INTERNATIONAL STANDARD

ISO 14744-6

First edition
2000-04-15

Welding — Acceptance inspection of electron beam welding machines —

Part 6: Measurement of stability of spot position

Soudage — Essais de réception des machines de soudage par faisceau d'électrons —

Partie 6: Mesure de la stabilité de la position de la tache focale

Reference number
ISO 14744-6:2000(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 734 10 79
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

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 3.

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 member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 14744 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 14744-6 was prepared by the European Committee for Standardization (CEN) in collaboration with ISO Technical Committee 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 standard, read "...this European Standard..." to mean "...this International Standard...".

ISO 14744 consists of the following parts, under the general title *Welding — Acceptance inspection of electron beam welding machines*:

— *Part 1: Principles and acceptance conditions*

— *Part 2: Measurement of accelerating voltage characteristics*

— *Part 3: Measurement of beam current characteristics*

— *Part 4: Measurement of welding speed*

— *Part 5: Measurement of run-out accuracy*

— *Part 6: Measurement of stability of spot position*

Contents

Foreword

The text of EN ISO 14744-6:2000 has been prepared by Technical Committee CEN/TC 121 "Welding", the secretariat of which is held by DS, 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 October 2000, and conflicting national standards shall be withdrawn at the latest by October 2000.

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

This draft European Standard is composed of the six following parts:

– Part 1: Principles and acceptance conditions;
– Part 2: Measurement of accelerating voltage characteristics;
– Part 3: Measurement of beam current characteristics;
– Part 4: Measurement of welding speed;
– Part 5: Measurement of run-out accuracy;
– Part 6: Measurement of stability of spot position.

1 Scope

This standard is intended for use when the stability of spot stability of welding machines complying with EN ISO 14744-1 is to be measured in connection with an acceptance inspection. It provides essential information to the procedure and apparatus to be used for making the measurements.

The stability of the spot position is a particularly significant parameter for prolonged welding applications and for electron beam welding with automatic devices positioning the workpiece. In such applications, the welding machine shall be able to reproduce, over prolonged periods and without additional correction of the position being required, a given beam-to-joint alignment. The purpose of measurement is to check whether and to what extent the electron beam generated by a welding machine keeps within the range of limit deviations specified for the spot position.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN ISO 14744-1:2000
Welding – Acceptance inspection of electron beam welding machines – Part 1: Principles and acceptance conditions (ISO 14744-1 : 2000)

EN ISO 14744-3
Welding – Acceptance inspection of electron beam welding machines – Part 3: Measurement of beam current (ISO 14744-3 : 2000)

ISO 1302
Technical drawings – Method of indicating surface texture

3 Terms and definitions

For the purposes of this European Standard, the following term and definition applies.

3.1
Spot position
geometrical position of the electron beam when it impinges on the workpiece surface (weld point) with respect to a system of coordinates perpendicular to the axis of the beam

4 Test arrangement

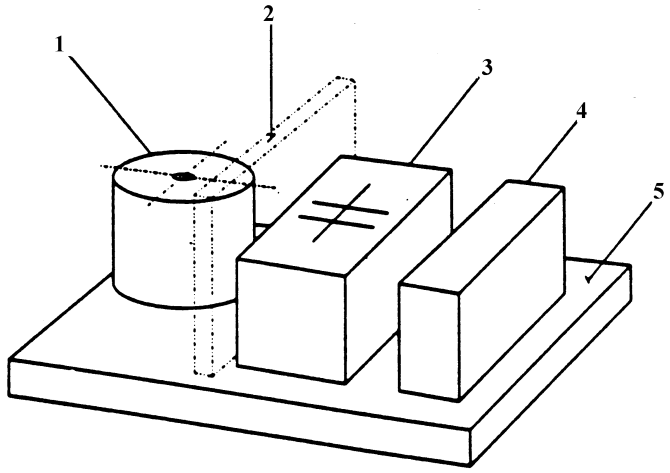
4.1 General

During the specified test period, the electron beam, at a given power, transmits its energy to a heatsink A or to a Faraday cup as described in EN ISO 14744-3 (see figure 1). For the actual measurement, a specially prepared workpiece, B, shall be positioned in the beam axis and the beam power adjusted to the welding task (small melt spots or melt runs).

The beam focal distance employed shall be the maximum practical in the work chamber.

The heatsink or the Faraday cup and the workpiece B shall be arranged relative to each other so as to prevent any thermal interaction.

To determine the beam current required for the measurement, as is normal in welding practice, a third workpiece, C, of the same height as workpiece B shall be provided (see figure 1).
To avoid beam deflection, the workpieces and devices used shall be made of non-magnetizable materials.



