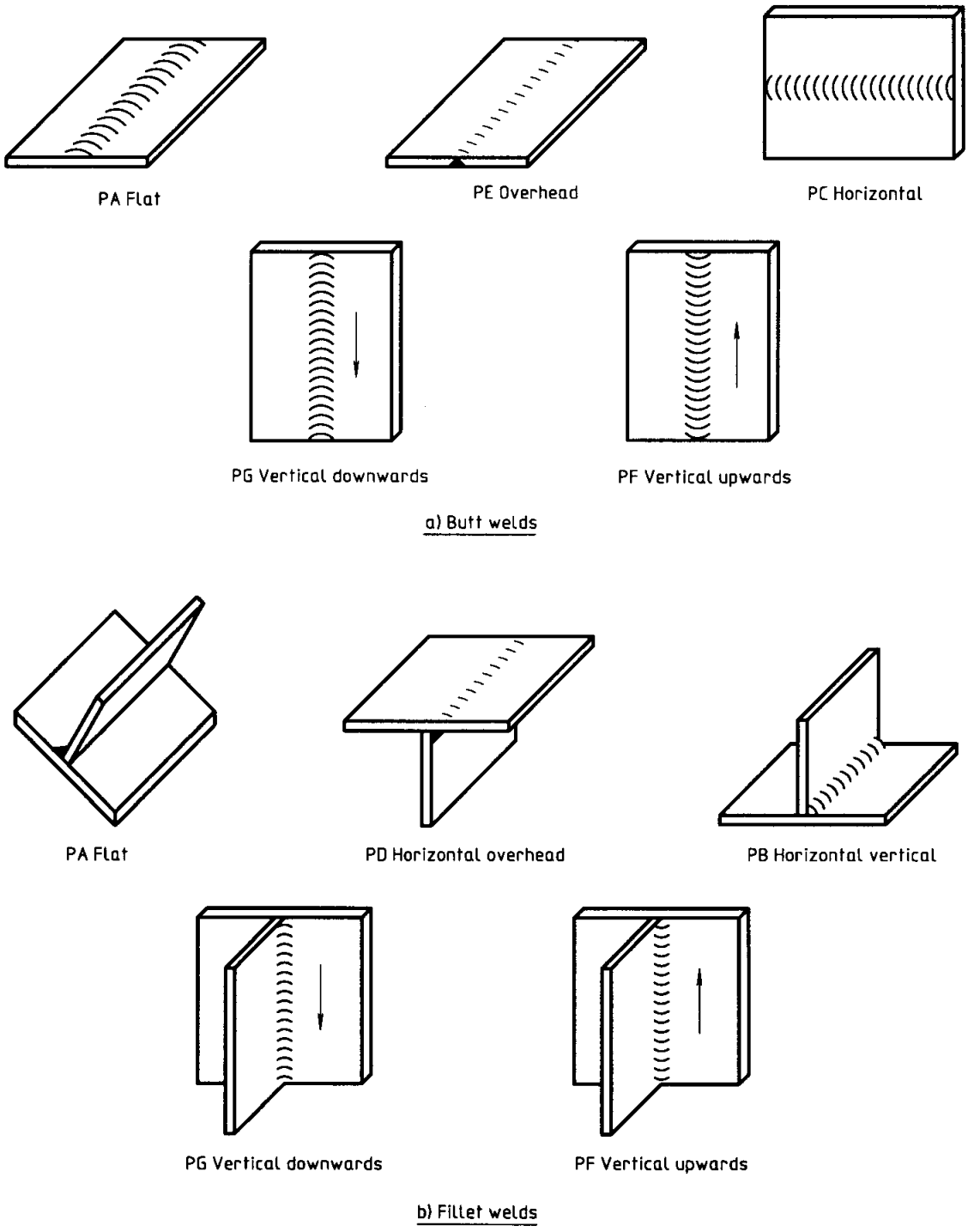
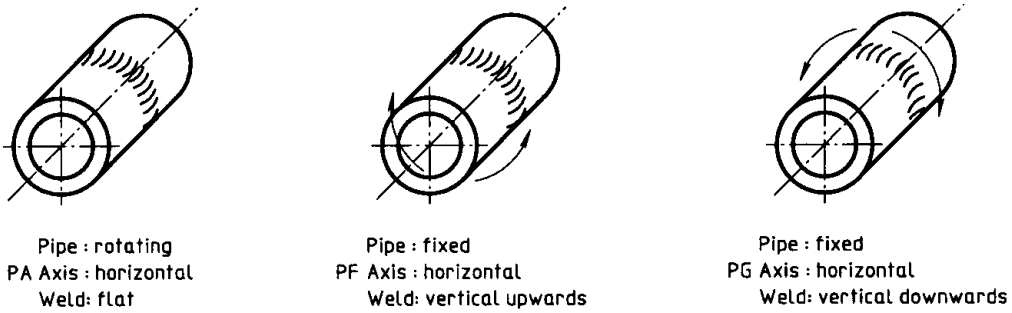


Figure 1 — Welding positions for plates



Pipe : rotating
PA Axis : horizontal
Weld: flat

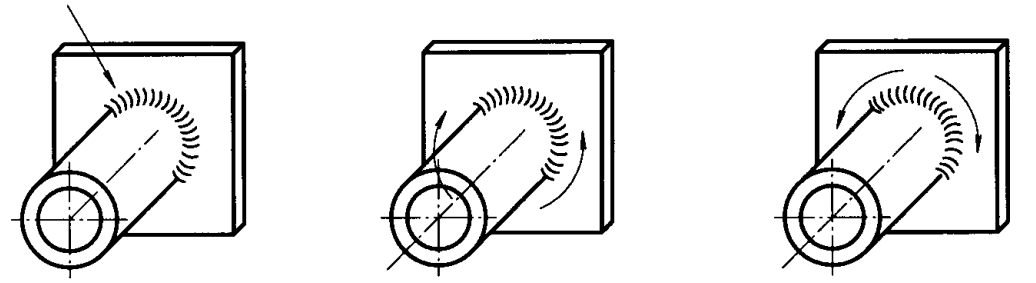
Pipe : fixed
PF Axis : horizontal
Weld: vertical upwards

