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

Part 13:

### Upset (resistance butt) and flash welding

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

*Partie 13: Soudage en bout par résistance pure et soudage par étincelage*

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

ISO 15614-13 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 6, *Resistance welding and allied mechanical joining*.

This third edition cancels and replaces the second edition (ISO 15614-13:2012), which has 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: Fusion welding of non-alloyed and low-alloyed cast irons
- Part 4: Finishing welding of aluminium castings
- Part 5: Arc welding of titanium, zirconium and their alloys
- Part 6: Arc and gas welding of copper and its alloys
- Part 7: Overlay welding
- Part 8: Welding of tubes to tube-plate joints
- Part 9: Arc 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: Upset (resistance butt) and flash welding

— *Part 14: Laser-arc hybrid welding of steels, nickel and nickel alloys*

Requests for official interpretations of any aspect of this part of ISO 15614 should be directed to the Secretariat of ISO/TC 44/SC 10 via your national standards body. A complete listing of these bodies can be found at [www.iso.org](http://www.iso.org).

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## Introduction

It is intended that all new welding procedure qualifications be carried out in accordance with this part of ISO 15614 from the date of its issue.

However, this part of ISO 15614 does not invalidate previous welding procedure qualifications made to other standards or specifications, provided the intent of its technical requirements is satisfied and the previous welding procedure qualifications 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 qualification technically equivalent, it is necessary only to perform the additional tests on a test piece made in accordance with this part of ISO 15614.

The various parts of ISO 15614 comprise, in their turn, a series of International Standards on welding, details of which are given in ISO 15607:2003, Annex A.

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

## Part 13: Upset (resistance butt) and flash welding

### 1 Scope

This part of ISO 15614 specifies tests for the qualification of welding procedure specifications applicable to upset (resistance butt) welding and flash welding of metallic materials, e.g. with solid, tubular, flat or circular cross-section. Its basic principles can also be applied to other resistance welding processes when this is stated in the specification.

This part of ISO 15614 defines the conditions for carrying out tests and the limits of validity of a qualified welding procedure for all the practical welding operations that it covers. The tests required to qualify the procedure for a particular component or assembly depend on the performance and quality requirements of the component or assembly, as defined in the design specification. The tests are intended to be carried out in accordance with the requirements of this part of ISO 15614, unless more severe tests are specified by the relevant application standard or specification and when these apply.

NOTE Specific service, material, or manufacturing conditions can require more comprehensive testing than specified by this part of ISO 15614. Such tests can include microsections, fatigue or endurance tests, impact tests, radiographic testing, ultrasonic testing, corrosion testing and tests of components or complete welded assemblies.

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This part of ISO 15614 covers the following resistance welding processes, as defined in ISO 4063:

- 24 flash welding, using direct current or alternating current with various movement sequences, constant flashing and pulsed flashing;
- 25 resistance upset welding, using direct current or alternating current with various pressure sequences.

### 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 669, *Resistance welding — Resistance welding equipment — Mechanical and electrical requirements*

ISO 4063:2009, *Welding and allied processes — Nomenclature of processes and reference numbers*

ISO 4136, *Destructive tests on welds in metallic materials — Transverse tensile test*

ISO 5173, *Destructive tests on welds in metallic materials — Bend tests*

ISO 6520-2, *Welding and allied processes — Classification of geometric imperfections in metallic materials — Part 2: Welding with pressure*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

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

ISO 9015-2, *Destructive tests on welds in metallic materials — Hardness testing — Part 2: Microhardness testing of welded joints*

ISO 11666, *Non-destructive testing of welds — Ultrasonic testing — Acceptance levels*

ISO 14271, *Resistance welding — Vickers hardness testing (low-force and microhardness) of resistance spot, projection, and seam welds*

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

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

ISO/TR 15608:2005, *Welding — Guidelines for a metallic materials grouping system*

ISO 15609-5, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 5: Resistance welding*

ISO 15620:2000, *Welding — Friction welding of metallic materials*

ISO 17637, *Non-destructive testing of welds — Visual testing of fusion-welded joints*

ISO 17638, *Non-destructive testing of welds — Magnetic particle testing*

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

ISO 17640, *Non-destructive testing of welds — Ultrasonic testing — Techniques, testing levels, and assessment*

ISO 17643, *Non-destructive testing of welds — Eddy current testing of welds by complex-plane analysis*

ISO 23277, *Non-destructive testing of welds — Penetrant testing — Acceptance levels*

ISO 23278, *Non-destructive testing of welds — Magnetic particle testing — Acceptance levels*

ISO 23279, *Non-destructive testing of welds — Ultrasonic testing — Characterization of discontinuities in welds*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 669, ISO 15607 and ISO 6520-2 apply.

