INTERNATIONAL STANDARD

ISO 15614-11

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Specification and qualification of welding procedures for metallic materials — Welding procedure test —

Part 11: Electron and laser beam welding

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

Partie 11: Soudage par faisceau d'électrons et par faisceau laser

Reference number
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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.

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

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this part of ISO 15614 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15614-11 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, *Unification of requirements in the field of metal welding*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this document, read "...this European Standard..." to mean "...this International Standard...".

ISO 15614 consists of the following parts, under the general title *Specification and qualification of welding procedures for metallic materials — Welding procedure test*:

— *Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*

— *Part 2: Arc welding of aluminium and its alloys*

— *Part 3: Arc welding of cast iron*

— *Part 4: Arc welding of aluminium castings*

— *Part 5: Arc welding of titanium, zirconium and their alloys*

— *Part 6: Arc welding of copper and copper alloys*

— *Part 7: Corrosion resistant overlay, cladding restore and hardfacing*

— *Part 8: Welding of tubes to tube-plate joints*

— *Part 9: Arc underwater hyperbaric wet welding*

— *Part 10: Underwater hyperbaric dry welding*

— *Part 11: Electron and laser beam welding*

— *Part 12: Spot, seam and projection welding*

— *Part 13: Flash and butt welding*

Annex ZA forms a normative part of this part of ISO 15614. Annex A is for information only.

Annex ZA provides a list of corresponding International and European Standards for which equivalents are not given in the text.

For the purposes of this part of ISO 15614, the CEN annex regarding fulfilment of European Council Directives has been removed.

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Foreword

This document (EN ISO 15614-11:2002) has been prepared by Technical Committee CEN/TC 121 "Welding", the secretariat of which is held by DS, in collaboration with Technical Committee ISO/TC 44 “Welding and allied processes".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2002, and conflicting national standards shall be withdrawn at the latest by September 2002.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

Annex A is informative. Annex ZA is normative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard : Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

Qualification of welding procedures serves to demonstrate that production operations fully comply with the agreed welding procedure including preliminary and subsequent treatment.

Before a particular welding procedure is used in a production operation, the manufacturer should determine and document the suitability of the Welding Procedure Specification (WPS) to produce a weld of the required quality.

To date the suitability of welding procedures has been established for weldments as part of the quality assurance activity. Until now, establishing the suitability of welding procedures by weld procedure testing was carried out and documented only for weldments involving safety and the public interest. The European harmonization of the provision for welding procedure tests is currently being sought by means of European Standards. In this way greater confidence will be generated for the customer by the manufacturer.

The proofs also serve as the basis for the mutual recognition of performance reached by the relevant authorities. In this standard, the term "welding procedure" comprises all the activities which influence the welding result, such as preparation, welding parameters, post treatment and reworking.

1 Scope

This European Standard specifies how a welding procedure specification for electron or laser beam welding is qualified by a welding procedure test.

This standard is a part of a series of standards, details of this series are given in prEN ISO 15607, annex A.

It defines the conditions for the execution of welding procedure qualification tests and the limits of validity of a qualified welding procedure for all practical welding operations within the range of variables listed in clause 8.

Tests shall be carried out in accordance with this standard together with additional tests when specified.

This standard applies to metallic materials, irrespective of the shape of the parts, their thicknesses, manufacturing method (rolling, forging, casting, sintering, etc.) and their heat treatment. It covers unlimitedly the production of new parts and repair work.

2 Normative references

This European 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 571-1, *Non destructive testing — Penetrant testing — Part 1 : General principles.*

EN 895, *Destructive tests on welds in metallic materials — Transverse tensile test.*

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

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

EN 1043-2, *Destructive test on welds in metallic materials — Hardness test — Part 2: Micro hardness testing on welded joints.*

EN 1290, *Non-destructive examination of welds — Magnetic particle examination of welds.*

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 ISO 6947, *Welds — Working positions — Definitions of angles of slope and rotation (ISO 6947:1993).*

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

prEN ISO 15609-3:2000,*Specification and approval of welding procedures for metallic materials - Welding procedure specification — Part 3: Electron beam welding (ISO/DIS 15609-3:2000).*

prEN ISO 15609-4:2000, *Specification and approval of welding procedures for metallic materials - Welding procedure specification — Part 4: Laser beam welding (ISO/DIS 15609-4:2000).*

EN ISO 13919-1, *Welding — Electrons and laser beam welded joints — Guidance on quality levels for imperfections — Part 1: Steel (ISO 13919-1:1996).*

prEN ISO 13919-2, *Welding — Electron and laser beam welded joints — Guidance on quality levels for imperfections — Part 2: Aluminium and its weldable alloys (ISO/FDIS 13919-2:1999).*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in prEN ISO 15607, prEN ISO 15609-3 and prEN ISO 15609-4 apply.

4 Welding procedure specification (WPS)

A pWPS (preliminary welding procedure specification) shall be prepared in accordance with prEN ISO 15609-3 for electron beam welding and prEN ISO 15609-4 for laser beam welding. It shall specify the tolerances for all the relevant parameters.

A WPS shall be classified as pWPS until it is qualified in accordance with this standard.

The welding procedure specification (WPS) shall give details on how a welding operation is to be performed, including tacking and fixturing.

5 Welding procedure test

The manufacture and testing of test pieces shall be in accordance with clauses 6 and 7 of this standard.

In order to take into account the service performance needs of the products, the qualification may be made according to any of the acceptance levels B, C or D as defined in EN ISO 13919-1 for steels or in prEN ISO 13919-2 for aluminium and its alloys.

The quality level necessary in each case should be specified by the application standard or the responsible designer.

6 Test piece

6.1 General

The assembly to which the electron or laser beam welding procedure applies in production may be represented by one or more standardized test pieces as defined in 6.2.

6.2 Shape and dimensions of test pieces

The test pieces shall be of sufficient size to ensure an adequate heat distribution and for the application of non-destructive and/or destructive tests.

