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

### Part 8: Welding of tubes to tube-plate joints

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

*Partie 8: Soudage de tubes sur plaques tubulaires*

[Revision of first edition (ISO 15614-8:2002)]

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This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

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# Contents

Page

Foreword .....	v
Introduction.....	vi
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions .....	2
4 Symbols and abbreviated terms .....	2
5 Preliminary Welding Procedure Specification (pWPS).....	3
5.1 General .....	3
5.2 Items for all welding process .....	3
5.3 Items for particular welding processes.....	4
6 Qualification of welding procedure .....	5
7 Welding of test pieces.....	5
7.1 General .....	5
7.2 Type of test piece .....	5
7.2.1 Joint preparation and joint construction .....	5
7.2.2 Tube ends welded on triangular pitch.....	5
7.2.3 Tube ends welded on square pitch.....	6
8 Examination and testing.....	7
8.1 Performance.....	7
8.1.1 General .....	7
8.1.2 Visual testing .....	8
8.1.3 Penetrant testing .....	8
8.1.4 Radiographic testing.....	8
8.1.5 Macroscopic examination .....	9
8.1.6 Hardness test.....	9
8.1.7 Push-out or pull-out test.....	9
8.2 Acceptance levels .....	9
8.2.1 General .....	9
8.2.2 Visual testing .....	10
8.2.3 Penetrant testing .....	10
8.2.4 Radiographic testing.....	11
8.2.5 Macroscopic examination .....	12
8.2.6 Hardness values .....	12
8.2.7 Push-out or pull-out load.....	12
8.3 Re-test.....	12
9 Range of qualification .....	12
9.1 General .....	12
9.2 Related to the manufacturer .....	13
9.3 Related to the material .....	13
9.3.1 Parent metal .....	13
9.3.2 Tube-plate and tube dimensions .....	13
9.3.3 Tube pitch .....	13
9.4 Common to all welding procedures .....	13
9.4.1 Welding process.....	13
9.4.2 Welding position of tube-plate.....	13
9.4.3 Type of joint .....	14
9.4.4 Filler metal, classification.....	14

9.4.5 Filler metal, dimensions.....14  
9.4.6 Type of current.....14  
9.4.7 Heat input .....14  
9.4.8 Pre-heat temperature.....14  
9.4.9 Interpass temperature .....14  
9.4.10 Post-weld heat treatment .....14  
9.4.11 Shielding gas.....14  
10 Welding, Procedure Qualification Record form (WPQR).....14  
Annex A (informative) Welding Procedure Qualification Record form for tube to tube-plate joints (WPQR) .....16

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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 2.

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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15614-8 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, and by Technical Committee CEN/TC 121, *Welding and allied processes* in collaboration.

This second/third/... edition cancels and replaces the first/second/... edition (EN ISO 15614-8:2002), [clause(s) / subclause(s) / table(s) / figure(s) / annex(es)] of which [has / have] been technically revised.

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 irons*
- *Part 4: Finishing welding of aluminium castings*
- *Part 5: Arc welding of titanium, zirconium and their alloys*
- *Part 6: Arc welding of copper and its alloys*
- *Part 7: Overlay welding*
- *Part 8: Welding of tubes to tube-plate joints*
- *Part 9: Underwater hyperbaric wet welding*
- *Part 10: Hyperbaric dry welding*
- *Part 11: Electron and laser beam welding*
- *Part 12: Spot, seam and projection welding*
- *Part 13: Flash and butt welding*
- *Part 14: Laser-arc hybrid welding of steels, nickel and nickel alloys*

## Introduction

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

Consideration of previous procedure qualifications to former national standards or specifications should be at the time of the enquiry or contract stage and agreed between the contracting parties.

Requests for official interpretations of any aspect of this standard should be directed to the secretariat if ISO/TC 44/SC 10 via your national standards body, a complete listing which can be found at [www.iso.org](http://www.iso.org).

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# Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 8: Welding of tube to tube-plate joints

## 1 Scope

This International Standard specifies requirements for the qualification testing of welding procedures for the arc welding of tube to tube-plate joints in metallic materials by manual, mechanized or automatic processes.

