SLOVENSKI STANDARD
SIST EN 1011-7:2004

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Varjenje ï Priporoļ ila za varjenje kovinskih materialov ï 7. del: Varjenje z elektronskim snopom

Welding - Recommendations for welding of metallic materials - Part 7: Electron beam welding

Schweißen - Empfehlungen zum Schweißen metallischer Werkstoffe - Teil 7: Elektronenstrahlschweißen

Soudage - Recommandations pour le soudage des matériaux métalliques - Partie 7 : Soudage par faisceau d'électrons

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ICS:

25.160.10 Varilni postopki in varjenje Welding processes

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This European Standard was approved by CEN on 30 April 2004.

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COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

This document (EN 1011-7:2004) has been prepared by Technical Committee CEN/TC 121 “Welding”, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by January 2005, and conflicting national standards shall be withdrawn at the latest by January 2005.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

This European Standard is composed of the following parts:

Part 1: General guidance for arc welding

Part 2: Arc welding of ferritic steels

Part 3: Arc welding of stainless steels

Part 4: Arc welding of aluminium and aluminium alloys

Part 5: Welding of clad steel

Part 7: Electron beam welding

Part 8: Welding of cast irons

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.

Introduction

This document contains special recommendations for the electron beam welding of metallic materials and should be observed in connection with the general recommendations for welding according to EN 1011-1. It includes details on quality requirements, production welding facilities as well as the weldability of some materials and informs about welding procedures.

The special properties of electron beam welding derive from the high power and power density possible in the beam spot, the resulting "deep welding effect" and the unique controllability of the process.

Electron beam welding is recommended for welding metallic materials which require low heat input, low shrinkage, low distortion, and for welding dissimilar or reactive metals. It allows high welding speeds and flexibility of design by joining simple components. The electron beam is able to join very thin and very thick sections and the combination of both. It is also suited to automation and quality control.

1 Scope

This document may be used for the electron beam welding (process no. 51 according to EN ISO 4063) of weldable metallic materials according to CR ISO 15608. It does not contain data on permissible stresses on weld seams or on the testing and evaluation of weld seams. Such data can either be seen from the relevant application standards or should be separately agreed between the contracting parties.

A requirement for the application of this document is that the recommendations should be used by appropriately trained and experienced personnel.

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 1011-1, *Welding — Recommendations for welding of metallic materials — Part 1: General guidance for arc welding*

EN ISO 13919-1:1996, *Welding — Electron and laser beam welded joints — Guidance on quality levels for imperfections — Part 1: Steel (ISO 13919-1:1996)*

EN ISO 13919-2:2001, *Welding — Electron and laser beam welded joints — Guidance on quality levels for imperfections — Part 2: Aluminium and its weldable alloys (ISO 13919-2:2001)*

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 14744-2, *Welding — Acceptance inspection of electron beam welding machines — Part 2: Measurement of accelerating voltage characteristics (ISO 14744-2:2000)*

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

EN ISO 14744-4, *Welding — Acceptance inspection of electron beam welding machines — Part 4: Measurement of welding speed (ISO 14744-4:2000)*

EN ISO 14744-5, *Welding — Acceptance inspection of electron beam welding machines — Part 5: Measurement of run-out accuracy (ISO 14744-5:2000)*

EN ISO 14744-6, *Welding — Acceptance inspection of electron beam welding machines — Part 6: Measurement of stability of spot position (ISO 14744-6:2000)*

EN ISO 15614-11:2002, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 11: Electron and laser beam welding (ISO 15614-11:2002)*

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

3 Terms and definitions

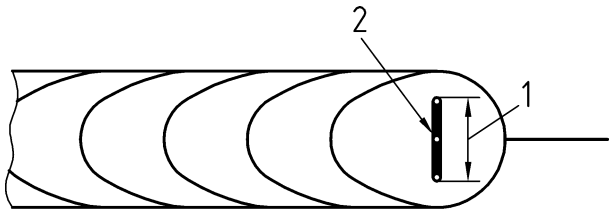
For the purposes of this document, the terms and definitions given in EN ISO 15609-3:2004, EN ISO 13919-1:1996, EN ISO 13919-2:2003, EN ISO 14744-1:2000, and EN ISO 15614-11:2002 and the following apply.

3.1
accelerating voltage
electric potential difference U_A between cathode and anode

3.2
beam current
value of the electric current in the beam I_B

3.3
beam oscillation
periodic deflection of the electron beam from the initial position defined in terms of pattern, dimensions and frequency

NOTE See Figure 1.



