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**Resistance welding — Weldability —**

Part 1:

**Assessment of weldability for resistance  
spot, seam and projection welding of  
metallic materials**

*Soudage par résistance — Soudabilité —*

*Partie 1: Évaluation de la soudabilité pour le soudage par résistance  
par points, à la molette et par bossages des matériaux métalliques*



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## Foreword

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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 18278-1 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 18278 consists of the following parts, under the general title *Resistance welding — Weldability*:

- *Part 1: Assessment of weldability for resistance spot, seam and projection welding of metallic materials*
- *Part 2: Alternative procedures for the assessment of sheet steels for spot welding*

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## Foreword

This document (EN ISO 18278-1:2004) has been prepared by Technical Committee CEN/TC 121 "Welding", the secretariat of which is held by DIN, 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of an identical text or by endorsement, at the latest by May 2005, and conflicting national standards shall be withdrawn at the latest by May 2005.

This standard consists of the following parts:

- Part 1: Assessment of weldability for resistance spot, seam and projection welding of metallic materials;
- Part 2: Alternative procedures for the assessment of sheet steels for spot welding.

This document includes a Bibliography.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.



## 1 Scope

This document recommends procedures for determining the generic weldability for resistance spot, seam and projection welding of metallic materials.

This procedure is applicable for the assessment of the weldability of uncoated/coated steels, stainless steels and non-ferrous alloys such as aluminium, titanium, magnesium and nickel and their alloys of single thickness lower than or equal to 5 mm.

The weldability of metallic materials in resistance welding is defined in terms of:

- the ability to make the weld in the first place;
- the ability to continue making welds;
- the ability of the weld to withstand the imposed service stresses.

The procedures recommended in this standard can be used to:

- compare the weldability of different metallic materials;
- compare the welding response of particular welding equipment and allow comparisons between different equipment and determine the influence of the static/dynamic properties of different welding equipment;
- determine the weldability of a material when any welding configuration is changed e.g. electrode material and/or shape, water cooling requirements etc.;
- investigate the effect of welding parameters such as welding current, weld time, electrode force or complex welding schedules including pulse welding, current stepping etc. on weldability.

## 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 ISO 8166, *Resistance welding — Procedure for the evaluation of the life of spot welding electrodes using constant machines settings (ISO 8166:2003)*.

EN ISO 14270, *Specimen dimensions and procedure for mechanized peel testing resistance spot, seam and embossed projection welds (ISO 14270:2000)*.

EN ISO 14271, *Vickers hardness testing of resistance spot, projection and seam welds (low load and microhardness) (ISO 14271:2000)*.

EN ISO 14272, *Specimen dimensions and procedure for cross tension testing resistance spot and embossed projection welds (ISO 14272:2000)*.

EN ISO 14273, *Specimen dimensions and procedure for shear testing resistance spot, seam and embossed projection welds (ISO 14273:2000)*.

EN ISO 14327, *Resistance welding — Procedures for determining the weldability lobe for resistance spot, projection and seam welding (ISO 14327:2004)*.

## ISO 18278-1:2004(E)

EN ISO 14329:2003, *Resistance welding — Destructive tests of welds — Failure types and geometric measurements for resistance spot, seam and projection welds (ISO 14329:2003)*.

EN ISO 15609-5, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 5: Resistance welding (ISO 15609-5:2004)*.

EN ISO 15614-12, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 12: Spot, seam and projection welding (ISO 15614-12:2004)*.

EN ISO 18278-2:2004, *Resistance welding — Weldability — Part 2: Alternative procedures for the assessment of sheet steels for spot welding (ISO 18278-2:2004)*.

ISO 669:2000, *Resistance welding — Resistance welding equipment — Mechanical and electrical requirements*.

ISO/DIS 14373, *Resistance welding — Procedure for spot welding of uncoated and coated low carbon steels*.

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

ISO/DIS 16433, *Resistance welding — Procedure for seam welding of uncoated and coated low carbon steels*.

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 669:2000, EN ISO 14329:2003 and EN ISO 18278-2:2004 and the following apply.

#### 3.1

##### **ability to make a weld**

characteristic of a component defined by the available welding current range

#### 3.2

##### **ability to continue making welds**

estimation of the electrode life as defined by the number of welds which can be made before the need for re-dressing or changing of the welding electrodes

#### 3.3

##### **service stresses**

as used in this context, applies not only to static and dynamic loading, but also includes stresses imposed by environmental conditions such as corrosion, humidity, low, elevated or fluctuating temperatures etc.

### 4 Test procedures

#### 4.1 General

Test procedures can be sub-divided into two groups as follows:

- those which are considered basic to an understanding of weldability. Such tests shall be carried out to assess the weldability of the material;
- those tests which provide additional information to any basic evaluation of a material. Such tests may be carried out depending on the end application.

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 type of failure shall be determined according to EN ISO 14329.



The procedure for spot welding on uncoated and coated low carbon and high strength steels shall be used in accordance with ISO/DIS 14373, for seam welding in accordance with ISO/DIS 16433 and for projection welding with ISO/DIS 16432. Other welding procedures shall be also be specified, if necessary.

## 4.2 Basic test procedures

### 4.2.1 Determination of the ability to make a weld

For the determination of the ability to make a weld a weldability lobe shall be determined according to procedures as specified in EN ISO 14327.

The purpose of this procedure is to provide information on suitable weld settings and the welding current range which can be used to give acceptable welds as defined within precise limits.

The weldability lobe is influenced by:

- the electrical and mechanical characteristics of the welding equipment;
- welding parameters;
- the electrical, mechanical and physical properties of the material being welded;
- the welding configuration used;
- the electrode material and design of the welding electrode;
- the test specimen or component being welded.