This standard is a part of a series of standards. Details of this series are given in ISO 15607, Annex A.

Qualification by tube to tube-plate joint tests can be used for all joints even if they are fully loaded or only seal welded as required in application standards.

In such cases, one or more special test pieces should be made to simulate the production joint in all essential features, e.g. dimensions, restraint, heat sink effects. The test should be carried out prior to and under the conditions to be used in production.

This standard applies to fusion welding of metallic materials for tube to tube-plate joints with a gap between the tube and the tube plate for some length of the tube plate thickness. This standard does not apply to tube-sheets with forged end connections with welded tubes (external/internal bore welds).

For welding of tube to tube-plate joints with mechanical expansion which is load bearing welding procedure test should be defined in the specification.

For other applications and/or requirements the standard can be used if required by the specification.

Repair welding should be considered in the welding procedure test.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1708-1, *Welding — Basic weld joint details in steels — Part 1: Pressurized components*

ISO 3452-1, *Non-destructive testing — Penetrant testing — Part 1: General principles*

ISO 4063, *Welding and allied processes — Nomenclature of processes and reference numbers*

ISO 6520-1:2007, *Welding and allied processes — Classification of geometric imperfections in metallic materials — Part 1: Fusion welding*

ISO 9015-1, *Destructive tests on welds in metallic materials — Hardness testing — Part 1: Hardness test on arc welded joints*

ISO 9606-1 *Qualification testing of welders — Fusion welding — Part 1: Steels*

ISO 9606-2, *Qualification test of welders — Fusion welding — Part 2: Aluminium and aluminium alloys*

ISO 9606-3, *Approval testing of welders — Fusion welding — Part 3: Copper and copper alloys*

ISO 9606-4, *Approval testing of welders — Fusion welding — Part 4: Nickel and nickel alloys*

ISO 9606-5, *Approval testing of welders — Fusion welding — Part 5: Titanium and titanium alloys, zirconium and zirconium alloys*

ISO 9692-1, *Welding and allied processes — Recommendations for joint preparation — Part 1: Manual metal-arc welding, gas-shielded metal-arc welding, gas welding, TIG welding and beam welding of steels*

ISO 14175, *Welding consumables — Gases and gas mixtures for fusion welding and allied processes*

ISO 14732, *Welding personnel — Qualification testing of welding operators for fully mechanized welding and weld setters for fully mechanized and automatic welding of metallic materials*

ISO 15607:2003, *Specification and qualification of welding procedures for metallic materials — General rules*

ISO/TR 15608, *Welding — Guidelines for a metallic materials grouping system*

ISO 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding*

ISO 15614-1, *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*

ISO 17636-1, *Non-destructive testing of welds — Radiographic testing — Part 1: X- and gamma-ray techniques with film*

ISO 17639, *Destructive tests on welds in metallic materials — Macroscopic and microscopic examination of welds*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15607 apply.

### 4 Symbols and abbreviated terms

For the purposes of this standard, the following symbols apply and are shown in Figures 1, 2 and 3:

- $a$  throat thickness (mm) (in this case, the minimal distance between root point and weld surface)
- $d_p$  pore size (mm)
- $d_a$  tube-outside diameter (mm)
- $d_l$  minimum distance between two pipes (mm), see Figure 2
- $g$  gap between tube and tube plate
- $s_p$  starting point of the root run
- $t$  tube-wall thickness (mm)
- $t_1$  cladding thickness (mm)



$t_2$  tube-plate thickness (mm)

$x$  overlap (mm)

