

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

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 It supersedes BS EN ISO 9956-10:1997 which is withdrawn.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:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 27 October 2004

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 10, an inside back cover and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

© BSI 27 October 2004

ISBN 0 580 44250 0

English version

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)

This European Standard was approved by CEN on 16 January 2004.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of 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.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Contents

page

Foreword.....	3
1 Scope	4
2 Normative references	4
3 Terms and definitions	4
4 Technical content of welding procedure specification (WPS).....	6
4.1 General.....	6
4.2 Welding process	6
4.3 Related to the manufacturer	6
4.4 Equipment used	6
4.5 Related to the parent materials	6
4.6 Filler or other additional material(s)	7
4.7 Joint design.....	7
4.8 Joint preparation.....	7
4.9 Jigs, fixtures and tooling	7
4.10 Welding position	7
4.11 Back and/or front support.....	7
4.12 Magnetism	7
4.13 Welding technique	7
4.14 Welding parameters	7
4.15 Pre and post weld heating	8
4.16 Operations after welding.....	8
Annex A (informative) Example of a Welding Procedure Specification for electron beam welding (process 51).....	9

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.

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)

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001. Fax: +44 (0)20 8996 7001. Email: orders@bsi-global.com. Standards are also available from the BSI website at <http://www.bsi-global.com>.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: info@bsi-global.com.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001. Email: membership@bsi-global.com.

Information regarding online access to British Standards via British Standards Online can be found at <http://www.bsi-global.com/bsonline>.

Further information about BSI is available on the BSI website at <http://www.bsi-global.com>.

Copyright

Copyright subsists in all BSI publications. BSI also holds the copyright, in the UK, of the publications of the international standardization bodies. Except as permitted under the Copyright, Designs and Patents Act 1988 no extract may be reproduced, stored in a retrieval system or transmitted in any form or by any means – electronic, photocopying, recording or otherwise – without prior written permission from BSI.

This does not preclude the free use, in the course of implementing the standard, of necessary details such as symbols, and size, type or grade designations. If these details are to be used for any other purpose than implementation then the prior written permission of BSI must be obtained.

Details and advice can be obtained from the Copyright & Licensing Manager. Tel: +44 (0)20 8996 7070. Fax: +44 (0)20 8996 7553. Email: copyright@bsi-global.com.