### 4 Preliminary welding procedure specification

The preliminary welding procedure specification (pWPS) shall be prepared in accordance with ISO 15609-5. It shall specify all relevant parameters and requirements.

### 5 Test pieces and test specimens

#### 5.1 General

The welded assembly tested shall be the actual component used in production or a standardized test piece according to references included in 5.2.

Test specimens may be cut from the actual component if required. Test pieces are to be tested separately, in accordance with 5.2.



## 5.2 Shape and dimensions of test specimens

### 5.2.1 General

The testing includes non-destructive testing (NDT) and/or destructive testing.

The selection of test class A or B, test types and the number of test specimens depends on the performance, safety and quality requirements of the component or assembly and shall be established before any qualification is undertaken. Examples are given in [Table 1](#).

If not otherwise specified, test specimens of the shape and dimensions stipulated in [5.2.2](#) to [5.2.6](#) shall be used.

**Table 1 — Examples for testing and examination of test specimens**

Work piece	Test type	Extent of test <sup>h</sup>	
		Test class A	Test class B
Bars/rods	Visual test	Every weld	Every weld
	Penetrant test	Every weld	Every weld
	Tensile test	Three specimens <sup>a</sup>	—
	Bend test	Six specimens <sup>a</sup>	Two specimens <sup>a</sup>
	Macrosection <sup>b</sup>	One weld	—
	Hardness test <sup>b</sup>	One measuring row <sup>g</sup>	—
Hollow profile	Visual test	Every weld	Every weld
	Penetrant test	Every weld	Every weld
	Tensile test	Three specimens	Two specimens
	Bend test	Six specimens <sup>a</sup>	Two specimens <sup>a</sup>
	Macrosection <sup>c</sup>	One weld <sup>a</sup>	—
	Hardness test	One measuring row <sup>g</sup>	—

<sup>a</sup> When the used test pieces are large enough, more than one specimen can be taken from one weld joint.

<sup>b</sup> Not required for steels in group 1 in accordance with ISO/TR 15608:2005 under static loading except for low temperature applications.

<sup>c</sup> With thin wall thicknesses, it is an advantage to carry out the cupping test instead of the bend test. A level surface of 70 mm in diameter is required for the cupping test (see 7.3.3). Circular tubes with thin walls can be tested using the petal test (see 7.3.4).

<sup>d</sup> At least two welds shall be carried out.

<sup>e</sup> One test specimen from each edge and one from the middle; if test class B is relevant, one specimen from the edge and one from the middle.

<sup>f</sup> The cupping test is preferred for steels which have a tensile strength up to 450 N/mm<sup>2</sup> and wall thicknesses up to 5 mm. For higher tensile strength(s) and/or thicker materials, use the bend test. With aluminium materials, the deformation capacity of the unaffected parent material determines the wall thickness, up to which the cupping test can be used for the welded joints.

<sup>g</sup> Measuring row in a macrosection transverse to the weld.

<sup>h</sup> For statistical analysis, a higher number of samples, e.g. 11, shall be tested to compute average and standard deviation.

Table 1 (continued)