The test piece shall be designed to represent, as far as possible, the component and joint geometry and shall be specified.

One or more additional test pieces or a longer test piece than the minimum size, may be used in order to allow for extra and/or for re-testing specimens, according to 7.5.

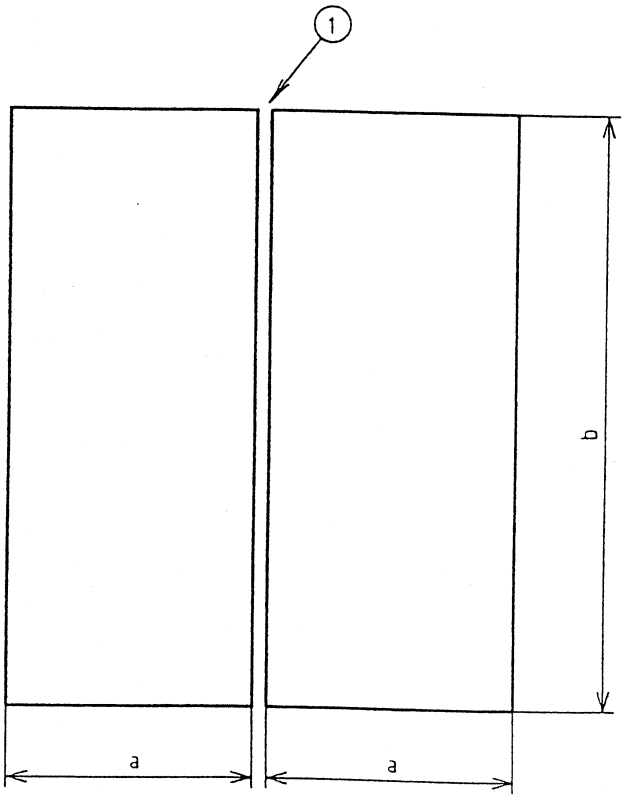
For plate material, the principal direction of rolling shall be marked on the test piece, if requested by the application standard or the specification.

The thickness and/or pipe outside diameter of the test pieces shall be selected in accordance with 8.5.2.1 to 8.5.2.2.

Unless otherwise specified, the shape and minimum dimensions of the test piece shall be as defined hereafter. Nonetheless, the length of the test piece shall be such as to permit the appropriate number of test specimens (as given in Tables 1 to Table 3) to be prepared.

6.2.1 Linear butt weld

The test piece shall be in accordance with Figure 1.



Key
1 Edge preparation and fit-up as detailed in the preliminary Welding Procedure Specification (pWPS)
a = 3 x t ; minimum value 150 mm
b = 6 x t ; minimum value 300 mm
t = thickness of the thinner material in a dissimilar thickness joint

Figure 1 — Test piece for a linear butt weld

6.2.2 Circular butt weld

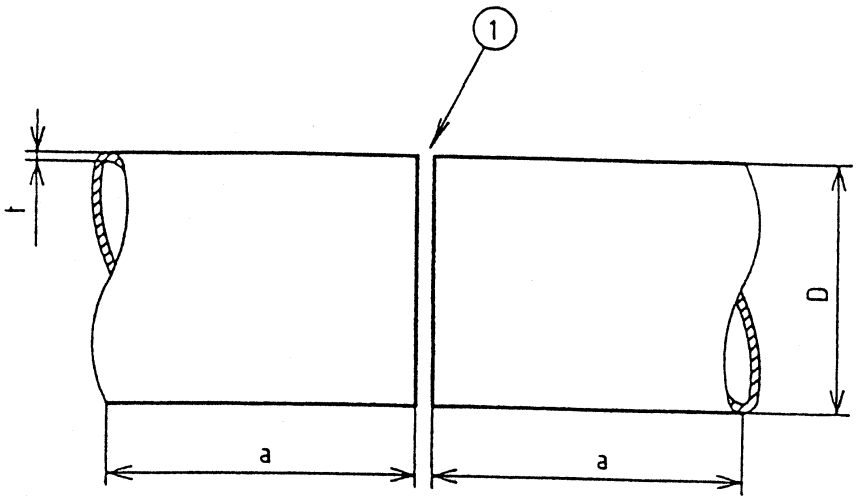
The test piece shall be in accordance with Figures 2 a) or 2 b). When small pipe diameters are used, several test pieces may be necessary.

In cases where the diameter, *D*, of the part is greater than 150 mm and *D* > 20 *t*, the qualification of the procedure may be achieved by welding a linear test piece. The test shall be designed to incorporate the weld overlap and slope down areas.

NOTE The word pipe is used to mean "pipe", "tube" or "hollow section".

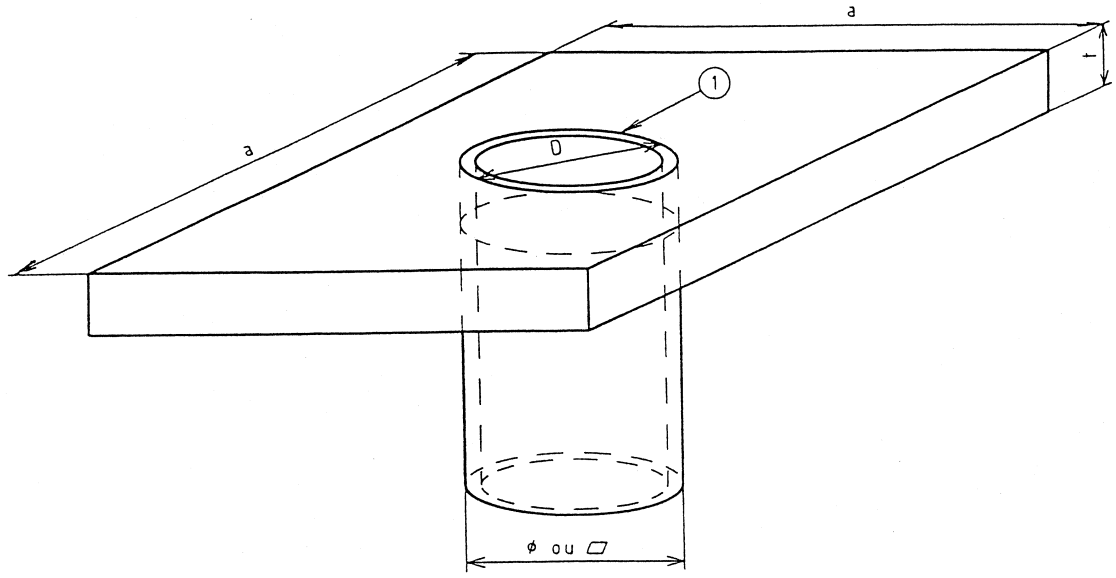
6.2.2.1 Radial butt weld in pipe (in accordance with Figure 2 a)

