INTERNATIONAL STANDARD

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

Part 12: Spot, seam and projection welding

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

Partie 12: Soudage par points, à la molette et par bossages

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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).

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).

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

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 44, *Welding and allied processes*, Subcommittee SC 6, *Resistance welding and allied mechanical joining* and by CEN/TC 121, *Welding and allied processes* in collaboration.

This second edition cancels and replaces the first edition (ISO 15614-12:2004), of which it constitutes a minor revision with the following changes:

— Annex ZA has been removed;

— ISO 14732 has been added to the Bibliography and has replaced EN 1418.

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 welding of copper and its alloys*

— *Part 7: Overlay welding*

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

— *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 International Standard should be directed to the Secretariat of ISO/TC 44/SC 6 via your national standards body. A complete listing of these bodies can be found at "www.iso.org."

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, Annex A.

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

Part 12: Spot, seam and projection welding

1 Scope

This part of ISO 15614 specifies the tests which can be used for qualification of welding procedure specifications for spot, seam, and projection welding processes.

This International Standard is part of the ISO 15614 series. Details of this series are given in ISO 15607, Annex A.

This part of ISO 15614 defines the conditions for carrying out tests and the limits of validity of a qualified welding procedure for all practical welding operations covered by this part of ISO 15614.

The tests required to qualify the procedure for a particular component/assembly depend on the performance and quality requirements of the component/assembly and shall be established before any qualification is undertaken.

Tests shall be carried out in accordance with this part of ISO 15614 unless more severe tests are specified by the relevant application standard or contract when these shall apply.

The acceptability of applying the principles of this part of ISO 15614 to other resistance welding processes should be established before any qualification is undertaken.

NOTE Specific service, material, or manufacturing conditions might require more comprehensive testing than is specified by this part of ISO 15614.

Such tests can include:

— method for fatigue testing for spot welded joints;

— specimen dimensions and procedure for impact, shear and cross-tension testing resistance spot and projection welds;

— bend test;

— surface crack detection;

— ultrasonic tests and X-ray test;

— chemical analysis and corrosion tests;

— micro examination, including assessment of hot cracking behaviour;

— tests of components or complete welded assemblies.

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

— 21 – resistance spot welding;

  — 211 – indirect spot welding;

- 212 – direct spot welding;
- 22 – resistance seam welding;
  - 221 – lap seam welding;
  - 222 – mash seam welding;
  - 225 – foil butt-seam welding;
  - 226 – seam welding with strip;
- 23 – projection welding;
  - 231 – indirect projection welding;
  - 232 – direct projection welding.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 10447, *Resistance welding — Peel and chisel testing of resistance spot and projection welds*

ISO 14270, *Specimen dimensions and procedure for mechanized peel testing resistance spot, seam and embossed projection welds*

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

ISO 14272, *Specimen dimensions and procedure for cross tension testing resistance spot and embossed projection welds*

ISO 14273, *Specimen dimensions and procedure for shear testing resistance spot, seam and embossed projection welds*

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

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

ISO 17653, *Resistance welding — Destructive tests on welds in metallic materials — Torsion test of resistance spot welds*

ISO 17677-1, *Resistance welding — Vocabulary — Part 1: Spot, projection and seam welding*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 669, ISO 15607, and ISO 17677-1 apply.

4 Preliminary welding procedure specification (PWPS)

The preliminary welding procedure specification shall be prepared in accordance with ISO 15609-5.

5 Welding procedure test

The preparation and testing of test pieces shall be in accordance with Clauses 6 and 7 of this part of ISO 15614.

6 Test piece

6.1 General

The welded assembly to which the welding procedure will relate to in production shall be represented by actual components or by preparing a standardized test piece in accordance with 6.2.

Test specimens shall be cut from the actual components; the test piece is welded separately according to 6.3. Test specimens or test pieces from the same material with relevant flange widths or overlap length should be used. When applicable, shunting and inductive effects shall be taken into account.