Work piece	Test type	Extent of test <sup>h</sup>	
		Test class A	Test class B
Sheet metal and strips	Visual test	Every weld <sup>d</sup>	Every weld <sup>d</sup>
	Penetrant test	Every weld <sup>d</sup>	—
	Tensile test <sup>e</sup>	Three specimens per weld joint <sup>d</sup>	Two specimens per weld joint <sup>d</sup>
	Bend test <sup>e f</sup>	Three specimens per weld joint <sup>d</sup>	Two specimens per weld joint <sup>d</sup>
	Cupping test <sup>e f</sup>	Three specimens per weld joint <sup>d</sup>	—
	Macrosection <sup>e</sup>	Three specimens per weld joint <sup>d</sup>	—
	Hardness test <sup>b</sup>	One measuring row <sup>g</sup>	—
Depending on the application, two optional test classes should be distinguished, according to the load:			
A: For application under static stress up to the highest fatigue stress for the parent material.			
B: For application under static stress of up to 50 % of the level allowed for the parent material.			
<sup>a</sup> When the used test pieces are large enough, more than one specimen can be taken from one weld joint. <sup>b</sup> Not required for steels in group 1 in accordance with ISO/TR 15608:2005 under static loading except for low temperature applications. <sup>c</sup> With thin wall thicknesses, it is an advantage to carry out the cupping test instead of the bend test. A level surface of 70 mm in diameter is required for the cupping test (see 7.3.3). Circular tubes with thin walls can be tested using the petal test (see 7.3.4). <sup>d</sup> At least two welds shall be carried out. <sup>e</sup> One test specimen from each edge and one from the middle; if test class B is relevant, one specimen from the edge and one from the middle. <sup>f</sup> The cupping test is preferred for steels which have a tensile strength up to 450 N/mm <sup>2</sup> and wall thicknesses up to 5 mm. For higher tensile strength(s) and/or thicker materials, use the bend test. With aluminium materials, the deformation capacity of the unaffected parent material determines the wall thickness, up to which the cupping test can be used for the welded joints. <sup>g</sup> Measuring row in a macrosection transverse to the weld. <sup>h</sup> For statistical analysis, a higher number of samples, e.g. 11, shall be tested to compute average and standard deviation.			

## 5.2.2 Tensile test specimen

The test specimen shall be prepared taking into consideration ISO 4136 and ISO 6892-1 and any standard referenced by the applicable contract or specification.

## 5.2.3 Bend test specimen

The test specimen shall be prepared in accordance with ISO 5173.

## 5.2.4 Cupping test specimen

The specimen dimensions shall be such that they can be tested on Erichsen testing equipment.

## 5.2.5 Hardness test specimen

The test specimen shall be prepared in accordance with ISO 9015-1 and ISO 9015-2.

A macrosection transverse to the weld shall be prepared and etched in order to clearly show the weld zone, the heat-affected zones (HAZ) and the unaffected parent material.

### 5.2.6 Petal test specimen using thin sheets

The test specimen shall be prepared in accordance with ISO 15620:2000, Figure 8.

Any deviations from the requirements shall be defined in the design specification.

## 5.3 Welding of components, test pieces or test specimens

Preparation of components, test pieces or test specimens and the welding of the test pieces shall be carried out in accordance with the welding procedure specification (WPS) and the general requirements of the corresponding manufacturing process.

## 6 Testing and examination

### 6.1 Extent of testing

The testing includes non-destructive and/or destructive testing (see examples in [Table 1](#)). It shall meet the quality requirements of the component to be welded.

The size of the test specimens shall include the zone in which failure is liable to occur, even outside the heat-affected zone (HAZ).

### 6.2 Non-destructive testing (NDT)

#### 6.2.1 General

For effective testing of specimens, the condition of the specimens shall comply with the specifications in the respective standards, e.g. complete burr removal for the penetrant test.

#### 6.2.2 Visual test

Visual testing shall be carried out in accordance with ISO 17637. Use a magnifying glass (six- to ten-fold magnification) to inspect the welds for visible imperfections, such as surface cracks. Metal expulsion and weld burr shall also be taken into consideration if they have not been removed directly after the welding process.

#### 6.2.3 Penetrant test

Penetrant testing shall be carried out in accordance with ISO 23277.

#### 6.2.4 Magnetic particle test

Ferromagnetic materials shall be subjected to magnetic particle testing in accordance with ISO 17638 and ISO 23278, instead of penetrant testing (7.2.3).

#### 6.2.5 Eddy current test

Ferritic materials shall be subjected to eddy current testing in accordance with ISO 17643, instead of penetrant testing (7.2.3) or magnetic particle testing (7.2.4).

#### 6.2.6 Ultrasonic test

Ultrasonic testing shall be carried out in accordance with ISO 11666, ISO 23279 and ISO 17640.