6.2.2.2 Axial weld in pipe to pipe or pipe to plate (in accordance with Figure 2 b)



Key
1 Edge preparation and fit-up as detailed in the preliminary Welding Procedure Specification (pWPS)
a = 3 x *t* ; minimum value 150 mm
D = outside dimension of the pipe
t = wall thickness of the thinner pipe in a dissimilar thickness joint

a) Test piece for a radial butt weld in pipe



Key
1 Edge preparation and fit-up as detailed in the preliminary Welding Procedure Specification (pWPS)
a = minimum plate dimension or component diameter
D = outside dimension of the pipe
$a \geq D + 6t$; minimum value $D + 150$ mm
t = plate thickness

b) Test piece for an axial weld in pipe to pipe or pipe to plate

Figure 2 — Test pieces for circular butt welds

6.2.3 Other types

6.2.3.1 T-joint

The test piece shall be in accordance with Figure 3.

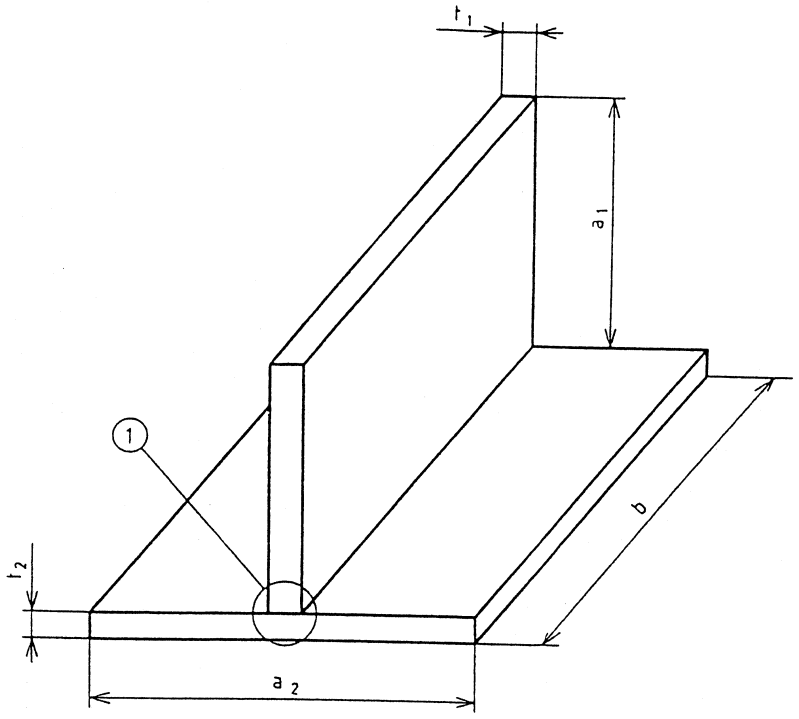
T-joint of the following types can be made :

a) T-butt from one side ;

b) T-butt from two sides ;

c) fillet weld (partial penetration) from one or two side(s) ;

d) a stake weld(s).



Key

1 Edge preparation and fit-up as detailed in the preliminary Welding Procedure Specification (pWPS)

For a), b) and c) configurations :

$a_1 \geq 6 \times t_1$; minimum value 50 mm

$a_2 \geq 6 \times t_1$; minimum value 100 mm

$b \geq 300$ mm

t_1 and t_2 = plate thicknesses

For d) configuration :

$a_1 \geq 6 \times t_2$; minimum value 50 mm

$a_2 \geq 6 \times t_2$; minimum value 100 mm

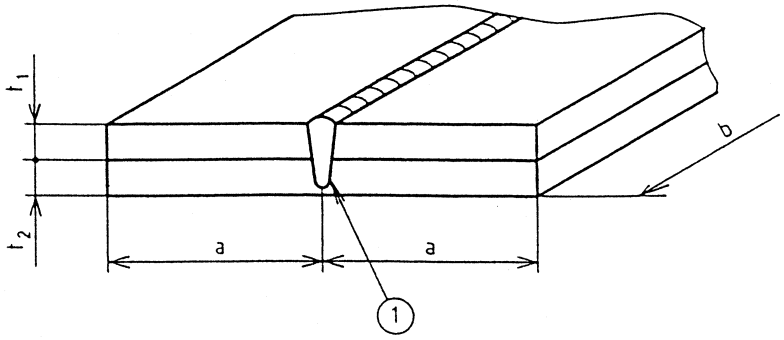
$b \geq 300$ mm

Figure 3 — Test piece for a T-joint

6.2.3.2 Lap weld

The test piece for a two layer lap weld shall be in accordance with the assembly shown in Figure 4.

The weld may be either partial or full penetration through all sheets or plates.



Key
1 Edge preparation and fit-up as detailed in the preliminary Welding procedure specification (pWPS)
$a \geq 4 \times (t_1 + t_2)$; minimum value 100 mm
$b \geq 300$ mm
t_1 and t_2 = plate thicknesses

NOTE The joint may also consist of three or more overlapping sheets.