### 4.2.2 Determination of the ability to continue making welds

For the determination of the ability to continue making welds the electrode life test determined at constant machine settings according to EN ISO 8166 shall be used.

The purpose of this test is to provide an indication of the number of acceptable welds which can be made from a pair of welding electrodes before the need to re-dress or change the electrodes.

If current stepping programs or pulse welding procedures are used, the test procedure shall be modified to take into account any necessary changes arising from the use of such welding schedules.

Factors which determine the value of electrode life include:

- electrode material and design;
- type of welding equipment;
- the electrical and mechanical characteristics of the welding equipment;
- welding conditions;
- welding rate;
- water cooling arrangements;
- transformer/electrode configuration;
- material being welded;
- shape of the test specimen or component being welded;

— surface conditions (e.g. pretreatment coating).

EN ISO 8166 does not apply to seam welding. Alternative procedures shall be specified or developed for the evaluation of electrodes for seam welding. Generally, special variants of the seam welding process are used to weld coated steels which eliminate the problems associated with electrode contamination. In these cases e.g. narrow wheel welding, continuous wire welding and foil butt welding, electrode life testing may be omitted.

In case where only slight modifications are made to the properties of the material being assessed and where there is adequate published information as to typical electrode life to be expected, then this test may be omitted.

### **4.2.3 Determination of the weld properties**

#### **4.2.3.1 General**

The relevant tests to be used according 4.2.3.2 to 4.2.3.6 shall be specified, if necessary.

The type of failure obtained in a test will depend on the material being welded, for example:

- rephosphorised steels, some high strength and ultra high strength steels can be give interfacial failures and partial plug failures depending on the welding parameters and the testing conditions used;
- in the case of aluminium and aluminium alloys porosity and cracks may occur;
- with nickel alloys hot cracking may occur;
- for the same type of material, increasing the thickness favours interface failures;
- the type of failure and the weld diameter will be influenced by the type of test.

#### **4.2.3.2 Shop floor tests**

Shop floor tests are used to determine the type of failure and the weld diameter by chisel or peel tests according to ISO 10447 or torsion test according to EN ISO 17653 and can be used for determining the weldability lobe. The results obtained from such tests give information on the ability to control weld quality, for example the weld setter and the inspection personnel used for quality control on the shop floor.

#### **4.2.3.3 Shear testing**

The shear testing shall be carried out according to EN ISO 14273.

The purpose of this test is to determine the failure type and the maximum shear force that the test specimen can sustain.

#### **4.2.3.4 Mechanised Peel testing**

The peel testing shall be carried out according to EN ISO 14270.

The purpose of this test is to determine the failure type and the peel force that the test specimen can sustain.

#### **4.2.3.5 Cross tension testing**

The cross tension testing shall be carried out according to EN ISO 14272.

The purpose of this test is to determine the failure type and the tensile force that the test specimen can sustain.

#### 4.2.3.6 Macrosections and hardness test

The shape and dimension of the weld nugget together with hardness values shall be determined on etched macrosections according to EN ISO 14329 and EN ISO 14271. The results of the tests give basic information on the influence of welding parameters (e.g. nugget dimension and hardness).

### 4.3 Additional tests

#### 4.3.1 General

The use of such tests should be based on shop floor conditions and applications.

Factors to be considered in the selection of any procedures shall include:

- the type of metallic material being welded;
- presence of metallic, conversion, primer, wax, lubricant, paint or organic coatings;
- the need to produce non-marking or low indentation welds;
- electrode configuration to be used;
- type of welding equipment to be used including any misalignment contact errors and dynamic properties, e.g. friction within the electrode head assembly, impact and bounce characteristics, see ISO 669 for details;
- characteristics of the secondary circuit i.e. direct/indirect/series/push-pull transformer configurations, dimensions of secondary loop, jiggling arrangements;
- production constraints for example, welding rate, production rate as dictated by robotic or automation requirements.

#### 4.3.2 Hold time sensitivity procedure

The influence of hold time should be determined in order to assess the likelihood of brittle failure in test specimens and the incidence of excessive hardness values in the weld zone.

The following standard can be used: ISO 10447, EN ISO 14271, ISO/DIS 14323, EN ISO 17653.

## 5 Further weld properties

Further weld properties can be sub-divided into:

- static properties;
- fatigue properties;
- impact properties.

For the determination of the static properties the following additional tests can be used:

- pressure testing of seam welds according to EN ISO 17654;
- multispot and projection test pieces or components as specified.

For the determination of the fatigue properties the following test can be used:

- fatigue testing according to EN ISO 14324.

For the determination of the impact behaviour the following test can be used:

- impact shear test according to ISO/DIS 14323.

Multispot, projection or seam welded test pieces or components are necessary to determine the influence of design variations and figure for calculations and assessment of corresponding tests. These expensive tests are necessary because the simple and cheap tests give no suitable results for the design influence and no figures for calculations.

## **6 Test report**

The results of the assessment shall be given in tabular form as stipulated in EN ISO 15609-5 and EN ISO 15614-12.

## Bibliography

EN ISO 14324, *Resistance spot welding — Destructive tests of welds — Method for the fatigue testing of spot welded joints (ISO 14324:2003)*.

EN ISO 17653, *Destructive tests on welds in metallic materials — Torsion test of resistance spot welds (ISO 17653:2003)*.

EN ISO 17654, *Destructive tests on welds in metallic materials — Resistance welding — Pressure test on resistance seam welds (ISO 17654:2003)*.

ISO 10447, *Welding — Peel and chisel testing of resistance spot, projection and seam welds*.

prEN ISO 14323, *Resistance spot welding and projection welds - Destructive testing of welds - Specimen dimensions and procedure for impact shear test and cross tension testing (ISO/DIS 14323:2003)*.