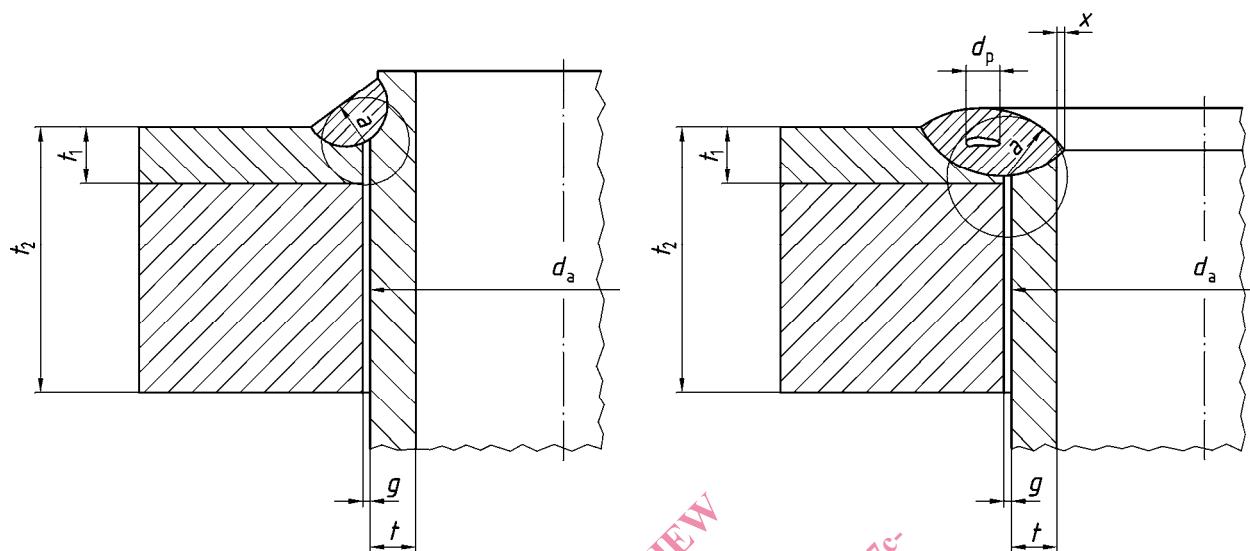


Figure 1 — Presentation of symbols in an example

## 5 Preliminary Welding Procedure Specification (pWPS)

### 5.1 General

The qualification for tube to tube-plate welding tests shall be based on a pWPS in accordance with ISO 15609-1. It shall specify the relevant parameters listed in 5.2 and 5.3.

### 5.2 Items for all welding process

Details relating to the following items shall be recorded for all welding processes:

- welding process, or processes when more than one is used in making a complete joint;
- tube-plate specification and thickness and details of any cladding and its thickness;
- tube specification, thickness and outside diameter;
- pitch type (square or triangular) and distance between pipes;
- joint geometry, actual borehole diameter and fit-up tolerances (sketch) in accordance with ISO 9692-1;
- cleaning and degreasing (time during the fabrication steps and type);
- jigging or tacking, tacking position and expansion;
- tube-plate and welding position;
- type and/or trade name of welding consumables;
- size (diameter) and wire lengths per run;
- pre-heating and interpass temperature, including method of control;

- l) welding speed (mechanized welding);
- m) number and arrangement of runs, starting points of runs and weld dimensions (sketch);
- n) welding sequence;
- o) post-weld heat treatment, including method of control;
- p) if necessary, the temperature and time recommended for drying/backing of welding consumables before use;
- q) any special features, including heat input control requirements, any heat sinks effects or post-weld tube expansion.

### 5.3 Items for particular welding processes

Details relating to the items given in 5.3 a) to 5.3 d) shall be recorded for these particular processes, in addition to the items given in 5.2. The reference numbers of welding processes relate to ISO 4063.

- a) Manual metal arc welding (111)
  - alternating or direct current and polarity;
  - current.
- b) MIG welding, MAG welding, solid wire or cored wire, with or without separate gas shield (114), (131), (135), (136), (137)
  - shielding gas designation in accordance with ISO 14175 and flow rate;
  - arc voltage;
  - wire feed speed or current;
  - for pulsed welding : the pulse time and frequency, pulsed current and background current.
- c) TIG welding (141)
  - shielding gas designation in accordance with ISO 14175 and flow rate;
  - alternating current (AC) or direct current (DC) and polarity;
  - current in ampere;
  - for pulsed welding : the pulse time and frequency, pulsed current and background current;
  - whether filler metal is used.
- d) Mechanized or automatic welding
  - all items detailed in b) or c) and the following items if necessary:
    - arc length or arc voltage;
    - where filler metal is used its rate of addition or wire feed speed relating to the wire diameter (see 5.2));
    - other pre-programmed welding variables such as: