BRITISH STANDARD

BS EN
1321:1997
Incorporating
Corrigendum No. 1

Destructive tests on welds in metallic materials — Macroscopic and microscopic examination of welds

The European Standard EN 1321:1996 has the status of a British Standard

ICS 25.160.40

BSI
British Standards

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee WEE/2, upon which the following bodies were represented:

Association of Consulting Scientists

British Constructional Steelwork Association Ltd.

British Iron and Steel Producers' Association

Electricity Association

Health and Safety Executive

Institution of Structural Engineers

Lloyd's Register of Shipping

Ministry of Defence

Power Generation Contractors' Association - PGCA (BEAMA Ltd.)

Welding Institute

Welding Manufacturers' Association (BEAMA Ltd.)

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Amendments issued since publication

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14972 Corrigendum No. 1	25 February 2004	Correction to headings in Table 1

The following BSI references relate to the work on this British standard
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Contents

National foreword

This British Standard has been prepared by Technical Committee WEE/2 and is the English language version of EN 1321:1996 *Destructive tests on welds in metallic materials — Macroscopic and microscopic examination of welds*, published by the European Committee for Standardization (CEN).

EN 1321:1996 was produced as a result of international discussions in which the United Kingdom took an active part.

BS EN 1321:1996 supersedes tests detailed in BS 709:1983, BS 4206:1987 and BS 3451:1973 which have been withdrawn by amendment.

Cross-reference

The British Standards which implement these international or European publications 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.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 9 and a back cover.

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1321

October 1996

ICS 25.160.40

Descriptors: Welded joints, destructive tests, microscopic analysis, macroscopic analysis, weld defects, specimen preparation, procedures, designation

English version

Destructive tests on welds in metallic materials — Macroscopic and microscopic examination of welds

Essais destructifs des soudures sur matériaux métalliques — Examen macroscopique et microscopique des assemblages soudés

Zerstörende Prüfung von Schweißverbindungen an metallischen Werkstoffen — Makroskopische und mikroskopische Untersuchungen von Schweißnähten

This European Standard was approved by CEN on 1996-09-27. 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.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 121, Welding, the Secretariat of which is held by DS.

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 April 1997, and conflicting national standards shall be withdrawn at the latest by April 1997.

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

Contents

1 Scope

This European Standard specifies the methods of specimen preparation, test procedures and their main objectives, for the macroscopic and microscopic examination of welds.

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.

EN 288-3*, Specification and approval of welding procedures for metallic materials — Part 3: Welding procedure tests for the arc welding of steels.*

EN 288-4*, Specification and approval of welding procedures for metallic materials — Part 4: Welding procedure tests for the arc welding of aluminium and its alloys.*

EN 26520*, Classification of imperfections in metallic fusion welds, with explanations.* (ISO 6520:1982)

CR 12187*, Welding — Guidelines for a grouping system of materials for welding purposes.*

CR 12361*, Destructive test on welds in metallic materials — Etchants for macroscopic and microscopic examination.*

3 Definitions

For the purposes of this standard, the following definitions apply.

3.1
macroscopic examination
examination of a test specimen by the naked eye, or under low magnification, with or without etching

3.2
microscopic examination
examination by microscope, with a magnification normally within 50 to 500 times, with or without etching

3.3
operator
the person who performs the macroscopic and/or microscopic examination

4 Principle

Macroscopic and microscopic examination is used to reveal the macroscopic and microscopic features of a welded joint, usually by examination of transverse sections.

This is done by visual and/or optical examination of the prepared surface before or after etching.

In the case of microscopic examination, higher magnifications are required compared with the visual examination.

5 Abbreviations

For the purposes of this standard, the following abbreviations apply:

A M<u>a</u>croscopic examination;

I M<u>i</u>croscopic examination;

E <u>E</u>tched;

U <u>U</u>netched.

Abbreviations for parent metals shall be in accordance with the grouping systems in EN 288-3 for steels and EN 288-4 for aluminium and its alloys.

Grouping systems for other materials are given in CR 12187.

The same grouping systems shall also be used for weld metal.