Pipe : fixed
PG Axis : horizontal
Weld: vertical downwards

Pipe : fixed
PC Axis : vertical
Weld: horizontal

Pipe : fixed
H-L045 Axis : inclined
Weld: upward

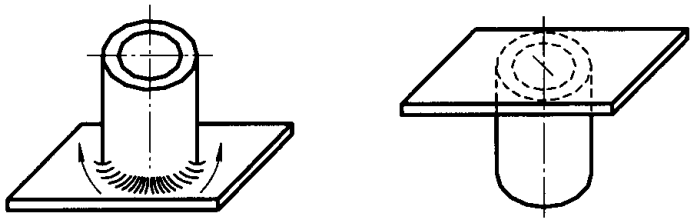
a) Butt welds



Pipe : rotating
PB Axis : horizontal
Weld: horizontal vertical

Pipe : fixed
PF Axis : horizontal
Weld: vertical upwards

Pipe : fixed
PG Axis : horizontal
Weld: vertical downwards



Pipe : fixed
PB Axis : vertical
Weld: horizontal vertical

Pipe : fixed
PD Axis : vertical
Weld: horizontal overhead

b) Fillet welds

Figure 2 — Welding positions for pipes

i) approval for butt welds in pipes without backing includes approval for branch connections within the same range of approval as in tables 3 to 7. For a branch weld, the range of approval is based on the diameter of the branch;

j) in cases where the production work is either predominantly branch welding or involves a complex branch connection, it is recommended that the welder should receive special training. In some cases a welder approval test on a branch connection may be necessary.

6.4 Material groups

According to the material group of the test piece, the range of materials for which a welder is approved is shown in tables 4 and 5 (see 5.4). For any steel not covered by any of the steel groups, the welder shall carry out an approval test which only approves for that steel.

6.5 Covered electrodes

A change in the type of electrode coating may require a change in the welder's technique. An approval test of electrode coating will confer approval of the welder for other coatings as specified in table 6.

6.6 Shielding gas and flux

A change of shielding gas or flux is permitted (see 5.5.1). However, a change from active to inert shielding gas or from inert to active shielding gas requires a new approval test for the welder.

6.7 Dimensions

The range of approval according to plate thickness or wall thickness of pipe and/or pipe diameter is shown in tables 1 and 2.

6.8 Welding positions

The range of approval for each welding position is given in table 7. The welding positions and codes refer to figures 1 and 2 (in accordance with ISO 6947).

Table 3 — Range of approval for tests on butt joints (Details of weld type)

Details of weld type				Range of approval					
				Butt welds in plate				Butt welds in pipe	
				Welded from one side ss		Welded from both sides bs		Welded from one side ss	
				with backing mb	no backing nb	with gouging gg	no gouging ng	with backing mb	no backing nb
Butt weld in plate	Welded from one side ss	with backing	mb	*	—	x	—	1)	—
		no backing	nb	x	*	x	x	1)	1)
	Welded from both sides bs	with gouging	gg	x	—	*	—	1)	—
		no gouging	ng	x	—	x	*	1)	—
Butt weld in pipe	Welded from one side ss	with backing	mb	x	—	x	—	*	—
		no backing	nb	x	x	x	x	x	*

Key
* indicates the weld for which the welder is approved in the approval test
x indicates those welds for which the welder is also approved
— indicates those welds for which the welder is not approved

1) See 6.3 b) and 6.3 c).

Table 4 — Range of approval for parent metal

Material group of approval test piece	Range of approval				
	W01	W02	W03	W04	W11
W01	*	—	—	—	—
W02	x	*	—	—	—
W03	x	x	*	—	—
W04	x	x	—	*	—
W11	x[1)]	x[1)]	x[1)]	x[1)]	*

Key
* indicates the material group for which the welder is approved in the approval test
x indicates those material groups for which the welder is also approved
— indicates those material groups for which the welder is not approved

NOTE — This table applies only when parent metal indicated by * and filler metal are in the same group.

1) When using filler metal from group W11.

Table 5 — Range of approval for dissimilar joints

Material group of approval test piece	Range of approval
W02	W02 welded to W01[1)]
W03	W02 welded to W01[1)] W03 welded to W01[1)] W03 welded to W02[1)]
W04	W02 welded to W01[1)] W04 welded to W01[1)] W04 welded to W02[1)]
W11	W11 welded to W01[2)] W11 welded to W02[2)] W11 welded to W03[2)] W11 welded to W04[2)]

1) For a dissimilar metal joint the filler metal shall correspond to the group of one of the parent metals.

2) When using filler metal from material group W11.

Table 6 — Range of approval for electrode coating

Type of covered electrodes of approval test piece	Range of approval				
	A; RA	R; RB; RC; RR	B	C	S
A; RA	*	—	—	—	—
R; RB; RC; RR	x	*	—	—	—
B	x	x	*	—	—
C	—	—	—	*	—
S[1)]	—	—	—	—	*

Key
* indicates the covered electrode type for which the welder is approved in the approval test
x indicates those electrode groups for which the welder is also approved
— indicates those electrode groups for which the welder is not approved

1) S only gives approval for the specific type of electrode coating used in the test.

Table 7 — Range of approval according to welding position

Welding position of approval test piece					Range of approval																		
					Plates										Pipes								
					Butt welds					Fillet welds					Butt welds Pipe-axis and -angle					Fillet welds			
															rotating	fixed			1)	fixed			
																0°		90°	45°		0°		90°
					PA	PC	PG	PF	PE	PA	PB	PG	PF	PD	PA	PG	PF	PC	H-L045	PB	PG	PF	PD2)
Plates	Butt welds			PA	*	—	—	—	—	x	x	—	—	—	x	—	—	—	—	x	—	—	—
				PC	x	*	—	—	—	x	x	—	—	—	x	—	—	x	—	x	—	—	—
				PG	—	—	*	—	—	—	—	x	—	—	—	—	—	—	—	—	—	—	—
				PF	x	—	—	*	—	x	x	—	x	—	x	—	—	—	—	x	—	x	—
				PE	x	x	—	x	*	x	x	—	x	x	x	—	—	—	—	x	—	x	x
	Fillet welds			PA	—	—	—	—	—	*	—	—	—	—	—	—	—	—	—	—	—	—	—
				PB	—	—	—	—	—	x	*	—	—	—	—	—	—	—	—	x	—	—	—
				PG	—	—	—	—	—	—	—	*	—	—	—	—	—	—	—	—	—	—	—
				PF	—	—	—	—	—	x	x	—	*	—	—	—	—	—	—	x	—	—	—
				PD	—	—	—	—	—	x	x	—	x	*	—	—	—	—	—	x	—	—	x
Pipes	Butt welds Pipe-axis and -angle	rotating	0°	PA	x	—	—	—	—	x	x	—	—	—	*	—	—	—	—	x	—	—	—
		fixed	0°	PG	—	—	x	—	—	—	—	x	—	—	—	*	—	—	—	—	x	—	—
				PF	x	—	—	x	x	x	x	—	x	x	x	—	*	—	—	x	—	x	x
			90°	PC	x	x	—	—	—	x	x	—	—	—	x	—	—	*	—	x	—	—	—
			45°	H-L045	x	x	—	x	x	x	x	—	x	x	x	—	x	x	*	x	—	x	x
	Fillet welds Pipe-axis and -angle	1)	0°	PB	—	—	—	—	—	x	x	—	—	—	—	—	—	—	—	*	—	—	—
		fixed		PG	—	—	—	—	—	—	—	x	—	—	—	—	—	—	—	—	*	—	—
				PF	—	—	—	—	—	x	x	—	x	x	—	—	—	—	—	x	—	*	x