Key
1 Heatsink or Faraday cup
2 Screen (to prevent possible thermal interaction)
3 Workpiece B with coordinate axis,
fixed to the work table
4 Workpiece C
5 Work table

Figure 1 - Test arrangement for measuring the stability of spot position

4.2 Workpiece preparation

The surface of workpiece B intended to be measured shall have a roughness value, *Ra*, equal to 1,6 μm as specified in ISO 1302.

5 Measurement procedure

5.1 Welding machine with optical viewing system

5.1.1 General

The measurement shall be carried out with the welding machine set as specified in 6.5 of EN ISO 14744-1:2000. No modifications, particularly no adjustments, shall be made to the welding machine between the steps described in the following subclauses.

5.1.2 Welding machine with a CNC work table

Measurements shall be carried out in the following way:

1) before starting the measurements, the settings necessary to obtain a small melt spot shall be determined for the selected focal distance on workpiece C, see figure 1;

2) then the first spot P_1 shall be melted on workpiece B by programming in the CNC-position:

x_1 = 0,000 mm;
y_1 = 0,000 mm;

3) The next spots P_2 and P_3 shall be melted at the coordinates:

x_2 = 5,000 mm;
y_2 = 0,000 mm; and

x_3 = 0,000 mm;
y_3 = 5,000 mm; see figure 2.

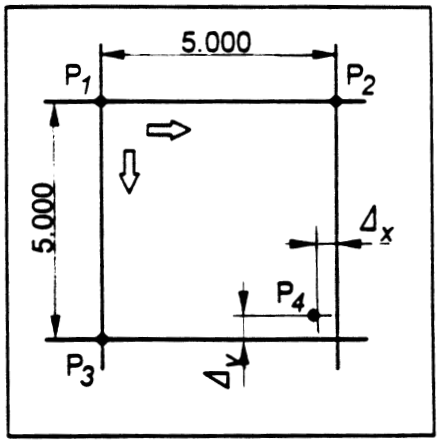


Figure 2 - Spot welds arrangement with CNC work table

To avoid backlash it is important to move the work table only in the same X- or Y-direction to reach the (⇒ ⇓) positions.

4) heatsink A or Faraday cup shall be positioned in the beam axis. The welding machine shall be switched on, interrupted and be set and maintained at the power and operating time specified in EN ISO 14744-1:2000 in 6.5;

5) workpiece B shall be positioned with table coordinates:

x_4 = 5,000 mm;
y_4 = 5,000 mm;

and the fourth spot shall be melted.

6) using the reference spots P_1, P_2 and P_3 workpiece B shall be positioned in the X- and Y-direction of a workshop travelling microscope. The coordinates x_4' and y_4' of the spot center P_4 shall be measured.

The deviation from the correct position x_4, y_4 shall be calculated as follows:

$$\Delta r' = \sqrt{\Delta x^2 + \Delta y^2}$$

where $\triangle x = x_4' - x_4$
$\triangle y = y_4' - y_4$

If a focal distance other than 300 mm has been used for melting the spots, the value $\triangle r'$ thus obtained shall be converted proportionally on $\triangle r$ to A_F = 300 mm.

5.1.3 Welding machine without a CNC work table

5.1.3.1 Workpiece B

Using a marking tool and a set square rule, engrave a system of axes (Y, X_A and X_B) on the surface of workpiece B as shown in figure 3, in such a way that values can be read to an accuracy of ± 0,02 mm under a workshop travelling microscope.

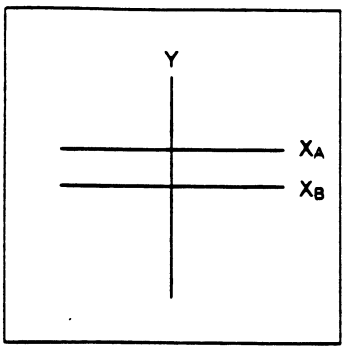


Figure 3 - Coordinate axes on workpiece B

5.1.3.2 Measurements

Measurements shall be carried out in the following way:

1) before starting the measurements, the settings necessary to obtain a small melt spot shall be determined for the selected focal distance on workpiece C, see figure 1. It shall be ensured by a slight adjustment that the melt spot is not at the centre of the coordinate system viewed through the viewing system;

2) then, workpiece B, having the same focal distance as workpiece C, shall be positioned under the optical viewing system so that axes Y and X_A coincide with axes Y' and X' of the viewing system (see figure 4). Following that, spot P_A shall be melted, using the values previously determined (see figure 4);