If required by the application standard, the direction of plate rolling shall be marked on the test piece.

6.2 Shape and dimensions of test pieces and test specimens for destructive testing

6.2.1 General

The shape and dimensions of the test pieces and test specimens and the test procedures are specified in the following International Standards: ISO 14270, ISO 14271, ISO 14272, ISO 14273, ISO 17653, and ISO 10447.

6.2.2 Macrosection

The test specimens shall be prepared and etched to produce transverse and/or longitudinal sections in order to clearly show the nugget, the heat affected zone (HAZ), and, if necessary, the weld profile.

The transverse macrosection shall include the unaffected parent material.

6.3 Welding of components, test pieces or test specimens

Preparation of components, test pieces or test specimens, and welding of test pieces or test specimens shall be carried out in accordance with the PWPS, and under the general conditions of production welding (parameters, equipment, etc.) which they shall represent.

If tack welds are used in the case of seam welds, they should be included in the final test piece.

Welding and testing of the test pieces shall be witnessed by an examiner or examining body and the details of this shall be established before any qualification is undertaken.

7 Examination and testing

7.1 Extent of testing

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

The selection of test types and the number of test specimens depends on the performance and quality requirements of the component/assembly and shall be established before any qualification is undertaken; examples are given in Table 1.

When the standard deviation for test results in shear and cross-tension tests is not necessary, the reduced number of specimens shall be established before any qualification is undertaken.

Table 1 — Examples for testing spot, seam, and projection welding joints

Test piece/specimen	Test type	Number of samples
One-spot or projection specimen	Visual examination	all
	Shear test	11
	Cross-tension[a]	11
	Macrosection[b]	2
	Hardness test	if requested
	Torsion test[c]	11
	Peel test	11
	Chisel test	11
Two-spot or projection specimen[d]	Visual examination	all
	Shear test[e]	11
	Cross-tension test[a]	11
	Macrosection[b]	2
	Hardness test[f]	if requested
	Peel test	11
	Chisel test	11
Multi-spot test or projection specimen[g]	Visual examination	all
	Shear test[h]	11
	Peel test	11
	Macrosection[b]	2
	Hardness test[f]	if requested
	Chisel test	11

[a] Substitute test for the shear test with predominant cross-tension loading.

[b] Two macrosections displaced by 90° and arranged perpendicular to the plane of the plate; elongated projections shall be located in the major axes.

[c] Substitute test for the shear/cross-tension test, if specimen preparation conforming to standards is not possible, or in the case of predominant torsion loading.

[d] Only with push-pull welding and indirect welding.

[e] The two-spot weld specimen shall be cut into single-spot weld specimens for the shear test. Deviations of the specimen width from the standard specimen result from the spot weld pitch.

[f] Two-spot welds.

[g] The multi-spot weld specimen shall be welded and tested with the same spot weld pitch, edge distance, and row spacing as on the component in production.

[h] In the case of spot weld rows, proceed in the same way as in two-spot weld testing.

[i] Substitute test for the peel test in case of predominant shear loading.

[j] Only if leak-tightness is required (pressure test).

[k] Only if high leak-tightness is required.

[l] One transverse section and one longitudinal section.

[m] At right angle to the weld, if applicable.

[n] Each side (top and bottom side).

[o] Only mash seam weld: each three specimens from the start, middle, and end of seam weld.

Table 1 *(continued)*

Test piece/specimen	Test type	Number of samples
Overlapped seamweld specimen (test piece)	Visual examination	all
	Peel test	11
	Shear test[i]	11
	Pillow test[j]	3
	Helium leakage test[k]	3
	Macrosection[l]	2
	Hardness test	if requested
Seam welding with strip, mash seam welding	Visual examination	all
	Shear test[m]	11
	Bend test[n]	2
	Peel test[o]	9
	Pillow test[j]	3
	Helium leakage test[k]	3
	Macrosection[l]	2
	Hardness test	if requested

a Substitute test for the shear test with predominant cross-tension loading.