Key

* indicates the welding position for which the welder is approved in the approval test
x indicates those welding positions for which the welder is also approved
— indicates those welding positions for which the welder is not approved

1) PB for pipes may be welded in two versions

a) pipe: rotating; axis: horizontal; weld: horizontal vertical
b) pipe: fixed; axis: vertical; weld: horizontal vertical

2) This is an approved position and is covered by the other related tests.

7 Examination and testing

7.1 Supervision

The welding and testing of test pieces shall be witnessed by an examiner or test body acceptable to the contracting parties: they may be members of a manufacturing company or of the purchaser or of a third party.

The test pieces shall be marked with the identification of the examiner and the welder before welding starts.

The examiner or test body may stop the test if the welding conditions are not correct or if it appears that the welder does not have the technical competence to achieve the required standard, e.g. where there are excessive and/or systematic repairs.

7.2 Shape and dimensions of test pieces

The shape and dimensions of test pieces (see 5.6) shall be as shown in figures 3 to 6.

7.3 Welding conditions

The approval test for the welder shall correspond to the conditions used in production and follow a WPS (see 3.4) prepared in accordance with ISO 9956-2. A format for the WPS is given in annex C.

When preparing the WPS, the following conditions shall apply:

a) the test shall be carried out with the welding process(es) to be used in production;

b) filler metal(s) shall be compatible for the particular welding process(es) and position(s);

c) the edge preparation of plates and/or pipes for the test piece shall be representative of that to be used in production;

d) the dimensions of the test piece shall be specified in the tables and figures in this part of ISO 9606 (see tables 1 and 2 and figures 3 to 6);

e) the welding equipment should be similar to that used in production;

f) the welding shall be carried out in the position(s) and angle(s) of branch connections normally used in production (see figures 1 and 2);

g) the combination of parent metal, filler metal and any auxiliary materials shall correspond to the conditions used in production;

h) the weld shall be assessed in accordance with clause 8;

i) the welding time for the test piece shall correspond to the working time under usual production conditions;

j) the test piece shall have at least one stop and one restart in the root run and in the top capping run and be identified in the inspection length to be examined;

k) any preheat or controlled heat input required in the WPS is mandatory for the welder's test piece;

l) any postweld heat treatment required in the WPS may be omitted unless bend tests are required;

m) identification of the test piece;

n) the welder shall be allowed to remove minor imperfections, except on the surface layer, by grinding, gouging or any other method used in production. The approval of the examiner or test body shall be obtained.

7.4 Test methods

Each completed weld shall be examined visually in the as-welded condition. When required (see table 8), visual examination can be supplemented by magnetic particle, dye penetrant (see ISO 3452) or other test methods, and macro tests on butt welds.

If accepted by visual inspection, additional radiographic, fracture tests and/or macro tests are required (see table 8).

The macro specimen shall be prepared and etched on one side to clearly reveal the weld.

When radiography is used, bend tests shall always be applied to butt welds made by MIG/MAG (131, 135) or by oxy-acetylene (311) processes.

Prior to mechanical testing, backing strips, where used, shall be removed. The test piece can be sectioned by thermal cutting or by mechanical means discarding the first and last 25 mm of the test piece at the end of the plates (figures 7 and 8).

