INTERNATIONAL STANDARD

ISO 18278-1

Third edition
2022-05

Resistance welding — Weldability —

Part 1: General requirements for the evaluation of weldability for resistance spot, seam and projection welding of metallic materials

Soudage par résistance — Soudabilité —

Partie 1: Exigences générales pour l'évaluation de la soudabilité pour le soudage par résistance par points, à la molette et par bossages des matériaux métalliques

Reference number
ISO 18278-1:2022(E)

COPYRIGHT PROTECTED DOCUMENT

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword ... **iv**

1 Scope ... **1**

2 Normative references ... **1**

3 Terms and definitions ... **2**

4 Weldability ... **4**
4.1 Weldability of a component ... 4
4.1.1 General ... 4
4.1.2 Metallurgical weldability ... 5
4.1.3 Operative weldability ... 5
4.1.4 Constructional weldability ... 5
4.2 Criteria for the evaluation of weldability ... 5

5 Preparation of welding equipment ... **6**
5.1 Welding machine ... 6
5.2 Welding electrodes ... 6
5.2.1 General ... 6
5.2.2 Spot welding ... 6
5.2.3 Seam welding ... 6
5.2.4 Projection welding ... 6
5.3 Measurement of parameters ... 7
5.3.1 Welding current ... 7
5.3.2 Electrode force ... 7

6 Test procedures ... **7**
6.1 General ... 7
6.2 Basic test procedures ... 7
6.2.1 Essential variables ... 7
6.2.2 Welding current range test ... 7
6.2.3 Electrode life test ... 8
6.2.4 Weldability lobe test ... 9
6.3 Evaluation of weld properties ... 10
6.3.1 General ... 10
6.3.2 Shop floor tests ... 10
6.3.3 Tensile shear testing ... 10
6.3.4 Mechanized peel testing ... 11
6.3.5 Cross-tension testing ... 11
6.3.6 Macro-sections and hardness test ... 11
6.3.7 Further weld properties ... 11

7 Test report ... **11**
7.1 General ... 11
7.2 Welding current range test ... 11
7.3 Electrode life test ... 12
7.4 Weldability lobe test ... 12

Annex A (informative) **How to evaluate the mass and friction of the welding head** ... **14**

Bibliography ... **15**

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 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.

This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 6, *Resistance welding and allied mechanical joining,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 121, *Welding and allied processes,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 18278-1:2015) and the first edition of ISO 14327:2004, which have been technically revised.

The main changes are as follows:

— the concept of weldability lobe was added to this document.

A list of all parts in the ISO 18278 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Resistance welding — Weldability —

Part 1: General requirements for the evaluation of weldability for resistance spot, seam and projection welding of metallic materials

1 Scope

This document specifies procedures for assessing the generic weldability for resistance spot, seam and projection welding of uncoated and coated metals.

The purpose of the tests described in this document are to

a) compare the metallurgical weldability of different metals,

b) assess the weldability of differing component designs, e.g. dimensional configuration, stack-up, projection geometry, etc.,

c) investigate the effect of changes in welding parameters such as welding current, weld time, electrode force or complex welding schedules including pulse welding, current stepping etc. on weldability, and/or

d) compare the performance of resistance welding equipment.

Precise details of the test procedure to be used depend on which aspect of items a) to d) will be evaluated relative to the welding result obtained.

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 693, *Dimensions of seam welding wheel blanks*

ISO 5182, *Resistance welding — Materials for electrodes and ancillary equipment*

ISO 5821, *Resistance welding — Spot welding electrode caps*

ISO 8167, *Resistance welding — Embossed projection welding — Projections for resistance welding*

ISO 14270, *Resistance welding — Destructive testing of welds — 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, *Resistance welding — Destructive testing of welds — Specimen dimensions and procedure for cross tension testing of resistance spot and embossed projection welds*

ISO 14273, *Resistance welding — Destructive testing of welds — Specimen dimensions and procedure for tensile shear testing resistance spot and embossed projection welds*

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

ISO 15614-12, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 12: Spot, seam and projection welding*

ISO 16432, *Resistance welding — Procedure for projection welding of uncoated and coated low carbon steels using embossed projection(s)*