b Two macrosections displaced by 90° and arranged perpendicular to the plane of the plate; elongated projections shall be located in the major axes.

c Substitute test for the shear/cross-tension test, if specimen preparation conforming to standards is not possible, or in the case of predominant torsion loading.

d Only with push-pull welding and indirect welding.

e The two-spot weld specimen shall be cut into single-spot weld specimens for the shear test. Deviations of the specimen width from the standard specimen result from the spot weld pitch.

f Two-spot welds.

g The multi-spot weld specimen shall be welded and tested with the same spot weld pitch, edge distance, and row spacing as on the component in production.

h In the case of spot weld rows, proceed in the same way as in two-spot weld testing.

i Substitute test for the peel test in case of predominant shear loading.

j Only if leak-tightness is required (pressure test).

k Only if high leak-tightness is required.

l One transverse section and one longitudinal section.

m At right angle to the weld, if applicable.

n Each side (top and bottom side).

o Only mash seam weld: each three specimens from the start, middle, and end of seam weld.

7.2 Location and cutting of test specimens

Test specimens shall be taken after visual testing or after an alternative non-destructive testing. The location of test specimens shall be in accordance with 6.2.

It is permitted to take the test specimens from locations avoiding areas showing acceptable imperfections.

7.3 Visual testing

The spot welds and roller seam welds shall be tested — as far as access is possible — using a magnifier (six to tenfold magnification), a mirror or an endoscope in order to identify the following features on the

outside: surface cracks, metal expulsion, spatters, deposit of electrode material, electrode indentation depth, and sheet separation.

7.4 Re-testing

If the component or the test piece fails to comply with any of the requirements for visual examination or other non-destructive examination, one further component or test piece shall be subjected to the same examination. If this additional component or test piece does not comply with the same requirements, the PWPS needs to be modified. The modified PWPS shall be approved according to the requirements of this part of ISO 15614.

If any test specimen fails to comply with the relevant requirements of 6.2 due to geometric weld imperfections (e. g. location, shape), further test specimens shall be obtained for each one that failed. These can be taken from the same test piece if there is sufficient material available or from a new test piece, and shall be subjected to the same test.

If any of these additional test specimens does not comply with the relevant requirements, the PWPS needs to be modified. The modified PWPS shall be approved according to the requirements of this part of ISO 15614.

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 welding procedure specification (WPS) obtained by a manufacturer is valid for welding in workshops or sites under the same technical and quality control of that manufacturer.

Welding is under the same technical and quality control when the manufacturer who qualified the WPS retains complete responsibility for all welding carried out to it.

8.3 Related to the material

All tests shall be carried out with materials used in production (thickness, chemical analysis, mechanical properties). Any modification shall be established before any qualification is undertaken.

8.4 Common to all welding procedures

8.4.1 Welding process

The qualification only applies to the welding procedure used in the welding procedure test.

Where welding equipment is provided with remote control for more than one welding program used at a work station as part of a sequential operation, the WPS should include details of all welding programs used.

In automatic or robotic operating with more than one weld program, the WPS should include details of all welding programs used, each of which requires qualification.

8.4.2 Type of current

The weld procedure is qualified using the type of current (alternating, direct, or pulsed), frequency and polarity used for the welding procedure test.

8.4.3 Welding cycle

The weld procedure is qualified using the welding cycle used for the welding procedure test.

8.4.4 Postweld heat treatment in the welding equipment

Any heat treatment provided for shall be taken in account in the welding procedure test.

8.4.5 Type of weld equipment

The weld procedure is qualified using the same type of welding equipment used for the welding procedure test.

8.4.6 Welding electrodes

The weld procedure is qualified using the electrode materials and configuration used for the welding procedure test.

9 Welding procedure qualification record form (WPQR)

A welding procedure qualification record (WPQR) is a statement of results of assessment of each test piece including re-test. The relevant items listed for the WPS in ISO 15609-5 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.

Bibliography

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

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

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