Dimensions in millimetres

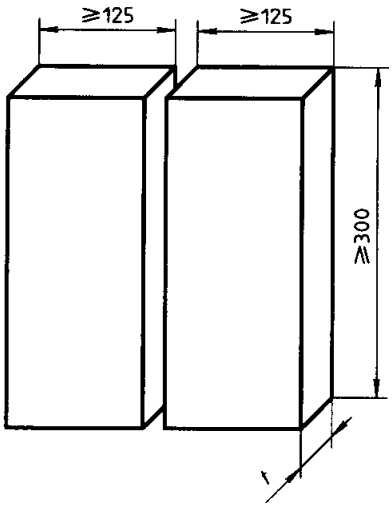


Figure 3 — Dimensions of test piece for a butt weld in plate

Dimensions in millimetres

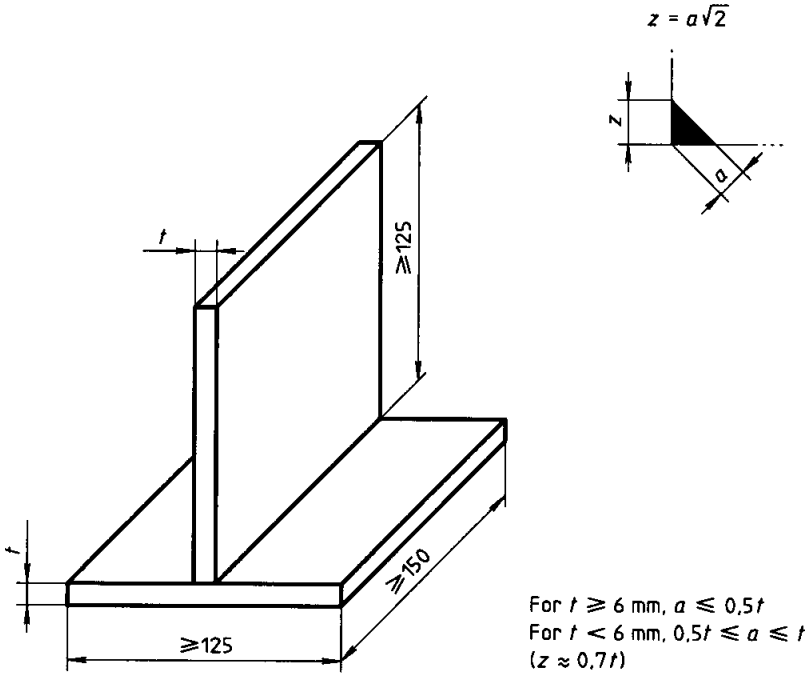


Figure 4 — Dimensions of test piece for fillet weld(s) on plate

Dimensions in millimetres

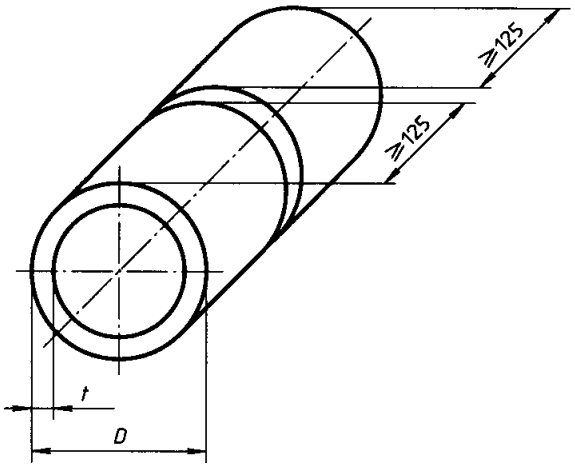


Figure 5 — Dimensions of test piece for a butt weld in pipe

Dimensions in millimetres

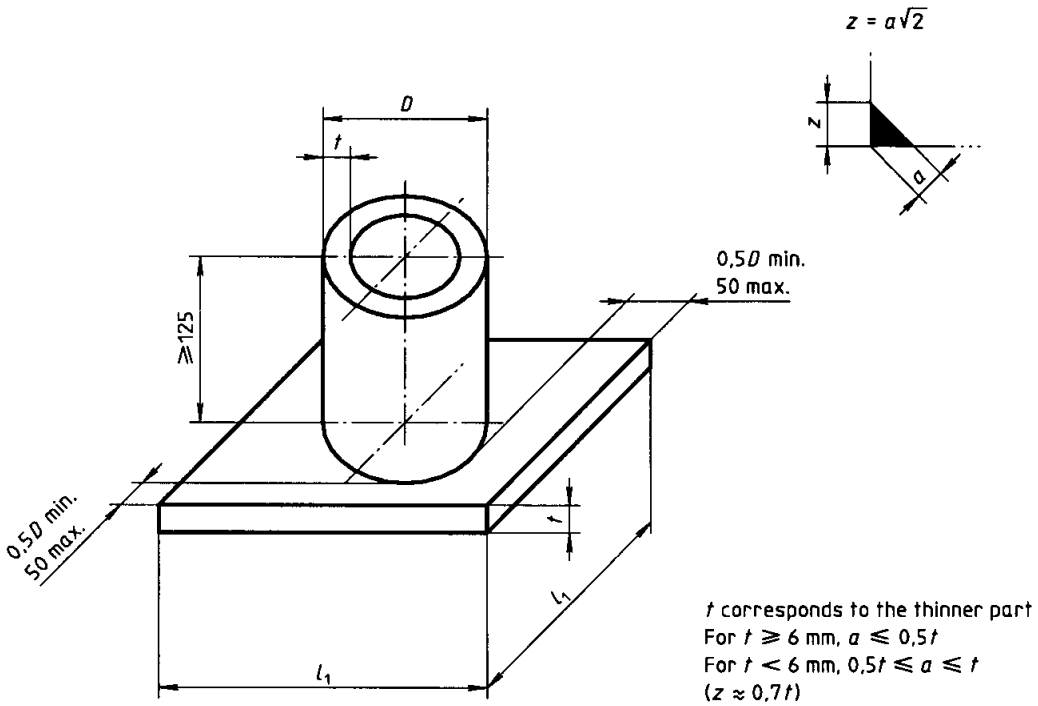


Figure 6 — Dimensions of test piece for a fillet weld on pipe

Table 8 — Test methods

Test method	Butt weld plate	Butt weld pipe	Fillet weld
Visual	*	*	*
Radiography	*1) 2)	*1) 2)	—
Bend	*3)	*3)	—
Fracture	*1)	*1)	*4) 5)
Macro (without polishing)	—	—	*5)
Magnetic particle dye penetrant	—	—	—

Key
* indicates that the test method is mandatory
— indicates that the test method is not mandatory

1) Radiography or fracture test shall be used, but not both.

2) The radiographic test may be replaced by an ultrasonic test for thickness greater than or equal to 12 mm on ferritic steels only.

3) When radiography is used, then additional bend tests are mandatory for the processes 131, 135 and 311.

4) The fracture test should be supported by magnetic-particle/dye-penetrant testing when required by the examiner or test body.

5) The fracture test may be replaced by a macro examination of at least four sections.

7.5 Test piece and test specimens

7.5.1 General

In 7.5.2 to 7.5.5, details of the type, dimensions and preparation of test pieces and test specimens are given. In addition, the requirements for mechanical tests are indicated.

7.5.2 Butt welds in plate

When radiography is used, the whole inspection length of the weld in the test pieces shall be radiographed in the as-welded condition in accordance with ISO 1106-1 or ISO 1106-2 using class B technique.

When fracture testing is used, the full test piece inspection length shall be tested and to do this, the test piece shall be cut into several test specimens [see figure 7 a)]. The length of any fracture test specimen shall be approximately 40 mm. If necessary, the weld reinforcement of the test specimen may be removed and additionally the weld edges may be notched to a depth of approximately 5 mm to facilitate fracture in the weld metal [see figure 7 b)]. In the case of single-sided welding (ss) without backing (nb), half of the inspection length shall be tested against the face side and the other half against the root side [see figures 7 c) and 7 d)].

When transverse bend testing is used for plate thickness as greater than or equal to 3 mm, two root bend test specimens and two face bend test specimens shall be tested in accordance with ISO 5173. The diameter of the former or the inner roller shall be $4t$ and the bending angle 120° unless the low ductility of the parent metal or filler metal imposes other limitations.

For plate thicknesses greater than or equal to 12 mm, the transverse bend tests may be substituted by four side bend tests in accordance with ISO 5173.

7.5.3 Fillet weld on plate

For fracture tests the test piece may be cut, if necessary, into several test specimens [see figure 8 a)]. Each test specimen shall be positioned for breaking as shown in figure 8 b), and examined after fracture.