ISO 17657-2, *Resistance welding — Welding current measurement for resistance welding — Part 2: Welding current meter with current sensing coil*

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

ISO/TR 581, *Weldability — Metallic materials — General principles*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17677-1, ISO 669, ISO/TR 581 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

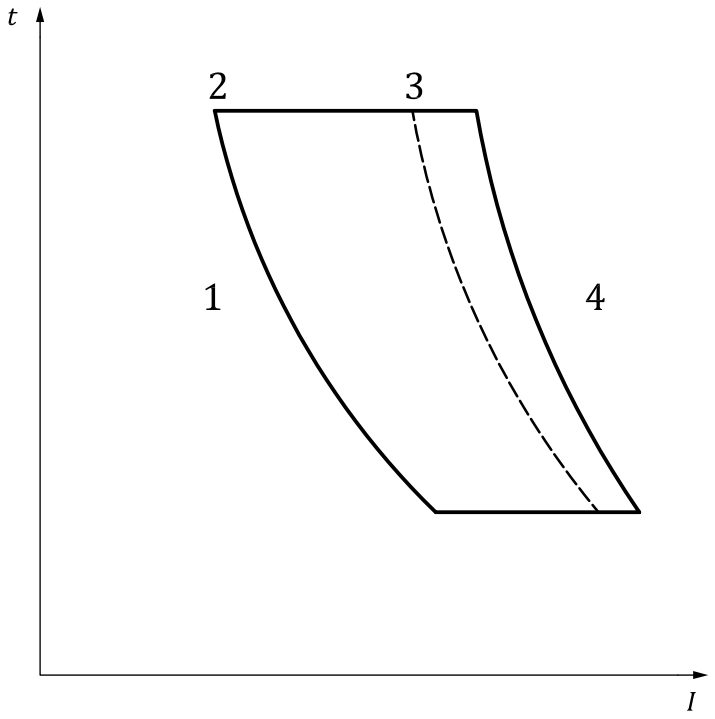
3.1
weldability
<resistance welding> capacity of the component to be welded under the imposed fabrication conditions into a specific suitability designed structure and to perform satisfactorily in the intended service

3.2
welding current range
welding current domain allowing the production of spot welds without expulsion and of a diameter equal to or more than a pre-determined value under constant machine settings

3.3
weldability lobe
welding current domain allowing the production of spot welds without splash and of a diameter equal to or more than a pre-determined value, using varied values of either welding time or electrode force

Note 1 to entry: In the case of resistance seam welding, welding speed (m/min) is used instead of weld time.

Note 2 to entry: To meet the above requirements, the weldability lobes can be a two-dimensional plot (see Figure 1) or a three-dimensional plot indicating the inter relationship between weld time (welding speed in the case of seam welding), welding current and electrode force:



Key

t weld time

I welding current

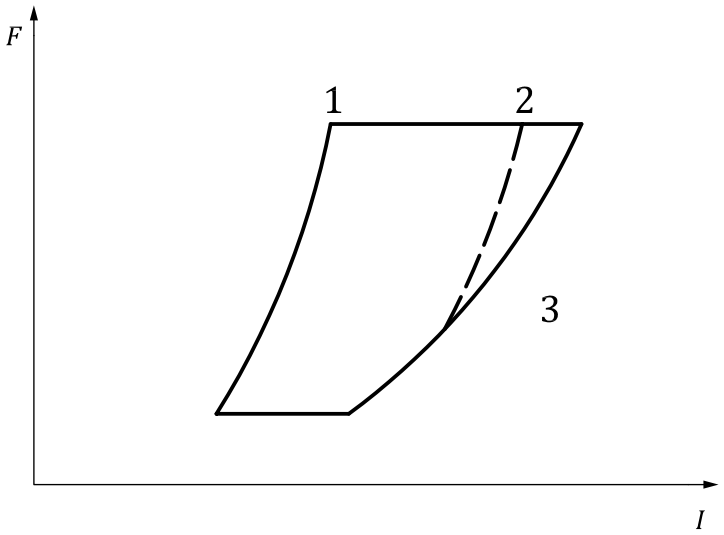
1 $<3{,}5\sqrt{t}$

2 $3{,}5\sqrt{t}$

3 $5\sqrt{t}$

4 expulsion

a) Spot welding — constant force



Key

F electrode force

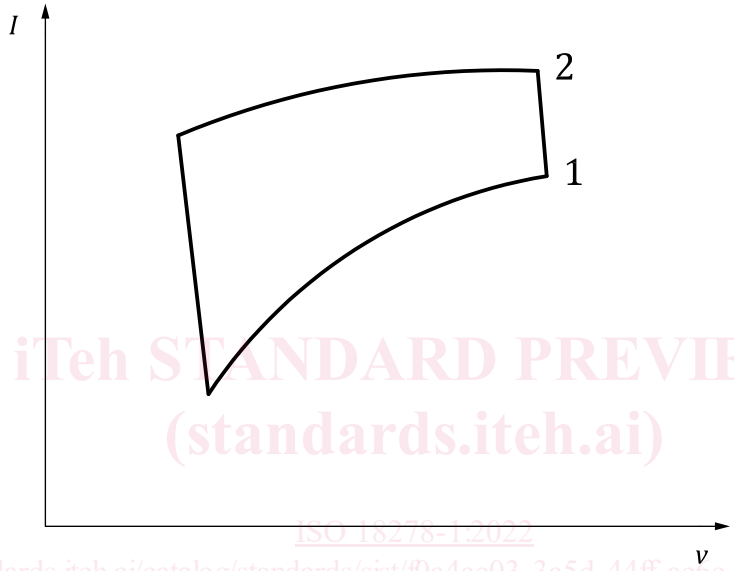
I welding current

1 $3{,}5\sqrt{t}$

2 $5\sqrt{t}$

3 expulsion

b) Spot welding — constant weld time



Key

I welding current (kA)

v welding speed (m/min)

1 lower limit

2 upper limit

c) Seam welding — constant weld force — typical for zinc coated steels

Figure 1 — Typical weldability lobes

4 Weldability

4.1 Weldability of a component

4.1.1 General

Weldability of a component is governed by three factors: material, design, and production (see Figure 2).

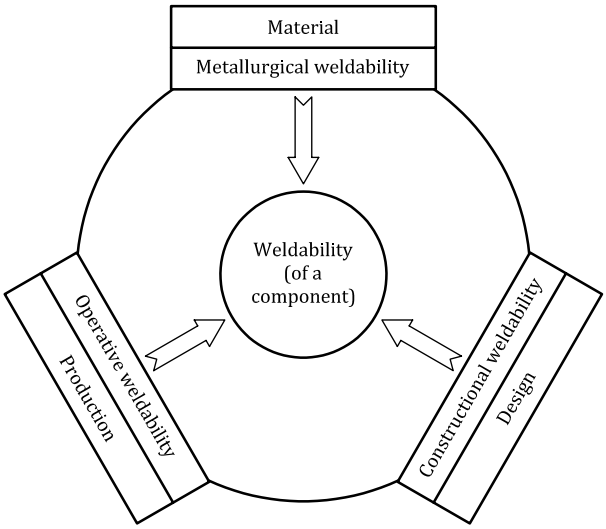


Figure 2 — Weldability

4.1.2 Metallurgical weldability

The less the factors governed by the material have to be taken into account when determining the welding procedure for a given construction, the better the metallurgical weldability of a material group.

The ease by which a material can be welded determines its metallurgical weldability.

4.1.3 Operative weldability

Operative weldability exists for a welding procedure if the welds envisaged for a particular construction can be made properly under the chosen conditions of production.

The less the factors governed by the welding procedure have to be taken into account in designing a construction for a specific material, the better is the operative weldability of a procedure intended for a specific structure or component.

4.1.4 Constructional weldability

Constructional weldability exists in a construction if the material concerned and the component remain capable of functioning under the envisaged operating conditions by virtue of their design.

The less the factors governed by the design have to be taken into account when selecting the material for a specific welding procedure, the greater the constructional weldability of a specific structure or component.

4.2 Criteria for the evaluation of weldability

Weldability in resistance welding requires the ability to make a weld in the first place, the ability to continue making welds, and the ability of the weld to withstand the imposed service stresses.