Figure 4 — Test piece for a lap weld

6.3 Welding of test pieces

Preparation and welding of test pieces representative of the application shall be carried out in accordance with the pWPS and under the same conditions as those used for welding production.

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

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

7 Examination and testing

7.1 Extent of examination and testing

Examination and testing include the non-destructive examination (NDE) and destructive testing which shall be in accordance with the requirements of Tables 1, 2 or 3, as appropriate.

Table 1 — Examination and tests for welds in accordance with acceptance level B

Test piece	Type of examination and test	Extent of examination and test	See table footnote
Butt weld	- Visual examination	100 %	-
Figures 1, 2 a) and 2 b)	- Radiographic examination	100 %	a
	- Ultrasonic examination	100 %	a
	- Surface crack detection	100 %	b
	- Metallographic examination	1 section minimum	c
	- Hardness test	if required	d
	- Transverse bend test	if required : 2 root bend specimens and 2 face bend specimens	e
	- Longitudinal bend test	if required : 1 root bend specimen and 1 face bend specimen	f
	- Transverse tensile test	2 specimens	g
	- Toughness test	1 set of specimens	h
T-joint	- Visual examination	100 %	-
Figure 3 [i]	- Surface crack detection	100 %	b
	- Ultrasonic examination	100 %	j
	- Hardness test	if required	-
	- Metallographic examination	2 sections	c
	- Other tests	if required	
Lap weld	- Visual examination	100 %	-
Figure 4	- Metallographic examination	2 sections	c
	- other tests (e.g. hardness, leak test, peel test, ...)	if required	-

a Radiographic and/or ultrasonic examination.

b Penetrant testing or magnetic particle examination. For non-magnetic materials, penetrant testing.

c One section required for a butt weld in plate ; three sections required for a butt weld in pipe (see Figure 6) ; for each standard welding position in accordance with EN ISO 6947. These sections shall be subjected to macroscopic and microscopic examinations.

d Hardness tests are required depending on base and filler material.

e The two root and two face bend test specimens should be preferably replaced by four side bend test specimens when $t \geq 20$ mm.

f Longitudinal bend tests may be used in the case of flat heterogeneous assemblies and replace transverse bend tests.

g For butt welds according to Figure 2 b) transverse tensile tests are not appropriate.

h Depending on the material and the thicknesses and except for butt weld according to Figure 2 b) one or more sets can be taken from the weld metal and from the HAZ. These tests are relevant when the parent metal has a specified toughness or when prescribed by the application standard. If no testing temperature is specified, the test shall be carried out at room temperature. See also 7.4.3. In case of use of any kind of filler material, additional toughness test specimens shall be taken from the top and the root area.

i When the WPS has not been qualified by other means, additional tests permitting the verification of the mechanical properties of the assembly shall be considered.

j Unless ultrasonic beam attenuation or material thickness causes ultrasonic examination to be impracticable.

Table 2 — Examination and tests for welds in accordance with acceptance level C

Test piece	Type of examination and test	Extent of examination and test	See table footnote
Butt weld	- Visual examination	100 %	-
Figures 1, 2 a) and 2 b)	- Radiographic examination	100 %	[a]
	- Ultrasonic examination	100 %	[a]
	- Surface crack detection	100 %	[b]
	- Metallographic examination	1 section minimum	[b]
	- Hardness test	if required	-
	- Transverse bend test	if required : 2 root bend specimens and 2 face bend specimens	[e]
	- Longitudinal bend test	if required : 1 root bend specimen and 1 face bend specimen	[f]
	- Transverse tensile test	2 specimens	[g]
T-joint	- Visual examination	100 %	-
Figure 3 [h]	- Surface crack detection	100 %	[b]
	- Ultrasonic examination	100 %	[i]
	- Hardness test	if required	-
	- Metallographic examination	1 section minimum	[c]
	- Other tests	if required	-
Lap weld	- Visual examination	100 %	-
Figure 4	- Metallographic examination	1 section minimum	[c]
	- other tests (e.g. hardness, leak test, peel test, ...)	if required	-

[a] Radiographic and/or ultrasonic examination.

[b] Penetrant testing or magnetic particle examination. For non-magnetic materials, penetrant testing.

[c] One section required for a butt weld in plate ; three sections required for a butt weld in pipe (see Figure 6) ; for each standard welding position in accordance with EN ISO 6947. These sections shall be subjected to macroscopic examination only.

[d] Hardness tests are required depending on base and filler material.

[e] The two root and two face bend test specimens should be preferably replaced by four side bend test specimens when $t \geq 20$ mm.

[f] Longitudinal bend tests may be used in the case of flat heterogeneous assemblies and replace transverse bend tests.

[g] For butt welds according to Figure 2 b) transverse tensile tests are not appropriate.

[h] When the WPS has not been qualified by other means, additional tests permitting the verification of the mechanical properties of the assembly shall be considered.

[i] Unless ultrasonic beam attenuation or material thickness causes ultrasonic examination to be impracticable.

Table 3 — Examination and tests for welds in accordance with acceptance level D

Test piece	Type of examination and test	Extent of examination and test	See table footnote
Butt weld	- Visual examination	100 %	-
Figures 1, 2 a) and 2 b)	- Radiographic examination	if required	-
	- Ultrasonic examination	if required	-
	- Surface crack detection	if required	-
	- Metallographic examination	1 section minimum	[a]
T-joint	- Visual examination	100 %	-
Figure 3	- Surface crack detection	if required	-
	- Ultrasonic examination	if required	-
	- Metallographic examination	1 section minimum	[a]
Lap weld	- Visual examination	100 %	-
Figure 4	- Metallographic examination	1 section minimum	[a]

[a] One section required for a butt weld in plate ; three sections required for a butt weld in pipe (see Figure 6) ; for each standard welding position in accordance with EN ISO 6947. These sections shall be subjected to macroscopic examination only.

7.2 Location and cutting of test specimens

The location of test specimens shall be in accordance with Figures 5 to 8.

In the case of the overlap area (slope up and slope down) two metallographic test specimens shall be taken from the following positions :

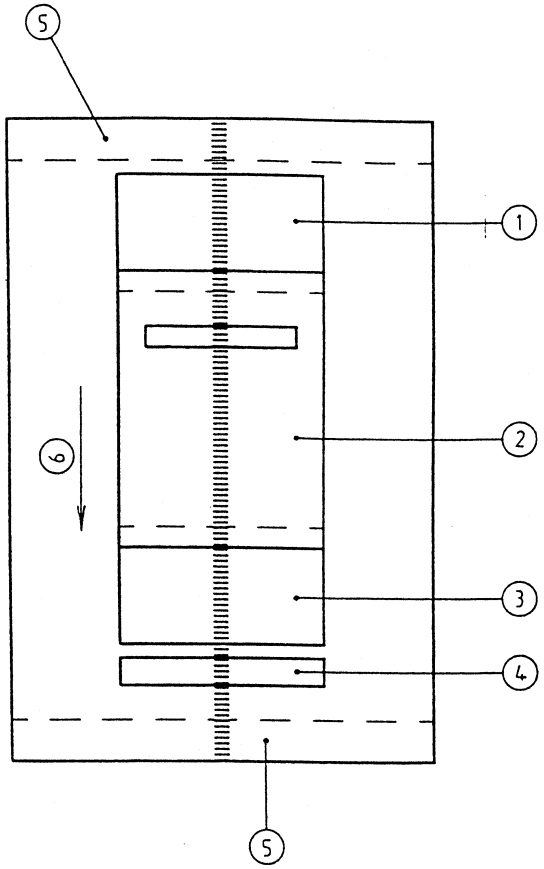
— one in the overlap ;

— one in the slope down area.

If it is not possible to take these two specimens because the extension of the overlap before start of slope down is too small, only one specimen shall be taken in the slope down area.

Other test specimens may be taken from this area if required in the specification.

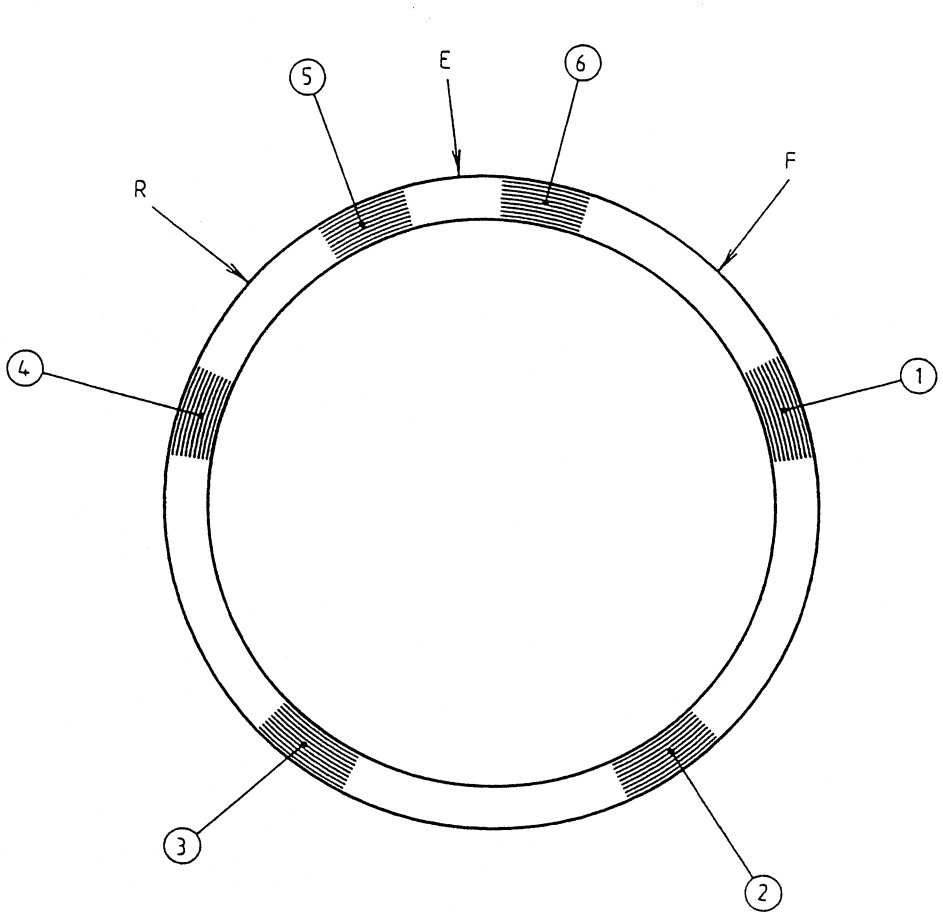
Test specimens shall be taken after non-destructive examination (NDE) has shown satisfactory results. It is permitted to take test specimens from locations avoiding areas showing acceptable imperfections as defined below in 7.3.2.



Key

1 Area 1 for 1 tensile specimen ; 1 root and 1 face bend specimen or 2 side bend specimens.
2 Area 2 for impact and additional test specimens if required.
3 Area 3 for 1 tensile specimen ; 1 root and 1 face bend specimen or 2 side bend specimens.
4 Area 4 for 1 metallographic specimen/hardness (if required) .
5 Discard : if $t \leq 25$ mm : discard 25 mm, if $t > 25$ mm : discard 50 mm minimum
6 Welding direction