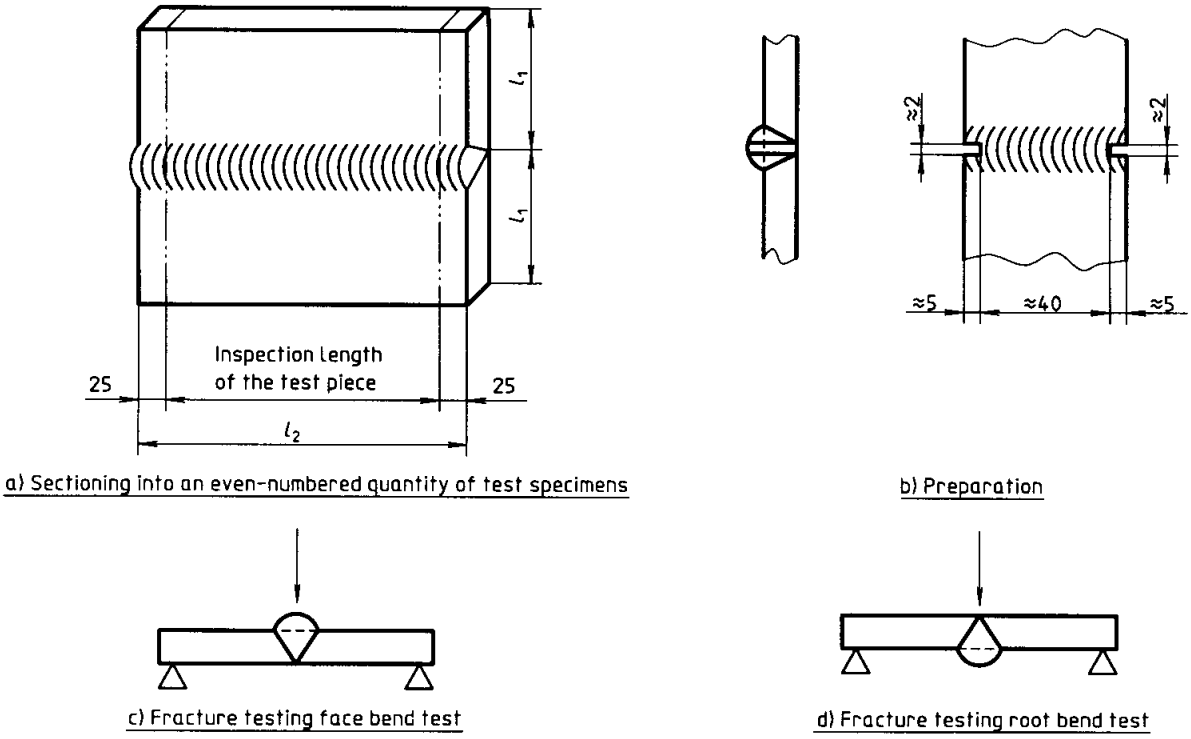
When macro examination is used, four test specimens shall be taken equally spaced in the inspection length.

7.5.4 Butt weld in pipe

When radiography is used, the whole inspection length of the weld in the test piece shall be radiographed in the as-welded condition in accordance with ISO 1106-3 using class B technique.

When fracture testing is used, the full test piece inspection length shall be tested and to do this the test shall be cut into at least four test specimens [see figure 9 a)].

Dimensions in millimetres



a) Sectioning into an even-numbered quantity of test specimens

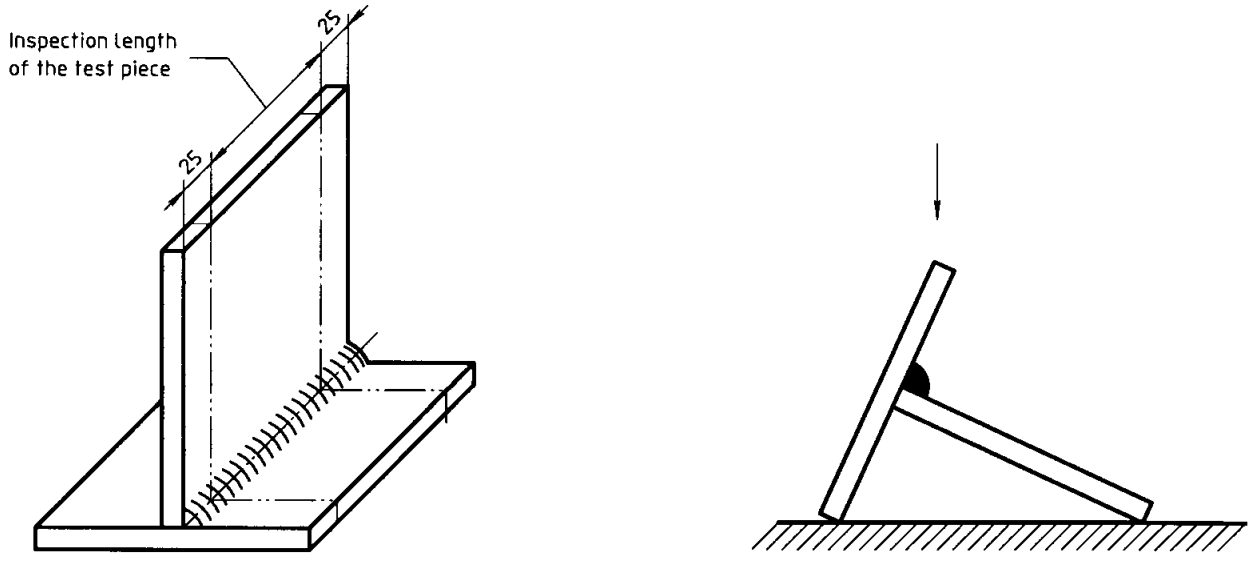
b) Preparation

c) Fracture testing face bend test

d) Fracture testing root bend test

Figure 7 — Preparation and fracture testing of test specimens for a butt weld in plate

Dimensions in millimetres



Note - The fillet weld may be notched if necessary.

a) Sectioning into an even-numbered quantity of test specimens

b) Fracture testing

Figure 8 — Preparation and fracture testing of test specimens for a fillet weld on plate

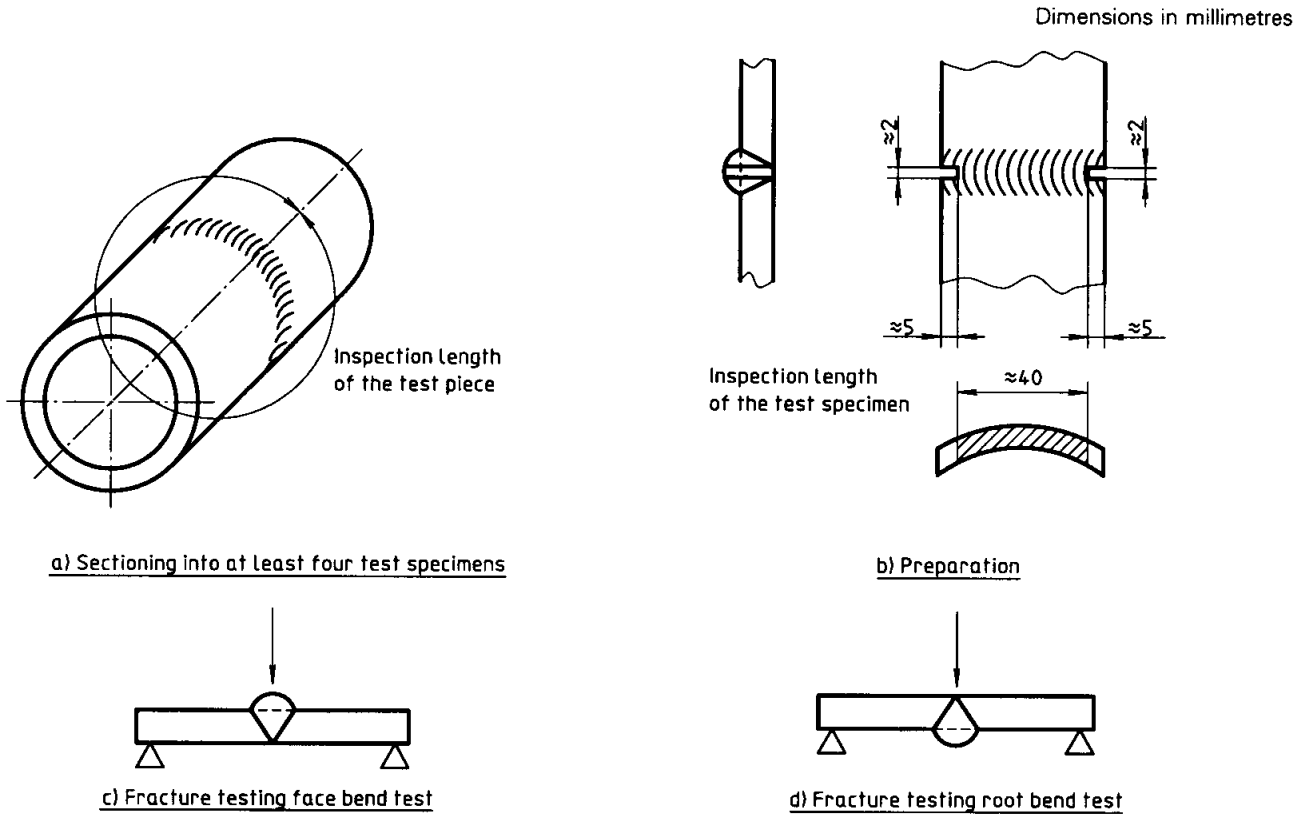


Figure 9 — Preparation and fracture testing of test specimens for a butt weld in pipe

If the pipe diameter is too small for testing, two or more test pieces shall be welded.

The inspection length of any test specimen shall be approximately 40 mm. If necessary, the weld reinforcement of the test specimen may be removed and additionally the weld edges may be notched to a depth of approximately 5 mm to facilitate fracture in the weld metal [see figure 9 b)]. In the case of single-side welding (ss) without backing (nb, ng), half of the inspection length of the test piece [see figure 9 a)] shall be tested against the face side and the other half against the root side [see figures 9 c) and 9 d)].

When transverse bend testing is used for wall thicknesses greater than or equal to 3 mm, two root bend test specimens and two face bend test specimens shall be tested in accordance with ISO 5173. The diameter of the former or the inner roller shall be $4t$ and the bending angle 120° unless the low ductility of the parent metal or filler metal imposes other limitations.

For the sectioning of test pieces welded in position PF, PG and H-L045 (see figure 2), test specimens shall be taken from different welding positions.

For wall thicknesses greater than or equal to 12 mm, the transverse bend tests may be substituted by four side bend tests in accordance with ISO 5173.

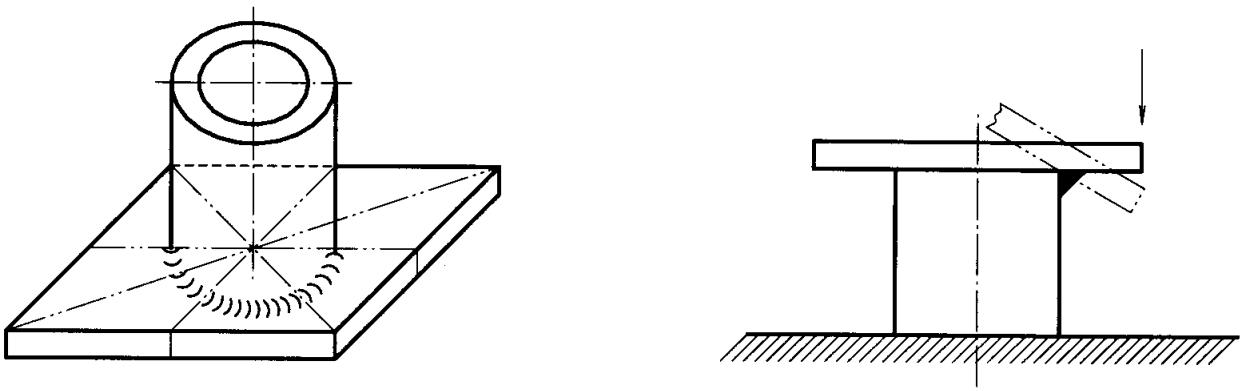
7.5.5 Fillet weld on pipe

For fracture tests, the test piece shall be cut into four or more test specimens and fractured (see figure 10).

When macro examination is used, at least four test specimens shall be taken equally spaced around the pipe.