Key

1 Oscillation width
2 Initial position of the beam
3 Oscillation length

Figure 1 — Terms of electron beam oscillation

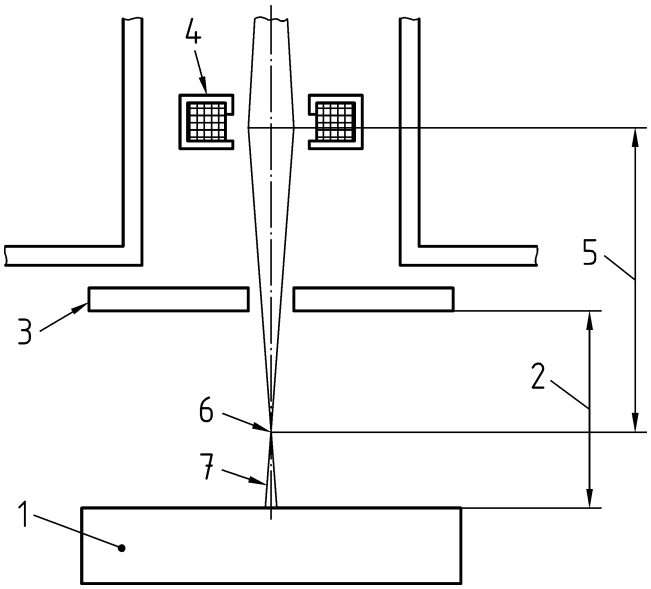
3.4
cosmetic pass
superficial remelting of the weld in order to enhance its appearance

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

3.5
defocusing
deviation from the normal focus position (e. g. focus on work piece surface)

3.6
focusing distance
distance between the focusing lens plane and beam focus position

NOTE See Figure 2.



Key

1 Work piece
2 Working distance
3 Heat protection
4 Focusing lens
5 Focusing distance
6 Beam focus
7 Beam spot

Figure 2 — Definition of working distance and focusing distance

3.7
working distance
distance between the surface of the work piece and a standard reference point on the equipment which is traceable to the true focusing lens plane

NOTE See Figure 2.

3.8
lens current
current I_L which flows through the electromagnetic focusing lens

3.9
slope down
controlled decrease of the beam power at the end of welding. The slope down region is the region on the work piece in which the effects of slope down occur

NOTE See Figure 3. The slope down region can consist of one or two areas, depending on the selected welding mode:

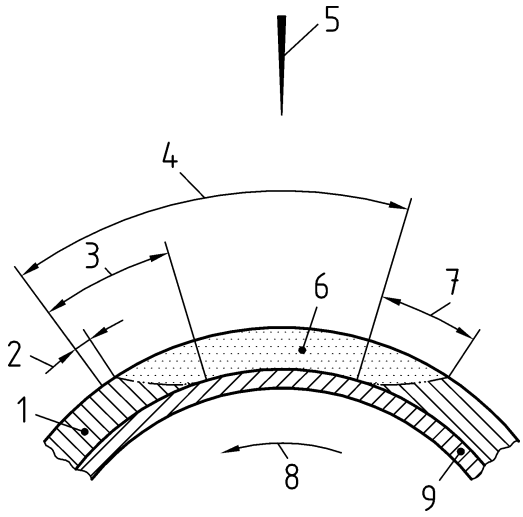
a) in partial penetration welding:

— a region where penetration decreases continuously.

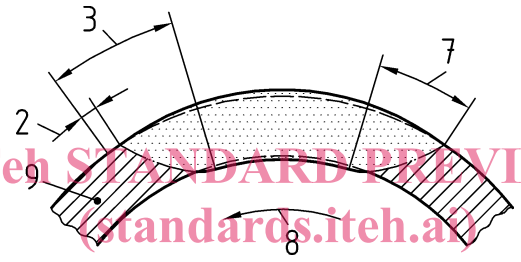
b) in full penetration welding:

— a region where beam penetration is still complete;

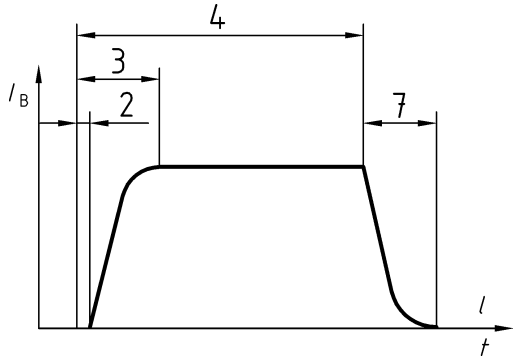
— a region where penetration is partial or decreasing.



a) Partial penetration welding (with overlap)



b) Full penetration welding (without overlap)



c) Typical beam current I_B profile for a circular weld with overlap

Key

1 Work piece (welded zone)
2 Delay between control starting and weld beginning
3 Slope-up region
4 Overlapping region
5 Electron beam
6 Remelted zone
7 Slope-down region
8 Direction of work piece motion
9 Work piece (unwelded zone)
I_B Beam current
l Weld length
t Weld time

Figure 3 — Definition for termination of circular seams

3.10
slope-up
controlled increase of the beam power at the beginning of welding

NOTE See Figure 3.

3.11
spiking
locally variation of fusion zone depths as a consequence of instabilities in the beam penetration mechanism

3.12
evacuation hole
hole for evacuating cavities in work pieces

NOTE See Figure 12.

3.13
working pressure
pressure measured in the welding enclosure in the vicinity of the work piece

3.14
interlayer material
alloy addition introduced by means of pre-placed foil at the joint interface to modify the weld fusion zone composition to improve weldability or weld performance

NOTE See Figure 4.

Joint prepared Joint welded

Key

1 Parent material A
2 Interlayer material
3 Parent material A or B
4 Fusion zone

Figure 4 — Welding with interlayer material

3.15
transition material
buffer material insert employed to allow welding of metallurgically incompatible materials

NOTE See Figure 5.