Figure 5 — Location of test specimens for a linear butt weld

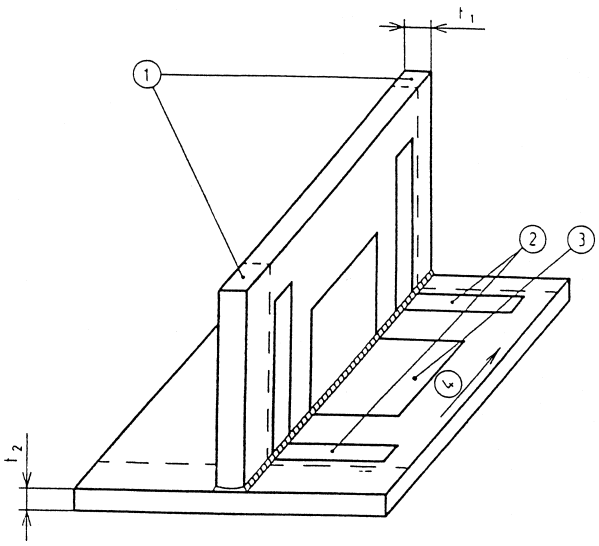


Key

1 Area 1[a] for 1 tensile specimen ; 1 root and 1 face bend specimen or 2 side bend specimens.
2 Area 2[a] for impact and additional test specimens if required.
3 Area 3[a] for 1 tensile specimen ; 1 root and 1 face bend specimen or 2 side bend specimens.
4 Area 4[a] for 1 metallographic specimen/hardness (if required).
5 Area 5 for 1 metallographic specimen.
6 Area 6 for 1 metallographic specimen.
R Location of beginning of overlap.
E Location of beginning of slope down.
F Location of end of slope down.

[a] Areas 1, 2, 3 and 4 shall be located outside the RE and EF zones and additionally metallographic examination for each standard welding position (for orbital welding only).

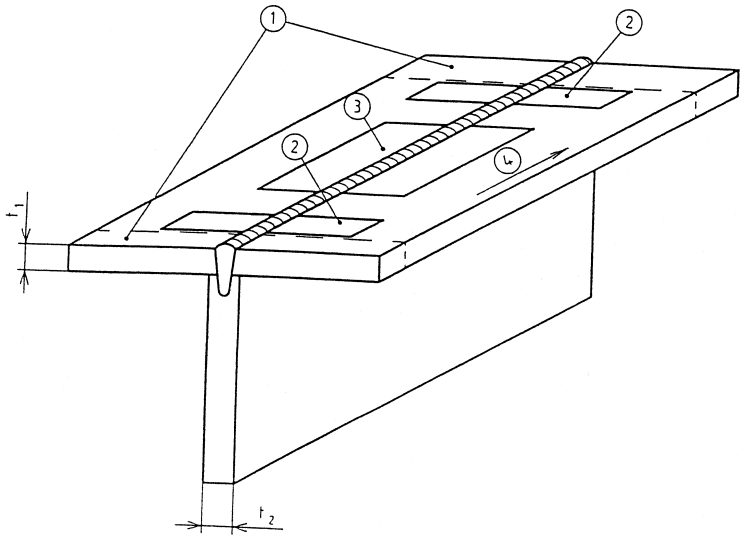
Figure 6 — Location of test specimens for a butt weld in pipe



Key

1 Discard : if (t_1 or t_2) ≤ 25 mm : discard 25 mm ; if (t_1 or t_2)> 25 mm : discard 50 mm minimum
2 Metallographic/Hardness test specimens (if required)
3 Other tests (if required)
4 Welding direction

a) in a T-butt from one or two sides or a fillet weld (partial penetration) from one or two sides

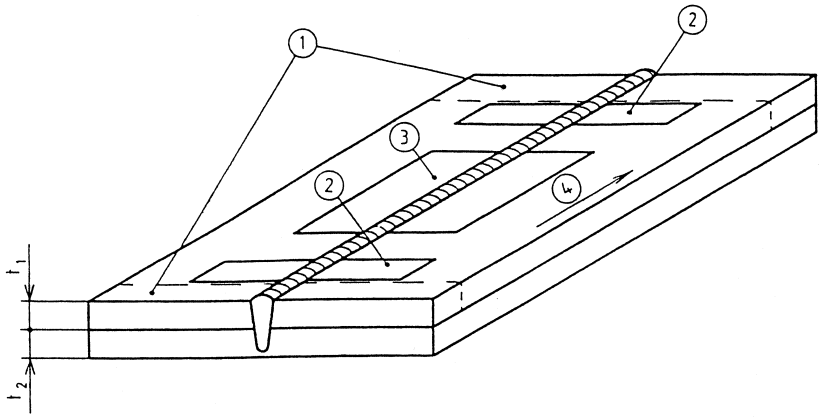


Key

1 Discard : if (t_1 or t_2) ≤ 25 mm : discard 25 mm ; if (t_1 or t_2) > 25 mm : discard 50 mm minimum
2 Metallographic/Hardness test specimens (if required)
3 Other tests (if required)
4 Welding direction

b) in a stake weld(s)

Figure 7 — Location of test specimens in a T-joint



Key
1 Discard : if (t_1 + t_2) ≤ 25 mm : discard 25 mm ; if (t_1 + t_2) > 25 mm : discard 50 mm minimum
2 Metallographic /Hardness test specimens (if required)
3 Other tests (if required)
4 Welding direction

Figure 8 — Location of test specimens in a lap weld

7.3 Non-destructive examination

7.3.1 Method

After any required post-weld heat treatment and prior to the cutting of test specimens, all test pieces shall be subjected to visual surface examination and non-destructive examination in accordance with the Tables of 7.1.

Depending upon joint geometry and material, non-destructive examination shall be carried out according to EN 970 (visual examination), EN 1435 (radiographic examination), EN 1714 (ultrasonic examination), EN 571-1 (penetrant testing), magneticle particle examination (EN 1290).

7.3.2 Acceptance level

A welding procedure is qualified if any imperfections detected in the test piece are within the specified limits given in the following standards, at the agreed acceptance level :

— EN ISO 13919-1, without the restrictive limitation of thickness, for steels ;

— prEN ISO 13919-2, for aluminium and its alloys.

7.4 Destructive tests

7.4.1 Transverse tensile testing

7.4.1.1 Method

Transverse tensile testing shall be performed at room temperature or other agreed test temperature. Test specimens and testing for transverse tensile testing for butt joints shall be in accordance with EN 895.