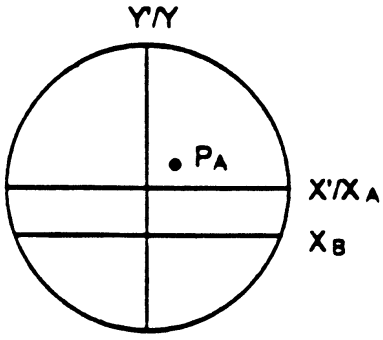


Figure 4 - Axes as seen through optical viewing system

3) heatsink A or the Faraday cup, as appropriate, shall be positioned on the beam axis. The welding machine shall be switched on, interrupted and be set and maintained at the power and operating time specified in EN ISO 14744-1;

4) workpiece B shall be positioned under the optical viewing system so that axes Y and X_B coincide with axes Y' and X' of the viewing system (see figure 5). Following that, spot P_B shall be melted, using the same settings, see figure 5;

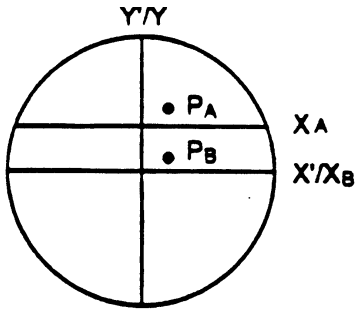


Figure 5 - Melt spots as seen through optical viewing system

5) using a workshop travelling microscope, distances x_1 and y_1 as well as x_2 and y_2 of weld spots P_A and P_B shall be measured, see figure 6. The stability of the spot positions shall be calculated from distances x_1 and x_2 for the X-axis and distances y_1 and y_2 for the Y-axis.

$$\Delta r' = \sqrt{\Delta x^2 + \Delta y^2}$$

where $\Delta x = x_1 - x_2$
$\Delta y = y_1 - y_2$

If a focal distance other than 300 mm has been used for melting the spots, the value $\Delta r'$ thus obtained shall be converted proportionally on Δr to A_F = 300 mm.

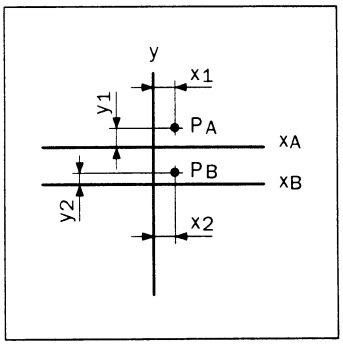


Figure 6 - Melt spots on workpiece B

5.2 Welding machine without optical viewing system

5.2.1 General

Only general information on the measurement procedure can be given, since the procedure depends, to a large extent, on the structure and the mode of operation of the welding machine.

5.2.2 Initial and end positions of focal spot

Instead of melting spots, before and after continuous operation of the machine, concentric circular melt runs shall be made on workpiece B by moving the beam around in a circular path, see figure 7.

Run R_A shall be made prior to, and run R_B after continuous operation, the radius of the latter being changed so that in the event of a displacement of the focal spot, the two runs will not overlap and thus prevent correct measurement. The machine settings for the runs shall be determined separately using a third workpiece, C, whilst the welding parameters for continuous operation are specified in EN ISO 14744-1.

For this purpose, it is assumed that the welding machine is equipped with devices permitting automatic positioning of the workpiece in relation to the beam axis without an optical viewing system being required. The positioning accuracy of these devices shall, where necessary, be tested separately.

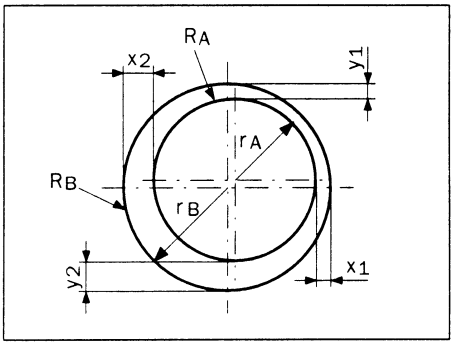


Figure 7 - Workpiece B with circular melt runs

5.2.3 Measuring the stability of spot position

Distances x_1, x_2, y_1 and y_2 on the four coordinate axes shall be measured using a workshop travelling microscope, see figure 7. The stability of the spot position shall then be calculated from:

$\Delta x = \frac{x_1 - x_2}{2}$ for the X- axis

$\Delta y = \frac{y_1 - y_2}{2}$ for the Y- axis

$\Delta r' = \sqrt{\Delta x^2 + \Delta y^2}$

If a focal distance other than 300 mm has been used for the melt runs, the value $\triangle$r' thus obtained shall be converted proportionally on $\triangle$r to A_F = 300 mm.

6 Evaluation

The measured values of stability of the spot position shall be assessed by comparing them with the limit deviations specified in EN ISO 14744-1.

ICS 25.160.30

Price based on 6 pages