The abbreviations for etchants should be taken from CR 12361 whenever applicable.

NOTE A trade mark can be used if CR 12361 is not applicable.

6 Purpose of the test

The purpose of macroscopic and microscopic examinations shall be to assess features as described in Table 1. The features to be examined shall be given in the application standard.

Table 1 — Guidelines for assessment of features by microscopic and macroscopic examination

Features	Defect in accordance with EN 26520	Macro examination without etching	Macro examination with etching	Micro examination without etching	Micro examination with etching	Notes
1 Hot cracks	100	X	X	X	X	
2 Cold cracks	100	X	X	X	X	Except for A1
3 Lamellar tearing	100	X	X	X	X	
4 Cavities	200	X	X	X	X	
5 Inclusions	300	X	X	X	X	
6 Lack of fusion/penetration	400	X	X	X	X	
7 Geometrical shape	500	X	X			
8 Heat affected zone			X		X	
9 Runs and layers			X		(X)	
10 Grain boundary				(X)	X	
11 Grain structure					X	
12 Solidification structure			X		X	
13 Joint preparation		(X)	X	X	X	
14 Direction of rolling/extrusion			X		X	
15 Direction of fibre structure (grain)			X		X	
16 Segregation			X		X	
17 Precipitation					X	
18 Repair and non-conformity		(X)	X	(X)	X	
19 Mechanical/ thermal effects			X		X	

NOTE X means features revealed; (X) means features may or may not be revealed.

7 Removal of test specimens

Testing usually applies to test specimens oriented perpendicular to the weld axis (transverse section) including the weld deposit and heat affected zones on both sides of the weld.

The test may also apply to other orientations.

The location, orientation and number of test pieces should be as specified in the relevant standards and/or specifications or by special agreement.

8 Test procedure

8.1 General

The following information shall be given:

— parent metals and consumables;
— composition of the etchant;
— surface finish (see **8.3**);
— etching methods (see **8.4**);
— etching time;
— additional measures (see **8.6**);
— any additional requirements;
— the object of the test.

8.2 Test specimen preparation

The test specimen shall be prepared for examination by cutting, mounting, grinding and/or polishing and/or etching as appropriate (see CR 12361). The surface to be examined shall not be adversely influenced by these processes.

8.3 Surface finish

The requirement for surface finish depends on aspects such as:

— the type of examination envisaged (macroscopic or microscopic);

— the type of material;

— the documentation envisaged (such as photographs).

NOTE Details of the grinding and polishing media and methods of grinding and polishing are given in CR 12361.

8.4 Etching methods

The following methods are commonly used:

— etching by immersing the test specimen in the etchant;

— etching by swabbing the surface of the test specimen;

— electrolytic etching.

Other methods may be used by agreement between the contracting parties.

When etching is completed, the test specimen should be washed and dried.

8.5 Etchants

Typical etchants for various parent metals, weld deposits, purposes and types of examination are given in CR 12361.

Depending on the information required, the type and concentration of the etchant as well as the etching temperature and time may be varied according to the material and type of examination.

For similar joints different etchants may be used.

8.6 Safety measures

The following safety measures shall be observed:

— wear eye or face protection, as appropriate;

— handle etchants with suitable gloves or tongs;

— mixtures shall be made in a fume cupboard or under a fume hood;

— always pour acid into water and not vice versa;

— always pour solute into solvent; i.e. the smaller quantity (solute) into the larger quantity (solvent).

9 Examination

The prepared surface may be examined before and/or after etching, as appropriate, or according to the relevant standards and/or specifications.

10 Designation

The examination shall be designated as follows:

— reference to this standard;

— the type of examination (macroscopic or microscopic examination);

— unetched or etched;

— the object of the test (weld metal and/or parent metal);

— welded joints (parent metal left, parent metal right and weld metal);

— etchant (number of the table in CR 12361.

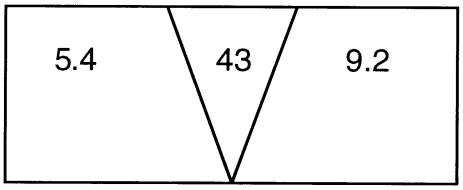
The designation may be given in a full or a shortened version: this is shown in examples 1 and 2.