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

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

7.4.1.2 Acceptance level

For welds in acceptance level B or C, the tensile strength of the specimen shall not be lower than the minimum value specified for the application and included in the pWPS.

7.4.2 Bend testing

7.4.2.1 Method

Test specimens and test method for bend testing for butt joints shall be in accordance with EN 910.

For dissimilar metal joints or heterogeneous butt joints in plates, one root and one face longitudinal bend test specimens may be used instead of the transverse bend test specimens.

The former diameter and the method of testing shall be specified in the pWPS.

The test specimens should be bent through 180° unless the strength and/or ductility of the parent metal or weld metal impose other limitations.

7.4.2.2 Acceptance level

During testing, unless otherwise specified, the test specimens shall not reveal any imperfection of a length > 3 mm in any direction. Imperfections not initiated by a weld defect, appearing at the corners of a test specimen during testing, shall be ignored in the evaluation.

7.4.3 Toughness testing

Due to difficulties in carrying out valid toughness tests in narrow electron beam and laser welds the test to be used and the acceptance level shall be defined in the specification.

7.4.4 Hardness testing

7.4.4.1 Method

The Vickers micro hardness testing shall be carried out in accordance with EN 1043-2.

7.4.4.2 Acceptance level

The indentation load and the value of hardness measured shall conform with the requirements laid down at the design stage for the part being fabricated and with the provisions of the application standard.

7.4.5 Metallographic examination

7.4.5.1 Method

Macroscopic examination shall be carried out in accordance with EN 1321 using either naked eyes or a magnification at up to x 50 as appropriate.

Macro examination shall include part of the unaffected parent metal. Microscopic examination shall be carried out in accordance with EN 1321.

For welds of acceptance level B the examinations shall include macroscopic and microscopic examinations. They shall be accompanied with supporting photographs.

For welds of acceptance level C and D, the examinations shall be macroscopic only and shall be accompanied with supporting photographs for class C and may be accompanied with supporting photographies for class D.

7.4.5.2 Acceptance level

The acceptance levels shall be as defined in the specification and as suggested in EN ISO 13919-1 for steels, prEN ISO 13919-2 for aluminium and its alloys.

7.5 Re-testing

If the test piece fails to comply with any of the requirements for visual examination or other non-destructive examinations specified in 7.3.2, one further test piece shall be welded and subjected to the same examination.

If this additional test piece does not comply with the relevant requirements, the pWPS shall be regarded as not capable of complying with the requirements of this standard without modification.

If any test specimen fails to comply with the relevant requirements of 7.4 due only to an overlooked imperfection, one further test specimen shall be obtained for each one that failed. The test specimen can be taken from the same test piece if there is sufficient material available, or from a new test piece subjected to the same testing conditions.

If the additional test specimen does not comply with the relevant requirements, the pWPS shall be regarded as not capable of complying with the requirements of this standard without modification.

8 Range of qualification

8.1 General

All the conditions of validity stated below shall be met independently of each other.

Changes outside of the ranges specified shall require a new welding procedure test.

8.2 Related to the manufacturer

A qualification of a WPS obtained by a manufacturer is valid only for welding in workshops under the same technical and quality control of that manufacturer.

8.3 Related to the equipment

A qualification of a WPS is valid only for the electron gun and laser system type used, according to 4.11 of prEN ISO 15609-3:2000, WPS for electron beam welding, and of prEN ISO 15609-4, WPS for laser beam welding.

This qualification can be extended to similar equipment from the same manufacturer using selected tests defined in the specification.

8.4 Related to the jigs, fixtures and tooling

A qualified WPS is valid only for jigs, fixtures or tooling specified in the WPS

8.5 Related to the parent material

8.5.1 Grades

A qualified WPS is valid only for the grade of parent material (or grades, in the case of heterogeneous assemblies) of the test piece.

The qualification could be extended to equivalent grades defined in the specification.

8.5.2 Geometry of the assembly

8.5.2.1 Thickness

t : thickness of the test piece ;

s : depth of penetration ;

s may be greater than t (presence of an external backing) or smaller (presence of a backing weld or sealing weld).

A procedure test carried out on a thickness "*t*" for a depth of penetration "*s*" shall qualify the thicknesses for the range of qualification given in Table 4.

Table 4 — Range of qualification for thickness

Dimensions in millimetres

Depth of penetration	Acceptance level B	Acceptance level C	Acceptance level D
$s < 5$	$t \pm 20$ %	$t \pm 25$ %	$t \pm 30$ %
$5 \leq s \leq 25$	$t \pm 15$ %	$t \pm 20$ %	$t \pm 25$ %
$s > 25$	$t \pm 10$ %	$t \pm 15$ %	$t \pm 20$ %

For each thickness range the manufacturer may adjust the beam power to achieve the required depth of penetration.

8.5.2.2 Diameter of the pipe

A procedure test carried out on a diameter "*D*" shall qualify the diameters for the range of qualification shown in Table 5.

Table 5 — Range of qualification for diameter

"*D*" diameter of the test piece	Range of qualification
D	$\geq 0{,}75\ D$

8.6 Related to the filler materials

The qualified WPS is valid only for the approved filler material (grade or designation, shape and sizes).

8.7 Related to the joint geometry

The qualified WPS is valid only for the joint geometry and within the limits of clearance and misalignment defined in the welding procedure specification, according to joint design in 4.5 of prEN ISO 15609-3:2000 for electron beam welding and of prEN ISO 15609-4:2000 for laser beam welding.

8.8 Related to the presence of a weld backing

The qualified WPS is valid only insofar as no backing is added or removed.

The following shall be considered as a backing :

— an external backing plate ;

— a weld support machined on one of the workpieces ;

— welding of the root of the test piece with a process other than electron or laser beam welding.

In the latter case, the conditions for the execution of the weld deposit remain associated with the qualification test and therefore they cannot be modified.

8.9 Related to the weld type

The qualification of a WPS obtained is valid only for the weld type used during the procedure test, i.e "full penetration" or "partial penetration".