8 Acceptance requirements for test pieces

Test pieces shall be evaluated according to the acceptance requirements specified for relevant types of imperfections. A full explanation of these imperfections is given in ISO 6520. The acceptance requirements for imperfections found by test methods in accordance with this part of ISO 9606 shall, unless otherwise specified, be assessed in accordance with ISO 5817. A welder is approved if the imperfections in the test piece are within the specified limits of level B in ISO 5817, except for imperfection types as fol-



a) Sectioning into test specimens

b) Fracture testing

Figure 10 — Preparation and fracture testing of test specimens for a fillet weld on pipe

lows: excess weld metal, excessive convexity, excess throat thickness and excessive penetration, for which level C shall apply.

If the imperfections in the welder's test piece exceed the permitted maximum specified, then the welder shall not be approved.

Reference should also be made to the corresponding acceptance criteria for nondestructive examination. Specified procedures shall be used for all desctructive and nondesctructive examinations.

9 Re-tests

9.1 General

If any test piece fails to comply with the requirements of this part of ISO 9606, the welder shall produce a new test piece.

If it is established that failure is attributed to the welder's lack of skill, the welder shall be regarded as incapable of complying with the requirements of this part of ISO 9606 without further training before re-testing.

If it is established that failure is due to metallurgical or other extraneous causes and cannot be directly attributed to the welder's lack of skill, an additional test is required in order to assess the quality and integrity of the new test material and/or new test conditions.

9.2 Additional test specimens

9.2.1 If a bend test specimen fails, two additional test specimens may be sectioned either from the same test piece, if there is sufficient material available or, if necessary, from an additional test piece and subjected to the same tests. Both test specimens shall be satisfactory.

9.2.2 If a fracture test specimen shows unacceptable imperfections, two additional test specimens may be sectioned as specified in 9.2.1.

9.2.3 If one of these additional test specimens in accordance with 9.2.1 and 9.2.2 does not comply with the requirements of this part of ISO 9606, the cause of failure shall be established.

9.2.4 If a bend or fracture test specimen from a pipe welded with fixed axis fails, two additional test specimens shall be taken from the equivalent position.

9.2.5 If a macro section is unacceptable, two additional test specimens may be sectioned as specified in 9.2.1 to 9.2.4.

10 Period of validity

10.1 Initial approval

The validity of the welder's approval begins from the date when all the required tests are satisfactorily completed. This date may be different to the date of issue marked on the certificate.

A welder's approval shall remain valid for a period of two years providing that the relevant certificate is signed at six-month intervals by the employer/coordinator and that all the following conditions are fulfilled:

a) The welder shall be engaged with reasonable continuity on welding work within the current range of approval. An interruption for a period no longer than six months is permitted;

b) The welder's work shall be in general accordance with the technical conditions under which the approval test is carried out;

c) There shall be no specific reason to question the welder's skill and knowledge.

If any of these conditions are not fulfilled, the approval shall be cancelled.

10.2 Prolongation

The validity of the approval on the certificate may be prolonged for further periods of two years, within the original range of approval, provided each of the following conditions in accordance with 10.1 are fulfilled:

a) the production welds made by the welder are of the required quality;

b) records of tests, e.g. documentation about X-ray or ultrasonic inspections or test reports about fracture test or comments of the appointed coordinators, shall be maintained on file with the welder's approval certificate.

The examiner or test body shall verify compliance with the above conditions and sign the prolongation of the welder's approval test certificate.

11 Certification

It shall be certified that the welder has successfully passed the performance approval test. All relevant test conditions shall be recorded on the certificate. If the welder fails any of the prescribed tests, no certificate shall be issued.

The certificate shall be issued under the sole responsibility of the examiner or test body and shall contain all the information detailed in annex B. The format of annex B is recommended to be used as the welder's approval test certificate.

If any other form of welder's approval test certificate is used, it shall contain the information required in annex A. The manufacturer's WPS as shown in annex C shall give information about materials, welding positions, processes and range of approval etc., in accordance with this part of ISO 9606.

The welder's approval test certificate shall be issued in at least one of the official ISO languages (English, French and Russian).

The practical test and the examination of job knowledge (see annex D) shall be designated by "Accepted" or "Not tested".

Each change of the essential variables for the approval testing beyond the permitted ranges requires a new test and a new approval certificate.

12 Designation

The designation of a welder approval shall comprise the following items in the order given (the system is arranged so that it can be used for computerization):

— reference to this part of ISO 9606;

— the essential variables:

- welding processes: see 5.2 and ISO 4063;
- semifinished product: plate (P), pipe (T), see 5.3;
- joint-type: butt weld (BW), fillet weld (FW), see 5.3;
- material group: see 5.4;
- filler metal: see 5.5;
- size of test piece: thickness (t) and pipe diameter (D), see 5.6;
- welding positions: see 5.7, figures 1 and 2 and ISO 6947;
- details of the weld type: see 6.3 and table 5, for abbreviations to 4.4.

The designation, where used for computerization, shall be in the following format:

"xxx xxxxxx", "xxx", "x", "xx", "xxx", "xx", "xxx", "xxxx", "xxxxxx", "xx", "xx"

EXAMPLES

"ISO 9606-1", "111", "P", "BW", "W11", "RB", "t10", "D200", "H-L045", "ss", "nb"

followed by further elements of the details of the weld type in the order as given in clause 4, separated by ",". These elements are not part of the computer record.

Designation example 1

Welder approval ISO 9606-1 111 P BW W11 B t09 PF ss nb

Explanation

Welding process: metal-arc welding with covered electrode	111
Plate:	P
Butt weld:	BW
Material group: austenitic steel	W11
Filler metal: basic covering	B
Dimension of test piece: thickness 9 mm	t09
Welding position: butt weld on plate, vertical upwards	PF
Details of the weld type:	
single side	ss
without backing	nb

Designation example 2

Welder approval ISO 9606-1 311 T BW W01 nm t02 D20 PA ss nb

Explanation

Welding process: oxy-acetylene welding	311
Pipe:	T
Butt weld:	BW
Material group: low-carbon alloyed steel	W01
Filler metal: no filler metal	nm
Dimension of test piece:	
thickness 2 mm	t02
pipe diameter 20 mm	*D*20
Welding position: butt weld on pipe, horizontal axis, flat	PA
Details of the weld type:	
single side	ss
without backing	nb

NOTE 3 For explanation of abbreviations used in the designation examples, see clause 4.

Annex A
(normative)

Comparison of steel groups

Comparison of steel groups in this part of ISO 9606 welder approval with the steel groups in the welding procedure standard ISO 9956-3.

