BRITISH STANDARD

BS EN ISO
15609-3:2004

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

Part 3: Electron beam welding

The European Standard EN ISO 15609-3:2004 has the status of a British Standard

ICS 25.160.10

BSI
British Standards

National foreword

This British Standard is the official English language version of EN ISO 15609-3:2004. It is identical with ISO 15609-3:2004. It supersedes BS EN ISO 9956-10:1997 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee WEE/36, Approval testing of welding procedures and welders, which has the responsibility to:

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Specification and qualification of welding procedures for metallic materials - Welding procedures specification - Part 3: Electron beam welding (ISO 15609-3:2004)

Descriptif et qualification d'un mode opératoire de soudage pour les matériaux métalliques - Descriptif d'un mode opératoire de soudage - Partie 3: Soudage par faisceau d'électrons (ISO 15609-3:2004)

Anforderung und Qualifizierung von Schweißverfahren für metallische Werkstoffe - Schweißanweisung - Teil 3: Elektronenstrahlschweißen (ISO 15609-3:2004)

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Foreword

This document (EN ISO 15609-3:2004) has been prepared by Technical Committee CEN /TC 121, "Welding", the secretariat of which is held by DIN, in collaboration with 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of an identical text or by endorsement, at the latest by February 2005, and conflicting national standards shall be withdrawn at the latest by February 2005.

This document supersedes EN ISO 9956-10:1996.

Annex A is informative.

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 standard specifies requirements for the content of welding procedure specifications for electron beam welding.

This standard is part of a series of standards, details of this series are given in EN ISO 15607:2003, annex A.

Variables listed in this standard are those influencing the quality and properties of the welded joint.

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 4063, *Welding and allied processes — Nomenclature of processes and reference numbers (ISO 4063:1998).*

EN ISO 6947, *Welds — Working positions — Definitions of angles of slope and rotation (ISO 6947:1993).*

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

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN ISO 15607:2003 and the following apply.

3.1
slope up
controlled increase of the beam power at the beginning of welding

3.2
slope down
controlled decrease of the beam power at the end of welding. The slope down region is the region on the workpiece in which the effects of slope down occur. It can consist of one or two areas, depending on the selected welding mode:

a) in full penetration welding:

   — a region where beam penetration is still complete;

   — a region where penetration is partial or decreasing.

b) in partial penetration welding:

   — a region where penetration decreases continuously.

3.3
working distance
distance between the surface of the workpiece and a standard reference point of the equipment which is traceable to the true focusing lens centre

NOTE This is a practical reference distance only.

3.4
tacking pass
pass made to hold the parts to be welded in proper alignment until the final welds are made

NOTE This may be produced by a continuous or discontinuous pass with partial penetration.

3.5
welding pass
pass ensuring fusion to the required depth

3.6
cosmetic pass
pass for superficial remelting of the weld in order to enhance its appearance

NOTE This pass is made with a defocused or oscillating beam.

3.7
overlap
portion of the welding pass remelted prior to the slope down

3.8
back or front support
plate placed against the workpiece on either the back or front face of the joint in order to retain the molten weld metal

3.9
beam current
value of the electric current in the beam

3.10
beam current pulsing
intentional periodic variation of the beam current

3.11
focusing lens current
current passing through the focusing lens coil

3.12
beam deflection
electromagnetic deflection of the beam from the gun axis

3.13
beam oscillation
an intentional periodic deflection of the beam, achieved by electromagnetic forces

NOTE An oscillation is defined by:

— signal shape e.g. circular, transversal, longitudinal,... ;

— the signal amplitude;

— the frequency;

— the orientation in relation to the welding direction.

4 Technical content of welding procedure specification (WPS)

4.1 General

The welding procedure specification (WPS) shall provide all information required to make a weld.

Welding procedure specifications may cover a certain range of thicknesses of the joined parts and may also cover a range of parent metals and even filler metals. Some manufacturers may additionally prefer to prepare work instructions for each specific job as part of the detailed production planning.

Information listed below is adequate for most welding operations. For some applications it may be necessary to supplement or reduce the list. The relevant information shall be specified in the WPS.

Ranges and tolerances, according to the manufacturer's experience, shall be specified when appropriate.

An example of a typical WPS format is shown in annex A.

4.2 Welding process

The welding process number is 51 in accordance with EN ISO 4063.

4.3 Related to the manufacturer

— Identification of the manufacturer;

— identification of the WPS;

— reference to the welding procedure qualification record (WPQR) or other documents, as required.

4.4 Equipment used

— Electron beam welding equipment, unique identification:

  — electron gun type;

  — cathode type.

— Filler material(s) feeding system (if any): a description (schematic) showing design, position of the filler material(s) feeding system in relation to joint, welding direction and welding point shall be provided.