8.10 Related to the welding position

The qualification of a WPS obtained is valid only for the welding position (defined according to EN ISO 6947) used during the procedure test.

8.11 Related to the welding parameters

8.11.1 Electron beam welding

The qualification of a WPS obtained is valid only insofar as the specified ranges of the welding parameters defined in the WPS (see 4.13 in prEN ISO 15609-3:2000) and the tolerances specified are met.

8.11.2 Laser beam welding

The qualification of a WPS obtained is valid only insofar as the specified range of the welding parameters defined in the WPS (see 4.13 in prEN ISO 15609-4:2000) and the tolerances specified are met.

8.12 Related to preheating

When a procedure includes preheating, it is not permissible :

— to delete it ;

— to decrease or increase the temperature out of the range defined by the WPS.

8.13 Related to post weld heat treatment

It is not permissible :

— to delete a post weld heat treatment ;

— to decrease or increase the temperature or duration out of the range defined by the WPS.

8.14 Related to the number of passes

The qualification of a WPS obtained is valid only insofar as the number of passes is the same as the one used for the procedure test.

8.15 Duration of validity

The duration of validity of the welding procedure qualification is unlimited provided that no major modification of the welding machine has been made.

9 Welding Procedure Qualification Record (WPQR)

The Welding Procedure Qualification Record (WPQR) is a statement of the results of assessment of each test piece including re-tests. The relevant items listed for the WPS in clause 4 of this standard shall be included, together with details of any features that would be rejectable by the requirements of clause 7.

If no rejectable features or unacceptable test results are found, a WPQR detailing the welding procedure test piece results is qualified and shall be signed and dated by the examiner or examining body.

A WPQR format shall be used to record details for the welding procedure and the test results, in order to facilitate uniform presentation and assessment of the parameters.

An example of the WPQR format is shown in annex A.

Annex A
(informative)

Welding Procedure Qualification Record form (WPQR)

Welding procedure qualification - Test certificate

Manufacturer's welding procedure — Examiner or examining body
Reference No: ..... — Reference No: .....
Manufacturer: .....
Address: .....
Code/Testing standard: .....
Date of welding: .....

Extent of qualification

Welding process: .....
Equipment type: .....
Joint type: .....
Depth of penetration: .....
Parent metal (s): .....
Material thickness (mm): .....
Outside diameter (mm): .....
Filler metal type (if any): .....
Vacuum: .....
Shielding gas: ..... Plasma gas : ..... Backing gas : .....
Welding position: .....
Preheat: .....
Post-weld heat treatment and/or heat treatment: .....
Other information: .....

Certified that test welds prepared, welded and tested satisfactorily in accordance with the requirements of the code/testing standard indicated above.

Examiner or examining body

....

Location — Date of issue

Name, date and signature

Details of weld test

Welding procedure specification

See annex A of prEN ISO 15609-3:2000 for electron beam welding and of prEN ISO 15609-4:2000 for laser beam welding.

Test results

Identification of the test piece :

Non destructive examination :

carried out by :

				Without defect	With defect	
					Acceptable	Not acceptable
. Visual examination :	required	Yes ☐	No ☐			
. Radiographic examination :	required	Yes ☐	No ☐			
Film type :	Mark :					
. Ultrasonic examination :	required	Yes ☐	No ☐			
. Penetrant testing :	required	Yes ☐	No ☐			

Destructive tests :

. Transverse tensile test : required Yes ☐ No ☐

carried out by :

Type of test specimen : Normal ☐ Reduced ☐ Machined flush weld : Yes ☐ No ☐

Test specimen		Size	Rm N/mm^2	% Elongation	Fracture location			Remarks
Mark	Type				Parent material	HAZ	Weld metal	

. Bend test : carried out by :

Transverse required Yes ☐ No ☐
Longitudinal required Yes ☐ No ☐

Test specimen		Specimen Size mm	Ø of mandrel mm	Loading span mm	Bending conditions			Bend angle	Remarks
Mark	Type				Face	Root	Side		

Identification of the test piece :

. Impact test : required Yes ☐ No ☐

carried out by :

Identification mark	Section at root of notch cm^2	Temperature °C	Location				K J/cm^2		Remarks
			Test specimen		Notch				
			Centre	Surface	WM	HAZ	Individual	Average	

WM : Weld Metal
HAZ : Heat Affected Zone

. Hardness test : required Yes ☐ No ☐

carried out by :

Sketch of the test specimen	Traverse N°	Results

. Metallographic examination : required Yes ☐ No ☐

carried out by :

Other tests carried out by .....
.....
The tests were made in accordance with : .....
Test report N° .....
Test results are acceptable : Yes ☐ No ☐

.....

Examiner or examining body

Tests carried out in presence of : Name, date and signature

Annex ZA
(normative)

Corresponding International and European Standards for which equivalents are not given in the text

At the time of publication of this part of ISO 15614, the given editions of the documents listed below were valid. Members of ISO and IEC maintain registers of currently valid International Standards.

European Standard given in clause 2	ISO standard corresponding	Title of ISO standard
EN 895	ISO 4136	Destructive tests on welds in metallic materials — Transverse tensile test
EN 910	ISO 5173	Destructive tests on welds in metallic materials — Bend tests
EN 970	ISO/DIS 17637	Non-destructive examination of fusion welds — Visual examination
EN 1043-2	ISO/DIS 9015-2	Destructive test on welds in metallic materials — Hardness test — Part 2 : Micro hardness testing on welded joints
EN 1290	ISO/DIS 17638	Non-destructive examination of welds — Magnetic particle examination of welds
EN 1321	ISO/DIS 17639	Non-destructive examination of fusion welds — Macroscopic and microscopic examination of welds
EN 1435	ISO/DIS 17636	Non-destructive examination of welds — Radiographic examination of welded joints
EN 1714	ISO/DIS 17640	Non destructive examination of welds — Ultrasonic examination of welded joints

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