Steel groups	
Welder approval	**Welding procedure in accordance with ISO 9956-3**
W 01	1
W 02	4, 5, 6
W 03	2, 3, 7 steel with a nickel content $5 < Ni\ \% \leqslant 9$ not included[1)]
W 04	8
W 11	9

1) Special welder's approval is required (see 6.4).

Annex B
(informative)

Welder approval test certificate

Designation: .....

Manufacturer's welding procedure specification reference No. (if applicable):

Examiner or test body reference No.

Welder's name:

Identification:

Method of identification:

Date and place of birth:

Employer:

Code/Testing standard:

Photograph
(if required)

Job knowledge: Acceptable/Not tested (Delete as necessary)

	Weld test details	Range of approval
Welding process		
Plate or pipe		
Joint type		
Parent metal group(s)		
Filler metal type/Designation		
Shielding gases		
Auxiliaries		
Test piece thickness (mm)		
Pipe outside diameter (mm)		
Welding position		
Gouging/backing		

Additional information is available on attached sheet and or welding procedure specification No.:

Type of test	Performed and acceptable	Not required
Visual		
Radiography		
Magnetic particle/		
Dye penetrant		
Macro		
Fracture		
Bend		
Additional tests[1)]		
1) Append separate sheet if required		

Prolongation for approval by examiner or test body for the following 2 years (refer to 10.2)

Date	Signature	Position or title

Name, date and signature

Examiner or test body

Date of issue

Location

Validity of approval until

Prolongation for approval by employer/coordinator for the following 6 months (refer to 10.2)

Date	Signature	Position or title

Annex C
(informative)

Manufacturer's welding procedure specification (WPS) [see ISO 9956-2]

Location:

Examiner or test body:

Manufacturer's welding procedure reference No.:

WPAR No.:

Method of preparation and cleaning:

Parent material specification:

Manufacturer:

Welder's name:

Welding process:

Material thickness (mm):

Joint type:

Outside diameter (mm):

Weld preparation details (sketch)*):

Welding position:

Joint design	Welding sequences

Welding details

Run	Process	Size of filler metal	Current A	Voltage V	Type of current/polarity	Wire feed speed	Travel speed[1)]	Heat input[1)]

1) If required.

*) If required.

Filler metal classification and tradename:

Any special baking or drying:

Gas/flux:

shielding:

backing:

Gas flowrate:

shielding:

backing:

Tungsten electrode type size:

Details of back gouging backing:

Preheat temperature:

Interpass temperature:

Postweld heat treatment and/or ageing:

Time, temperature, method:

Heating and cooling rates:*)

Other information:*)

e.g. weaving (maximum width of run):

Oscillation: amplitude, frequency, dwell time:

Pulse welding details:

Standoff distance:

Plasma welding details:

Torch angle:

Manufacturer

Name, date and signature

Examiner or test body

Name, date and signature

Annex D
(informative)

Job knowledge

D.1 General

The testing of job knowledge is recommended, but it is not mandatory.

However, some countries require that the welder undergoes a job knowledge test. If the job knowledge test is carried out, it should be recorded on the welder's certificate.

This annex outlines the job knowledge that a welder should have to ensure that procedures are followed and common practices are complied with. The job knowledge indicated in this annex is only pitched at the most basic level.

Owing to different training programmes in various countries, it is only proposed to standardize general objectives or categories of job knowledge. The actual questions used should be drawn up by the individual country, but should include questions on areas covered in D.2, relevant to the welder approval test.

The actual tests of a welder's job knowledge may be given by any of the following methods or combinations of these methods:

a) written objective tests (multiple choice);

b) oral questioning following a set of written questions;

c) computer testing;

d) demonstration/observation testing following a written set of criteria.

The test of job knowledge is limited to the matters related to the welding process used in the test.

D.2 Requirements

D.2.1 Welding equipment

D.2.1.1 Oxy-acetylene welding

a) Identification of gas cylinders;

b) Identification and assembly of essential components;

c) Selection of correct nozzles and welding torches.

D.2.1.2 Arc welding

a) Identification and assembly of essential components and equipment;

b) Type of welding current;

c) Correct connection of the welding return cable.

D.2.2 Welding process

D.2.2.1 Oxy-acetylene welding (311)

a) Gas pressure;

b) Selection of nozzle size;

c) Type of gas flame;

d) Effect of overheating.

D.2.2.2 Metal-arc welding with covered electrode (111)

a) Handling and drying of electrodes;

b) Differences of types of electrodes.

D.2.2.3 Shielded metal-arc welding (114, 131, 135, 136, 141, 15)

a) Types and size of electrodes;

b) Identification of shielding gas and flowrate (without 114);

c) Type, size and maintenance of nozzles/contact tip;

d) Selection and limitations of mode of metal transfer;

e) Protection of the welding arc from draughts.

D.2.2.4 Submerged arc welding (12)

a) Drying, feeding and correct recovery of flux;

b) Correct alignment and travel of welding head.

D.2.3 Parent metals

a) Identification of material;

b) Methods and control of pre-heating;

c) Control of interpass temperature.

D.2.4 Consumables

a) Identification of consumables;

b) Storage, handling and conditions of consumables;

c) Selection of correct size;

d) Cleanliness of electrodes and filler wires;

e) Control of wire spooling;

f) Control and monitoring of gas flowrates and quality.

D.2.5 Safety and accident prevention

D.2.5.1 General

a) Safe assembly, setting up and closing down procedures;

b) Safe control of welding fumes and gases;

c) Personal protection;

d) Fire hazards;

e) Welding in confined spaces;

f) Awareness of welding environment.

D.2.5.2 Oxy-acetylene welding

a) Safe storage, handling and use of compressed gases;

b) Leak detection on gas hoses and fittings;

c) Procedure to be taken in the event of a flashback.

D.2.5.3 All arc processes

a) Environment of increased hazard of electric shock;

b) Radiation from the arc;

c) Effects of stray arcing.

D.2.5.4 Shielded gas arc welding

a) Safe storage, handling and use of compressed gases;

b) Leak detection on gas hoses and fittings.

D.2.6 Welding sequences/procedures

Appreciation of welding procedure requirements and the influence of welding parameters.

D.2.7 Edge preparation and weld representation

a) Conformance of weld preparation to procedure specification (WPS);

b) Cleanliness of fusion faces.

D.2.8 Weld imperfections

a) Identification of imperfections;

b) Causes;

c) Prevention and remedial action.

D.2.9 Welder approval

The welder shall be aware of the range of the approval.