NOTE The object of the test should be expressed between hyphens.

EXAMPLE 1. Full version

A microscopic examination with the following conditions:

Etched;	
Object of the test:	43;
Parent metal:	left: 5,4;
	right: 9,2;
Consumable:	43;
Etchant:	xy.



EXAMPLE 1a. Object of the test: weld metal only
Examination EN 1321 - I - E - 43 - 5.4 / 9.2 / 43 / xy
where

EN 1321	= reference to this standard;
I	= microscopic examination;
E	= etched;
43	= object of the test;
5,4	= steel with Cr max. 9 %, Mo max. 1,2 %;
9,2	= austenitic stainless steel;
43	= weld metal: Ni/Fe/Cr/Mo with Ni max. 40 %;
xy	= etchant.

NOTE xy stands for table number in the relevant annex of CR 12361.

EXAMPLE 1b. Object of the test: weld metal and parent metal left
Examination EN 1321 - I - E - 43, 5,4 - 5,4 / 9,2 / 43 / xy
where

EN 1321	= reference to this standard;
I	= microscopic examination;
E	= etched;
43, 5,4	= object of the test;
5,4	= steel with Cr max. 9%, Mo max. 1,2 %;
9,2	= austenitic stainless steel;
43	= weld metal: Ni/Fe/Cr/Mo with Ni max. 40 %;
xy	= etchant.

EXAMPLE 1c. Object of the test: weld metal and parent metals left and right
Examination EN 1321 - I - E - 43, 5,4, 9,2 - 5,4 / 9,2 / 43 / xy
where

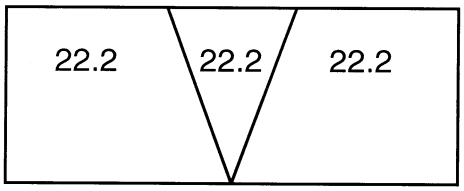
EN 1321	= reference to this standard;
I	= microscopic examination;
E	= etched;
43, 5,4, 9,2	= object of the test;
5,4	= steel with Cr max. 9 %, Mo max. 1,2 %;
9,2	= austenitic stainless steel;
43	= weld metal: Ni/Fe/Cr/Mo with Ni max. 40 %;
xy	= etchant.

EXAMPLE 2. Shortened version

A macroscopic examination with the following conditions:

Etched;	
Object of the test:	22,2;
Parent metal:	left: 22,2;
	right: 22,2;
Weld metal:	22,2;
Etchant:	xy.

NOTE Object of the test (22,2) means weld metal and parent metals left and right.



Examination EN 1321 - A - E - 22,2- 22,2 / xy

where

EN 1321	= reference to this standard;
A	= macroscopic examination;
E	= etched;
22,2	= object of the test;
22,2	= parent and weld metals: aluminium – magnesium alloys with 4 % up to 5,6 % Mg;
xy	= etchant.

11 Test report

The test report shall contain the following:

a) reference to this standard;

b) designation of the examination;

c) location and orientation of the test specimen and the examined surface;

d) Welding Procedure Approval Record (WPAR) or, if this is not available, then at least the type of parent metal and consumables and, when used, the post-weld heat treatment and/or etching shall be recorded;

e) type of etchant and etching method;

f) if necessary, a description of the examined surface;

g) if required, photographs and/or sketches; sizes of magnification.

An example of a typical test report is given in Annex A.

Annex A (informative)
Test report

Test report according to EN 1321.

Letters in brackets refer to Clause **11** of this standard.

WPAR: No. d)

Manufacturer:

Purpose of examination:

Test piece:

Test specimen:

Parent metal:

Consumable:

Post weld heat treatment and or ageing treatment:

Designation	b)		
Macrographic etchant	e)	Micrographic etchant	e)
g) and f)		g) and f)	
Figure: No.: Location Magnification Surface description	 c) g) f)	Figure: No.: Location Magnification Surface description	 c) g) f)
Operator (Name, date, signature)		Authorized person/body (Name, date, signature)	

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