4.5 Related to the parent materials

4.5.1 Parent material type/grade

— Designation of the material(s) and any backing plates or supports used and any reference standard(s);

— identification of the type of product (e.g. forged, cast, rolled, extruded).

A WPS may cover a group of materials.

4.5.2 Dimensions of materials

— Thickness range of the joint;

— for circular workpieces the range of outside diameters.

4.6 Filler or other additional material(s)

— the designation and reference standard for any filler material(s) or other additional material(s) used in the joint;

— the dimensions of any filler material(s) or other additional material(s) used in the joint;

— any special handling instructions for any filler material(s) or other additional material(s) used in the joint.

4.7 Joint design

A sketch showing the joint design/configuration, dimensions and tolerances, including surface finish, or reference to another standard which provides this information.

4.8 Joint preparation

— Joint preparation method, cleaning, degreasing etc.;

— for magnetic materials any recommendation will be specified on the WPS, if necessary;

— any necessary protection/shielding of the prepared joint.

4.9 Jigs, fixtures and tooling

The methods to be used for workpiece fixturing (including manual tack welding, if used).

4.10 Welding position

Applicable welding positions in accordance with EN ISO 6947.

4.11 Back and/or front support

Type(s) and dimensions (if any).

4.12 Magnetism

If necessary, the components should be demagnetised using a qualified procedure with a reference number.

4.13 Welding technique

The welding technique sketch showing details of all welding passes (tacking pass, welding pass, cosmetic pass).

4.14 Welding parameters

4.14.1 Electrical parameters

— Accelerating voltage in kilovolts (kV);

— beam current in milliamperes (mA) (pulse parameters if pulsing used);

— focusing lens current(s) in amperes (A), current control device setting(s) (arbitrary units) or focus position with respect to workpiece surface;

— beam deflection:

1) direct current (DC) deflection, dimensions at workpiece surface;

2) alternating current (AC) oscillation: shape, and orientation with respect to the welding direction, frequency in hertz (Hz), dimensions (mm of deflection);

— overlap, slope up, slope down [in seconds (s), millimetres (mm) or degrees (deg)];

— slope profile.

4.14.2 Mechanical parameters

— Travel direction;

— surface travel speed (mm/min or mm/s);

— travel speed ramping details (if necessary) ;

— wire/filler feed rate, direction, position and angle.

4.14.3 Other parameters

— Working distance in millimetres (mm) and/or gun to work distance;

— pressure in the gun in pascals (Pa) or millibars (mbar);

— pressure in the chamber in pascals (Pa) or millibars (mbar).

4.15 Pre and post weld heating

If preheating and/or post heating and/or post weld heat treatment are required, the temperature and time at temperature shall be included on the WPS complete with any other instructions related to the heat treatment. If the electron beam is to be used for pre or post heating, the relevant parameters shall be recorded on the WPS.

4.16 Operations after welding

Any mechanical and/or chemical and/or heat treatment.

Annex A
(informative)

Example of a Welding Procedure Specification for electron beam welding (process 51)

WPS identification:

Manufacturer:

WPQR N°:

Equipment identification : — welding machine:
— gun type:
— cathode type:
— filler material(s) feeding system:

Parent material specification : 1:
2:

- material thickness (mm) : 1: — outside diameter (mm):
2:

Filler or other additional material: — designation: — dimensions: — handling:

Joint type: — sheet or plate ☐ — cylindrical ☐ — axial ☐
— radial ☐
— other ☐

Joint design	Welding technique

Jigs, fixtures and tooling: yes ☐ no ☐
☐ Mechanically fixed:
☐ Tack weld; process:

Back support : yes ☐ no ☐ Front support: yes ☐ no ☐

Preparation:			
Demagnetisation procedure reference number:			
Procedure			
	Tacking pass	Welding pass	Cosmetic pass
Welding position			
Welding technique			
Accelerating voltage (kV)			
Beam current (mA) — continuous — pulse: - frequency: - amplitude: - other:			
Focusing lens current(s)(A) or Focus setting			
Beam deflection — DC deflection — AC oscillation — shape — frequency (Hz) — dimensions : -longitudinal - transverse			
Overlap (s, mm or deg)			
Slope up (s, mm or deg)			
Slope down (s, mm or deg)			
Slope profile			
Travel direction			
Surface travel speed (mm/min or mm/s)			
Travel speed ramping [a]			
Wire/filler feed rate [a]			
Working distance (mm)			
Gun pressure (mbar or Pa)			
Chamber pressure (mbar or Pa)			
Additional equipment			
— Preheating[a] — Postheating[a]			
Operations after welding [a]			
Additional information			
[a] If required			

.....
Manufacturer
(name, signature, date)

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