INTERNATIONAL STANDARD

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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

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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.

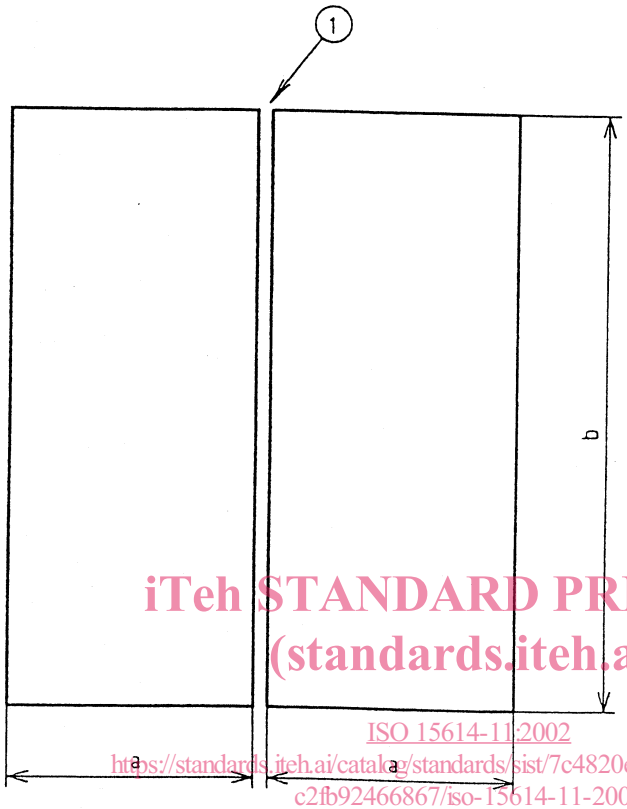
For plate material, the principal direction of rolling shall be marked on the test piece, if requested by the application standard or the specification.

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

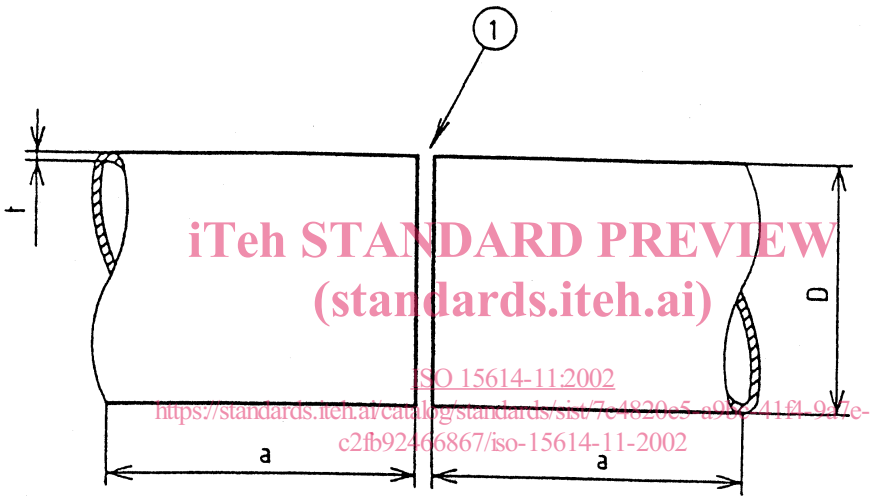
The test piece shall be in accordance with Figures 2 a) or 2 b). When small pipe diameters are used, several test pieces may be necessary.

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".

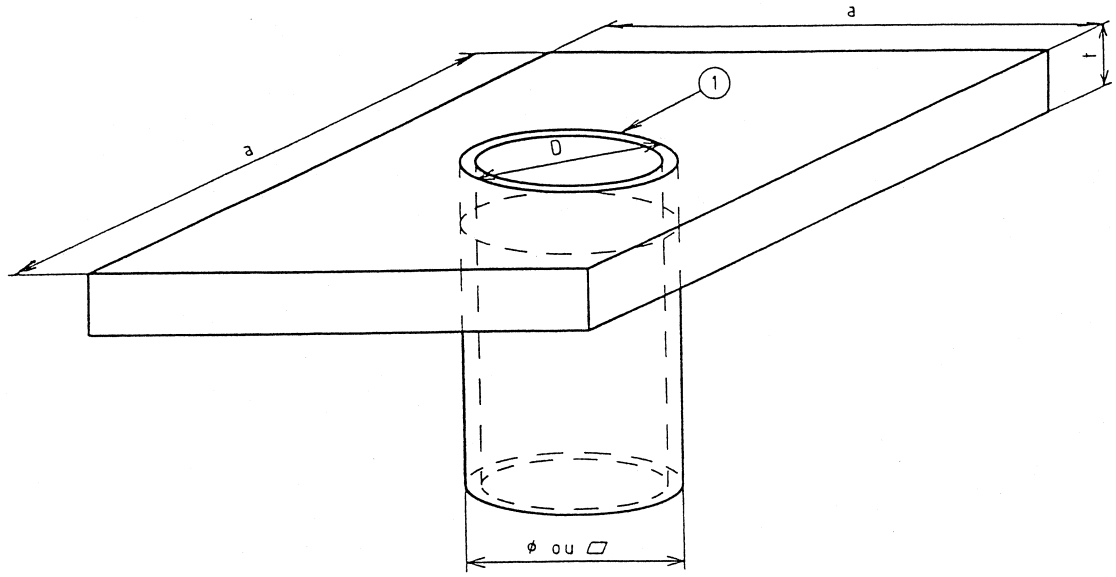
6.2.2.1 Radial butt weld in pipe (in accordance with Figure 2 a)

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)
$a = 3 \times t$; 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.

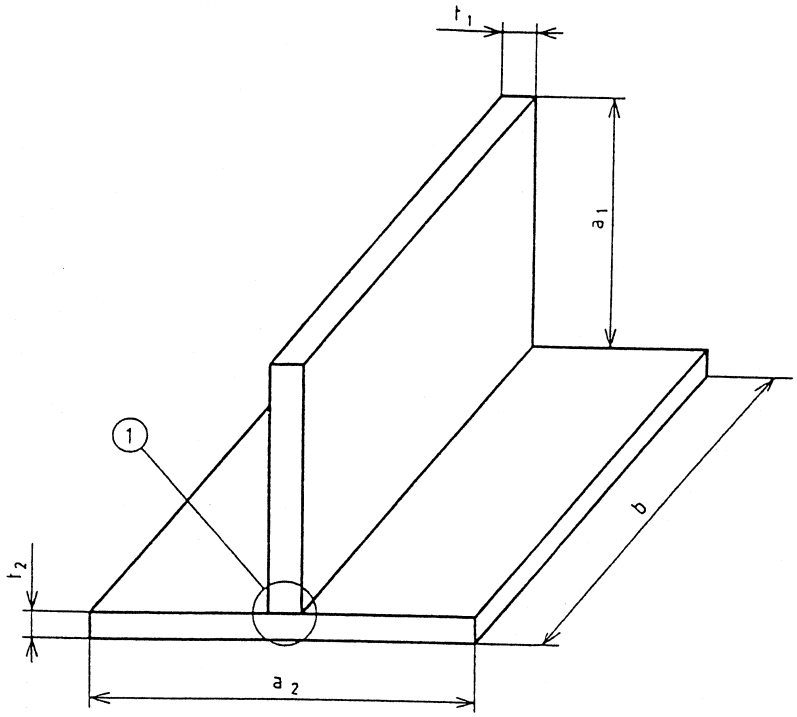
T-joint of the following types can be made :

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 ≥ 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.