Criteria for the evaluation of the weldability in resistance welding are typically as follows:

— weldability lobe and welding current range which quantify ability to make a weld (see NOTE);

— electrode wear and life which quantify the ability to continue making welds (see NOTE);

— strength of joints under different load directions;

— material hardness modifications;

— presence, number, and size of the surface or inner cracks, pores, shrink holes, and other defects;

— fracture behaviour under different load directions;

— resistance to service stresses such as corrosion, humidity, low, elevated, or fluctuating temperatures etc.

NOTE Results of weldability lobe, welding current range and electrode life investigations do not only reflect material characteristics, but are also highly related to the characteristics of the welding equipment employed.

A final evaluation of weldability in each case can only be estimated by considering the prioritized criteria laid down by the end user.

5 Preparation of welding equipment

5.1 Welding machine

The electrical and mechanical characteristics of the welding machine used for the tests shall meet the requirements specified in ISO 669.

In a.c.-welding machines and single-phase d.c.-welding machines, wherever possible, a transformer tap setting should be selected which allows the secondary welding current to be achieved using a conduction angle greater than 120°. The water supply to the transformer and/or rectifier and welding controller cooling circuits should be independent of cooling water to the electrodes. If this is not possible, the water should flow from the electrode to the welding controller/transformer circuits and not vice versa.

The mass and static friction properties of the welding head can be determined in accordance with Annex A. It is recommended to record the test results to evaluate the mechanical characteristics of the welding machine.

NOTE If low electrode force values are used, then the welding process can be adversely influenced by the follow-up behaviour of the electrode head assembly. If electrode force levels near the top end of the available range are used, then contact errors and electrode approach are more important.

5.2 Welding electrodes

5.2.1 General

The welding electrodes shall conform to alloys as specified in ISO 5182 unless otherwise agreed between contracting parties. Electrodes should be of sufficient cross-sectional area and strength to carry the welding current and electrode force without overheating, deformation, or excessive deflection.

5.2.2 Spot welding

In the case of spot welding, the electrode dimensions shall conform to the requirements of ISO 5821. Alternative electrode shapes and dimensions may be used by agreement between contracting parties.

5.2.3 Seam welding

In the case of wide wheel seam welding, the electrode dimensions shall conform to the requirements of ISO 693. Alternative electrode wheel width and face profile may be used by agreement between contracting parties.

5.2.4 Projection welding

In the case of embossed projection welding, the electrode dimensions shall conform to the requirements of ISO 16432. Alternative electrode shapes and dimensions may be used by agreement between contracting parties.

5.3 Measurement of parameters

5.3.1 Welding current

The welding current shall be measured with a current measuring system of high accuracy class in accordance with ISO 17657-2. The welding current value shall be measured over the total weld time.

The shape of the welding current waveform shall be measured using a suitable device to determine the regularity of welding current peak values and conformity of the actual welding cycle with the programmed welding cycle.

5.3.2 Electrode force

The electrode force shall be expressed in kilonewtons with an accuracy of ±3 % and measured without current flow.

6 Test procedures

6.1 General

Tests which are considered necessary by the user for assessing the weldability shall be specified.

Acceptance criteria for each test will depend on the requirements of the product being welded and shall be specified before commencing the test programme.

The evaluation of weldability requires the following steps:

— ensure the welding equipment is within specifications;

— analyse and determine material properties;

— carry out the test procedure according to pWPS (ISO 15614-12, ISO 15609-5);

— document and evaluate the test results.

6.2 Basic test procedures

6.2.1 Essential variables

The weldability lobe, welding current range and electrode life are influenced by the following:

a) the electrical and mechanical characteristics of the welding equipment, including cooling conditions;

b) the welding parameters, including welding rate for electrode life;

c) the electrical, mechanical and physical properties of the material being welded;

d) the welding configuration used;

e) the electrode material and design of the welding electrode;

f) the test specimen or component being welded.

6.2.2 Welding current range test

For the determination of the ability to make a weld, a welding current range shall be determined according to the procedures agreed upon between the contracting parties. In producing a welding current range, electrode wear can occur due to heavy expulsion, surface expulsion, mushrooming, or